

D6.2. Established conditions for regular curriculum implementation and academic mobility

**ESSENCE: Establishing Smart Energy System Curriculum at
Russian and Vietnamese Universities**

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Key Action 2: Cooperation for innovation and the exchange of good practices.

Capacity building in the field of higher education

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List of Abbreviations

Abbreviation	Definition
CBHE	Capacity building in the field of higher education
EACEA/ Agency	Education, Audiovisual & Culture Executive Agency
EC	European Commission
P1 / RTU	Riga Technical University; PIC 999920718
P2 / Grenoble INP	Institut Polytechnique de Grenoble; PIC 999875225
P3 / TUKE	Technical University of Košice; PIC 999839238
P4 / TPU	Tomsk Polytechnic University; PIC 997438488
P5 / INRTU	Irkutsk National Research Technical University; PIC 941879895
P6 / UrFU	Ural Federal University named after the first President of Russia B.N.Yeltsin; PIC 963580347
P7 / KSPEU	Kazan State Power Engineering University; PIC 916033857
P8 / NEFU	North-Eastern Federal University; PIC 967900436
P9 / HCMUTE	Ho Chi Minh City University of Technology and Education; PIC 923816846
P10 / HUMG	Hanoi University of Mining and Geology; PIC 922118085
WP	Workpackage

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1. Introduction

During the project lifetime, ESSENCE consortium partners have contributed a lot of efforts and resources not only to reach project goals and produce project results, but also to ensure that the results will outlive the project eligibility period and be sustainable.

The project sustainability rests considerably upon the new and modernized ESSENCE educational programs (both non-degree and degree). The latter have become the part of the regular academic offer of partner universities in Russia and Vietnam and enjoy stable and high interest of students and university administration. The partners have furthermore explored and used different sources to ensure the financial independence of the programs.

The courses developed within the framework of the project also contribute to ESSENCE sustainability. Shared via the request form through project web-site, courses enable further dissemination and exploitation of advanced knowledge and approaches as well as support ESSENCE consortium members in finding new partners in the field of smart energy systems.

Human resources involved into the project implementation is another asset to ensure the project sustainability. ESSENCE team members advanced their competences and skills in such fields as curriculum development, QA, project management, teaching techniques and surely use and distribute them during the project lifetime and after.

Attractive project website and developed promo materials also support further dissemination and exploitation of project results.

To support the cooperative ties established/strengthened during the project realization, agreements have been signed between consortium members. The legal framework is used to implement new initiatives.

2. ESSENCE project sustainability

New and modernized programs

Short-term and long-terms programs

The core curriculum as well as selected courses developed within the project have become the basis for a number of programs developed and launched by universities in partner countries. The number and diversity of ESSENCE programs considerably exceeds the planned numbers. On the whole, partners modernized/ launched/ prepared for launching 23 programs as follows (Table 2. 1):

- 7 existing master degree programs have been modernized;
- 2 new master degree programs have been opened;
- 6 master degree programs have been developed using ESSENCE outcomes and outputs and to be launched in September 2022 (marked with * in the table);
- 8 non-degree programs have been developed with ESSENCE contribution and have been implemented during the project lifetime: 3 programs of professional training/retraining, 2 internships, 1 academic exchange program, 2 MOOCs (marked with ** in the table).

Table 2. 1 List of ESSENCE programs

Partner	Program name	Program type Duration, ECTS	Language of instruction	# of students during project life	# of students planned (on yearly basis)
P4/TPU	Power systems operation and control	Master degree program 2 years, 120 ECTS	Russian	40	12
P4/TPU	Information technologies for power systems	Master degree program 2 years, 120 ECTS	Russian	40	12
P4/TPU	Smart energy systems**	Exchange semester 6 months, 30 ECTS	English	11	8
P5/INRTU	Digital power engineering	Master degree program 2 years, 120 ECTS	Russian	46	15
P5/INRTU	Digital power engineering*	Master degree program 2 years, 120 ECTS	English	n/a	From 2022 10
P6/UrFU	Artificial intelligence for power industry applications*	Master degree program 2 years, 120 ECTS	Russian	n/a	From 2022 10
P6/UrFU	Artificial intelligence for power industry applications*	Master degree program 2 years, 120 ECTS	English	n/a	From 2022 12
P6/UrFU	Design and operation of power systems	Master degree program 2 years, 120 ECTS	Russian	14	10
P6/UrFU	Power systems, grids, operation modes, stability, reliability	Master degree program 2 years, 120 ECTS	Russian	21	20
P6/UrFU	Power systems digital control	Master degree program 2 years, 120 ECTS	Russian	14	10
P6/UrFU	Energy for smart cities*	Master degree program 2 years, 120 ECTS	Russian	n/a	From 2022 10
P6/UrFU	Energy for smart cities*	Master degree program 2 years, 120 ECTS	English	n/a	From 2022 12
P6/UrFU	Machine learning application in the power industry**	Professional training program, 3 ECTS	Russian	78	70
P6/UrFU	Machine learning in the power industry**	MOOC 3 ECTS	Russian	50	50

P6/UrFU	Machine learning in the power industry**	MOOC 3 ECTS	English	n/a	50
P6/UrFU	Machine learning in the power industry**	Internship 3 months, 8 ECTS	English	15	10
P6/UrFU	Robotics in the power industry**	Internship 3 months, 8 ECTS	English	10	10
P7/KSPEU	Smart energy systems	Master degree program 2 years, 120 ECTS	Russian	21	15
P7/KSPEU	Power engineering and electrical technology**	Professional retraining program 12 months, 14 ECTS	Russian	115	30
P7/KSPEU	Power engineering and electrical technology**	Professional retraining program 24 months, 27 ECTS	Russian	34	20
P8/NEFU	Smart power engineering*	Master degree program 2 years, 120 ECTS	Russian	n/a	From 2022 8
P9/HCMUTE	Electrical Engineering	Master degree program 18-24 months, 90 ECTS	Vietnamese	26	20
P10/HUMG	Electrical engineering	Master degree program 18-24 months, 90 ECTS	Vietnamese	37	10

During the project lifetime, 572 students took part in programs implementation; after project lifetime, intake of 434 students is planned annually. Along with planned project beneficiaries – students and staff of partner universities, external audience has become the participants of non-degree ESSENCE programs:

- students of Penjaba University (India), Conservatoire National des Arts et Métiers (CNAM, France), National School of Electrical Engineering and Computer Science (ENSEA, France);
- staff from Russian HEIs: Novosibirsk State Technical University, Chuvash State University; Vyatka State University; Orenburg State University; Udmurtia State University; Magnitogorsk State University; Almetiev State Oil University; Surgut State University; Siberian State University of Water Transport; Yugra State University; Mordovia State University; North-Caucuses Federal University; Saint-Petersburg State Economic University; Tambov State Technical University; Irkutsk State University of Railway Engineering; Groznyy State Oil Technical University; Chechen State University; Vologda State University; Samara State Technical University; Mari State University; South-Western State University; Omsk State Technical University; Povolzhie State Technological University; Tyumen Industrial University; Kovrov State Technical Academy; Kabardino-Balkaria State University.
- employers from JSC “Grid company” (headquarters and affiliates).

The following program features gained through ESSENCE project inter alia guarantee the stable interest of students as well as administration of universities in partner countries towards the programs:

- Innovative topics covered by programs (smart grids, artificial intelligence, machine learning, renewable energy sources, digitalization etc) are in line with the national agenda of all consortium members and is the step towards resilient and sustainable energy future via training of next generation electrical power engineers;

- Purchased laboratory equipment supports the laboratory works implementation including tasks allowing to gain new experience to study state of the art technologies, to learn both about hardware and software and its interactions as well as to emulate real cases while in lab; the additional equipment (virtual lab benches) was purchased to maintain the educational process under the Covid-19 restrictions.
- Involvement of industrial partners confirmed via signed agreements that provide additional quality control of programs realization, practical training placement and increased job placement opportunities for program graduates.
- Principles used by the development of a number of programs: alignment with Bologna and EQF requirements, learning outcome approach application, involvement of industry into curriculum development (needs analysis).
- Extended quality assurance procedures applied: peer-review of syllabi and teaching materials, survey of main stakeholders on the quality of project implementation, developed QA procedures for the future.

Financially, the programs are supported as follows:

- A number of programs at RU partners have got “budget” places (i.e. “budget” students do not pay tuition fee and get the state scholarship): Digital power engineering (15 places per year) at P5/INRTU, Power system operation and control (12-15 places per year) at P4/TPU, Smart energy systems (15 places per year) at P7/KSPEU, Artificial intelligence for power industry applications (10 places per year) at P6/UrFU, Energy for smart cities (10 places per year) at P6/UrFU, Design and operation of power systems (5 places per year) at P6/UrFU; Power systems, grids, their operation modes, stability, reliability (10 places per year) at P6/UrFU; Power systems digital control (5 places per year) at P6/UrFU.
- As public universities, P9/HCMUTE and P10/HUMG have annual financial support from state budget for education, in which modernized master degree programs in electrical engineering is a part.
- International students enrolled to RU regular master programs can apply for state scholarships under intergovernmental agreements;
- Industrial partners annually provide 10-15 scholarships for students enrolled to P4 master program Information technologies for power systems;
- Erasmus+ ICM grants for students enrolled to P4 academic exchange program;
- Training on professional retraining programs Power engineering and electrical technology is paid by P7/KSPEU industrial partner JSC “Grid company”;
- The programs are a part of universities’ regular academic offer and thus enjoy the same resource allocation as other programs (payment to academic and non-academic staff, access to University facilities, inclusion to standard university admission campaigns etc).

A number of programs developed on the basis of ESSENCE courses have been commercialized:

- P6/UrFU professional development program Machine learning application in the power industry;

- P7/KSPEU professional retraining programs Power engineering and electrical technology;
- P6/UrFU internships Machine learning in the power industry and Robotics in the power industry;
- P6/UrFU MOOC Machine learning in power industry.

Industrial partners, higher educational institutions, national and foreign students demonstrate strong interest to the programs ensuring their financial sustainability and further development.

Employability of ESSENCE program graduates

Successful employability of ESSENCE master program graduates also confirms the sustainability of programs. Due to program extension, the number of ESSENCE master degree programs has got graduates during the project lifetime.

On the whole, 60 students from RU partner universities graduated from ESSENCE master degree programs in 2021. Based on surveys, 90% of graduates have been employed during 3 months after completing their studies. 93% of employed graduates work for energy sector (Annex 1).

At Vietnamese partner universities, due to COVID-19 pandemic, the graduation of ESSENCE program students has been postponed: at P9/HCMUTE the graduation takes place in February 2022, at P10/HUMG in November 2021. Based on pre-surveys, P10/HUMG will have 8 graduates, all of them having potential employers.

ESSENCE Summer School

ESSENCE Summer School has become one of the most successful activities of the project. Its participating students come not only from consortium universities, but also from other universities in France, Russia, Vietnam and from HEIs India. The Summer School innovative topic (smart energy systems), more than actual format (online), application of diverse teaching techniques (case study, video lectures, online consultations, mentorship), comprehensive dissemination (promo materials, branded handouts, social media coverage, onsite and online presentations), QA (satisfaction survey) – all this make the Summer School unique product with the strong potential to become a regular event. Based on surveys, both partners and industrials involved into the School, express the strong desire to hold and participate in the event once per two years.

Agreements on academic mobility

In order to build a legal framework for further collaborations including double degree programs development, to extend the mobility opportunities for partners' students and staff including also those who are not directly involved into the project and programs as well as to impart the developed programs international dimensions, consortium members signed cooperative agreements:

- Agreement on cooperation between P1/RTU and P4/TPU;
- Agreement on cooperation between P1/RTU and P5/INRTU;
- Agreement on cooperation between P1/RTU and P9/HCMUTE;
- Agreement on cooperation between P1/RTU and P10/HUMG;

- Agreement on cooperation between P2/Grenoble INP and P7/KSPEU;
- Agreement on academic mobility between P3/TUKE and P5/INRTU;
- Agreement on academic mobility between P3/TUKE and P6/UrFU;
- Agreement on cooperation between P4/TPU and P6/UrFU;
- Agreement on academic mobility between P4/TPU and P10/HUMG;
- Agreement on cooperation between P5/INRTU and P6/UrFU;
- Agreement on academic mobility between P5/INRTU and P9/HCMUTE;
- Agreement on academic mobility between P5/INRTU and P10/HUMG;
- Agreement on cooperation between P6/UrFU and P7/KSPEU;
- Agreement on cooperation between P6/UrFU and P8/NEFU;
- Agreement on cooperation between P6/UrFU and P9/HCMUTE
- Agreement on cooperation between P6/UrFU and P10/HUMG;
- Agreement on cooperation between P7/KSPEU and P9/HCMUTE.

Arrangements and agreements between some partners existed prior ESSENCE; during the project realization the activities intensified, got a new impetus and facets; once terminated, the agreements will be prolonged:

- Agreement between P1/RTU and P2/Grenoble INP;
- Agreement between P1/RTU and P3/TUKE;
- Agreement between P1/RTU and P6/UrFU;
- Agreement between P2/Grenoble INP and P4/TPU.

New projects and collaborations

ESSENCE project has become a fruitful ground for ideas, joint projects, collaborations and initiatives.

- In 2018, P1/RTU with ESSENCE partners has submitted two applications for Erasmus+ ICM grant: with VN partner (P10) and RU partners (P4, P5, P6). The applications haven't been supported. It is planned to submit new application in 2022.
- P7/KSPEU and P1/RTU: Algarysh grant of Tatar Republic (Russia) has been awarded to P7 to support teachers' mobility (lecturing) from P1 to P7 (the visit has been postponed due to COVID-19 pandemic).
- P7/KSPEU and P2/Grenoble INP: Algarysh grant of Tatar Republic (Russia) has been awarded to P7 ESSENCE master degree program students to support the realization of the project "Creation of a draft structural diagram of an intelligent active-adaptive electric power network of Tatar Republic" at P2/Grenoble INP during 3 months (the visit has been postponed due to COVID-19 pandemic).
- P6/UrFU, P2/Grenoble INP and faculty members of P4/TPU: application for the joint grant of Russian Research Foundation and French National Research Agency (project Adaptive Multi-agent Models for Operational Management of Power Systems Comprising Multiple Renewable Energy Sources) in 2020; the project wasn't supported, plan to re-submit.
- P6/UrFU and P2/Grenoble INP: application of P6/UrFU candidate for Vernadskiy PhD scholarship to make research at P2/Grenoble INP.
- P6/UrFU organized the professional development program for power engineering specialists with active participation of RU ESSENCE partners.

- P6/UrFU and P7/KSPEU: joint activities under the grant of Russian Ministry of Science and Higher Education “Development of new educational programs” to develop and launch a new master degree program in artificial intelligence (a number of courses developed under ESSENCE contributed to the master program).
- During the project lifetime, ESSENCE partners made joint publications (Annex 2).
- P1/RTU and P5/INRTU are member of another CBHE con
- In 2021-2022, a number of ESSENCE partners will continue cooperation within Erasmus+ program and apply for another CBHE grant.
- ESSENCE partners took part in the USEC-2020 and USSEC-2021 conferences (<http://cigre.ru/en/rnk/youth/use/>) and are members of conference program committee.

3. Conclusion

Many activities implemented during the project realization as well as the majority of project results directly or indirectly contributed to ESSENCE project sustainability:

- Based on developed courses, all universities except P8/NEFU in partner countries have launched new or modernized the existing master degree programs in the field of power engineering to the extent appropriate/needed (P8 is in the process of submitting documents for the master program licensing to Russian Ministry of Science and Higher Education). The demand for these programs among students is ensured inter alia via the following:
 - o approaches used by programs development (EQF and Bologna requirements, learning outcome approach) and implementation (advanced teaching techniques);
 - o strengthened and extended cooperation with industrial partners to support new/modernized programs, ensure graduates' job placement after graduation and thus increase the demand for the programs among the students.
 - o quality control procedures developed and recommended for application to ensure the quality of new/modernized programs realization.
- Along with planned master programs, developed courses have been used to open other educational programs such as MOOCs, internships, professional training/retraining programs, summer school, etc.
- Partners explored and used different sources and approaches to ensure the financial independence of the programs such as scholarships from the state and industry, commercialization.
- The partners have furthermore agreed and signed a number of MOUs and academic exchange agreements to enable academic mobility of students and staff to impart international dimensions to new/modernized programs and thus increase their attractiveness as well as to provide a ground and a legal framework for new projects including DD programs.
- Intangible project results such as raised competences of involved staff in curriculum development, QA, new teaching techniques, project management have been transferred to other staff of universities in partner countries and will be used after the project is over.
- The project web-site essence-erasmus.org will be active at least for 3 years after the project eligibility period is over and will contribute to further project sustainability as follows:
 - o advertising of ESSENCE degree and non-degree programs: the web-site section "SES programs" gives an overview of all programs, provides short description for each program and the direct link to the program's home university;
 - o sharing the developed courses: the section "SES core curriculum" provides access to developed courses via the request form. The latter also serves as a tool to find new partners in the field of SES.
- Motivating promo video is an excellent tool to advertise new programs.
- Due to active networking during the project lifetime, additional initiatives aimed at expanding cooperation between selected partners have been realized, a number of agreements has been reached to establish new cooperative modalities among partners in EU, Russia and Vietnam.

Annex 1 Job placement of ESSENCE master programs graduates

Partner	Program	# of graduates	Employer
P4/TPU	Power System Operation and Control	3	JSC Russian Power System Operator, Central Dispatch Office
	Information technologies for electrical power industry		
P4/TPU	Power System Operation and Control	1	JSC Russian Power System Operator, North-West Dispatch Office
	Information technologies for electrical power industry		
P4/TPU	Power System Operation and Control	1	JSC Russian Power System Operator, South Dispatch Office
	Information technologies for electrical power industry		
P4/TPU	Power System Operation and Control	1	JSC Russian Power System Operator, Middle Volga Dispatch Office
	Information technologies for electrical power industry		
P4/TPU	Power System Operation and Control	7	JSC Russian Power System Operator, Siberia Dispatch Office
	Information technologies for electrical power industry		
	Power System Operation and Control	2	JSC Russian Power System Operator, Ural Dispatch Office
	Information technologies for electrical power industry		
P4/TPU	Power System Operation and Control	1	JSC Russian Power System Operator, Siberia Dispatch Office
P4/TPU	Power System Operation and Control	1	South Energo Engineering, Ltd
P5/INRTU	Digital power engineering	6	Melentiev Energy System Institute of Siberian Branch of Russian Academic of Sciences (SB RAS)
P5/INRTU	Digital power engineering	2	Paritet, LLC (housing and communal services)
P5/INRTU	Digital power engineering	1	Baikalskaya Energy Company, LLC
P5/INRTU	Digital power engineering	1	Ministry of Construction of Irkutsk region
P5/INRTU	Digital power engineering	1	Irkutsk National Research Technical University
P6/UrFU	Design and operation of power systems	1	LLC "UralORGRES"
P6/UrFU	Design and operation of power systems	1	PJSC "Machinery plant named after Kalinin"
P6/UrFU	Design and operation of power systems	1	JSC "Federal testing center"
P6/UrFU	Design and operation of power systems	2	LLC "Energostal"
P6/UrFU	Design and operation of power systems	3	R1 design office
P6/UrFU	Power system grids, their operation modes, stability, reliability	1	SC Sberbank
P6/UrFU	Power system grids, their operation modes, stability, reliability	4	LLC "Prosoft-Systems"
P6/UrFU	Power system grids, their operation modes, stability, reliability	1	Design company "Intertechelectro"
P6/UrFU	Power system grids, their operation	1	Mining company "Cvetmetnaladka"

	modes, stability, reliability		
P6/UrFU	Power system grids, their operation modes, stability, reliability	2	JSC System Operator of the Unified Power System
P6/UrFU	Power system grids, their operation modes, stability, reliability	1	FGC UES Sverdlovsk power grid enterprise
P6/UrFU	Power systems digital control	1	Ekaterinburg Distribution Grid Company
P6/UrFU	Power systems digital control	1	Ural Federal University
P7/KSPEU	Smart energy systems	2	Kazan State Power Engineering University
P7/KSPEU	Smart energy systems	1	Power supply company, LLC
P7/KSPEU	Smart energy systems	1	Energorazvitie LLC
P7/KSPEU	Smart energy systems	1	TataAISenergo LLC

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