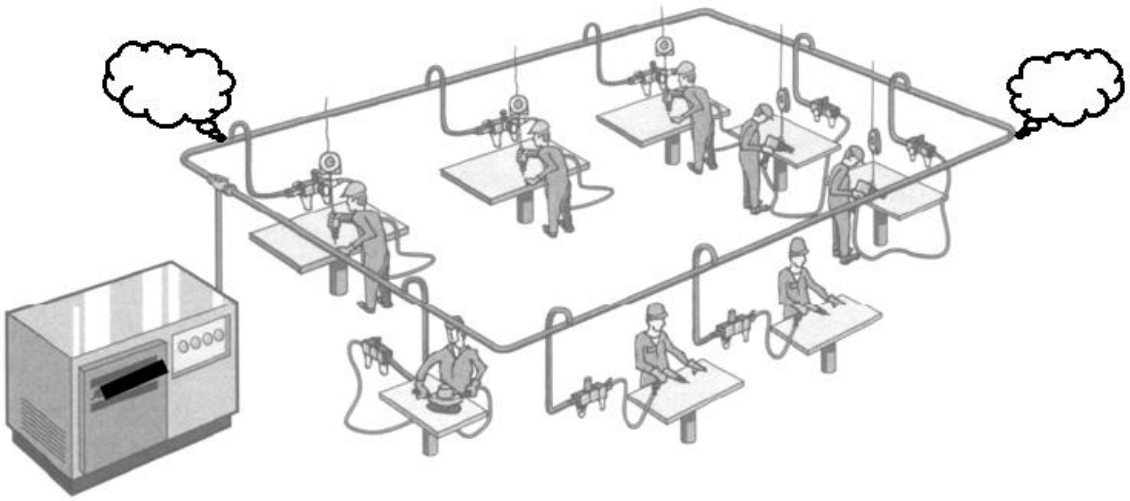
FH AACHEN
UNIVERSITY OF APPLIED SCIENCES

Business Administration

Business Plan:
Compressed Air Maintenance Service



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1 Introduction

At industrial enterprises the usage of compressed air is very common. In Europe, 10% of the industrial power requirement is used for the production of compressed air.[1] This is because of the broad spectrum of applications for example from compressed air pistols over manufacturing devices as compressed-air screwdrivers to machine tools, and pneumatic systems of production lines. The main advantage compared to an electric motor is, that the energy is instantly available, so within a short time period the force can be fully transmitted.

Unfortunately the usage of compressed air is connected with disadvantages, because the equipment for compressed air production and distribution has to be paid and the running energy-costs for the production of compressed air are very high.

For the production of compressed air, compressors are used to compact the air. Furthermore, the air has to be dried and filtered as condensed water in the tubes can lead to damaging of the machines. The diameters and setup of the tubes of the conducting network have to be adapted to the air-flow to provide constant pressure. The leakage should be as small as possible by the usage of adequate materials and sealing of connecting devices. Unfortunately, the growth of network in many companies with time leads to an insufficient setup. Moreover, the network is often leaking due to aging or poor workmanship and it is rarely repaired. As the network is often deficient, by constant maintenance and optimization a lot of money can be saved.

This also coincides with the current trend of companies aiming to be more energy efficient.

2 Company idea

The idea for this business – plan is based on the experiences gained from a project of an energetic optimization of a compressed-air system. From this knowledge the main concept for the prospective company is derived.

2.1 Project: Energetic optimization of a compressed-air system

At the University of Applied Science Amberg-Weiden Prof. Dr.-Ing. A. Weiss developed a laboratory for compressed air. Because of the good relations to the local industry a project has been set up between the university and a middle-sized company, which name is not to be mentioned. The company installed for the manufacturing of their products a compressed-air network that enables the utilization of air operating machines. This network has been growing within the expansion of the company and was not enlisted into a plan. Furthermore the system was leaking air at several locations.
The task of recording and optimizing of this compressed-air-network was conferred to the University Amberg-Weiden and executed by 3 bachelor students of mechanical engineering in the framework of a project.

2.2 The project was realized by execution of the following tasks:

2.2.1 Mapping of the network

For the efficient leakage detection a system was developed with the approach of dividing the company in certain areas. These sections were chosen according to a plan of the company and labeled with letters.

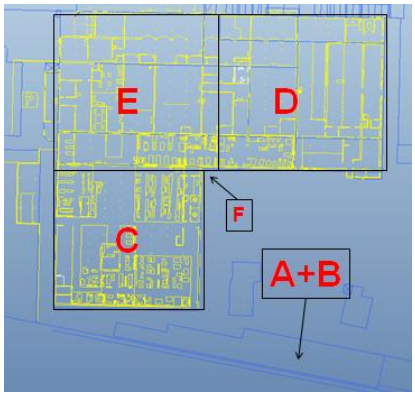

Figure 2-1 Network plan for leakage detection

In the same plan, the network with the corresponding tube diameters is sketched in.

2.2.2 Leakage detection

Simultaneously to the mapping of the network the tubes and the connection devices were checked for leakage. The leakage can be recognized by the noise of emerging air. As the measurement was done while the machines are running and producing a high noise level, a special leakage detector was used that works in the ultrasound range and enables a sound location of the high frequencies, arising from the leaking air.

Figure 2-2 Ultrasonic Leakage Detector

2.2.3 Labeling of the leaking holes and devices

When a leakage was detected, the location was marked with an eye-catching label. Furthermore a number was allocated to this location in the plan, a picture was taken and the task for improvement recorded on a separate sheet. Thus it is possible afterwards to order the right spare parts for the reparation and find the corresponding place. The following pictures show common examples of situations of leaking air.

Figure 2-3 Examples of Air Leakage

2.2.4 Repair

The repairing of the leaking devices was done by the company itself. Unfortunately they couldn't tell us how many hours they worked on and how much material they needed for the improvement of the system.

2.2.5 Measurement of the leakage rate

The measurement of the leakage rate has to be done before and after the repair to enable the calculation of the decreasing energy costs. The measurement can be done with several methods. It is important that the measurement is done when machines are in standstill and the network is in working condition. This has to be done either before or after the shifts or during the weekend.

One approach is, to measure the working-time of a compressor over a certain time period. At an ideal network, the compressor would not have to be active as no air was leaking. As this is not the case it is possible to calculate the running energy costs due to leakage by the time of the running compressor, the power of the compressor and the electricity price for the company. By an extrapolation the annual leakage costs can be determined and compared with the total electricity costs for the compressors.

2.2.6 Results

The calculations show a stunning outcome. It appeared that the leakage rate before the repair is almost half of the total compressor energy costs. The annual energy consumption caused by leakage was determined to 150 MWh which results by electricity costs of 0.12€/kWh in the total annual costs of almost 18000€. The measurement after the repair shows that the leakage rate was reduced significantly to 12% of the now lowered total costs. In fact the annual energy consumption caused by leakage dropped down to 20 MWh which leads to a prediction of just 2410 € leakage costs per year. In summery the company saves 15585€ per year through this project, which is a considerable amount. Considering that each student just spent about 20 hours for the mapping and detection the invested work was rather low compared to the benefit. Finally it is to mention that by saving of energy also the CO^2 emission drops which would be produced during the electricity generation.

		Before	After	Δ
Leakage - rate	**L**	47,05 %	12 %	35,05 %
Annual leakage	**V_a**	1463003 m³/a	195275 m³/a	1267728 m³/a
Annual energy consumption caused by leakage	**E**	150 MWh/a	20 MWh/a	130 MWh/a
Annual leakage costs	**S_a**	17995 €/a	2410 €/a	15585 €/a
CO_2 emission	**CO_2**	90 t	12 t	78 t

Figure 2-4 Comparison : Before and After Services

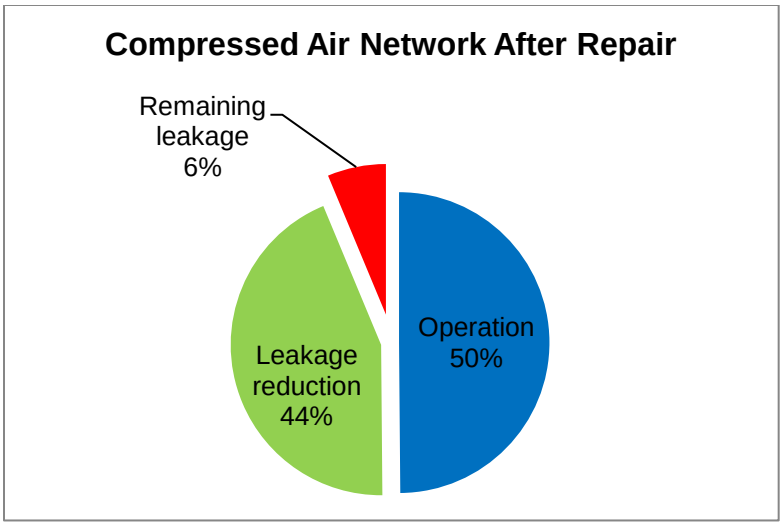

Figure 2-5 Compressed Air Network After Repair

2.3 Service

The prospective company will provide a service which is related to the described project. This service includes the following tasks, which can be divided into analysis, planning, implementation and sustainability:

2.3.1 Analysis

- Measuring of the following parameters
  - Compressor operating times
  - Energy consumption measurement
  - Quality of compressed air
  - Pressure level
  - Leakage loss
- Classifying leakage and cost analysis
- Identify inappropriate compressed air usage
- Measurement of total network from the compressor to the pneumatic applications or individual machines
- Mapping of the compressed air network
- Detecting leakages using ultrasound detectors during operation
- Systematic marking and documentation of the leaks discovered, indicating their location and size
- Classifying the leaks in order to calculate air losses
- Recording the information needed for repairs and improvement

2.3.2 Planning

- Recording of all technical specifications for eliminating leaks (e.g. replacement parts required, etc.)
- Development of a condition monitoring system (Placing sensors at certain places that indicate higher consumption)
- Optimization plan for compressed air generation and compressed air applications

2.3.3 Implementation

- Professional elimination of leaks, i.e. repair or replacement of leaking or faulty pneumatic components (Benefit for the customer: We have the knowhow and now additional burden for the maintenance stuff)
- Installation and commissioning of the new solutions
- Programming, installation and commissioning of condition monitoring system in selected machines
- Instruction of operating staff

2.3.4 Sustainability

- Regular leakage detections
- Regular analysis of compressed air consumption and quality
- Inspection & preventive maintenance
- Training and consulting for engineers that set-up new pneumatic systems

3 Market analysis

3.1 Europe and Germany

As mentioned in the beginning are in Europe 10 % of the industrial electricity used for the generation of compressed air. According to a study[2] of the Frauenhofer institution in 2001 the european consumption of compressed air is about 72 TWh per year. Only in Germany 14 TWh have to be generated just for the production of compressed air which corresponds to the total energy consumption of the Deutsche Bahn.

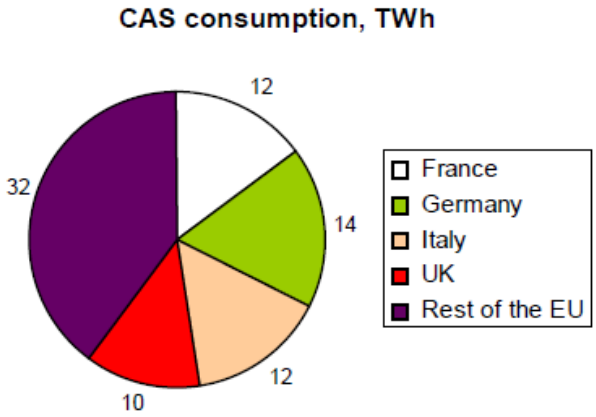

Figure 3-1 Compressed air consumption

For germany an estimated number of 62000 air compressors are already installed. The capital costs for a compressor is rather small. The maintenance cost and energy consumption costs make 90 % of the total expenses.

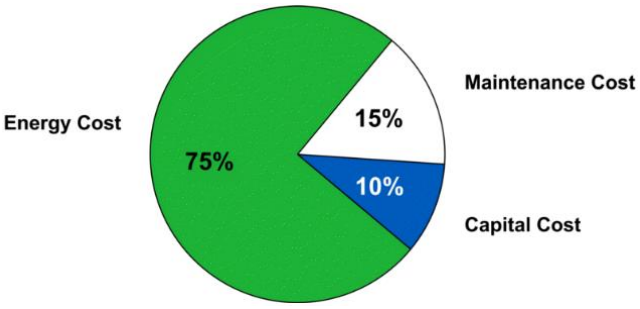

Figure 3-2 Captial Costs for Companies in Germany

In 2004 the campaign “Druckluft-effizient”[3] was started which analyzed the compressed air system of 59 German companies of different sizes. The result was that an average of 33.6% of the energy costs could be saved. The following diagram shows the energy consumption over the calculated saving-potential. In the mean each company had a potential of 20000€ per year.

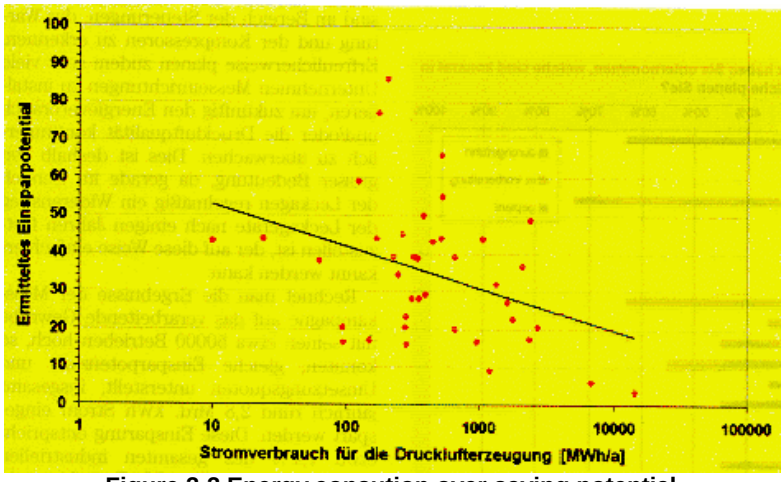

Figure 3-3 Energy consution over saving potential

These facts show that the student-project was not only an exception and that there is a huge energy saving potential. It appears that there is a very big market because a lot of companies take advantage of compressed air. Although they mostly know that the usage of compressed air is expensive, it seems that these companies are not aware of how much energy they waste. Especially due to the rising energy prices, the loss has now an even bigger impact. By a quantification of this loss and the offered services there is a high potential for a successful maintenance company. The following diagram of the study for compressed air systems in the European Union states, that a measuring campaign, information and training cover a very high potential.

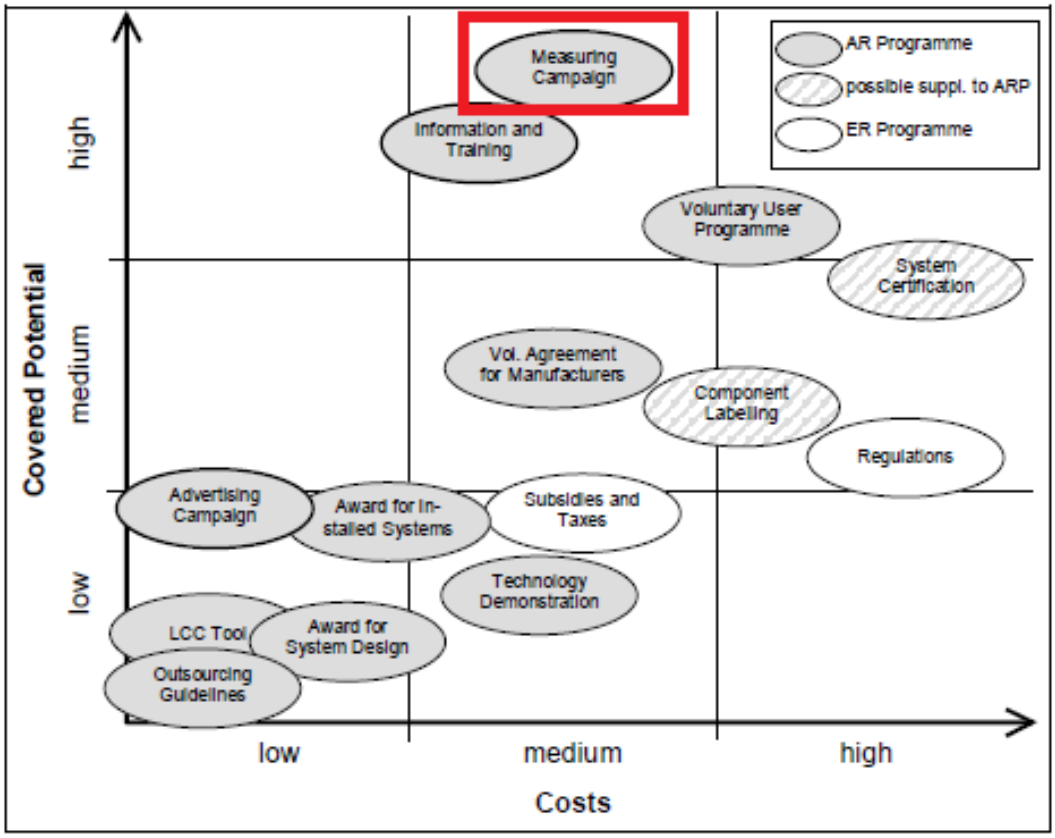

Figure 3-4 Study of compressed air systems in European Union

3.1.1 Concurrence

Facing the concurrence in this service it appears that there are already several companies, offering maintenance to compressed air systems. Especially FESTO plays a bigger role and offers similar services. The most of these companies are however specialized on service to the compressors and not to the correction of the air leaking network.

All in all the market is estimated as very big and not enough explored so it provides enough potential for a small service company.

4 Organization of the company

4.1 Company Organization

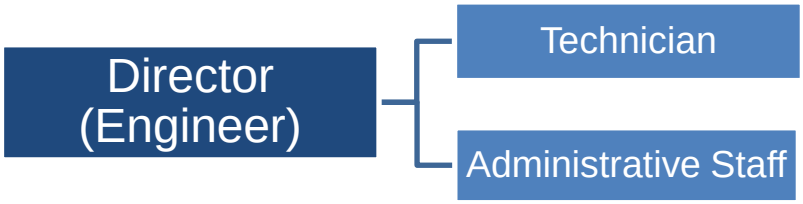

Figure 4-1 Company Organization

4.2 Job Description:

4.2.1 Director (Engineer)

The Engineer acts as a Director of the company. His job is mainly to go to client companies and do the detection and also the repair work along with a Technician.

4.2.2 Technician

The Technician is a certified personnel in the field of metal works. His is employed based on his ability to handle tools and machinery, for instance a welding machine. He must also have the experience working with conduction tubes as for example used in heating systems.

4.2.3 Administrative Staff

An Administrative Staff is hired to handle the office work. A typical office work includes documentations for the company and also the client companies. However, this staff is also responsible for marketing. He will need to call the client companies and offer our services. In order to save cost and to avoid redundancy, this staff is hired on a part time basis where he works only 4 hours a day.

4.3 Definition of Working Hours

For the price definition, it is important to know the amount of working hours for the Engineer and Technician that the customer can be charged for. Since the Engineer and the Technician are working together, the hours are defined as such:

	Total Days/year	Total Hours/year
Working Days	250	2000
Holidays	-25	-200
Sick Days	-10	-80
Free measurement	-15	-120
Grand Total	**200**	**1600**

*Calculation is based on 8-hour work day

The total of working hours of the Engineer and Technician that the customer can be charged for is 1600 hours per year **each.** Further 120 hours per year each are considered to provide the free measurement service to gain customers as it will be explained in the marketing section.

For 1 month: 1720/12 = 143 hours
For 1 week: 143/4 = 35.8 hours

Therefore, the Engineer and Technician work an average of 36 hours per week **each**.

5 Investment analysis

5.1 Investment costs

5.1.1 Workshop + Office

For this business, we will need a workshop where we can store equipments like machines and tools and also the materials for repair work. This is the integral part of the business since it deals with a lot of tools and machineries. For administrative work, a partition will be made within the workshop as an office where an administrative staff will be placed to take care of the paper works. As this facilities don't need to be very big, the amount of investments is 100,000€ for the workshop space.

5.1.2 Renovation

For the office partition, a unique renovation will be made at a cost of 15,000€.

5.1.3 Company Car:

Due to the fact that the transportation of the tools, materials, ladder… needs a car that provides a lot of space, the choice for a company car is a Mercedes sprinter for up to 35000 € including service. It is considered to buy the car as some changes might be necessary for the tools transportation.

Figure 5-1 Company Car

5.1.4 Office Equipment

The cost of Administration includes the cost of basic office supplies, such as:

Item	Quantity	Unit Cost (€)	Cost (€)
Computer	1	500	500,00
Telephone	1	69	69,00
Fax Machine	1	250	250,00
Printer	1	100	100,00
Photocopy machine	1	750	750,00
Papers	10	3,99	39,90
Fax Papers	10	4,99	49,90
Stationery	1	20	20,00
Reference books		500	500,00
Coffee machine	1	69	69,00
Total			**2,347.80**

5.1.5 Furniture

Furniture is meant for the office. Furniture needed is as such:

Item	Quantity	Unit Cost (€)	Cost (€)
Desk	1	99	99
Swivel Chair	1	59	59
Chairs	2	19	38
Couch	1	269	269
Coffee Table	1	69	69
Shelf	2	79	158
Carpet (250x180)	2	89	178
Table Lamp	1	19	19
Pantry Table	1	29	29
Dustbin	1	4	4
Total			**922**

5.1.6 Machines & Tools

Description	Quantity	Cost (€)
Industrial Ladder (4m)	1	350
Tool box	1	800
Power drill	1	400
Transportable welding machine + protection	1	700
Sound level meter	1	100
Ultrasound Leak Detector	1	1000
Others		1000
Total		**4350**

In total, machinery costs of 4350 € will be considered.

5.1.7 Materials

To provide a fast repair service there is material needed which should be kept highly available. The material should be stored in the workshop, and for some often needed components, in the car. The material will be divided in the following stock:

- Raw material & semi-finished goods
  - Metal sheets
  - Welding material
  - Conduction tubes of several diameters
  - Adhesive foil
  - Clips, screws, nails…
- Spare parts
  - Valves
  - Clogging ups
  - Air pistols

The costs for the material used for the repair in a company will be transferred directly on the bill, so the invested money is returned to the company. However it is important that there is a certain contingent of spare parts and material always available to ensure a fast repair service without long ordering times of raw material and spare parts. Furthermore the ordering should be done in high quantities to receive a price reduction. Therefore 20000€ are planned for materials investments.

5.1.8 Marketing

Marketing is one of the most important factors of a successful company. The main concept of marketing will be the offer of free measurements and networking, as this is seen as a strategy with high potential. The marketing will include the following methods:

- A free leakage-measurement-service will be offered. As managers of companies are often not aware of how much they lose, they might be unwilling to spend money already for a measurement. If the measurement is offered cost-free, more companies might decide to check their leakage. If the leakage is high and we are already at the company, it is meant as way easier to get the acceptance for the whole service job.
- Setting up of a Facebook-page and starting of several chain-mails to all friends (over 1000) to inform them about the service and to ask them about sharing the offer to their friends (snow-ball principle), families and especially to persons that work in higher positions of companies.
- Sharing a You-tube video that gives an example about a company that reduced significantly their leakage costs through our work. The movie should contain a passage, where the boss of a company is complimenting the person that advised him to give the job to our company.
- The advertising should in general increase the awareness of how much money they lose
- Also advertising and offers by emails, letters, company cards and advertisement on the company car should be considered
- Furthermore should the company become a member of compressed-air institutions so they are always up-to-date and new customers can be found at the meetings.

As networking needs only little investment money, a total amount of 7000€ for marketing should be enough to get started.

5.1.9 Unexpected

An amount of 40,380€ is set aside for contingencies.

5.1.10 Circulating Capital

A circulating capital of 5,000€ to allow liquidity in transactions.

5.2 Total Investment Costs

The total investment costs including the annual depreciation are as such:

Expenditures	Costs (€)	Depreciation rate in years	Depreciation rate (%)	Annual Depreciation (€)
Workshop + Office	100,000	20	5	5000
Renovation (1 time)	15,000			
Company Car	35,000	5	20	7000
Office Equipment	2,348	10	10	234.78
Furniture	922	10	10	92.2
Machines & Tools	4,350	10	10	435
Marketing	7,000	4	25	1750
Material	20,000			
Unexpected	40,380			
Circulating Capital	5,000			
Total	**230,000**		**Total Depreciation per annum**	**14,511.98**

The total investment costs is €230,000. The total depreciation per annum is €14,511.98.

5.3 Financing

Total Investments	**230,000**	
Shareholder Equity	130,000	
	Shareholder 1	**Shareholder 2**
	65,000	65,000
Bank Loan	100,000	

The total investment is 230,000€. A bank loan of 100,000€ is made with an interest of 7% over a period of 10 years. The balance of 130,000€ will be split between 2 shareholders, the Director himself and the nominal shareholder. Each having a 50 % share.

5.4 Interest Paid on Debt

Year	Balance of Debt (€)	Interest rate	Interest paid p.a. (€)	Repayment p.a. (€)
1	100,000	7%	7,000	10,000
2	90,000	7%	6,300	10,000
3	80,000	7%	5,600	10,000
4	70,000	7%	4,900	10,000
5	60,000	7%	4,200	10,000
6	50,000	7%	3,500	10,000
7	40,000	7%	2,800	10,000
8	30,000	7%	2,100	10,000
9	20,000	7%	1,400	10,000
10	10,000	7%	700	10,000
Total Interest Paid (€)			**38,500**	
Total Repayment (€)				**100,000**

The total bank loan is 100,000€. As agreed with the participating bank, the interest rate is 7% over a period of 10 years. Therefore, the interest per year and the repayment is shown as above. At the end of 10 years, the total interest paid will be 38,500€.

5.5 Labour Costs

Description	Annual Salary (€)
Director (Engineer)	65,000
Technician	45,000
Administrative Staff	20,000
Total Personnel Cost	**130,000**

The annual salary is shown as above. As the size of the company is small, the total cost for personnel adds up to 130,000€ per year. The Director who is also the Engineer will cost 65,000€ per year. The certified Technician earns 45,000€ per year and the part time Administrative Staff will earn 20,000€.

5.6 Self-cost per hour

Year	1	1	2	3	4
Utilization of Capacity (%)	60	60	80	100	100
Amount of hours	1,920	1,920	2,560	3,200	3,200
Cost	**Cost per hour**	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Depreciation Cost (€)	7.558333333	14,512	14,512	14,512	14,512
Financing Cost (€)	3.645833333	7,000	6,300	5,600	4,900
Labour Cost (€)	67.70833333	130,000	130,000	130,000	130,000
Sum of Cost (€)		151,512	150,812	150,112	149,412
Total Cost per hour (€)	78.9125	78.9125	58.9109	46.9100	46.6912

5.7 Price Definition

After the self-cost calculation, the final price per hour is set at 60€. This agreed figure is based on the compromise between 2 factors.

i. To have a margin of profit to cover the investment costs
ii. To remain competitive in the market

5.8 Turnover

The projected turnover for a period of 10 years.

Year	Utilized Hours	Price per Hour (€)	Turnover (€)
1	1920	60	115,200
2	2560	60	153,600
3	3200	60	192,000
4	3200	60	192,000
5	3200	60	192,000
6	3200	60	192,000
7	3200	60	192,000
8	3200	60	192,000
9	3200	60	192,000
10	3200	60	192,000

5.9 Cash Flow

Year	1	2	3	4	5
Turnover/Revenue	115200	153600	192000	192000	192000
Depreciation Cost	14512	14512	14512	14512	14512
Labour Cost	130000	130000	130000	130000	130000
Financing Cost	7000	6300	5600	4900	4200
Loss carried forward		-36,312	-33,524		
Profit before tax	-36,312	-33,524	8,364	42,588	43,288
Taxes (40%)	0	0	3345.60	17035.20	17315.20
Profit after Taxes	-36,312	-33,524	5,018	25,553	25,973
Cash flow (Net profit+ Depreciation)	-21,800	-19,012	19,530	40,065	40,485
Repayment Credit	10,000	10,000	10,000	10,000	10,000
Dividend (€)	-31,800	-29,012	9,530	30,065	30,485

This cash-flow of up to 5 years shows that the company will make a loss in the first 2 years. These losses are then carried forward to the third year as profit will be made.

5.10 Cash Flow Over a Period of 10 years

Year	1	2	3	4	5	6	7	8	9	10
Turnover/Revenue	115200	153600	192000	192000	192000	192000	192000	192000	192000	192000
Depreciation Cost	14512	14512	14512	14512	14512	14512	14512	14512	14512	14512
Labour Cost	130000	130000	130000	130000	130000	130000	130000	130000	130000	130000
Financing Cost	7000	6300	5600	4900	4200	3500	2800	2100	1400	700
Loss carried forward		-36,312	-33,524							
Profit before tax	-36,312	-33,524	8,364	42,588	43,288	43,988	44,688	45,388	46,088	46,788
Taxes (40%)	0	0	3345.60	17035.20	17315.20	17595.20	17875.20	18155.20	18435.20	18715.20
Profit after Taxes	-36,312	-33,524	5,018	25,553	25,973	26,393	26,813	27,233	27,653	28,073
Cash flow (Net profit+ Depreciation)	-21,800	-19,012	19,530	40,065	40,485	40,905	41,325	41,745	42,165	42,585
Repayment Credit	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Dividend (€)	-31,800	-29,012	9,530	30,065	30,485	30,905	31,325	31,745	32,165	32,585

5.11 Total Dividend

Total dividend over 10 years: €167,992

5.12 Equity Profitability

Year	Equity	Profit After Tax (€)	Dividend (€)	Interest made on equity (%)
1	130,000	-36,312	-31,800	-24.46
2	130,000	-33,524	-29,012	-22.32
3	130,000	5,018	9,530	7.33
4	130,000	25,553	30,065	23.13
5	130,000	25,973	30,485	23.45

In the first and second year, shareholder will have losses but by the third year shareholders will earn an appreciation on equity of 7.33% and by the fourth year 23%.

6 Conclusion

6.1 Perspective

All in all, this business plan is classified as an idea with high potential as it is still a niche in the market. The prerequisite are not very complex so it should be possible to gain the essential experience within a short time.

Anyhow, with the rise of the energy price, companies are striving to save as much energy and to be as efficient as possible. This leads to a high perspective for the future and also promotes awareness to our environment.

6.2 Further possible investigations

If the measurement-service is done successful and enough experience is gained, it would be a good option to expand the service to installation of compressed air systems, not only maintenance. Therefore customers can be won already in the beginning and money can be earned with a long-time service contract.

7 References

[1] Drucklufttechnik, Zeitung für die Anwendung in der Industrie, vereinigte Fachverlage, 07.07.2010

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[3] Druckluft effizient, Messkampagne, 2004