

# AZart

Participant of development programs on platforms:

AGENCY FOR  
STRATEGIC  
INITIATIVES

20.35  
UNIVERSITY

NTI PLATFORM

Sk  
Skolkovo



Moscow Confederation of  
Industrialists and  
Entrepreneurs  
(Employers)

## INNOVATIVE MULTI-FUEL (HYDROGEN) INTERNAL COMBUSTION ENGINE

RUS 2021

[www.az69art.ru](http://www.az69art.ru)

**Trend:**

## **LOW CARBON ECONOMY**

Environmental friendliness and efficiency of internal combustion engines (ICE) are the main factors predetermining the prospect of their further use as the main propulsion and generating power plants.

The calculated efficiency of our rotary vane engine (RVE AZART) is about 1.5 times higher than that of the classic piston engine, and the design power density is about 5 times higher.

A more progressive increase in pressure at the compression stroke and a more progressive increase in the volume of the combustion chamber in the working stroke of the AZART RVE create conditions corresponding to the characteristics of the ignition and combustion of hydrogen, which makes the RVE better adapted to use **hydrogen** as a fuel than the classic ICEs.

The possibility of dynamic and significant change in the compression ratio makes it possible to design RVE AZART multi-fuel, with a dynamic transition to hydrogen (or gas, gasoline), which makes such an engine an indispensable missing link in the transition to "**green**" mobility and support for the transition of the country's economy to hydrogen energy.

The compact and powerful RVE will be relevant for use as power drives for manned and unmanned aerial vehicles, as part of hybrid power plants of transport, mobile generating plants and in many other areas of application.

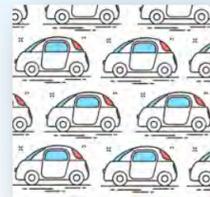
# Problem

Expected changes by 2050:



Population of the planet:

**+ 2 billion**



Car fleet of the planet:

**+ 1 billion**

**Consequently:**



Deterioration of the ecological situation

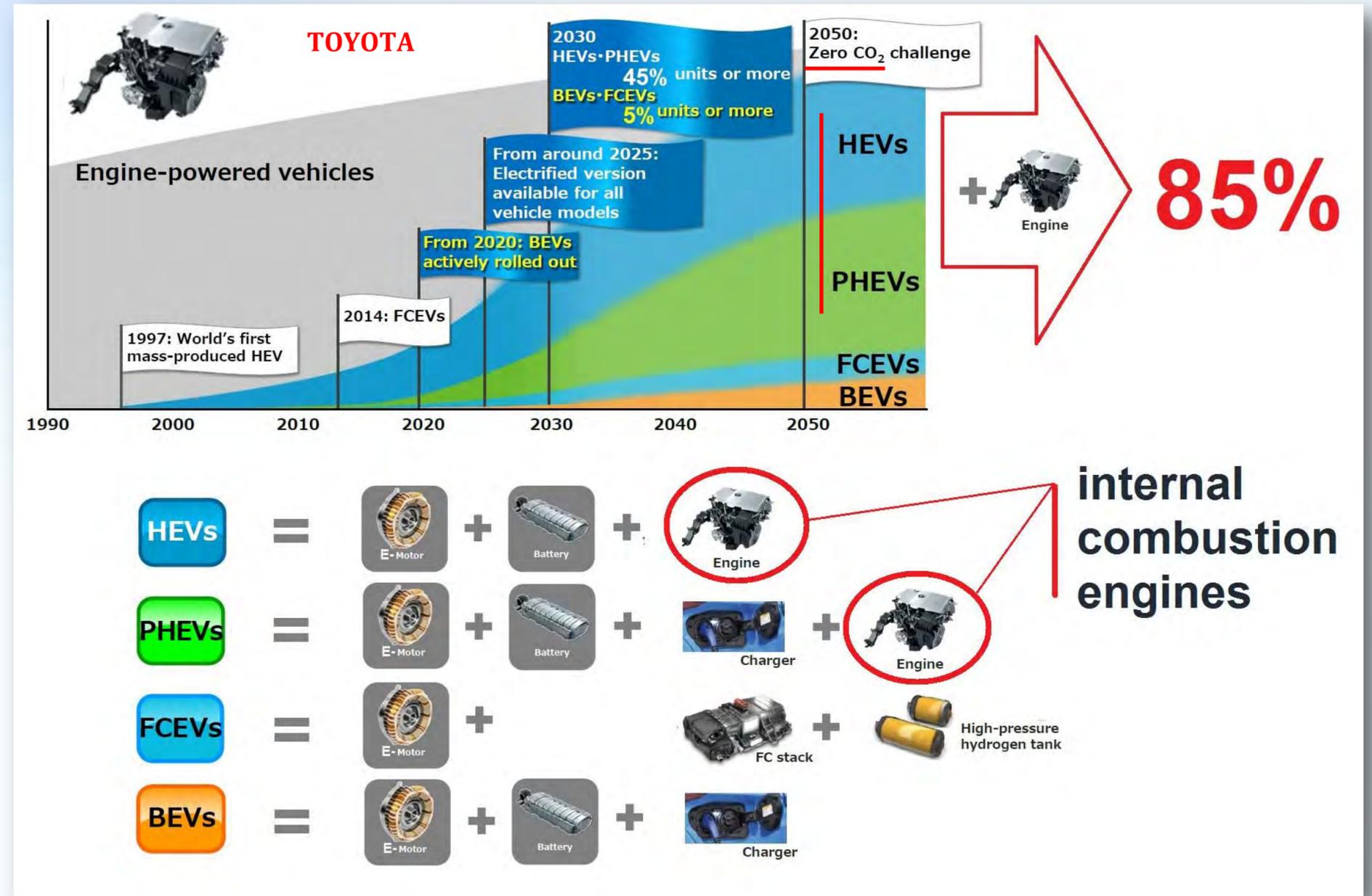


The need to take measures to increase the share of electric transport



Environmentalists insist on «Zero CO<sub>2</sub>», but consumer needs

**effective mobility!**

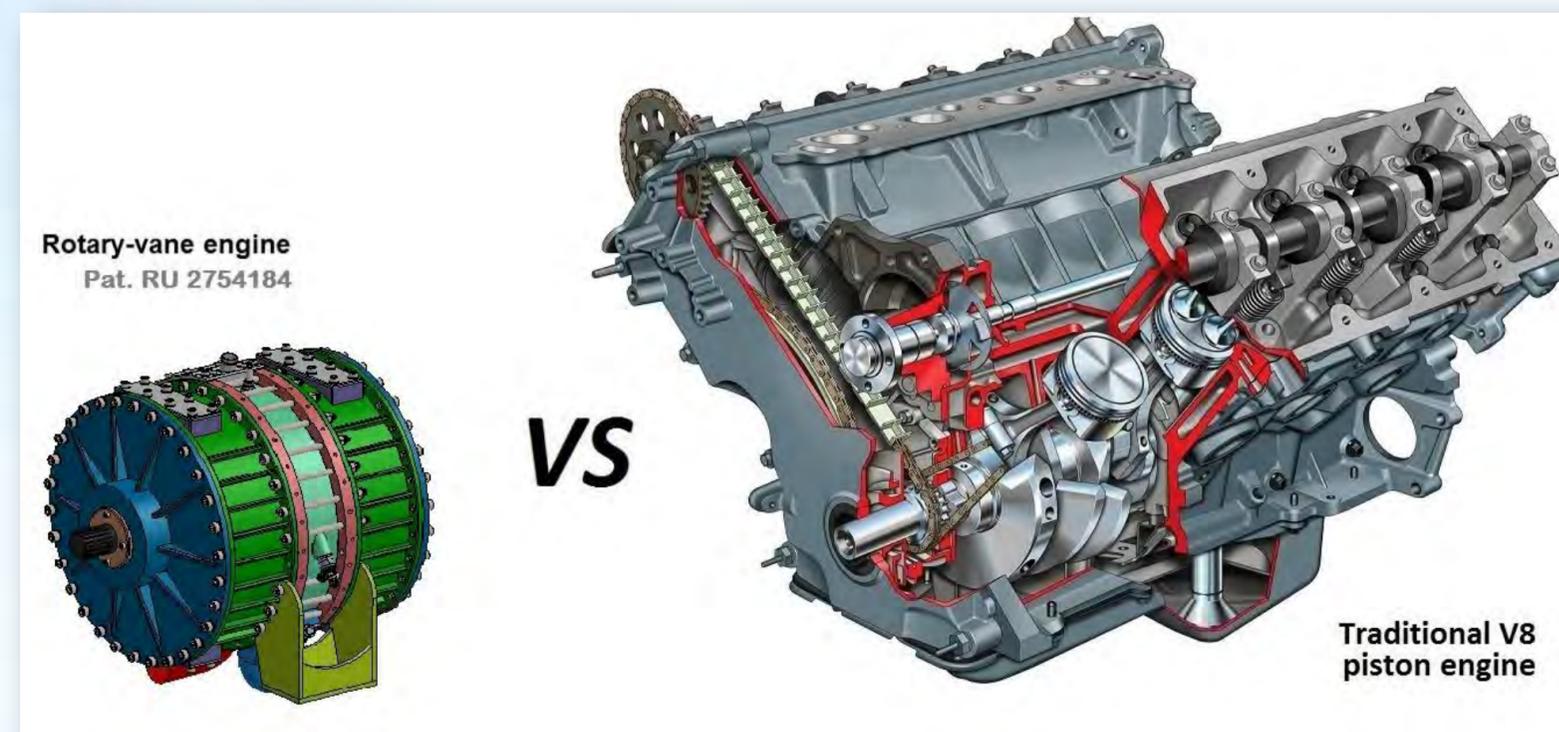


How to reduce the level of CO<sub>2</sub> emission?!

# Solution

The innovative **rotary vane engine (RVE)** has all the necessary qualities to become the most efficient alternative to traditional internal combustion engines.

<b>RVE</b>	Specific power	<b>x 5</b>
	Fuel consumption	<b>x 1,5</b>
	Efficiency	<b>x 1,5</b>



**For the user:**

**For the manufacturer:**

**For environmentalists and politicians:**

**savings + pleasure**

**profit**

**solution to the problem**

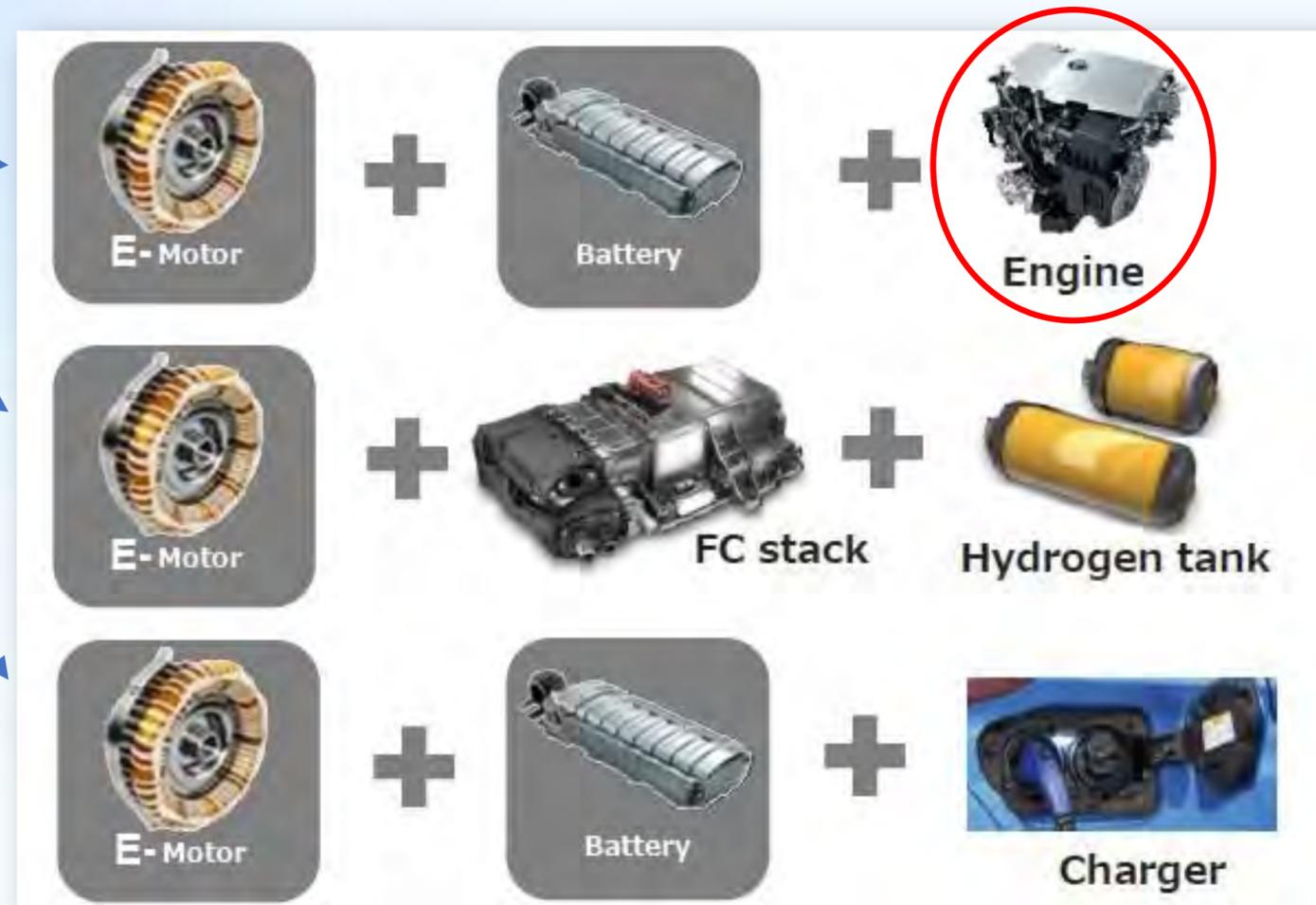
# Main trends in the field of the project

## Directions of electromobilization

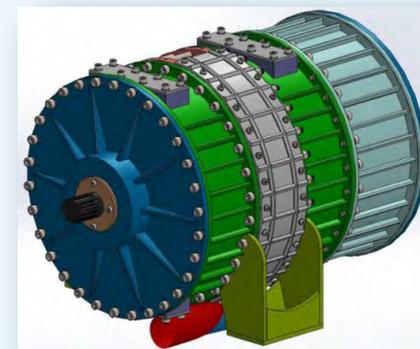
Internal combustion engines will gradually be replaced by power plants with electric drives.

One of the most popular segments will have an internal combustion engine as part of a hybrid power plant.

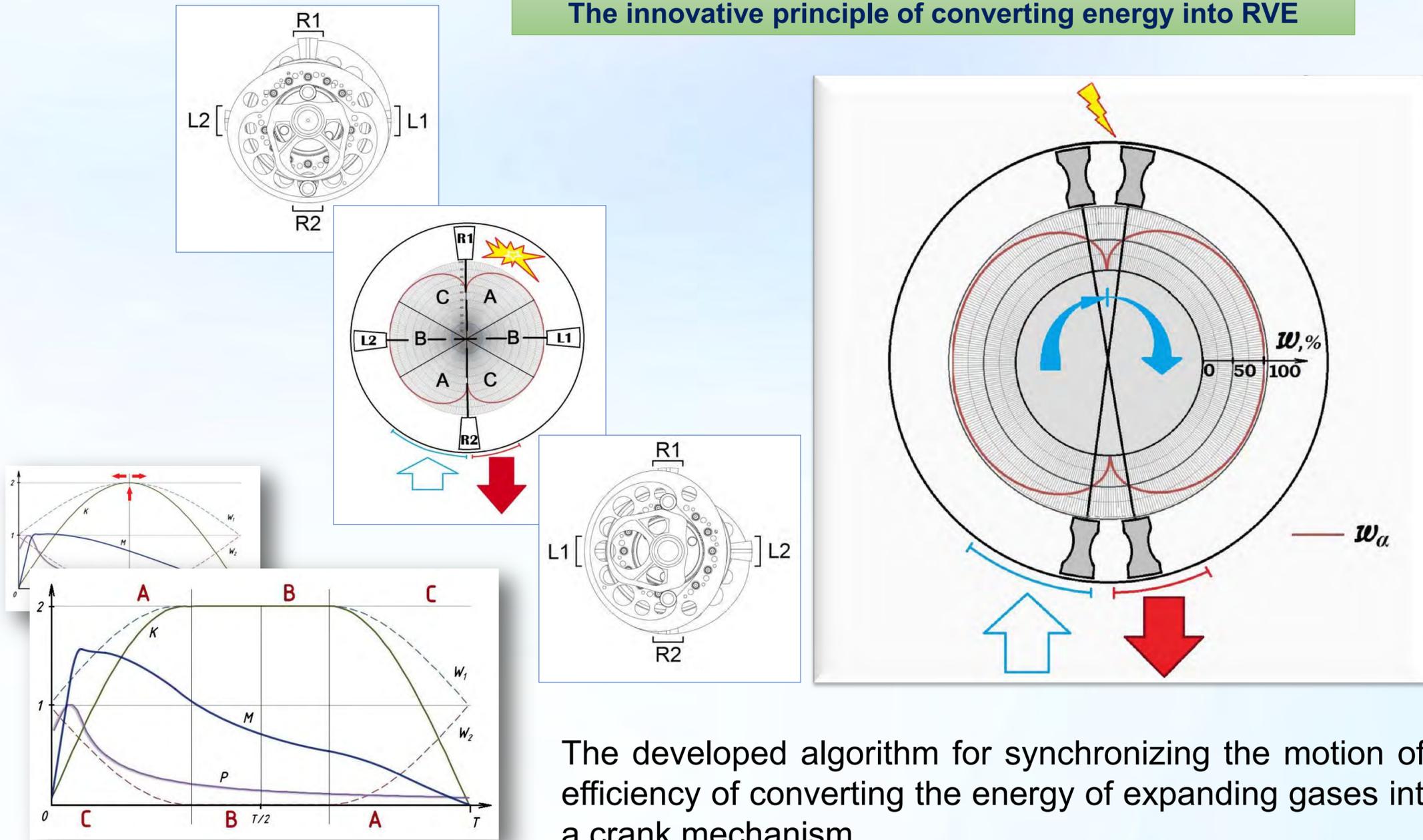
The innovative rotary vane engine (RVE) has all the necessary qualities to become the most efficient alternative to traditional internal combustion engines in hybrid and classic propulsion systems.



**RVE + EM = the best solution for hybrid technologies**



## The innovative principle of converting energy into RVE



The fundamental advantage of the rotor-vane scheme is the compact size of this type of engine, since in four working chambers of one section of the RVE, in one shaft revolution, the flow of 4 full four-stroke cycles is ensured, which corresponds to such a characteristic of a 8-cylinder traditional piston engine.

Accordingly, when comparing material consumption, the number of assemblies and parts, mechanical losses, product cost, etc., one should compare a 1-section RVE with an 8-cylinder engine of traditional design.

The developed algorithm for synchronizing the motion of the blades makes it possible to achieve the efficiency of converting the energy of expanding gases into torque, which is impossible for engines with a crank mechanism.

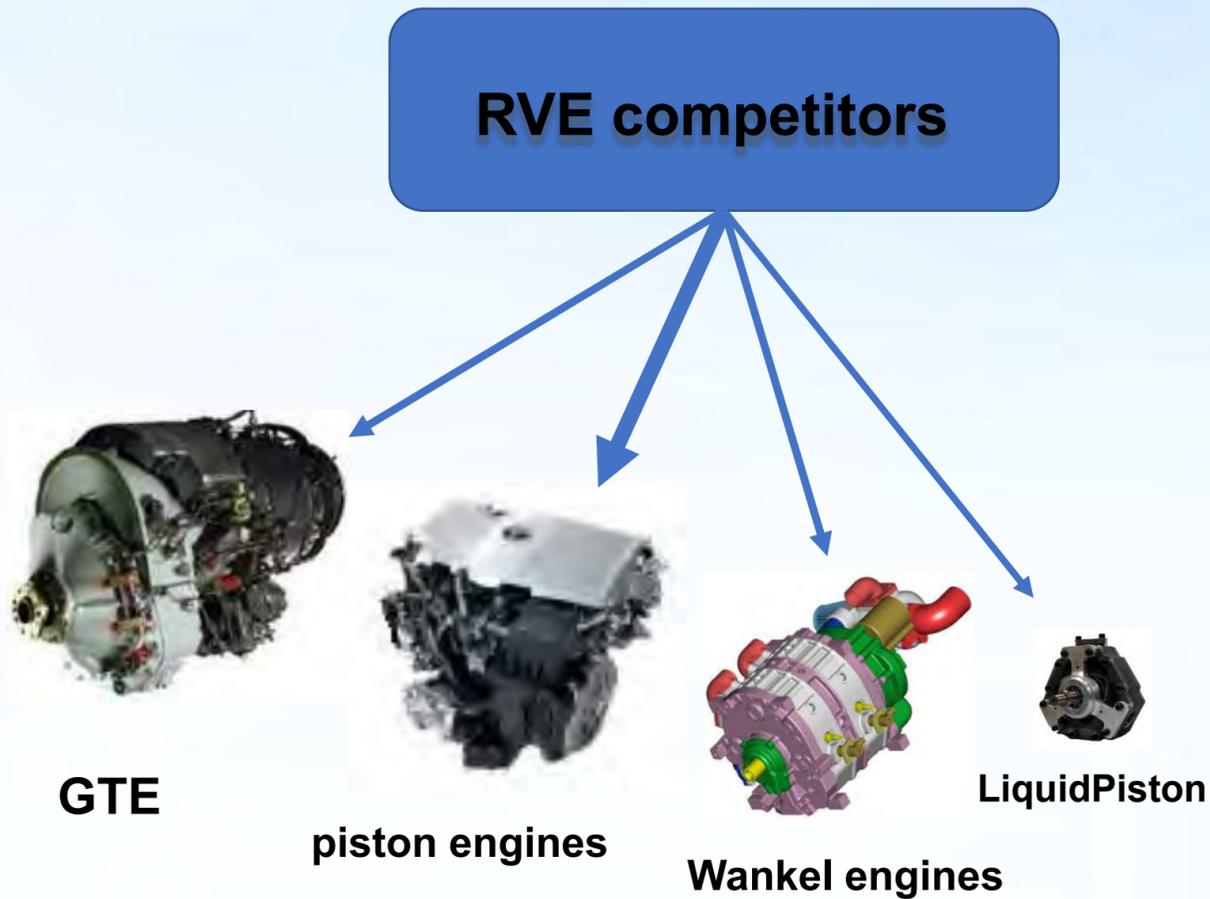
At the same time, the peculiarities of the dynamics of changes in the volumes of the working chambers in the RVE AZART create better conditions for the use of **hydrogen** as fuel than in classic internal combustion engines.

In addition, the ability to dynamically change the compression ratio makes it possible to make the RVE AZART multi-fuel, with a dynamic transition to a **hydrogen** supply.

# Effects of implementation

1. The calculated efficiency of the RVE AZART is about 1.5 times higher than that of the classic piston engine. At the same time, its calculated specific power is approximately 5 times higher. The overall effect will make it possible to save at least 50% of hydrocarbon fuels in all areas of ICE application with a corresponding reduction of harmful emissions.
2. The introduction of a **hydrogen** RVE will give the «Zero CO<sub>2</sub>» effect → no "carbon footprint" of vehicles.
3. The ability to dynamically change the compression ratio makes it possible to make RVE AZART multi-fuel, with a dynamic transition to **hydrogen** power, which makes RVE AZART the missing link in the transition to "green" mobility with the effect of a flexible and painless transition from traditional fuels to "environmentally friendly".

# Competitors



Comparative characteristics of upcoming\* and manufactured engines

Engine	Liquid Piston (estimates)	Honeywell TPE-331-12	<b>RVE* (estimates)</b>	Wankel KKM 504d	Lycoming IO-540 - AF1A5	RED A03
type	rotary engine	turboprop engine	rotary-vane engine	4-rotor rotary engine, turbo & intercooler	air-cooled horizontally opposed 6-cylinder piston engine	compression-ignition four-stroke V12 piston engine, turbo&Intercooler
fuel type	heavy fuel	kerosene	multi-fuel	multi-fuel	gasoline	multi-fuel
power output, kW	37	810	745	300	194	373
RPM	7000	41730	5000	8000	2700	4000
displacement, L	...	...	2,0 (eq. - 16,0)	2,0	8,9	6,1
dry weight, kg	18	175	160 — 170	121	188	357
L x W x H, mm	280 x 280 x 280	1088 x 533 x 676	600 x 490 x 500	793 x 480 x 435	1025 x 850 x 560	1114 x 870 x 712
overall volume, dm <sup>3</sup>	21	392	147	166	488	690
power-to-weight ratio, kW / kg	2	4,6	<b>5,2</b>	2.48	1,03	1,04
specific power, kW / dm <sup>3</sup>	1,8	2.1	<b>5.1</b>	1.8	0.4	0.5



RVE line

	100	300	1000
power output, h.p.	100	300	1000
dry weight, kg	22 — 23	50 — 53	160 — 170
L x W x H, mm	300 x 250 x 270	400 x 330 x 350	600 x 490 x 500

**RVE = E<sup>3</sup>**

more efficiently  
more economical  
more environmentally friendly

# Market parameters

RVE, as a more efficient type of engine, is able to replace traditional piston engines in almost all areas of their application.

The most relevant for the development of RVE technology are the following areas:

**Aviation sector.** The aircraft engine industry as a whole, and even more so in Russia, is in dire need of new technologies to create more compact, reliable and efficient engines with a high power density.

The market volume is not large, but stable and it is developing even in the sector of production of engines for UAVs.

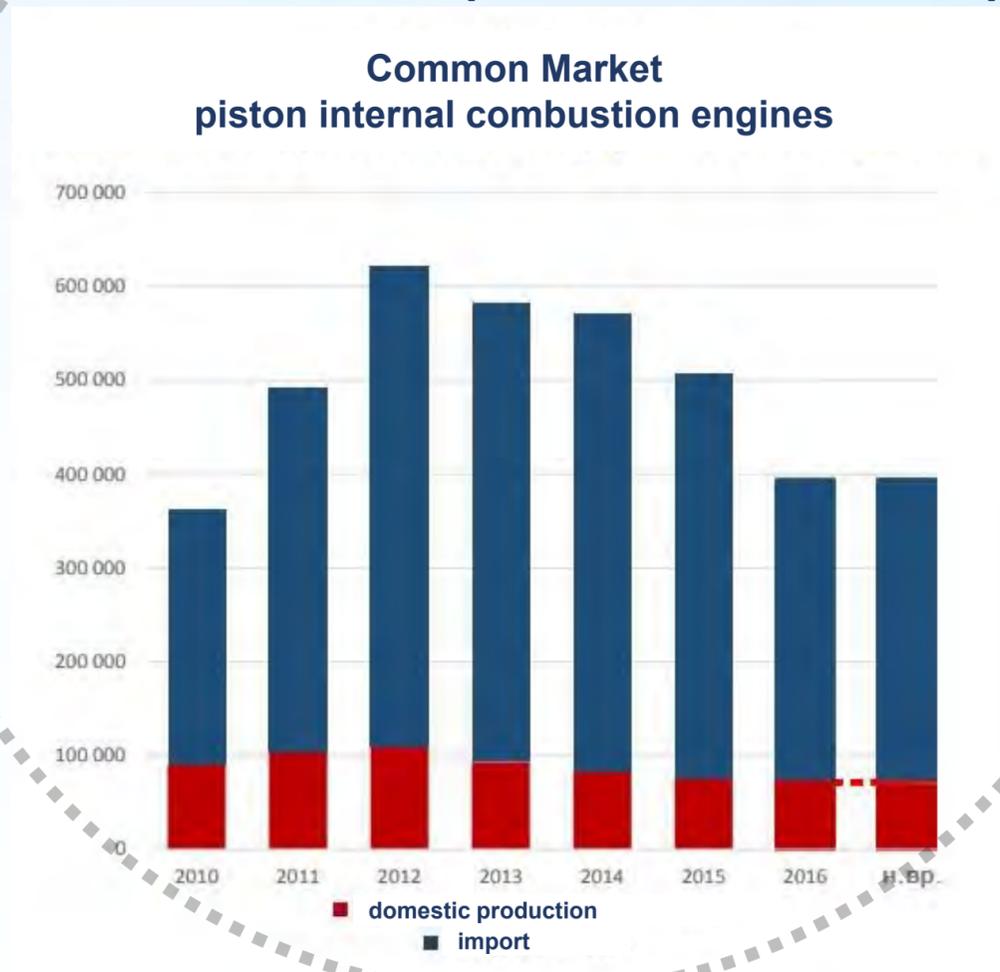
**Automotive sector.** The huge volume of the automotive engine market is quite inert, but it also anticipates increased demand for efficient, compact, high power density engines for use in hybrid powertrains, which, along with electric drives, are expected to displace traditional powertrains from the market soon.

**Mobile generation sector.** The market volume is not large, but stable. More compact and economical RVEs will easily displace traditional ICEs from this sector.

**Special attention** is paid to the most capacious **automotive engine market**. Today, the ICE market is not stable due to the economic downturn, tightening environmental standards, and also due to the development of electric mobility.

These trends play into the hands of our project because the decrease in the production of ICE vehicles is compensated by the emergence of a large number of hybrid vehicles. And hybrid technologies desperately need a compact and efficient internal combustion engine, which is a rotary vane engine.

**RUSSIAN MARKET**  
**₽400 billion (1.2 million units)**



**\$600 billion** ← is much wider → **150 million units**  
**than the Russian market**

# Resources

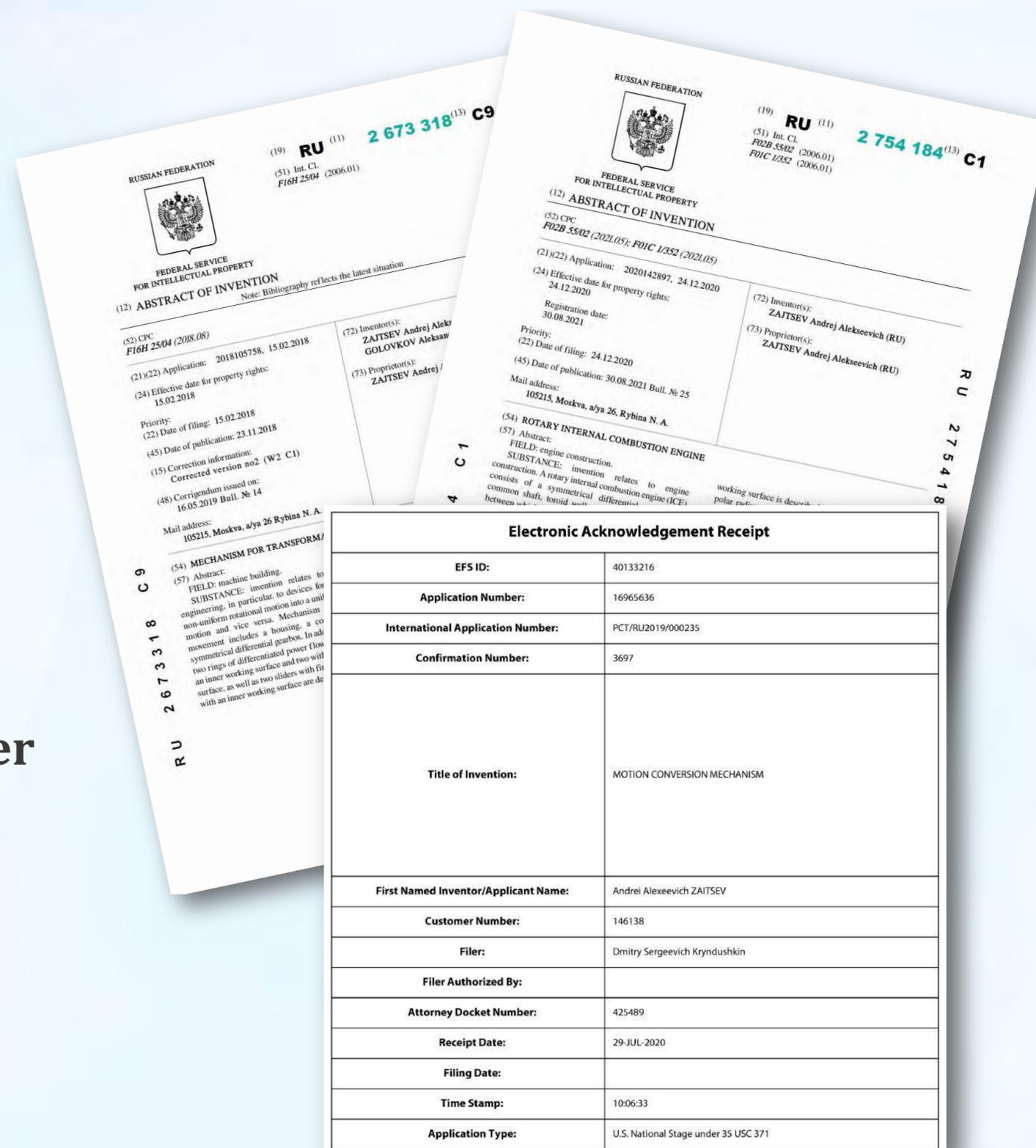
At the moment, the project is developing exclusively on the basis of the internal resources of the team.

The stage of preliminary design has been completed, prototyping has been carried out, kinematic tests and computer modeling of work processes has been carried out, research work continues.

On the design of the RVE, patents of the Russian Federation were obtained and a patent application was made in the United States.

The status of a resident of the Skolkovo innovation center was received.

Further development of the project requires the attraction of additional resources.



The image shows two Russian patent application documents from the Federal Service for Intellectual Property. The top document is for a rotary internal combustion engine (RU 2 754 184 C1) and the bottom document is for a mechanism for transforming motion (RU 2 673 318 C9). Both documents include technical details, inventor information (ZAJTSEV Andrej Alekseevich), and filing dates.

Electronic Acknowledgement Receipt	
EFS ID:	40133216
Application Number:	16965636
International Application Number:	PCT/RU2019/000235
Confirmation Number:	3697
Title of Invention:	MOTION CONVERSION MECHANISM
First Named Inventor/Applicant Name:	Andrei Alexeevich ZAJTSEV
Customer Number:	146138
Filer:	Dmitry Sergeevich Kryndushkin
Filer Authorized By:	
Attorney Docket Number:	425489
Receipt Date:	29-JUL-2020
Filing Date:	
Time Stamp:	10:06:33
Application Type:	U.S. National Stage under 35 USC 371

# Objectives of the project

The project will continue to develop further with any kind of additional support from the following:

- **cooperation with a specialized corporate partner;**
- **financial support from a venture investor;**
- **receiving a grant.**

#	Purpose and timing
1	During 2021-2022, to develop design documentation for a prototype engine, collect prototypes, conduct tests and bring the design to the state of an industrial design.
2	In 2023-2024, to introduce RVE into mass industrial production.
3	In 2024-2025, to ensure the quantitative and nomenclature expansion of production to occupy the maximum possible number of niches for the use of internal combustion engines.

**>\$200 million**

The cost of the company according to the results of the 1st stage

The capture of  
**>50% market share by 2030**

**AZ** *art*

**AZART Ltd**

**Director**

**Andrey Zaytsev**

**Contacts**

[www.az69art.ru](http://www.az69art.ru)

+7 (495) 7744150

[7744150@gmail.com](mailto:7744150@gmail.com)