Executive summary:

Painting of metal surfaces used in outdoor applications is necessary in order to protect the product from corrosion and also to increase the esthetical value. The corrosion protection performance is dependent on the quality of the paint coating and on the pre-treatment of the metal surfaces. Zinc phosphate has been used as the pretreatment process for the last 40 years when high corrosion protection is necessary. The process requires high consumption of energy, chemicals and water and it produces a lot of waste. The need for alternative systems is high.

New pretreatments have been under development for about a decade and are based on Zr/Ti chemicals that precipitate an oxide on the metal surfaces. The Zr/Ti can also be in a combination with silanes. These chemicals have no hazardous marking, are used in low concentration and are easy to handle. Some of the new systems are launched as "being able to replace zinc-phosphating". The strategic objective of the project has been to present individual knowledge to the SME partners, which should enable the technology shift from zinc phosphate pretreatment to the new Zr/silane based systems. To make the objective realistic, verifiable and easy to communicate the knowledge has been packaged in a "Tool box for successful implementation of new pretreatment systems".

The toolbox contains information about:
- How to evaluate, adapt and implement the new pretreatment systems;
- How to control the new pretreatment processes.

The points below summarize the results and present the most important findings:
- The new pretreatment systems can to a large extent be evaluated by the procedures which today are used in the vehicle industry in order to qualify/accept a surface treatment system. The tests concern adhesion and corrosion performance of the pretreatment-coating system. One important research question was if the existing accelerated corrosion tests would be reliable and correlate well with field test (painted panels mounted on bus/truck that runs in traffic). Several tests were performed together with field test and it was found that the conventional tests used by Volvo (ACT1 and 2) correlated well with results from field while salt spray test don't correlate. These types of results have not been presented before, neither by suppliers nor in the corrosion research literature either. Accelerated tests and field tests showed that the new pretreatments are generally inferior to zinc phosphate in corrosion protection although the choice of paint system has an influence.
- A new pretreatment can easily be implemented in an existing line designed for zinc phosphate. Life cycle assessment (LCA) confirms the large savings possible with respect to energy, water and chemical consumption. New pretreatment processes can easily be semi automatically controlled through the automatic collection of easily accessible data such as temperatures, conductivities, pH values, and daily measured concentration of a couple of elements. Multivariat data analyses performed in the project on data collected at one of the SMEs running a new Zr-based pretreatment confirmed that the process is very stable.
- Electrochemical tests, which are experimental test simulating corrosion, showed that zinc phosphate generally contributes to a higher resistance towards corrosion than the new pretreatment systems.

Conclusions

The new pretreatments are not ready for introduction at a painting job shop that performs surface treatment on a wide variety of materials in the same line. Good results can be obtained on aluminium and to some extent on galvanized material but less good results are obtained on steel. There is still a need for product development and the environmental profile of new systems make the development worthwhile.

Project Context and Objectives:

Painting of metal surfaces used in outdoor applications is necessary in order to protect the product from corrosion and also to increase the esthetical value. The corrosion protection performance is dependent on the quality of the paint coating and on the pre-treatment of the metal surfaces i.e. the cleaning and the pre paint coating.

Zinc phosphating has been used since the beginning of 1970th for pre-treatment of metal surfaces for out-door use. It is a chemical process with a high consumption of high quality water and energy and with use of potentially toxic chemicals like nickel and zinc. Another reason for the need to substitute zinc phosphating are related to pretreatment of light weight material e.g. aluminum and magnesium. Those substrates cause substantial increase of sludge formation and also quality problems.

The surface coatings industry consists to a large extent of SMEs who work as job shops, coating many different products made out of different materials e.g. aluminum, steel and galvanized steel. When these substrates are mixed in a product or treated in the same process they are called multi metal.

The problems and needs are specified by the following three statements
Statement 1
Many of the SMEs in the surface coating industry will have to change their pre-treatment process within the next 3-5 years due to increasing demands from customers and public authorities. The new requirements concern the reduction of water and energy consumption as well as the reduction of waste. The development of new products for example light weight vehicles also put demands on multi metal treatment with foreseen increase in the use of aluminum, magnesium and titanium. These materials cannot be efficiently pretreated with the existing process.

Statement 2
Being in the lead at replacing a well known process can either be a success or a disaster for the company.

The aim of this project is to make the change to a potential for growth for the SMEP. There are however some bad experiences so far. The chemical suppliers have sometimes used their customers eg. job shops as test pilots but the discrepancy between results from the supplier and from the job shop are often big. Bad result has sometime forced the SME to change back to zinc phosphating.

The development of the new pretreatment systems has been going on for the last decade and has resulted in many different processes. The introductions of the new systems have started at some job shops and the new pre-treatments are used on products with low requirements on the corrosion protection for example components that are used in the interior of use.

Statement 3
There is a general lack of knowledge concerning the capability of the new pretreatment when higher performance is demanded and when multi material is used.

The actual performance of the new pretreatment systems is not clarified especially when deposition on multi metal for outdoor applications is considered. The results from accelerated corrosion tests presented by the suppliers have not been correlated with field tests. There is a lack of resources at the individual SMEs to make all of the required testing in order to obtain the information needed for decision on the introduction of a new process. There is also a lack of knowledge concerning the process control and necessary adaption of the process to different substrates. Last but not least, it is not known whether the accelerated test methods used by many vehicle producers actually are applicable on the new pre-treatment systems or how they correlate to field tests.

Objectives
The strategic objective of the project is to present individual knowledge to the SME partners, which will enable the technology shift from zinc phosphate pretreatment to the new silane/zirconium based systems. To make the objective realistic, verifiable and easy to communicate it will be packaged in a "Tool box for successful implementation of new pretreatment systems". The toolbox will contain

how to evaluate, adapt and implement the new pretreatment systems
how to control the new pretreatment processes.

Once the tool box is set up it is also a vital part of the project to disseminate the tool box through network organization/ business associations and at conferences.

To be able to fulfill the strategic objectives research and development will be outsourced to the RTDs in the project with the demand to reach the well specified S&T objectives that can be divided in the following parts

1. Specify the demands on cleaning for different substrate materials
2. Knowledge development regarding how the new systems improves the corrosion protecting properties and on how the properties can be improved
3. Develop/adapt accelerated test procedure for corrosion protection that correlates with field tests
4. Define which and how process parameters should be controlled and how the running following up of coating quality should be done

Changing from zinc phosphating to the new pretreatment processes has the objective to reach eg. I) energy and water savings II) less sludge III) phasing out nickel IV) increased flexibility to handle eg light weight materials V) reduced total costs.

The state of the art of the new pretreatment processes can be summarized as "promising" regarding the use for out-door products. At the same time to implement the systems that is on the market today could be a very problematic to the SMEs.

The knowledge development that this proposal will bring forward is described below.

Knowledge development – Test procedurs
Improved accelerated test procedures will be developed which show correlation with field tests. They will be adapted to the new type of pretreatment systems.

The limitations with the commonly used NSS method (Neutral Salt Spray) will be clearly shown and disseminated. This is important for all industries and in all cases but especially in this case when a new way of protecting the product is evaluated with an old system.

Knowledge development – Quality assured corrosion protection
New knowledge will be brought forward regarding corrosion protecting mechanisms for the new systems. This will be input for improving a pretreatment process owned by the SMEP Glo.

It will also be used for the development of technology and routines to control and follow up the process bath and also on how to control the coating properties in running production. This is available today at zinc phosphating but not the new systems.

Hands-on knowledge to the SMEs
The knowledge developed will be adapted to be used at the SMEs by presenting the results as a toolbox. This will include information about
- method to control and follow up the pretreatment process and product quality
- test procedures that can be used for selection of coatings by showing the correlation between results from accelerated tests methods and results from corrosion field tests.
- demands on cleanliness that will make it possible for SMEs to a larger extent handle different substrates with varying degree of contamination
- how the change procedure to a new process should be done

Project Results:

Main S&T results

This report follows to a large extent the plan of work packages that has been used in the project.

1 Specification of requirements and test procedures
The SMEP participating in the project "Environmentally Acceptable Pretreatment Systems for Painting Multi Metals" can be divided into groups having to fulfill different requirements depending on their customers.

1.1 Customer requirements

1.1.1 Subcontractors to Automotive industry

The SMEP Tacsa and Falk are subcontractors to the automotive industry painting spare parts, parts to chassis etc. The requirements that are set on the painted products are specific for each automotive company, often based on an accelerated corrosion test method developed by the OEM. Company specific standards often express the requirements as maximum spreading of corrosion from scribe made on a painted panel that have been exposed to a cyclic test with certain variation in temperature and humidity.

It is difficult to find correlations between the various accelerated tests among automotive OEM and a subcontractor has to fulfill each one of the tests to be accepted as a supplier.

Below are some of the requirements given as more specific according to certain standards which are not only OEM specific:
- DIN 50021
- Example: 800h salt spray on steel with pretreatment and ED paint
- Example: 500h salt spray on cast iron and galvanized steel with pretreatment and ED paint
- DIN 53151 Adhesion test with cross cut measurement. Test panels must have GT0

1.1.2 Job shop painting SME

The SMEP Jyllak and QPC are rather typical job shop painting companies with a wide variation in the requirements set by the customers. It should also be mentioned that some of their customers do not always know the relevant requirements to put on the surface treatment. Jyllak paint parts for wind mills that have to fulfill corrosion class C5M but also lower requirements as corrosion class C3. The standard ISO 12944 gives examples of each of the corrosion classes, making it possible to qualitatively determine a suitable corrosion class for a certain product. The problem is that the only test method referred to in the standard is salt spray test which does not produce results that give the possibility to predict corrosion performance in real life.

QPC has some customers requiring fulfillment of ISO 12944 but QPC has also shown that some of their surface treatment systems pass the requirements set by Volvos ACT (accelerated corrosion test). This type of marketing has been a successful way of getting new customers.

AiP is an SMEP surface treating objects from their production mainly cabins for various types of forest machinery. The requirement set by their customer is class C3 and the requirement has been expressed as a maximum of 10 mm corrosion spreading in SCAB test after 1 year. SCAB stand for Simulated Corrosion Atmospheric Breakdown and the panels are exposed outdoors for at least 6 months with salt spraying being applied twice a week.

1.1.3 Chemical supplier SME

Glomax is a supplier of surface treatment chemicals and until recently their focus has been passivation chemistry for galvanized material. In the project some of their products are tested as pretreatment for paint and some modifications will also be tested. Fiat is one of their customers interested in new pretreatment systems and this OEM has as many others their own accelerated corrosion tests.

1.2 Authority requirements

There is no legislation that limits or forbids the chemicals used to create zinc phosphate layers. However, the legislation promotes the use of less harmful substances whenever possible (the substitution principle) and the OMS objective for 2016 with zero emission of Ni can forbid processes such as zinc phosphating.

Each SMEP will according to their local environmental authority have a certain upper limit for handling of dangerous/toxic material. The permissions are limited for each amount of substance for example; Ni inside water (closed system) x kg/year; Zn inside water: y kg/year. These figures are connected to the size of the plant. There is an international agreement Paris Commission (PARCOM) concerning the amount of Ni, Zn and phosphate that can be released per litre of waste water from surface treatment industry and the latest limit is 0.5mg/l for each substance. The maximum amount of suspended material in the waste water is 10 mg/l. The new pre-treatments are classified as non dangerous following the CE 67/548/CEE o 1999/45/CE directive.

2 Corrosion studies

The electrochemical measurements were performed with an electrochemical test cell consisting of a glass beaker with the bottom sealed towards the test panel. Tests were performed on painted or unpainted panels. In the latter case it means directly on the pretreatment film. The beaker contained various test solutions such as sodium borate or sodium chloride. The results show generally a higher corrosion resistance on samples that have been pretreated with zinc phosphate than samples pretreated with one of the new systems. Example of results from potentiodynamic polarization scan on galvanized painted substrates with current density (x –axis) vs potential (y-axis) showed that the results for zinc phosphate had a lower current density than new pretreatments which means a higher corrosion resistance. Similar results were obtained on cold rolled steel.

A method for accelerated breakdown of the paint coating was tested on painted samples. A schematic illustration of the breakdown of paint and the corresponding reactions that take place can be drawn showing how the corrosion can start beneath the pain layer, when a current is applied and the responding voltage is measured. This will be repeated many times during several hours in order to accelerate the breakdown of the paint layer. The method accelerates the paint breakdown and can be used for an estimation of the corrosion resistance of the surface treatment systems. An exposure tests of painted samples was performed at the testing station near the Ligurian Sea (Italy). Direct exposure was used to measure the relative field performance in terms of corrosion mechanism/mode. Inside the cave was 80 relative humidity and panels were exposed to sea water environment. No corrosion was detectable after 15 days of exposure.

3 Evaluation of process, selection and implementation

3.1 Screening

The objective of a screening of new pretreatment systems and comparison with the SME partners systems used today was to obtain knowledge about state-of-performance at the beginning of the project. The screening included the two largest suppliers of new pretreatment systems in Europe and zinc phosphate was used as reference pretreatment system. A common requirement for the new pretreatment systems to be evaluated was that they should be intended for multi metals treatment and outdoor applications.

Each SMEP prepared test panels with their own pretreatment system, coated by I) a powder paint that was used also for the new pretreatment systems and the zinc phosphate reference and II) a paint system of their choice. The screening was planned for and combined with the evaluation of a number of accelerated test methods. It was decided that the screening should be performed on cold rolled steel and galvanized steel. All of the SMEP had interests in these substrates. The cold rolled steel panels also had a weld on the panel in order to gain information about the cleaning and adhesion ability of the new systems on a sample that had been contaminated/unevenly heat treated through the welding.

Pretreatment with the reference ZnPh was performed at Volvo Cars production line in Gothenburg, Sweden. Application of the new pretreatment systems was performed in the pilot line at Swerea IVF. The pilot line is a dipping line that includes a spray cleaning step. The bath sizes vary from 63-130 liters. 100 liter baths were used for the pretreatment step. The new pretreatments are much easier to control than a zinc phosphate line, has lower concentration of chemicals (only 1-1.5%) which means that the handling of waste is very easy. Also, the processes have a pH in the range 4-4.5 which is almost neutral. Cold rolled steel panels that have been treated achieve a slightly golden appearance while galvanized panels get slightly blueish. Aluminium panels will have a transparent coating which can't be detected. It would be desirable from a user point of view if the appearance could be quick quality estimation but that is unfortunately not the case. Coating weights were measured with a hand held X-ray fluorescence instrument. This equipment can easily be used in a production line.

Electrodeposition (ED) of paint was also performed in the pilot plant line at Swerea IVF. The test panels that had a weld applied got paint defects from oxides remaining on the weld. These types of defects were expected and purposely included in the test matrix.

Powder paint was applied either on top of the pretreatment films or on the ED paint. It is important the paint coating is even and have the same thickness on panels that are tested together. Some of the panels painted at the SMEP plants had slightly thicker paint films. The powder paint was throughout the project called "ENABLE powder".

Several properties of the paint film were measured such as:
- Exposure in tropical chamber – high relative humidity and 40µC. Evaluation of blisters in paint film.
- Cross-cut test – measures adhesion of paint
- Scrape test-adhesion when paint is scribed with knife

- High pressure water jet test – high pressure water is flushed at a scribe in the paint. Max 20% of the paint may peel from the surface.

The new pretreatment systems pass all automotive requirements concerning adhesion but the properties are inferior to zinc phosphate when corrosion performance was tested.

The corrosion testing was performed with several accelerated test methods as described below.
- ACT1 (6 w): 35 - 45°C; 50-95% R.H.; 1w% NaCl rain twice/week
  - requirement: steel: = 8 mm corrosion spreading from scribe; galvanized steel: = 5 mm;
- ACT2 (6w) : 25 - 50 °C; 70 – 95% R.H.; 0.5w% NaCl rain 5times/week
  - requirement: steel: =12 mm; galv: = 6 mm; Al: = 4 mm
- ACT + mud + trigger: ACT 1 with mud+sand+salt on the panel= testing of risk for anodic delamination (a type of corrosion)
- Neutral Salt Spray (NSS) – tex ISO 12944:
  - 35 °C, 5w% NaCl, continuous spray

Field test: panels on trailer; Stockholm – Zwolle (Holland); 200 000 km/year

CRS

Approved corrosion results on CRS are obtained with the reference pretreatment (zinc phosphating) combined with reference paint system (4 layers) or electrocoat + ENABLE powder paint. The reference pretreatment combined with ENABLE powder paint is disapproved on CRS. The SME´s own paint systems generally perform well (in most cases approved) while the SME´s pretreatment combined with ENABLE powder paint are nearly all disapproved. The new pretreatment systems combined with electrocoat + ENABLE powder paint or ENABLE powder paint only do not reach approved levels on CRS. In the ACT I testing, the new pretreatment systems combined with ENABLE powder paint are better than the SME´s pretreatment combined with ENABLE powder paint and better than the reference pretreatment combined with ENABLE powder paint. However, as mentioned, they do not reach approved levels.

Introducing an electrocoat layer before the ENABLE powder paint improves the corrosion resistance of CRS with the reference pretreatment. This is what one would expect. However, with the new pretreatment systems the opposite occurs. The scribe creeps with New A or New B combined with electrocoat + ENABLE powder paint are significantly larger than the corresponding variants with no electrocoat present.The corrosion spread from scribe over or near weld is generally higher or significantly higher than the corresponding values on the general (undisturbed) surface for all pretreatments. In other words, it is imperative that the weld areas are properly cleaned before pretreatment.

HDG

The corrosion test results are approved on the reference pretreatment combined with any tested paint and on the SME´s pretreatments combined with any tested paint. The variation of the corrosion spread is small within each of the test methods ACT I, ACT II and ACT + mud
For the new pretreatment systems combined with electrocoat + ENABLE powder paint or ENABLE powder paint only the results are approved or nearly approved ("borderline").

3.2 Application II- evaluation of improved systems

The topic of improved pretreatment processes or products were discussed with the suppliers. Changed process and/or product were evaluated by the same methods and tests as for the screening.

- There is a large difference in reactivity between different substrates and different alloys, giving a wide spread in the coating weights that are obtained. This is probably the reason for the wide range given by the suppliers.
- The correlation between coating weight and corrosion performance is rather weak although very low coating weight seem to be detrimental. Other studies have shown that a low coating weight is an advantage for New pretreatment Bs system.
- The application of ED needs to be carefully tested and optimized before chosing the paint and/or parameters when using NPT (new pretreatment).
- The results from 2011 and 2012 are repeatable and show that NPT do not pass requirements on CRS and in some cases pass the requirements for HDG.

3.3 Application III

This evaluation was focused on the effect of new pretreatments on aluminium profiles and cast iron. The results showed that a silicate free degreasing agent resulted in better corrosion resistance for the aluminium. The corrosion protection of aluminium with new pretreatments is generally very good. The results on cast iron showed that zinc phosphate was superior in corrosion protection regarding the spreading from scribe. However, all panels suffered from general corrosion. The evaluation was performed with only electrodeposited paint which means that the paint coating was very thin, only 20 µm.

3.4 Journal article summarizing the evaluations

3.4.1 New Pretreatments ready to substitute Zinc Phosphate?

Finding a substitute for zinc phosphate has been in focus for the surface treatment business for the last decade. A European Union project, called "ENABLE" involving small enterprises (SME) in Europe has been running for two years. The objective was to facilitate the transition to New Pretreatment (NPT) systems through building knowledge about performance and process control. Suitable methods to evaluate corrosion protection and how to introduce new systems at job shops have been in focus.

The project will deliver a web based "Tool box" with information easily accessible for companies who consider introduction of NPT. The project involves the Spanish company Tacsa, the Italian company Glomax, Jyllak which is placed in Denmark and three Swedish companies; Falk Lack, QPC and Allt I Plat. The research is performed by Swerea IVF, a Swedish research institute, Volvo Surface Treatment Centre and the University of Milan.

How do the New Pretreatment systems work?

The new systems are generally based on the precipitation of zirconium oxide on the metal surface. The precipitation can be compared to zinc phosphating which means that phosphate crystals are precipitated and adhesion is created by establishing a larger surface area.

The coating thickness is a big difference between the phosphate coatings and those of new systems. A phosphate coating is often about 1 µm thick (1/1000 of a millimeter) and the crystals are needle shaped which helps in creating a mechanical interlocking of the paint when it is cured. The coatings of new systems are 10-100 times thinner and the precipitations are like small nodules or bumps. The mechanical interlocking of the paint is not expected to be as high as for zinc phosphate but the results from adhesion tests normally give excellent results.

The new pretreatment systems sometimes contain silanes beside the zirconium component. These molecules can react with each other and create a net work on the surface. The silanes can also have reactive groups that are supposed to improve the bonding to the paint.

Do the New Pretreatment systems pass the requirements set in standards? The demand from the partners in the ENABLE project was that the new systems should be able to substitute zinc phosphate on products for outdoor use independent of metal. The systems must give a corrosion protection that is as good as that obtained with zinc phosphate. Experiences from the ENABLE project show that the new systems generally pass the requirements for hot rolled steel, galvanized material and aluminium.

The results vary a lot for cold rolled steel and are related to the specific alloy. The new systems did not pass the requirements set in Volvos standard on substrates collected from industry. The requirements were however fulfilled on steel sheet panels prepared in a laboratory.

Comparison between New Systems and SME systems
The "ENABLE" project started with an evaluation of a large number of panels and each of the participating SMEs got their own system tested together with the new systems. The companies decided which substrates should be chosen, as well as which suppliers and pretreatment systems. Objective test results of the companies own system in comparison with the new systems was an important input for the consideration of introducing a new pretreatment system. The results showed that most companies fulfilled the requirements set by Volvo on both cold rolled steel and galvanized material but they had somewhat higher corrosion spreading than the reference system consisting of zinc phosphate + electrocoating paint + polyester powder paint.

How should the systems be evaluated?
One of the research issues for new pretreatment systems is the question which test method that will give the best correlation to the results obtained in field test. Four accelerated test methods were used and the evaluations were performed at Volvo Surface Treatment Centre. The test method ACT1 have been used for many years but ACT2, which is more aggressive, was introduced during the last 5-7 years. ACT2 can be used as accelerated test method not only for steel and zinc but also for aluminium. Another test method was "ACT1 mud+trigger" which means that the test panel was coated with a layer of mud and salt during a normal ACT1 cycle. These methods were compared with neutral salt spray (NSS) and field test.

Results from corrosion testing
"ZnPh" is short for zinc phosphate and "New 1" and New 2" are two different new pretreatment systems. The paint systems used were one layer polyester powder paint or electro coating paint and polyester powder on top. As a summary, it can be concluded that the test methods based on ACT cycles ranked the pretreatment systems in the same order but NSS ranked differently. The results obtained in the different accelerated methods were compared to the results from field test.

Another evaluation was performed with the same paint system as mentioned above. This was done in order to learn more about how large the variation could be for new systems. By experience it is well known that the variation for Zinc phosphate is rather small. The same process parameters, the same pretreatment systems and the same paint systems were used. The reference zinc phosphate (ZnPh) gave a surprisingly low corrosion protection on cold rolled steel and better result was expected. Rather good results were obtained with one layer polyester powder with new pretreatment systems with a corrosion spreading value of 10 and 8 mm. However, none of the systems would pass Volvos requirement of = 8mm corrosion spreading on cold rolled steel.

New pretreatments and Electrocoating paint – a question of compatibility? The results were improved considerably when two paint layers were applied, i.e. electrocoating and polyester powder paint when the panels were pretreated with zinc phosphate. The results with two paint layers give a larger corrosion spreading on steel and they are not improving much on HDG. There is probably a need for process development and optimization of process parameters when electrocoating is done on a new pretreatment coating.

Some problems with uneven paint deposition during electrocoating, called mapping, are well known from other evaluation of new pretreatment systems. This influences the corrosion protection and is a problem that must be addressed by the suppliers.

Powder primer improves corrosion protection when using NPT
This ACT evaluation on hot rolled steel gave better results for a two layer paint system consisting of powder primer and powder top coat than for the different paint systems consisting of electrocoating paint (ED) and powder on top.

Several evaluations have shown that powder paint as a first paint layer on new pretreatment systems give very good results independent of the type of paint used as top coat. This is true specifically for the corrosion spreading from scribe and says something about the excellent adhesion that is obtained when applying powder paint. However, if the corrosion spreading from the edges of the test panel is evaluated, it will be clear that the edge coating capacity of electrocoating paint is superior. Edge coating is a weak spot for powder paint systems.

Conclusion
The test panels were prepared at the same time in 2011 and the field test was run from March 2011 to May 2012 on a trailer driving between Stockholm and Zolle (200 000 km/year). The same ranking between the paint systems is at hand i.e. one layer powder paint on new pretreatment performs better than electrocoating paint+ powder. However, the results for new pretreatments and one layer polyester powder on steel are more in par with zinc phosphate than the results from ACT1.

To conclude, it is clear that New Pretreatment systems have important advantages of better environmental profiles and easier process control which contribute to economical savings.

The corrosion protecting performance on galvanized material and aluminium is often on the same level as zinc phosphate. However, the performance on cold rolled steel is less convnincing and must be studied further. There is a need for product development to raise the performance in the next couple of years in order to meet the high demand on outdoor performance set by the vehicle industry.

ACT1 results on cold rolled steel; test panels (DC 04) and car body sheet (DC 05). The result for each system is an average of the corrosion spreading on 3 panels each with two scribes. Volvos requirements on steel: ACT1= 8 mm.

3.5 Experiences of production trials with new pretreatment

3.5.1 Background

The company (A) perform surface treatment of automotive parts and wanted to make production trials with a new pretreatment with as low loss of production as possible. One of the suppliers was contacted and suggested a solution which made it possible to save the activation bath and the zinc phosphating bath during the trials. The zinc phosphating process is outlined with the following baths in a line:
Degreasing, degreasing, rinse (tap water), activation, Zinc phosphate (with Manganese and Nickel), rinse (tap water), rinse, rinse,

The suggested outline for a new pretreatment looks like this:
Degreasing, degreasing, rinse tap water, (the activation bath is shut down), (the zinc phosphate bath is shut down), distilled water rinse, New pretreatment, rinse

The suggestion with bath no 7 and 8 containing new pretreatment was due to the high pace of the conveyor/transportation in this specific line. However, during the experimental trials that took place over a weekend only bath no 8 was used for new pretreatment. The pace was reduced to 50% which resulted in a treatment time that was long enough to get the desired coating weight.

3.5.2 Cleaning

The baths normally used for activation as well as the zinc phosphating bath were both closed during the experiments. The tunnel for pretreatment was cleaned with high pressure water jet in order to remove all possible chemical remnants from the activation or phosphatation. Remaining chemicals could act as poison for the new pretreatment and it is very important that the cleaning is done thoroughly. No cleaning of bath containers was necessary since the step no 8 only had been used for rinsing with water. The existing line did not have a passivation step which otherwise could have been number 7 or 8.A cleaning of the process bath would have been necessary in that case but the chemistry of the passivation step and new pretreatments are often alike (excludes passivation with chromate!).

3.5.3 Experimental running

The new pretreatment bath was mixed by the supplier. The concentration of various chemicals is generally low and not higher than 1-1.5%. The pH is around 4-4.5. When setting the bath the concentration of Zr is determined with a spectrometer. The bath sample is mixed with some reagents giving a certain colour of the solution. The same procedure is used for determination of the Cu concentration. The pH is adjusted with additives that can contain sodium carbonate or nitric acid.

Some parts with and without test panels mounted on the surface were run through the process. The temperature in the new pretreatment bath increased from 26 to 29µC during the day but this is normal. It is recommended to heat the bath a few degrees before a production start in order to speed up the steady state.

The coating weight could have been measured by an XRF instrument on test panels. However, there is a measuring difficulty on parts that have been blasted as in this case. The blasting increases the surface area and makes the substrate more reactive. A special reference with known amount of Zr must be prepared. Visual inspection showed an even gold/brown layer on the test panels. A number of panels were ED coated and evaluated by accelerated corrosion test (ACT, 6 weeks), dry and wet adhesion, outdooor accelerated corrosion test (6 months), field test on car (2 years), stone chip test.

Company (A) draw the conclusion that NPT can be introduced without any major investments and that considerable savings will be made on energy and water expenses.

3.6 Installing a process supervision system.

When installing a new pretreatment system it is of great advantage to install a process supervision system that automatically collects process data and responds to out of range values by alarming or dosing chemistry to the pretreatment bath.

The chemical suppliers may require and provide a supervision system. This system supervises several parameters and automatically dosages chemicals for each step required. The following parameters are measured each 5 minutes:

- pH, temperature and conductivity in alkaline degreaser,
- conductivity and temperature in rinse 1, 3 (DI-rinse before conversion step) and 4 (DI-rinse directly after conversion step)
- pH, conductivity and temperature in the pretreatment bath

Other parameters that are manually measured but can be logged in a supervision system are alkalinity in the degreasing step and in the concentration of F^-, Zr and Cu in the pretreatment bath. The concentrations of Zr and Cu are measured.

Installing a system can take 3 days. Most often a person from equipment sales or the chemical suppliers' consultant will lead the work. An electrician and a plumber will be needed. The key issue is installing the various measurement units that collect the process data.

The pH and the temperature will be controlled in the degreasing bath. A dividing breeching tube is installed and a flow of the bath is run through a container with the pH meter and the thermometer. The same concept is used for controlling the conductivity and the temperature in the rinses. The pretreatment bath will have two containers with measurement equipment; one for the conductivity electrode and one for the pH electrode and thermometer.

The reading from every measurement unit will be collected by the systems' software. Parameter settings will be given in the system and an out of range reading can then be coupled to an alarm. However, the pretreatment chemistry is automatically dosed and most often connected to the pH in the pretreatment bath. Pumps can be installed in the containers with the concentrated product which is on demand released into the bath where it will be diluted. The zirconium component is often dosed this way while the cupper is dosed according to the amount of Zr. Both substances must be controlled manually by taking a bath sample, mixing a certain volume with some chemical additives to obtain a colored solution that is measured with a spectrometer. This is usually repeated every 4-8 h. A spectrometer unit must be bought from the chemical supplier (or elsewhere) and is required in order to run the processes that are intended to substitute zinc phosphate.

3.7 Evaluation of cost and environmental impact

A certain company, below called "company X" made a change from zinc phosphate to a new pretreatment. A calculation of the costs involved in changing the process was made as well as a Life Cycle Assessment. The section below contains reporting from this work

Summary

This part contains life cycle assessments of two pretreatment systems. Company X has made a process change from zinc phosphating to a new pretreatment system. The study is a cradle to gate study. The company changed the system but all other parameters, such as yearly production, are the same.

All environmentally significant processes and their resource consumption and related emissions within the system boundary are included in the study except for the chemical manufacturer. Raw materials are included for the chemical manufacturer but energy use and emissions in this step of the process is excluded.

Energy, global warming potential, acidification, eutrophication, photochemical smog, ozone depletion, ecotox, humantox carcinogenic and humantox non-carcinogenic is presented for Company Xs two systems.

For Company X, which has the most reliable results, all impact categories are greatly reduced. Some of the categories such as non-carcinogenic humantox are reduced by as much as 95% when changing from zinc phosphating to a new pretreatment system.

For Company X it can also be seen that the water usage decreased with 59% when changing system. Also, sludge is assumed to be reduced by almost 100%. When including cost for chemicals, maintenance, sludge treatment and heating of baths, the cost reduction becomes 47% with the new pretreatment system. The pay-back period of 10 months is calculated by Company X and is only based on less cost for chemicals. Loss of production has been excluded from these calculations.

3.7.1 Life cycle assessment

The purpose of this study is to compare two different pretreatment systems from an environmental and economic point of view. Company X has recently changed from zinc phosphating to a new pretreatment system and therefore the data for this assessment has a high reliability.

The outline of the zinc phosphating process at Company X is outlined below:

Zinc phosphating process
- Degreasing 55 °C
- Rinse
- Activation
- Zn (Mn, Ni)Ph 45 °C
- Rinse

- Rinse
- Rinse
- The outline of the new pretreatment at Company X can be seen below:

- New pretreatment
- Degreasing 55 °C
- Rinse
- Rinse
- Rinse
- New pretreatment 20-30 °C
- Rinse
- Rinse

LCA according to ISO 14044 (ISO 2006) consist of four stages: Scooping, inventory, environmental impact assessment and interpretation. All stages except the one for environmental impact assessment are considered obligatory. The stages are often repeated in an iterative way that gradually refines the assessment. None of the stages are unique to the LCA methodology. What makes LCA unique is that all (or as many as possible/relevant) life cycle phases of the analyzed object are included from raw material extraction to the product's end-of-life. The life cycle phases are often referred to as raw material production, (own) manufacturing, use and end-of-life.

When all life cycle phases are included in an LCA study, it is referred to as a cradle-to-grave study. Studies that only include data about raw material production and own manufacturing are referred to as cradle-to-gate studies.

Streamlined life cycle assessment has been used which in this case means that the LCA model was built around the current pretreatment system at Company X The chemical suppliers provided detailed information about the chemicals used for zinc phosphating and for the new pretreatment systems and associated resources and emissions were found in existing databases for LCA. Background data has mainly been collected from the database Ecoinvent 2.0 (Ecoinvent, 2008). SimaPro 7.3.3 was used for the calculations. The software is also a source of generic data and was also used to store the collected site-specific data in. The study is protected in the software.

When all life cycle phases are included in an LCA study, it is referred to as a cradle-to-grave study. Studies that only include data about raw material production and own manufacturing are referred to as cradle-to-gate studies.

Functional unit

The principal functional unit was defined as the yearly production of 105 000 m2 for the comparison of Company Xs two systems.

The systems that were compared were zinc phosphating and the company's new pretreatment system. There have been some changes to the process due to the change of system. The total energy usage is the same except that one heat exchanger was removed when changing system. Some electricity used for pumps has been moved from the surface treatment part to the degreasing part. This is due to that two of the baths that prior were connected to the surface treatment part are now converted to rinse steps for the degreasing. The chemicals used in the surface treatment have been changed and also there is less need for maintenance due to the new system. The water treatment system is remained the same as prior to the change of system.

System boundary

The system boundaries have been set to include the process, the production of energy and chemicals, and the waste treatment at each investigated plant. The waste water system has been excluded for Company X since it is the same for both cases. The study includes all emissions and discharges connected to deposit/landfill of waste from Company Xs pretreatment system. Cleaning chemicals used at Company Xs plant has been included. A small amount of chemicals is assumed to evaporate with the water from the hot pretreatment baths.

Transportation has been excluded. The products from companies have not been included after leaving the factory. Water usage has been included in the study.

Energy and waste at the chemical manufacturing have not been included in this study.

It includes chemicals raw materials, chemicals manufacturing, energy and water used by the surface treatment company, airborne emissions, waste and deposit but NOT product life.

As a general rule, all environmentally significant processes and their resource consumption and emissions within the system boundary are included.

Using study specific data, all materials were tracked back to the point of resource extraction, mainly by using cradle-to-gate data from the Ecoinvent database (Ecoinvent, 2008). The Ecoinvent data contains associated inputs from nature and emissions, including estimations of losses. So in that respect a 0 % cut-off was used. Some materials that could not be found in the databases were replaced (in the model) with similar materials.

Environmental Impact

The EPD-rules in the General Programme Instructions (IEC, 2008) do not allow weighing to a single value indicator in EPDs. Instead five impact categories should be reported:
- Global warming potential
- Acidification
- Ozone depletion
- Photochemical smog
- Eutrophication

Other categories that are relevant for this study and is therefore also reported is:
- Energy
- Ecotox
- Humantox carcinogenic
- Humantox non-carcinogenic

Usetox has been used to calculate ecotox and humantox.
The categories have not been weighed to a single value since there is no generally acceptable method today that can weigh together different impact categories into one value. Weighing, or weighting, to a single value indicator is also explicitly forbidden in ISO 14044 (ISO, 2006) in life cycle assessments intended for comparative assertions to the general public.

Study specific data

Information about chemical compounds was delivered from chemical suppliers. This data will not be published in this report.
The table 1 I accompanied file gives the key data used for modeling the pretreatment systems at Company X (except data for the chemicals).

3.7.2 Results

It shows that the energy consumption can be reduced with almost 30% and the global warming potential will be decreased with about 35%, acidification with almost 50% and eutrophication with 90%. All other environmental factors are also reduced by introduction of a new pretreatment system.

3.7.3 Discussion

The new pretreatment system at Company X was installed a couple of months ago. Therefore, consumption data for chemicals is an assumption for the yearly usage. However, these values are accurate if compared with the usage for the first couple of months. So far, there hasn't been any sludge formation at Company X with the new system, but there is still a chance that the sludge formation is not completely eliminated.

The water consumption for Company X has been calculated based on how much water that previously was used for cleaning each day, how much water that goes through the evaporator and how much water that is assumed to evaporate in the heated baths.

The production is the same for the zinc phosphating system and the new pretreatment system at Company X. The sources of error are therefore smaller for this study compared to the one for the three other companies. The three other companies have many differences towards each other within the production and their hanging capacity. Since there is no information about the content in the sludge, this is also a factor that has been assumed.

4 Testing and verification

4.1 Recommended test procedure for complete paint system on new pre-treatment

4.1.1 Description

Several test methods are involved in testing the corrosion resistance of New Pretreatment Systems. The test methods involve ACT I, ACT II and Neutral Salt Spray according to requirements and a Field Test for comparison of the accelerated test methods reliability in predictability.

The Field test simulates the susceptibility to corrosion of the paint system when exposed to road environment. However, due to the length of the ENABLE project, the exposure at field has only been 1 year and two months, a period of 2 – 3 years is recommended for reliable predictability.

In addition the ACT test with mud and trigger has also been included to investigate the susceptibility of the New Pretreatment Systems to anodic delamination.

4.1.2 Results

Test material:
Substrates: Cold rolled steel (CRS DC01, 2 mm), Hot dip galvanized steel (HDG Z100 0,8 mm)
Pretreatments: Zinc phosphating REF, New Pretreatments A and C (additional B and I for HDG; SMEs D-G)
Paint systems: One-layer polyester powder paint (ENABLE), Electrocoat+polyester powder paint (ED+ENABLE) and reference a car body paint system (REF, electrocoat+primer surfacer basecoat+clear coat).

On CRS with the New Pretreatment (A and C), the corrosion spread from scribe in the Field test short term is much lower with ENABLE, but similar with ED+ENABLE when compared with ACT I or ACT II and higher compared to NSS. This correlate with ACT I and ACT II where the demands are not fulfilled, while NSS show the opposite results with low values The ranking within the same paint system are similar.

On HDG with the New Pretreatments and both paint systems, ED+ENABLE and ENABLE, the corrosion spread from scribe in the Field test short term is lower than in ACT I or ACT II and much lower than NSS. The ranking within the same paint system are similar.

With zinc phosphate on both CRS and HDG and with both of the paint systems, ED+ENABLE and ENABLE, the corrosion spread from scribe in the field test short term is lower than in ACT I or ACT II, while in NSS for CRS similar and for HDG much lower.

There is a tendency of opposite behaviour in the Field test short term for New Pretreatments with ENABLE compared to phosphating with more corrosion on HDG than CRS.

On the reference system (with zinc phosphate and an automotive 4 layer paint system) the corrosion spread is lower in field compared to the accelerated methods except for CRS in NSS where the field result is higher.

4.1.3 Discussion

The Field short term results in general show, as expected, lower delamination than the accelerated tests.
The results show the opposite results for NSS especially on CRS and do not correlate with field short term, while both ACT 1 and ACT 2 as well as mud and trigger are similar in ranking. However, for a reliable predictability a final evaluation should be performed after long term exposure.

With some exception, the ranking is similar in field as in the other methods of exposure. In viewing these two lists one has to take into account that there is some spread in the data which means that systems standing close to one another in the list may well change place only due to statistical variations.

4.1.4 Conclusions

The results received in the ENABLE project shows that ACT I and ACT II give similar ranking of the pretreatment systems as short term field test. This indicate that ACT I and ACT II can be regarded as reliable accelerated test methods for New pretreatments but comparison with results from longer field test are desirable.

NSS cannot be regarded as reliable test method since the ranking of the systems was opposite to the field test.

Trigger+mud+ACT gave similar results as ACTI/ACTII and indicates that anodic delaminating is not a problem for New Pretreatments.

4.2 Validity of ACT test with mud and trigger

4.2.1 Description

Several test methods are involved in the testing of New Pretreatment Systems. The test methods involve ACT I, ACT II, Neutral Salt Spray and Field Test. One of the purposes with the ACT test with mud and trigger was to investigate the susceptibility of the New Pretreatment Systems to anodic delamination. In the corrosion process under a paint film, corrosion propagation occurs either by anodic or cathodic delamination. With advanced paint systems, anodic delamination is the more common mechanism. Cathodic delamination is usually linked with inferior paint systems (but can also occur under other circumstances).

By using this novel test method, ACT test with mud and trigger, the anodic process is enhanced. The enhancement is achieved by appling a cathodic trigger. In this case the cathodic trigger is a stainless steel (variant 2343) screw. The stainless steel provides an excellent cathode which drives the anodic process under the paint coating. Furthermore, a conductive bridge between the cathode and the anode is necessary. The applied mud film function as this conductive bridge. The mud film contains 3 weight-% sodium chloride which endows the mud film a high conductivity.

The ACT cycle used in ACT test with mud and trigger is the same as in ACT I but without any rain.

4.2.2 Results

On CRS with the New Pretreatment (A and C), the corrosion spread from scribe is much smaller with ACT + mud + trigger than with ACT I or ACT II. However, the corrosion products are bulkier on the samples with ACT + mud + trigger so the amount of corroded steel may still be the same. Anyway, in this case, it does not seem that the ACT + mud + trigger speeds up the corrosion process.

On the reference system (with zinc phosphate and an automotive 4 layer paint system) the corrosion spread is low with ACT + mud + trigger and about the same with ACT I or ACT II.

On HDG, the corrosion spread with ACT + mud + trigger tends to be a little bit higher than with ACT I and about the same as, or sometimes a little bit lower than, ACT II.

4.2.3 Discussion

The idea with the ACT + mud + trigger test was to enhance the anodic delamination process. The results show, that a small increase in delamination occurs with HDG generally. However, the increase is small and one cannot say that it is greater with the New Pretreatments than with zinc phosphate.

On CRS and the New Pretreatments the delamination in the ACT + mud + trigger test is less than in ACT I or ACT II. With zinc phosphate the delamination in the ACT + mud + trigger test is about the same as in ACT I or ACT II.

It must however be reminded, that the statement is valid for the delamination as measured in millimeters from the scribe. For HDG this measure is directly related to the amount of zinc consumed in the corrosion process, since only the zinc layer is oxidised while the underlying steel is protected. For HDG this means, that there is a small increase in the corrosion speed with ACT + mud + trigger test compared to ACT I . The increase is small and one cannot say that it is greater with the New Pretreatments than with zinc phosphate.

For CRS one cannot directly make a similar statement concerning the corrosion speed. Visually, with the New Pretreatments, the corrosion attack seems to go deeper into the substrate. So, while the delamination with the New Pretreatments actually is considerably less with the New Pretreatments on CRS with the ACT + mud + trigger test compared to ACT I or ACT II, the amount of corroded steel could still be the same or maybe even larger. This has to be investigated further.

As to the validity of the test method "ACT + mud + trigger" one can as the first point state that it is valid in its own right. That is, it simulates the susceptibility to corrosion of the paint system when it is part of a galvanic element. The other test methods, ACT I, ACT II and NSS do not simulate such a condition. As the second point, the "ACT + mud + trigger" is intended to test the susceptibility to anodic delamination. The results do not show, that the New Pretreatments have an increased susceptibility to anodic delamination. As a third point, one could expect, that by adding an external cathode and thereby increasing the driving force, to achieve an increased delamination rate. The "ACT + mud + trigger" does not increase the delamination rate and is therefore not more accelerated than ACT I or ACT II. The final point, which can not be answered yet, is whether the test method correlates with Field. The test results from the field will be finalised in the summer 2012.

With some exception, the ranking is similar in ACT + mud + trigger as in the other methods of exposure. In viewing these two lists one has to take into account that there is some spread in the data which means that systems standing close to one another in the list may well change place only due to statistical variations.

4.2.4 Conclusions

- The New Pretreatments are not more sensitive to anodic delamination than zinc phosphate on HDG.
- On HDG, the ACT + mud + trigger test only slightly enhances the corrosion spreading compared to ACT I. Compared to ACT II, it is slower.
- On CRS with the New Pretreatments, the ACT + mud + trigger test gives a slower delamination than ACT I or ACT II. On CRS with zinc phosphate the delamination is about the same.
- ACT + mud + trigger is not a more accelerated test than ACT I and ACT II.
- ACT + mud + trigger gives a similar ranking as ACT I and ACT II.
- ACT + mud + trigger is useful for testing the susceptibility to galvanic effects.

Potential Impact:

The project will strengthen the competitiveness of the SME partners in different ways due to their different situation. According to the benefit they will gain from the project and the reason why they joined the project the companies can be divided into three different categories.

1. Companies with the objective to change to a silane/zirconium based pretreatment from the pretreatment they are running today; zincphosphate, ironphosphate and/or chromate. Those are Fal, Tasca and AIP
2. Companies using already silane/zirconium based pretreatment with the objective to change to a new (generation) of the system and/or improve the reliability of the existing process in order to meet more demanding customers. Those are QPC and Jyl.
3. One company (Glo) is a supplier of pretreatment processes having the objective to improve their knowledge about the process and also to be able to improve and adapt it to different demands.

Improved industrial competitiveness for category 1. New process for applicators

The new process will give the SMEs the possibility to reach new markets and to expand existing markets due to
- improved capability to handle different substrate materials. The new process improves the capability to efficiently coat new materials and combination of materials and by that meet the demands on treating e.g. light weight materials like aluminum, manganese and high strength steel.
- improved environmental impact. Heavy metals like zinc, nickel, manganese and chromium-6 will be phased out. Decreased energy consumption. Both are demands from many of their customers e.g. the car and truck producers having the demand on heavy metal substitution and energy reduction not only in their own production but also at their subcontractors
- improved cost efficiency. The new process is estimated to give lower costs because of fewer process steps, lower energy consumption and reduced waste.

The aim is that the SMEs at the end of the project will have a base for decision of which process to choose and how the process should be run to reach the quality level needed. After the project is finished the process must be approved by their customers. This will be done by first getting a preliminary approval based on laboratory tests on real components. Next step will be to set up the process in production and after that pretreat and paint real products. These test samples should run a full corrosion test. The time for the whole procedure is estimated to 1 year.

Improved industrial competitiveness for category 2. Improved process for applicators

The companies running the new type of pretreatment processes today (QPC and Jyllack) will be able to implement new knowledge on how to improve and run the processes. This will open up for new markets due to

- improving the properties of the coating including securing the quality. Today the properties will not reach the demands from e.g. the car and truck industry.
- increasing the knowledge on how cleaning of different substrate materials should be carried out. The companies will be able to handle an

increased variety of substrates and by that increasing the volume of products from existing customers and also getting new customers
- improved cost efficiency. Today problems like bad quality are often handled in a trial-and-error manner. Increased knowledge of the process will improve the possibility to solve problems in a more scientific way.

Improved industrial competitiveness for category 3. Improved processes for supplier

Glomax being a supplier will gain from participating in the project by increasing their knowledge about how the new systems will improve corrosion protection and how different substrates must be treated (WP2). They will also improve their knowledge about critical parameters in the process bath and by that assist their customers both at setting up a new pretreatment process and at running the process.

Improved industrial competitiveness for all categories
All SMEs in the project will benefit from participating being in the lead at converting to the new processes. They will also receive documented results instead of having "trial-and-error results" and getting an action plan for process evaluation and implementation.

Contribution at program level to improve industrial competitiveness across the European Union

The project will lead to that a change to the new pretreatment systems comes earlier and that the change will be made in a more efficient and secured way. The change will contribute to the competitiveness in the European Union since the new systems have a number of advantages compared with the existing zinc phosphating that is described earlier; improved environment, cost efficient and more flexible to handle different substrates.

A successful change to the new pretreatment systems by the project partners will of course lead to followers. Facts will be presented in the project and disseminated outside the consortium The project will have a strategic impact on the coating industry across Europe in different ways.

The change that is foreseen to come sooner or later will be a paradigm shift in the coating industry of the same magnitude as the one in the beginning of the 1970th. At that time zinc phosphating followed by electrodip coating (ED) was introduced firstly in the vehicle industry and later in other high demanded applications.

This project will make it possible to change process without causing similar problems due to the development and efficient dissemination of --reliable procedures for evaluating the new systems
-reliable procedures for process following up
-a tool-box for evaluation, implementation and control of the new systems.

The increased knowledge developed in this project will be disseminated to the coating industry at the end of the project by using e.g. the European (CETS) and national (SPF, AIAS and VOM) network that the partners in this project are active in.

Impact for the participating SMEs / SME Associations and their members
Partner 4 Tacsa

As a subcontractor to the vehicle industry Tacsa has to be qualified by their customers. The corrosion and test research performed in the project will contribute with valuable results and information that will facilitate the introduction of new pre treatment. Tacsa will have to verify all results in their own process but the experience gained in the project will make the introduction faster. The savings on phasing out zinc phosphate concerns environmental issues but also savings in personnel due to introduction of a less complex process.

Partner 5 QPC
QPC has estimated that the results which are foreseen will increase their turn over within two years with 67% from 1 700 to 2800 kEuros and the number of employees from 14-18. This will be done in mainly two ways. One is to keep their stand as the leading job coater to their biggest customer today (Hags AB) and the other is an active market strategy focused on new business areas.

Hags has increased their selling and has estimated a continuous market growth the next 5 years with 40%. They have also increased their demands on the painting system since the US market will have restrictions on using zinc coating on steel. This means that the same corrosion protection must be achieved with a new system having "only" pretreatment and painting as the one used today with zinc coating, pretreatment and painting.

New generations of the pretreatment systems and improved reliability will make it possible to reach new markets. The strategy will be the following
- Vehicle industry. In the near future focus will be on components not demanding ED-coating before painting. QPC don´t have and is not planning to set up the process. QPC will establish business contacts with this sector by painting components with lower demands on corrosion protection. In the future it is foreseen by the chemical suppliers that the new pretreatment systems will be able to replace both zinc phosphating and ED-coating. At that time the strategy at QPC will be set up the new processes and market their capability to deliver painted components in this high demanded vehicle sector.
- Replacing expensive galvanized material; tests have shown that the new pre treatment systems hold the promise to replace expensive galvanized material. This will open a new market and requires a new offensive strategy that QPC is preparing.

QPC will use their existing network and distribution channels to inform about their new capability to produce high qualified coatings. To reach new customers different channels will be used. Suppliers of pretreatment chemicals and paint to QPC will be used to reach new customers. The Swedish Coating journal called Ytforum will be used to get a broad dissemination of the capability of QPC. Ytforum reaches more than 3000 persons in the Nordic counties including personnel in surface treatment and purchasers of surface treatment.
QPC will increase their international business by delivering high quality coating to their Swedish customers selling products on an international market. QPC is not organized today in a way that they can deliver coatings to companies outside Sweden.

Partner 6 Falklack
Having their largest customer in the vehicle industry, Falklack will benefit from introducing a new pretreatment system since the use of aluminum in vehicles is foreseen to increase from less than 5 % to about

15-20% within the next 5 years. Introduction of an environmentally acceptable pretreatment system will help Falklack keep their stand as one of the leading sub contractors to Scania with a very well running process, adapted to a change towards light weight metals.

There is a big advantage in being pro-active for environmental reasons and Falklack considers this as an important reason for changing pretreatment process. The estimated savings on elimination of sludge handling, deposition fees and savings on waste water treatment is about 38 000 EUROS per year on the annual turnover. Falklack experiences an increasing demand on environmentally acceptable processes from customers. Having introduced a new pre treatment system, the building sector will be a new market for Falklack, for product having high requirements on the corrosion protection. The reliable documentation from a project will improve the competitiveness and shorten the entrance on a new market.

Partner 7 Jyllak
Jyllaks' customers are to 95% within the general industry and 5 % is within architecture and wind power industry. With successful outcome with new pretreatment systems it is foreseen that the architecture market can expand and there is a possibility to enter the vehicle sector. This means a possible expansion of about 35% of the annular turnover. Considerable savings are foreseen if the pre treatment with hexavalent chromium can be replaced. This pretreatment is today performed in a 5 step line and the objective is to replace this process with a new pre treatment system. The saving will mainly come from less hazardous waste water and less costs for handling of toxic chemicals.

Partner 8 Glomax
Glomax expects to increase its annual turnover due to the possibility to enter market as supplier of the pre treatment chemicals. They have ideas about new products for aluminum, which possibly can be used also on zinc. Glomax will take advantage of the results of the project to consolidate its supplier position for the automotive sector in Italy and Europe, and to strength its actual action worldwide. The company will also take advantage of the fact that their pilot plant will used and their pre treatment applicator evaluated, which will be an important part of their equipment development.

Partner 9 Allt i Plåt
Allt i Plåt will considerably improve the quality of their painted products by the introduction of a new pre treatment system with enhanced performance. Products with higher demands on corrosion protection will be possible to produce and also components including stainless steel. This will increase the market. The company will be able to get a system implemented during the project with a lot of support from other participant, sharing their experience.

Dissemination activities
Publication in painting magazines and choice of conferences/shows

The ENABLE project, new pretreatments and relevant results have been presented both orally and written in journals. Below is a list of the presentations that have taken place or will take place:

- Oral presentation at "Scandinavian Coatings Show", Copenhagen, Denmark, 11-12 April, 2011

- Written article in "Ytforum" No 8, 2010, Sweden with the translated title: "Questions about New Pretreatments require answers"

- Written article in "Ytforum" No 5, 2011, Sweden with the translated title: "Energy consumption has the largest environmental impact show LCA at QPC" (SME in ENABLE)

- Written article in "Ytforum" No 3, 2012, Sweden with the translated title: EU project about new Pretreatments"

- Written article in "Ytforum" No 4, 2012, Sweden with the translated title: LCA shows large differences in environmental impact of zinc phosphating and new pretreatments."

- Written article in "Overfladebehandling", June 2012, Denmark with the translated title: "New pretreatments in practice".

- Poster presentation at "Eurocorr 2012", Istanbul, Turkey, 9-12 September, 2012 with the title: "Corrosion behavior of paint systems with Novel pretreatment Coatings"

- Written article with the title:"New pretreatments in practice" sent to national paint association representatives in Irland, U.K, Belgium and France for possible publication in suggested journals intended for/read by job shop painters/SMEs

- Release of Tool box on project home page and sent to national paint association representatives in "CETS" to be linked into associations' home pages.

List of Websites:
http://www.enablepretreatments.com