



**UNIVERSITAT  
JAUME·I**

**EXPANDER TECH  
STRATEGIC PLAN 2017-2020**

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# **1. INTRODUCTION**

## **1.1. History**

Expander Tech is a technology-based company that originated when a group of engineers that were doing energy consulting realized that their clients began to worry about energy cost. It was after this realization when they got in touch with a senior researcher from Jaume I University and created Expander Tech, a spin-off company of this university. The new team of engineers realized that, back then, there was not a technology on the market capable of recovering waste heat at low temperatures. Thus, they started R & D activities in 2006 aiming at bringing to the market a solution to meet this need. These are the main characteristics of the company's current strategy:

**Table 1. Summary of the company's characteristics**

<b>VARIABLE</b>	<b>EXPANDER TECH</b>
Stage of Business Life cycle	Growth
Growth strategy	Market penetration Product development Related diversification
Competitive strategy	Cost leadership
Horizontal differentiation	Departmentalization by process
Vertical differentiation	Hierarchy

*Source: Own elaboration*

## **1.2. Rank technology**

Rank ® designs and assembles microgeneration, microcogeneration and combined heat and power (micro-CHP), equipments for energy recovery from low grade heat sources. These equipments can generate electric power up to 50-100 kWe using temperatures from 80°C. Furthermore, Rank® systems can also generate electric and thermal power at the same time, up to 400 kWt of thermal power (in the form of hot water up to 85°C).

High temperature heat sources are easily recoverable, but Rank® equipments cover a range of power generation above 80°C in which currently no company operates. Low

grade heat sources, using traditional Rankine cycle with water steam, do not give satisfactory results because of its low efficiency. Our technology replaces water with other working fluid able to recover low thermal sources. Thus, this technology has enabled the company to recover energy from many different sources:

- Natural sources: (thermo solar, geothermal, biomass, etc..)
- Waste heat from industrial processes (kilns, dryers, boilers, cooling systems, etc..)
- Waste heat from electric power generators (chimney, thermal oil from cooling system, etc..)

### **1.3. Mission**

Expander Tech is a technology-based company that designs and manufactures microgeneration and microcogeneration equipments intended to provide its customers with an energy-saving solution which translates both in an economic saving and a reduction of the emissions of greenhouse gases.

### **1.4. Vision**

Expander Tech aims to become a world leader in the sector of renewable energies, having a great impact on the energy efficiency and profitability of its customers while significantly contributing to the fight against climate change

### **1.5. Corporative values**

- Quality
- Guarantee
- Balance
- Accountability
- Innovation
- Integrity
- Ownership



## **1.6. Product portfolio**

### **Rank® Low Temperature**

Rank® LT\_microgeneration equipments are designed to produce electricity using heat sources from 80°C. The electricity generated can be used for self-consumption or to sell it to the grid with a power up to 50 kWe. These equipments can generate electricity using waste heat captured from any industrial or natural source (heat engine cooling, exhaust gases, process waste heat, solar thermal ...) that can produce activation temperatures above 85 °C.

Typical payback periods for these systems range from 2 to 5 years. Rank® LT equipments reduce energy spending while being, at the same, environmentally friendly as they reduce the carbon footprint of the facility or process in which the equipment is installed.

### **Rank® High Temperature**

Rank® HT microgeneration equipments have the same characteristics as the Rank LT equipments with the only difference that they designed to produce electricity using heat sources from 140°C. The electricity generated can be used for self-consumption or to sell it to the grid with a power up to 100 kWe.

### **Rank® High Temperature C**

Rank® HT-C are designed to produce electricity using natural/waste heat sources from 140°C, to obtain electricity or electricity and heat (hot water up to 85°C for heating systems, pools, domestic uses, industrial processes or cooling systems with absorption systems).

These equipments are able to utilize almost all the heat captured by transforming this waste heat in a useful heat in the desired conditions of use, and, at the same time, generate electricity for self-consumption or sale to the grid. Typical payback periods for these equipments are very low as they are energy-saving and environmentally friendly.

In this table are shown some of the equipments developed by Expander Tech.

**Table 2. Installed RANK equipments**

CUSTOMER	EQUIPMENT	APPLICATION
University of guanajuato (mexico)	Expansor 5 Kw	Academic use
University Rovira Virgili (Tarragona)	Expansor 5 kW	Academic use
Acciona	Rank HT	Biomass-fed trigeneration and solar concentrators
Keros Cerámica	Rank HT	Waste heat recovery from ceramic kiln
Heliotec	Rank LT	Electric generation through heat pipes
Complejo Hospitalario de Ourense	Rank HTC	Electric generation and ACS from waste heat from a cogeneration engine.
Universidad Jaime I (Castellón)	Rank LT	Academic use
University of Palermo (Italy)	Rank HT	Biomass-fed trigeneration and solar concentrators
Consorzio Arca (Italy-Cyprus)	Rank HT	Biomass-fed trigeneration and solar concentrators

Source: RANK

### **1.7. Current projects**

ExpanderTech, S.L. participates in the collaborative project BRICKER “Total Renovation Strategies for Energy Reduction in Public Building Stock (BRICKER), call FP-2013-NMP-ENV-EeB, project number 609071, coordinated by Acciona Infraestructura, S.A. The project has an overall budget of 12,919,479.20 of which the European Union contributes 8,645,352.00. It is executed by a consortium of 18 participants where ExpanderTech, S.L. must develop three power cycles adjusted to the needs of energy recovery. The budget to be executed by ExpanderTech, S.L. amounts to 1,294,700.00 of which the European contribution is 967,200.00.

It also participates in the project LIFE12 ENV/ES/000787 entitled “A2 Supermarket retrofit for zero energy consumption”, project acronym: LIFEZEROSTORE. The project is coordinated by EROSKI S COOP and executed by a consortium of four members. The overall budget is 1,924,792.00 and the EU contribution amounts to 882,395 euros. ExpanderTech, S.L. develops an ORC for a cogeneration system that combines heat and electrical energy. The European contribution to be executed by the company amounts to 335,699.00 euros.

## **1.8. Staff**

**Manager 1 (male):** is a Mechanical Engineer PhD and Professor at Jaume I University in Castellón. He has joined in 18 competitive research projects, financed with public funds. He is author and co-author of over 45 national and international scientific publications and over 60 conference papers. He is a Rank founding

**Manager 2 (male):** is a Mechanical engineer graduated from the Polytechnic University of Valencia. He has extensive experience leading industrial and R+D projects. He is a Rank founding partner.

**Manager 3 (male):** is an agronomic engineer graduated from the University of Lleida. He has extensive experience leading industrial and R+D projects. He is a Rank founding partner.

**Manager 4 (male):** is an Electrical/electronics technical engineer graduated from the Polytechnic University of Valencia. He has extensive experience leading industrial and R+D projects. He is a Rank founding partner.

**Employee 1 (male):** is an Industrial Technical Engineer specialized in Mechanical Engineering from the Polytechnic University of Valencia. He has extensive experience as a participant in industrial and R+D projects.

**Employee 2 (male):** is a Technical Engineer in Industrial Design by the Jaume I University of Castellón who has extensive experience as a participant in industrial and R+D projects.

**Employee 3 (female):** holds a Degree in Business Administration. She has extensive business management experience.

**Employee 4 (male):** is a Telecommunication Engineer with extensive research experience in various companies and entities (Ihren Ingenieros, S.L., Consultores Sostenibles, S.L., Universitat Jaume I).

**Employee 5 (male):** Phd in industrial engineering with relevant research experience (Universitat Jaume I).

In summary, it is a multidisciplinary team, combining technical and research capacity and previous experience in various engineering companies and research centers. This experience allows them to have a deep understanding of technology and market demands.

## **1.9. Awards**

### **a) Business Career Award-2013 CEEI-IVACE.**

The event was held on June 7, 2013 at its headquarters in Castellón. CEEI (European Business and Innovation Centre) is an initiative promoted by the Generalitat Valenciana, through Impiva, serving entrepreneurs and SMEs, whose main objective is to support the creation of companies, mainly innovative, and promote entrepreneurship and innovation within their territory.

### **b) Mediterranean Award for R & D + i Company of the year 2013.**

Rank also received from the Director of Public Administration and Large Business of Telefónica, José Manuel del Arco the Mediterranean Award for R & D + i Company of the year 2013.

### **c) Ecoinnovation Company 2014 prize**

## **2. ANALYSIS**

### **2.1. PEST analysis**

#### **2.1.1 Political factors**

The main political factor that affects the company is the amount of money allocated by each country or supranational entity to finance R & D programmes and the feed-in tariff scheme that is designed to accelerate investment in renewable energy technologies by offering long-term contracts to renewable energy producers, typically based on the cost of generation of each technology.

##### **a) Paris climate agreement**

The European Commission his website defines the Paris Agreement as a “bridge between today's policies and climate-neutrality before the end of the century”.

Governments agreed to:

- A long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels;
- To aim to limit the increase to 1.5°C, since this would significantly reduce risks and the impacts of climate change;
- On the need for global emissions to peak as soon as possible, recognising that this will take longer for developing countries;
- To undertake rapid reductions thereafter in accordance with the best available science.

The EU has been at the forefront of international efforts towards a global climate deal. Following limited participation in the Kyoto Protocol and the lack of agreement in Copenhagen in 2009, the EU has been building a broad coalition of developed and developing countries in favour of high ambition that shaped the successful outcome of the Paris conference.

The EU was the first major economy to submit its intended contribution to the new agreement in March 2015. It is already taking steps to implement its target to reduce emissions by at least 40% by 2030.

## **b) European Union Research and innovation programmes**

### **Horizon 2020 and SMEs**

Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly EUR 80 billion of EU funding available over 7 years (2014 to 2020), in addition to the private investment that this money will attract. It promises more breakthroughs, discoveries, and 'world-firsts' by taking great ideas from the lab to the market.

Under the legal base of the work programme "10. 'Secure, Clean and Efficient Energy' Horizon 2020 program" for the years 2016-2017 (European Commission's decision of 9 March, 2016) there are included several European challenges with which Expander Tech activities are aligned:

**a) The objective EE-17-2016 that seeks the recovery of waste heat from industrial systems.** A significant part of the consumed energy is lost as waste heat either because energy losses are difficult to recover and reutilize in the same process or in another part of the production process or because the required investment is too high to make the ROI attractive. To meet this challenge, the company intends to build, test and demonstrate new processes or innovative components aimed at recovering waste heat from industrial processes.

**b) The objective EE-13-2016: "Cost reduction of new Nearly Zero-Energy buildings".** According to article 9 of the Energy Performance of Buildings Directive (EPBD), the member states will ensure that, by the end of 2020 (2018 in public buildings) all new buildings are nearly zero-energy buildings (NZEB). However, the process is being slower than expected and requires the development of energy-efficient solutions at reduced cost that increase energy efficiency and integrate energy production through renewable energies.

Being a SME both objectives are included within the topic Stimulating the innovation potential of SMEs for a low carbon and efficient energy system

### **European Structural and Investment Funds**

The new European Structural and Investment Funds (ESIF) will dedicate around EUR 110 billion to innovation activities, ICT, small and medium-sized enterprise (SME) competitiveness, and the low carbon economy. Regions have to develop smart specialisation strategies prior to receiving ESIF funding for projects in the area of innovation. This process should allow regions to concentrate their investments on their comparative advantages.

## European Fund for Strategic Investments

The Investment Plan for Europe aims to revive investment in strategic projects around Europe to ensure that money reaches the real economy. The Investment Plan will be driven by the European Fund for Strategic Investment (EFSI) to help speed up economic recovery and boost investment and growth in Europe.

### c) Feed-in Tariffs (FITs)

Feed-in Tariffs (FITs) are aimed at fostering the use of a range of small-scale renewable and low-carbon electricity generation technologies. They help covering the cost disadvantages faced by some renewable energies on liberalised electricity markets. These tariffs may benefit those eligible to receive them in three different ways:

- **Generation tariff:** the energy supplier pays a set rate for each unit (or kWh) of electricity that is generated. Tariff levels are guaranteed for the period of the tariff (up to 20 years) and are index-linked.
- **Export tariff:** consisting in the payment by the energy supplier of a further rate for each unit that is exported back to the electricity grid, thus allowing the sale of electricity surplus.
- **Energy bill savings:** derived from buying less electricity to the energy supplier as a consequence of energy self-generation.

### d) Electricity prices

The pricing of electricity in Europe is done on a daily basis at midday and the price fixed for the day lasts during the following 24 hours. In this daily market the point at which the supply and demand curves meet determines the price and volume traded over a specific hour. The mechanism used for setting the price of electricity is called market splitting and consists in fixing the price by the last selling agent (power generation plant) that offers its power in the market. This marginal pricing model based on the algorithm approved for all European markets (EUPHEMIA) is currently applied in Spain, Portugal, Austria, Belgium, Czech Republic, Denmark, Estonia, France, Finland, Germany, Hungary, Italy, Latvia, Lithuania, Luxemburg, the Netherlands, Poland, Romania, Slovakia, Slovenia, Sweden, Norway, and the United Kingdom.

In the daily market, electricity sale bids from nuclear and hydraulic plants are the first to enter the pool since they offer at 0 euros because they are almost fully amortized. In the second place, come the renewable energies which also offer at 0 euros, due to the

fact that they do not have fuel costs. Finally, come the remaining power plants, especially gas and carbon plants, which have high fuel costs and are very polluting, although its use is residual in the Spanish electrical system. Notwithstanding, these last plants make the demand and offer curves meet, fixing the price of energy.

This mechanism to fix electricity prices has not been exempt from controversy during the last years. Following the announcement by the Ministry of Industry to withdraw the 3.6 billion euro contribution aimed at offsetting the tariff deficit in 2013, electricity prices began to rise. Besides this, a report published by the Spanish Comisión Nacional para los Mercados y la Competencia on the annulment of an electrical bid in which the electricity price went up by 11%, points to the fact that some power plants (two nuclears and some hydraulic and gas plants) were not operating on purpose so that more expensive energies entered the market, making the price rise. In this report the CNMC hints at the lack of competence in the energy market.

Renewable energies enter the pool at a price of zero before the rest of plants so that they reduce the need for so much gas or coal production and expel from the market plants that offer at higher prices due to their operating costs or to the price of fuel. As a consequence of this, renewables have the effect of reducing prices on the daily market.

According to Juan Fabra Utray, chairman of Economistas frente a la crisis and former CEO of Red Eléctrica de España, renewable energies were expensive because their development had to be promoted, but now they can compete in costs with the rest of technologies.

## **2.1.2. Economic factors<sup>1</sup>**

### **a) Economic growth**

Amid great uncertainty, the economies of all EU Member States are expected to grow in 2016, 2017 and 2018 for the first time in almost a decade, thus strengthening the European recovery which has seen real GDP growth for 15 consecutive quarters in the Euro area, being driven mainly by private consumption while the pace of investment growth continues but remains subdued.

In its last Forecast the European Commission expects that the euro area GDP will grow by 1.6% in 2017 and 1.8% in 2018, based on an improvement in performance in the

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<sup>1</sup> This section has been based on the European Commission Winter 2017 Economic Forecast



second half of 2016 and a robust growth during the first months of 2017. This means an upward revision from the last forecast that predicted a growth of 1.5% in 2017 and 1.7% in 2018. In the European Union as a whole the Commission forecasts a growth of 1.8% both for 2017 and 2018.

Expectations of fiscal stimulus from the new administration of the United States have had the effect of both increasing long term interest rates and appreciating the US dollar. This has resulted in an improvement of growth prospects for the OECD economies. Moreover, emerging market economies are also expected to increase their growth rates in 2018, although the extent of this growth will vary across countries and regions. All in all, this expected improvement in world growth and the consolidation of the economic recovery could have positive effects on European exports.

#### **b) Inflation rates**

Inflation has recently increased fueled by the rise of energy prices which have kept inflation rates very low during the past two years. The European Commission expects inflation in the Euro area to reach higher levels in 2017 (1.7%) and 2018 (1.4%), a significant increase from the 0.2% inflation rate registered in 2016 although closer to the 2% defined as price stability. In the European Union as a whole inflation is forecast to rise from 0.3% in 2016 to 1.7% in 2017 and 1.8% in 2018.

#### **c) Consumption and investment**

On the one hand, private consumption will continue to be the main growth driver in the European Union strengthened by the fall in the unemployment rate, even though its growth is expected to slow down due to the rise in inflation that will have the effect of reducing the growth of household purchasing power.

On the other hand, investment is set to continue its moderate upward trend boosted by low financing costs and greater global activity. It is expected to grow by 2.9% this year and by 3.4% in 2018 in the Euro area (2.9% and 3.1% in the EU), an increase of 8.2% since the start of the recovery in 2013. The main drawback comes from the fact that the share of investment in GDP is set at 20%, a much lower figure than that registered at the beginning of the current century when it stood at 22%, thus casting doubt over the sustainability of the recovery and economic growth.

#### **d) Sovereign debt and public deficits**

Public deficit in the euro area is predicted to fall from 1.7% of GDP last year to 1.4% in 2017 and 2018. This positive trend towards public deficit reduction is the result of the

combined effects of two factors: on the one hand the exceptionally low interest rates in the international financial markets have resulted in a decrease of the amount of money that the states must pay to meet national debt interests and on the other hand further improvements in the labour market have decreased the unemployment expenditure while increasing the number of people that are paying taxes and contributions. As a result of this, revenues have gone up while expenditures have gone down, thus improving the budgetary situation of the different member states.

Regarding the debt-to-GDP ratio, it is forecast to diminish gradually from 91.5% in 2016 to 90.4% in 2017 and 89.2% in 2018 as a consequence of the aforementioned deficit reduction.

### **2.1.2. Social factors**

#### **a) Global warming awareness**

Temperatures on earth have increased approximately 1.4°F since the early 20th century. Over this time period, atmospheric levels of greenhouse gases such as carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) have notably increased. There is an ongoing debate on whether these increases have been caused by human activities or are the result of natural changes

The pro side argues rising levels of atmospheric greenhouse gases are a direct result of human activities such as burning fossil fuels, and that these increases are causing significant and increasingly severe climate changes including global warming, loss of sea ice, sea level rise, stronger storms, and more droughts. They contend that immediate international action to reduce greenhouse gas emissions is necessary to prevent dire climate changes.

The con side argues human-generated greenhouse gas emissions are too small to substantially change the earth's climate and that the planet is capable of absorbing those increases. They contend that warming over the 20th century resulted primarily from natural processes such as fluctuations in the sun's heat and ocean currents. They say the theory of human-caused global climate change is based on questionable measurements, faulty climate models, and misleading science.

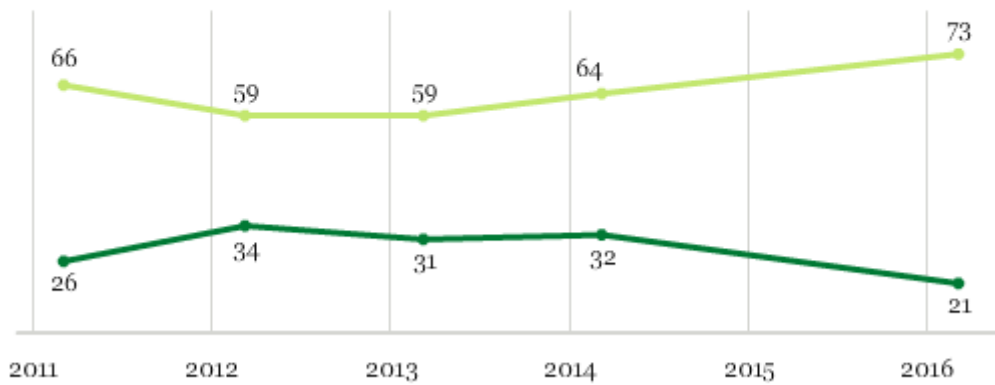
A recent poll conducted by GALLUP in the United States has shown that awareness among Americans about climate change is at a record high.

Seventy-three percent of Americans say they prefer emphasizing alternative energy, rather than gas and oil production, as the solution to the nation's energy problems. This marks the highest percentage of Americans prioritizing alternative energy since Gallup first asked the question in 2011.

*Americans' Preferred Solution to Energy Problems*

Which of the following approaches to solving the nation's energy problems do you think the U.S. should follow right now?

■ Emphasize production of oil, gas    ■ Emphasize alternative energy

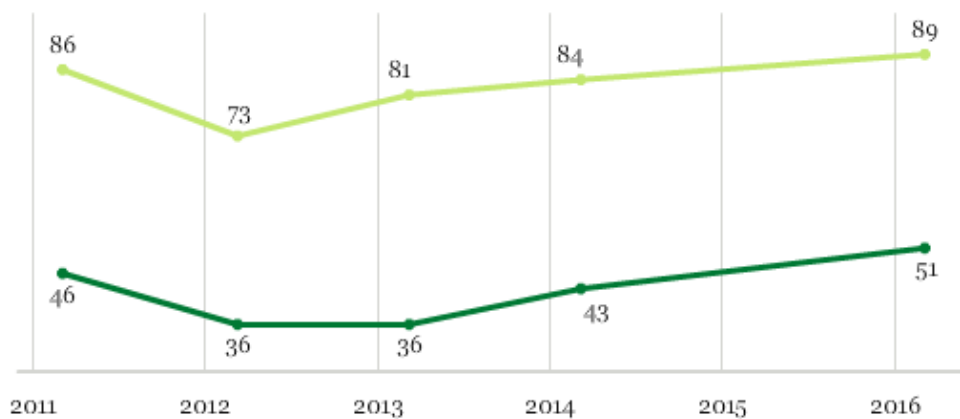


GALLUP®

The poll also shows that for the first time since these polls are conducted a majority of Republicans and Republican leaning independents now prefer an alternative energy strategy as is shown in figure 2:

*Desire to Emphasize Alternative Energy, by Party Identification*

■ % Republicans/Republican leaners    ■ % Democrats/Democratic leaners



GALLUP®

A link between falling fuel prices and support for alternative energies has also been observed in the poll. This is explained because high fuel costs may induce American consumers to prefer increased production of oil and gas as a means to reduce energy prices. On the other hand, low fuel prices make Americans think that traditional fuel is in good supply, so that they may be more willing to sanction an emphasis on alternative sources because there is little risk of exhausting fossil fuel even with the shift in emphasis.

**Table 3. Relation between average gas price and support for alternative energy**

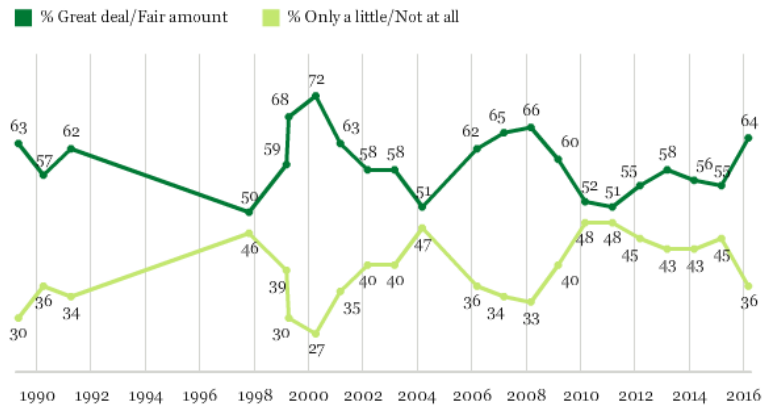
	Average Gas Price\$	Emphasize Alternative Energy%
March 2-6, 2016	1.87	73
March 6-9, 2014	3.43	64
March 7-10, 2013	3.74	59
March 8-11, 2012	3.64	59
March 3-6, 2011	3.26	66

Gas price data from U.S. Energy Information Administration. Average gas prices taken from month before poll.

GALLUP POLL, MARCH 2-6, 2016

The same poll also shows that Americans are taking global warming more seriously than at any time in the past eight years. Sixty-four percent of U.S. adults say they are worried a "great deal" or "fair amount" about global warming, up from 55% at this time last year and the highest reading since 2008.

*How Much Americans Worry About Global Warming*

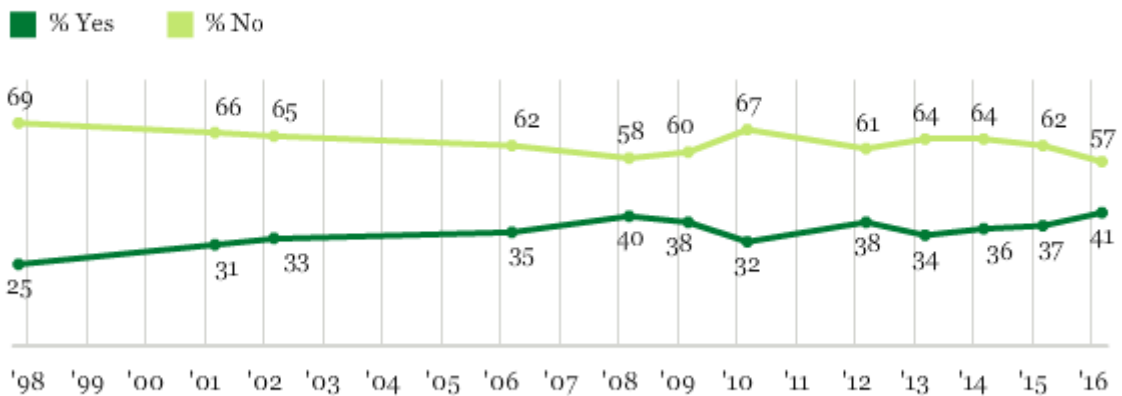


GALLUP

Another key indicator of public concern about global warming is the percentage of U.S. adults who believe the phenomenon will eventually pose a serious threat to them or their way of life. Forty-one percent now say it will, up from 37% in 2015 and, by one point, the highest in Gallup's trend dating back to 1997.

*Americans' Perception of Global Warming as a Serious Threat*

Do you think that global warming will pose a serious threat to you or your way of life in your lifetime?



GALLUP

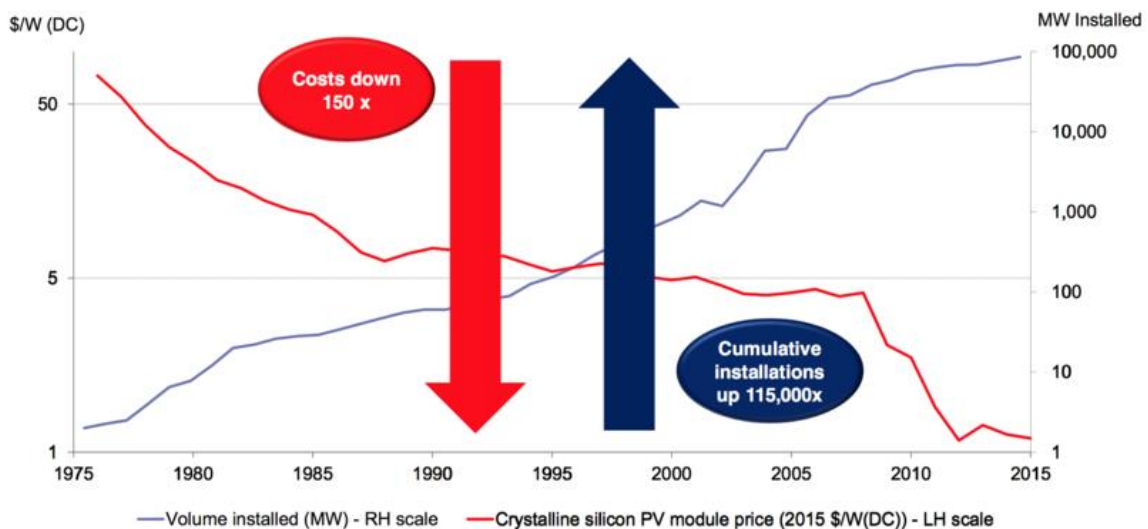
From the results of this poll it may be concluded that Americans are expressing a record-high concern about global warming and its link with human activities. Several years of unseasonably warm weather -- including the 2011-2012, 2012-2013 and 2015-2016 winters -- has potentially contributed to this shift in attitudes. If that's true, continuation of such weather patterns would likely do more than anything politicians and even climate-change scientists can to further raise public concern.

## 2.1.4. Technological factors

### a) Falling prices of renewables energies

Over the past years government subsidies have helped wind and solar get a foothold in global power markets, but economies of scale are the true driver of falling prices: It has been observed that the cost of solar power has fallen to 1/150th of its level in the 1970s, while the total amount of installed solar has soared 115,000-fold. According to BNEF, every time global wind power doubles, there's a 19 percent drop in cost whereas each time solar power doubles, costs fall 24 percent.

**Figure 5. Relationship between installed volume (MW) and module price**

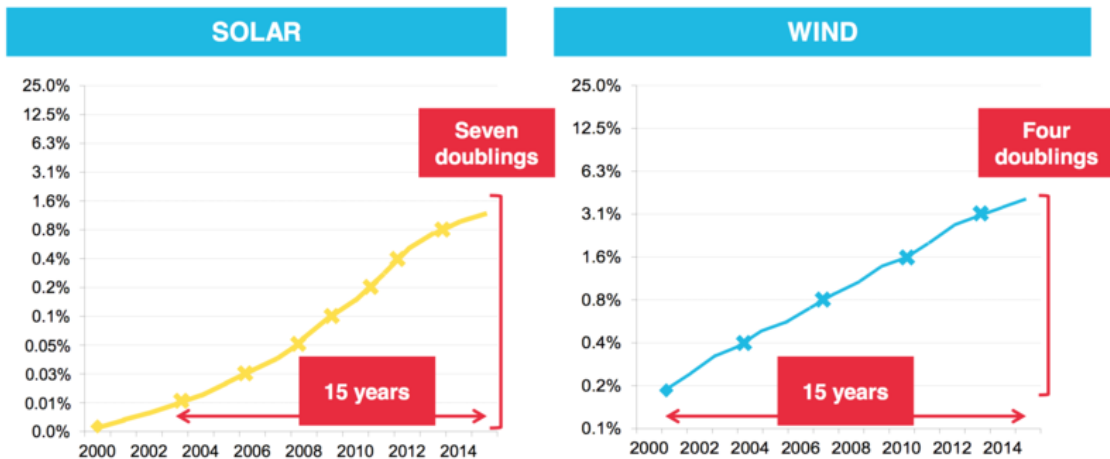


Source: BNEF

The reason why solar-power generation will keep on thriving is that it is a technology, not a fuel so that efficiency increases and prices fall as time goes on. On the other hand, the price of batteries to store solar power when the sun isn't shining is falling in a similarly stunning arc.

Just since 2000, the amount of global electricity produced by solar power has doubled seven times over. Even wind power, which was already established, doubled four times over the same period. For the first time, the two forms of renewable energy are beginning to compete head-to-head on price and annual investment.

**Figure 6. Renewables' share of power generation. Scale is shown in doublings.**



Source: BNEF

Nowadays renewable energies are becoming economically profitable besides being environmentally and socially beneficial. This is causing a dramatic shift towards renewable energy all over the world, with renewable power capacity accounting for more than half of capacity additions in the global power sector since 2011. For example, a German PV rooftop system cost roughly €14,000/kW in 1990. At the end of last year the price was less than one tenth that amount at €1,300/kW.

**Table 4. Levelized energy cost for new power plants**

Power Plant Type	Cost \$/kW-hr
Coal	\$0.095-0.15
Natural Gas	\$0.07-0.14
Nuclear	\$0.095
Wind	\$0.07-0.20
Solar PV	\$0.125
Solar Thermal	\$0.24
Geothermal	\$0.05
Biomass	\$0.10
Hydro	\$0.08

Source: Adapted from US DOE Annual Energy Outlook 2015.

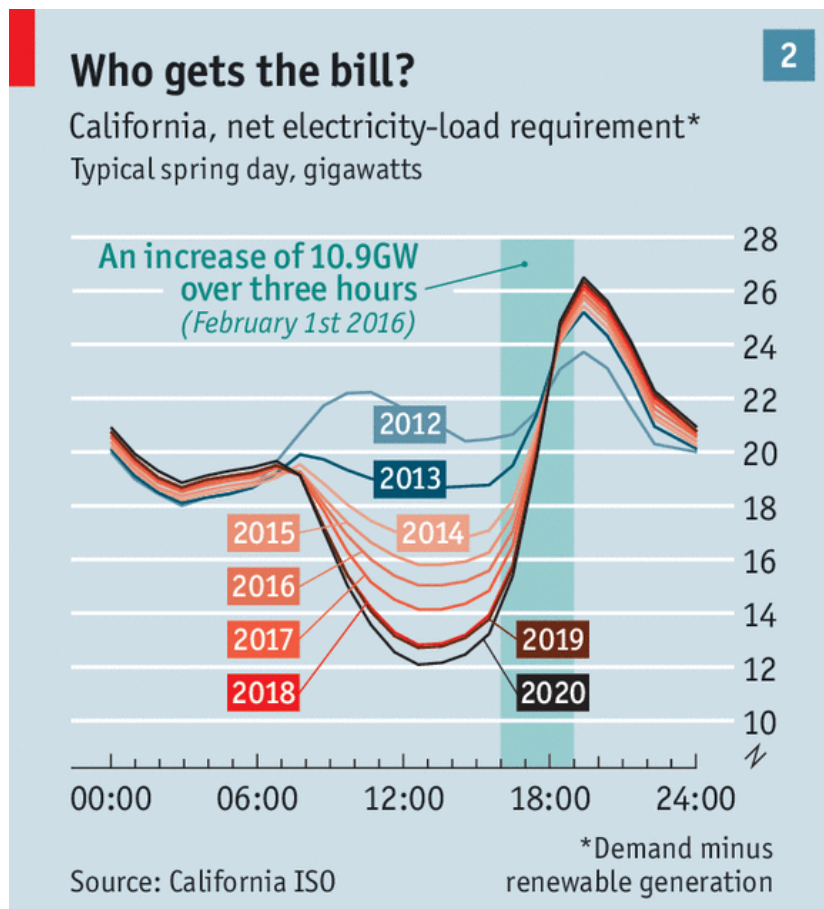
Due to the declining costs of solar and wind technologies global growth of renewable energy is increasingly driven by voluntary procurement by utilities and corporations. These improving economics are empowering many customers to seek greater control

over their energy choices, and a movement toward localized energy procurement seems to be underway.

However, renewables are intermittent, which means that fossil-fuel, hydroelectric and nuclear plants are needed more or less as much as ever at times when the sun doesn't shine and the winds don't blow. As things stand, countries with lots of renewables need to keep older fossil-fuel capacity available as a standby and to cover peaks in demand. These peaks and valleys are best shown in California where there is an icon for the effect that domestic renewables have on the demand for grid electricity, and thus on the revenues of utilities: it is called the duck (see chart 2). Every year more Californian consumers have solar cells so that electricity demand during the day falls, and revenue falls accordingly while during the night when there is no sun households have to rely on the grid to obtain power.



Figure 7. Net electricity load requirement in California



Economist.com

## 2.2. SWOT analysis

### 2.2.1. Strengths

#### HTHP Technology Patent

Heat pumps currently available on the market are only capable of raising the temperature up to 90°C while a lot of industrial processes demand thermic sources within a temperature range from 100-140°C. This is why the company is currently using its acquired knowledge regarding ORC Rankine and the properties of different organic coolant fluids to develop a high temperature heat pumps that will be capable of recovering waste heat from 40-60 °C to raise it up to 140°C, thus making it usable in many industrial processes.

**Table 5. Main suppliers of heat pumps with temperatures and power**

Brand/Model	Maximum temperature of produced useful heat [°C]	Maximum temperature of recovered waste heat [°C]	Thermal power [kW]
OSCHNER HEAT PUMPS	98	55	190-750
THERMECO2	90	40	45-1100
HITACHI / YUTAKI S80	80	40	10-17.8
KOBELCO / HEM-HR90	90	40	173-272
JOHNSON CONTROLS / SABROE HEATPAC	90	40	Hasta 1800
MHI-MITSUBISHI / ETW	90	50	340-600
MAYEKAWA	83	35	320-539

Source: RANK

The first HTHP aimed at industrial customers will allow energy from waste heat thermic sources that due to its low temperature cannot be used for other processes, being thus wasted.

Recent studies for the German market have shown that heat demand for industrial processes at 120-140°C is superior to that at 70-80°C. The sectors that have the highest thermic demand within these ranges are the food, paper and chemical industries. Similar conclusions have been reached by some studies conducted for the French market as shown in table X.

**Table 6. Thermic demand by sector**

NACE code	Industrial branches	Temperature ranges	
		0 – 100 °C	100 – 200°C
21	Pulp, paper and paper products	10 %	35 %
15	Food products and beverages (tobacco, dairy and sugar industries excluded)	25 %	9 %
25	Rubber and plastic products	5 %	9 %
15.5	Dairy products	10 %	3 %
15.83	Sugar industry	9 %	3 %
34 & 35	Transport equipments	7 %	1 %
26.5	Cement, lime and plaster	1 %	5 %
27.1	Basic iron, steel and ferro-alloys	2 %	3 %
Total (per column)		69 %	68 %

Source: CEREN

### Proven innovative capacity

The founders of the company observed that the use of low temperature residual heat was a field with a great potential still unexploited. For this reason, an important part of its activity since its founding has involved the research and development of its own technologies that allow the manufacture and distribution of microgeneration equipments through Organic Rankine Cycles (ORC) in order to generate electricity from low temperature heat sources.

These products have been validated in several applications and are currently in the commercialization phase. Moreover, it has been found that, once the products have been launched on the market, the main demand for equipment has come from biomass cogeneration applications and renewable energy systems.

Furthermore, the company has developed and tested, in internal and external laboratories that allow replicating the real operating conditions, the high temperature heat pumps (HTHP) and the low power microgeneration systems fed with biomass.

Regarding the RANK ORC systems (low power ORC microgeneration equipments capable of operating at low temperature), the company already has several products on the market so that their technology readiness level is 9.

As regards the biomass-fed mCHP system, its technology readiness level is 8. It has been proven that the technology works in its final form and under the expected conditions. However, there are still development and evaluation tests to be made in order to prove that the system meets the design specifications. After the system has been tested and its proper functioning has been certified, the marketing structure must be consolidated.

With respect to the HTHP, its technology readiness level prior to project execution is 6. The company has been able to validate the viability of the technology in a simulated operational environment and in internal and external laboratories (Universitat Jaume I). Through this project the company intends to build a pilot plant in order to validate the technology in an operating environment.

### **Good Human Resources management**

Rank ® has a staff of engineers and researchers from various fields (energy, mechanics, electronics, electricity, and telecommunications). This multidisciplinaryity is what gives the company the dynamism and responsiveness needed to address and resolve each project successfully.

As it is a technology-based company human resources are managed on a flexible basis. Employees get to work from 9:00 to 14:00 and from 15:30 to 18:00 and they do not work on Friday afternoon. The management do not control the working hours so that employees do not have to clock in and out. Decision-making is centralized but employees are encouraged to give their opinion freely so that the working climate is pleasant for all.

## **Entrepreneurial structure**

Expander Tech has a simple, flat structure. It consists of one large unit with one or a few top managers. The organization is relatively unstructured and informal compared with other types of organization, and the lack of standardized systems allows the organization to be flexible.

A young company that's tightly controlled by the owner is the most common example of this type of organization. However, a particularly strong leader may be able to sustain an entrepreneurial organization as it grows, and when large companies face hostile conditions, they can revert to this structure to keep strict control from the top.

The entrepreneurial organization is fast, flexible, and lean, and it is a model that many companies want to copy. However, as organizations grow, this structure can be inadequate as decision-makers can become so overwhelmed that they start making bad decisions. This is when they need to start sharing power and decision-making. Also, when a company's success depends on one or two individuals, there is significant risk if they sell up, move on to new entrepreneurial ventures, or retire.

## **Technological leadership**

The company holds some patents of some components of the machine that give it the technological leadership. These patents are as follow:

- Encapsulated technology both for the expander and the pump
- Direct connection from the generator to the grid without an electronic module
- Autonomous and automatic software that controls the ORC
- Very low maintenance equipments.

### **2.2.2. Weaknesses**

#### **a) Logistic problems**

The equipments marketed by Expander Tech have drawn attention from companies and institutions all over the world and the company receives daily messages from people interested in them. However, this poses a problem to the company that stems from the nature of the products that it commercializes: big equipments that must be assembled and operated by trained technicians.

Another key issue is that of the annual maintenance and guarantee. This is a small company that cannot afford to send technicians all over the world to fix and check the machines it sells. This could only be profitable if the equipments were geographically close.

**b) Return on investment rates are too high**

On its website Rank states that the typical payback periods for the equipments it sells range from 2 to 5 years. However, this is an average approximation and the real ROI varies from customer to customer. Factors like the price of energy in the country, the number of hours a day that the company consumes energy, the quantity of energy consumed and the existence of government schemes that foster the installation of these equipments affect the ROI, which in some cases does not result attractive enough for the customers.

**c) Expensive products (catalog references)**

There are currently more than 100 references in the catalog of the company. The customers can customize the product according to their energetic needs. However, this makes the equipments more expensive to produce because the company cannot benefit from discounts from its suppliers since it buys different components for each new machine. A more standardized product would eventually lower the costs due to the effect of better deals with suppliers and economies of escale.

**d) Reliance on public subsidies**

The demand for microgeneration and microcogeneration equipments in the United Kingdom has recently increased as a consequence of the feed-in tariff scheme which has made investment in this kind of equipment more profitable. This shows that, despite the recent breakthroughs in the sector, this kind of equipments still rely on public subsidies to thrive. There is also the reliance on public subsidies to

### **e) Low bargaining power with suppliers**

According to Porter (1998) the following conditions indicate that a supplier group is powerful:

- It is dominated by a small number of companies and is more concentrated than the industry to which it sells
- It is not required to contend with substitute products for sale in the industry
- The industry is not one of the supplier's important customers
- Its products are an important part of the buyer's business
- Its products are differentiated or they are built-up switching costs
- It poses a definite threat of forward integration

Expander Tech has the policy of buying only from the best and most reliable suppliers on the market, mainly from German and Swedish companies. The company has been building a small amount of equipments a year so far and due to the large numbers of catalog references the components bought have been very different so that the company has not been able to benefit from quantity discounts. Besides, its suppliers are big companies like Siemens that have a huge bargaining power.

### **f) Lack of experience dealing with distributors**

The staff of the company is made up by engineers and the managers are engineers too who, due to their role as entrepreneurs and lack of resources to hire more staff, have had to learn to run a business and be polyvalent. However, the company has recently started its international expansion and the managers still lack some skills and knowledge when dealing with the distributors of this sector. Things like the usual share of the distributor, the sale price that must be applied, the conditions of the agreements... etc are not well known by the company

## **2.2.3. Opportunities**

### **a) Paris climate accord**

It represents an opportunity for the company because this agreement aims at reducing greenhouse emissions worldwide. The equipments marketed by Expander Tech are intended to recover energy from waste heat sources, thus maximizing energy efficiency and having a real impact on the reduction of carbon emissions. This kind of equipments are an attractive option to be taken into account by governments when considering

ways of reducing emissions so that the Paris climate accord may give a boost to its demand.

#### **b) Good economic prospects**

GDP is expected to keep on growing in the foreseeable future both in the EU and worldwide. The depression has been left behind and nowadays unemployment decreases while consumption and investment go up and the macroeconomic imbalances are being gradually corrected. On the other hand, the countries of the EU have all reduced their public deficits and are on their way to achieve fiscal consolidation. With these positive economic prospects people and governments will have more money to spend on efficiency energy solutions like the ones marketed by Expander Tech

#### **c) Global warming awareness:**

The media and the scientific community have contributed to raise public awareness on this important issue. Thus, it is becoming more popular among people to seek energy self-consumption solutions like solar cells and biomass boilers and for companies to instal energy-efficiency equipments, among which are the range of energy solutions marketed by Expander Tech.

#### **d) Feed in tariffs**

These public outlays intended for those who instal small-scale renewable and low-carbon electricity generation equipments like those offered by Expander Tech represent a great opportunity for this company because they make their products much more economically attractive to their potential buyers

#### **e) Low fuel prices**

As commented above the current low prices of oil and gas due to an excess of the demand are affecting positively to the development of renewable energies because people feel that oil and gas reserves are still abundant so there is no need to invest in the drilling of new oil wells or the use of new technologies like fracking to obtain oil. Nowadays, investment is mainly channeled towards renewables while investment in fossil fuel plants is in decline.

## **2.2.4. Threats**

### **a) USA withdrawal from the Paris accord**

The Trump administration has announced that the USA will withdraw from the Paris accord to renegotiate it in terms more favourable to the interests of the United States. The leaders of the EU, China, India and all the other countries that signed the agreement have reaffirmed their commitment to fulfil its obligations within the accord. So, what at first sight may seem a threat for the development of clean and efficient energies may in turn just become a shift from the USA to Europe in the world leadership of renewable energies which would be an opportunity for Expander Tech, a European company.

### **b) Technological obsolescence risk**

Nowadays technology advances very rapidly and all technology-based companies run the risk of seeing their technology become obsolete. It may happen that other companies develop new technologies that are more efficient than those currently in the market, thus pushing them out.

Obsolescence risk affects all companies to some extent, being a necessary side effect of a thriving and innovative economy. A company must especially take into account this risk when it is deciding the amount of money to invest in a new technology. The question is whether that technology will remain superior long enough for the investment to pay off or it will become obsolete very quickly, thus making the company lose its investment. Thus, in order to remain competitive and profitable a company must be prepared to make large capital outlays when a major product, service or factor of production becomes obsolete. The main challenge lies in predicting obsolescence and budgeting accordingly.



Table 7. SWOT analysis

	POSITIVE	NEGATIVE
INTERNAL	<ul style="list-style-type: none"> <li>• HTHP patent</li> <li>• Technological leadership</li> <li>• Good human resource management</li> <li>• Proved innovative capacity</li> <li>• Entrepreneurial structure</li> </ul>	<ul style="list-style-type: none"> <li>• Logistic problems</li> <li>• High return on investment</li> <li>• Expensive products</li> <li>• Reliance on public subsidies for R&amp;D</li> <li>• Low bargaining power with suppliers</li> <li>• Lack of experience dealing with distributors</li> </ul>
EXTERNAL	<ul style="list-style-type: none"> <li>• Paris climate accord</li> <li>• Feed in tariffs in some countries (UK)</li> <li>• Good economic prospects</li> <li>• Global warming awareness</li> <li>• Low fuel prices</li> </ul>	<ul style="list-style-type: none"> <li>• U.S. withdrawal from the Paris accord</li> <li>• Technological obsolescence risk</li> </ul>

Source: Own elaboration

### **2.3. Competitors analysis**

There are 24 manufacturers of ORC systems all over the world. These are listed below::

- Adoratec
- Aqylon
- Bosch
- Durr
- Electratherm
- Eneftech
- Enerbasque
- Enertime
- Enogia
- Exergy
- E-Rational
- Freepower
- GMK
- Infinity Turbine
- Novotek Industry
- Opcon
- Ormat
- Phoenix
- Termocycle
- TransPacific
- Triogen

- Turboden
- Verdicorp
- Zuccato

However, it has been impossible to find information about the following companies:

- Anguil
- Conpower
- General Electric
- LTI Recovery
- Newcomen
- Purecycle
- Siemens
- UTC Power
- Zae Bayern

The following companies have been discarded from the analysis by taking into account their activities during the last five years based on the number of references provided by themselves.

- Aqylon
- Enerbasque
- E-Rational
- Freepower
- Infinity Turbine
- Novotek Industry
- Phoenix
- Termocycle
- Verdicorp

The list of the fifteen companies that have been used for this analysis is included in the following table:

**Table 8. Companies considered for this analysis**

<b>Manufacturer</b>	<b>Country</b>	<b>Website</b>
Adoratec	Germany	<a href="http://www.adoratec.com/">http://www.adoratec.com/</a>
Bosch KWK	Germany	<a href="http://www.bosch-kwk.de/en/solutions/bosch-kwk-systeme-orc-systems/">http://www.bosch-kwk.de/en/solutions/bosch-kwk-systeme-orc-systems/</a>
Durr Cyplan	Germany	<a href="http://www.durr-cyplan.com/energy-technology-products/">http://www.durr-cyplan.com/energy-technology-products/</a>
Electratherm	United States	<a href="https://electratherm.com/">https://electratherm.com/</a>
Eneftech	Switzerland	<a href="http://www.eneftech.com/">http://www.eneftech.com/</a>
Enertime	France	<a href="http://www.enertime.com/en">http://www.enertime.com/en</a>
Enogia	France	<a href="http://www.enogia.com/">http://www.enogia.com/</a>
Exergy	Italy	<a href="http://www.exergy-orc.com/">http://www.exergy-orc.com/</a>
GMK	Germany	<a href="http://www.gmk.info/home.html">http://www.gmk.info/home.html</a>
Opcon Energy System	Sweden	<a href="http://opconenergysystem.com/en/home/">http://opconenergysystem.com/en/home/</a>
Ormat	United States	<a href="http://www.ormat.com/">http://www.ormat.com/</a>
Transpacific Energy	United States	<a href="http://www.transpacenergy.com/">http://www.transpacenergy.com/</a>
Triogen	The Netherlands	<a href="http://www.triogen.nl/">http://www.triogen.nl/</a>
Turboden	Italy	<a href="http://www.turboden.eu/en/home/index.php">http://www.turboden.eu/en/home/index.php</a>
Zuccato Energia	Italy	<a href="http://www.zuccatoenergia.it/index.php/es/">http://www.zuccatoenergia.it/index.php/es/</a>

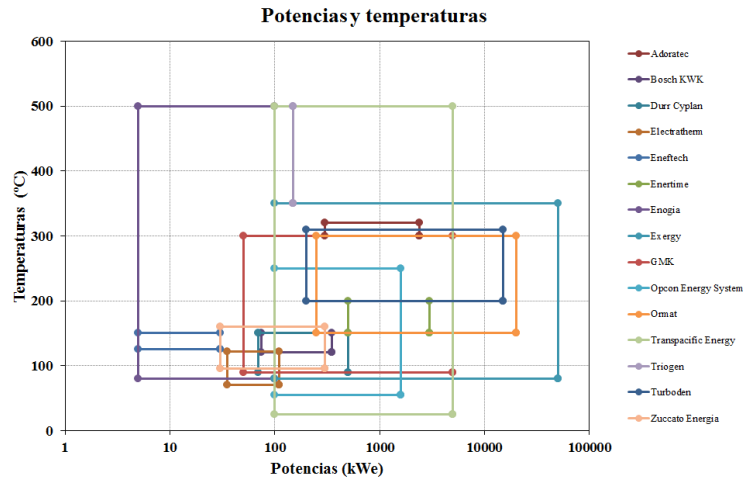
Source: Expander Tech

As noted above the two main products marketed by Expander Tech are:

- Rank Low Temperature which operates at temperatures above 80°C
- Rank High Temperature which operates at temperatures above 140°C

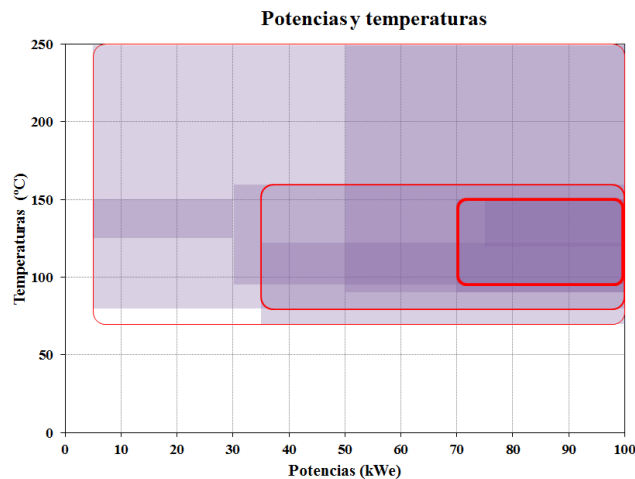
It can be concluded that the competitors of Expander Tech are those companies that manufacture ORC systems that operate within this temperature range (80-140 °C). The power and activation temperatures of the ORCs marketed by the different company as well as those companies that operate within the same temperature range as Expander Tech are shown in the following images.

**Figure 8. Powers and activation temperatures of the ORCs of the 15 companies**



Source: Expander Tech

**Figure 9. Companies within the 80-160 °C range**



Source: Expander Tech

Thus, the seven companies that are the true competitors of Expander Tech are Bosch, KWK, Durr Cyplan, Electratherm, Eneftech, Enogia, GMK and Zuccato Energia. Their main features are collected in the following table:

**Table 9. Main features of the seven competitors**

	<b>Bosch KWK</b>	<b>Durr Cyplan</b>	<b>Electratherm</b>	<b>Eneftech</b>	<b>Enogia</b>	<b>GMK</b>	<b>Zuccato</b>
<b>Max temp °C</b>	150	150	122	150	500	300	160
<b>Min temp °C</b>	120	90	70	125	80	90	95
<b>Max Power (kWe)</b>	350	500	110	30	100	5000	300
<b>Min Power (kWe)</b>	75	70	35	5	5	50	30
<b>Number of products</b>	5	12	3	4	12	Indefinite	9
<b>Other products</b>	Related	Non-related	None	None	None	None	None
<b>Country</b>	Germany	Germany	United States	Switzerland	France	Germany	Italy

Source: Expander Tech

**Table 10. Installed power and number of installations per company**

	<b>Installed Power (kWe)</b>	<b>Number of installations</b>	<b>Average installed Power (kWe)</b>
<b>Bosch KWK</b>	230	3	77
<b>Durr Cyplan</b>	850	2	425
<b>Electratherm</b>	-	28	-
<b>Eneftech</b>	45	2	23
<b>Enogia</b>	137	12	11
<b>GMK</b>	5,180	18	288
<b>Zuccato Energia</b>	915	12	76

Source: Expander Tech

The company with the largest number of installations is Electratherm, which is the main competitor of Expander Tech followed by Enogia and Zuccato Energia with 12 installations each. On the other hand, KWK and Eneftech have 3 and 2 installations respectively.

### **3. STRATEGY FORMULATION**

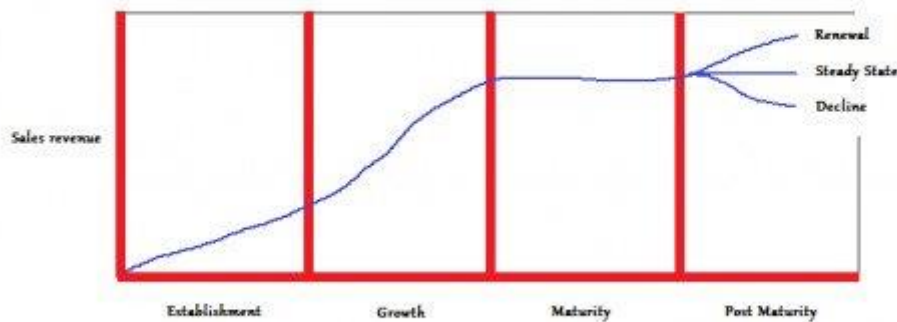
#### **3.1. Business life cycle**

##### **3.1.1. Stages**

The life cycle of a business is made up by four stages. Each stage has its own special features and challenges. All successful businesses will go through these phases more than once. The phases are as follows:

- Establishment
- Growth
- Maturity
- Post-Maturity

**Figure 10. Stages of the business life cycle**



Source: <https://toughnickel.com/business/The-Business-life-cycle-Establishment-Growth-Maturity-Post-Maturity>

#### **Establishment**

This is the birth of the business. At this stage there is no profit or it is negative. The owner has invested both time and money preparing for what is to come. The vulnerability of the company is very high at this point since both external and internal environmental factors can have a great effect on the future of the business.

The aim is to get the business onto a stable foundation of profitable sales and a

consistent cash flow. Detailed planning during this stage can greatly increase the chances of success.

### **Growth**

In this phase, the company experiences an expansion increasing the number of customers so that sales keep on growing and cash flow is almost always. In the case of a small business there are often between 10 and 15 employees working on a consistent roster.

With growth there is an increase in complexity, responsibility and a need for long term planning. During the establishment and growth stages advertisement is very important, as is the need to invest in relevant equipment or employees to build up a good reputation. Owners must be careful not to expand faster than their business can adapt to the changes.

### **Maturity**

Maturity begins when sales come to a plateau. At this stage the company still has a good customer base and regular cash flow. Its now that a more formal, detailed approach towards planning should take place. During growth, it is more important to make quick decisions with a good chance of success. Now the rate of change has slowed; more detailed long term plans can be made so it is the moment to take a more formal and detailed approach towards planning.

### **Post-Maturity**

The final stage consists of three possible outcomes

- **Renewal:** New areas of growth cause increased sales and profits
- **Steady State:** A continuing state of maturity.
- **Decline:** Profits begin to fall as a result of poor management; often a direct result of a drop in sales or excess expenses.

#### **3.1.2. Expander Tech's case**

Expander Tech is currently moving from the establishment to the growth stage. The company is more than ten years old, has five employees and four managers/owners and has installed more than 10 equipments in several countries including Italy, Mexico and Spain. It has recently experienced an increase in the demand but this has not consolidated yet and the managers have doubts whether this trend will continue in the

future. Despite this, they are optimistic because this sector has a lot of potential growth and room for technological improvement. As noted above, the sectors of renewable energies and energy efficiency follow a trend of efficiency improvement as time goes on, thus enhancing their profitability.

## **3.2. Growth strategies**

### **3.2.1 Types of growth strategies**

The Russian American Igor Ansoff in his 1957 paper came up with the concept of the Ansoff matrix, a very useful strategic planning tool that provides managers and executives with a framework to devise their future growth strategies. He described four growth alternatives:

#### **a) Market penetration**

This option consists in gaining a greater market share in the current market scenario, that is to say, using its existing offerings (products and services) in the existing markets. This can be done selling more products or services to established customers or by finding new customers in the market. To attain this goal companies carry out a series of actions aimed at:

- Increasing the sales to current customers
- Attracting customers from competitors
- Attracting non-current customers
- Attracting new customers from the same segment by increasing advertising or promotion

This strategic option is the one that offers greater security and a smaller margin of error, since the company operates with products that it knows, in markets that it also knows.



## **b) Market development**

This strategy consists in expanding into new markets but using its existing offerings. This can be accomplished by focusing on

- Different customer segments
- Industrial buyers for a good that was previously sold only to the households
- New areas or regions in the country
- Foreign markets

## **c) Product development**

This option consists in developing new products targeted for the existing market. Markets are constantly changing so that it is logical, under certain circumstances, to launch new products or to modify or update the existing ones in order to meet the needs generated by those changes. The main strategies include:

- Developing new products
- Developing new product ranges (changes in quality)
- Developing new models or sizes

## **d) Diversification**

In this strategy the company develops new products for new markets, thus being the most risky strategy that a company can undertake. Diversification can be:

- **Related Diversification:** there is relationship and potential synergy between the current products the company sells and the markets where it operates and the new product/market space.
- **Unrelated Diversification:** also known as conglomerate growth because the resulting corporation is a conglomerate, namely, a group of businesses without any relationship to one another. A strategy for company growth through starting up or acquiring businesses outside the company's current products and markets

### **3.2.2. Expander Tech's case**

After examining all the growth possibilities it can be concluded that Expander Tech is currently following three internal growth strategies.

#### **a) Market penetration**

The company is trying to consolidate its position in the market in which operates (ORC systems) through a strategy of market penetration. As it has been noted before the main competitor of Rank is Electratherm, the market leader. The company is trying to be more competitive in this market by reducing production costs and investing in R&D to keep improving the efficiency of the machines. However, competition in this sector is not very high because there are few competitors and the market is currently expanding so that the number of customers is growing.

On the other hand, the company is trying to gain funding from the European Union to finance a project aimed at the diversification and expansion of its product portfolio. This business project aims to bring to the market two types of equipments that are complementary to the ORC generation and cogeneration systems currently marketed by the company. These new products will allow the company to offer a wider range of solutions for the energy recovery from waste heat as well as for the generation of energy obtained from renewable sources. These equipments are aimed at reducing both energy consumption and the use of fossil fuels. In particular, the company intends to sell the two following product families:

#### **b) Product development strategy**

It consists in the development of High Temperature Heat Pumps (HTHP) intended to turn low temperature waste heat into heat at higher temperature which can be used in other industrial processes. This product line will complement the ORC microgeneration systems for the recovery of low temperature waste heat to produce electricity. Thus, waste heat generated in industrial processes will be recovered either by obtaining heat at higher temperature that can be used in other processes (HTHP) or by the generation of electrical energy (ORC) according to the type of industry and productive process.

The development of HTHP is a strategy of product expansion. The company is launching a new product that are aimed for energy recovery in industrial processes. This strategy is existing market. The customers of this product will be the same as those of the ORC since these equipments are adequate for this company since it has a great capacity to develop new products through R&D activities.

## **New product**

The HTHP is an equipment not available on the market. When analyzing the heat pumps that are currently marketed it is observed that they have limitations on the operating temperatures of both heat sources. They allow neither heat production above 100°C nor the recovery of waste heat from all industrial environments, limiting the maximum temperature of the waste heat to be reused to 60°C.

The heat pump developed by Rank will be able to recover heat sources up to 100°C, and generate useful heat up to 140°C. The development of this HTHP system represents a new industrial product with great potential for use.

## **Same market**

HTHP which is aimed at industrial customers, allows to energetically exploit waste heat sources that, due to their low temperature, cannot be exploited directly. It is an energy source currently wasted despite the fact that in several industrial processes there are thermal needs for other subprocesses.

Heat demand in industrial processes at a temperature between 120 and 140°C is higher than (166 TWh) demand at 70-80°C (148 TWh). The sectors that have the highest thermal demand within these temperature ranges are the food, paper and chemical industries.

## **c) Diversification strategy**

Microgeneration systems powered by biomass (mCHP) intended for domestic or light commercial use. The company currently sells ORC cogeneration equipments from 20-100 kWe for applications or commercial buildings. The new product will have a much more reduced power (1,63 kWe) and will consist of a standardized solution that will allow the generalization of a fully renewable cogeneration equipment (biomass-fed) in residential buildings.

In this case the company is following a strategy of diversification since it intends to sell a new product (mCHP) in a new market (domestic or commercial use). The main reason behind this strategy lies in the slow growth of the demand of the ORC systems until very recently. The company intends to reduce the overall risk of the company should the ORC business failed. Expander Tech is aware that this strategy has the highest level of risk since selling a new product in an unknown market means a lack of experience in the new skills and techniques required. Therefore, the company puts

itself in a great uncertainty. In order to reduce these risks the company participates with other firms to get a grant from the European Union to develop this project, thus minimizing the financial exposure of the company.

### **New product**

There are currently on the market systems that first convert biomass into biogas and then use a reciprocating internal combustion engine for the cogeneration. These are systems for powers from 25 kWe although they usually have far superior power. Furthermore, these equipments present problems related to the fuel generated through the gasification (dirty fuel and of low calorific value), the hot cleaning of synthetic gases and the maintenance, which is why they cannot be used for homes.

There are other systems based on natural gas combustion engines like the Dachs system, which generates 5.5 electrical kW and 15 thermal KW but is powered by fossil fuels so that it neither contributes to the reduction of carbon emissions nor does it cover the same need that the mCHP product to be marketed. There is also on the market a gas boiler incorporating a Stirling engine which offers 1 kWe and 6 kWt. Again, this is a system powered by a fossil fuel which can only be applied in gasified areas, while biomass can be transported and, therefore, used without this limitation.

### **New market**

Regarding the mCHP system, the mature technology currently marketed consists of reciprocating internal combustion engines (RICE) powered by natural gas. These systems use fossil fuels that can only be utilized in areas where there are natural gas infrastructures. Moreover, they have a thermal and electrical power that exceeds the needs of an individual dwelling.

Consequently, there is a demand for microgeneration systems that can be applied to meet domestic needs in countries where there is a high heating demand and an abundant availability of biomass.

In the countries identified as a priority objective for the commercialization of mCHP systems (United Kingdom, Germany, Finland, Sweden, Norway, Denmark as well as in the Canadian province of Ontario) there is a high demand for heating, high availability of biomass, a considerable environmental sensitivity, in some cases public incentives for biomass cogeneration and a high number of individual or isolated single-family constructions where a biomass-fed cogeneration system is of high value.

### **3.3.Competitive strategies**

#### **3.1.Types of competitive strategies**

A company has a competitive advantage when it possesses some distinguishing feature over its competitors, which gives it the capacity to obtain higher yields in a sustainable manner over time. To be really effective a competitive advantage must be:

- Unique
- Valued by customers
- Sustainable over time
- Profitable and difficult to imitate

In order to understand the different sources that give a competitive advantage one has to examine the concept of profit. This is obtained as the difference between the amount of money that customers are willing to pay for the product or service that the company offers and the costs of these. Consequently, the profit may grow either due to an increase in the amount of money customers are willing to pay or as a reduction in the costs. Thus, there are two sources of competitive advantage: consecuencia, el beneficio puede crecer bien por un aumento en lo que los clientes están dispuestos a desembolsar o bien por una reducción de costes.

#### **a) Cost leadership**

Cost leadership means that the company has the lowest production costs of the sector. It involves the capacity to manage all the activities so that the costs of producing and selling each unit of product are lower than those of its competitors. Even though that product or service is not better than the rest and does not have any special attribute there will be customers whose main factor to be taken into account when deciding to purchase a product will be its price regardless of its quality or other aspects. In order to obtain this kind of advantage a company must focus all its resources and capabilities on cost reduction while keeping at the same time a minimum level of quality. Cost leadership is not about offering a bad product but an acceptable one at a very low price. Only one company can be the cost leader.

#### **b) Differentiation strategy**

Differentiation means that the company possesses something that other companies do not have, thus allowing it to set a higher price to its products than its rivals, thus obtaining higher profits. It consists in incorporating some specific attribute to the

company's offerings so that a kind of partial monopoly is generated. Unlike cost leadership any company can pursue a differentiation strategy and be successful since there are many distinguishing attributes that can be incorporated into the offerings of the company. The main objective is to find which characteristics are more appreciated and valued by the customers.

### **3.3.2. Expader Tech's case**

Expander Tech sells equipments aimed at reducing energy costs. These machines are very expensive, require annual maintenance and a defective piece costs a lot of money to repair. Taking into account these characteristics we can deduce that the most valued and appreciated factors by the customers in this market are price and reliability. Customers want to buy a cheap and reliable machine that will have the least number of failures since these are very expensive to correct. We have a scenario in which those companies who opt for a differentiation strategy would have to focus on reliability, innovation and marketing campaigns geared towards stressing the high quality of the machines, while those companies opting for a cost leadership strategy would have to focus on strategies to reduce costs while keeping up the quality standards of the components. Differentiation is difficult to achieve since customers do not really care about the design or the brand of the machine they mostly look for efficiency, durability, reliability and price.

Expander Tech has some competitive advantages compared to its main competitor:

- Location: real wages in Spain are much lower than in the United States providing the company with a cost advantage
- Patents: the company is in possession of some patents of components that make the ORCs more efficient.

On the other hand it also has some handicaps when comparing it to Electratherm

- Brand: Electratherm is a more consolidated and known firm plus being an American company increases its prestige.
- Experience: Expander Tech has less experience when dealing with foreign customers, investors or distributors.

Taking all this into account it would be advisable for the company to follow a cost leadership strategy since Expander Tech machines are cheaper than those marketed by its main competitors, especially those of Electratherm, while the quality of its components is very good. The company should endeavor to make this known to the

public by building a reputation of being a company that strives for offering lower prices through technical innovation and good management while keeping high standards of quality.

## **4. PLANNING AND CONTROL**

### **4.1. Role of management and employees**

**Table 11. Ways to understand strategic implementation**

<b>Model</b>	<b>Ways to understand strategic implementation</b>
Executive	Implementation is about meeting strategic objectives
Change	Implementation is about how to modify or adapt the organizational structure and incentive and control systems to make them fit strategy demands and facilitate strategy execution
Participative	Implementation consists in getting the management committed to the development of organizational strategy
Cultural	Implementation is about infusing a set of corporate values to the employees which will eventually determine their behaviour and will perpetuate the mission of the company
Entrepreneurial	Implementation consists in a set of daily actions carried out by executives in search of new opportunities

*Source: Own elaboration*

Expander Tech, being a technology-based and innovative SME which is transitioning from the establishment stage to that of growth, understands implementation in an entrepreneurial way. Managers are always looking for new ideas to keep the business going and employees are encouraged to innovate. It must be taken into account that all the staff but two people are engineers so that new ideas are always welcomed and encouraged since technological breakthroughs are the *raison d'être* of the company and constitutes its main source of competitive advantage. Thus, the role of the management will be that of promoter and evaluator while the employees will be encouraged and expected to experiment and take risks.



## **4.2. Organizational structure**

### **4.2.1 Horizontal differentiation**

It divides the company's activities in simpler, homogenous and more manageable organizational units

#### **4.2.1.1. Departmentalization by procedure**

##### **a) Functional departmentalization**

It consists in grouping activities according to the functions performed like human resources, IT, accounting, manufacturing, logistics and engineering. Functional departmentalization can be used in all types of organizations.

##### **b) Process departmentalization**

It consists in implementing a process through the combination of related activities into different groups or specialized functional areas which are distinct from one another. The advantage of this process is drawn from the fact that separation of the process into groups of smaller activities makes it easier to perform.

#### **4.2.1.2 Departmentalization by purpose**

##### **a) Product departmentalization**

It consists in dividing the business activities according to the type of goods or services produced. This kind of departmentalization usually groups tasks related to a specific product or product line under a single manager specialized in that aspect of the business.

##### **b) Customer departmentalization**

It consists in grouping activities according to the common customers or types of customers. The assumption is that customers of each kind have specific needs that can be best met by specialized employees.

##### **c) Geographic departmentalization**

It consists in grouping activities on the basis of territory. If the customers of a company are geographically dispersed, they can be grouped based on geography.

## **4.2.2 Vertical differentiation**

### 4.2.2.1 Types of vertical differentiation

#### **a) Flat organizations**

Flat organizations are also oftentimes called or referred to as self-managed organizations. This kind of organizations have little or no hierarchic levels between employees and management so that there are no job titles, managers, seniority, executives...etc. The main idea is that employees will be more productive when they are more directly involved in decision-making and not supervised by a hierarchy of managers. This kind of organizations foster employee participation through a decentralized decision-making process, thus giving employees more responsibility. This empowerment of employees has the effect of fastly spreading commentaries and new ideas and suggestions and to all the staff involved in taking decisions, thus improving communication.

This structure is only possible for small or medium size organizations. When companies reach a certain size they can still keep a simplified structure but they are incapable to keep a structure wholly flat without productivity being affected.

#### **Advantages**

- Less bureaucratic costs (less managers)
- Faster decision-making
- More flexibility
- Increased closeness to customers
- Employees empowerment  
Faster reaction to changes

#### **Disadvantages**

- Lack of structure can make accountability and reliability an issue
- Challenges for communication and collaboration by formation of exclusive cliques
- Creation of informal hierarchies based on seniority

<http://www.encyclopediainanciera.com/organizaciondeempresas/estructura-organizacion/organizaciones-planas.htm>

## **b) Hierarchical structures**

They are also called pyramid-like structures where one person is in charge of a functional area or department with one or more subordinates handling the sub-functions. In this kind of organizations higher levels up the ladder imply greater superiority and domination than the lower ones, and the chain of command extends straight from the top to the bottom. Employees are given clearly defined roles and leaders. Although a hierarchical structure has some disadvantages, the structure comes with several advantages that make it worth considering for a small company with several employees.

### **Advantages**

- Authority is obvious
- Managers are skilled in specific areas
- Clear promotional pathway
- Department loyalty

### **Disadvantages**

- Innovation stagnates
  - Communication flow from the top to the bottom
  - Less employee engagement
  - Low level of collaboration
  - Sluggish and bureaucratic environment
- Read more:

#### 4.2.2.1. Expander Tech's case

##### **Horizontal differentiation**

Regarding horizontal differentiation, Expander Tech divides its departments according to the different stages of the production process which are as follow:

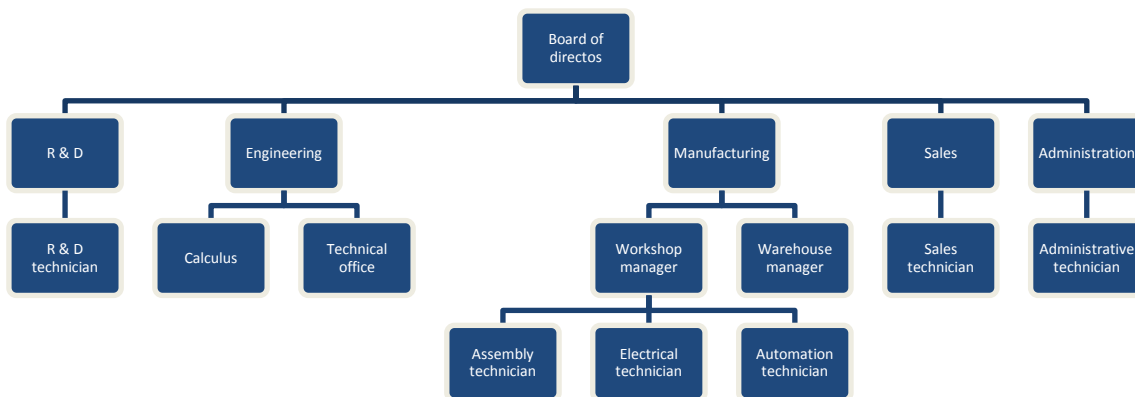
**a) R&D:** it is the first stage of a potential new service or product. The department is staffed by engineers tasked with developing new products. The main difference between R&D and the other departments of the company lies in that the former is not intended to yield immediate profit, and generally carries greater risk and an uncertain return on investment.

**b) Engineering:** it makes the theoretic ideas of the R&D department more feasible by designing the prototypes. Activities like calculus, 2D and 3D plans, search of information and materials, schematics of principle are done in this area of the company.

**c) Production:** it mainly consists in the assemblage of the different components and pieces of the machine since the company only manufactures the expandere. There is very little stock because the company only manufactures on request,

**d) Sales:** it is mainly in charged with looking for new attractive markets, companies that meet the requirements to be distributors, organizing events and participation in fairs.

**Figure 11. Expander Tech organizational chart**



*Source: Own elaboration*

### **Vertical differentiation**

With respect to the vertical differentiation, the structure of the company is hierarchical. This is normal, taking into account that it is a young small company transitioning from the nascent to the growing phase where there is much at stake so that managers want to keep a tight control of the company.

### **4.2.3. Main features of Expander Tech organizational structure**

#### **a) Complexity**

It refers to the degree of work specialization. In this case it is very low since the company has less than ten employees and almost all of them are engineers. This means that they sometimes are required to perform different tasks. For example, an engineer of the engineering department may be required to do translation work from Spanish to English for a project or research about the working of the energy market. The managers, who are also entrepreneurs, perform different kinds of tasks since resources are scarce and there is a lot of work to be done.

#### **b) Formalization**

It refers to the existence of rules, procedures and policies that determine how employees must perform their tasks. In this particular case the degree of formalization is also very low since not much planning has been done in the company so far. The employees are given a free hand to do their work provided they do it in time.

#### **c) Decentralization**

It refers to the transfer of decision making power and assignment of accountability and responsibility for results. In this case decision-making is concentrated within the management level since there are four managers, who are also owners of the company. Being a small company where almost half the employees are owners makes it reasonable for managers who want to keep control of them company to keep decision-making for themselves.

## **4.3. Balanced Scorecard**

### **4.3.1. Perspectives of analysis**

#### **a) Resources perspective**

It refers to the most important resources for value creation: employees and technology. It views organizational performance through the lenses of human capital, infrastructure, technology, culture and other capacities that are key to performance. It encourages the identification of measures that answer the question "How can we continue to improve, create value and innovate?". Examples are: life cycle to product maturity, time to market versus competition, time to develop new generation of products...etc.

**b) Internal processes perspective**

This perspective offers valuable information regarding the extent to which each area of the company is properly operated. It examines organizational performance according to the quality and efficiency related to the product or services or other key business processes. It encourages the identification of measures that answer the question "What must we excel at?". Examples are: cycle time, new product introductions, yield, unit cost...etc.

**c) Customer's perspective**

In order to achieve a high financial performance a company must have loyal and satisfied customers. This perspective measures the relationship between the company and customers and the expectatives that the latter have about the company's products or services. Measures must answer the following question: "What is important to our customers and stakeholders?" Examples: share of important customers' purchases, percent of sales from new products, ranking by important customers, on time delivery..etc.

**d) Financial perspective**

It reflects the ultimate goal of companies of getting the maximum return on investments. It measures the capacity to generate value, maximizing profits and minimizing costs. The measures chosen by designer must answer the question "How does the company look to shareholders?" Examples are: sales growth, operating income, cash flow, return on equity...etc.

### 4.3.2. Expander Tech's Balanced Scorecard 2017-2020

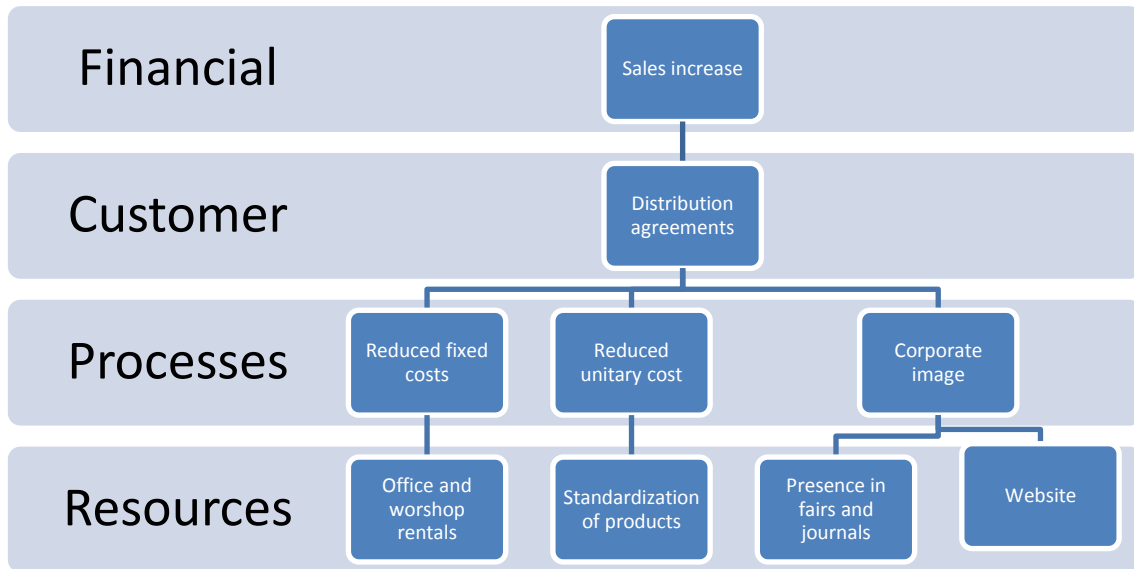
Table 12. Balanced Scorecard

STRATEGIC PRIORITIES	OBJECTIVES	INDICATORS	TARGETS
<b>FINANCIAL</b>	Increase in sales	Annual sales	400% increase
<b>CUSTOMERS</b>	Distribution and maintenance agreements	Number of agreements signed	Four
<b>INTERNAL PROCESSES</b>	Unitary cost	Manufacturing cost	10% decrease
	Fixed costs	Overhead costs	10% decrease
	Improve corporate image	% of expenses in advertisement and promotion	5% of total costs
<b>RESOURCES</b>	Improve web (English)	Spelling and grammar mistakes	Zero mistakes
	Presence in fairs and journals	Number of fairs and articles	Four of each
	Standardization of product	Number of references	12 references
	Office and workshop rental	Rental costs	10% decrease

Source: Own elaboration

As noted above the company is currently selling its products all over the world but it cannot afford to build up a logistic structure for each country so Rank has opted for signing distribution agreements, thus selling the product to the distributor and this in turn selling it to the final customer and also taking over the maintenance of the equipments. For this company, getting those distribution agreements is vital to increase its sales since it doesn't have the structure to sell its products by itself. This balanced scorecard contains a series of goals all of them aimed at lowering costs and improving corporate image to get these agreements.

Figure 12. Strategic map for Expander Tech



Source: Own elaboration



## **5. FINAL REMARKS**

Some opportunities have recently arisen for the ORC systems market. The Paris climate agreement has strengthened the global commitment to fight climate change and has shown the global awareness on that issue, thus opening new opportunities for energy-recovery companies like Expander Tech.

Renewable energies, especially wind and solar power, have demonstrated to increase their efficiency and diminish their costs as times goes by. It is then very plausible to think that the same trend will occur in the ORC's market so that it can be expected an increase in the efficiency of these equipments over time.

Expander Tech holds several patents that give it the technological leadership in the sector. In spite of this, the company is still unknown to the public and has some logistic problems that arise both from the nature of the product, which is very expensive, heavy and requires annual maintenance and from the nature of the market which is global, making thus shipment and maintenance very expensive. That is why it is so important for this company to close favorable distribution agreements. These distributors will provide the required sales infrastructure that the company lacks and will take over the after-sales and annual maintenance services which cannot be done directly by Expander

Having examined all these factors, this strategic plan has been focused on furthering the cost leadership strategy undertaken by the company by increasing its sales through its distributors. The company has a great growth potential and may be able to pursue a differentiation strategy in the future but, for now, it must begin by gaining a foothold in the market.

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