Graduate Program for Power Energy Professionals

Waseda University

Challenge

挑戦

Towards the uncharted realms of another dimension

Fostering doctoral human resources that can break new grounds in the era of revolutionary changes in power and energy

“Fostering world-class human resources who can pioneer the future of our society”

Graduate Program for Power Energy Professionals (PEP) was selected by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2018 as one of its WISE Programs (Doctoral Programs for World-leading Innovative & Smart Education), an initiative aiming to cultivate talented doctorate human resources.

As global interest in achieving the SDGs and a carbon-neutral society heightens, the fostering of human resources capable of leading the world in the power/energy sector, which is one of the mainstays of the coming Super-Smart Society, has become an urgent issue. This program offers an unprecedented educational environment, created through the establishment of an inter-university graduate excellence platform that resulted from the collaboration of 13 national, public, and private universities. We also work closely with domestic and international companies, research institutes, and overseas universities to create an environment in which industry and academia can work together in full-scale effort in education and research.

In November of 2021, Waseda University declared the “WASEDA Carbon Net Zero Challenge 2030s”. With this program as the backbone of our carbon-neutral research and doctoral human resource development, we hope to foster world-class human resources in the field of carbon neutrality. We hope to fulfill our mission of fostering world-class human resources and will continue to contribute to society by being an exceptional model of graduate school reform not only for the power/energy field but also for other disciplines.

Program director Koichi SUGA
Senior Executive Vice President Professor, Faculty of Political Science and Economics

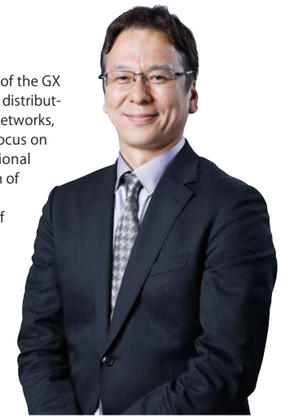
“An all-Japan effort for the creation of new industries”

A new era in the power/energy sector has already begun. With the development of digital technology and the acceleration of the GX and DX movements, energy is changing from the traditional one-way flow of supply-side to demand-side, to a complex system of distributed supplies that includes energy generated from the demand-side. As more things become connected to energy via information networks, the related technical areas will span many fields, from materials to systems. In such an era, scientists and engineers must not only focus on their respective fields of expertise but also comprehensively tackle issues beyond technology, such as institutional reform, international standardization strategies, and business model creation, in order to create new value chains and spawn innovation through the integration of new technology into our society.

This program was established as an education and research platform of unparalleled quality and scope under the collaborative cooperation of industry, government, and academia. We are proud that this program will contribute greatly to the creation of new industries while providing the best educational environment and exchange opportunities for talented minds.

Since the first graduating class of 2020, we have sent off many graduates into the real world. Hearing of their success from all corners of society has perhaps been the most gratifying moment as the program's coordinator. We hope that our graduates will become “PEP”-minded people who will positively transform the world by collaborating across industry boundaries and playing an active role in energy and innovation, which is essential for achieving carbon neutrality.

Program coordinator Yasuhiro HAYASHI Professor, Faculty of Science and Engineering



Create

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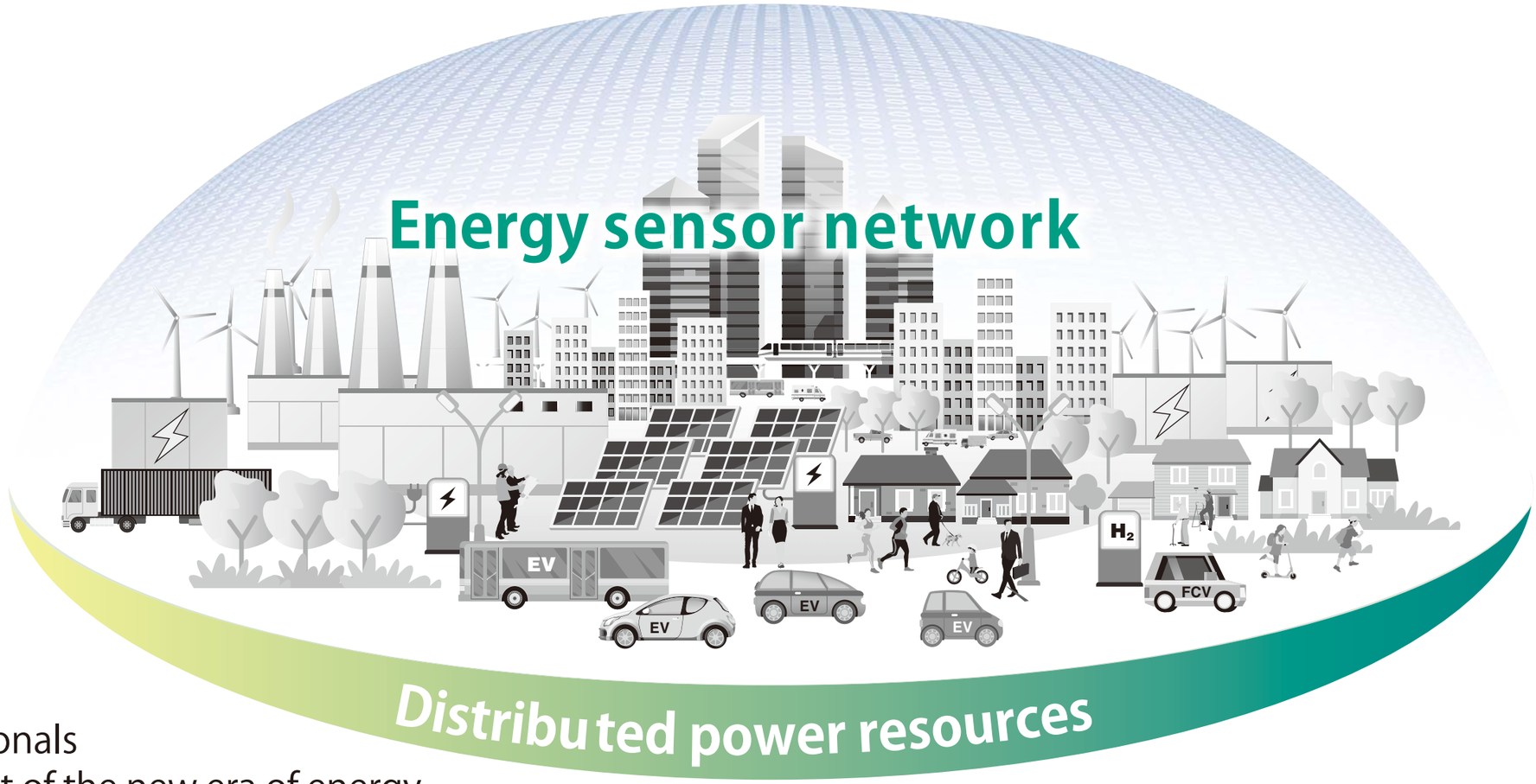


Intellectual professionals for the establishment of the new era of energy

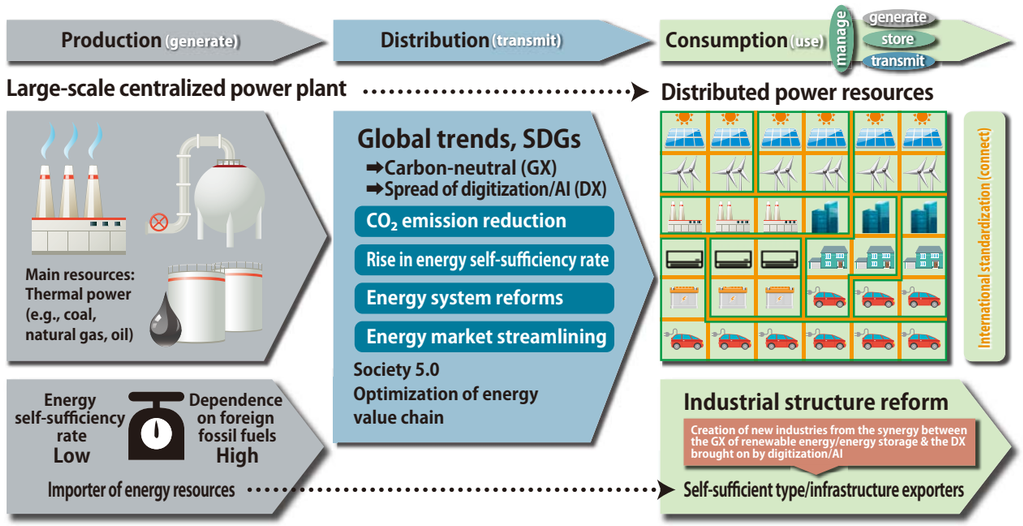
In addition to the worldwide trend towards global environment protection, digitization, and the adoption of Artificial Intelligence for the realization of a sustainable society, Japan is introducing new policies on scientific and technological innovations for the realization of Society 5.0 and is reforming its energy systems for the first time in 6 decades. Consequently, frameworks of industries related to power/energy infrastructure are facing a turning point. Therefore, an alternative kind of professional doctoral human resources with new skills will become highly sought-after going forward.

The total extension of the electrical grid infrastructure is said to be 30 times the Earth's circumference. The size of the industry related to energy infrastructure including oil and gas has become huge; it is expected to expand to other fields such as information and communication, automobile, architecture/construction, and services.

With the spread of renewable energy and systems for managing its use, advances in technological developments such as electric vehicles (EVs) and storage batteries, and the progress in information and communication technology such as IoT, the Green Transformation (GX) and Digital Transformation (DX) movements are picking up pace. To cope with this change, the conventional energy supply has begun to shift from a large-scale centralized to a small-scale distributed system; thus, requiring breakthrough changes and restructuring in the energy network system.

When all sorts of things become connected to the energy network system, the ultimate challenge will be to what extent the entire digitally managed system can be optimized. To find a solution, we will need human resources that have an end-to-end view from the development of materials for the highly efficient generation of energy through to the development of systems including distribution and consumption, and ultimately have the knowledge and coordination ability to socially implement new technologies.

The coming of innovative era in power and energy infrastructure

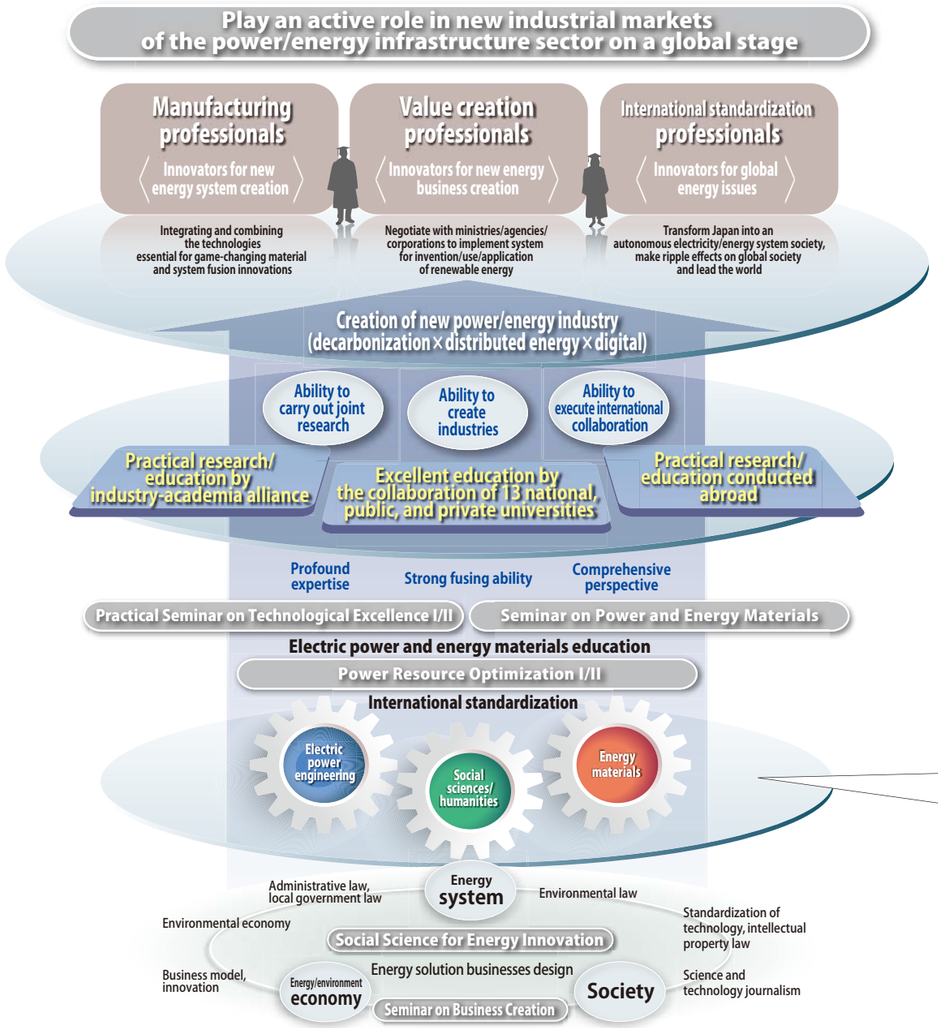


Theory

理 The scheme for fostering human resources that contribute to technological innovation, business creation, and international standardization

Our program offers a systematic education/research program based on a new scientific principle named "Power Resource Optimization". With technological and social innovations as the 2 main objectives, we aim to foster human resources with excellent comprehensive problem-solving skills who can lead the creation of new power/energy industries.

PEP's talent training scheme



A cross-disciplinary graduate education based on Power Resource Optimization

Our program aims to produce 3 types of "intellectual professionals" : 1) manufacturing professionals - innovators for new energy system creation; 2) value creation professionals - innovators for new energy business creation; and 3) international standardization professionals – innovators for global energy issues.

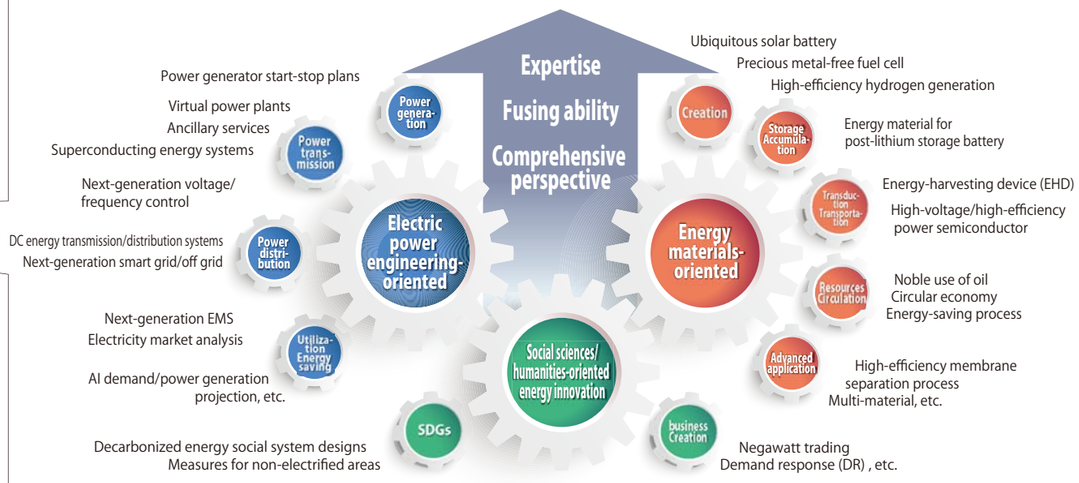
In order to foster such human resources, we established "Power Resource Optimization" as the new scientific principle for the creation of new industries. We view the future energy value chain as a chain of new values from electrical charge, the smallest unit of the phenomenon, through to massive electrical grid systems, to correspond with the new era. By doing so, an end-to-end connection will be made between the energy material field that generates a highly functional distributed power resource with renewable energy and storage batteries that allow charge control on a nano-scale level, and the electric power engineering field that optimally consolidates, controls and operates the energy of such resources through projection and analysis.

Furthermore, we aim to create an optimal energy value chain by including social science fields that bring unconventional added value to fruition as a business from the perspective of "Energy as a Service" , such as the designing of systems in which many players have an active role, including small-scale inter-customer power trading, thereby ultimately contributing to the United Nations' SDGs.

Through a fusional education of electric power engineering, energy materials, and social sciences/humanities, our program will nurture deep expertise, a strong fusing ability, and a comprehensive perspective. With those abilities, our students will further enhance their ability to engage in joint research, the creation of industries, and international cooperation, and set out into the world as professionals of new industry creation.

Scientific principle of "Power Resource Optimization"

Optimal energy value chain
(Chain of new values in materials, system, kW/Δ kW, and environment)



新 Excellent educational program structure

The features of our program that cannot be acquired through traditional doctoral programs:

1. Wide-ranging collaborations with 13 domestic universities, overseas universities, corporations, and research institutions

In order to create new industries, a wide range of industry-government-academia alliances is needed; thus, we established an education/research platform of quality and quantity that has never been achieved. 13 national, public, and private universities that have proven track records in the power/energy field joined forces; we also obtained cooperation from top-rated universities and research institutes in the United States, Europe, and Asia that serve as the core in each region to promote researches in the power/energy field. From the industrial world, we are collaborating with organizations of all energy domains, namely electricity, gas, oil, and hydrogen, and will continue to call for wider cooperation in the future.

2. Cross-disciplinary education for the designing of future society

In order to create new industries with the global market in scope, ample knowledge surrounding the specialized fields and the ability for social design are essential. Our program brings together the wisdom of science and engineering faculty from 13 partner universities and humanities and social sciences faculty from Waseda University to focus on “Power Resource Optimization”, a science and engineering course of electric power and energy material fields, but have also established “Social Science for Energy Innovation (lecture)”, a humanities and social science course that provides a comprehensive perspective of environmental economics, social systems, laws, business models, as well as “Seminar on Business Creation”. Furthermore, to enhance social design skills in humanities and social sciences education, students have the opportunity to come into contact with many business ideas by serving as judges for business idea competitions co-sponsored by power companies and publishing companies. Thus, the program is designed to build up students' abilities through a "3-level education": students acquire basic knowledge in lecture courses, learn theories and methods of business creation in seminar courses, and put their learning into practice as judges in business idea competitions.

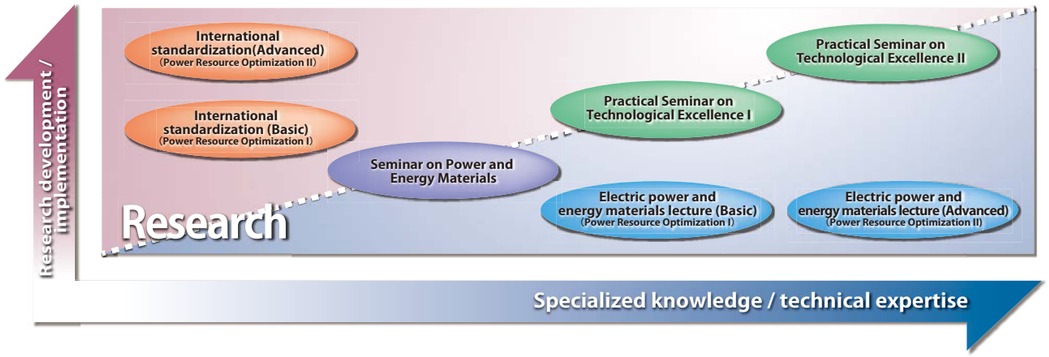
3. Education on international standardization for the global development

In the course of overseas business development, it is essential to bring regulations, benchmarks, and product standards into compliance with international standards; it is extremely important to promote them strategically.Waseda University is well-experienced in the operation of the EMS Shinjuku R&D Center, the sole institute in Japan that has socially implemented demand-response standardization techniques through the industry-government-academia alliance. The Center will be converted into an educational facility for international standardization education based on seminars with real machines.

4. Industry-academia collaboration on education

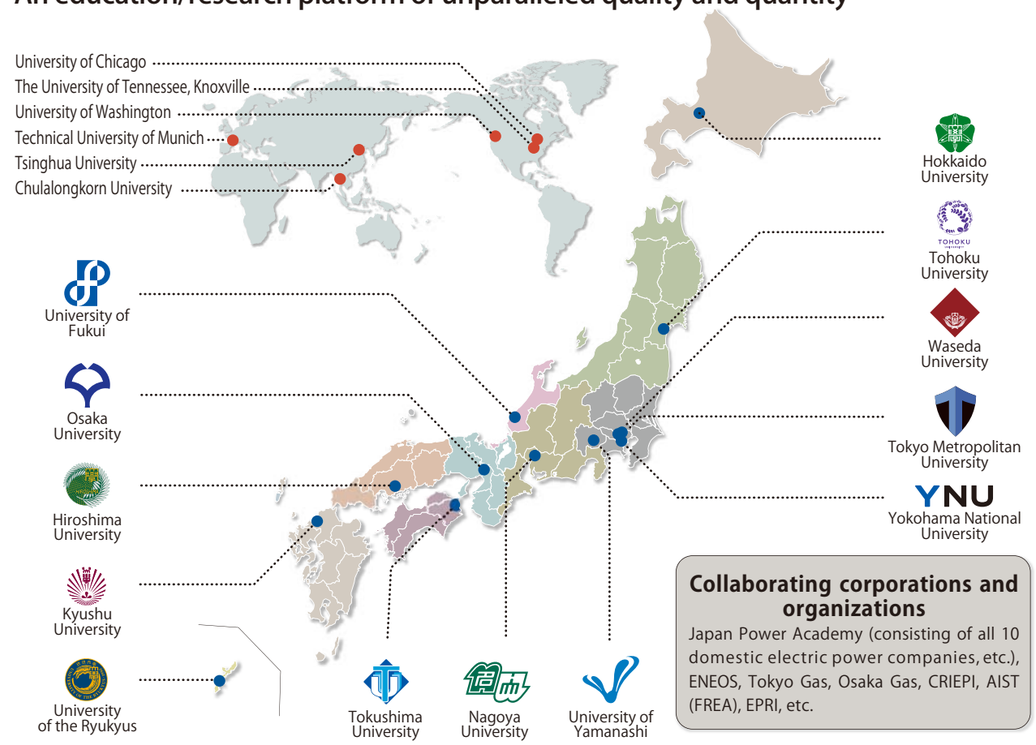
The program offers practical education and conducts joint research in cooperation with core companies and research institutes that represent Japan in the development of infrastructure and cutting-edge technologies related to electric power and energy materials. In the “Practical Seminar on Technological Excellence”, jointly developed through industry-academia collaboration, students learn cutting-edge specialized technology from front-line experts and businessmen through lectures with abundant examples and exercises using actual equipment that are not open to the general public. In the “Seminar on Power and Energy Materials”held by 13 universities on a rotating basis, students learn about the local energy supply chain, demonstration projects, and other energy sites from a variety of perspectives.

Cultivation of expertise and pragmatic resolve as a foundation for the creation of new energy industries



A wide range of collaboration with 13 domestic universities, corporations, research institutes, and universities abroad

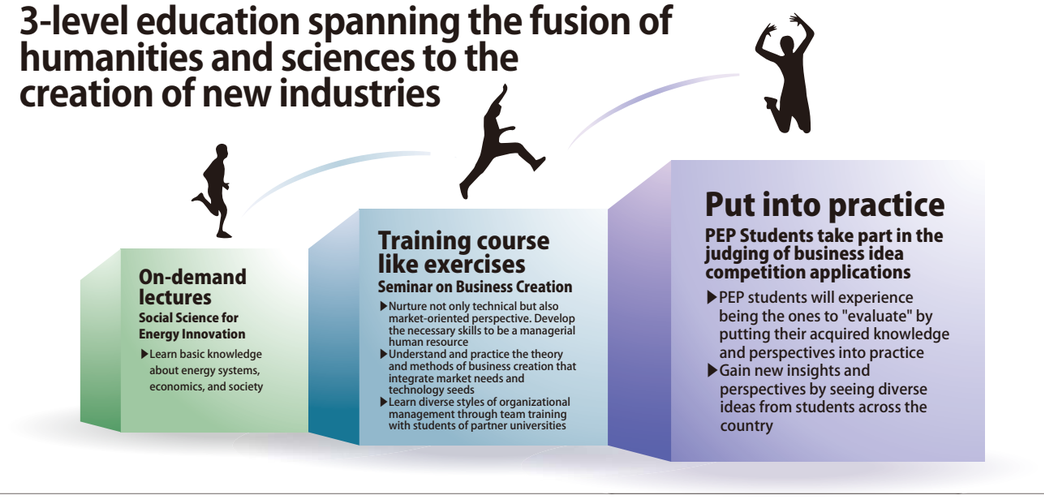
An education/research platform of unparalleled quality and quantity



Collaborating corporations and organizations

Japan Power Academy (consisting of all 10 domestic electric power companies, etc.), ENEOS, Tokyo Gas, Osaka Gas, CRIEPI, AIST (FREA), EPRI, etc.

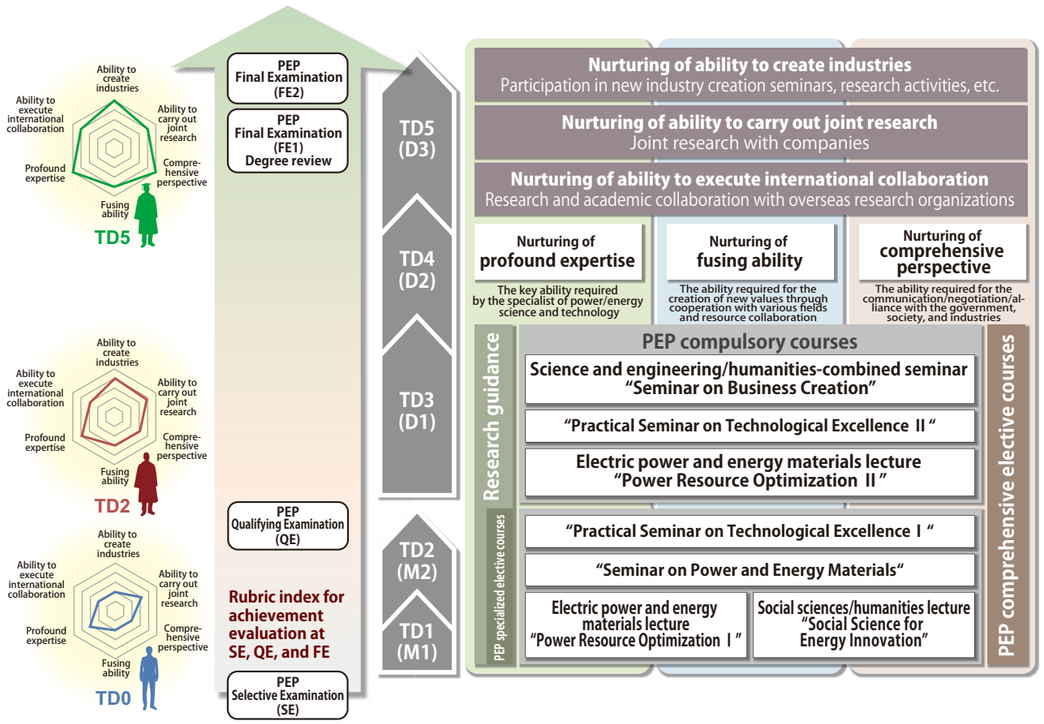
3-level education spanning the fusion of humanities and sciences to the creation of new industries



伸 The program overview and our solid quality guarantee

Our program is a 5-year integrated degree program that students can enroll in and complete while attending one of the 13 partner universities. We offer excellent student support, such as the funding of Research Assistant (RA) expenses and curriculum costs in exchange for their research, on top of the unique student support system of each participating university. We have also created the "PEP rubric" by subdividing the 6 major capabilities to be fostered (deep expertise, strong fusion, broad overview, industry creation, research collaboration, and international collaboration) into 26 capabilities. This rubric will be used as a standardized educational indicator across all 13 universities to measure the 5-year growth of each student.

Overview of the education program



● Curriculum

PEP is a 5-year integrated program that considers the master's and the doctoral program as TD years 1-5.

[PEP compulsory courses (common across 13 partner universities, 10 credits required)]

Consists of 7 courses: "Power Resource Optimization I & II" by science and engineering faculties from the 13 partner universities; "Social Science for Energy Innovation" and "Seminar on Business Creation" by Waseda University's social sciences and humanities faculties; "Seminar on Power and Energy Materials" for real-life cutting edge knowledge in the power/energy field; "Practical Seminar on Technological Excellence I & II" with guidance from experts cooperating with partner companies and research institutions.

[PEP specialized elective courses (15 or more credits required*1)]

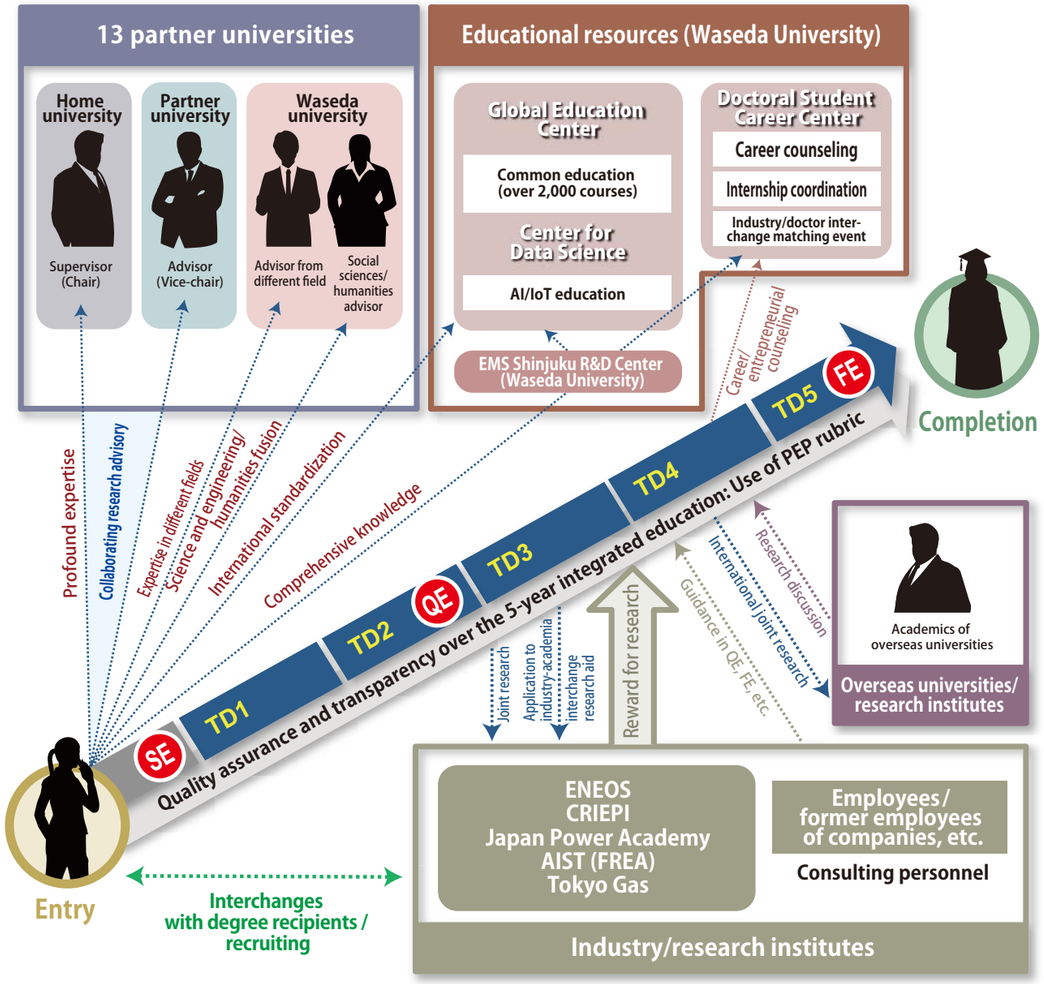
Specialized courses designed by the participating universities under the program's common curriculum policy. Electric power engineering students will take specialized courses on electric power equipment (hardware) and projection/operation/control (software), while energy material students study basic and applied specialized courses on physicality, materials, and processing.

[PEP comprehensive elective courses (5 or more credits required*1)]

At each of the participating universities, we offer a wide selection of courses in accordance with each student's preference, such as lab rotations, fieldwork at training institutions overseas, corporate internship, leadership courses, basic courses on AI and IoT as well as those on social sciences and humanities.

*1: The number of credits is different for TD3 transfer students.

Excellent educational/research guidance and student support



● Review Process

[PEP Selective Examination (SE)]

A qualification review for program entrants. It will assess the entrant's acquisition of fundamental knowledge in specialized fields. Undergraduate students of the 13 partner universities that intend to advance to graduate school, and are expected to graduate in the current academic year, are eligible to take the exam. Furthermore, several openings are available for those transferring from TD years 1-3 (including those who are already in the workforce).

[PEP Qualifying Examination (QE)]

Students who have completed the prescribed courses (30 credits) and submitted at least one academic paper are qualified to take the examination*2. The exam will assess their research achievements, depth of understanding, and post-TD year 3 research project.

*2: The timing and eligibility for taking the QE will differ for some TD2 transfer students and all TD3 transfer students.

[PEP Final Examination (FE1)]

A review of the degree. It will assess the student's advanced specialized research ability in the power/energy field, ranging from materials to systems.

[PEP Final Examination (FE2)]

Students who have taken the prescribed courses (45 credits) and have coauthored one or more academic papers with one of the participating institutions, in principle, for international conferences are eligible to take the exam*3. The feasibility and the social significance of the research outcome are evaluated through an oral examination.

[Rubric evaluation of the PEP Graduate Program]

QE and FE2 will be cross-assessed - self-assessed and assessed by the judges - using rubric indicators.

*3: TD3 transfer students have different eligibility requirements for FE2.

Leap

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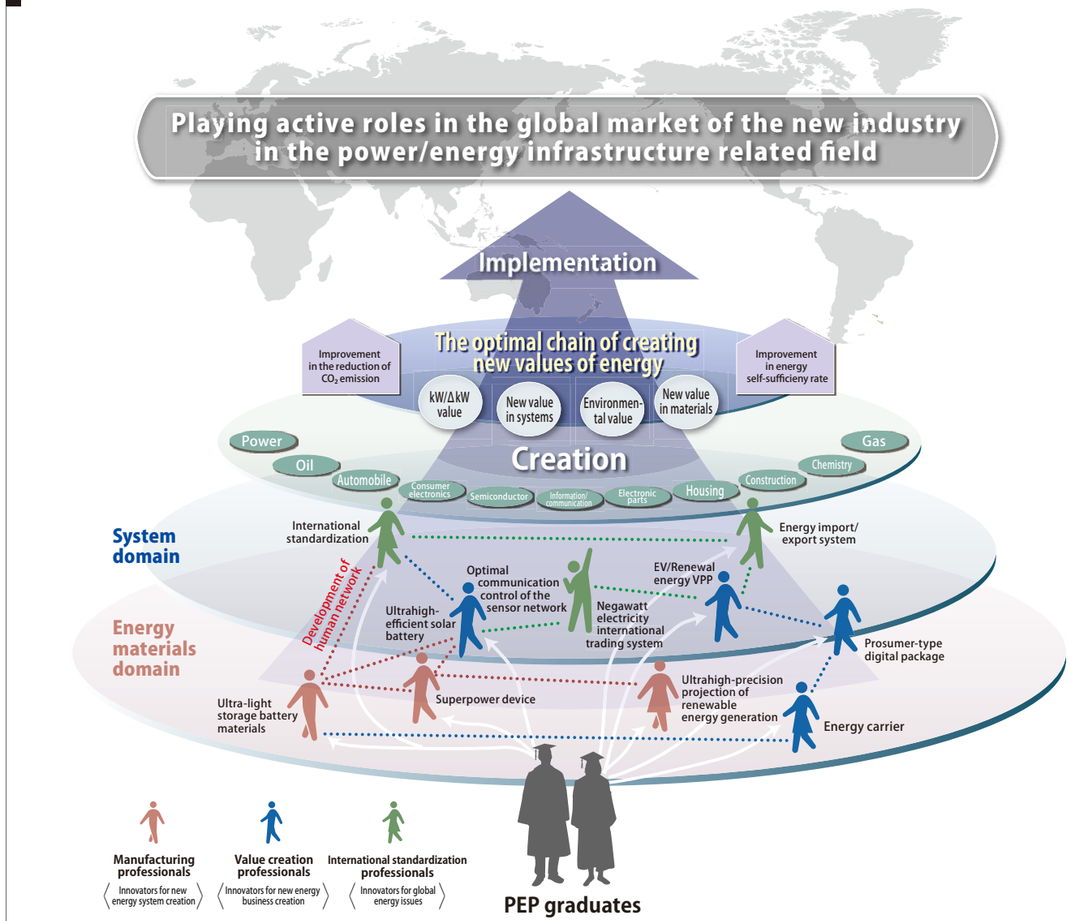
PEP graduates pioneering the future of the power/energy sector

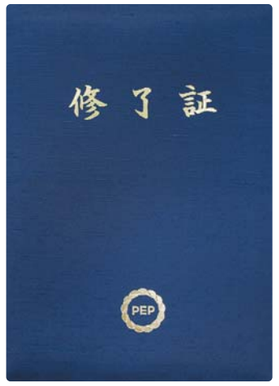
This program advocates an energy future society where a stable supply of power and energy, environmental response, and economic growth are coexisting through the creation of new industries, which we believe can be attained when the new value created by innovative materials, devices, and systems overlap in a complex yet timely manner, and the stream of small innovations spills over into larger innovations. Therefore, one of the main goals of this program is to build a strong human network among partner universities, companies, research institutions, and students while they are still attending university. Graduates of this program will be able to use the extensive human network they have built up to successfully carry out projects in their respective career paths by sharing their ideas and gaining new collaborations with those around them, and ultimately go on to pioneer the future of the power/energy sector.

Creation of new values in energy in the global society by PEP graduates



PEP graduates are active not only in academia, such as universities and research institutes but also in the private sector.
We have a proven track record of graduates finding employment with manufacturers and trading companies as well as power/energy infrastructure companies that we collaborate with.

Certificate of program completion

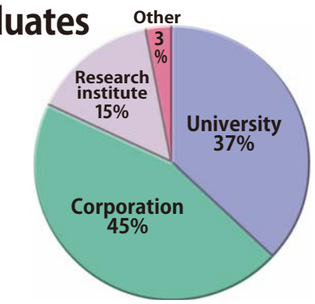


Those who successfully complete the PEP Final Examination will receive a certificate of program completion, stamped with the seals of the presidents and chancellors of the 13 partner universities, on top of the doctoral degree awarded at each university. It is a testament to the advanced knowledge, extensive experience, and skills acquired through the PEP program.

Prominent employment opportunities for graduates

Places of employment (no particular order)

ENEOS Corporation
Central Research Institute of Electric Power Industry
National Institute for Materials Science
TechnoPro R&D Company
Honda R&D Co., Ltd.
Suzuki Motor Corporation
Sumitomo Electric Industries, Ltd.
Tosoh Corporation
Tokyo Electric Power Services Company
Mitsubishi Materials Corporation
Toshiba Energy Systems & Solutions Corporation
Toshiba Electronic Devices & Storage Corporation
Mitsui & Co., Ltd.
AGC Inc.
Indonesian Institute of Science (LIPI), etc.



In today's Japan, doctoral graduates who can play an active role in the industrial sector are highly sought after. Many of our graduates are employed in the private sector.

Attending lectures for PEP compulsory courses (left), facility tours (right)

Exchange meeting of students from 13 universities

Departure - together with friends, time to leap into the future

Through the PEP program, students from 13 universities will study together, connect and form friendships.
We hope this friendship will become your lifelong asset.

Professors

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Faculty members

Education and research advice offered by a group of top-rated researchers from home and abroad

■ Program coordinator

Yasuhiro HAYASHI
Professor
Dept. of Electrical Engineering and Bioscience & Dept. of Advanced Science and Engineering,
Waseda University

[Research Field] Power system engineering

■ Vice program coordinator

Takayuki HOMMA
Professor
Dept. of Applied Chemistry,
Waseda University
Vice President for Academic Affairs

[Research Field] Functional surface chemistry

■ Cooperation promotion manager

Hideo ISHII
Professor
Advanced Collaborative Research Organization for Smart Society,
Waseda University

[Research Field] Integration of distributed energy resources

■ Program member

Toru ASAHI
Professor
Dept. of Life Science and Medical Bioscience & Dept. of Advanced Science and Engineering,
Waseda University

[Research Field] Bio-solid state science, Chiral science

Yoshiharu AMANO
Professor
Dept. of Applied Mechanics and Aerospace Engineering,
Waseda University
Dean of Research Promotion Division

[Research Field] Energy system engineering

Toshihide ARIMURA
Professor
Dept. of Economics,
Waseda University

[Research Field] Environmental economics

Atsushi ISHIYAMA
Professor
Dept. of Electrical Engineering and Bioscience,
Waseda University

[Research Field] Electrical engineering

Akie IRIYAMA
Professor
Waseda Business School (Graduate School of Business and Finance),
Waseda University

[Research Field] Strategic Management, International Business

Kenichi OYAIZU
Professor
Dept. of Applied Chemistry & Dept. of Advanced Science and Engineering,
Waseda University

[Research Field] Polymer chemistry

Tomoko KAWAKAMI
Professor
Waseda Business School (Graduate School of Business and Finance),
Waseda University

[Research Field] Marketing and innovation

Hiroshi KAWARADA
Professor
Dept. of Electronic and Physical Systems,
Waseda University

[Research Field] Electrical and electronics engineering, Electronic devices

Jin KUSAKA
Professor
Dept. of Environment and Energy Engineering,
Waseda University

[Research Field] Mechanical engineering

Satoshi KUROKAWA
Professor
Graduate School of Social Sciences,
Waseda University

[Research Field] Environmental law

Keiichiro KONDO
Professor
Dept. of Electrical Engineering and Bioscience,
Waseda University

[Research Field] Power electronics

Yasushi SEKINE
Professor
Dept. of Applied Chemistry & Dept. of Advanced Science and Engineering,
Waseda University

[Research Field] Catalyst chemistry, Resource chemistry

Mikihito TANAKA
Professor
Graduate School of Political Science,
Waseda University

[Research Field] Science and technology studies

Yuka TABE
Professor
Dept. of Pure and Applied Physics & Dept. of Advanced Science and Engineering,
Waseda University

[Research Field] Soft matter physics

Chiharu TOKORO
Professor
Dept. of Earth Sciences, Resources and Environmental Engineering,
Waseda University

[Research Field] Resources and environmental engineering

Yosuke NAKANISHI
Professor
Dept. of Environment and Energy Engineering,
Waseda University

[Research Field] Power system engineering

Suguru NODA
Professor
Dept. of Applied Chemistry,
Waseda University

[Research Field] Chemical engineering, Materials processing

Takeshi HITOMI
Professor
Waseda Law School,
Waseda University

[Research Field] Administrative law, Local government law

Kanetaka MAKI
Associate Professor
Waseda Business School (Graduate School of Business and Finance),
Waseda University

[Research Field] Socio-Economics of Innovation and Entrepreneurship

Masahiko MATSUKATA
Professor
Dept. of Applied Chemistry,
Waseda University

[Research Field] Membrane separation engineering, Catalytic chemistry

Yasushi MATSUNAGA
Professor
Center of Research Strategy ,
Waseda University

[Research Field] Plasma science, Research strategy

Noboru MURATA
Professor
Dept. of Electrical Engineering and Bioscience & Dept. of Advanced Science and Engineering,
Waseda University

[Research Field] Mathematical engineering

Christoph RADEMACHER
Professor
Graduate School of Law,
Waseda University

[Research Field] Intellectual property law

Shinji WAKAO
Professor
Dept. of Electrical Engineering and Bioscience,
Waseda University
Vice President for Research, and Industry-Academia Collaboration

[Research Field] Electromagnetic energy system engineering

Takanobu WATANABE
Professor
Dept. of Nanoscience and Nanoengineering,
Waseda University

[Research Field] Semiconductor interfaces, Semiconductor devices, Computational physics

Hiroyuki KITA
Professor
Div. of Systems Science and Informatic,
Hokkaido University

[Research Field] Power system engineering

Ryoichi HARA
Associate Professor
Faculty of Information Science and Technology,
Hokkaido University

[Research Field] Power system engineering

Hiroumi SAITOH
Professor
Dept. of Electrical Engineering,
Tohoku University

[Research Field] Power system engineering

Makoto TSUDA
Professor
Dept. of Electrical Engineering,
Tohoku University

[Research Field] Electric energy system engineering, Superconductivity engineering

Masakazu ITO
Professor
Dept. of Electrical and Electronics Engineering,
University of Fukui

[Research Field] Solar power generation system,Power system engineering

Hiroshi IRIE
Professor
Clean Energy Research Center,
University of Yamanashi

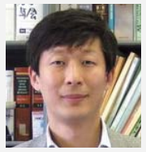
[Research Field] Material chemistry

Kenji MIYATAKE
Professor
Clean Energy Research Center,
University of Yamanashi

[Research Field] Polymer science

Hiroyoshi KAWAKAMI
Professor
Dept. of Applied Chemistry for Environment,
Tokyo Metropolitan University

[Research Field] Polymer chemistry



Shinsuke TAKAGI

Professor
Dept. of Applied Chemistry for Environment,
Tokyo Metropolitan University

[Research Field] Photochemistry

Mahito ATOBE

Professor
Dept. of Chemistry and Life Science,
Yokohama National University

[Research Field] Organic electrochemistry,Electrosynthesis, Electropolymerization

Takao TSUJI

Professor
Dept. of Mathematics, Physics, Electrical Engineering and Computer Science,
Yokohama National University

[Research Field] Power system engineering, Smart grid, Renewable energy

Shigenori MITSUSHIMA

Professor
Dept. of Chemistry and Life Science,
Yokohama National University

[Research Field] Applied electrochemistry, Energy chemistry

Takeyoshi KATO

Professor
Institute of Materials and Systems for Sustainability,
Nagoya University

[Research Field] Energy system engineering

Naoki HAYAKAWA

Professor
Dept. of Electrical Engineering,
Nagoya University

[Research Field] Power engineering

Yasunobu YOKOMIZU

Professor
Dept. of Electrical Engineering,
Nagoya University

[Research Field] Energy control engineering

Yutaka YOSHIDA

Professor
Dept. of Electrical Engineering,
Nagoya University

[Research Field] Energy materials engineering

Tsuyoshi FUNAKI

Professor
Div. of Electrical, Electronic and Infocommunications Engineering,
Osaka University

[Research Field] Power electronics

Yoshifumi ZOKA

Professor
Graduate School of Advanced Science and Engineering,
Hiroshima University

[Research Field] Power engineering, Power system engineering

Masahide HOJO

Professor
Graduate School of Technology, Industrial and Social Science,
Tokushima University

[Research Field] Application of power electronics for power system

Junya SUEHIRO

Professor
Dept. of Electrical Engineering,
Kyushu University

[Research Field] Applied electrostatics

Tomonobu SENJYU

Professor
Graduate School of Engineering and Science,
University of the Ryukyus

[Research Field] Power system engineering, Power electronics

Atsushi YONA

Associate Professor
Graduate School of Engineering and Science,
University of the Ryukyus

[Research Field] Power energy conversion engineering

Kevin TOMSOVIC

CTI Professor
Dept. of Electrical Engineering and Computer Science,
University of Tennessee Knoxville

[Research Field] Power system engineering

Stuart ROWAN

Barry L. MacLean Professor
Inst. for Molecular Engineering and Dept. of Chemistry,
University of Chicago

[Research Field] Organic polymer chemistry

Daniel SCHWARTZ

Boeing-Sutter Professor
Dept. of Chemical Engineering,
University of Washington

[Research Field] Electrochemical engineering

Guiping ZHU

Professor
Dept. of Electrical Engineering,
Tsinghua University

[Research Field] Energy storage

Naebboon HOONCHAREON

Associate Professor
Dept. of Electrical Engineering,
Chulalongkorn University

[Research Field] Power system engineering

Hans-Arno JACOBSEN

Professor
Dept. of Informatics,
Technical University of Munich

[Research Field] Power system engineering

Gilsoo JANG

Professor
School of Electrical Engineering,
Korea University

[Research Field] Electrical engineering

Hajime YASUDA

Manager
Office, Japan Power Academy

[Research Field] Power engineering

Toshiya OHTAKA

Senior Staff Member
Planning Group,
Central Research Institute of Electric Power Industry

[Research Field] High-current arc phenomena, Power system analysis

Kenji OTANI

Leader
Energy Network Team,
Renewable Energy Research Center,
National Institute of Advanced Industrial Science and Technology

[Research Field] Advanced control technology of PV system

Shuhei SAKIMA

Deputy General Manager
Technology Strategy Office,
Central Technical Research Laboratory,
ENEOS Corporation

[Research Field] Resources and energy engineering, Business administration

Shinobu KAWAGUCHI

Senior Manager
Solution Technology Dept.,
Customer & Business Solution Company,
Tokyo Gas Co., Ltd.

[Research Field] Energy engineering, Strength and fracture of materials

■ Program partners

■ Name	■ Affiliations and positions	■ Research field
Yutaka IINO	Associate Professor, Advanced Collaborative Research Organization for Smart Society, Waseda University	Control engineering
Atsushi SHIMOJIMA	Professor, Dept. of Applied Chemistry, Waseda University	Inorganic synthetic chemistry
Akihiko FUKUNAGA	Professor, Dept. of Applied Chemistry, Waseda University	Functional material devices
Joel T. ASUBAR	Associate Professor, Dept. of Electrical and Electronics Engineering, University of Fukui	Electronic devices
Kenji SHIOJIMA	Professor, Dept. of Electrical and Electronics Engineering, University of Fukui	Semiconductor surface and interface evaluation
Ryuto SHIGENOBU	Senior Assistant Professor, Dept. of Electrical and Electronics Engineering, University of Fukui	Power systems engineering
Junji INUKAI	Professor, Clean Energy Research Center, University of Yamanashi	Fuel cells
Makoto UCHIDA	Professor, Fuel Cell Nanomaterials Center, University of Yamanashi	Electrochemistry
Katsuyoshi KAKINUMA	Professor, Clean Energy Research Center, University of Yamanashi	Functional material, Device
Akiyoshi KUZUME	Associate Professor, Clean Energy Research Center, University of Yamanashi	Physical chemistry, Analytical chemistry
Eiichi KONDOH	Professor, Dept. of Science for Advanced Materials, University of Yamanashi	Microfabrication
Satoshi WADA	Professor, Faculty of Engineering Materials Science (Applied Chemistry), University of Yamanashi	Solid-state chemistry
Hidenori OKUZAKI	Professor, Faculty of Engineering Materials Science (Applied Chemistry) , University of Yamanashi	Applied science
Koichi KAJIHARA	Professor, Dept. of Applied Chemistry for Environment, Tokyo Metropolitan University	Inorganic material chemistry
Kiyoshi SATO	Associate Professor, Dept. of Applied Chemistry for Environment, Tokyo Metropolitan University	Structural organic chemistry
Wataru SETAKA	Professor, Dept. of Applied Chemistry for Environment, Tokyo Metropolitan University	Physical organic chemistry, Functional solid-state chemistry
Takashi YANAGISHITA	Professor, Dept. of Applied Chemistry for Environment, Tokyo Metropolitan University	Material chemistry
Kazuhide UENO	Associate Professor, Dept. of Chemistry and Life Science, Yokohama National University	Electrochemistry, Organic materials science
Yoshiyuki KURODA	Associate Professor, Dept. of Chemistry and Life Science, Yokohama National University	Inorganic synthetic chemistry, Energy materials
Masayoshi WATANABE	Specially Appointed Professor, Institute of Advanced Sciences, Yokohama National University	Organic materials chemistry, Electrochemistry
Muneaki KURIMOTO	Associate Professor, Graduate School of Engineering, Nagoya University	Nanomaterial science, Power system engineering
Yutaka SASAKI	Associate Professor, Graduate School of Advanced Science and Engineering, Hiroshima University	Power engineering, Power system engineering
Naoto YORINO	Specially Appointed Professor, Graduate School of Advanced Science and Engineering, Hiroshima University	Power engineering, Power system engineering
Masataka IWAKUMA	Professor, Faculty of Information Science and Electrical Engineering, Kyushu University	Superconducting engineering
Hiroshi KIKUSATO	Research Scientist, Energy Network Team, Renewable Energy Research Center, National Institute of Advanced Industrial Science and Technology	Power engineering, Power equipment engineering

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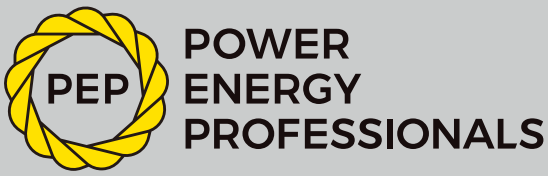

Waseda University
Graduate Program for Power Energy Professionals (PEP)

Administration Office
3-4-1 Okubo, Shinjuku-ku, Tokyo 169-8555 Japan
Phone: + 81 3 5286 3238/ Fax: +81 3 5286 2847
E-mail: pep-info@list.waseda.jp
URL: https://dpt-pep.w.waseda.jp/en/

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