DYNAMIC
AIR COOLING
The only coolant is air!

Frequently asked questions

Technical Information – Brief description of the technology

We have developed a fundamentally new cooling technology. The essence of dynamic air cooling technology is the direct transformation of warm air into cold air through the use of gas-dynamic effects. The technology is based on a mixed universal cycle developed by the authors. The cycle combines two gas-dynamic and two thermodynamic processes:

- adiabatic and isentropic air compression in the compressor;
- adiabatic and isentropic expansion, cooling and acceleration of air in the working element;
- isothermal reduction of the kinetic energy of the airflow in the air turbine;
- isobaric heating of air when removing heat from the cooled volume of the refrigerating chamber.

Compared with the traditional vapor compression technology:

- DAC uses air instead of hydrofluorocarbons to transfer energy, eliminating this source of pollution.
- It generates no thermal emissions - in all cooling applications, energy is removed from an air that is being cooled. In traditional cooling units, this energy has then wasted the heat is disseminated into the atmosphere further boosting global warming. In DAC, the energy extracted from the cooled air is not emitted as heat into the atmosphere – instead, it is turned into electricity.
- This electricity is used to contribute towards powering up our units, hence it is 30% more energy efficient compared with traditional compression AC/refrigeration system. This means that DAC is much cheaper to run.
- Due to much simpler design and smaller size, the manufacturing costs of our devices are 30% lower.

What stage is your technology at?

MVP

What problem have you identified that your technology addresses?

Problem 1: Air-conditioning and refrigeration

The world needs much more air-conditioning and refrigeration than before:

- Worldwide power consumption for air conditioning alone is forecast to surge 33-fold by 2100 as developing world incomes rise and urbanization advances.
- Already, the US uses as much electricity to keep buildings cool as the whole of Africa uses on everything.

- By mid-century people worldwide will use more energy for cooling than heating.

However, the old technology cannot provide an answer for this demand:
- cold is still overwhelmingly produced by burning fossil fuels
- emission targets agreed at international climate summits are very tight and limiting
- almost all cold is still produced by vapor-compression refrigeration, 100-year-old technology that uses refrigerants - hydrofluorocarbons (HFCs). However, HFCs produce greenhouse gases that can be up to 4,000 times more potent than carbon dioxide.

Problem 2: Food security
The world needs an awful lot more refrigeration - cold's role in food security is the key - as much as a third of all food is lost or wasted between harvest and home, mostly in the developing world. Losses amount to about 1.3 billion tons per year. Food is lost or wasted throughout the supply chain, from initial agricultural production down to final household consumption. Halving food waste would feed 800 million of the 1 billion chronically undernourished people in the world (research by the International Institute of Refrigeration).

Food losses represent a waste of resources used in production such as land, water, energy, and inputs, increasing the green gas emissions in vain.

What is the potential impact of your technology? If applicable, please quantify the potential energy created and/or the energy and carbon emissions saved.

Replacing refrigerants that damage the atmosphere would reduce total greenhouse gases by the equivalent of 90bn tonnes of CO2 by 2050. Making more energy-efficient could double that. By comparison, if 1/2 world's population were to give up meat, it would save only 66bn tonnes of CO2. Replanting 2/3 of degraded tropical forests would save 61bn tonnes. A 1/3 increase in global bicycle journeys would save just 2.3bn tonnes).
Let´s take into consideration just the two smallest refrigeration segments (shipping containers and refrigerated trucks). We will be able to achieve the following benefits:
- There are 1,5M reefers (shipping containers) in the world = 7,5M MTCO2 emissions
- There are 4M refrigerated trucks in the world = 20M MTCO2

According to European Trading System: the cost of cutting down one ton of CO2 = €7. This provides us with the total economic benefit of €192 500 000 just from these two market segments.

Hydrofluorocarbons (used in AC/refrigeration units) are the fastest-growing type

of greenhouse gas. Their use around the world is increasing by 10-15% a year as the global need for cooling grows.

Though hydrofluorocarbons do not deplete Earth's ozone layer in the way the chlorofluorocarbons did, they contribute disproportionately to global warming – HFCs are far more potent at trapping heat than carbon dioxide is. One of the most widely used hydrofluorocarbons R-134a (a refrigerant used in the AC equipment of cars) has a global warming potential (GWP) of 1,430. Weight for weight, it is 1,430 worse than carbon dioxide. Today R-134a is the most abundant hydrofluorocarbon in the atmosphere, accounting for ¼ of the total global annual output.

Result:
Replacing the hydrofluorocarbons that are used today in AC/refrigeration systems with less harmful chemicals could reduce the forecast global temperature increase by as much as 0.5°C.

What is the approximate size of the market that can be addressed with your technology?

If we address just two market segments (HVAC and shipping containers) the situation will be as follows:

According to Statista report, the global heating, ventilation, and air conditioning (HVAC) market is projected to reach about €338.7B by 2030, based on a compound annual growth rate (CAGR) of 3.9 percent between 2020 and 2030. According to The Economist report, globally, by 2030, 460M new units of cooling equipment will be sold every year, compared with just 260M unit sales in 2010 and 336M in 2018. China, the US, and India are by far the three largest markets – accounting for 49% of total sales in 2030. In 2024, India will overtake the US as a source of cooling demand, with 38.M unit sales. Across the six markets, India and Indonesia are growing the fastest, albeit from lower bases than the US and China. Domestic refrigeration, residential AC, and mobile AC will make up over 90% of unit sales in India and Indonesia in 2030. However, the fastest growing sector for both countries will be transport refrigeration which will grow at around 14% per year from 2018 to 2030.
This means that businesses will play an increasing role in driving demand for cooling sales out to 2030, in addition to the important role they already play in the residential and mobile AC sectors (as real estate developers and automobile manufacturers). This highlights the imperative of businesses shifting to more efficient, climate-friendly cooling models.

Our addressable market is:
Total addressable market (TAM): Our target market is the air conditioner market and refrigerated containers. According to Valuates report, the global air conditioner market size is €72B. Global refrigerated container market is

estimated as 1.2m. With an average price of a cooling unit €6,000, the total market size is €7.2bn.
Serviceable available market (SAM): Our target market is Europe and America, so our serviceable available market is estimated at €15.84 bn (approximately 20% of TAM).
Serviceable obtainable market (SOM): This gives us a sizeable market entry for which we have a very good product fit. Our forecast is that in 5-year time, DAC will achieve €21m of revenue. This is just 0.2% of our SAM.

What benefits does your technology impact or support?

DAC is able to provide significant benefits:

Social:

- affordable cold and AC for people in regions with hot climates
- better preservation of food products, medical supplies
- increase in food production
- reduction of energy costs

Environmental:

- reduction of greenhouse gas emissions
- reduction of thermal pollution of the atmosphere
- ability to organize production with no CO2 emission limitations

How are others, or how might others attempt to solve the same customer or industry problem? If applicable, please include specific details including company and/or researchers' names and relevant patents.

The cooling market globally is dominated by 12 large established players and a long tail of mid-sized companies. HVAC is an area that attracts many start-ups globally. Many of them focus on tracking & optimization of energy use. Yet a very small number is working on alternatives to traditional AC/refrigeration technologies. None of the current technology providers (in both HVAC and refrigerated container segments) have technology with potential like DAC's. Most of them require either a chemical coolant (HFC or alternatives) or water (for evaporation) to be used. Our technology is environmentally friendly, much more energy-efficient and requires much less complicated installation and service procedures. DAC offers a significantly lower total cost of ownership for our customers—our biggest competitive advantage.

Why is your solution the right one?

DAC USPs include:

- Immediate (seconds from the start of operation) cooling of air by -60°C. DAC technology can potentially provide cooling by -172°C.
- Cooling process occurs under very low pressure (3-7 bars).
- DAC uses no chemical refrigerants.
- DAC system is smaller & more efficient (uses up to 30% less electricity) than a conventional vapor compression AC/refrigeration system.
- DAC is more affordable and easier to install.
- DAC does not qualify as hazardous for environment equipment (less bureaucracy= more attractive for customers)

Has your technology been vetted by any external sources (customers, investors, industry participants, tech transfer offices, etc). What have they told you?

So far the company achieved the following:

- 2015 - Research team led by Oleksandr Razumtsev starts development of DAC technology;
- 2017 - First patents received;
- 2018 - DAC receives initial financing from VCs and angel investors;
- 2018 - DAC wins KyivTechHub Startup Competition;
- 2019 - DAC technology achieves TRL 4 validation under laboratory conditions (expect to reach TRL5 validation in other relevant environments in 2021);
- 2019 - DAC wins Pitching Match London at the European Startup Festival;
- 2019 - DAC selected for participation in Brightlands Innovation Factory Acceleration Program, Netherlands;
- 2019 - DAC wins 3rd place in 2019 Poland Prize Acceleration Program funded by the government of Poland;
- 2020 - Polish patent application approved;
- 2020- DAC signs BridgeAlfa investment agreement with ShapeVC;
- 2020, March - DAC wins UK Department of International Trade "Sustainable Fast Track Award";
- 2020, April - DAC selected for participation in BRINC ScaleUP program, Poland;
- 2020, May - DAC receives Horizon 2020 Seal of Excellence Award;
- 2020, July - DAC wins Vestbee Award at PowerUP! in the EIT InnoEnergy Grand Final;
- 2020, September - DAC wins the KSSE Special Award at the European Economic Congress Tech and Start-Up Days;
- 2021, January - DAC wins Poland's National Centre for R&D (NCBR) Fast Track Competition;
- 2021, February - DAC wins the Seal of Excellence Grant competition receiving grant funding of 4 million Polish zlotys (1,1M USD);
- 2021, February - DAC submits a patent application to PCT;

- 2021, April - DAC selected for participation in the Venture for ClimateTech Accelerator in New York, USA;
- 2021, May - DAC selected for participation in the MassChallenge Switzerland 2021 Acceleration program;
- 2021, August - DAC conducts first tests of DAC cold generator in a refrigerated trailer;
- 2021, September - DAC is named Hello Tomorrow´s Deep Tech Pioneer for Global Summit 2021 in Paris;
- 2021, September - DAC is named CEE Hardware startup of the month by Vestbee;
- 2021, September - DAC is nominated for the Central European Startup Awards;
- 2021, November - DAC completed the first test round of the 18kW cold generator prototype. The team achieved a temperature delta of -90°C. Computer modeling and simulation process for a cooling process with a temperature delta of -170°C was successfully completed;
- 2021, November - DAC is nominated for Breakthrough Energy Fellows Program, USA;
- 2021, December - DAC is in the finals of Huawei Startup Challenge, Poland;
- 2021, December - DAC successfully secured a European Innovation Council and SMEs Executive Agency (EISMEA) support with a recommendation for immediate direct EU equity financing.

What intellectual property exists? What rights do you have to the technology? What rights do others have to the technology?

All DAC IP has been developed internally & is fully owned by the company. We have secured 4 national patents within and outside the EU. The Polish patent application was submitted in February 2020 and granted in June 2021. PCT application was submitted in February 2021.
The team currently prepares more patent applications based on the most recent development of the cooling technology.
In general, we are pursuing an aggressive patent filing strategy to protect our technology. We develop an in-depth IP protection strategy taking into account the specific of our European & Asian target markets.
We have also carried out a preliminary patent search to assess our freedom to operate & discovered no patents that we might infringe on. This has been separately validated through our interaction with our early-stage customers.