Practical Demonstrator 9

Development of a high-end security part from using recyclates

IDEA
The main aim is to show that it is possible to use by-products such as sprues before they become waste for a very complex and security-related part, but also illustrate the environmental gains resulting from co-operation within industrial networks.

RESULTS
- Reduction of GHG emissions: 47%
- Reuse and recycling of waste: 100%
- Reduction of freshwater utilisation: 36%

PARTNERS
- Continental Teves AG & Co. OHG (DE)
- S.C. Greentronics Srl (RO)
- Austrian Society for Systems Engineering and Automation (AT)
- University of Southampton (UK)
- University of Natural Resources and Applied Life Sciences (AT)

About ZeroWIN

Project Motivation
Waste prevention has been assigned the highest priority under European waste management law. However, the initiatives which have been taken so far have not reduced the regular increase in total waste arisings across Europe.

Goals
The ZeroWIN project develops innovative approaches and effective strategies for the prevention of waste in industrial networks based on industrial symbiosis. Expected Results are a reduction of at least 30% of greenhouse gas emissions, 70% of overall re-use/recycling of waste and 75% of fresh water utilisation.

Consortium
The ZeroWIN consortium has 30 partners from 11 countries (AT, DE, ES, FR, HU, IE, PL, PT, RO, UK, TW), dominated by industry – 6 large companies (one of which is the electronics cluster in the Basque region) and 10 SMEs.

Project Facts
- Coordination: SAT
- Consortium: 30 partners from 11 countries
- Duration: May 1, 2009 – April 30, 2014
- Budget: 9,5 Mio. €
1. Introduction

The automotive sector is one of the most important sources for value creation and employment within the European Union. The industrial network of practical demonstrator 9 covers this sector. Under the lead of the Tier1-supplier Continental an industrial network around a PET plastics component is established. The production of one kilogram of PET results in the consumption of 1.1 kilogram of oil, 2.97 kilogram of greenhouse gas emissions and 15.5 litres of water. The use of recycled plastics in automotive components offers potentially significant environmental improvements. Note that in today’s industry practice, plastics recyclate is employed for components with low requirements, e.g. bumpers. In order to raise the share of recyclate and enlarge the possible use cases, this practical demonstrator aims at producing a security relevant part of the brake system with recyclate, respectively a mixture of recyclate and virgin materials.

The aim of the industrial network is to collaboratively develop the aforementioned security relevant part which incorporates a recyclate share, establishes appropriate production processes, sets up an industrial network which main goal is to establish secure and controlled sourcing of the recyclate and serves as enabler and nucleus for a zero waste production and resource exchange network. In the baseline scenario of the industrial network, the component was manufactured with virgin glass fibre enforced PET ("PET-GF35") with a moulding process creating 10-20% of the weight as waste (sprues).

In the pilot scenario, this waste is now recycled in a plastics mill and mixed with virgin materials. This mixture is then used for producing the security relevant parts by different production processes, also enabled by major effort in the product development. The industrial network at present consists of a Tier2-supplier (plastics component supplier), Tier1-supplier Continental (system integrator) and one original equipment manufacturer (OEM). This network is very likely to grow during the project’s duration. The conceptual scenario also could involve further cross-industry collaboration.

Barriers of the concept versus the real case, which will be successfully tackled by this practical demonstrator, are identified in the material quality, the quantity of the type of plastics, prejudice against the use of recyclate and insufficient knowledge by the OEMs.

Practical Demonstrator 9 has achieved following practical progress so far:

- A more complicated but successful product development for the security relevant part.
- The extended efforts in material properties testing led to the elaboration of material specifications and testing processes for the recyclate materials. They are now available. Their availability is an important...
precondition to find other sources for the recycling material and to approach the conceptual scenario.

- The Tier2-supplier has changed its production process and established a recycling process for the sprues.

A first pilot customer OEM agreed on a recyclate quota of 33% in the security relevant part. Mass production starts in the second half of the year 2012 with an expected quantity of 600,000 for the first year of production. The fulfilment of these preconditions enabled the formation of the industrial network of the improved case and the conceptual case also now becomes a possible scenario. Hence, this pilot case is a first step towards the example conceptual industrial network for the automotive sector.

2. Implementation

Five Prevention Practices – From the company to the network level

Process design vs. network design
For the implementation of the production of the security relevant part at the Tier2-supplier, a new process follow, which includes milling of sprues and dust filtering as well as changing from a cold channel moulding process to hot channel moulding (which prevents production waste), was implemented at the Tier2-supplier. At Continental extended product development effort has been spent in order to being able to use recyclate for the security relevant component. This interplay between product development and changes in the production process on each company level enables the formation of the industrial network. Continental also took responsibility for the network design, when co-financing the recycling mill at the Tier2-supplier factory.

Input substitution vs. primary resources substitution
For the demonstrator 33% of the input (virgin PET-GF35) is substituted by recyclate. This is also a primary resources substitution.

Plant improvement vs. network infrastructure improvement
Since production mainly takes place at the Tier2-supplier, plant improvement takes place there. The infrastructure of the network was improved with the recycling mill which enables to granulate the sprues.

Good housekeeping vs. cooperative network responsibility
On a first level, each of the involved companies is responsible for its own good housekeeping. This includes continuous improvement process regarding the energy and materials efficiency of (production) processes and product design. Cooperative network responsibility is at Continental: As systems integrator Continental is liable in first place to the OEM for the compliance to requirements of the whole braking system. Therefore, requirements and production processes are agreed on in cooperation with the Tier2-supplier.

Reuse, recovery & recycling vs. exchange of resources
Practical Demonstrator 9 is on the recovery and recycling of production waste (sprues from cold channel moulding). This former production waste is recycled to nearly 100%. A further exchange of resources is desirable. Additional resources for the PET-GF35 are assessed. A barrier is seen in the materials requirements for the security relevant use case.

Five Resource Productivity Themes – From the company to the network level

Effective resource utilization and materials efficiency
The effective resource utilization and the raise of materials efficiency is one main issue of practical demonstrator 9. The resource utilization is made more effective by the introduction of a recycling process for sprues from cold channel moulding which formerly were production waste. In the pilot scenario, also by a switch to hot channel moulding process for the production of the demonstrator, no sprues are created anymore and material efficiency raises; the yield from the used material is maximized preventing this former valuable material becoming waste.
Reduction of process waste and enhancement of by-product values

Process waste in the baseline scenario comes from sprues which account for 10-20% of the weight of total material used when producing the security-relevant part. These sprues are now used as input for the security-relevant part which is manufactured with a different moulding process (i.e. hot channel moulding). This process totally prevents the waste generation because it is a sprue-free production process. Thereby, also the sprues are revaluated because they can be used for the same use case as virgin materials. The latter has purchasing costs of € 3000/ton.

Reduction of water use and impacts

Water use is only reduced from the substitution of virgin materials. The new recycling process itself (dust cleaning and milling) does not consume any water.

Reduction of energy consumption and greenhouse gas emission

Energy consumption is reduced from the substitution of primary materials. The dust cleaning and milling process only consumes a minor amount of energy compared to this. Overall, there are significant energy savings from the baseline scenario to the demonstrator.

Improvement of control of minor elements and toxic materials

In automotive, there is already a strict regulation of hazardous substances in place for the whole supply chain. OEMs, Continental (Tier1 supplier) and the Tier2 supplier have therefore hazardous substances management in place for complying with regulations such as e.g. RoHS and REACH. This includes lists for the declaration of substances, consideration the exclusion of toxic materials in purchase agreements and/or audits, both internal and for suppliers. For the security-relevant part these requirements are fulfilled. Therefore, there are no issues seen which could be improved concerning this point within practical demonstrator 9.

3. Assessment

In the current demonstrator (pilot scenario) the security-relevant part is manufactured from a recyclate-virgin materials mixture. The share of recyclate is 33%.

From the ecological assessment the production of primary PET-GF 35 as well as the injection moulding process shows the most contribution to the total emissions depending from the environmental category. For the ODP (Ozone Depletion Potential) the waste incineration plays a significant role and affects therefore the results considerably. Yet, in each environmental category the baseline scenario shows more total emissions than the pilot scenario except for ODP, where the credits given from waste incineration are responsible for the better result of the baseline scenario. As far as the greenhouse gas emissions are concerned it can be noticed that the production of the primary PET-GF 35 shows the most contributions to the total emissions in both scenarios. Injection moulding shows the similar emissions in both scenarios as differences between cold and hot channel injection moulding which is used in the baseline and in the pilot scenario respectively are not assessed.

Transport in general shows very low influence, the same is true for the milling of secondary PET-GF 35. In total the pilot scenario contributes 34,3% less to GWP (Global Warming Potential) than the baseline scenario. Therefore the goal of ZeroWIN can be achieved with the actual pilot study by using one third of secondary material for the production of the control housing.

The waste goal is already totally fulfilled with the current demonstrator (100% recycling and reuse of waste). The recyclate is reprocessed from former production waste which accumulates from sprues when moulding the security-relevant part with cold channel moulding. For the demonstrator, therefore this waste is totally avoided. Only about 5% of the weight of the sprues is dust loss when milling.

The water reduction goal of ZeroWIN is not achieved. It can be noticed that the water depletion of the pilot scenario and for the conceptual scenario can be slightly
decreased compared to the baseline scenario. This is due to the water intensive production process of the PET-GF 35, which is reduced in the pilot and the conceptual scenario. However, injection moulding has the most contribution to water depletion. In total an overall reduction potential of 15% can be reached by the pilot scenario compared to the baseline. Even if 100% secondary material would be used in the case study, the reduction potential would only reach 36% as a maximum. A reduction of the fresh water utilisation can therefore only be achieved by measures within the process injection moulding.

Furthermore, economic benefit is seen by the material cost savings. Investment costs for the recycling mill (€ 120.000,-) occur. Continental and the Tier2-supplier are confident that these investment costs will be paid back by the decreased material costs.

Social assessment of practical demonstrator 9 sees benefits in the realization of public education, as the Continental-internal flagship project for the use of recycled plastics is presented in workshops among own engineers and OEMs and also to the addressed community (of engineers). An additional indicator was implemented by partners in practical demonstrator 9 which is relevant for the practical demonstrator, regarding the total workforce in the local community. Being on the competitive edge regarding technology and products assure the future security of employment of the workers.

At this stage of the project, two out of the three ZeroWIN goals seem feasible to reach by practical demonstrator 9 would make the practical demonstrator a success. The target to reach a reduction of 75% of fresh water utilisation could not be reached under the given circumstances as the major influence is coming from the injection moulding and this is necessary in any case. The overall re-use rate depends on the range of secondary material that is used. This target can be reached if 70% of secondary material is taken.

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<tr>
<th>Target</th>
<th>Eco Control Housing (33% secondary material)</th>
<th>100% secondary material</th>
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<tbody>
<tr>
<td>Decrease of 30% greenhouse gas emissions</td>
<td>34% decrease</td>
<td>47% reduction</td>
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<tr>
<td>Reduction of 75% of fresh water utilisation</td>
<td>15% decrease</td>
<td>36% decrease</td>
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<tr>
<td>70% of overall re-use and recycling of waste</td>
<td>33% re-use</td>
<td>100% reuse</td>
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The research leading to these results has received funding from the European Community’s Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 226752.