

Scientific Research Activities

Samara State Technical University (SSTU) plays a key role in shaping and implementing the scientific and technical policy and the strategy for the socio-economic development of the Samara region, as well as strategies for the technological development of specific sectors of regional industry. The university ensures a close connection between fundamental science, applied research, and the strategic interests of the real economic sector.

As the systemic coordinator of the region's ecological safety and waste management strategy, SSTU implements projects aimed at eliminating sites of accumulated environmental damage in the Samara region. The total area of remediated sites within the region in 2024 amounted to 46 hectares. During design and survey work at an unauthorized waste disposal site of alcohol stillage within the National Park "Samarskaya Luka," detailed studies were conducted to assess soil degradation, geological environment, and biotopes. The result was the effective neutralization and utilization of 25,000 cubic meters of alcohol production waste within a short period (8 months).

In 2024, activities continued under the federal project "Improvement of the Volga" as part of the national project "Ecology," focusing on the development of industrial biotechnology to solve major environmental problems related to the disposal of technogenic waste and the elimination of accumulated damage. The total area of remediated negative impact sites in the Samara region reached 46 hectares. For instance, projects for reclamation of technogenically degraded territories due to unauthorized disposal of alcohol stillage by composting in temporary structures, without waste removal, were developed and implemented near the rural settlement of Rozhdestveno in the Samara region. The technology developed reduced the duration of reclamation works from 24 to 8 months, resulting in an economic benefit exceeding 400 million rubles.

In 2024, on behalf of the Ministry of Industry and Trade of the Samara Region, design and estimate documentation was prepared for the reclamation of the former OAO "Srednevolzhsky Chemical Plant" (Chapayevsk urban district). Hydraulic structures were designed to protect sludge pond Sh2, containing about 400,000 tons of toxic substances. The implementation of technical solutions resulted in isolating the source of chemical hazard and reducing the technogenic load on the environment, including the prevention of toxic emissions into the Chapayevka River and the Volga River basin.

The total funding for work aimed at eliminating pollution sites, disposing of solid household waste, designing treatment facilities, and neutralizing waste, including that accumulated from hazardous chemical production, performed by SSTU in 2024 exceeded 30 million rubles.

In 2024, SSTU scientists developed a comprehensive methodology for monitoring motor traffic flows (including analysis of composition, intensity, and temporal dynamics), which revealed significant exceedances of the maximum permissible concentrations (1.5–2.9 MPC) of carbon monoxide at key traffic interchanges in Togliatti during a test launch. The spatial-temporal data obtained serve as the basis for developing emission reduction measures, including optimizing road infrastructure (traffic light regulation, interchange modernization) and encouraging fleet renewal towards low-emission vehicles (hybrids, electric cars) and those meeting environmental standards. This methodology has the potential for replication in other urban agglomerations. The work was supported by the Ministry of Science and Higher Education of the Russian Federation (project No. FSSE-2023-0003) as part of the SSTU state assignment.

Under the leadership of Professor S. Stepanov, a team of researchers developed an innovative dynamic mathematical model for automated quality control of treated wastewater, integrating the international ASM-2d methodology with a patented VODGEO/SSTU enzymatic kinetics approach. The uniqueness of the software lies in its adaptability to local parameters of specific treatment facilities (waste composition, technological features) and its capability to analyze data from metering devices in real time to optimize key processes—namely aeration and reagent dosing. Unlike foreign counterparts requiring lengthy training and modeling of all known technologies, this solution allows rapid deployment (2-3 days) and targeted adaptation to the enterprise's technological scheme. The practical significance of this development was confirmed through pilot operation at Samara treatment facilities, achieving reductions in

aeration energy consumption, reagent use for phosphorus removal, and environmental fees. The project received support from the Innovation Assistance Fund grant ("Start-1") and plans to extend the model to regional water supply companies and other utilities.

Staff of the Department of Water Supply and Sewerage at SSTU also developed a concept for modern treatment facilities at water intakes in the Central and Komsomolsky districts of Togliatti, which will bring drinking water quality in these areas up to standards established by SanPiNs (Sanitary Regulations 1.2.3685-21, Construction Rules SP 31.13330.2021). The implementation of this concept will be a significant step in ensuring quality water supply to the population (an agreement has been signed between SSTU and the company "Volzhskiy Kommunalnyye Sistemy").

The scientific team of the Department of Electromechanics and Automotive Electrical Equipment, led by its head, Doctor of Technical Sciences Yuri Makarichev, proposed improvements to wind turbine operations to promote renewable energy sources and strengthen the country's technological sovereignty.

A student design bureau at the Novokuybyshevsk branch of Samara Polytech implemented a project for practical integration of alternative energy into university infrastructure. The installation of a solar power plant, consisting of eleven photovoltaic modules and an inverter complex, will supply electricity to the laboratory building by converting solar radiation into alternating current. The project, supported by the industrial partner Solar Systems Group, serves as a model for integrating educational, research, and industrial competencies to advance sustainable energy and train specialists in alternative energy.

In the reporting year, SSTU joined the Federal Scientific and Educational Consortium "Advanced EcoTechnologies" of the Rosatom State Corporation, aimed at uniting scientific potential and creating a personnel reserve for the hazardous industrial waste management industry of hazard classes I–II. As a leader in energy education, the university initiated the creation of Russia's first Association of Core Universities "T Plus," incorporating representatives from companies and universities in ten Russian regions. The association's activities focus on two areas: training highly qualified personnel via "university-enterprise" schemes and developing scientific and technological solutions for the engineering challenges of "T Plus."

For the first time, SSTU was included in the pilot BRICS university ranking by the Ranking Compilers Association of the Moscow International Ranking "Three Missions of the University." Nationally, the university ranks 103–126 among 161 institutions, and globally it places 401–450 among 600 universities from Russia, China, Brazil, Egypt, India, Iran, the UAE, Saudi Arabia, Ethiopia, and South Africa.

The volume of funding for R&D in environmental management, environmental protection, and sustainable development in 2024 amounted to approximately 150 million rubles, including work done by the Scientific-Analytical Center for Industrial Ecology and the Institute for Design and Surveying.

To utilize and commercialize intellectual property results, SSTU filed applications in 2024 for inventions and software related to environmental protection and sustainable development, including:

- 11 invention applications covering topics such as thermal power plants, continuous hydrogen and graphite production from methane pyrolysis, integrated monitoring systems for hydraulic structures, wastewater drainage and sediment removal systems, combined-cycle power plants, natural gas liquefaction methods, biodegradable polyesters, and fire extinguishing methods and devices.

- An application for state registration of computer software for the calculation of multistage processes.

Additionally, intellectual property protection documents received include:

- 16 Russian patents for inventions covering fuel preparation methods, energy-generating devices, compressor station operations, thermal power plant operation methods, experimental installations for continuous hydrogen and graphite production, comprehensive monitoring systems, tank cleaning devices, soil subsidence detection, biodegradable polyester production, and content determination methods for phosphorus in soil.

- A certificate for state registration of software for calculating multistage methane dehydrogenation processes.

The university is a founder of scientific and popular media, including:

- The SSTU Bulletin, Technical Sciences series, with a focus on energy and electrical engineering;
- The scientific journal "Urban Development and Architecture," covering water supply, sewage, water resource protection building systems, and environmental safety in construction and urban facilities;
- The popular scientific journal "Technopolis of the Volga Region," featuring exclusive publications on nationally and internationally recognized scientific schools, notable Samara scientists, and innovative technologies in energy, environmental protection, and the food industry;
- The newspaper "Engineer," one of the oldest corporate publications in Samara, published since 1933.

In 2024, a youth experimental-industrial laboratory "Oil and Gas Technologies for Hydrogen and Graphite Production" was established within SSTU's research unit to develop scientific foundations for hydrogen and graphite production technology from natural and associated petroleum gases with minimal environmental impact. Funding from the national project "Science and Universities" amounted to 51 million rubles.

In 2024, the Dissertation Council 24.2.377.05 (fields 1.5.15 "Ecology" and 2.1.4 "Water Supply, Sewerage, Building Systems for Water Resource Protection" in technical sciences) awarded one doctoral and four candidate of sciences degrees. One doctoral defense is planned in 2025.

In 2024, 390 articles on sustainable development were published in leading scientific journals.

SSTU scientists play a key role in shaping sustainable environmental policies and developing effective strategies for environmental protection, actively participating in public councils and working groups within regional and federal ministries and agencies, facilitating integration of scientific knowledge into environmentally sound decision-making processes, including:

- The International Academy of Sciences for Ecology and Life Safety, associated with the UN Department of Information;
- The Scientific Council of the Russian Academy of Architecture and Construction Sciences (RAASN) on "Water Use Engineering Systems";
- The Expert Council of the Higher Attestation Commission (VAK) on energy, electrification, and energy engineering;
- The Public Council on Environmental Safety under the Governor of the Samara Region;
- Public Councils under the Department of Urban Economy and Ecology of the Samara City Administration;
- The Public Council under the Ministry of Forestry, Environmental Protection, and Nature Management of the Samara Region;
- The Committee on Alternative Energy of the World-Class Scientific and Educational Center "Engineering of the Future."

Young scientists at SSTU actively present achievements and developments at prestigious international and national conferences. Competition successes testify to the high quality of research and contribute significantly to the university's scientific and technical potential:

- Under the federal project "University Technology Entrepreneurship Platform," the top 1000 university startups ranking for 2024 included 19 of SSTU's most promising projects, six of which were completed by young scientists of the Polytech. In resource-saving energy, the project by K.V. Parfenov, "Development of a kinetic tile for generating heat and electric energy," was highlighted. This kinetic tile is an innovative energy-generating device capable of producing both electrical and thermal energy from a single mechanical impact, resistant to environmental factors under Russian climatic conditions. The technology's uniqueness lies in converting mechanical deformation energy into electrical and thermal energy using a highly viscous fluid that heats upon compression and transfers heat to Peltier elements, creating a temperature differential that facilitates electricity generation. The tile can also generate electricity from solar

radiation over an extended period using thermal energy. Investment in the kinetic tile offers attractive prospects amid growing interest in sustainable and innovative technologies.

- At the international forum "Russian Energy Week," SSTU's team "Power of Thought," composed of eco-activists, secured third place in the final of the "IT Championship of the Oil and Gas Industry," having developed a software prototype for the automation, robotization, and integration of casing pipe operations into the integrated drilling process management system.

- At the IX All-Russian Youth Scientific Forum "Science of the Future – Science of the Youth," the best work in the section "Earth Sciences, Ecology, and Rational Nature Management" was awarded to Yana Russkikh, a postgraduate student of SSTU's Higher School of Biotechnology. Her research focuses on improving the efficiency of sewage treatment.

- Students of the SSTU EcoClub "Zhizn" participated in a competition for corporate grants from LLC "SamaraNIPIneft." Based on project defenses at the All-Russian Scientific-Practical Conference "Ashirovskie Readings-2024," students won prizes.

- Master's student of the Institute of Oil and Gas Technologies, Gor Shushanyan, won the "Best SSTU Student Researcher" contest held at the end of 2023. The young scientist works as an engineer at the Scientific-Analytical Center for Industrial Ecology, with research focusing on ecological aspects of oil and gas production.

In practical student activities, sampling from the fuel oil lakes of Zubchaninovka was conducted, aiming at comprehensive study of the hydrocarbon fraction resource potential using gas chromatography, calorimetry, and elemental analysis. The obtained data will allow determining valuable component content and assessing the degree of chemical transformation of waste. The project implementation will reduce waste hazard class and facilitate the inclusion of secondary resources into economic circulation.

In 2024, the International Scientific Research Center for Theoretical Materials Science (MNITSM) and the Department of General and Inorganic Chemistry of SSTU organized the first young scientists' school-conference with international participation, ICME "Ionic Conductors: From Modeling to Experiment," hosted at the SSTU Boiling Point Hub. This scientific event on the development of electrochemical energy storage systems brought together researchers of energy storage materials from Russia, Belarus, Germany, Spain, and India. The program included presentations (both in-person and via videoconference), poster sessions, workshops on theoretical methods for predicting ionic conductivity, discussions of modern theoretical and experimental methods for analyzing conductive properties of crystalline materials, and coverage of current issues in electrochemical energy storage system development.

Scientific Research activities within the framework of environmental management system for 2024

Competence Center

- Samara State Technical University is the system coordinator for the strategy for ensuring environmental safety and waste management in the region
- For the first time, the **ICME school-conference for young scientists with international participation, «Ionic Conductors: From Modeling to Experimentation»** was organized at the Boiling Point Center of SamSTU by scientists from the International Research Center for Theoretical Materials Science (IRCTM) and the Department of General and Inorganic Chemistry
- The project **«Development of a kinetic tile for generating heat and electricity»** was included in the **TOP-1000** university startups ranking of the federal project "University Technological Entrepreneurship Platform."

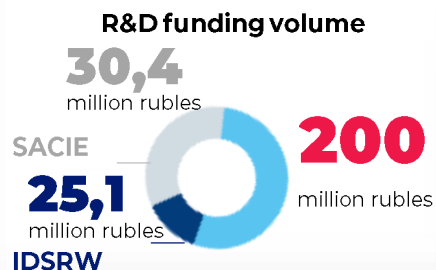
Key Features

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The research department has established a **youth pilot laboratory, «Oil and Gas Technologies for Hydrogen and Graphite Production»**, to develop the scientific foundations for producing hydrogen and graphite from natural and associated petroleum gas while minimizing environmental damage.

SSTU initiated the creation of the first in the country



In 2024, it became part of the Federal Scientific and Educational Consortium **"Advanced EcoTechnologies" of the Rosatom State Corporation**

Industrial partners

