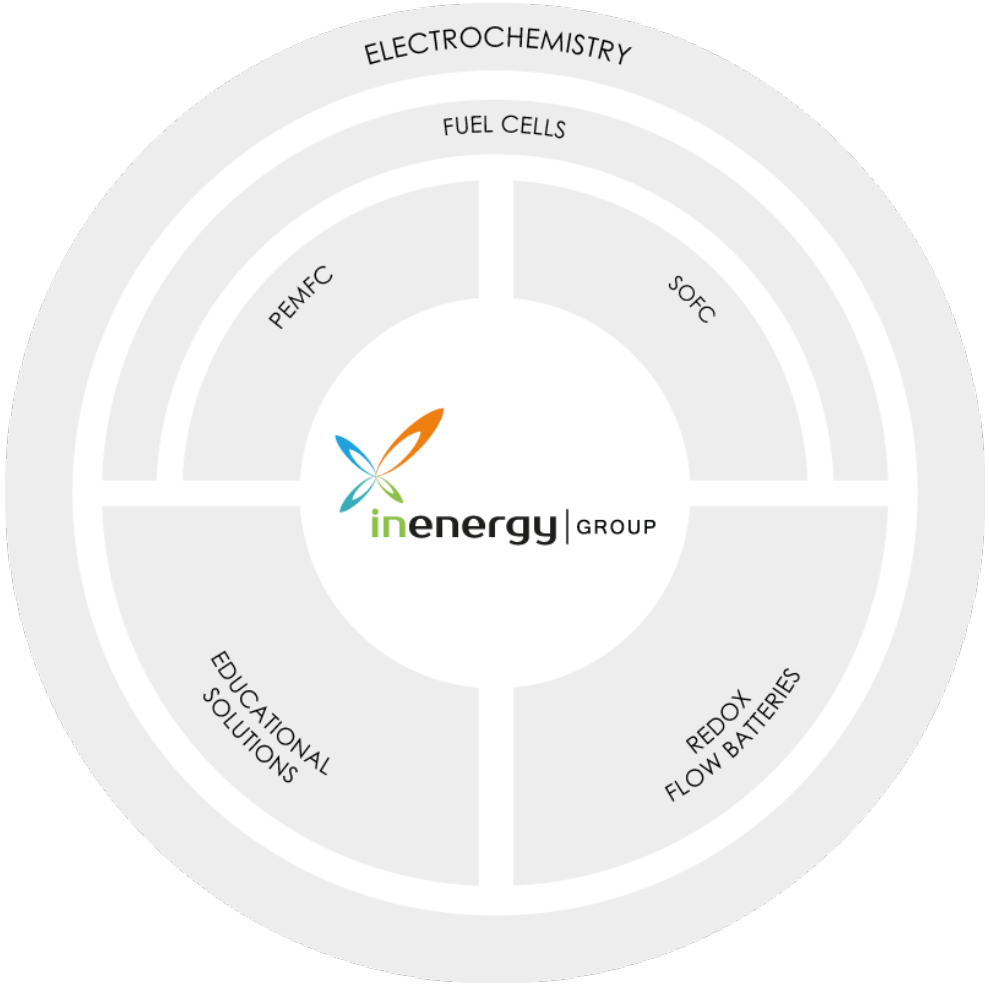
LEADING RUSSIAN DEVELOPER AND MANUFACTURER OF FUEL CELL PRODUCTS AND RELATED SOLUTIONS

INENERGY GROUP

GENERAL PRESENTATION

MOSCOW
2020

INENERGY GROUP



WHAT MAKES OUR COMPANY UNIQUE?

We have 4 companies in our portfolio covering a full value-add chain – from raw material via research and development, design and production to full turn-key-solutions

We have one-a-kind Research and Development Center with 60 experts in electrochemistry field. 15 of them are researchers holding Ph. D. degrees

14 joint laboratories with leading scientific institutes

We have own production facilities, Technology and Research Park, which brings together innovative enterprises in a single location

We have created a unique platform that allows you to develop complex scientific and technological projects in the field of electrochemistry and bring them to the global markets of energy systems, using the capabilities of the best experts in the field of science and project management

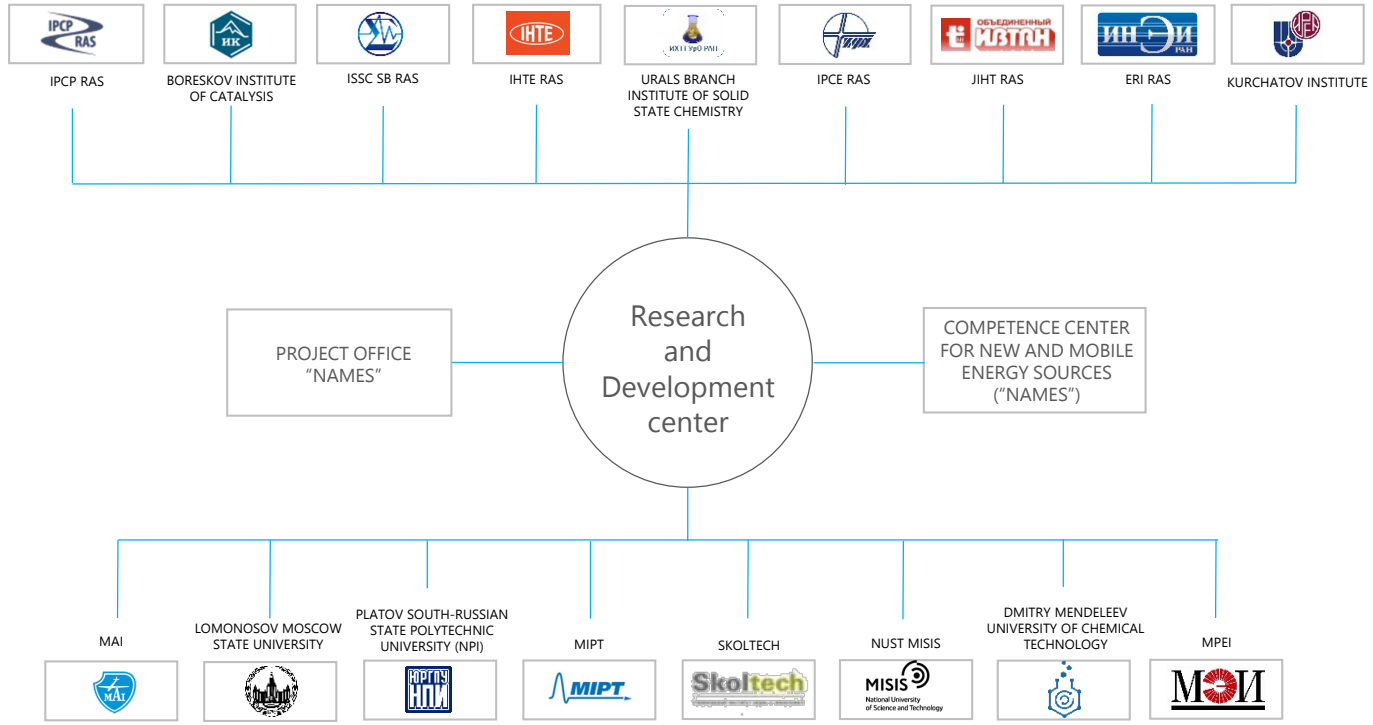
INENERGY GROUP

MAKING A DIFFERENCE WITH ELECTROCHEMICAL TECHNOLOGIES

Distributed R&D center with the leading research institutions of the Russian Federation allow us to solve fundamental and applied problems for the development of principally new products for the global market

JOINT PROJECTS

STRUCTURE OF R&D AND PROJECT LANDSCAPE*



* For more information, please visit the website: www.inenergy.eu

CENTER OF COMPETENCE FOR NEW & MOBILE ENERGY SOURCES ("NAMES")

Leading Russian scientific and educational centers, innovative enterprises and foreign organizations joint consortium for the implementation of the program NAMES

THE TEAM

InEnergy management is a coherent team of professional, combining in a synergetic way experience of strategic management, knowledge of Russian and international markets and expertise in fundamental electrochemical science.

MANAGEMENT

Alexei Kashin
CEO, Chairman of the BoD

Andrey Golodnitskiy
Chief designer

Yiri Dobrovolsky
Chairman of Scientific council

Nurbulat Duysinaliev
Director Oil&Gas

Michael Kozlov
Director for strategic development

Evgeny Sarak
Financial Director

Alexander Sivak
R&D director

Andrei Tomin
Technical director

Yuna Tkachuk
Administrative Director

PRODUCTS LINEUP

InEnergy develops advanced technologies and products in the field of fuel cells and energy storage.

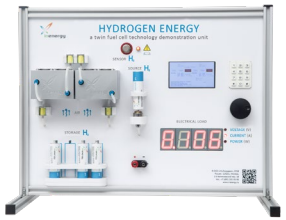
PRODUCTS

ASTRA AND COMPONENTS

Modular autonomous platform for permanent, back-up and emergency power supply running on PEM fuel cells, 100 W – 30 KW

TOPAZ

Modular platform for permanent, back-up and emergency power supply running on microtubular solid oxide fuel cells, 10 W – 1000 W



STEMINARIUM

Educational resource kits and curricula for study of fuel cells and other “new energy” basics

ENERGY STORAGE SYSTEMS AND COMPONENTS

Redox flow batteries, hybrid energy storage systems and V_2O_5 electrolyte.

PARTNERS AND CUSTOMERS

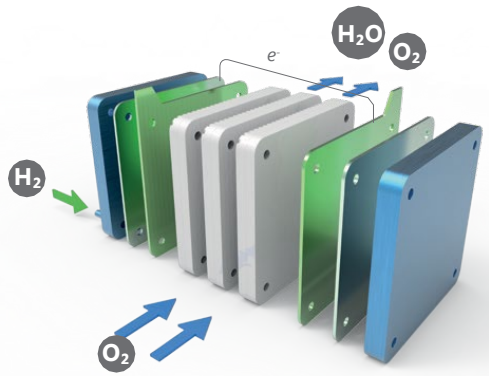
ASTRA

EFFICIENT, HIGH ENERGY DENSITY AND ENVIRONMENTALLY FRIENDLY POWER SOURCES

Environmentally clean and silent hydrogen-fueled power source with capacity in the range of **100 W – 100 kW** for e-mobility and stationary solutions

ADVANTAGES

- High efficiency
- High specific energy density
- The only reaction product is distilled water
- No moving parts (silent work, high reliability, long service life)



Energy conversion efficiency of PEMFC reaches 60%, and pure water is the only waste produced by the technology

APPLICATIONS

Transport:

- unmanned aerial vehicles
- motorbikes and scooters
- trucks and cars
- forklifts
- trains
- ships

Stationary:

- environmentally friendly back-up power sources instead of diesels
- distributed electricity generation (and cogeneration) for households
- off-grid micro- and mini- power supply grids

TOPAZ

TOP PERFORMING COMPACT OFF-GRID ENERGY SOURCES

Electrochemical fuel cell generators are most efficient power sources in the capacity range from few watts to kilowatts.

Topaz is a product line of electrochemical generators, based on solid oxide fuel cell (or SOFC) technology.

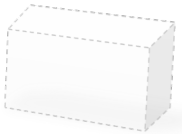
The technology enables high efficiency and is applicable in portable autonomous systems for broad market of small and medium capacity electronics, as well as stationary power sources.

TOPAZ-S

A PORTABLE OFF-GRID GADGET CHARGER

TOPAZ-M

MOBILE POWER UNIT for small robots



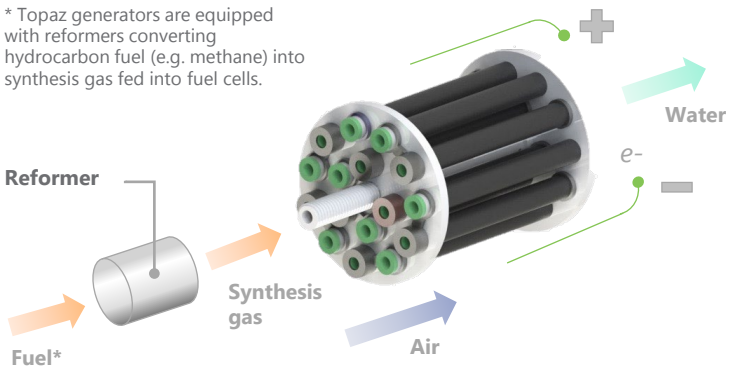
TOPAZ-L

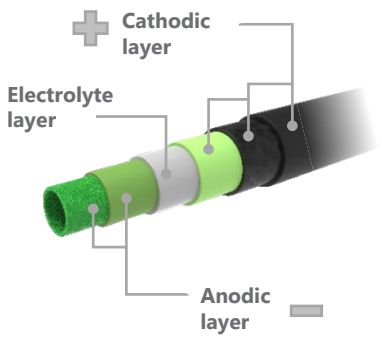
STATIONARY POWER UNIT

Capacity limit	100 W	300 W	1 kW
Main fuel	propane-butane	propane-butane	natural gas
Service life	10 000 hours	10 000 hours	60 000 hours
LCOE (Levelized Cost of Energy)	$7,2 / kW·h	$1,2 / kW·h	$0,2 / kW·h

MICROTUBULAR SOFC

* Topaz generators are equipped with reformers converting hydrocarbon fuel (e.g. methane) into synthesis gas fed into fuel cells.





Fuel cells are **transforming chemical energy** contained in fuel **directly into electricity** without intermediate stages of converting chemical energy into heat and mechanical energy

ADVANTAGES OF TOPAZ PRODUCT LINE

- High specific power density in conjunction with high electric efficiency – ideal combination for power source for field conditions, lighter and smaller than internal combustion engine of comparable capacity
- Easily available fuel (methane, butane, LNG, etc., unlike other types of fuel cells)
- No self-discharge in stand-by regime (unlike accumulators of all types)
- Ability to operate under low temperatures (unlike accumulators of all type)
- Stable operation independent from weather conditions and time of the day (as opposed to wind and solar generation)

STEMINARIUM – EDUCATIONAL SOLUTIONS

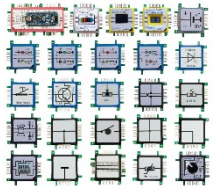
STEMINARIUM is a set of STEM educational programs based on teaching aids (educational panels and resource kits) complete with software and methodological materials. The programs are designed for secondary schools, extracurricular activities and pre-university training. The topics are primarily focusing on electrochemistry and chemical physics forming theoretical basis of new energy but also cover other important areas of science and engineering.

The methodological approach pays special attention to creative activity of students, teamwork and developing "soft skills".

BASIC COURSES

LASER TECHNOLOGY AND OPTICS

ENERGY COURSE



CIRCUITS AND ELECTRONICS COURSE

THE MAIN AIM OF INENERGY EDUCATION TECHNOLOGIES IS TO:

- Promote the basics of power generation and use of electric energy
- Prepare a younger generation to embark on their carriers/professions of XXI century and develop their respective areas of competence

BASIC PRODUCTS

SOLAR ENERGY

VANADIUM REDOX BATTERY

HYBRID CAR MODEL WITH BLUETOOTH CONTROL

HYDROGEN ENERGY FOR ROBOTICS

THERMOELECTRICITY

HYDROGEN ENERGY

VANADIUM REDOX FLOW BATTERY. HYBRID ENERGY STORAGE SYSTEM

Redox flow battery is an electrochemical storage device in which energy is stored in electrolytes

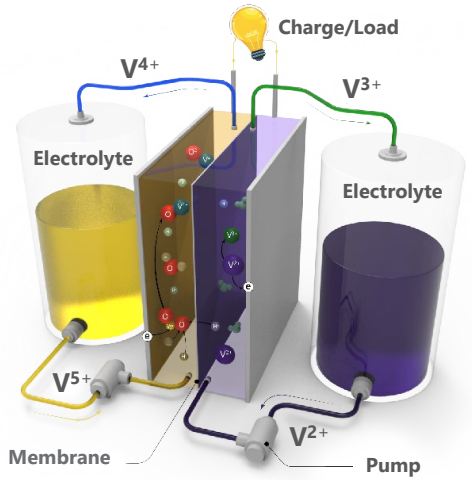
The storage capacity is determined by the volume of the electrolyte, **the power** is determined by the discharge characteristics of the membrane-electrode block

Redox flow batteries are scalable and can be easily adapted to the needs of the consumers.

APPLICATIONS:

- Grid scale peak shaving and load leveling for 35–110 kV. Demand Response utility.
- Distributed renewables integrating with Hybrid ESS
- Back up battery. Emergency storage. Bill management

THE TECHNOLOGY

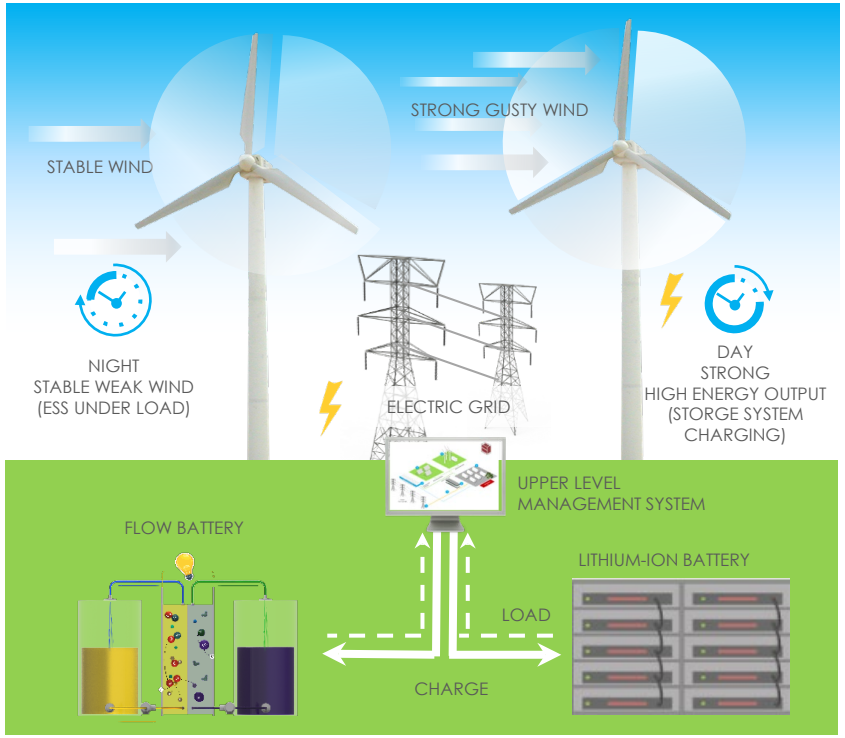


$$V^{5+} + 2H^{+} + e^{-} \leftrightharpoons V^{4+} + H_2O$$
$$V^{2+} \leftrightharpoons V^{3+} + e^{-}$$

ADVANTAGES

- Low LCOS among electrochemical energy storage systems*
- High cyclical resource **20 000** cycles
- Capacity and energy density can be increased independently from each other
- Fire and explosion safe
- **-30 ... +60 °C** Operations in broad range of temperatures
- Efficiency – **75%**
- Service interval **1 year**

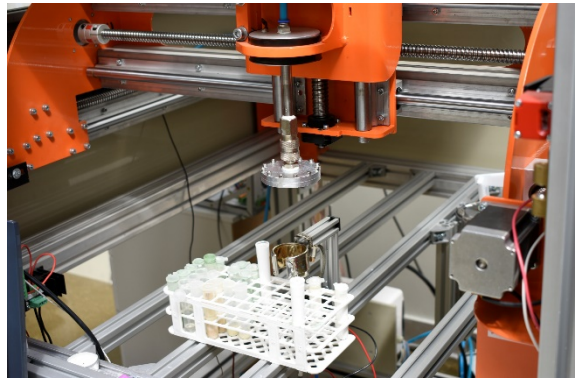
*Lazard's Levelized Cost of Storage Analysis v.4.0

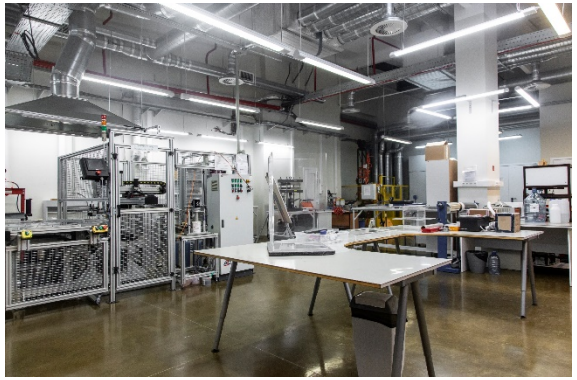


Containerized hybrid energy storage system (ESS) combining **lithium-ion** and **flow batteries**.

- **Adaptability** – Hybrid ESS can be customized by setting number of Li-ion and RFB modules.
- **Affordability** – LCOS of hybrid system lower than in cases of stand-alone RFB or Li-ion systems.

R&D





SERVICES OF THE RESEARCH AND DEVELOPMENT DEPARTMENT

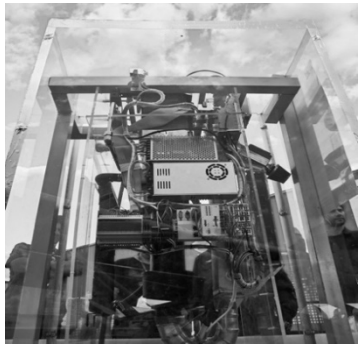
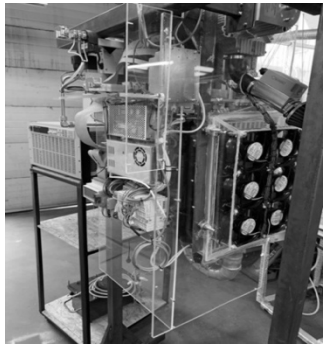
- Manufacturing catalysts on the customer requirement
- Design development and MEA manufacturing
- Stacks development for industrial solutions
- Components design and prototyping
- Development and production of laboratory and testing equipment for research institutions and customers
- Testing and certification of power sources

OUR ADVANTAGES

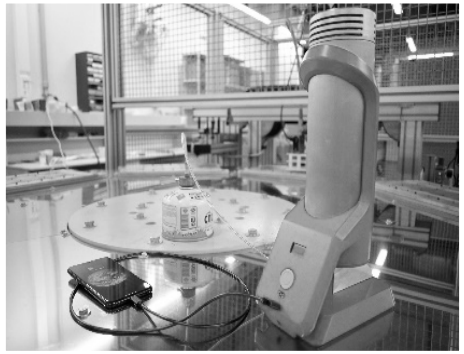
- Development of digital product models, full cycle modeling and testing
- Development of technologies and materials for the whole cycle of added value in fuel cells
- Cooperation with leading world manufacturers and developers of technologies and materials for chemical energy sources
- Proprietary test equipment and SW
- Testing base for single FC and power supply systems of up to 100 KW
- Gas infrastructure supply (hydrogen, methane, propane)

KEY CUSTOMERS

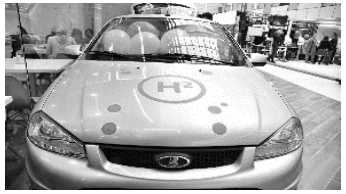
ELECTROCHEMICAL GENERATORS: OUR EXPERIENCE


Electrochemical generation with ASTRA system,
designed specifically for light-engine aircraft

Portable generator TOPAZ-S (10 W) was presented
to the President of Russia in 2019


The first Russian electric car with ASTRA fuel cell range extender.
It increased its range from 200 km to 400 km.



Pilot project with MTS –
Base station power supply ASTRA system 7,5 kW

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LEADING RUSSIAN DEVELOPER AND MANUFACTURER OF FUEL CELL PRODUCTS AND RELATED SOLUTIONS

inenergy topaz hypercopter НОВЫЕ И МОБИЛЬНЫЕ ИСТОЧНИКИ ЭНЕРГИИ

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