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Recycling waste heat to cool down the planet

A renewable energy company founded in 2008, Orcan Energy offers standard components for heat power generators that recycle waste heat by turning it into electricity, using the Organic Rankine Cycle (ORC), a process similar to that used in steam engines. Having started as a spin-off from the Technical University of Munich (TUM) in Germany, Orcan now has 65 employees. Patents are important, because the risk of Orcan's standard components being copied is high. Eight early patents were filed by the TUM and then subsequently acquired by Orcan. Ownership of these patents was vital in order to attract funding. Orcan co-operates with other companies, but simplifies patent management by avoiding joint ownership. It has a detailed patent protection strategy and understands when to file a patent application and where to file it.

Orcan Energy's compact ORC module offers up to 25 kW of electrical power. Stacks of two or more modules can be used where needed, depending on the customer's waste energy output.

Orcan Energy is a renewable energy company founded in 2008 by three researchers – Richard Aumann, Andreas Sichert and Andreas Schuster – as a spin-off from the Technical University of Munich (TUM). Today the company has 65 employees (2013: 35). Despite its international business reach, the company is still based in Munich, where it is firmly rooted by its research co-operation activities.

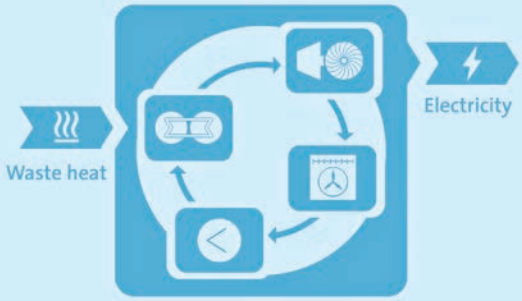
The company emerged from a government-supported programme for university-based business start-ups. A research group was given the task of building a compact and cost-efficient ORC (Organic Rankine Cycle) system for waste heat recovery from combustion engines. The main challenge was to find suitable technical components from adjacent fields such as compressors or expanders that could be adapted for use in the ORC process. This resulted in two main inventions, protected by two patents covering the basic technology (EP2499343 and EP2476869), and several related patents on specific aspects.

Orcan designs and constructs heat power generators to produce electricity from heat. Its innovative technology enables energy to be produced from recycling waste heat using the ORC process. Its current core business is waste heat recovery in three fields: renewable power plants and combined heat and power (CHP) units, industrial applications, and marine and stationary power systems. The fleet of reference plants is based in Europe, and preparations are underway for developing the business in North America and China.

Like a steam engine

The ORC process is analogous to that of a conventional steam power plant, which works by converting heat, transferred in the form of steam, into electricity. However, as the name implies, in the ORC, the water is replaced by an organic fluid. Smart selection of the fluid allows the engine to operate at a lower temperature due to a lower liquid-vapour phase change compared with water, enabling the use of lower-temperature waste heat to run the process. Examples of such low-grade heat sources include the waste heat from industrial processes or biogas, solar or geothermal plants. In energy terms, waste heat equivalent to 100 million litres of diesel is produced every hour across the globe. Recycling this heat as electricity could bring about a significant reduction in the amount of CO_2 emissions.

TECHNOLOGY PROFILE



The ORC process essentially works like a conventional steam engine, except that an organic fluid is used instead of water. The fluid is pumped to a boiler, where it is evaporated. The vapour powers a turbine (volumetric expansion machine), which produces rotational energy. A generator then converts the mechanical energy into electrical energy. The vapour is converted back to the original fluid by being passed through a heat exchanger, and the fluid is pumped to the beginning of the cycle, where it is heated once more, and the cycle starts all over again.

The ORC process is not new, nor is its application in the recovery of energy from waste heat sources. However, ORC installations used to be individually tailored to large-scale equipment with a high engineering workload. Orcan has made a number of adaptations to the process, moving away from a bespoke to a standardised product business, avoiding the high engineering workload for each facility. The use of standardised and tested industrial components makes it cheaper, simpler, more reliable and easier to maintain. There is also an operator model for customers who do not want to be involved in the operation or maintenance of their installations.

However, the move to standard components required a great deal of technical innovation. The components had to be sourced from completely different applications and adjusted for integration into the new application in terms of process control and the way they are operated in the cycle.

Dealing with cavitation

One example where inventive skills were required was in the prevention of pump cavitation (EP2499343). This occurs when liquid suddenly evaporates in the inlet of a pump, resulting in a reduction in pressure to a level lower than the saturation pressure of the liquid at this point. Cavitation can cause two problems. Firstly, the vapour created blocks the pump, so that the pumping effect stops immediately. Secondly, the sudden condensation of the vapour can cause massive damage to the blades of the rotor, due to extremely high local temperatures of more than 1000 °C and pressure of up to 10 000 bar.

These are well-known problems in the industry, and ways to mitigate them, such as increased apparatus height and subcooling, have been developed. But none of these methods could be applied in Orcan's small-scale installations. Orcan's innovative solution was to add a special non-condensing gas such as nitrogen to the working fluid. This applies a partial pressure which increases the overall system pressure, thus eliminating cavitation.

More than 100 granted patents

Orcan's standard components could easily be reverse-engineered by competitors, so patents are essential if the company is to stop its assets being copied. However, a single patent is not enough to protect Orcan's products, as the ORC process as such is an established technology. Instead, the company has made sure that it protects the relevant innovative aspects of the components that make up the control system. It has 23 patent families and more than 100 granted patents in its portfolio. Although most of them are the result of in-house development, eight of them stem from research carried out during the founders' time at the TUM. These patents hence belonged to the TUM.

> "Without patents we would never have been able to attract early funding from professional investors."

Andreas Sichert
Co-founder and CEO, Orcan Energy

When the company was spun off, it was important for it to get access to these patents as quickly as possible. Patent protection is critical when it comes to venture capital funding for early-stage technology companies, who need to actually own the patents rather than just license them. There are two reasons for this. Firstly, the company must be able to minimise complexity by being able to control and manage patent issues related to their key assets direct, so as to reduce the risk of delaying decision-making or missing deadlines. These aspects were especially important for Orcan's investors. Secondly, through patents, backers can create a return for their investment even if the young technology company fails in the first instance and a turnaround is required. This would not be possible if the patents were simply licensed. Last but not least, the fact that a technology-driven start-up has its own patents is good for its reputation.

TAKEAWAY

UNIVERSITY SPIN-OFFS

University spin-offs need access to the relevant university-owned IP early on.

Once business angels and venture capitalists showed an interest in Orcan, there was very little time left to negotiate a win-win deal with the university. As Andreas Sichert recalls, although the TUM supports spin-offs, it also has to protect the interests of inventors who are not involved in the venture, as well as those of the taxpayer, by securing a fair and competitive market price for its patents. The fact that there is no transparent and established market makes it intrinsically difficult to assess a market price.

In 2010, Orcan and the TUM reached a transitional agreement under which the company was able to acquire the patents in return for a fair remuneration.These patents were one of the reasons why the company was awarded two big research projects early on, one in the marine industry and one for industrial waste heat. They helped to communicate the company's technical advantage and innovation skills.

Use of Orcan Energy's compact ORC module in an anaerobic digestion plant.

Open innovation and patent strategy

Orcan also engages in Open Innovation. It works closely with other manufacturers to investigate and develop new applications of standard components, often resulting in jointly created inventions. Ownership of these inventions has to be carefully negotiated and agreement reached on the commercial terms for exploiting them. Orcan and its partners have therefore agreed to make things much simpler by avoiding joint patent ownership. Instead, the parties agree on who will file the patent, this normally being the partner for whom the invention is more business-relevant. The other partner then obtains the freedom to operate (FTO) through cross-licensing arrangements. Special arrangements granting the licensee more rights than usual can be made to cover scenarios in which the invention is equally relevant for both parties.

Orcan's agreements with its partners cover aspects such as the sharing of patenting costs and potential licensing revenues, as well as filing and validation strategy for the patent. In its co-operation with universities, it pays special attention to agreements that benefit both parties. University students can also be considered in such arrangements, either as part of the university agreement or as individuals. If they are not employed by the university they can retain ownership of their inventions.

TAKEAWAY

R&D CO-OPERATIONS

You can simplify the IP management that results from co-operation by avoiding joint ownership of patents. Each partner should file an application for those inventions which are relevant to them. FTO for the other partner can be achieved, for example, by means of cross-licences.

Orcan has not yet considered out-licensing to other players, nor has it explored opportunities to exploit applications of its patented technologies in different markets. It is, however, in the process of evaluating the potential to expand its business model accordingly, and is aware that its IP strategy will have to be adjusted as well.

The compact ORC module with its registered design. The characteristic shape of the housing is a special design feature of Orcan Energy's products and won the prestigious iF Design Award in 2016.

Growing the IP portfolio in a smart way

Orcan places great weight on the importance of innovation and encourages its employees to submit invention disclosure reports on a regular basis. For promising cases, a first patentability check and FTO analysis are carried out in-house, and an external IP specialist consulted if necessary.

TAKEAWAY

IN-HOUSE RESOURCES

Filing for patent protection creates work for the inventors too! They not only have to draft an invention disclosure report, but also contribute to the evaluation of the invention and the drafted patent application. They may also get involved in the patent prosecution process, if the attorney has to respond to the search report and other communications from the patent office during the patent examination procedure.

"To get patent applications granted successfully, close collaboration between the patent attorney and the inventor is essential. Excellent results will only be reached if the legal expertise of the attorney and the technical experience of the inventor are combined."

Andreas Schuster
Co-founder and CTO, Orcan Energy

If the overall evaluation is positive, the documentation is shared with a patent attorney, who then drafts a patent application. The final decision on whether to file is taken by the in-house IP specialist and a general manager. A major criterion is whether the claims of the application will support Orcan's business activities.

TAKEAWAY

CO-OPERATION WITH PATENT ATTORNEYS

The time and money spent discussing your technology with your patent attorney will be worth it, as it is vital that they understand the essence of the invention and your business case, so that they can come up with the best solution for optimum claim coverage.

The application is usually filed at the EPO first, to obtain a high quality search report within the priority year. Alternatively, the company might decide to file an international (PCT) application and then select the EPO as the international searching authority.

The geographical scope of the patent protection depends on the importance of the invention to the company. A distinction is made between key patents covering the basic technology and patents relating to specific, narrower applications of the technology. Countries are ranked in order of importance, based on the location of Orcan's main customers and competitors. The current top four European countries are Germany, Italy, France and the UK. Further major markets are the USA and China and, for some patents, Japan.

While Orcan's earlier, key patents covering the underlying main technology were validated in a larger number of countries, subsequent patents limited to details relevant to certain applications only were considered not to require such broad geographical coverage. The choice of which countries to patent in is based on a cost-benefit analysis. The Unitary Patent will make this decision much easier in the future as, in addition to simplifying the administrative processes involved, it will allow the company to obtain patent coverage in a larger number of countries more cost-efficiently.

TAKEAWAY

UNITARY PATENT

The Unitary Patent will make it easier to manage patents and will offer better-value patent protection in Europe.

Orcan owns the trade mark family for the company name, which is protected in the main markets, including the EU (EUTM013909478), the USA and China. It also has a number of registered designs (EM002922898).

COMPANY PROFILE

ORCAN ENERGY AG

- Headquarters: Munich, Germany
- Year of establishment: 2008
- Staff: 65
- www.orcan-energy.com

PRODUCTS/SERVICES

Waste heat power generators using the Organic Rankine Cycle (ORC) process

MARKET AND TECHNICAL AREA

Energy

CUSTOMERS

Energy producers and suppliers, transportation companies, AD plants

SELECTED AWARDS

2016 iF Design Award 2016
2016 TOP 100 Innovator Award

PATENT PORTFOLIO

23 patent families, including EP2574742, EP2538040 and EP2469047

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