Professional MBA
Entrepreneurship & Innovation

# ANALYSIS & STRATEGY FOR A CHEMICAL PROCESS

A Master's Thesis submitted for the degree of
"Master of Business Administration"

supervised by
Prof. Dr. Anthony Warren

Luis Miguel Coronado González
h8930213

Vienna, 30th of June 2012

# Affidavit

I, **Luis Miguel Coronado Gonzalez**, hereby declare,

1. that I am the sole author of the present master's thesis **Analysis & Strategy for a Chemical Process**, 76 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and

2. that I have not prior to this date submitted this master's thesis as an examination paper in any form in Austria or abroad.

Vienna, 30th of June 2012

_____

Signature

# Abstract

The aim of this master thesis is to investigate the reasons why manufacturers of flat stainless steel products are hesitant to acquire spray-roasting type acid regeneration plants for mixed acid, despite all the economic and environmental advantages.

The thesis begins with an overview of the stainless steel market and the market potential for acid regeneration technologies. It continues with a short overview of existing commercialized technologies and their potential. Lastly, barriers to investment from the customers' perspective have been investigated and analyzed.

The main reasons for the reserved investment willingness of customers are three-fold: a) lack of information about the economic and environmental impact of the technology, b) weak local environmental regulations which incentivizes the purchase of low-budget and environmentally unfriendly technologies and c) less willingness to invest in new technologies due to the high competitiveness and precarious financial situation of steel manufacturers.

A proposal to counteract these three dimensions is then conducted, concluding that a) the lack of information can be mitigated by a strategy of marketing and the diffusion of innovations, b) local authorities could be advised and consequently environmental regulations could be tightened through strategic lobbying and c) an alternative to the traditional sales model could be a service-oriented business model: the BOOT and "Chemical Leasing Concept." This innovative and environmental friendly concept is then adapted to the steel manufacturing industry.

The last chapter is a proposal for the launch of an innovation management department in Andritz, but may also be applicable to any other company or organization with a similar structure and culture.

Keywords: spray roasting, acid regeneration, strategy

# Preface

This Master Thesis is the culmination of the Professional MBA Program “Entrepreneurship & Innovation” at the Vienna University of Economics and Business. It was conducted with the intent of understanding the international market for acid regeneration technologies in the stainless steel industry.

The motivation for writing this thesis arose from the question of why steel manufacturers are hesitant to acquire proven technologies -- in this case a spray-roasting process -- despite it reducing production costs, having a positive environmental impact and representing an attractive return on investment.

The idea first came to my mind while working as a Technical Product Manager for the Pyromars Process at Andritz Metals. I wanted to examine why we have not been more successful in selling regeneration plants employing this process to steel manufacturers, given all the aforementioned economic and technological advantages. What can we improve within our organization to better reach potential customers? Does innovation matter in such a conservative industry? And finally, how can we boost innovative processes within our company?

Firstly, I would like to thank my employer Andritz for their support during my completion of the MBA-Program. I hope this master’s thesis will be a valuable contribution to our development of future strategies in acid regeneration technologies.

A big thank you to my thesis advisor Tony Warren (Pennsylvania State University, USA) for all his advice and contributions to the project.

Many thanks to all my colleagues who shared their invaluable experience with me. Without this information it would not have been possible to finish my work.

Last – but certainly not least -- I want to thank Claire for all her support during the MBA program.

# Table of Contents

# Table of Figures

# List of Tables

# List of Abbreviations

| | |
|---|---|
| AAG-M | Andritz AG, Metals Division |
| APU™ | Acid Purification Unit |
| ARP | Acid Regeneration Plan |
| BOOT | Build Own Operate Transfer |
| IP | Intellectual Property |
| COD | Customer Oriented Design |
| OPAR | Outokumpu Pickling Acid Recovery |
| PPP | Public Private Partnership |
| ROI | Return on Investment |
| SAR | Scanacon Acid Recovery |
| STAR | Steuler Total Acid Regeneration |
| SCR | Selective Catalytic Reduction |
| UNIDO | United Nations Industrial Development Organization |
| USP | Unique Selling Proposition |

# 1 Introduction

The pickling process is an important surface treatment step during the production of stainless steel flat products. Here, *mixed acid,* which consists of hydrofluoric and nitric acid, is used at 50°C-55°C in a pickling bath until certain metal concentrations are reached. After that, the waste mixed acid is either disposed and neutralized or recycled in an acid regeneration plant. There are already several existing processes for the recycling of waste mixed acid on the market but their adoption remains limited.

As an example, the Pyromars process is a unique process in the stainless steel market for the total regeneration of "mixed acid", the mixture of fluoric and nitric acid used in pickling baths in stainless steel production. *Total regeneration* refers to the recovery of free and bounded nitric and hydrofluoric acid, but also of dissolved metals. After treating the waste acid in a pyrohydrolytic[1] step, the gases are cooled down in a pre-concentrator and subsequently treated in an adiabatic absorption column and washing system. The resultant effluent gases are treated in a SCR-process (Selective Catalytic Reduction) before they are transported to the atmosphere. The regenerated mixed acid (product) is reused in the pickling line and the metal oxide (by-product) can be reused either for steel manufacturing or for the recuperation of nickel and chromium.

A regeneration method with membrane techniques was also developed and put in operation in the previous two decades. It consists of one microfiltration and two nanofiltration steps, followed by crystallization, pyrohydrolytic reaction and off-gas cleaning. This process has a higher complexity during operation and is also characterized by the short lifetime of membranes, which results in high maintenance costs. The success has been modest; only 3 plants have been built despite the technology's advanced age.

A quite popular technology for partial regeneration is Retardation. It is probably the most diffused technology in this area. The APU™ (Acid Purification Unit from EcoTec) systems or the SAR units (Scanacon Acid Recovery) use a resin sorption process to remove dissolved metals from the pickling acid and return the unused acid to the pickling process. It is a simple method based on ion-exchange in resins (EcoTec, Acid Purification System for Stainless Steel Pickling Acids). Today, ion exchange technology has been introduced in many stainless steel processing plants; however nitric acid influences the stability of the resin which has raised concerns with regards to the life time of the units. These units have

[1] Decomposition by the combined action of heat and water vapor.

low investment and operation costs and are therefore appealing to many steel manufacturers despite the loss of metals.

The electro dialysis, solvent extraction and others have also been used for waste mixed acid treatment combined with other separation technologies, without low success until now.

There are many advantages and disadvantages with the different technologies on the market. However, when weighed against these other processes, the spray-roasting technology is the most appealing option for customers looking for a cost-efficient and environmental friendly technology for the total recovery of mixed acid. An illustration of the various pros and cons is included in chapter 2.2.

## 1.1 Problem Formulation & Objective of the Master's Thesis

Despite the leading market position of the Pyromars technology in the segment of total regeneration processes, it has not achieved the widespread adoption befitting of its utility; customers are still reluctant to acquire this kind of regeneration technologies. At the same time, competitors are increasingly interested either in developing alternative technologies, or simply in replicating this process, despite the partly protection through patents.

The aim of this master thesis is to conduct an analysis of the environment (market position, trends, competitors, customers, etc) of mixed acid regeneration plants, and to develop short and long term strategies (objectives, resources, implementation, etc.) to increase the sales of spray-roasting technology.

A further aim is the investigation and implementation of new innovation methods within the company and the exploration of new business concepts for the sale and operation of such plants.

## 1.2 Course of Investigation

The investigation starts with a brief analysis of the present stainless steel market. Some events in the recent past, such as the financial crisis and the shifting of the steel production to emerging markets, have dramatically impacted the market. A forecast for the near future will anticipate how large the market for regeneration technologies will be.

Commercial acid regeneration technologies available on the market will be discussed to determine competitors, market shares and potentials.

A survey within the sales department and selected lead users will give valuable information about customer demands, the most relevant purchasing attributes and also the barriers to investment to overcome.

The results from this research and analysis of the development of the steel market lead to a formulation of a proposal of how to improve customer approach and sales' strategy.

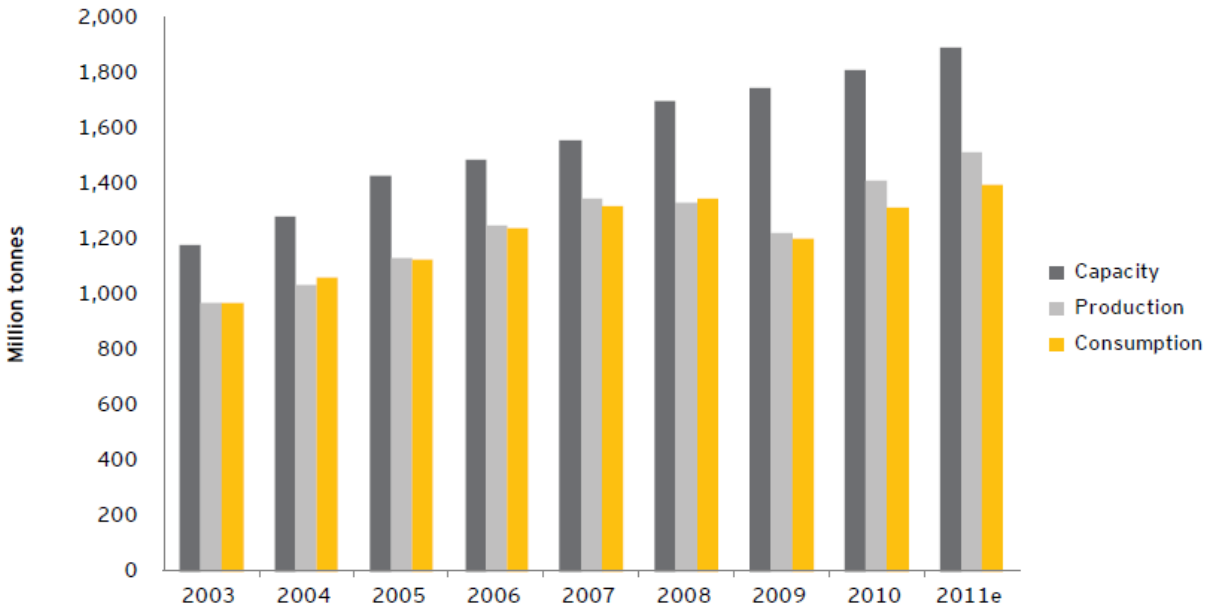
Finally, a proposal to introduce an innovation management department is completed.

# 2 Overview and Investigation

## 2.1 Global Steel Production – Trends and Outlook

Global steel production increased consistently beginning of the first decade in the 21st century. The growth of production capacity remained unchanged during the global economic crisis of 2008-2009. During this time, steel mills were operating at full capacity when demand suddenly fell sharply. The surplus in steel production caused an imbalance in the market which affected the profitability, but also the investment behavior of manufacturers. In the midst of and immediately after the crisis, steel consumption was lower than production and much lower than production capacity. Today there remains a lag between demand fluctuation and production adjustments as there is still structural overcapacity in certain product segments. Many private steel manufacturers have already consolidated to just a few enterprises, as for example ACERINOX, OUTOKUMPU-INOXUM and APERAM in Europe.

Figure 1: Global steel capacity vs. supply vs. demand




Source: ABARE, Worldsteel Association, JPMorgan and Ernst & Young analysis

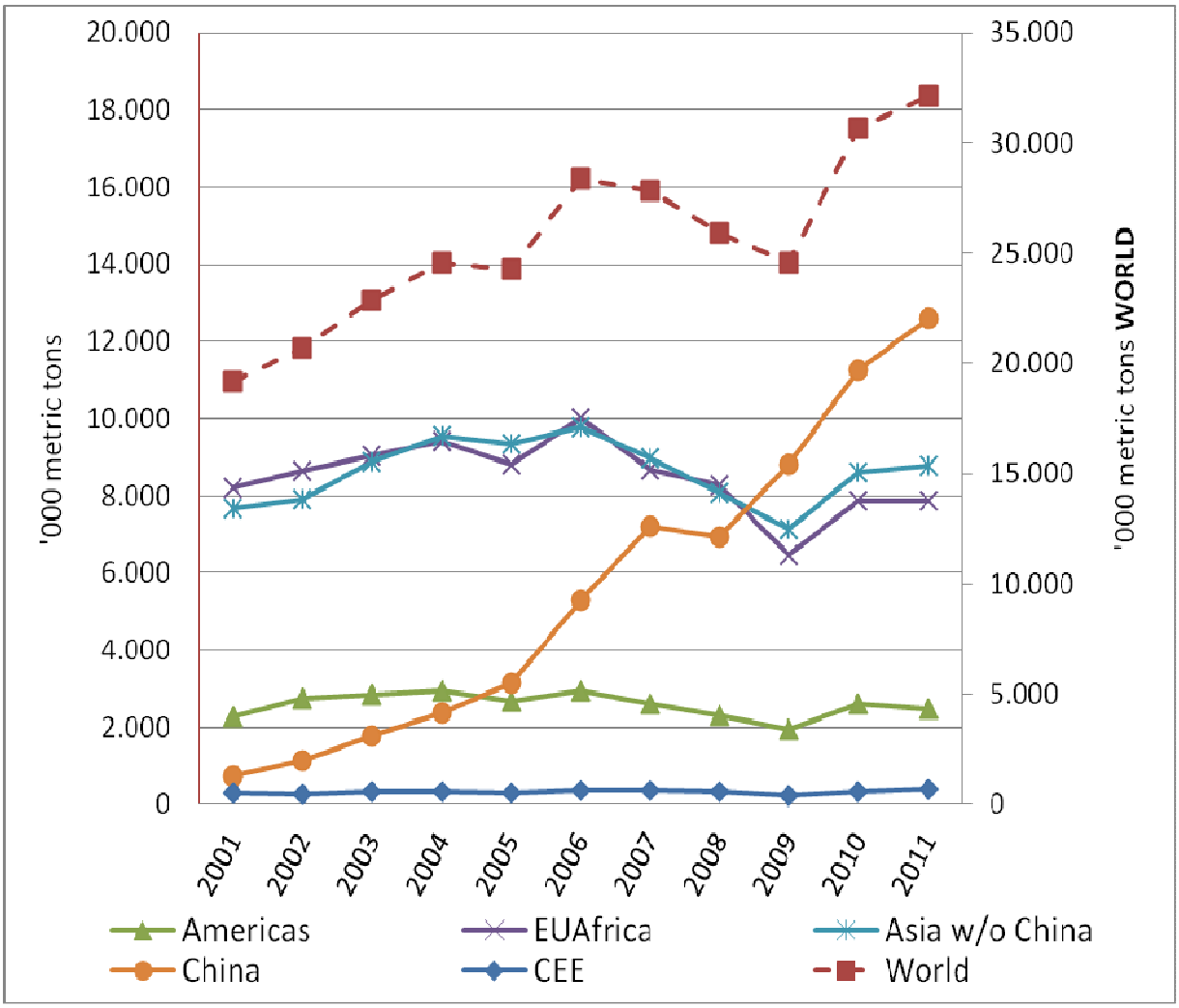
The likelihood that this consolidation process will continue in other regions of the world is very high. These new groups are facing a margin pressure due to overcapacity, market volatility in the cost of raw materials and a shifting of the steel production and demand from

mature to emerging economies. China is already playing a significant role in the world steel production; India is striving to increase capacity to capitalize on that growth. (Agrawal A., Nestour M., Mangers P., Beifus A., Sarkar S., 2011).

### 2.1.1 Stainless Steel

About 2,15% of the total steel in the world is stainless steel. According to the World Steel Association, global stainless steel melting activities increased to a new record of 32.1 million metric tons in 2011. Asian countries are melting 66,5% of the world stainless steel, with China representing the largest share.

Figure 2: Stainless and Heat Resisting Steel Crude Steel Production (Ingot/Slab Equivalent)



The steel demand in Europe and NAFTA is expected to rise at a moderate rate. However, the higher consumption in these regions will be met by the over capacity from Asian countries. Chinese steel production and consumption will continue to outperform the rest of the world in the next years. The steel consumption in BRIC-countries generally will be higher than in developed countries.

Steelmakers are adopting different strategies and focusing on cost optimization to keep their companies competitive. One of these strategies is the optimization of the eco-efficiency of products throughout their life cycle. The recycling of steel, for example, is much more heavily promoted by some manufacturers than in years prior. The recycling of waste from steel production may gain importance in the future, possibly supported by stronger environmental regulations. These factors are opportunities for acid regeneration technologies which could begin to play a more significant role in the future of steel production.

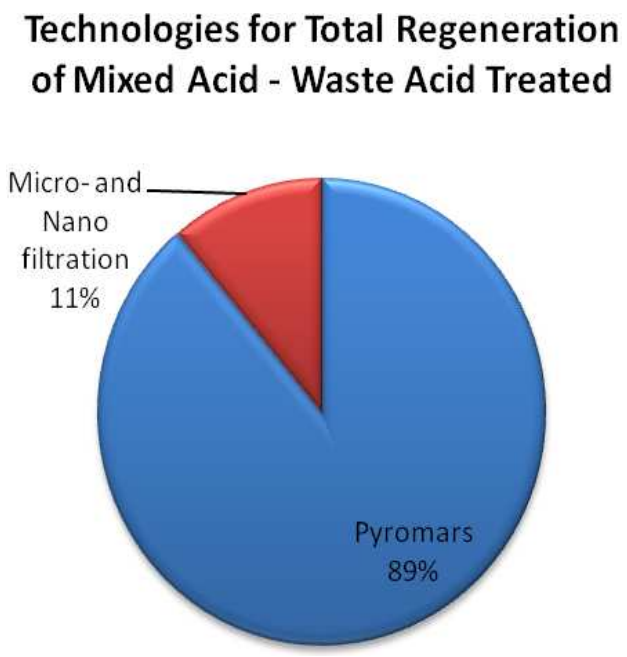
## 2.2 Acid Regeneration Technologies - Outlook

Steel pickling is a finishing step in flat steel production whereby impurities such as rust or scale are removed from the surface by dissolution in acid. This is done in a so called pickling bath, where steel bands, bars, pipes etc, are treated with acids, sometimes combined with electrolytic baths. The most widespread acid in the stainless steel production is a mixture of nitric and hydrofluoric acid, called “mixed acid”.

In the last two decades, different technologies for total and partial mixed acid recovery have been developed, however only some of them have had success and regularly used by steel manufacturers. **Total regeneration** refers to the recovery of *both* bounded and free acids as well as dissolved metals, which have a high concentration of nickel and chromium. This depends on the material treated in the pickling line. **Partial regeneration** is characterized by the recovery of part of the free acid only; bounded acid and dissolved metals have to be mostly disposed in this process. The pyrohydrolytic regeneration of mixed acid was developed from the “Ruthner Spray Roasting Process” originally applied to the regeneration of hydrochloric acid. In 1995 the first total regeneration plant for mixed acid using the Pyromars-Process was successfully built and put in operation in Spain. Seventeen further plants with a total capacity of 90 $m^3/h$ have been built and are in operation worldwide. Another 30 $m^3/h$ capacity (four plants) will go in operation beginning in 2013. This process is now the most accepted solution for total recovery of metals and acids.

Another regeneration method using membrane techniques has also been developed and put in operation in the last twenty years. It consists of one microfiltration and two nanofiltration steps, followed by crystallization, pyrohydrolytic reaction and off-gas cleaning. This process has a higher complexity during operation and is also characterized by the short lifetime of membranes, which results in high maintenance costs. The success of this method has been modest; only 3 plants have been built since the technology’s advent. The graph bellow depicts the actual market distribution of total regeneration technologies.

Figure 3: Overview of Total Regeneration Technologies – Waste Acid Treated



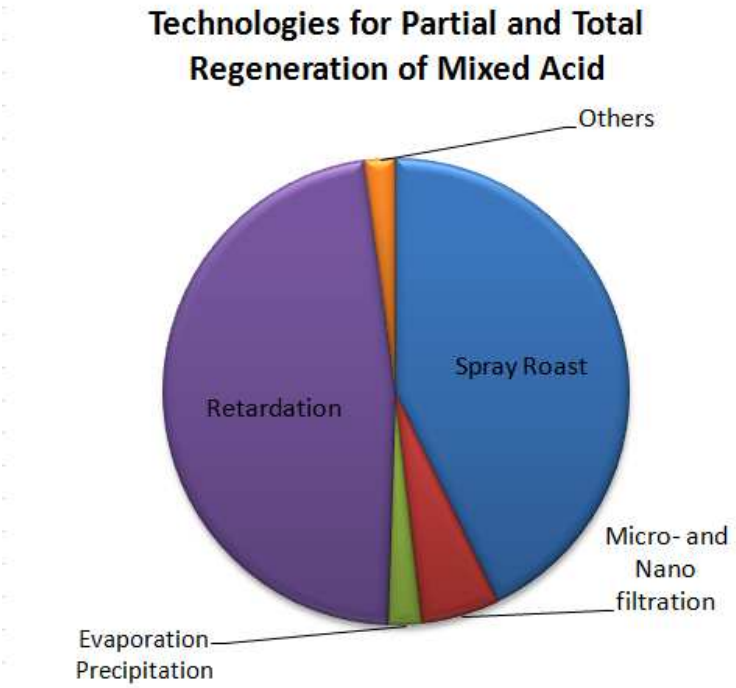

The OPAR process developed by Outokumpu is based on a mixed acid treatment with high concentrated sulfuric acid under vacuum. The metals are precipitated as metal sulfates and treated as hazardous waste. HNO3/HF are evaporated and recovered in a condensation step (Regel-Rosocka, M., 2010). This technology has high investment and operation costs, and only 1-2 plants in Finland currently in operation.

Retardation is probably the most diffused technology for partial regeneration. The APU™ (Acid Purification Unit from EcoTec) systems or the SAR units (Scanacon Acid Recovery) use a resin sorption process to remove dissolved metals from the pickling acid and return the unused acid to the pickling process. It is a simple method based on ion-exchange in resins (EcoTec, Acid Purification System for Stainless Steel Pickling Acids). Up to now, ion exchange technology has been introduced in many stainless steel processing plants, however the stability of the resin in contact with nitric acid has caused concern and the life time of the units has been affected. These units have low investment and operation costs and are therefore appealing to many steel manufacturers despite the loss of metals.

The electro dialysis technology has also been used for waste mixed acid treatment (approx. 2 plants in operation) combined with other separation technologies. Solvent extraction (Benedetto, J.S. et al) is able to attain a partial recovery of the acids but no proposal for the management of metals in this context has been done. Solvent extraction and non-dispersive

solvent extraction showed some success in laboratory settings in the 1980s, but have not yet reached the maturity stage for commercialization. There have been many efforts in combining some of the technologies mentioned above, but up to now none of them has been successful.

Figure 4: Overview of Regeneration Technologies




This graph depicting the distribution of both total and partial recovery technologies reveals a different story than Figure nr. 3. Retardation technology is a market leader despite all disadvantages. Thus, all manufacturers using retardation can be seen as potential customers for total regeneration technologies.

The following table is an overview of the main technologies currently available in the market. It illustrates the advantages and disadvantage, as well as their respective recovery rates of acids and metals.

Table 1: Advantages and Disadvantages of Existing Regeneration Techniques

| | **Process** | **Advantages and Recovery Rates**[2] | **Disadvantages** |
|---|---|---|---|
| **1** | Spray-Roasting | Regeneration of free and bounded acid as well as dissolved metals, proven technology.<br>No limitations in processing all typical waste acid concentrations (AISI Steel Grades: AISI 200, AISI 300, AISI 400, hot and cold strip)<br>Higher concentration of acids in the product (regenerated acid).<br>Recovery rates:<br>HF: 99%<br>HNO3: 70% (80% with $H_2O_2$)<br>Metals: 99% | High investment and operation costs<br>Recovery of HNO3 70% only. |
| **2** | Micro- and Nano filtration, Crystallization, Roasting<br>(STAR) | Regeneration of free and bounded acid as well as dissolved metals.<br>Recovery rates:<br>HF: 99%<br>HNO3: 90%<br>Metals: 60% (also 99% at increased plant capacity) | High investment, operation costs, limited life time of membranes<br>Processing of waste acid with specific HF concentrations only. |
| **3** | Evaporation, Precipitation<br>(OPAR) | Regeneration of free and bounded acid<br>No dust emissions<br>Recovery rates:<br>HF: 93%<br>HNO3: 99%<br>Metals: 0% | High investment and operation costs, high consumption of $H_2SO_4$, metals are precipitated and treated as hazardous waste. |
| **4** | Retardation | Regeneration of free acid, low investment and operation costs<br>Recovery rates:<br>HF: 15-35%<br>HNO3: 90%<br>Metals: 0% | Loss of bounded acid (HF) and metals.<br>High production of waste water<br>Diluted regenerated acid |
| **5** | Electro dialysis | Recovery rates:<br>HF: 55%<br>HNO3: 60%,<br>Metals: 0% | High costs for bi-polar membranes |

### 2.2.1 SWOT-Analysis from Pyromars-Process and Andritz Metals

An analysis of the internal and external environment is an important part of the strategic planning process. The SWOT analysis provides information that is helpful in matching the firm's resources and capabilities to the competitive environment in which it operates. The following chart refers to the spray roasting technology and Andritz. Identification of SWOTs

[2] Recovery rates of acid refer to total acid amount (free and bounded)

is essential because subsequent steps in the process of planning to achieve the selected objective may be derived from the SWOTs analysis.

Table 2: SWOT Analysis from PYROMARS-PROCESS

| | POSITIVE | NEGATIVE |
|---|---|---|
| INTERNAL FACTORS | **Strengths - Organization**<br>• Reputation and brand recognition<br>• Highly skilled and experienced employees<br>• Strong financial background through mother company<br>• Wide experience in pickling and regeneration technologies (spray roasting)<br>**Strengths – Product**<br>• Most references worldwide – experience<br>• High recovery rates of acids and metals (except $HNO_3$ , see right field)<br>• High availability of the plant<br>• ROI: 2-3 years<br>• user-friendly plant despite a high degree of complexity | **Weaknesses - Organization**<br>• Improvement potential in marketing and innovations<br>• Improvement potential in after sales services.<br>• Improvement potential in customer oriented strategy<br>• Complex structure due to large size<br>• Less flexible and agile than medium size and smaller companies<br>**Weaknesses – Product**<br>• Moderate recovery rate of nitric acid 60-70%<br>• Sensitive process (no mistakes are allowed)<br>• High energy consumption (compared with competitors<br>• High investment |
| EXTERNAL FACTORS | **Opportunities - Organization**<br>• Changes on environmental regulations<br>• Consolidation of steel manufacturers<br>• Demographic development in emerging markets (BRIC) leads to a higher demand for (stainless) steel<br>**Opportunities – Product**<br>• Application of regeneration technology in analogous markets – e.g. ore industry<br>• Stainless steel manufacturers without any regeneration technology<br>• Steel manufacturers with other technologies (partial recovery) are potential customers | **Threats - Organization**<br>• Competition although high barriers of entry<br>• Price pressure<br>• Financial crisis and over production of steel – lower investments, less projects<br>**Threats – Product**<br>• Reverse-engineering by competitors<br>• Emerging of alternative regeneration technologies<br>• Emerging of alternative pickling technologies (less probable) |

## Analysis:

Organization: Andritz Metals

There is clear potential for improvement in the customer oriented strategy, marketing and after sales services. This could enhance the reputation of the firm but also elevate and differentiate the company from all competitors. The company's human resources have a high potential to counteract reverse-engineering and compete against alternative technologies through the implementation of innovations.

The financial crisis was a blow to the whole steel industry, and could only be weathered due to the firm's strong financial background. The steel demand in emerging markets will increase in the future; thus, it is particularly essential to increase marketing activities in these countries. The market oriented innovations and their associated marketing strategies will be essential for long-term growth.

The consolidation among steel manufacturers is an opportunity, as changes in environmental regulations could lead to the adoption of uniform policies within the companies in order to fulfill these new requirements. Then, for example, a corporate group could decide to install total regeneration technologies in some or all subsidiaries at once.

Product: Pyromars

The high energy consumption and investment must be contextualized, as the short ROI and high availability of the process compensate for these characteristics. The recovery rate of nitric acid and the sensitivity of the process have improvement potential.

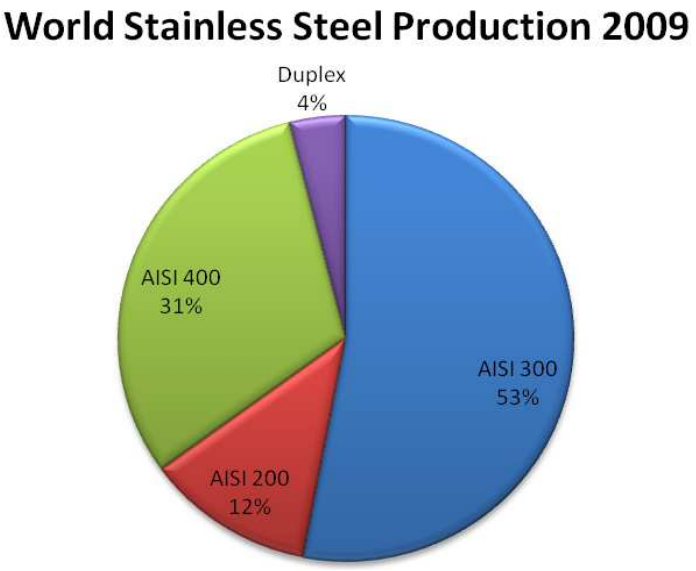
The engineering team is able to counteract the threat of reverse-engineering. This is possible through continuous incremental innovations (patents) in the product under consideration of cost-benefit consequences.

Alternative technologies are a threat only in the long term, as steel manufactures are cautious in acquiring new products. Still, it will remain important to monitor the development of new technologies. The strong financial background and presence of highly skilled employees could help maintain the leading position.

### 2.2.2 Mixed Acid Consumption - Estimation

Total stainless steel production in the world is estimated at 32 million tons as of 2011 (World Steel Association). The majority of the production in 2009 was austenitic steel (300 series) with a proportion of approximately 53%. The proportion of ferritic steel (400-series) was 31% and of 200-series (austenitic with lower nickel content) above 11% (ISSF Annual Report 2010). The product mix did not change significantly in the following years.

Figure 5: World Stainless Steel Production 2009, AISI-Grades and Duplex[3]




Based on this production mix, an estimation of the total mixed acid used worldwide was conducted in order to determine the market potential for total recovery technologies. The mixed acid treated by existing plants for total recovery in operation has been deducted from the total acid amount. There are also some stainless steel producers with a comparatively low volume of waste acid production -- too low for the operation of such a plant to be economically viable. This amount has been appraised and deducted respectively.

The result is an estimation of the market potential for future plants for total regeneration (see Appendix A). There is an actual need of approximately 18-25 plants to satisfy the global demand for total recovery processes.

[3] Duplex is stainless steel with two-phase microstructure consisting of grains of ferritic (AISI 400 series) and austenitic stainless steel (AISI 300 series).

According to the SMR (Steel and Metals Market Research, January 2012), the production of stainless steel will increase in 2015 by up to 37 million tons, which represents a potential of approximately 10m³/h per year for total recovery technologies over the next two years. The production mix (steel type by percentage) is expected to remain stable.

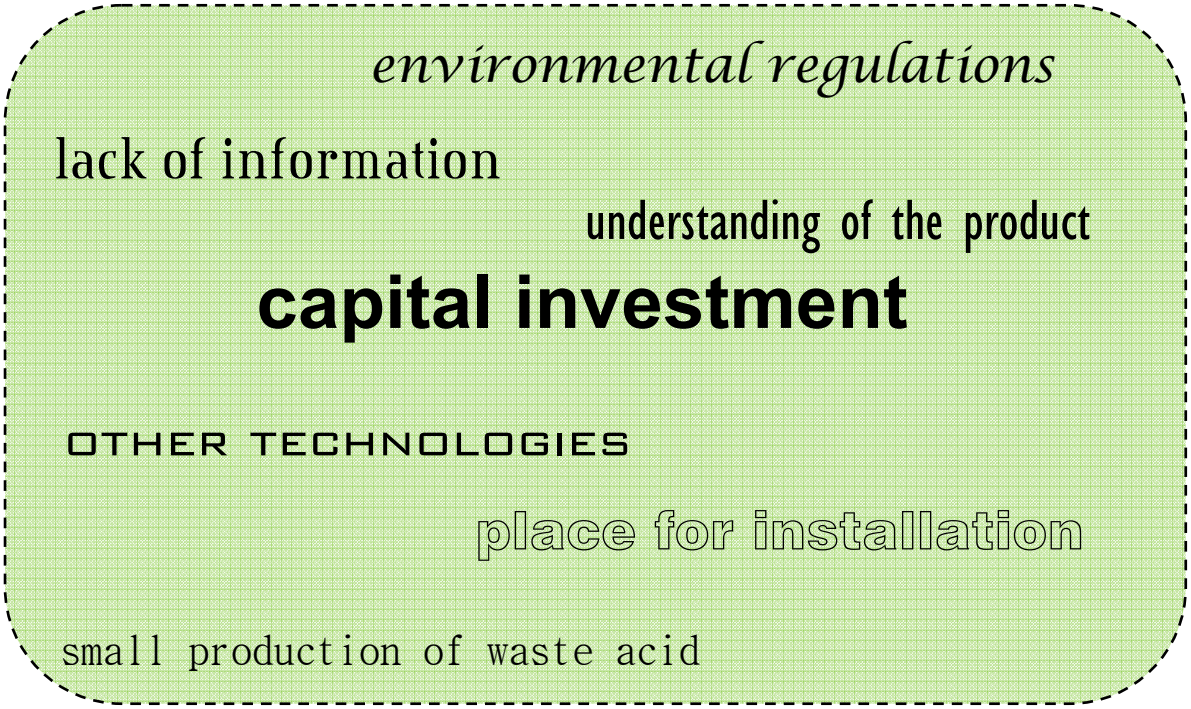
#### *2.2.2.1 Analogous markets*

The spray-roasting technology also has potential application in analogous markets, such as the ore-industry. While in most cases hydrochloric acid is used, there are special applications for hydrofluoric acid. This is true in the exploitation of rare earths (lanthanides), for example. Though spray roasting technology has not yet been utilized in this field, therefore an investigation of the behavior of rare earths would be necessary. Another potential market is in the pickling process of Titanium band. It is a quite reduced market with small amounts of waste acid production.

## 2.3 Decision Making Criteria

### 2.3.1 Barriers to Investment

The impetus for a customer to adopt new regeneration technologies is two-fold: cost optimization and environmental issues. The first can be subdivided in cost reduction, production process and optimization of the acid life cycle. The second refers to local environmental regulations which must be fulfilled by the steel manufacturer, as for example regulations regarding the concentration of nitrates in waste water or the sludge produced after neutralization.



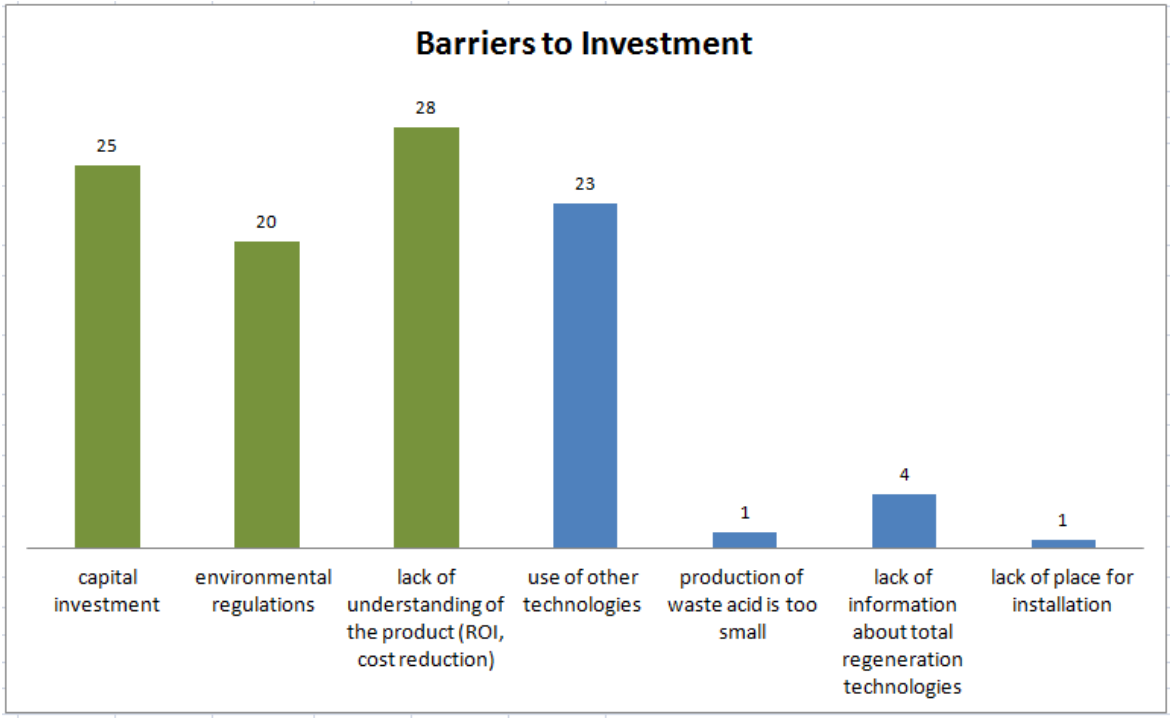

Despite the large demand for total regeneration, customers are still reluctant to acquire acid regeneration technologies. In order to comply with local environmental regulations, steel manufacturers will often opt for low-budget technologies (e.g. retardation, electro dialysis, etc). These technologies represent the bare minimum for compliance, but are enough to satisfy local authorities.

The reasoning behind customer acquisition (or not) of the Pyromars technology was investigated through questionnaires disseminated in the sales department. The questions were discussed in a face to face meeting and the interviewees completed the questions at their own leisure (see Appendix B).

The responses to the questionnaire included:

- lack of information about the product and its impact (ROI and cost reduction)
- environmental regulations
- capital investment
- use of other technologies ( membrane technology, retardation, etc..)
- production of waste acid is too small for a Pyromars plant
- lack of place for installation
- lack of information about regeneration technologies

Figure 7: Barriers to Investment




The factors which influence the purchase behavior of customers include region (emerging markets or developed country), market position and financial background. Among all reasons mentioned in the above questionnaire, three of them were highlighted in the survey.

a) capital investment.

b) lack of information,

c) environmental regulations

A) Capital investment is often, but not always, the main obstacle for the acquisition of new plants. In response to that, technology suppliers could change their sales model

to a service-based business model to support chemical management with regeneration and pickling technologies. One possibility is the promotion of the BOOT-Model (Build Own Operate Transfer) combined with the Chemical Leasing concept. BOOT is a form of project financing, wherein an entity (e.g. Joint Venture) receives a concession from a steel manufacturer to finance, design, construct and operate, in this case, an acid regeneration plant. The unit of payment would be the $m^3$ of waste acid treated. The BOOT-model does not consider the environmental impact of the acids consumed during the pickling process. The integration of BOOT with the Chemical Leasing business model brings a different approach to the acid management. **Chemical Leasing** is an innovative service-oriented business model developed by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water management (BMLFUW). The Chemical Leasing model has won 2 awards so far: in 2004 the "Genius 2004," an award in innovation sector, and in 2005 the "Constantinus", award in the sector of management. In 2007 UNIDO picked up the idea of Chemical Leasing applied it on an international basis (Jakl T., Schwager P., (Et al.), 2008). The unit of payment with the Chemical Leasing concept would be the surface treated ($m^2$ of pickled band) instead of the $m^3$ of waste acid. More about the advantages of BOOT- Chemical Leasing is in chapter 3.1.

B) Some of the steel manufactures are simply unaware of acid regeneration technologies and their financial and environmental impact. They are mainly focused on the production lines, revenues, market share, etc. and are often ignorant of the environmental consequences of their production. The environmental regulations in developing countries, for example, are often too weak and lead to steel producers either investing in low-budget technologies or simply disposing of the waste acid into the environment. The potential for cost reduction through breakthrough technologies such as total regeneration is not widely known.

After market targeting and identification of potential customers, a communication and marketing strategy has to be defined. Effective marketing requires an integrated communication plan combining both personal selling efforts and non-personal ones (Silk A. J., 2006), such as advertising, participation in conferences and the publication of articles in relevant magazines. A proposal for a marketing plan is described in chapter 3.2.

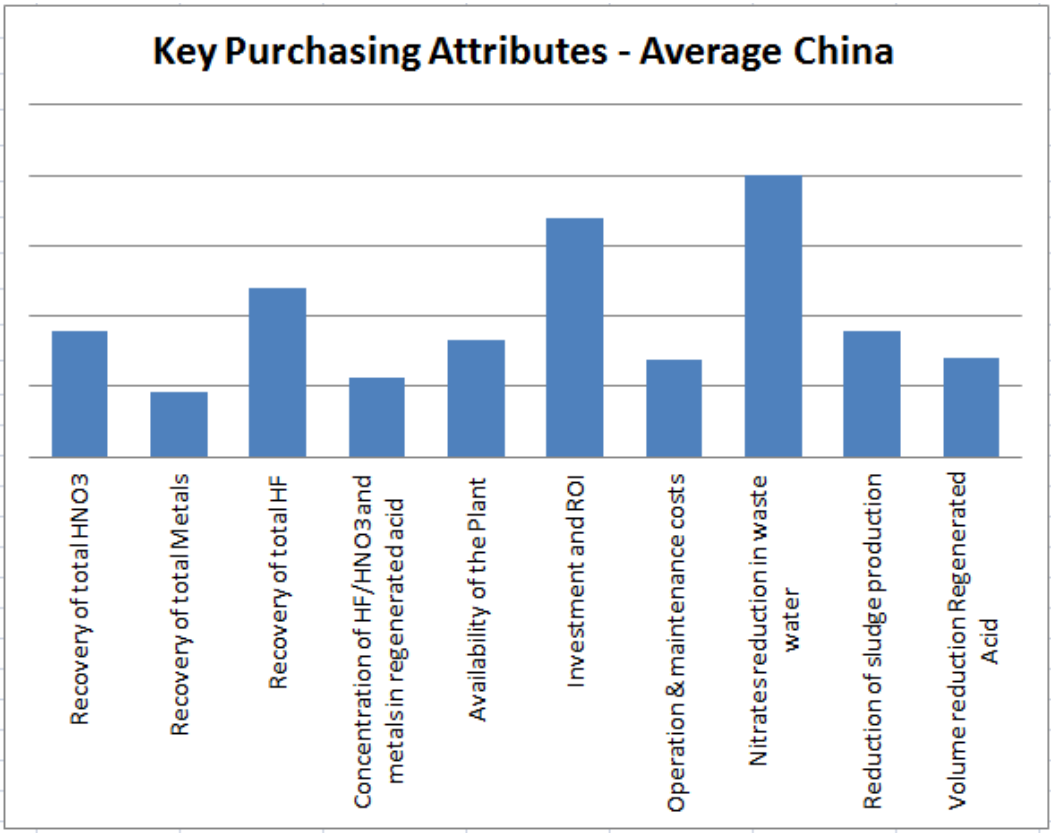
C) Environmental requirements in terms of nitrate concentrations in waste water and sludge production are still too weak in many countries, and this leads customers to invest in low-budget technologies. In most cases these technologies are enough to fulfill the requirements for operation of steel plants. In order to counteract this effect, it is important to understand the structure of local authorities and their decision making process. This is a very difficult job, particularly in Asian countries whose political systems may vary widely from country-to-country. Successful lobbying-work is the key to bringing the right people to make the right decisions. How to increment this work is proposed in chapter 3.3.

### 2.3.2 Purchasing Attributes

Steel producer's purchasing criteria was investigated through questionnaires. These were sent by email to some lead users and also discussed in person in the sales department.

Some of the lead users added purchasing attributes which were originally not mentioned, although they were included indirectly in the questionnaire. Such was the case with sludge reduction, for example, which is a result of the high HF and metal recovery rates. This demonstrates the varying sense of importance attached to attributes within the same product. Understanding customers' perceptions of value is a key component of the purchasing process. A similar case is seen in the reduction of nitrates in waste water. This characteristic is partly reflected in the recovery rate of HNO3, which was an attribute rated quite low by the interviewees. A pressing need for customers seems to be nitrate reduction in waste water, which puts in perspective the relatively low recovery rate of the spray roasting process. Nitrate reduction in waste water with the spray roasting process is 99%, of which 70-80% is recovered and reused in the pickling process. The rest is treated in a SCR (Selective Catalytic Reduction) step where NOx is reduced to nitrogen and consequently transported to the atmosphere.

Figure 8: Key Purchasing Attributes



Return on investment is another important attribute cited in the questionnaire responses. As already mentioned in the chapter regarding barriers to investment, the short ROI and cost reduction is not well known but is particularly relevant to some customers.

The volume reduction was pointed out by one lead user with a deep understanding of combining pickling technologies and regenerated acid from the spray roasting process. This attribute might not be so important for those customers with less experience in this field, however.

The aforementioned attributes are the most relevant in the responding customers purchasing process. The level of importance attached to specific attributes may vary from country to country and also depend on the knowledge level of the customer. Nevertheless, it is essential to bear all of them in mind during the sales process and emphasize the most relevant and applicable to the particular customer's situation and environment. Doing so will impress upon the customer the value that acquiring a spray roasting plant will add to their production.

# 3 Strategy

## 3.1 BOOT-Chemical Leasing Concept, a Win-Win Business Model

Background

The competition among steel manufacturers is becoming more and more intense; companies around the world are focusing on higher efficiency and cost reduction. Besides this, steelmakers have to deal with higher volatility of raw materials (A. Agrawal, M. Nestour, P. Mangers, A. Beifus, S. Sarkar, 2011) which has been exacerbated by the change from annual to shorter-term price contracts. This new phenomenon enabled suppliers of raw materials to modify the pricing strategy. However, this has created challenges for steel manufacturers. This development is significantly affecting their willingness to invest in new production plants.

As a result, suppliers of equipment for steel manufacturing are facing the problem of selling new plants and are obliged to think about innovative business models for the steel market.

First, one must define customer neet al. Do steel manufacturers really need to regenerate the waste acid used in the pickling process? From a holistic perspective, the real need is to have a clean and shiny surface on the steel band, which reflects the quality of the product. The pickling process is also a core competence of the manufacturer. The acid management and its optimization is something they “have to do”, in some cases to meet environmental regulations, in others for cost optimization of the production. This new perspective leads us to think about meeting customer’s demands in terms of acid management and to think about **service-oriented business models**.

There are many reasons why service oriented business models can provide significant growth opportunities, greater stability and higher profit margins (Reinartz W. Ulaga W., 2006). Some of these reasons are:

- Improving predictability of sales and cash flow. The market and supply of technology for steel producers is becoming more saturated with tough competition for market share. This results in the “commoditization” of products, as e.g. the case of regeneration plants, and hence lower profit margins. Adding service revenue can mitigate against some or all of these factors.

- The same reasons could lead steel producers to focus on their core competences and turn to outsourcing to provide many of the functions that were once performed in-house.
- Services can differentiate a company from competitors and establish closer relationships with customers. It is relatively easy for a competitor to provide a better and/or lower cost product, but much more difficult to replace an "intimate and trusting" relationship between suppliers and customers
- Innovation in services typically results in increased customer satisfaction and loyalty. Both are concerned with the direct attributes of the service offering, but also with the image of the supplier.

There are major cultural changes that must occur to shift the firm's understanding of the tremendous potential of the service opportunity. Once the profit opportunity is identified, the firm must set up the structures, processes and resources to exploit it.

Another critical step is changing the customer interactions from transactional to relational-based selling. The optimal agreement for the service provider is a fixed-price contract, covering all services over an agreed period; this transfers the risk of equipment failure to the service provider and focuses on relationship-based services centered on the product and operational availability and response time in case of failure. (Susman G., Warren A. Ding M., 2006).

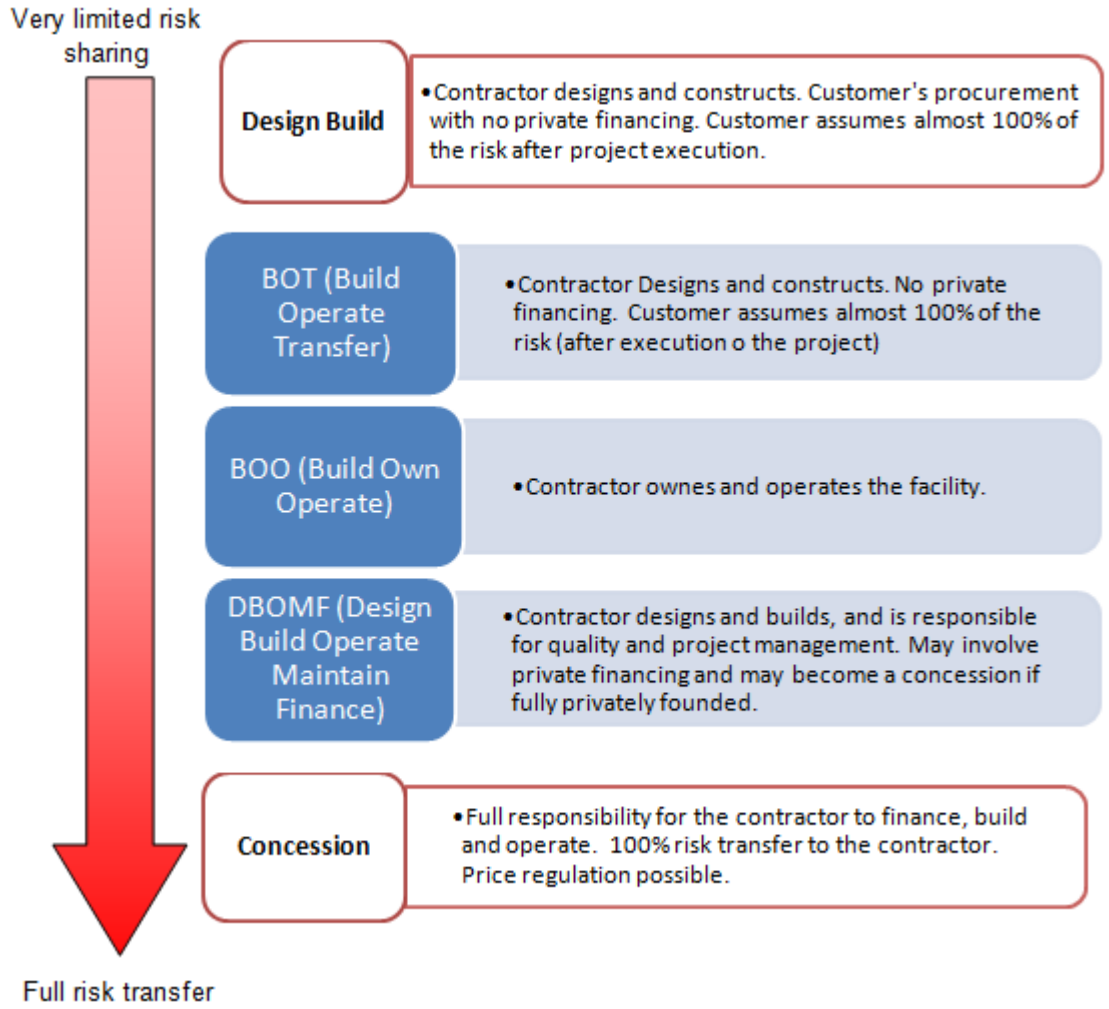
Traditionally, production plants and auxiliary plants were sold to customers, who operate them on their own. The responsibility of the supplier ends with the final transfer of the plant to the customer after fulfilling all requirements of the contract.

An alternative to the traditional sales-model is the BOOT (Build Own Operate Transfer) and the "Chemical Leasing Concept" (Jakl T., Schwager P., 2008) adapted to the steel manufacturing market.

BOOT is a form of project financing derived from Private Public Partnerships (PPP), PPPs are arrangements between government (in this case would be the "steel manufacturer") and private sector entities (e.g. Joint Venture) for the purpose of providing infrastructure, facilities and related services. Such partnerships are characterized by the sharing of investment, risk, responsibility and reward between the partners. The reasons for establishing such partnerships vary, but generally involve the financing, design, construction, operation and maintenance of infrastructure and services (Ministry of Municipal Affairs of British Columbia

1999). The BOOT could be replaced by the BLT model (Build-Lease-Transfer), DBFO model (Design-Build-Finance-Operate) or BOO as well. In the last two models there is no ownership transfer. For more about Public Private Partnerships see Appendix D and F. (Ministry of Municipal Affairs of British Columbia,1999). The roles and responsibilities of the partners may vary from project to project. For example, in some projects the private sector partner (joint venture) will have significant involvement in all aspects of service delivery, while in others they may have only a minor role.

Figure 9: Public Private Partnerships (OECD, 2008)




Determining the appropriate model for a project must be decided on a case-by-case basis. The core idea is that the end customer does not have to make an investment for the regeneration plant and is not in charge of the operation of it. In all these models the common denominator would be the more waste acid is treated in the plant the higher the revenues and profit for the JV. The environmental factor – eco-efficiency of chemicals used – is not

considered at all. Therefore, a combination with a Chemical Leasing model makes sense to reduce the consumption of pickling acids.

### 3.1.1 Chemical Leasing Business model

This business model stands for a service oriented concept in which companies producing chemicals are connected to companies applying chemicals. It is a shift from the traditional business concept that focuses on a constant increase in sales volume towards a more service and value-added approach. (T. Jakl, P. Schwager, 2008)

UNIDO Definition:

- *Chemical Leasing is a service-oriented business model that shifts the focus from increasing the sales volume of chemicals towards a value-added approach. The producer mainly sells the functions performed by the chemical, and functional units are the main basis for payment*[4].
- *Within Chemical Leasing business models, the responsibility of the producer and service provider is extended and may include the management of the entire life cycle.*
- *Chemical Leasing strives for a win-win situation. It aims to increase the efficient use of chemicals while reducing the risks of chemicals and protecting human health. It improves the economic and environmental performance of participating companies and enhances their access to new markets. Key elements of successful Chemical Leasing business models are proper benefit sharing, high quality standards and mutual trust between participating companies.*

The first step is the definition of the real pickling costs (e.g. fresh acids, neutralization, disposal of sludge, etc) and secondly, the potential of process optimization with a total regeneration technology. According to Joas R. (2008), in practical case studies the potential reduction by process and chemical optimization is often higher than 40%. In the case of the

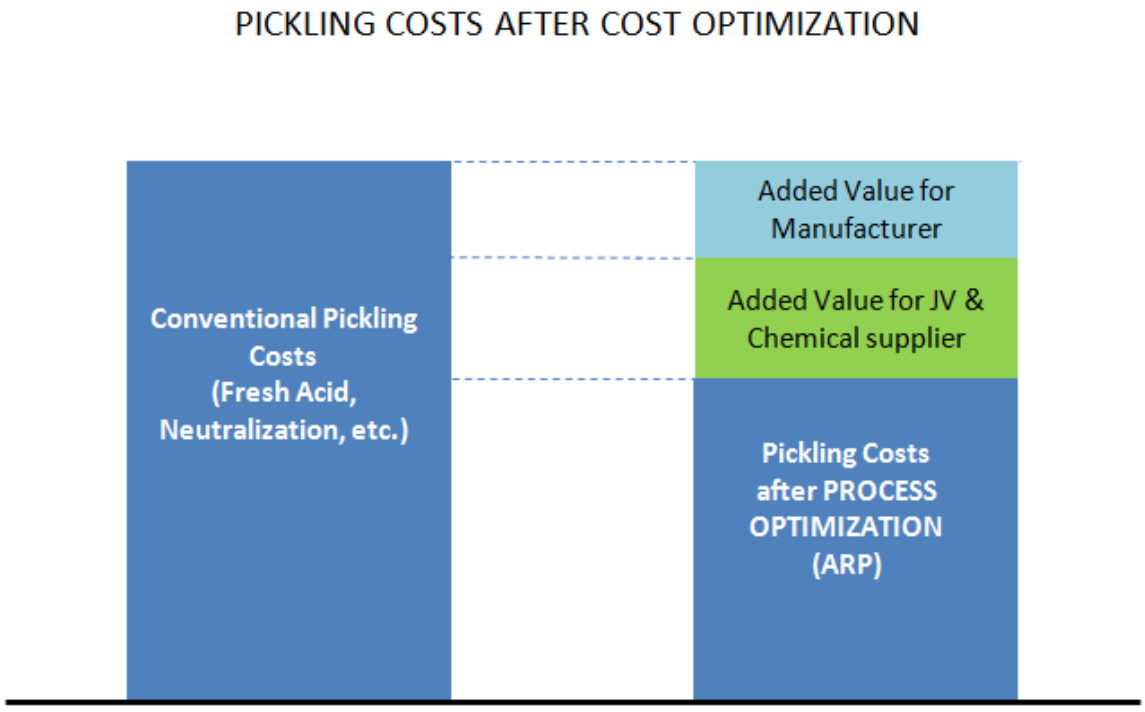
[4] Functions performed by a chemical might include: number of pieces cleaned; amount of area coated, etc.

Pyromars process, the consumption of HF would be reduced in approx. 95% and HNO3 in approx. 40%. Furthermore, the sludge disposal would be less and the metals recovery would be high.

In contrast to traditional business models, the basis of payment is not the amount of waste acid treated but the **m² treated surface** in the pickling line.

The principle behind of this unit of payment leads to a "less is more" situation – this means higher earnings for the supplier within Chemical Leasing while fewer chemicals are used (Joas R., Jakl T., Schwager P., et al., 2008).

Figure 10: Pickling Costs after Cost Optimization




### *3.1.1.1 Advantages of BOOT – Chemical Leasing:*

The customer does not need to raise financing for the plant. Cost savings in the pickling process are achieved by reduction of chemical consumption and are shared among the JV and the customer. The JV optimizes the pickling and neutralization process and therefore has to purchase less fresh acid. The customer pays a lower price to obtain this benefit than if it buys the chemicals and applied applies them in a traditional way.

In the “BOOT-Chemical Leasing” concept, the regeneration plant, pickling process and the fresh acid supply would be administrated from one hand. This structure would increase the efficiency of the chemicals used. The steel manufacturer could increase his competitive advantage.

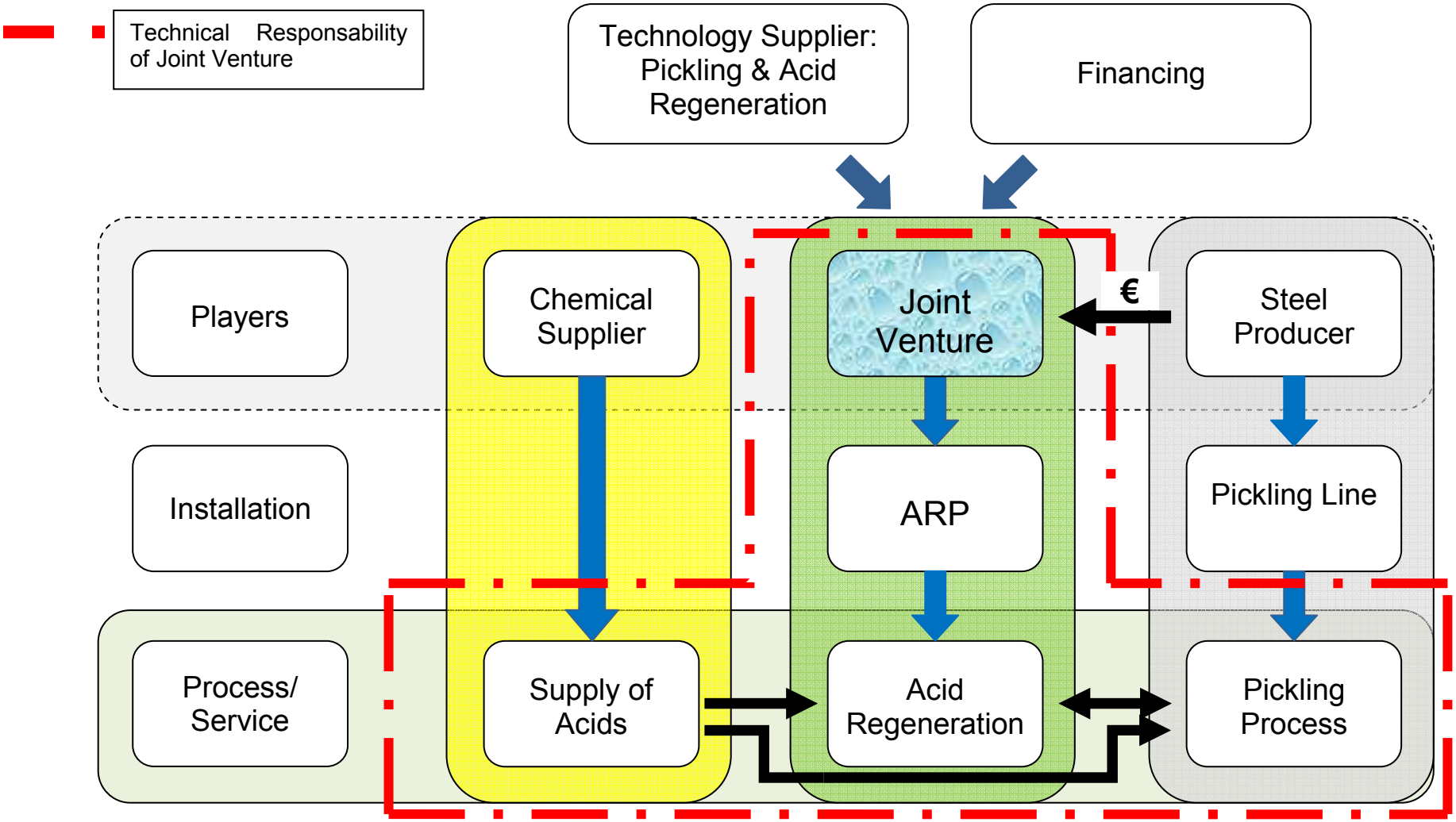
The technology supplier can also profit from a stronger customer relationship and the continuous feed-back from the operation and maintenance work. On the other hand, the customer can concentrate on his core business and cede responsibility for the management of acids.

From the environmental point of view, both partners can clearly benefit by a more innovative and positive public image. Process optimization not only leads to a reduced chemical consumption but very often also to a reduction in other costs such as sludge disposal or the waste of metals. As a result, the waste load as well as air and water pollution will decrease, reducing the total environmental impact of the steel manufacturing.

In the specific case of the steel industry, companies selling technology and equipment for steel production would be connected to the chemical suppliers and be in charge of the pickling result and acid management. With this concept, business interests are no longer related to the sale of manufacturing equipment but to the sale of pickling and acid regeneration services. It is in the interest of all parties involved to maximize the efficiency of pickling acids and consequently to reduce costs and environmental pollution.

The following graph shows the responsibility of the joint venture. The whole acid management including the purchase of fresh acid would be administrated from one side.

Figure 11: BOOT – Chemical Leasing Concept



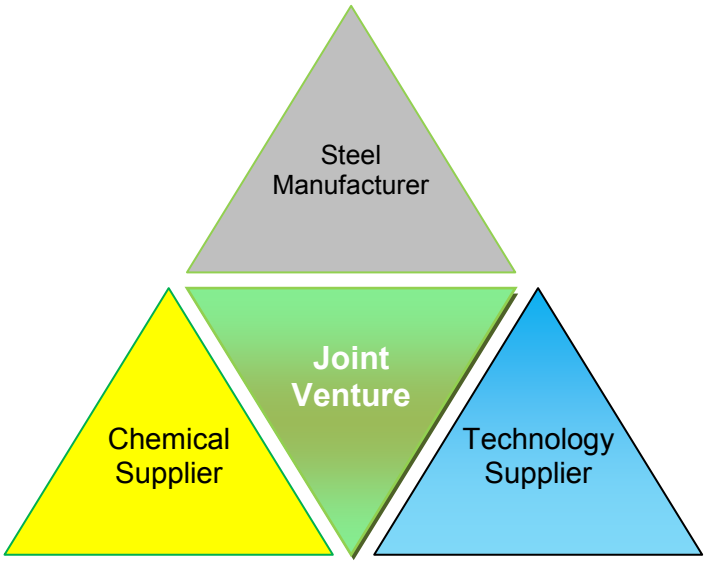
### *3.1.1.2 Actors of BOOT-Chemical Leasing*

As opposed to the traditional Chemical Leasing model where the chemical supplier plays the main role, here the JV takes the responsibility for investment operation and optimization. The key-player in the BOOT-Chemical Leasing model is the JV, which could be founded by the technology supplier and a local company or even with the customer itself.

The prime partner of the JV is the steel manufacturer who benefits from cost reduction due to the acid management service. The technology supplier benefits not only from the installation of the plant, but from a better relationship with the customer and technological feed-back from the acid regeneration plant. The chemical supplier is a third partner of the model.

To establish the business model it is useful to involve a party who can act as a mediator between the different partners and raise confidence among them. This task can be outsourced to private consultants, but also to particular institutions specialized in providing advice to industry, such as UNIDO Cleaner Production Centres (Joas R., Jakl T., Schwager P. Et al., 2008)

Figure 12: Actors of BOOT – Chemical Leasing Concept



#### *3.1.1.3 Hurdles to Overcome by BOOT-Chemical Leasing Model*

There are several barriers to implementation. As in a chemical reaction, an initiator and some “catalysts” are necessary to start the “reaction”. Possible initiators are international organizations like UNIDO, but also companies who already successfully apply Chemical Leasing may be a driving force behind this business model. (Joas R., Jakl T., Schwager P., Et al., 2008)

The main challenges are:

- Find the right partners and create confidence with them
- Find an adequate financing concept and partner
- Devising fair contracts that meet expectations
- Quality assurance

Other risks in this business models include:

- Dependency caused by a too narrow a customer-supplier relationship
- Difficulty defining interfaces between all shareholders
- Technical and logistical problems

All parties involved in the implementation of the concept must be aware of the difficulties in the first pilot project. An increasing number of successful projects demonstrate the effectiveness of this model, paving the way for additional implementation.

## 3.2 Marketing & Diffusion of Innovation

Many stainless steel manufacturers are focused on the production process and are not aware of acid regeneration technologies and their economic and environmental impact. They very often ignore the environmental consequences of their production and its potential for optimization. The cost reduction through breakthrough technologies such as total regeneration is not always very well known.

The value creation through acquisition of such technologies has to be promoted in an effective way. The marketing and communication strategy for an established product and company can support this aim; it has specific needs which have to be considered carefully.

The following steps have been classified as highlights of a marketing strategy. They are not a marketing plan but reflect important aspects of how marketing activities towards customers' oriented design and innovation could be improved. The highlighted aspects are:

a) Analysis and definition of the market, Understanding the target market
b) Understanding customers and their needs
c) Defining the competitive landscape, positioning (comparison with competitors)
d) Customer Oriented Design: Improvement of Innovation and USP
e) Incorporating the green perspective
f) Diffusion of Innovation with Roger's 5 Factors:

### 3.2.1 Analysis and Definition of the Market

How a particular market and its competitors are defined is crucial for the strategy. The definition should be done concisely to maximize impact. The broader the definition of the market is, the greater the opportunities. Here are four steps to define the acid regeneration market and some examples how a market strategy could look:

A) **Benefit or need-related definition:** “we compete with all suppliers of technologies and facilities for regeneration of hydrofluoric and nitric acid produced in the stainless steel-, special materials- and ore-industry”.

B) **Market definition:** “our market comprises the creation of customer value through the supply of technology for manufacturing of metal bands, but also for the recycling of hydrofluoric and nitric acid”

C) **Competitors:** EcoTec, STAR, etc… (see below Competitors Analysis)

D) **Competitive measures:** The acquisition of key equipment suppliers for our products (vertical integration) and especially for our competitor's products could provide a competitive advantage, as long as they fit into the company’s portfolio.

### 3.2.2 Competitors Analysis

Understanding the competition and their products is crucial to effective marketing. A company must compare its products, prices, distribution and promotion with those of close competitors to discern areas of potential competitive advantage and disadvantage. This can be done in five steps:

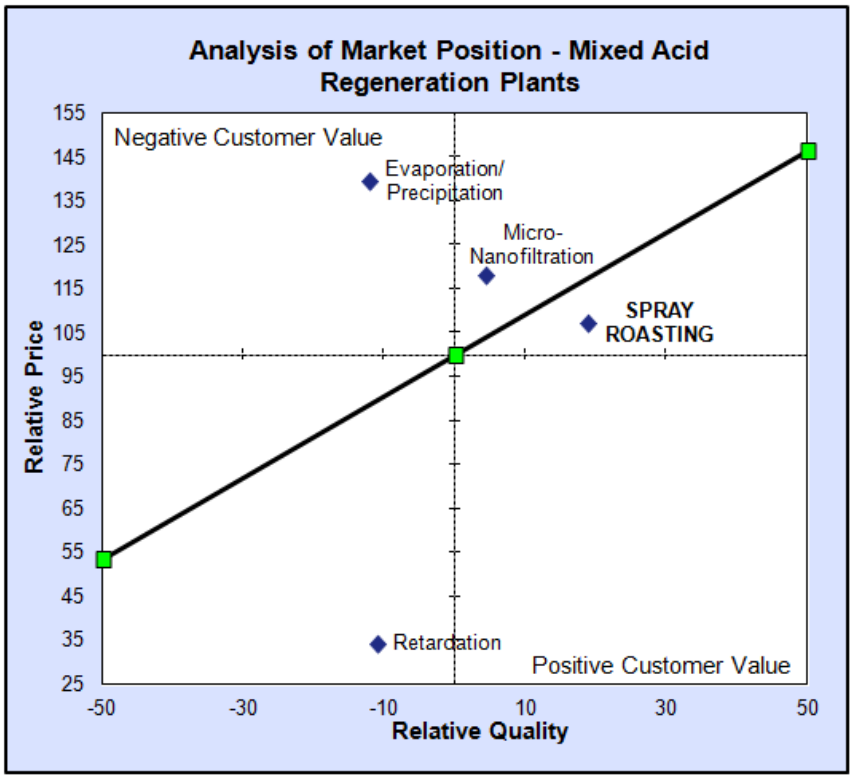
1. Identify competitors: essentially any companies who address the same customer needs and are fighting for the same contracts are our competitors.
2. Competitor’s strategy should be identified. The more a firm’s strategy resembles another firms’ strategy, the more closely they compete.
3. A company should determine competitor’s objectives.
4. Identify competitors’ strengths and weaknesses. This involves analyzing competitor sales, market share, profit margin, ROI, cash flow, new investments and capacity utilization.
5. Determine competitor’s reaction patterns.

Information about a company’s competitors must be collected and disseminated within the firm. The company must design a system to constantly analyze competitors and provide information to managers who use the information as an input to planning (Loudon D., Stevens R., Wrenn B., 2005).

The analysis of the market position reflects many aspects already mentioned in prior chapters. The relative quality reflects the quality from customer’s point of view measured by the key purchasing attributes mentioned in chapter 2.5.2. The relative price is the

comparison to main competitors. The OPAR process is characterized by the huge amount of waste produced by metal sulfates. The operations costs are high while the customer value is modest. The STAR process is positioned above the "average value for price-line" and near the PYROMARS process, and is therefore the strongest competitor. Pyromars is below the average value price line which reflects a slight advantage. The future strategy for Pyromars should focus on shifting more to the right-down field to increase the positive customer value.

Figure 13: Analysis of Market Position




The position of retardation technology (APU/SAR) reflects the low investment necessary for its acquisition and the moderate customer value.

### 3.2.3 Customer-Oriented Design (COD) Improvement of Innovation

Regardless of a firm's size, customer oriented design is an important approach to integrate customer needs into equipment design. There are several tools for the implementation of COD. Empathic design and the Kano Model have been chosen in this case due to their practicality.

#### *3.2.3.1 Empathic design:*

The foundation of empathic design is observation, and the goal is to identify latent customer needs in order to create or improve upon products that the customers may not even be aware they need. In some cases, this requires finding solutions that customers have difficulty envisioning, perhaps due to lack of familiarity with the possibilities offered by new technologies or because they are locked in an old mindset. This design relies upon observation of consumers as opposed to traditional market research (Mattelmäki, T. and Battarbee, K., 2002). This technique could generate insights for new features and products that customers may not be conscious of, and can be used to improve performance and maintenance of plants.

The implementation of the empathic design process can be structured in the following 4 steps:

1. Organization of Observation
   First, one has to define who is going to be observed, who is going to organize the observation and what behavior should be observed.
   For example, operators and employees in charge of maintenance could be the target group. The commissioning personnel could organize the observation and their reaction during maintenance or any kind of problem during operation would be the observation behavior.

2. Data gathering
   Here are the main questions that observers could pose to the target group:
   - Why are you doing this at the moment?
   - What are the main problems with the plant? Use an observation protocol with pre-defined questions.
   - What movement is the customer doing? Video recording and pictures are necessary.

3. Analysis and interpretation of the data
   - Which are the most important usage problems
   - Which function has the highest potential for improvement?
   - Based on how a product is used, are there any indications of possible innovative modifications?

4. Development of “first problem” solutions
   - Transform observations into concrete visual and physical representations of possible solutions
   - Sometimes two prototypes, one emulating the function and one illustrating the physical appearance.
   - Present the prototypes to the team and to the clients to stimulate discussion

The evaluation and implementation of solutions of new ideas are discussed in a group. In order to increase the performance of working groups, the number of participants should not exceed 6 people.

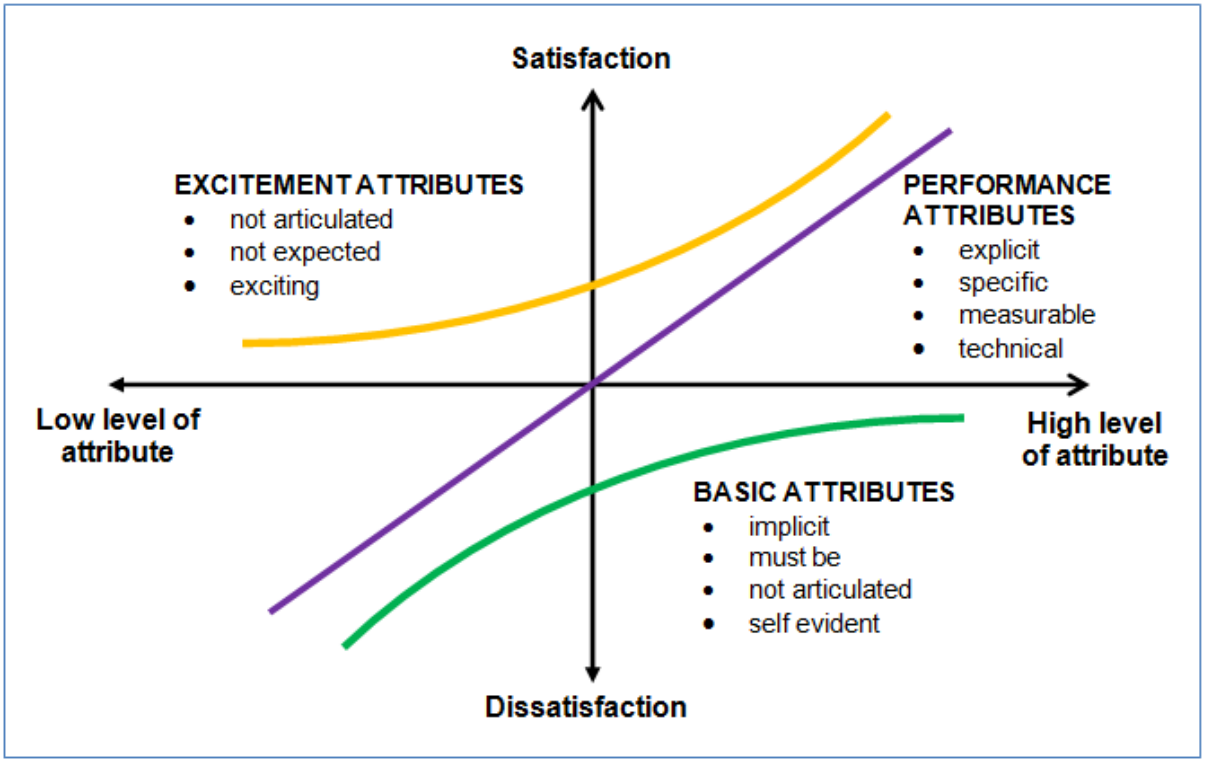
#### *3.2.3.2 The Kano Model:*

The Kano model is a graphical representation of the relationship between all attributes of a product, and was developed in the 80s by professor Noriaki Kano. It depicts customers’ satisfaction or dissatisfaction as the attributes increase or decrease.

Basic Attributes: These are the basic features that the product must have in order to meet customer demands. If this attribute is overlooked, the product is essentially incomplete. If a new product is not examined using the threshold aspects, it may not be possible to enter the market. This is the first and most important characteristic of the Kano model (Jacobs, R. (1999)).

Performance Attributes: are those for which more is generally better, and will improve customer satisfaction. Conversely, an absent or weak performance attribute reduces customer satisfaction. Of the needs customers verbalize, most will fall into the category of performance attributes. These attributes will form the weighted needs against which product concepts will be evaluated. The price for which customer is willing to pay for a product is closely tied to performance attributes. For example, customers would be willing to pay more for an acid regeneration plant that provides them with better fuel economy.

Figure 14: The Kano Model



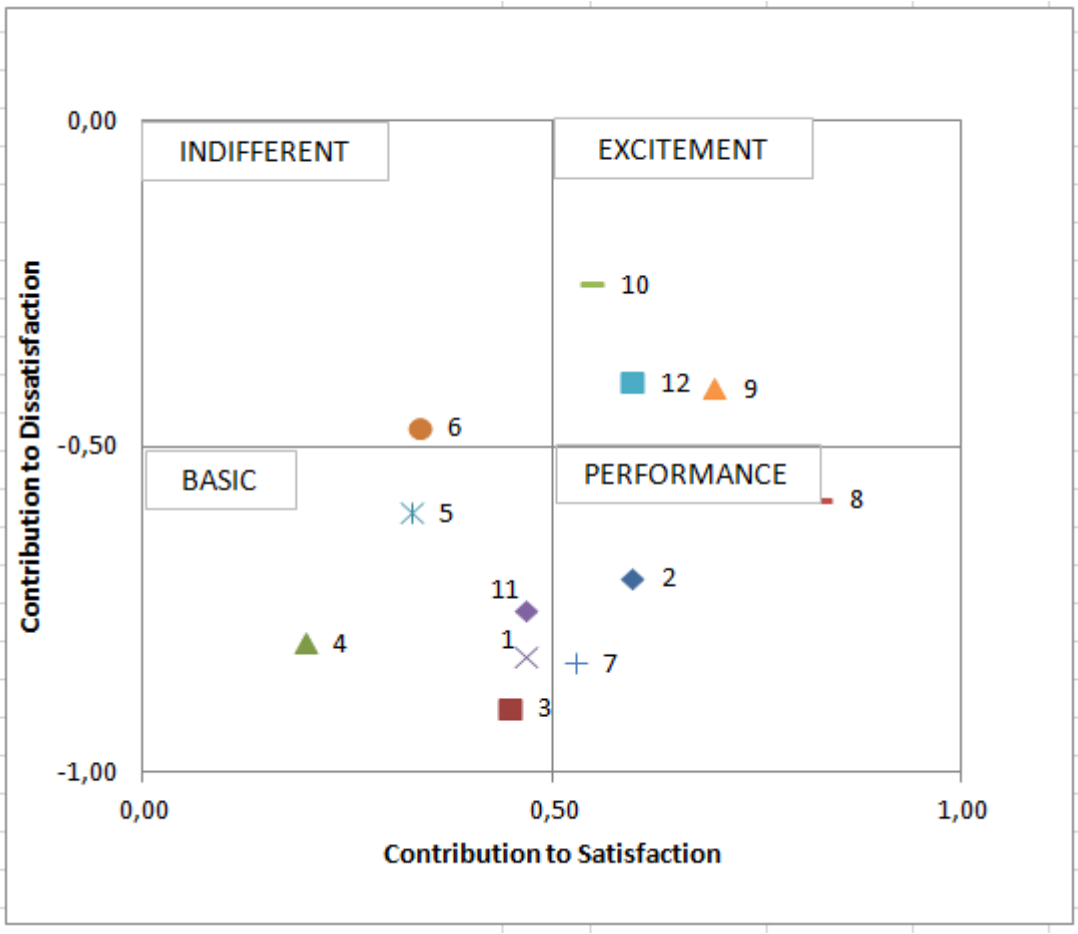

Excitement Attributes: are unspoken and unexpected by customers but can result in high levels of customer satisfaction, however their absence does not necessarily lead to dissatisfaction.

Excitement attributes often satisfy latent needs – real needs of which customers are currently unaware. In a competitive marketplace where manufacturers' products provide similar performance, providing excitement attributes that address "unknown needs" can provide a competitive advantage. Although they have followed the typical evolution to a performance then a threshold attribute, cup holders were initially excitement attributes.

Other Attributes: Products often have attributes that cannot be classified according to the Kano Model. These attributes are often of little or no consequence to the customer, and do not factor into consumer decisions. An example of this type of attribute is a plate listing part numbers can be found under the hood on many vehicles for use by repairpersons.

The key performance attributes of mixed acid regeneration plants have been discussed in chapter 2.3.2. Additional attributes have been added based on studies from similar plants considered to be relevant in this case; an empirical evaluation was done consequently.

Figure 15: The Kano Model, Example ARP




After getting feedback from the customers, the results can be shown as in the graph above. The attributes are:

1. Recovery of total $HNO_3$
2. Recovery of metals
3. Recovery of total HF
4. Availability of the plant
5. Investment and ROI
6. Operation & maintenance costs
7. Nitrates reduction in waste water
8. Reduction of sludge production
9. Volume reduction regenerated Acid

10. High automatism operation level
11. Long Equipment life time
12. Free after Sales Service

The essential features the process must have in order to satisfy customers' demands are: a high acid recovery rate, reasonable ROI, availability of the plant and an acceptable equipment life-span.

The reduction of nitrates in waste water and the reduction of sludge during metals recovery are performance gauges; the higher these are rates the more a customer is satisfied. These attributes are important selling points to emphasize as they can directly influence customers purchase behavior.

The reduction regenerated acid volume relative to the waste acid is a primary advantage of the pickling process as it makes it easier to control the acid concentration in the pickling baths for different steel qualities. This attribute -- together with high automatic operation level and the free-after sales service -- are excitement attributes. The level of automatism can reduce the errors of operators, though admittedly it has the disadvantage producing less direct experience (and therefore customer understanding) of the process. Free after sales service refers to regular visits to maintain the performance of the plant. These visits could improve the relationship with the customer and eventually increase sales in the spare part business.

Operation and maintenance costs could be unimportant to most of the steel producers since such costs are negligible compared to others. Nevertheless, there are customers who attach more importance to these costs and this could influence their decisions during the sales phase. In this case, operation and maintenance costs would be rather a performance attribute.

#### *3.2.3.3 Incorporating the green perspective*

The need for environmentally friendly technologies that aim to reduce chemical consumption and emissions is becoming increasingly urgent and is an important growth market in the steel manufacturing sector. The green wave of the 1980s put the focus on ecology and sustainability and reached an important position in our society. This environmental megatrend will have even greater significance in the coming years. For companies, it will be

more important to consider and improve the environmental impact of their technologies. This phenomenon can already be observed in the food-, pharmaceutical-, car-industry and many others. Many technology suppliers still have a long way to go.

The implementation of an ecological focus in a company should not be just a marketing ploy. The green perspective has to be taken seriously at all levels; it has to be practiced consciously during planning, design and erection of industrial plants.

An acid regeneration plant itself makes a great contribution to the reduction of contaminants in waste water and solid disposals. Therefore, it should also be communicated as such to customers and authorities. The green perspective should be integrated in all documents and catalogues, etc. Articles and advertisements in relevant magazines could emphasize this strategy.

#### *3.2.3.4 Diffusion of Innovation with Roger's 5 Factors*

In his Book *Diffusion of Innovations* Everett Rogers defined the 5 most relevant intrinsic characteristics of innovations that influence an individual's decision to adopt or reject an innovation. (Rogers E., 1983). The information is based on a large research from over 500 diffusions studies. These 5 factors are a helpful tool to promote acid regeneration technologies during the negotiation phase, especially for customers which are not familiar with this technology.

- **Relative Advantage:**
  Underline the advantages of an acid regeneration technology compared with competitors and old designs.

- **Compatibility:**
  Acid regeneration plants are easy to operate and can be installed in any stainless steel manufacturing plant.

- **Complexity**
  After training of the operators by our commissioning staff, they are able to run the plant without difficulty. Despite the high complexity of the process, the potential customer should have a feeling of confidence and safety during operation of the plant.

- **Trialability:**

  Customers should have the opportunity to visit an existing plant and to run it by themselves, or at least to see how it is done by experienced personnel.

- **Observability:**

  The existence of this technology should be promoted through publications in newspapers or relevant magazines.

## 3.3 Lobbying

Background

Environmental requirements in terms of nitrate concentrations in waste water are in many countries still too weak and lead customers to invest in low-budget technologies. In most cases this is enough to fulfill the requirements for operation of steel plants. How to counteract this? It is important to understand the structure of local authorities and their decision makers. This is a difficult job, particularly in Asian countries. Successful lobbying-efforts could influence the decision making process to strengthen environmental regulations in order to reduce nitrate concentrations in waste water of stainless steel works.

There is a wide definition of lobbying in the literature of both the European Union and US-Government. Technology suppliers can learn from their strategies and techniques to approach decision makers.

The term lobbying refers more specifically to the work of private companies, known as lobbyists, which are employed by organizations to represent their views to government in a variety of ways, such as arranging meetings, organizing protests or providing briefing material (BBC).

According to Coen (2002), successful lobbying requires firms to have established at least four strategic capacities:

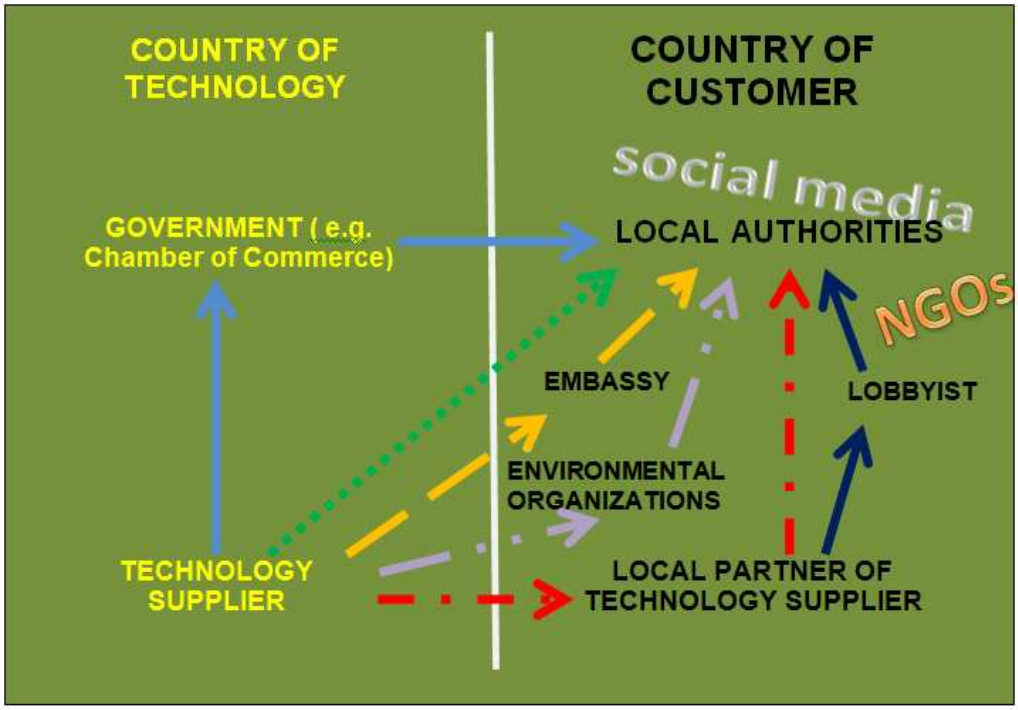
- the ability to identify clear and focused policy goals;
- develop relationships and credibility in the policy process;
- understand the nature of the policy process and institutional access;
- look for natural allies and alliances to develop profile and access

Lobbying could also be supported by a social media oriented strategy. There are different technologies which could be used to support the lobbying efforts, for example internet forums, social blogs (Twitter), content communities (e.g., YouTube) and social networking sites (e.g., Facebook). The goal would be first to improve public awareness about waste water pollution, and second to draw the attention of the society affected by environmental pollution to protest and pressure local authorities. NGOs are also critical players in this

scene. They could use their repertoire of action and communication channels to spread information about pollution and the alternative technologies to counteract it.

The figure 16 shows possible ways to reach decision making people in local authorities. Probably the most efficient ways are through the Chamber of Commerce of Vienna and through a lobbyist in the respective country.

Figure 16: Channels of Communications between Technology Supplier and Local Authorities.




The chamber of commerce and the European Union organize trade delegations and congresses about state of the art of European technologies. Participation in these delegations could support efforts to achieve the objective.

A local lobbyist could probably better reach the decision-makers at high government levels than a foreign enterprise. Such an individual would probably need connections to develop a better strategy; for example at environmental, agricultural and health organizations, as well as both governmental and non-governmental entities who are interested in the reduction of nitrates in water discharged from industry in the environment.

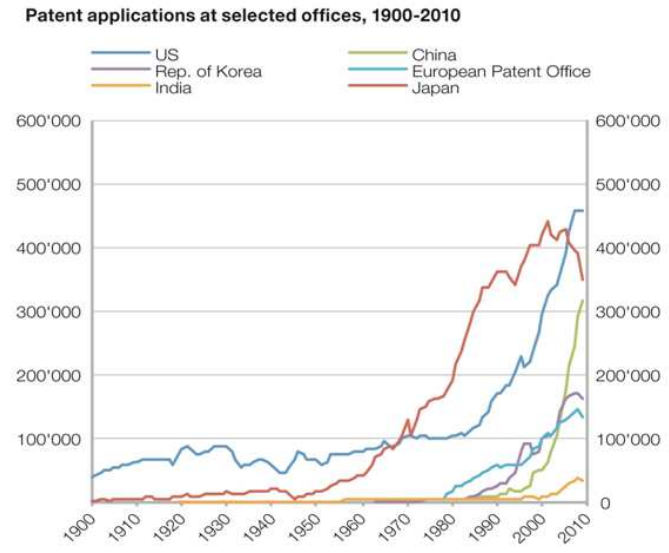
## 3.4 Innovation

"There are all kinds of alternatives to innovation. In the short term, you can cut costs, make acquisitions and buy back your own shares. But in the medium to long term there is no alternative [to innovation]." GARY HAMEL (2005),

Innovation is a central driver of economic growth development and better jobs. It is the key that enables firms to compete in the global marketplace, and the process by which solutions are found to social and economic challenges (WIPO 2011).

Patent applications are an indicator for the innovation performance of a country. USA and Japan have been the leading countries in this field in the last century. Asian countries, especially China are developing very fast in this matter.

Figure 17: Demands for Patents




Note: The figures show applications data for the six top offices. Data for other large offices exhibit a similar trend. One or more classes may be specified on each trademark application, depending on whether an IP office has a single or multiclass filing system, thus complicating the comparison between countries.[89]

Source: WIPO Statistics Database, October 2011.

In 1995 China applied accounted for 1,8% of the world patents. In 2009 China's share increased to 17%. In 2010 the total amount of Chinese patents exceeded 300.000 and outperformed Europe and Korea. The trend is likely to continue in the following years.

This is just an indicator of the progress in terms of innovation -- independent of the validity of each application -- that China has made relative to Western countries in recent years. It is also a promising sign that China is getting serious about protection of intellectual property.

Technology suppliers have to take this development seriously into account. In the long term, technological leverage (advantage) will become the main avenue of competition between countries. Innovation in terms of products and services has to be the soul of a companies' culture, and therefore become integrative and integral part of an organization.

### 3.4.1 Creation of an Innovative Organization

High-Growth companies understand that innovation is what drives growth. It is achieved by employees with a growth oriented attitude, a passion for problem solving and a penchant for turning ideas into reality. Companies that continuously innovate will create new markets, products, services and business models – which leads to more growth. The top-management commitment towards innovation is essential for nurturing a culture of innovation within a company.

The following components are among others key-components to build a sustainable innovation organization:

#### *3.4.1.1 Vision for Innovation*

Vision is understanding the need to create something new, and understanding the emerging opportunities and/or challenges that a team should address. Vision is also about being able to communicate those facts to others and get them to see the same opportunities as you do.

Innovation teams should have a vision to strive towards; the vision should stretch the organization and take them out of their comfort zone.

It does not really matter "who" has the vision as long as someone is willing to stick their neck out and declare the vision. In many cases the vision is stated by someone who isn't the initiator of the project, and doesn't have the "right" authority. Vision and passion are the key-elements for a systematic innovation process and framework. (Phillips J., 2010).

### *3.4.1.2 Creating Culture of Innovation*

Part of fostering an innovative culture includes being explicit about the role of innovation in strategy; encouraging diversity in creativity; having a balanced portfolio; providing the right resources while demanding that people work efficiently; embracing Open Innovation; applauding initiative; supporting competent failure; supporting brave people taking proportionate risks; promoting the right people; rewarding the right behaviour and results. It is also important to measure the right things by focusing corporate, team and individual objectives on innovation output and process metrics (McFarthing K., 2012).

There are two aspects to be considered carefully in the organizational design of a company:

- *human component* and
- *structure component.*

The first refers to competences of employees, coordination of departments and teams, incentives, innovation culture and others. The second component describes the organization itself but also goals and strategy of the company.

The implementation of new strategic tools requires the right organizational structure and processes. A team with a flat organization and task oriented groups has the best chance of success. The team members should be selected engineers and should have following characteristics: flexibility, creativity and willingness to learn from their own (and others') mistakes. The boundaries should be flexible to avoid interferences in the daily work since the team members will continue monitoring the ongoing projects.

From the **resource based view**, many companies own an invaluable richness of high-skilled engineers in many different fields. Based on these resources, the knowledge could be exploited to explore either new products, improve existing products or investigate analogous markets.

From the **market based view**, the definition of long term strategies will depend from the monitoring of target markets. Trend analysis and changes in the industry (corporate foresight) are important factors to determine the performance of the company.

#### *3.4.1.3 Identify consumer needs:*

Each division or product manager, together with the Innovation Team, should identify the customer demands which can be divided in terms of production, future needs and trends from their point of view. This research should be done by personal interviews with relevant customers and also with end consumers of the products.

The results of this research should be classified in

- Actual demands of steel producers
- Future demands of producers
- Actual demands of end-consumers
- Future demands of end-consumers

The analysis of the results should then be transcribed into brief descriptions of problems to solve. A SWOT-analysis can help to underline the results. New strategies are developed based on the analysis of the consumer needs, review of internal resources and market development. Retropolation effects should also be considered for this purpose.

This strategy has to be discussed and reviewed once a year within the management level. The same team has to define the **top 5 demands of customers and end-consumers and the top 5 market trends**. The outcome of the analysis is the foundation for the strategy for the future.

#### *3.4.1.4 Focusing:*

After analysis of the trends and demands, some products possessing specific challenges – either potential improvements or new market developments, for example – should be taken from the group and explored individually.

Example of the some trends:

- Shortage of resources, e.g. energy, raw materials
- Environmental restrictions from governments
- Globalization: increasing competition in and from Asian countries
- Increasing demands for specific materials

Here some questions which might help the team members to focus:

- Which new products should be developed for future markets? (unoccupied technology areas)
- Are some killer applications out there for our technologies?
- Which technological improvements should we do to become the best supplier?
- What do we need to modify in our existing products to meet better the customer needs?
- Which resources are necessary for the implementation and what strategic value do they have?

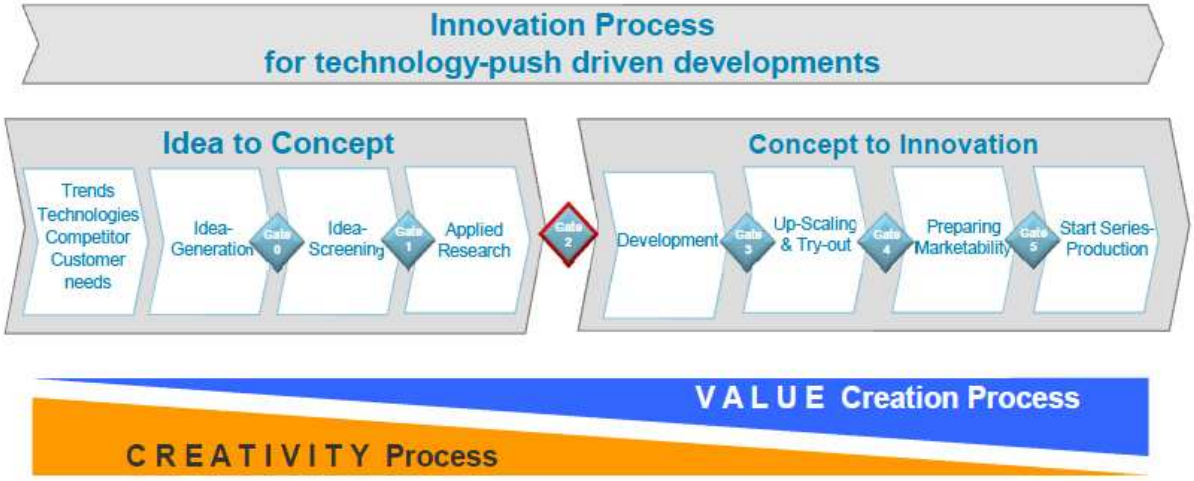
### 3.4.2 Innovation Process

An innovation process describes and defines actions and outcomes that result from the application of specific methods and tools in a specific sequence. One of the important aspects of the process is that is not linear.

The process of innovation relies on the non-linear methods of **iteration** and **abstraction**. Iteration because that is how we learn things and obtain new knowledge: by going back, refining and maturing what we know to gain insight and understanding of the things we see and learn. Abstraction because that is how we synthesize knowledge, see patterns and make connections to new things. Both of these activities, iteration and abstraction, are inherently non-linear, yet must necessarily take place over time as a series of concrete actions by people using a process for innovation (Schmidt, L. 2008).

Figure 18 shows an innovation process for technology-push driven developments. Iteration and abstractions processes can occur during the idea concept stage but also during the concept of innovation stage.

Figure 18: Innovation process for technology-push driven ideas (Peruzzi, M. 2012)




### 3.4.3 Cooperation with external partners

The increased complexity of knowledge processes, which are the backbone of new technologies and innovation, leads firms to search beyond their own boundaries for valuable knowledge and skills in order to complement their own capabilities (Becker W. and Dietz, J. 2004). Since the 1980s, the increasing instability of the competitive environment, with shorter product and technological life cycles, has forced firms to reconsider their innovation strategy in order to widen their technology base (Nijssen et al., 2001). In this context, cooperation with external partners has gained an important role in the innovation process at the firm level, since innovation cooperation activities are considered an efficient means for the industrial organization of complex R&D and innovation processes. Cooperation activities with other firms (sub-suppliers, customers) or institutions (universities, Research Labs) are opportunities to access complementary technological resources which can contribute to support innovation processes.

### 3.4.4 Boosting Innovation

Here additional examples how innovation can be supported:

**Innovation Task Force:** The company could nominate “Innovation explorers”, whose responsibility would be to search for trends, new technologies of existing and analogous products. They participate in conferences and visit expositions. In regular intervals all *innovation explorers* meet together with all product managers (Innovation task force). The explorers present to all members the results and observations garnered from all activities. This sharing of information is crucial to discuss together and analyze what is happening “outside”. The innovation task force would decide new strategies or adjust existing ones.

**Innovation Challenge**: The company could make an innovation competition among the employees. The proposals could be improvements in the daily processes in the company or technical advancements in processes. This project could motivate and encourage employees to be innovative and also would give them the opportunity to make their ideas public. The winners of the best three innovations would get a representative financial reward and win prizes during the Innovation Conference mentioned above.

**Innovation Division:** The company could create an Innovation Division with all necessary financial and human resources to monitor and execute all above mentioned projects. The members of this division would work out long term strategies together with all R&D departments and division managers.

**INNOVATION CONGRESS**

**Internal Sources**

The idea of this congress is to bring all experts within the big companies once a year with several divisions together to know each other and to present an overview of their products and working fields.

The introduction speech in the congress should be done by the CEO followed by a presentation of a guest, an internationally recognized expert in open innovation. This presentation might introduce all participants into the new era of innovation. Social events should not be underestimated; they play an important role in bringing people together.

The level of resistance within the experts for this project might be high; therefore each activity and presentation should be planned carefully. The congress must create an inspiring atmosphere for innovation, co-operation and team work.

Afterwards the chosen challenges, as mentioned above for example, are presented in workshops with the intention of getting solutions or ideas from colleagues from other divisions.

Some examples:

1. One challenge might be the production of pellets or similar forms out of oxide dust produced in regeneration plants. Experts from the biofuel and processes division with their knowledge on production of pellets might help colleagues from metals divisions in the handling of oxide powder.

2. Pulp & Paper could need some support from Metals division to improve specific machines.

#### *3.4.4.1 Control of Innovation - The "Scorecard" as Management Control System:*

The Balanced Scorecard (BSC) is a strategic performance management tool - a semi-standard structured report, supported by proven design methods and automation tools that can be used by managers to keep track of the execution of activities by the staff within their control and to monitor the consequences arising from these actions (Kaplan and Norton (1992).

The main characteristic of the Balanced Scorecard is the presentation of a mixture of financial and non-financial measures each compared to a 'target' value within a single concise report. The report is not meant to be a replacement for traditional financial or operational reports, but rather a succinct summary that captures the information most relevant to those reading it. It is the method by which this 'most relevant' information is determined (i.e. the design processes used to select the content) that most differentiates the various versions of the tool in circulation.

One of the disadvantages of the Balanced Scorecard mentioned by Jensen, Michael C is that it does not provide a bottom line score or a unified view with clear recommendations: it is simply a list of metrics (Jensen, M.C 2001)

The four perspectives of the Balance Score Card:

The 1st Generation design method proposed by Kaplan and Norton (1992) was based on the use of three non-financial topic areas as prompts to aid the identification of non-financial measures in addition to one looking at Financial. Four "perspectives" were proposed:

Table 3: Four Perspectives of the Balance Score Card

| PERSPECTIVES | EXPLANATION | INDICATORS |
|---|---|---|
| Financial | encourages the identification of a few relevant high-level financial measures. In particular, designers were encouraged to choose measures that helped inform the answer to the question "How do we look to shareholders?" | costs of manufacturing, (engineering hours), % of sales from new product |
| Customer | encourages the identification of measures that answer the question "How do customers see us?" | Product quality, delivery time and customer satisfaction (interviews) |
| Internal Business Processes | encourages the identification of measures that answer the question "What must we excel at?" | construction time (engineering hours), erection time |
| Innovation and Learning | encourages the identification of measures that answer the question "How can we continue to improve and create value?" | number of patents, number of new ideas implemented in projects |

Reporting System and Control Type of Information to be reported externally:

Reporting systems are important to measure the performance of a team, company, etc. It is also important to define which kind of information makes sense to be reported to upper management levels.

The team members are usually overloaded with work during the execution of projects. Therefore it has to be considered that any reporting system is additional work and would most likely create dissatisfaction. It would be convenient to evaluate the innovations after finishing each project.

The information to be reported to the middle management should be concise, indicating the stage before and after the implementation. The best way could be a table with the following columns:

- Innovation
- Description Before Implementation
- Description after implementation
- Relevance/Impact of Innovation (costs, performance of equipment)

The control type is focused on Process steps but also on outputs of the innovation process. A summary of the most important innovations would be reported once a year to the top management. It is recommendable to evaluate the total costs and performance over the year.

# 4 Discussion and Recommendations

This last chapter begins with a discussion of the results from this study and ends with compiled recommendations based on these results.

## 4.1 Discussion of Results

The main purpose of this thesis was to investigate the reasons why manufacturers of stainless steel are hesitant to acquire spray-roasting type acid regeneration plants for mixed acid. It was also intended to contribute a concept and strategy to overcome demonstrated and anticipated obstacles to boost the sales of this technology.

Stainless steel production is a growing market. The financial crisis in 2008/2009 reduced the demand in western countries but did not impact the growth trend in Asian countries. At the moment there is an overcapacity in steel production that is slowing down investment in new steel plants. Nevertheless, there are still some steel works without total regeneration technologies which could be retro-fitted in the future, and many steel works with low-budget technologies that could be as well. China is and will remain by far the largest market. The market in other Asian countries is small to moderate and unlikely to undergo significant changes in the near future.

Different technologies for total and partial mixed acid recovery have been developed, however only some of them reached the maturity level necessary for commercialization. Spray roasting is the most diffused and successful process in the field of “total regeneration,” with Nano- and Microfiltration representing its strongest competitor in this field. Retardation is the market leader in partial regeneration but also a direct and strong competitor of total regeneration technologies. Other processes and combination of them remain unconvincing from a technical and economic point of view, and still have a long way to go before attaining market penetration.

The factors which influence customer purchase behavior include region (emerging markets or developed country), market position and financial background. Three reasons have been determined to be the most important:

a) Capital investment,

b) Lack of information and

c) Environmental regulations.

The problem of capital investment can be solved with an alternative business model. BOOT-Chemical Leasing represents one possibility to overcome this obstacle; it is an innovative and environmentally friendly service-oriented business model. The unit of payment with this concept would be the surface treated ($m^2$ of pickled band) rather than the $m^3$ of waste acid. The addition of a service-oriented business model around manufacturing products can have major benefits in terms of increased revenues, profits and creating barriers to competitors. Adding services may seem at first glance a rather easy expansion of the portfolio. Nevertheless, it can be difficult to manage these changes in the firm.

The lack of information could be mitigated by a strategy of marketing diffusion of innovations. Effective marketing requires an integrated communication plan combining both personal selling efforts and non-personal ones such as advertising, participation in conferences and the publication of articles in relevant magazines.

Environmental requirements in terms of nitrate concentrations in waste water and sludge production are still too weak in many countries, and this leads customers to invest in low-budget technologies. In most cases these technologies are enough to fulfill the requirements for operation of steel plants. In order to counteract this effect, it is important to understand the structure of local authorities and their decision making process. Local authorities could be advised and consequently environmental regulations could be tightened through strategic lobbying and social media.

The purchasing criteria from steel producers may vary depending on their experience with regeneration technologies but also on the level of information about this field. The nitrates reduction in waste water seems to be one of the most important attributes. Investment and ROI, Availability of the plant and volume reduction of the regenerated acid are also important attributes which complement the acid recovery rates.

## 4.2 Recommendations

Steel demand and consequently the opportunities for acid regeneration plants in emerging markets will increase in the future, particularly in the Asian region; thus, it is essential to launch a customer oriented strategy, increase marketing activities and after sales services in these countries. This could enhance the reputation of the firm but also elevate and differentiate the company from all competitors.

### Service-oriented Business Model

In addition to the aforementioned changes, equipment suppliers need to alter their business models by introducing greater operating flexibility and becoming more customer-focused in their product mix and more innovative in how they price their products. A new win-win business model and its advantages has already been mentioned: BOOT-Chemical Leasing. This innovative approach to customers' demand could increase the competitive advantage of Andritz. It would also solve the IP problem since the joint venture or company in charge of the operation of the ARP would control the know-how of the process.

The launch of a service-oriented business model is associated with a major cultural change in the company. Once the profit opportunity is identified, the firm must set up the structures, resources and processes to exploit it.

### Purchasing Attributes:

The purchasing attributes have been mentioned in chapter 2.3.2. Their relevance can vary from customer to customer. Nevertheless, the most important have been listed and rated by some current customers. These are important components to consider during the sales stage.

### Innovation Management and Intellectual Property

The engineering team is able to counteract the threat of reverse-engineering and alternative technologies. This is possible through continuous incremental innovations in the product under consideration of cost-benefit consequences. Intellectual property ownership should

become a relevant issue in the product strategy. Patents can be used for a certain period of time as an instrument to support the technological advantage against competitors.

It is advisable to develop an efficient and financially sustainable regeneration process for total recovery of capacities lower than 1000 l/h. These plants should be installed in a modular way to cover the market segment of lower volume of waste acid production.

## Lobbying as Strategy:

To develop and maintain a good rapport with our customers and senior decision makers is essential in the industry. This job might not be easy in many countries and particularly with steel manufacturers. Nevertheless, this is a significant factor and must become a priority in each project. All people involved in the sales process should put their efforts together to understand the customer's organization and the decision making structure and process. Decision makers are often both at management level and operating level, and have to be considered equally.

Lobbying work with governmental entities responsible for environmental regulations is another difficult yet integral element of the information dissemination and sales strategy. Cooperating with agricultural and health organizations, as well as non-governmental entities who are interested in the reduction of nitrates in water discharged from industry in the environment, could help facilitate this work. Fostering a positive relationship through these entities could also achieved by working through the chamber of commerce and local representatives. The goal should be to outline the positive role of total acid recovery technologies in the relevant environmental law and define a specific concentration of waste allowed to in the disposal process. If successful, the benefits for ARP suppliers would be significant.

## Further Recommendations:

Many of the users of spray roasting are struggling to dispose of the oxide produced in the acid regeneration plants. This by-product is a valuable source of nickel and chromium and can be reused in steel manufacturing. However, the infrastructure for reclaiming this material is not yet widespread. An oxide handling concept, including the appropriate form, degree of moisture, packing (e.g. containers, big bag, etc) for further processing could represent a competitive advantage. Therefore, it would be necessary to investigate first the local oxide market and the required oxide quality and packing, in order to optimize the oxide handling

equipment of the ARP in this regards. Consequently, Andritz could introduce the ARP owner (and oxide producer) in the local market and offer a solution to the oxide handling problem.

The consolidation process of companies is a strong trend in the industry. A vertical integration of the supply chain for the design and erection of industrial plants could bestow a strategic advantage among competitors. The acquisition of suppliers of key-components such as chemical pumps, specific fans, filters, etc. could simplify and accelerate the project execution and gain strategic edge over companies that serve the same market. Furthermore, the spare parts business would be in one's control and allow for better customer support service.

# 5 Bibliography

**Agrawal A., Nestour M., Mangers P., Beifus A., Sarkar S.** (2011): Global Steel – 2011 trends, 2012 outlook, Competing for growth in the steel sector. UK, Ernst & Young

**BBC**, Lobbying http://news.bbc.co.uk/2/hi/uk_news/politics/82529.stm

**Becker W., Dietz J.** (2004): R&D cooperation and innovation activities of firms−evidence for the German manufacturing industry, Research Policy, 33 (2) (2004), pp. 209‑223

**Benedetto J.S., Morais C.A., Bocardo P.A.** (2005): Recovery of nitric acid and hydrofluoric Acid from industrial waste. Proceedings of the International Solvent Extraction Conference, ISEC 2005.Chinese Academic Journal, Beijing, p. 485-489

**BOT** http://en.wikipedia.org/w/index.php?oldid=487952437

**Coen, D**., "Business Interests and European Integration", in: Balme, R., Chabanet, D. and Wright, V. (eds): L'action collective en Europe, Sciences Po Press, Paris, 2002, p. 261-267.

**Dusart A., El-Deeb H., Jaouhari N., Ka D., Ruf L.** (2011): Final Report ISSF Workshop. Paris, Université Paris, International Stainless Steel Forum

**EcoTec** Chemical Recovery: Acid Purification System for Stainless Steel Pickling Acids. Prospect.

**Gatti, Stafano** (2007): Project Finance in theory and practice. Academic Press. pp. 414. ISBN 0123736994, 9780123736994.

**Gerybadze A., Hommel U., Reiners H. W., Thomaschewski D.** (2010): Innovation and International Corporate Growth. Germany, Springer Verlag.

**Hamel, G.** (2005): Cited in: Floodgates open uo to a sea of ideas – Simon London analyses the changing nature of innovation, as in-house genius gives way to an open source approach, Financial Times, 8.6.2005.

**Ireland D., Hitt M. A.** (1992): Missions Statement: Importance, Chanllenge and Recommendations for Development, Business Horizons 35, no.3, p.34-42

**Jacobs, R.** (1999): Evaluating Satisfaction with Media Products and Services: An Attribute Based Approach". European Media Management Review

**Jakl T., Schwager P. Et al.,** (2008): Chemical Leasing Goes Global, Selling Services Instead of Barrels. Wien, Springer Verlag

**Jensen, M.C** (2001): Value Maximization, Stakeholder Theory, and the Corporate Objective Function.

**Joas R., Jakl T., Schwager P., Et al.** (2008): Chemical Leasing Goes Global, Selling Services Instead of Barrels. Wien, Springer Verlag

**Kaplan, R., Norton D.**, (1992): The Balanced Scorecard - Measures that Drive Performance", Harvard Business Review

**Lehmann W., Tušar A., Schuman R.** (2003): Lobbying In The European Union: Current Rules And Practices, Working Paper. European Parliament

**Loudon D., Stevens R., Wrenn B.** (2005): Marketing Management. New York, Best Business Books -The Haworth Press

**Mattelmäki, T. and Battarbee, K.** (2002): "Empathy Probes", The Proceedings of PDC2002, Malmo 23-25.6.2002

**McFarthing, K.** (2012): Building a Culture of Innovation, www.innovationexcellence.com

**Ministry of Municipal Affairs of British Columbia** (1999): Public Private Partnership A Guide for Local Government

**Nijssen, E., Van Reekum, R., Hulshoff, H.** (2001):Gathering and using information for the selection of technology partners, Technological Forecasting and Social Change, 67 (2) (2001), pp. 221‑237

**OECD (Organization for Economic Co-operation and Development, (2008):** Public-Private Partnerships, In Pursuit of Risk Sharing and Value for money

**Peruzzi, M.** (2012): Challenges in the front end of innovation, Innovation Management at voestalpine Stahl GmbH, VOEST-ALPINE

**Phillips, J.** (2010): Vision and Passion for Innovation Success, www.innovationexcellence.com

**Regel-Rosocka M.** (2010): A review on methods of regeneration of spent pickling solutions from steel processing. Poznan University of Technology, Poland. Journal of Hazatdous Materials 177, 57-69

**Reinartz, W. Ulaga W.** (2006): Growth beyond the core, Financial Times 31st of March 2006: 10.

**Rogers E.** (1983): Diffusion of Innovations. New York: Free Press. ISBN 978-0-02-926650-2

**Schmidt, L.** (2008): What is an Innovation Process?, The Process of Innovation, Inovo Innovations. http://inovo-innovation.wetpaint.com

**Silk A.J.** (2006): What is Marketing? Unites States of America, Harvard Business School Publishing Corporation.

**Steel and Metals Market Research**, January 2012

**Strecker, N** (2009): Innovation Strategy and Firm Performance. Gabler | GWV Fachverlage GmbH, Wiesbaden

**Susman G., Warren A. Ding M.** (2006): Product and Service Innovation in Small and Medium-Sized Enterprises, Smeal College of Business, The Pennsylvania State University for The National Institute of Standards and Technology

**UNIDO** United Nations Industrial Development Organization – Chemical Leasing, http://www.unido.org/index.php?id=o4460

**WIPO** World Intellectual Property Organization (2011): WIPO Economics & Statistics Series Report, The Changing Face of Innovation.

**World Steel Association** (2011): World Steel in Figures 2011. Belgium

# 6 Appendix

## Appendix A:

| Waste Acid World Production | | 32.110.000 | t/a | | | Author Dr. J. Starcevic | | 25.04.2012 |
|---|---|---|---|---|---|---|---|---|
| | | LOSS % | hot t/a | thicknes mm | PLoss g/m² | Density t/m3 | PLoss t/a | Metal conc. g/l | Waste Acid m3/a |
| AISI 300 | 53% | 3% | 17.528.849 | 3 | 17 | 7,9 | 25.147 | 35 | 718.482 |
| AISI 200 | 12% | 3% | 3.968.796 | 3 | 35 | 7,9 | 11.722 | 40 | 293.055 |
| AISI 400 | 31% | 3% | 10.252.723 | 3 | 25 | 7,7 | 22.192 | 45 | 493.156 |
| Duplex | 4% | 3% | 1.322.932 | 3 | 15 | 7,95 | 1.664 | 20 | 83.203 |
| total Hot | 100% | | 33.073.300 | | | | 60.725 | | 1.587.896 |
| | | | | | | | | 38,1 | |
| | | Hot > Cold | cold t/a | thickness | PLoss g/m² | | Ploss t/a | ME g/l | Waste Acid m3/a |
| AISI 300 | | 60% | 10.517.309 | 1,1 | 6 | 7,9 | 14.523 | 35 | 414.952 |
| AISI 200 | | 60% | 2.381.278 | 1 | 8 | 7,9 | 4.823 | 40 | 120.571 |
| AISI 400 | | 70% | 7.176.906 | 0,8 | 3 | 7,7 | 6.990 | 45 | 155.344 |
| Duplex | | 30% | 396.880 | 1,1 | 4 | 7,95 | 363 | 20 | 18.153 |
| total Cold | | | 20.472.373 | | | | 26.700 | | 709.021 |
| Sum Pickled Material | | | 53.545.673 | t/a | | | 87.425 | t/a | 2.296.917 |

**Appendix B:**

# Barriers to Investment 投资的顾虑：

The PYROMARS-Process is a technology developed for total recycling of the waste acid produced during the pickling of stainless steel. Despite a short ROI of 2-3 years and the environmental impact in reduction of nitrates in waste water, many steel manufacturers are still reluctant to acquire such technology.

PYROMARS 工艺是一种对不锈钢酸洗过程中的产生的废酸进行完全回收的工艺。虽然 ROI（投资回报率）在两年至三年并且可以减少废水中氮对环境的影响，很多钢铁制造商仍然不愿意接受这种技术。

How would you evaluate from your point of view the main reasons why your company did not buy a PYROMARS plant before? 您认为为什么你们公司没有选择 PYROMARS 产线?

| | | |
|---|---|---|
| 1 | lack of information about the product and its impact (ROI and cost reduction)<br>缺少本产品的信息以及缺少投资回报和削减开支等方面的信息 | |
| 2 | environmental regulations (e.g. approval from local authorities for additional plants in existing steel works due to neighborhoods and residential areas )<br>环保规定（比如：在居民区附件新建生产线需要当地政府部门的批准） | |
| 3 | capital investment<br>资本投资 | |
| 4 | use of other technologies ( membrane technology, retardation, etc..)<br>使用其他的技术（膜技术，延缓技术等） | |
| 5 | production of waste acid is too small for a Pyromars plant<br>废酸的量太少，不足以使用 Pyromas 生产线 | |
| 6 | lack of place for installation<br>没有足够的区域安装生产线 | |
| 7 | lower nitrate concentrations in waste water are **not** requested by local authorities 当地政府部门没有规定废水中最低氮的含量。 | |
| | | |
| | others.. (please specify)<br>其他原因 （请注明） | |
| | SUM 总计： | 100 % |

Do you have and operate already a technology for total recovery of mixed acid?

yes _(pls specify)_____ no

你们有正在运行的混合酸酸再生生产线吗？ 如果有，请注明

**Appendix C:**

# Quality: Key Purchasing Attributes 质量：关键的采购因素

How would you estimate the importance of attributes, before acquiring any acid regeneration technology? 您在采购任何酸再生技术时，您认为哪些是重要的采购因素。

| ( from customer perspective) 从客户的角度 | | |
|---|---|---|
| 1. | Recovery rate of total HNO3 全部硝酸的回收率 | |
| 2. | Recovery rate of total Metals 全部金属离子的回收率 | |
| 3. | Recovery rate of total HF 全部氢氟酸的回收率 | |
| 4. | Concentration of HF/HNO3 and metals in regenerated acid 再生酸中氢氟酸/硝酸以及金属离子的浓度 | |
| 5. | Availability of the plant 生产线的有效性 | |
| 6. | Investment and ROI 投资和投资回报率 | |
| 7. | Operation & maintenance costs 操作和维护成本 | |
| 8. | Reduction of nitrate concentration in waste water (environmental regulations) 在废水中降低氮的浓度（环保规定） | |
| | Others (please specify) 其他（请注明） | |
| | | |
| | SUM 总计 | 100% |

# Appendix D (page 1 of 4):

## (Fig 2.1) *Types of Public Private Partnerships*

| Type of PPP | Features | Local Government Applications | Advantages | Disadvantages |
|---|---|---|---|---|
| **1 Operations and Maintenance** | The local government contracts with a private partner to operate and maintain a publicly owned facility. | A broad range of municipal services including water and wastewater treatment plants, solid waste removal, road maintenance, parks maintenance/ landscape maintenance, arenas and other recreation facilities, parking facilities, sewer and storm sewer systems. | • potential service quality and efficiency improvements<br>• cost savings<br>• flexibility in structuring contracts<br>• ownership vests with local government | • collective agreements may not permit contracting out<br>• costs to re-enter service if contractor defaults<br>• reduced owner control and ability to respond to changing public demands |
| **2 Design-Build** | The local government contracts with a private partner to design and build a facility that conforms to the standards and performance requirements of the local government. Once the facility has been built, the local government takes ownership and is responsible for the operation of the facility. | Most public infrastructure and building projects, including roads, highways, water and wastewater treatment plants, sewer and water systems, arenas, swimming pools and other local government facilities. | • access to private sector experience<br>• opportunities for innovation and cost savings<br>• flexibility in procurement<br>• opportunities for increased efficiency in construction<br>• reduction in construction time<br>• increased risk placed on private sector<br>• single point accountability for the owner<br>• fewer construction claims | • reduced owner control<br>• increased cost to incorporate desirable design features or change contract in other ways once it has been ratified<br>• more complex award procedure<br>• lower capital costs may be offset by higher operating and maintenance costs if life-cycle approach not taken |
| **3 Turnkey Operation** | The local government provides the financing for the project but engages a private partner to design, construct and operate the facility for a specified period of time. Performance objectives are established by the public sector and the public partner maintains ownership of the facility. | This form of public private partnership is applicable where the public sector maintains a strong interest in ownership but seeks to benefit from private construction and operation of a facility. This would include most infrastructure facilities, including water and wastewater treatment plants, arenas, swimming pools, golf courses and local government buildings. | • places construction risk on the private partner<br>• proposal call can control design and location requirements as well as operational objectives<br>• transfer of operating obligations can enhance construction quality<br>• potential public sector benefits from increased efficiency in private sector construction<br>• potential public sector benefits from increased efficiency in private sector operation of the facility<br>• construction can occur faster through fast-track construction techniques such as design-build | • reduced local government control over facility operations<br>• more complex award procedure<br>• increased cost to incorporate changes in design and operations once contract is completed<br>• depending on the type of infrastructure, financing risk may be incurred by the local government |

7 PUBLIC PRIVATE PARTNERSHIP: A Guide for Local Government

## Appendix D (page 2 of 4):

| Type of PPP | Features | Local Government Applications | Advantages | Disadvantages |
|---|---|---|---|---|
| **4 Wrap Around Addition** | A private partner finances and constructs an addition to an existing public facility. The private partner may then operate the addition to the facility for a specified period of time or until the partner recovers the investment plus a reasonable return on the investment. | Most infrastructure and other public facilities, including roads, water systems, sewer systems, water and wastewater treatment plants, and recreation facilities such as ice arenas and swimming pools. | • public sector does not have to provide capital funding for the upgrade<br>• financing risk rests with private partner<br>• public partner benefits from the private partner's experience in construction<br>• opportunity for fast-tracked construction using techniques such as design-build<br>• flexibility for procurement<br>• opportunities for increased efficiency in construction<br>• time reduction in project implementation | • future facility upgrades not included in the contract with the private partner may be difficult to incorporate at a later date<br>• expense involved in alteration of existing contracts with the private partner<br>• perceived loss of control<br>• more complex contract award procedure |
| **5 Lease-Purchase** | The local government contracts with the private partner to design, finance and build a facility to provide a public service. The private partner then leases the facility to the local government for a specified period after which ownership vests with the local government. This approach can be taken where local government requires a new facility or service but may not be in a position to provide financing. | Can be used for capital assets such as buildings, vehicle fleets, water and wastewater treatment plants, solid waste facilities and computer equipment. | • improved efficiency in construction<br>• opportunity for innovation<br>• lease payments may be less than debt service costs<br>• assignment of operational risks to private sector developer<br>• improve services available to residents at a reduced cost<br>• potential to develop a "pay for performance" lease | • reductions in control over service or infrastructure |
| **6 Temporary Privatization** | Ownership of an existing public facility is transferred to a private partner who improves and/or expands the facility. The facility is then owned and operated by the private partner for a period specified in a contract or until the partner has recovered the investment plus a reasonable return. | This model can be used for most infrastructure and other public facilities, including roads, water systems, sewer systems, water and wastewater treatment plants, parking facilities, local government buildings, airports, and recreation facilities such as arenas and swimming pools. | • if a contract is well structured with the private partner, the municipality can retain some control over standards and performance without incurring the costs of ownership and operation<br>• the transfer of an asset can result in a reduced cost of operations for the local government<br>• private sector can potentially provide increased efficiency in construction and operation of the facility<br>• access to private sector capital for construction and operations<br>• operational risks rest with the private partner | • perceived or actual loss of control<br>• initial contract must be written well enough to address all future eventualities<br>• private sector may be able to determine the level of user fees, which they may set higher than when under local government control<br>• difficulty replacing private partner in the event of a bankruptcy or performance default<br>• potential for local government to reemerge as the provider of a service or facility in the future<br>• displacement of local government employees<br>• labour issues in transfer of local government employees to the private partner |

8 MAY 1999

## Appendix D (page 3 of 4):

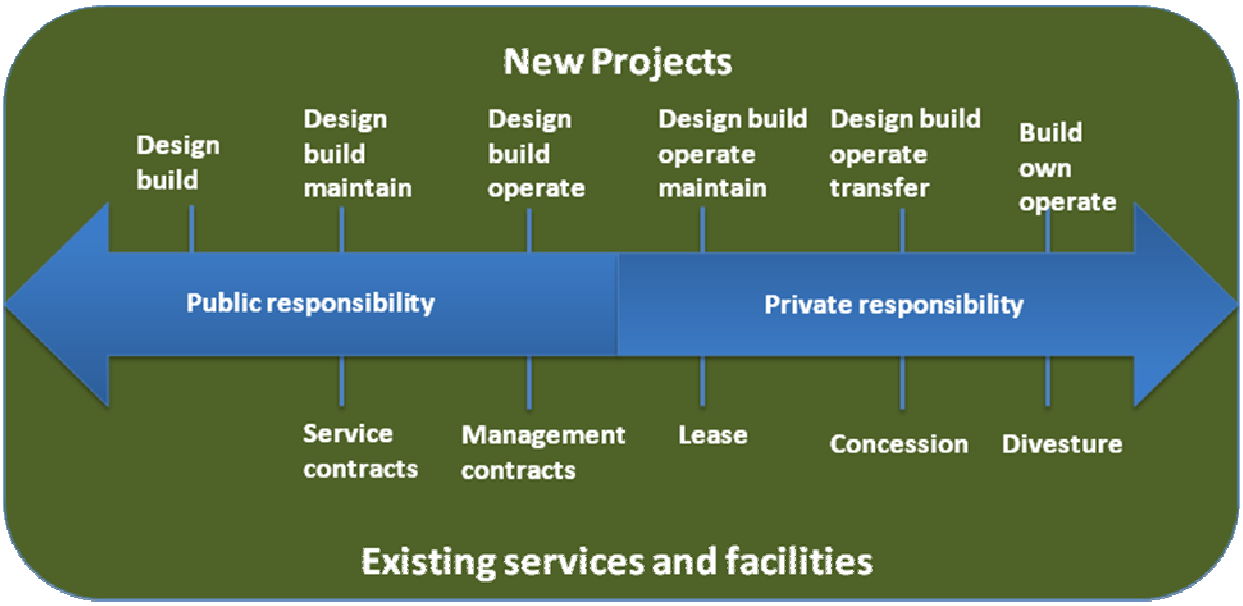
| Type of PPP | Features | Local Government Applications | Advantages | Disadvantages |
|---|---|---|---|---|
| **7 Lease-Develop-Operate or Buy-Develop-Operate** | The private partner leases or buys a facility from the local government, expands or modernizes it, then operates the facility under a contract with the local government. The private partner is expected to invest in facility expansion or improvement and is given a specified period of time in which to recover the investment and realize a return. | Most infrastructure and other public facilities, including roads, water systems, sewer systems, water and wastewater treatment plants, parking facilities, local government buildings, airports, and recreation facilities such as arenas and swimming pools. | • if the private partner is purchasing a facility, a significant cash infusion can occur for the local government<br>• public sector does not have to provide capital for upgrading<br>• financing risk can rest with the private partner<br>• opportunities exist for increased revenue generation for both partners<br>• upgrades to facilities or infrastructure may result in service quality improvement for users<br>• public partner benefits from the private partner's experience in construction<br>• opportunity for fast-tracked construction using techniques such as design-build<br>• flexibility for procurement<br>• opportunities for increased efficiency in construction<br>• time reduction in project implementation | • perceived or actual loss of control of facility or infrastructure<br>• difficulty valuing assets for sale or lease<br>• issue of selling or leasing capital assets that have received grant funding<br>• if a facility is sold to a private partner, failure risk exists—if failure occurs, the local government may need to reemerge as a provider of the service or facility<br>• future upgrades to the facility may not be included in the contract and may be difficult to incorporate later |
| **8 Build-Transfer-Operate** | The local government contracts with a private partner to finance and build a facility. Once completed, the private partner transfers ownership of the facility to the local government. The local government then leases the facility back to the private partner under a long-term lease during which the private partner has an opportunity to recover its investment and a reasonable rate of return. | Most infrastructure and other public facilities, including roads, water systems, sewer systems, water and wastewater treatment plants, parking facilities, local government buildings, airports, and recreation facilities such as arenas and swimming pools. | • public sector obtains the benefit of private sector construction expertise<br>• public sector obtains the potential benefits and cost savings of private sector operations<br>• public sector maintains ownership of the asset<br>• public sector ownership and contracting out of operations limits any provincial and federal tax requirements<br>• public sector maintains authority over the levels of service(s) and fees charged<br>• compared to a Build-Operate-Transfer model, avoids legal, regulatory and tort liability issues<br>• under *Occupiers' Liability Act*, tort liability can be avoided<br>• government control of operational performance, service standards and maintenance<br>• ability to terminate agreements if service levels or performance standards not met, although facility would continue to permit repayment of capital contributions and loans and introduction of new private partner<br>• construction, design and architectural savings, and likely long-term operational savings | • possible difficulty in replacing private sector entity or terminating agreements in event of bankruptcy or performance default |

PUBLIC PRIVATE PARTNERSHIP: A Guide for Local Government 9

## Appendix D (page 4 of 4):

| Type of PPP | Features | Local Government Applications | Advantages | Disadvantages |
|---|---|---|---|---|
| **9 Build-Own-Operate-Transfer** | The private developer obtains exclusive franchise to finance, build, operate, maintain, manage and collect user fees for a fixed period to amortize investment. At the end of the franchise, title reverts to a public authority. | Most public infrastructure services and facilities, including water and wastewater systems, recreation facilities, airports, local government administration and operations buildings, parking facilities and solid waste management facilities. | • maximizes private sector financial resources, including capital cost allowance<br>• ensures the most efficient and effective facility is constructed, based on life-cycle costs<br>• allows for a private sector operator for a predetermined period of time<br>• the community is provided with a facility, without large up-front capital outlay and/or incurring of long-term debt<br>• all "start-up" problems are addressed by the private sector operator<br>• access to private sector experience, management, equipment, innovation and labour relationships may result in cost savings<br>• risk shared with private sector | • facility may transfer back to the public sector at a period when the facility is "work" and operating costs are increasing<br>• public sector loses control over the capital construction and initial mode of operations<br>• initial contract must be written sufficiently well to address all future eventualities<br>• the private sector can determine the level(s) of user fees (unless the public sector subsidizes use)<br>• less public control compared to Build-Transfer-Operate structure<br>• possible difficulty in replacing private sector partner or determining agreements if bankruptcy or performance default |
| **10 Build-Own-Operate** | The local government either transfers ownership and responsibility for an existing facility or contracts with a private partner to build, own and operate a new facility in perpetuity. The private partner generally provides the financing. | Most public infrastructure and facilities, including water and wastewater systems, parking facilities, recreation facilities, airports, local government administration and operations buildings. | • no public sector involvement in either providing or operating the facility<br>• public sector can "regulate" the private sector's delivery of a "regulated/ monopolistic" service area<br>• private sector operates the service in the most efficient manner, both short-term and long-term<br>• no public sector financing is required<br>• income tax and property tax revenues are generated on private facilities, delivering a "public good"<br>• long-term entitlement to operate facility is incentive for developer to invest significant capital | • the private sector may not operate/construct the building and/or service "in the public good"<br>• the public sector has no mechanism to regulate the "price" of the service, unless it is a specifically regulated commodity<br>• the good/service being delivered is subject to all federal, provincial and municipal tax regulations<br>• no competition, therefore necessary to make rules and regulations for operations and to control pricing |

## Appendix E:


New Projects
Design build
Design build maintain
Design build operate
Design build operate maintain
Design build operate transfer
Build own operate
Public responsibility
Private responsibility
Service contracts
Management contracts
Lease
Concession
Divesture
Existing services and facilities