LIFE Project Number

LIFE12 ENV/IT/000423

TECHNICAL FINAL Report

Covering the project activities from 01/07/2013 to 31/12/2016

Reporting date

31/03/2017

LIFE+ PROJECT NAME or Acronym

GLUELESS

Project Data

Project location	Pescara - Italy
Project start date:	01/07/2013
Project end date:	31/12/2016
Total Project duration (in months)	42 months
Total budget	€ 3.079.493,00
Total eligible budget	€ 2.904.493,00
EU contribution:	€ 1.443.124,00
(%) of total costs	
(%) of eligible costs	49.69%

Beneficiary Data

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List of abbreviations

EC	European Commission
FAM	Fameccanica.data
UNIMAN	University of Manchester
PC	Project Coordinator
GA	Grant Agreement
CB	Coordinating Beneficiary
MT	Monitoring Team
IR	Inception Report
MTR	Mid term report
PR	Progress Report
FR	Final Report
AHP	Absorbent Hygiene Products
ADL	Acquisition & Distribution Layer
RM	Raw material
ppm	Pieces per minutes
NW	Non woven material
BS	Backsheet
TS	Topsheet
SAP	Super Absorbent Material
FT	Frontal Tape
LCA	Life Cycle Analysis
LCC	Life Cycle Costing
GWP	Global Warming Potential
PED	Primary energy Demand
GHG	Greenhouse gas emissions

2 Executive summary

The present document is an abbreviated version of the Final Report of the GLUELESS project which contains only technical information and can be used for publication scope. The report covers 42 months of the project, i.e. the period from July 1st 2013 to December 31st 2016.

PROJECT OBJECTIVES

The project objectives have been successfully reached. Glueless project succeded to demonstrate to industry and policy makers that significant environmental impact reduction in Absorbent Hygiene Products (AHP), such as diapers, can be realized by drastic reduction of the use of glue in the production process.

The project demonstrates the feasibility, maintaining critical product performance and speed production, to get the following results:

1. More than 65% savings of glue;
2. 10% less energy used in the production process;
3. An annual 0,5 M€ cost reduction.

Since in the Grant Agreement on several occasions objectives 1 and 2 are shown in terms of absolute saving with different units, not easily comparable, in order to remove any doubts here there are the following absolute value and the assumption used to produce them.

1. More than 65% savings of glue (with the assumption of 24 billion diapers/yr for European Market this will lead to a saving of 20kton of glue per year).
2. 10% less energy used in the production process (600 KWh/day per single production line and with the assumption of 24 billion diapers/yr for European Market made by 150 production line this will lead to a saving of 33GWh of energy in diapers production per year).

The aim of the Glueless project is also:

1. Convincing AHP producers to adopt this cost effective (and environmentally friendly) alternative bonding solution, by demonstrating that it meets performance criteria, now that use of glue is increasing due to product innovations.
2. Underpinning with an industrial showcase (including dissemination to multiple industrial sectors) public environmental policy objectives of decoupling environmental impact from economic growth and implementing the number one priority in the waste hierarchy; waste avoidance.

KEY DELIVERABLES AND OUTPUTS

The GLUELESS project key deliverables are the following:

Nr	Deliverable name	Delivery date	Submitted with
D1	Notice board 1	31/08/2013	IR
D1	Preparation of the newsletter	30/09/2013	IR

A1	ADL Raw material and Bonding Specification	30/04/2014	MTR
A1	Core Structure Report	01/10/2013	IR
A1	Elastic application plan	01/10/2013	IR
E1	Inception Report	28/02/2014	IR
A1	"Pattern" of bonding for the Application of the frontal tape defined	30/09/2014	MTR
A1	Frontal Tape Raw material and Bonding Specification	01/01/2015	MTR
D1	Project website ready	01/01/2014	IR
D1	Notice board 2	15/01/2015	MTR
B1	Optimized production process and equipment Report for application of the acquisition layer	01/02/2015	PR
B1	Report on test for application of the acquisition layer	01/02/2015	PR
A1	Back and Front Ear Raw material specification	01/03/2015	MTR
D1	LIFE-GLUELESS mid-term workshop conference	01/03/2015	MTR
D1	Preparation of brochures	01/03/2015	MTR
B2	Optimized production process and equipment Report for Elastic application	01/04/2015	PR
B2	Report on test for Elastic application	01/04/2015	PR
E2	Mid-term Report with payment request	30/04/2015	MTR
E3	Networking with other EU projects report	09/12/2015	FR
B3	Optimized production process and equipment Report for core building	30/09/2016	FR
B3	Report on test for core building	30/09/2015	FR
B5	Optimized production process and equipment Report for back and front ears application	01/01/2016	PR
B4	Optimized production process and equipment Report for frontal tape application	21/10/2016	FR
B5	Report on test for back and front ears application	01/01/2016	PR
B4	Report on test for frontal tape application	21/10/2016	FR
E2	Progress Report	29/04/2016	PR
D1	Notice board 3	01/06/2016	FR
E4	After-LIFE Communication Plan	23/12/2016	FR
C1	Environmental performance report of the novel product	16/09/2016	FR
E2	Final Report with payment request	31/03/2017	FR
D1	LIFE-GLUELESS final workshop conference	23/12/2016	FR
D1	Layman's report	07/12/2016	FR
C2	Market analysis and LCC report	16/09/2016	FR
D1	Preparation of brochures and final poster	23/12/2016	FR
B6	Technical performance report of the final selected demo-diaper prototypes	23/12/2016	FR
D1	Preparation of the newsletter	31/12/2016	FR

In 2016 the Glueless consortium completed the remaining tasks foreseen in the GA of the project taking advantage of the 6-months buffer period granted to the consortium in the starting phase of the project. In this last period the two technical actions still pending have been concluded (Core building and Frontal Tape application) and the final validation of the product features was concluded with the action B.6. FAM, machines builder, and FATER, manufacturer of diapers, worked elbow to elbow in order to merge the respective skills with the aim to first build and then test samples starting from concept developments. Through the product quality control performed (consumer test carried out by Fater) it was possible to achieve more significant results which allowed FAM to compare the

performance of a benchmark product and Glueless samples and evaluated directly by end users (mothers and children).

The environmental impact analysis deriving from glueless activities carried out by UNIMAN in action C was continuously fed by the innovations developed by the FAM team and its completion was consequently affected by a schedule shift of about two months compared with the statements in GA. The results obtained by this analysis in terms of energy saving, greenhouse gas emissions decrease and polluting materials amount to be disposed reduction have been very impressive. The approach "cradle to gate" allowed, not only to find out calculation models of high industrial significance, but also to identify the direction to be taken to build a more sustainable business and oriented to the environmental safety.

The dissemination activities were carried out during the project execution in parallel with the technical actions in order to keep the technical community updated about news in the field of development of glueless technologies. The final conference held in the headquarters of the “Confindustria di Pescara” in November was the perfect opportunity to present the results of the latest innovations and to disseminate the benefits of a concrete development made by projects co-financed by the EU. To make more visible the fruits of the analysis made in the international scenario, the dissemination team also organized a presentation of the entire project results in one of the largest and most important showcases of the AHP market (Inda conference - Hygienix 2016). The description of the events and all the dissemination tools put in place are described in the next paragraphs and in the document annexed to this final report.

The project management planning allowed the coordination of the entire consortium to have fluid information sharing between partners and to ensure that the postponement of some activities had not effect on the whole project schedule. Phone calls on monthly base and meetings during the monitoring visits have been the right way to make the overall team job as much as possible oriented to achieve the stated output.

The financial statement of the project shows that in terms of costs the partnership fully accomplished the goal of targeting the budget proposed on Grant Agreement. Nevertheless there are some changes versus the data contained in the budget that will be adequately explained in the relevant section. Despite these variations that we will highlight, it’s necessary to emphasize that the activities put in place and the results achieved for the individual actions are perfectly in line with the objectives of the project.

FINAL REPORT BRIEF SUMMARY

The Section 3 provides a brief Introduction regarding the project backgrounds, problems/issued addressed and objectives.

The project management system and its evaluation have been providing in the Section 4 along with the description of the task of each person and the Gantt chart. A detailed overview of the technical and dissemination activities implemented during the project is reported in Section 5 including the evaluation of the project implementation and the analysis of its long-term benefits.

The financial information (costs and deviations justifications) is provided in Section 6.

The Section 7 includes all project deliverables and other annexes.

The Section 8 provides the Financial statements, payment request, auditor's report and the answers (Annex "Answers to LIFE12 ENV/1T/000423 LIFE GLUELESS_Final Report") to the issues indicated by the EC in the occasion of the previous reports/monitoring visits to be given with the present report.

3 Introduction

Glue is the most widely spread solution used in the market, even if less desirable from an environmental point of view. Only in the production of diapers, European industry uses over 30kton of glue per year and careful calculations estimate this to be responsible for an environmental footprint of over 200kton CO_{2eq}.

The Glueless project wishes to demonstrate to industry and policy makers that significant environmental impact reduction in AHP, such as diapers, can be realized by drastic reduction of the use of glue in the production process. FAM has researches and lab results showing that is possible to use thermo bonding and ultrasonic welding in 5 different sub processes (Figure 1): application of ADL, elastic application, core building, frontal tape application and ears application as shown below.

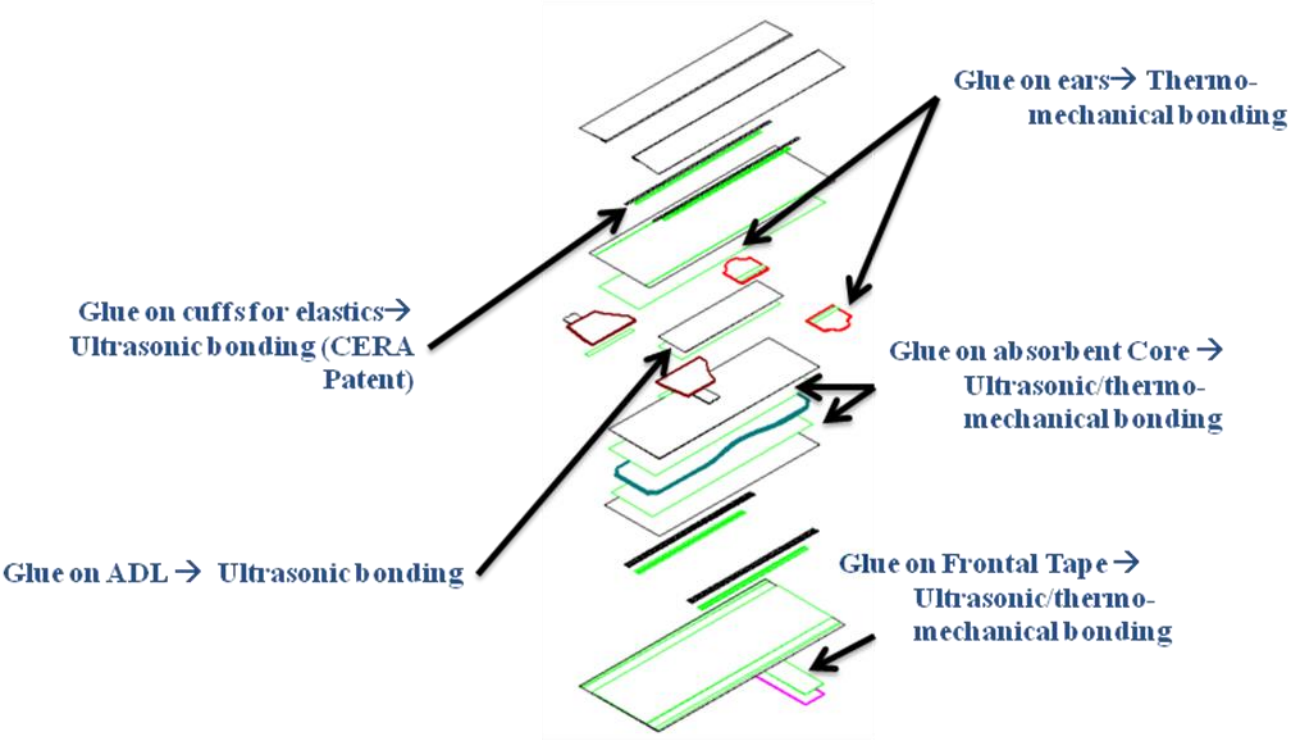


Figure 1 Standard product design

These new technical solutions will lead to more than 65% savings of glue (for single product reduction is expected to be equal to 0,87g on a total of 1,25g) for each diaper and 10% less energy consumption in the production process (reducing the use of glue and replacing it with less energy intensive processes).

Demonstration took place on a full scale diaper production process at FAM, combining results in a single demo product, to showcase product and process performance, environmental and cost benefit to a wider group of AHP producers.

As FAM is leading equipment developer and supplier of the main global AHP producers (P&G, SCA, etc.) the replication potential of the proposed technology is huge and promising. In a short time these processes could be applied to the entire AHP industry in whole Europe and the world.

4 Administrative part

4.1 Description of the management system

In order to manage and collect all the documents and information as well as possible, the coordinating beneficiary (FAM) has created a dedicated team for Glueless project for every department. The figure 2 shows the Glueless project management structure.

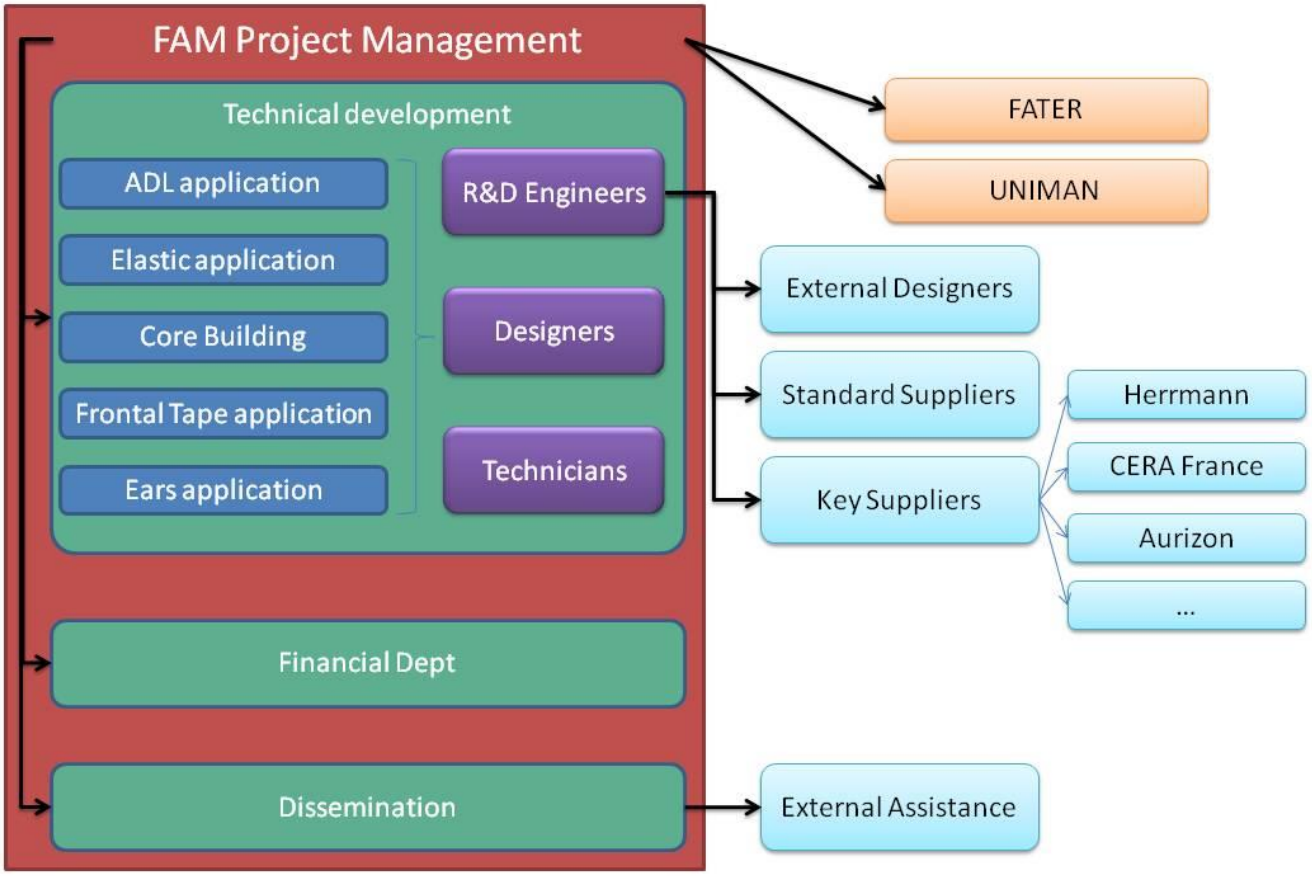


Figure 2 Glueless project management structure

- The project coordinator, Francesco D'Aponte, takes care of the internal information flow checking on a daily basis in order to assure that actions, documents and specifications are in line with the Glueless project rules; he keeps in touch directly with the associated beneficiaries in order to guarantee the correct merging of the partnership. The kick off meeting arranged on 30/10/2013 was the official starting point of the consortium's collaboration. Monthly meetings are scheduled in order to update all the beneficiaries about the ongoing activities (UNIMAN joins these meetings by conference call).

  In collaboration with the technical project leader, Diego Gualtieri, and the dissemination manager, Alessandro D'Andrea, the PC involves the external assistance and the key suppliers in the project to improve project results and to find sponsors.

  The Project Coordinator checks on a daily basis the status of the Glueless project using

the internal databases management which allows to control:

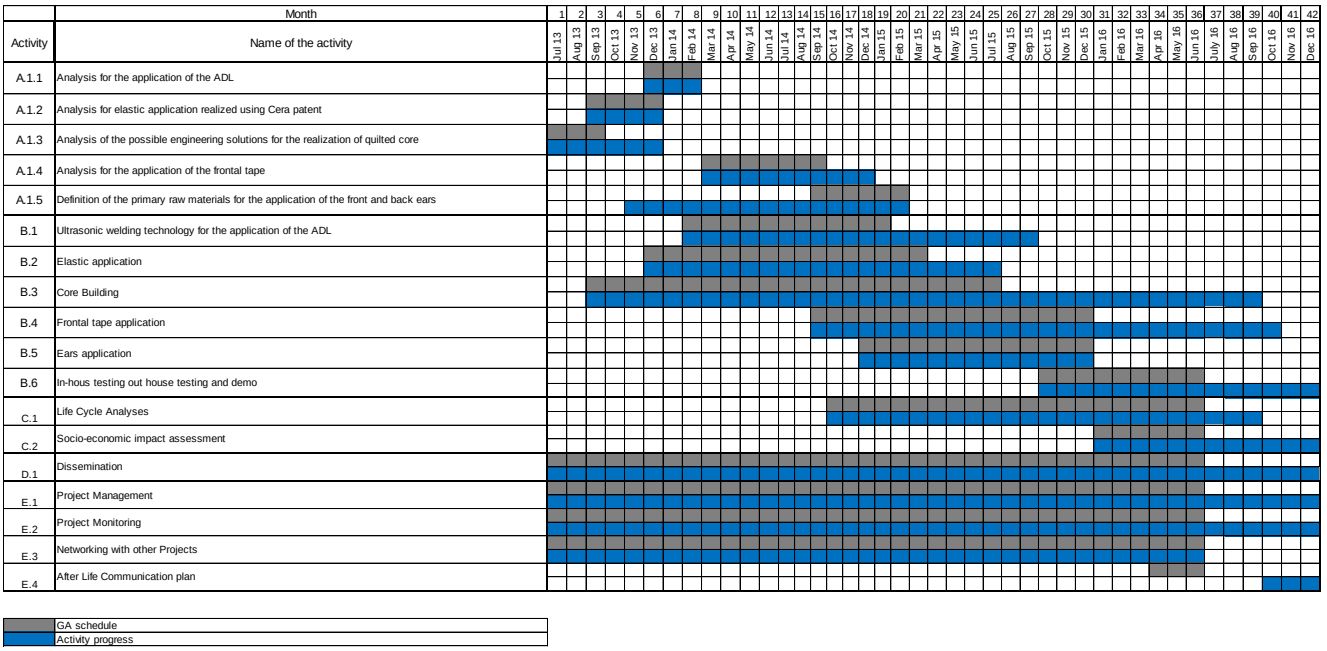
- The design status through the BOM and drawings management
- The assembly and test progress
- The purchase progress
- The financial administration.

Furthermore the Project Coordinator sends updates, on a monthly basis, to the monitoring team describing the project progress.

Every six months the project coordinator compiles an "Interim report" in order to describe the activities progress and the future plans.

- The technical project leader, Diego Gualtieri, manages the engineering team composed by "R&D Engineers", "Designers" and "Technicians"; he coordinates internal and external activities arranging daily meetings and internal design reviews. In collaboration with "R&D Engineers" he coordinates "External Designers", "Standard Suppliers" and "Key Suppliers" in order to optimize the test stands design and construction and to improve both the FAM's know how and the technical project results.
- The dissemination manager, Alessandro D'Andrea collects all technical improvements of the Glueless project reporting the results to the markets community. In collaboration with the external assistance he updates all the online documents (websites, newsletter, etc.) and schedules events for the Glueless project results' demonstration.

The following Gantt chart illustrates the activities progress during the 42 months of the project.



Attached to this Final Report the detailed schedule of the project with the main event highlighted (Schedule.pdf).

Following the Glueless project management structure:

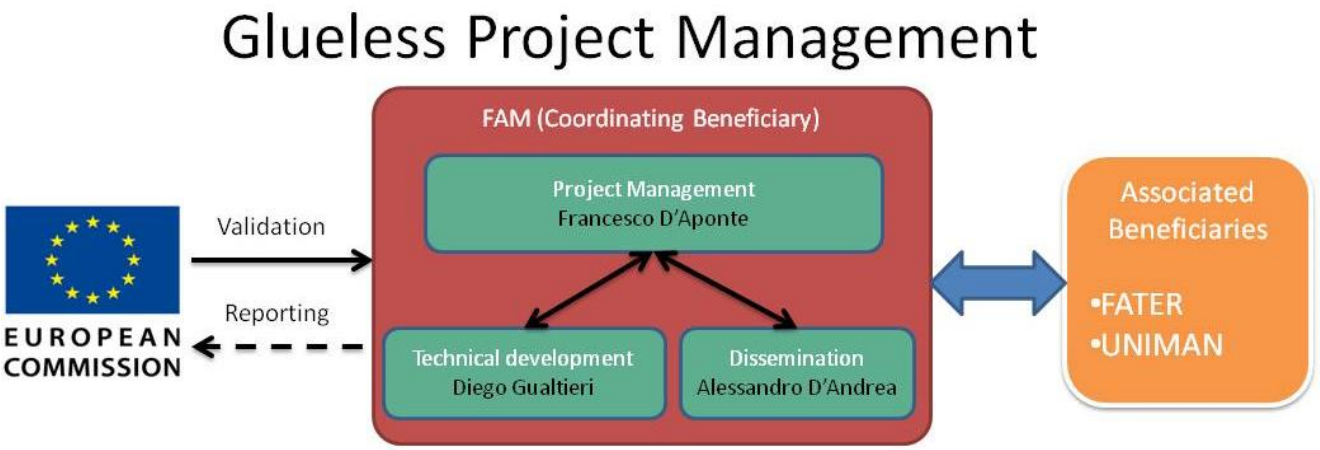


Figure 3 Glueless project management structure

As indicated here above, FAM as the coordinating beneficiary is the only one point of contact for the EC. FATER (Manuela Cinti as official reference) and UNIMAN (Adisa Azapagic as official reference) are the Associated Beneficiaries. They supported FAM in technical, monitoring, communication and management activities. During the project's life FAM collected information from the beneficiaries and reported it to the MT and EC (monthly reports, Inception Report, Mid Term Report, Progress Report and the present Final Report) in order to demonstrate the state of the art of the Glueless project.

The Partnership agreements were submitted to the Commission with the Inception Report.

4.2 Evaluation of the management system

Generally speaking, the project management process respected the agreements statements and both UNIMAN and FATER provided their added value as expected. There were no deviations from the arrangements contained in the partnership agreement.

FAM as coordinating beneficiary communicated with Monitoring team monthly (or more frequently) in order to share updates about the Glueless project or to submit questions regarding the project management. The CB has submitted the official reports in line with the schedule: Inception Report (deadline 28/02/2014 – submitted), Mid Term Report (deadline 30/04/2015 – submitted), Progress Report (deadline 29/04/2016 – submitted) and Final Report (deadline 31/03/2017 – the present document).

5 Technical part

5.1 Technical progress, per task

In this chapter every technical task will be described. For each action there will be a brief illustration of:

- The schedule: planned activities and adherence to the schedule
- Product feature: explanation of the field of analysis
- Process: description of the action aim
- Eventual modifications and problems encountered
- Results achieved (preliminary or definitive)
- Description of the prospective after the end of the Glueless project
- Documents produced
- Outputs.

The technical actions for the Glueless project are grouped in two parts:

- Action A: analysis of the possible technical solutions, of the raw materials and technologies selected;
- Action B: implementation of the engineering solutions found in A.1, design and construction of the test stands and tests for process validation.

5.1.1 **ACTION A.1 – Analysis of possible engineering solutions**

START DATE / END DATE	Foreseen start date: July 2013 Actual start date: July 2013 Foreseen end date: February 2015 Actual end date: February 2015

FAM had already demonstrated at lab scale the possibility to use thermal and ultrasound technology in the diaper production process nevertheless further analysis were needed.

During the preparatory actions, FAM did not face significant problems so all the sub-actions have been in line with the schedule.

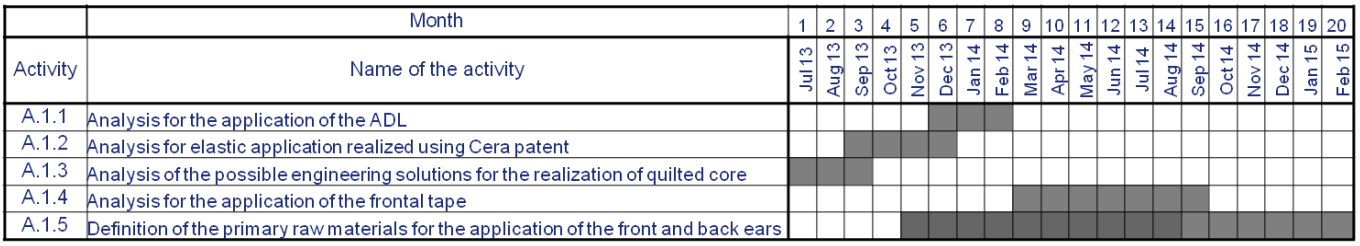


Figure 4 Action A.1 - Schedule

During the action A.1 FATER and FAM collaborated in order to analyze the new glueless products and the standard quality control methods in order to find the right criteria to perform tests for each testing iteration.

Following a brief description of the engineering analysis for every sub-process:

1. Analysis for the application of the ADL.

   This activity started in M6 and was completed in M8 as scheduled. In this phase several activities were done to define the boundary conditions for the bonding process between ADL and NW Topsheet.

   Two test days @ Herrmann facility (supplier for ultrasonic bonding) were done to define the best results in terms of raw materials and bonding pattern selection. The outcome of this action was the selection of 2 sonotrode shapes, 5 raw materials and 1 sonotrode position (no more positions were needed.

   The final RMs' list is described in the deliverable "ADL raw material and bonding specification".

   Milestones:

   - "Pattern" for Application of the defined acquisition layer (ADL) (deadline 28/02/2014) - achieved.

   Deliverables:

- ADL RMs and bonding specification (deadline 28/04/2014): sent with the MTR.

2. Analysis for elastic application obtained using Cera patent

   This activity started in M3 and was completed in M6 as scheduled. The R&D Engineers from FAM examined in depth the mechanical entrapment of the elastic strands on the basis of the CERA France patent "US6291039" in order to find all the physical variables of this process.

   Furthermore the R&D Engineers, assisted by the Technicians, worked in the lab for:

   - Lycra elastic characterization: define the behavior of an elastic strand during a controlled stretch ("Elastic shrinkage.pdf" annexed with the IR);
   - NW mechanism of entrapment analysis: understand the real physical effect linked to the elastic "entrapment" process.

   Milestones:

   - Engineering solutions for elastic application identified (deadline 31/12/2013) - achieved.

   Deliverables:

   - Elastic application plan (deadline 30/09/2013): sent with the IR.

   Results:

   - Sonotrode/anvil shapes identified: 2 instead of 4 as estimated. Just two patterns were chosen because Cera France already tested several sonotrode and anvil pattern shapes and defined the best ones. Their suggestion was to fine tune the process with this hardware asset.

3. Analysis of the possible engineering solutions for the realization of quilted core.

   Activity started in M1 and was closed in M6 (unlike M3 foreseen in the GA). Starting from a standard absorbent core, several analyses were done in order to define a new product design.

   This activity was divided in two parts:

   - analysis for development of a handmade core construction equipment: being this a new kind of product, it was necessary to design a system to quickly produce "handmade" absorbent cores with several bonding patterns; this phase was useful to define the product specifications;
   - analysis for development of a core forming prototype: in this phase new units were studied using fluid dynamic CAD instruments, structural calculations and experimental data ("Fluff phase velocity.jpeg", sent with the IR, resume the result of this analysis); this phase was important to understand what are the bullet points in the process.

   Milestones:

- Engineering solutions for the realization of "quilted" core using thermal and or ultrasonic welding identified (deadline 30/09/2013): achieved.

Deliverables:

- Core structure report (deadline 01/10/2013): sent with the IR.

Results:

- 3 sealing shapes, selected from several bonding patterns, were analyzed (more than 3). Quality control performance was done to define the shapes with optimal performance.

4. Analysis for the application of the Frontal Tape

   This activity started in M9 and was completed in M18 (3 months later the scheduled date in the GA).

   The R&D Engineers from FAM selected the most suitable RMs for the frontal tape application and defined the best bonding area value and the pattern shape to be tested.

   Further activities were done in order to find an alternative solution to bond a Frontal Tape material on a NW backsheet material, paying attention to the existing patent regarding this process. The conclusion of this study was the definition of a new concept of Frontal Tape in-line construction. For this reason a new patent for this new process was requested (the cost for patent request was not charged on the Glueless project).

   The reason of the delay was explained in detail in the MTR and it didn't affect the schedule of the other actions.

   Milestones:

   - "Pattern" of bonding for the Application of the frontal tape defined (deadline 30/09/2014): achieved (15/12/2014).

   Deliverables:

   - "Pattern" of bonding for the Application of the frontal tape defined (deadline 30/09/2014): sent with the MTR.
   - Frontal tape raw material and bonding specification (deadline 01/01/2015): sent with the MTR.

   Results:

   - 4 bonding patterns selected (2 standard + 2 for the patent concept);
   - 9 raw materials selected.

5. Definition of the primary raw materials for the application of the front and back ears.

   This activity started in M5 and was completed in M20. As declared in the IR, it started before the date stated in the GA because of the opportunity to make preliminary tests on the

customer's machine at FAM plant.

The aim of the test is to compare the thermo-welding ears application and gluing application. Following are the process variables:

- Raw materials for ears and cuffs
- Glue amount for ears application
- Temperature and pressure for the calender.

A new equipment tested in Fameccanica lab gave FAM the opportunity to add a new feature to the project, to be integrated as a sub-action for the realization of a new glueless elastic RM for ears. This activity had not impact on the Glueless project schedule and no additional costs were charged for this development.

Milestones:

- Primary raw materials for the application of the defined front/back ears (deadline 28/02/2015): achieved.

Deliverables:

- Back and Front Ear Raw material specification (deadline 01/03/2015): sent with the MTR.

Results:

- 2 bonding patterns selected;
- 4 raw materials selected for ears.

5.1.2 **ACTION B.1 – Ultrasonic welding technology for Application of the Acquisition Layer (ADL)**

START DATE / END DATE	Foreseen start date: February 2014 Actual start date: February 2014 Foreseen end date: January 2015 Actual end date: September 2015

This activity started in M8 and ended in M27 (8 months after the deadline reported in the GA). The additional months were spent in order to achieve all the results and to gain a robust knowledge of the whole process. The final results of the action B1 were in line with the expectations and the above mentioned delay did not affect the overall schedule of the project or other action results.

	Month	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Activity	Name of the activity	Sep 13	Oct 13	Nov 13	Dec 13	Jan 14	Feb 14	Mar 14	Apr 14	May 14	Jun 14	Jul 14	Aug 14	Sep 14	Oct 14	Nov 14	Dec 14	Jan 15	Feb 15	Mar 15	Apr 15	May 15	Jun 15	Jul 15	Aug 15	Sep 15	Oct 15
1	Design																										
2	Purchase																										
3	Test bench construction																										
4	Preliminary tests																										
5	Process' speed up & flaws analysis																										
5.1	Vibration mapping																										
5.2	Units Primary frequencies analysis																										
5.3	Ultrasonic stack analysis																										
5.4	Ultrasonic stack restore																										
6	Test campaign with all the raw materials																										
7	Design of the second pattern																										
8	Purchase																										
9	Test campaign with all the raw materials																										
10	Long run & stress condition																										
11	Quality control																										

Figure 5 Action B.1 - Schedule

After the validation of the first pattern, the R&D Engineer of FAM took advantage of the process learnings achieved in order to improve the ADL application technology. As described in the MTR the main aspects to review were:

1. Vibration phenomena
2. Pattern design
3. Online vision system
4. Bonding unit SW

On the basis of the above described notes the R&D engineers of FAM performed the following actions:

1. Design of a new frame for the ultrasonic bonding unit and anvil.
2. In order to guarantee the correct bonding balance, the new pattern was optimized using a new tool developed within the Glueless project.

   Starting from the pattern design, this SW allows to calculate the specific bonding area in MD and to optimize its balance. Below the analysis performed for the second bonding pattern.

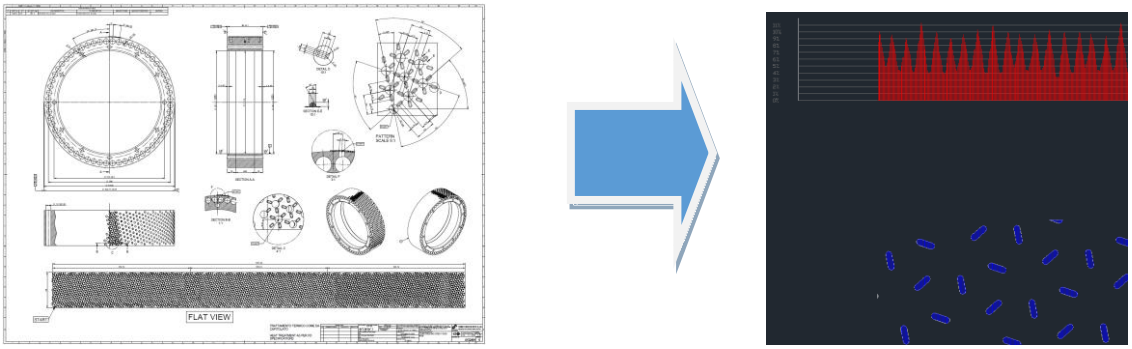


Figure 6 Example of bonding pattern optimization

3. The researches on the market showed that the best technology to detect big patches of product is the linear camera. This vision system indeed allows to scan the web with a certain number of lines and it rebuild the product shape on a screen so that it is possible to check automatically the dimension and the position of the discrete pieces of product. The image below shows an example of the sample detection.

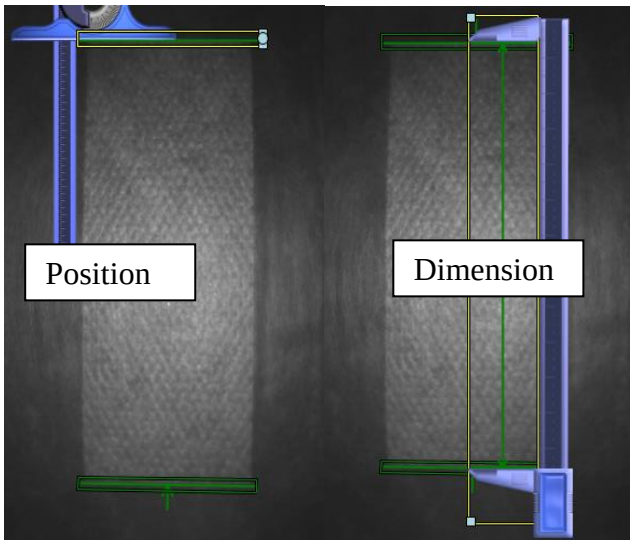


Figure 7 ADL vision check

4. The R&D engineers from FAM interviewed the technicians from Herrmann in order to check the SW release and to evaluate the possibility to upgrade it. The analysis revealed that no upgrades were needed and just few parameters were tuned to achieve better performance in intermittent mode at high speed.

The equipment for the ADL ultrasonic bonding was updated on the basis of the above described upgrading tools and it was ready for the test in M25 (3 months after what declared in the MTR). The root causes for this delay was the pattern optimization and the anvil manufacturing which needed iterative fine tunings not foreseen. This schedule variation did not affect the schedule of the whole project.

This new optimized asset allowed to validate the second pattern without facing relevant issues and the target results were fully achieved.

Following the summary for the target achieved which matched the expected results:

- The equipment and pilot line design have been defined. In the deliverable "Optimized production process and equipment - Report for application of the acquisition layer.pdf" has been reported the final layout and the integration of the equipment in a production line.
- Engineering specification for the overall process application between ADL and Topsheet have been defined: the SW management of the ultrasonic bonder and the process parameters (web handling, vacuum system and units relative positions) were optimized for an intermittent bonding application between the ADL and Topsheet;
- Performance test for each testing iteration has been performed: for 2 bonding patterns, all the 5 RMs selected and 1 sonotrode position, 50 pieces of demo product were collected and tested (peel test) in order to identify the best configurations; for every setting the target value of peel strength was achieved so no further test have been necessary to validate the second pattern;
- Quality control test to evaluate the fluid handling in collaboration with Fater.

The test results are annexed to this document ("Test welding ADL.xlsx").

Furthermore the disaster check was performed respecting the following conditions:

- No scraps when the tapes for joining the raw materials (ADL or NW topsheet) cross the bonding point;
- No scraps during the ramp up or ramp down;
- No scraps during the long run (10 minutes).

Based on the results achieved this action can be consider completed.

Documents:

- TEST_STAND_ADL.pdf (Annexed to the MTR)
- Vibration analysis.pdf (Annexed to the MTR)
- Bonding pattern 1 _ 4133003.pdf (Annexed to the MTR)
- Bonding pattern 2 _ 4150863.pdf (Annexed to the MTR)
- ADL fluid handling test.pdf (Annexed to the MTR)
- Test glueless welding ADL.xls (Annexed to the MTR)
- ADL - Peel Test method.pdf (Annexed to the MTR)
- Peel test.pdf (Annexed to the MTR)
- PP166-D01_R01_ModaleRullo controsaldante.pdf (Annexed to the MTR)
- Glueless - Saving process ADL.xls (Annexed to the MTR)
- Test welding ADL.xlsx (Annexed to the PR)

Milestones:

- Best solution for the application of ADL – (deadline 01/02/2015) Achieved – 19/09/2015.

Deliverables:

- Optimized production process and equipment report for application of the acquisition layer (deadline 01/02/2015) (completed in 01/02/2015): sent with the PR.
- Report on test for application of acquisition layer (deadline 01/02/2015) (completed in 01/02/2015): sent with the PR.

Results:

With the conclusion of action B.1, FAM has demonstrated that it is possible to weld in line ADL and NW topsheet at the project target speed. This process can be integrated both on premium and low speed platforms made by FAM without any product design restrictions.

Looking at the test results it was found that the raw materials selection (ADL and topsheet) is important to maximize the result in terms of welding strength, improving the process reliability. Furthermore, it has been demonstrated the ability to manage the design of the pattern, respecting the limits imposed by the bonding area, in a flexible way thanks to the tool "Distribuzione aree" that allows to balance the welding surface.

The quality control of the product finally confirmed that the performance in terms of product fluid handling with and without glue are comparable, then for producers of AHP can choose the two different technologies without any restriction.

5.1.3 **ACTION B.2 – Elastic application**

START DATE / END DATE	Foreseen start date: December 2013 Actual start date: December 2013 Foreseen end date: February 2015 Actual end date: July 2015

This activity started in M6 and it ended in M25 (5 months after the deadline stated in the GA). The five extra months were necessary for achieving the action targets and this delay did not affect the whole project schedule.

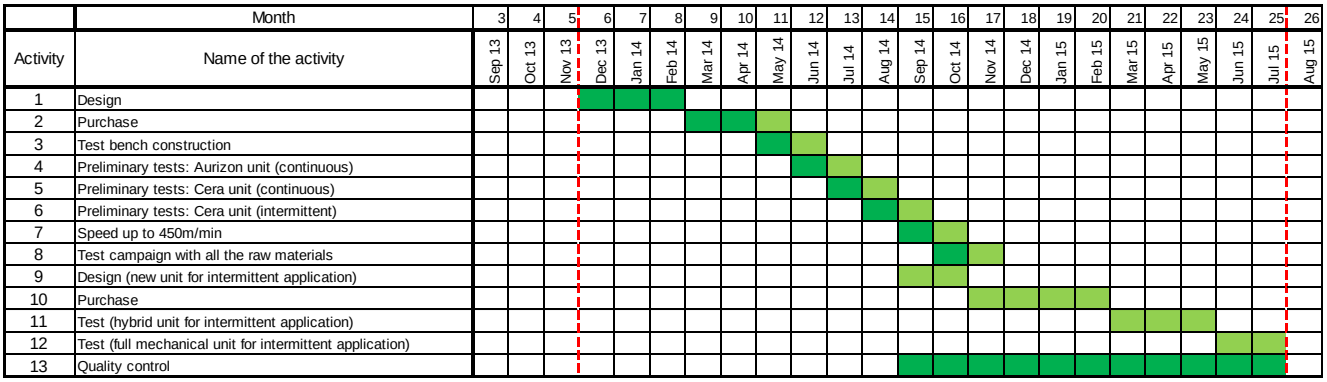


Figure 8 Action B.2 - Schedule

When the Glueless project started the elastic entrapment was a very innovative and unknown process for FAM. For this reason the technical approach of the R&D engineers of FAM was to study the state of the art of the technology and to learn as much as possible about the process in order to speed up and optimize it.

As stated in the MTR, two technologies were tested since M20 (CERA and Aurizon) but they were not completely ready for the process validation. Further tests for an hybrid solution (FD concept) were on going. Even though the preliminary results @ lower speed were promising, the hybrid solution concept showed several limitations @ target speed. Indeed analyzing the vibration amplitudes for the three axes, the R&D engineers of FAM surprisingly discover that the ultrasounds induce an undesired big vibration in cross direction.

This vibration can be locally transferred to the raw material with a subsequent movement in CD.

This movement forces the lycra elastic to get out of the cavity i.e. to be cut by the anvil.

In spite of the unsuccessful results, these last tests allowed R&D engineers of FAM to learn more about the elastic entrapment process so that a new solution could be tested. Indeed the test showed that the web handling management is the real key aspect for reaching the process stability and the bonding technology is a secondary choice. On the basis of this new information R&D engineers and technicians decided to arrange a new elastic entrapment configuration using a mechanical bonding unit.

In M25 the updated test stand was ready to run. The results were soon positive both in continuous and intermittent mode and using every pattern available for the test.

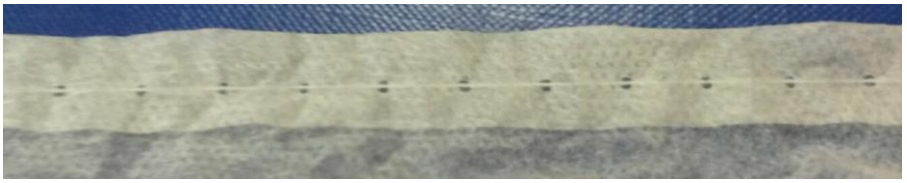


Figure 9 Elastic entrapment samples

The process was very reliable so that the R&D engineer decided to perform the validation test using this mechanical asset.

Following the summary for the target achieved which matched the expected results:

- The equipment and pilot line design have been defined. In the deliverable "Optimized production process and equipment - Report for elastic application.pdf" the final layout and the integration of the equipment in a production line have been reported;
- Engineering specification for the overall elastic application process: the pattern design and the folding plates were optimized to best fit in the layout of the machines;
- Performance test for each testing iteration has been performed: 1 NW for cuff, 2 elastic threads (680dtex and 800dtex), 5 bonding patterns, 2 bonding applications (continuous and intermittent), 50 pieces of demo product were collected and tested (contraction); for every setting the target contraction curve was in line with the expectations;
- Product quality control performed for each sample to evaluate the laminate elasticity. The test criteria were defined by the R&D engineers from FATER and FAM in order to find the best procedure to be applied to this new concept product.

The disaster check was performed in respect of the following conditions:

- No scraps when the tapes for joining the raw materials (NW topsheet or elastic yarns) cross the bonding point;
- No scraps during the ramp up or ramp down;
- No scraps during the long run (25 minutes);
- No elastic snap back when it is cut.

Milestones:

- Best solution for elastic Application (deadline: 01/04/2015) achieved – 24/07/2015).

Deliverables:

- Optimized production process and equipment. Report for Elastic application (deadline 01/04/2015) (completed in 27/07/2016) - Attached to the progress report;
- Report on test for Elastic application (deadline 01/04/2015) - completed in 27/07/2016 Attached to the progress report.

Results:

Among the Glueless projects, the elastic entrapment was definitely the one that required more concept analysis to keep confidence of the process. The tests on the two welding technologies (thermomechanical and ultrasonic) has allowed to identify strengths and weaknesses for both in order to determine what was the best option to be proposed as a final solution.

In the final lab validation, it was demonstrated that the process is stable up to the target speed and in the most stressful conditions of a production line. As well as for the application of the ADL, also the elastic entrapment process is applicable both on premium and low speed platforms. No limits were detected on the raw materials currently used in standard processes. In terms of the product, in addition to the savings due to the elimination of the glue, it has found a further saving achieved by the reduction of the raw material NW which makes the appeal of this development even higher. Finally, it is important to note that the concept of the elastic entrapment can be extended to other parts of the product in which today the elastic yarns are glued achieving further product cost savings.

Customers interest towards this new product features is such that the FAM in 2017 will execute the process validations on two production lines.

5.1.4 **ACTION B.3 - Core Building**

START DATE / END DATE	Foreseen start date: September 2013 Actual start date: September 2013 Foreseen end date: July 2015 Actual end date: September 2016

This activity started in M3 and it ended in M39. The action B3 should end in M25 but the R&D team of FAM, that worked on it, faced several unexpected issues which had impact on the schedule. This delay did not affect the overall schedule of the process.

	Month	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Activity	Name of the activity	Sep 13	Oct 13	Nov 13	Dec 13	Jan 14	Feb 14	Mar 14	Apr 14	May 14	Jun 14	Jul 14	Aug 14	Sep 14	Oct 14	Nov 14	Dec 14	Jan 15	Feb 15	Mar 15	Apr 15	May 15	Jun 15	Jul 15	Aug 15	Sep 15	Oct 15	Nov 15	Dec 15	Jan 16	Feb 16	Mar 16	Apr 16	May 16	Jun 16	July 16	Aug 16	Sep 16
1	Design core building prototype and hand made bench																																					
2	Purchase																																					
3	Test benchs construction																																					
4	Preliminary tests: sealing&forming unit																																					
4.1	Forming unit new design and optimization																																					
4.2	Purchase																																					
4.3	Preliminary tests: sealing&forming unit (step 2)																																					
5	Preliminary tests: forming module																																					
6	Sealing test up to 450 m/min																																					
7	Forming test up to 450 m/min																																					
8	Test campaign with all the selected raw materials																																					
9	Analisys of the defiberization process																																					
10	Anlaysis of the alternative technical solutions																																					
11	Design of the new technical solution																																					
12	Purchase																																					
13	Validation test																																					
14	Quality control																																					

Figure 10 Action B.3 - Schedule

FAM had analyzed during the preliminary action A1 all the details of the present core due to the fact that the absorbent core is the most important feature in a diaper. It determines how the hygiene product performs in terms of fluid handling and containment. In a standard diaper it is composed by a mixture made of fluff (fiber of cellulose) and SAP (superabsorbent polymer) carried by two webs of NW or a web of NW folded. Currently the ratio fluff/SAP is 40%/60%, but the trend of the market tends to increase the SAP quantity up to a maximum of 100%.

Further details about the absorbent core are described in the deliverable "Core structure report" (sent with the IR).

The aim of this action was to define, prepare and test a prototype for the absorbent core construction. After the analysis for the raw materials and core structure in action A.1, in the action B.3 FAM conducted two activities strictly linked to each other:

- Handmade core building prototype: construction of a prototype for lab tests in order to confirm raw materials choice and overall core structure;
- Final core building prototype: construction of the final prototype in order to validate the best technology to product the quilted absorbent core.

In the action A.1, preliminary tests were done to define the basic principles to design the handmade prototype and in B.3 FAM designed the optimized units. The hand made core prototype was built and validated.

Considering that the Glueless quilted product is very different than a standard core, the prototype design started with several innovative ideas and without layout constrain. This means that in this phase the overall dimensions (height, length and width) were not taken into account as a limitation. The detail of the equipment design is described in the annexed deliverable "Optimized production process and equipment Report for core building".

A new development was necessary because the target ratio fluff/SAP of the project was 20/80. It was a challenging target but realistic looking at the products of the next future. As the SAP flows into the injection pipe and fluff in to the forming chamber they "start" to mix in point A ("start" because from point A to the drum they keep on mixing). The quality of the mix (checked in the product) depends on how the following fluid dynamic variables are managed and controlled:

- SAP flow rate
- Fluff flow rate
- Air flow rate in the forming chamber and in the injection system
- Pressure in the injection system
- Geometry of the forming chamber and the injection system
- Fluff and SAP technical specifications (drag coefficient).

A fluid dynamic analysis and a recursive DOE (design of experiments) was done to explore every possible scenario and to define the shape of the two ducts.

The second and more important analysis, was the forming drum optimization. In a standard machine the drum is used to create the absorbent pad whereas in the glueless project it also has the function of anvil for the termo-mechanical bonding. Indeed the forming drum for quilted core has dots used as areas where the pad is not formed and the NW carriers of the pad are bonded.

For this reason the drum must be designed in order to guarantee at the same time:

- big air conveyance sections (for forming)
- structural stiffness (for bonding).

As reported in the MTR, until M20 preliminary test without SAP were performed up to 450m/min to validate the core bonding process. Since then the technical results were:

- Pad forming: the equipment allowed to make defined pads without lacking fluff zones; the core was not perfectly homogeneous (because of the presence of knots), but perfectly in line with the FAM quality control standard;
- Sealing pattern: the core without SAP was well bonded.

The technician of FAM started to feed SAP in the process in two steps:

1. Forming process optimization without bonding dots: in this phase the goal was to achieve the best forming asset in order to produce pads with an optimal mix fluff-SAP and without absorbent particles in the bonding areas (edges and central dots);

2. Core building optimization by bonding the two layers of NW: in this process the goal was to fine tune the bonding process in order to encapsulate the absorbent core once built.

As soon as the first step started, the R&D of FAM realized that it would have been very difficult to form the absorbent pad at full speed keeping the small dots in the middle of the core cleaned.

Taking into account that this could be the most critical aspect of the core building process and that SAP particles could damage the sealing roll, several FMEAs about the process were performed before continuing the tests.

The cellulose pulp defiberization was considered the root cause of the dot contamination. In effect the SAP particles were not completely merged with the fluff fibers so that they could move toward the bonding zones during and after the forming process. The equipment modifications defined by R&D engineers and technician allowed to achieve strong improvements in terms of defiberization and pad homogeneity and as a consequence the bonding areas seemed to be more clean (defibration tests results in the annexed documents "20151028_Test_VP_Core_Glueless_Curve.xlsx", "20151111_Test_VP_Core_Glueless_Grinding bar.xlsx" and "Standard_ pulp_vs_treated_pulp.jpeg").

Even though the pad quality was optimized, very small particles of SAP were still present over the dots surface. In this condition it was possible to seal the two layers of NW but micro holes were still visible on the bonding surfaces.

On the basis of these results the quality control started to assess the product performance in order to understand if the bonding strength was enough to guarantee the core integrity.

Several actions were performed to clean the dots after the forming chamber (using air cleaning jet or brush), but the results were not positive.

Considering the above process limitations, the R&D engineers of FAM explored new solutions to block the SAP particles over the surface of the NW without using glue. Performing preliminary screening of the possible solutions they found out the possibility to improve the SAP entrapment activating the backing NW after the dosing process.

This technical solution was inspired by the FAM's "Fluffless" product concept (with glue) developed in the last few years, so the R&D team of FAM was quite confident that it could works at full speed.

Specific concept tests were performed in M32 in order to understand if it is possible to remove glue by making a combination of different parameters.

Considering the preliminary results achieved a new product design was developed (Figure 14).

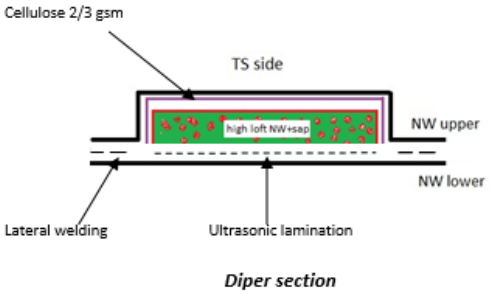


Figure 14 Absorbent core

In the new core design there are 2/3 g of cellulose on top of ADL material. With this solution it is possible to immobilize free SAP on ADL material.

The methods employed to carry out the results have been:

- test criteria coming from the market and R&D expert from FATER;
- comparison between new core structure and standard core structure;
- iterative trial test in the FAM' laboratories.

For the best product configurations, disaster check have been performed:

- long run (30 min for each);
- splice test for each raw material (pulp and NWs).

The specific performance for the core structure have been defined and are listed in the deliverable "Report on test for core building" and they were measured considering:

- 50 pieces checked for each iteration;
- For each raw material selected (more than 3);
- the quality control methods used have been: hardy test (core integrity), acquisition time and rewet;
- the tests were performed in one bonding pattern configurations: internal channels bonded. Considering the test performed for the quilted core building, the number of bonding shape tested was 3.

The disaster check did not show any process issues.

Looking at the results it's possible to conclude that:

- with the last product design FAM demonstrated the capability to build an absorbent core for a diaper product without using glue and considering the following technical specification:
    - fluff amount: 2 - 3g
    - SAP amount: 14g
    - Production speed: 450m/min or 1000ppm
- the fluff layer is necessary in order to guarantee the core integrity in dry and wet condition;

- the glue elimination allows to improve the fluid handling performances;
- the fluff amount influences the product fluid handling performances;
- the equipment and pilot line has been defined;
- the engineering specifications for the process have been defined in the deliverable "Optimized production process and equipment Report for core building".

Following are reported the documents of the Action B.3 and the relevant milestones and deliverables.

Documents (Annexes):

- PP133-D01_R01_ProjectReport.pdf: DOE analysis (annexed with the MTR);
- Defiberization quality control.pdf (annexed with the MTR);
- Final report Form&Sealing unit optimization.pdf (annexed with the MTR);
- Layout.pdf (annexed with the MTR);
- 3066553 - Die cutting machine.pdf (annexed with the MTR);
- 3066554 - Dots bonding machine.pdf (annexed with the MTR);
- 3066558 - Continuous bonding machine.pdf (annexed with the MTR);
- Layout SAP module.pdf (annexed with the MTR);
- Layout mill module.pdf (annexed with the MTR);
- Layout forming module.pdf (annexed with the MTR);
- 1° gluless log book (CORE).pdf (annexed with the MTR);
- 2° gluless log book (CORE).pdf (annexed with the MTR);
- Test n.3 del 14.01.2014.pdf: example of quality control for core integrity (glueless product) (annexed with the MTR);
- Test n.5 del 15.01.2014.pdf: example of quality control for core integrity (commercial product) (annexed with the MTR);
- 20150109 Fluff defiberization.pdf (annexed with the MTR);
- 20151028_Test_VP_Core_Glueless_Curve.xlsx (annexed with the PR);
- 20151111_Test_VP_Core_Glueless_Grinding bar.xlsx (annexed with the PR);
- Standard_ pulp_vs_treated_pulp.jpeg (annexed with the PR);

Milestones:

- Best solution for core building (deadline 01/08/2015) - achieved in M39.

Deliverables:

- Optimized production process and equipment Report for core building (deadline 01/08/2015) - completed in 30/09/2016 and annexed with the present FR;
- Report on test for core building (deadline 01/08/2015) - completed in 30/09/2016 and annexed with the present FR.

Results:

The core building project was certainly the most complex feature among those developed in the whole Glueless project. Historically FAM met the main difficulties upgrading this technology because of the experimental approach adopted. The analytic method implemented by FAM allowed to overcome the difficulties met and to deal with issues of the forming process never investigated within the projects development of the FAM and above all to use new methods of study and analysis that can be re-used in future projects. The unsatisfying results of the quilted core construction process have been useful to understand what are the limits of a process that joins welding and forming technologies (three-phase fluid flows) in the same feature.

As final consideration, it's important to point out that the last market analysis pointed out that the preliminary choice of product design (20% fluff + 80% SAP) is perfectly in line with the actual/future AHP market needs, so FAM expects that the new glueless core building design will be successful.

5.1.5 **ACTION B.4 - Frontal tape application**

START DATE / END DATE	Foreseen start date: September 2014 Actual start date: October 2014 Foreseen end date: December 2015 Actual end date: October 2016

This action started in M15 and it ended in M40 (10 months after the dead line stated in the GA). In light of the learnings achieved during the action B.2, the R&D engineers of FAM have set the activities of this action in order to validate the two welding patterns in the most efficient way. Moreover, starting from a preliminary product analysis, emerged the opportunity to optimize the application of the FT to ensure best product performances and benefits for manufacturers of diapers in addition to the glue saving itself. For these reasons the R&D engineers of FAM decided to define the design of the second pattern just after the validation of the first one in order to collect all the useful feedbacks and take advantage of the know how achieved for the development of the innovative solution. This approach, together with difficulties encountered in the realization of the second welding pattern, led to the delay above mentioned, but it has been successful in terms of quality of the result reached.

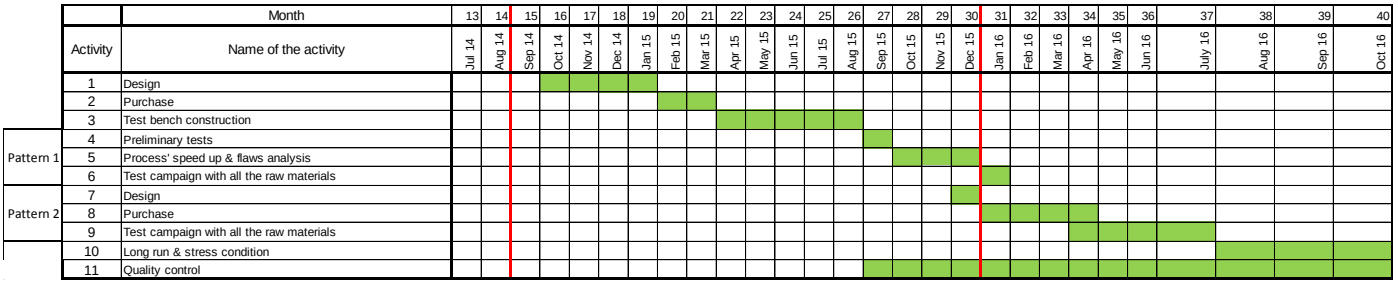


Figure 15 Action B.4 - Schedule

The aim of this action was to validate the glueless application of FT using an ultrasonic bonding technology. The frontal tape is that part of the diaper which allows its closure when it is worn by the baby.

The FT is the product feature that allows to close the diaper and to let it fits with the baby's body. Indeed the back ears are attached to the FT in order to let the diaper fit the baby's waist.

Figure 16 Fastening tape attachment

This kind of attachment is called "fastening" and it is made through the interaction of the FT and BE surfaces. They are physically treated so that they can couple as a "hook and loop" joint (see the picture below).

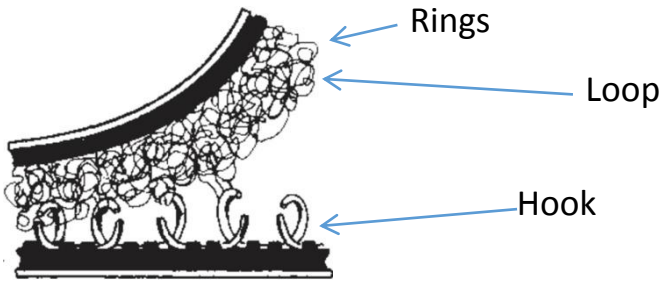


Figure 17 Hook and loop attachment

The hook tape is attached over the BE as a plastic tape and the FT is made so that the external surface is full of little rings.

The way in which the loop material can be realized and attached over the BS surface has been the main object of the R&D engineers analysis. Indeed, the glueless attachment of the FT must guarantee the same performances of the glue fixation in terms of:

- Peel strength: force needed to delaminate FT and BS;
- Shear strength: force needed to open the fastening joint.

In a standard product (with glue) these two versions are independent because the amount of glue used influences the peel strength whereas the loop quality (and compatibility with the hook) defines the shear strength without any interaction between themselves.

On the other hand, to attach the FT on the BS without glue it's needed to join the two surfaces through a bonding pattern. This pattern damages the loop rings because it locally melts the NW fibres and

disables it disables their main function. So the greater is the bonding area and the better is the attachment strength but, at same time, the poorer is the shear strength.

On the basis of the above mentioned consideration, the R&D engineers have split the development in two separate phases:

- Ultrasonic attachment of a standard FT over a BS surface. This asset has been chosen as the best compromise between peel and shear strength;
- In line loop forming process through a specific pattern design and raw material combination: lamination of a carded NW with oriented fibres and NW BS made by loop-friendly pattern design. This is an innovative technical solution oriented to an optimization of the FT attachment and functionality because it allows to reach a good peel strength creating in line the loop rings (and not damaging the existing ones).

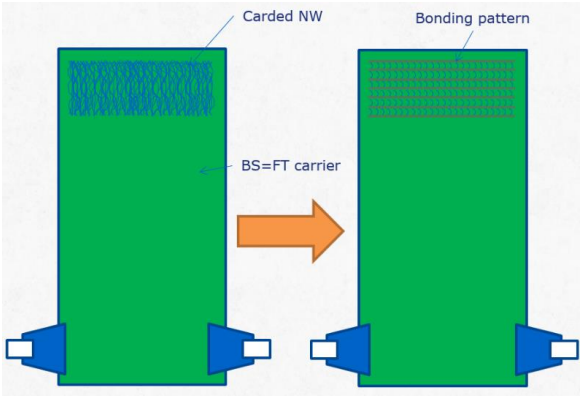


Figure 18 Loop FT bonding definition

As described in action A.1, the Frontal Tape application layout is quite similar to what the R&D engineer of FAM developed for the ADL application.

We need to underline that in a standard process the frontal tape is attached with glue on the NW backsheet side of a laminated material made of the NW backsheet itself and a Poly Backsheet (this lamination can be done either on line or off line).

With the new glueless application, the Frontal Tape has to be attached on the NW backsheet before the backsheet lamination in order to guarantee that the poly backsheet is not perforated during the ultrasonic bonding of the patch (holes on the backsheet's surface would mean liquid leakage).

The FAM R&D Engineers, on the basis of the preliminary tests done in the action A.1, designed the Frontal Tape application module.

As declared in the GA two different bonding patterns have been designed and tested:

- The first one was specifically designed for the application of the standard FT on the NW backsheet

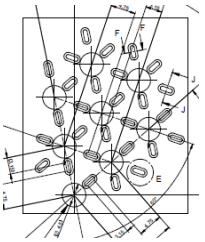


Figure 19 First bonding pattern design

The bonding area and the holes pattern were dimensioned in order to optimize the frontal tape patches management and the sealing process

- On the basis of the learning achieved with the first pattern validation, the second pattern was designed in order to perform both the standard FT application and loop FT

  More details about the design of this pattern are reported in the deliverable of this action annexed in the present final report ("Report on test for frontal tape application.docx").

Thanks to the learnings collected during the ADL validation, the technician from FAM did not faced big issues in the FT kit start up and final validation.

In the images below are reported the tables which resume the peel tests carried out for every product sample under the following constrains:

- 50 samples for every family of product considering, as peel reference value, the lowest between CD and MD peel;
- 9 kinds of raw materials used (8 FT and 1 NW backsheet);
- The combinations of raw materials not bondable have not been included into the lists;
- For each bonding pattern just one dimensional setup was included into the tables (FT length=40mm – NW backsheet length= 510mm).

The results shown in the table point out the pattern/RM combinations that best perform in the FT ultrasonic application process. The second pattern performed better than the first in terms of peel and shear resistance. For the second pattern there are no peel test results because it was no possible to pull and fix the patch on the Zuick measurement system (see method "Landing zone quality control.pdf" in the project folder).

Furthermore, the second pattern allowed to construct the "loop FT" achieving good performances in terms of dynamic shear (comparable to the standard FT).

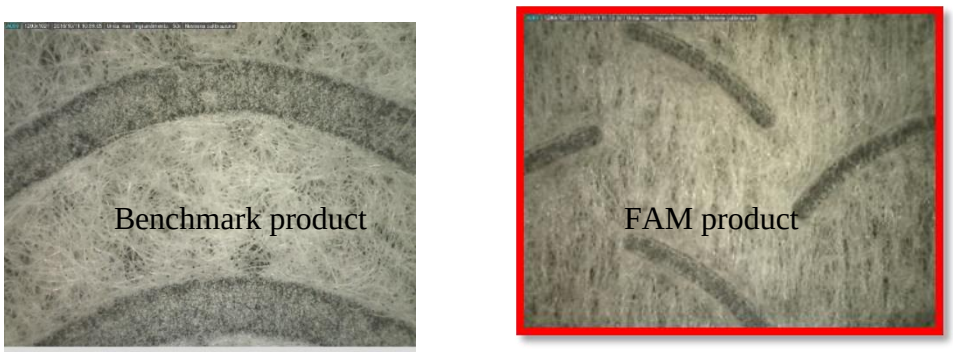


Figure 22 Banchmark product vs loop frontal tape

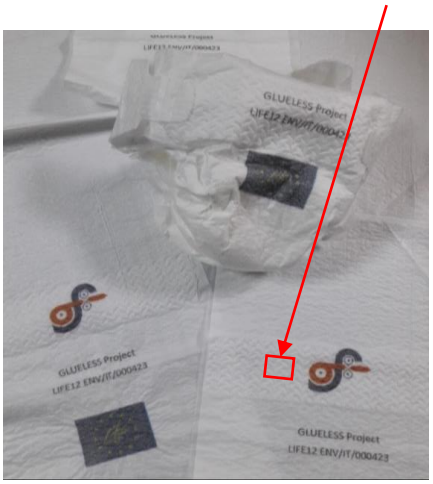


Figure 23 Loop frontal tape on glueless product

Moreover, a disaster check test was performed:

- 1 hour run (the machine was stopped just for the reels substitution); the configuration of test number 6 was taken as reference;
- The vision system checked the position, the dimensions and the product defects for every patch of product;
- 100 samples were randomly selected during the test in order to check the peel and shear force was higher than the target. FATER expert helped the R&D engineers from FAM to adapt and tailor the standard quality control method to the glueless FT application.

The disaster check test showed that no samples were out of the target in terms of peel force and product defects. In the table below the reject percentage detected with the vision system.

The Equipment and pilot line and the engineering specifications for the process have been defined and described in the deliverable “Optimized production process and equipment. Report for frontal tape application”. The performance test results description is reported in the deliverable “Report on test for frontal tape application”.

Furthermore, no components wear issues came up after 1-hour test. More process learnings are described in the deliverable annexed to the present final report.

Documents (Annexes):

- EP2636782A1-Aplix patent.pdf (annexes with the MTR);
- Landing zone quality control.pdf (annexes with the MTR);
- VeBe_OptVe_Kd_Anwendung_E_14_02_01(AGe).pdf: test results @ Herrmann (annexes with the MTR);
- Frontal Tape Peel Test.xlsx (annexes with the PR);

Milestones:

- Best solution for frontal tape application (deadline 01/01/2016) (achieved in M40).

Deliverables:

- Optimized production process and equipment. Report for frontal tape application (deadline 01/01/2016); completed in 21/10/2016 and annexed with the present FR;
- Report on test for frontal tape application (deadline 01/01/2016 completed in 21/10/2016 and annexed with the present FR;

Results:

The frontal tape glueless application development gave FAM the opportunity to face a technical issue never met in the past in the field of AHP market. The knowledge achieved in welding processes allowed FAM to adequately analyze raw materials and study the process equipment to handle, apply and weld pieces of FT on NW backsheet.

The product analysis also made it possible to develop and patent an innovative product design which allows to save raw material and customize the bonding shape according to customer requirements. From preliminary market analysis, the "loop FT" turns out to be one of the FAM’s product innovations most appreciated by customers for the reasons described above.

5.1.6 **ACTION B.5 – (front and back) ears Application**

START DATE / END DATE	Foreseen start date: December 2014 Actual start date: April 2014 Foreseen end date: December 2015 Actual end date: December 2015

The action B.5 started in M10 and ended in M30 as foreseen in the GA.

	Month	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Activity	Name of the activity	Sep 13	Oct 13	Nov 13	Dec 13	Jan 14	Feb 14	Mar 14	Apr 14	May 14	Jun 14	Jul 14	Aug 14	Sep 14	Oct 14	Nov 14	Dec 14	Jan 15	Feb 15	Mar 15	Apr 15	May 15	Jun 15	Jul 15	Aug 15	Sep 15	Oct 15	Nov 15	Dec 15	Jan 16	Feb 16	Mar 16	Apr 16	May 16	Jun 16
1	Test on 2285 machine																																		
2	Quality control																																		
3	Secondary bonding for ears reinforcement																																		
4	Quality control																																		

Figure 24 Action B.5 - Schedule

This action's aim is to identify the characteristics of the raw materials in order to guarantee perfect sealing of the ears (back and front) without the addition of glue as support.

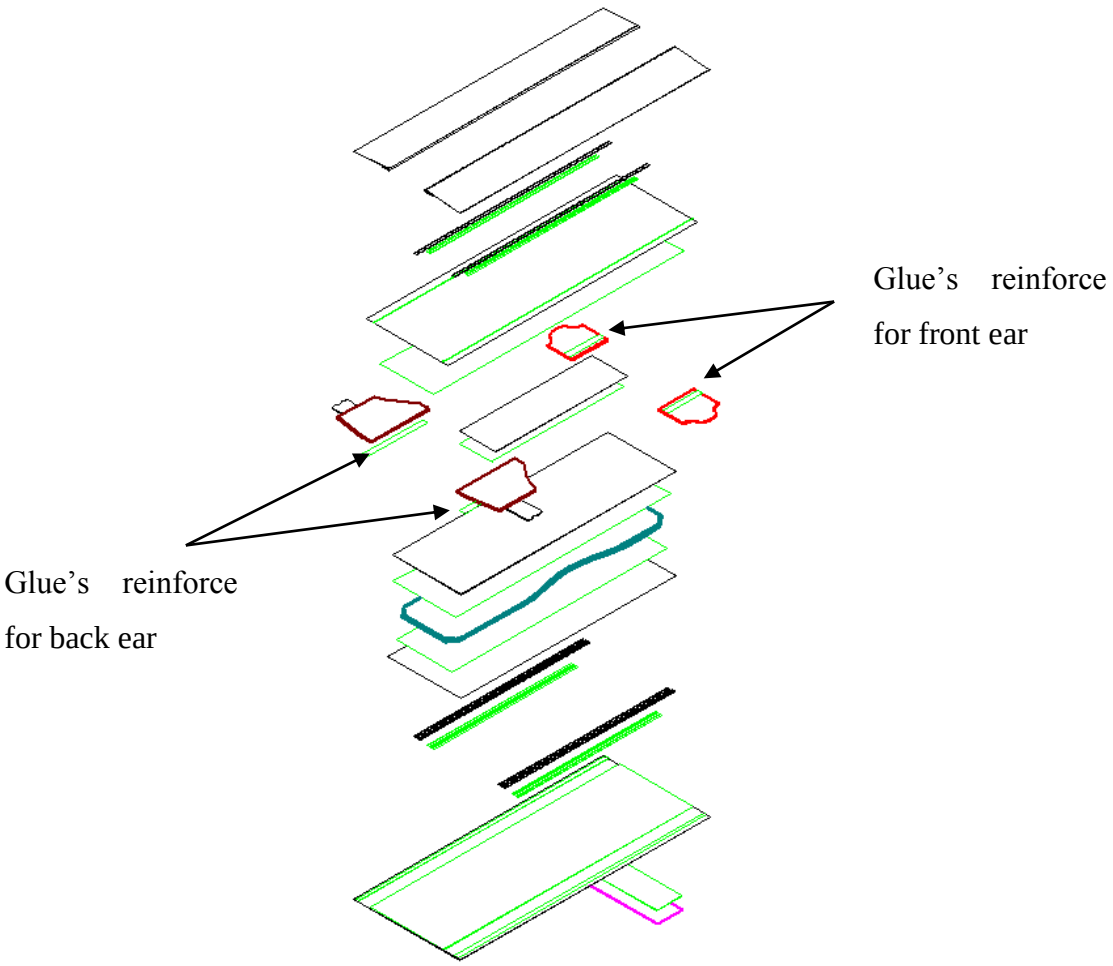


Figure 25 Glue application for ears

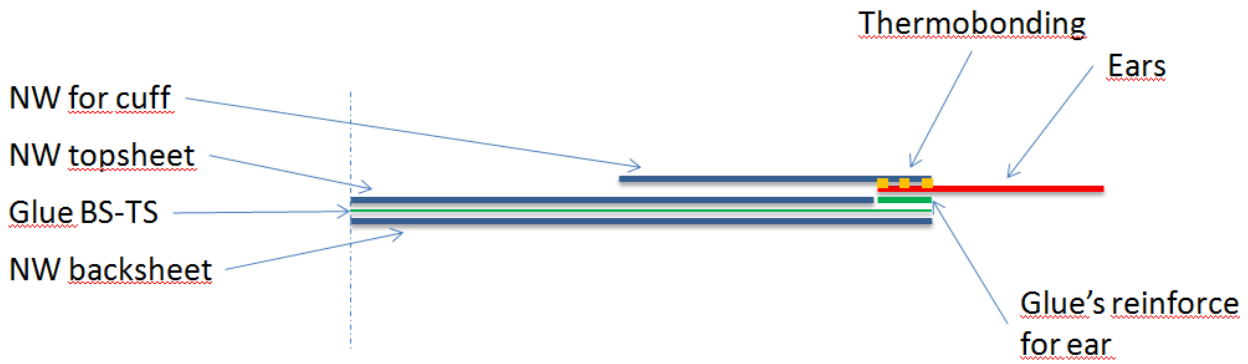


Figure 56 Product section for ears application

Considering the above product's section (some product's features have been hidden), the process sequence is:

- Ears are thermo bonded on the NW for cuff (already combined with NW Topsheet);
- Ears' glue reinforcement for ear is applied on the NW backsheet (intermittent glue application);
- Glue BS-TS is applied on the NW backsheet;
- Ears+NW for cuffs+NW topsheet are combined with NW backsheet.

The ears' glue reinforcement (20÷30 gsm) is used to make the attachment between the ears and the backsheet stronger.

In the test performed in M10 several raw materials (NW for cuff and ears) were tested eliminating or reducing the glue's reinforce for ears (annexed the layout which shows the locations on the machine where tests were performed; "Machine layout for ears test").

In the deliverable annexed to the progress report of the project ("Report on test for back and front ears application") the quality results are detailed (peel test made by an automatic machine - Zwick): two NW for cuff brands and two back ears brands were used. Furthermore the Glueless elastic raw material for ears was tested as third and preferred back ear option (called FAM's BE). These test were performed in collaboration with FATER using their standard criteria to test the resistance of the welding joints.

Considering that the minimum peel force for this product should be 20 N/inch, the combination FAM's BE and cuff 1 was the only one accepted as glueless application.

The R&D Engineers made several further tests (the results in the annexed "gluless log book (ear).pdf") in order to point out the sensible process variables:

- Glue reinforce
- Calander temperature
- Calander gap
- Glue TS-BS amount.

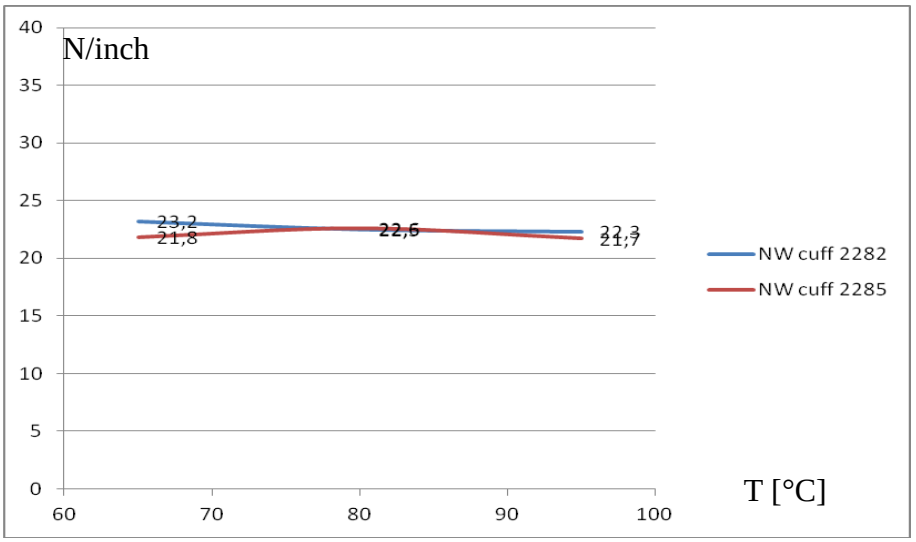


Figure 6 Peel test vs bonder temperature

The results showed that only one of the RMs combination allowed to reach the target performance declared in the GA. Looking at these results the R&D engineers of FAM understood that just the RMs combination would not be enough to cover the aim of the project. For this reason, they studied the possibility to reinforce the ears application using a secondary bonding pattern realized on the backsheet side of the diaper. Below two pictures which show the standard ears application (with glue) and the ears attachment reinforced with the secondary bonding pattern (without glue).

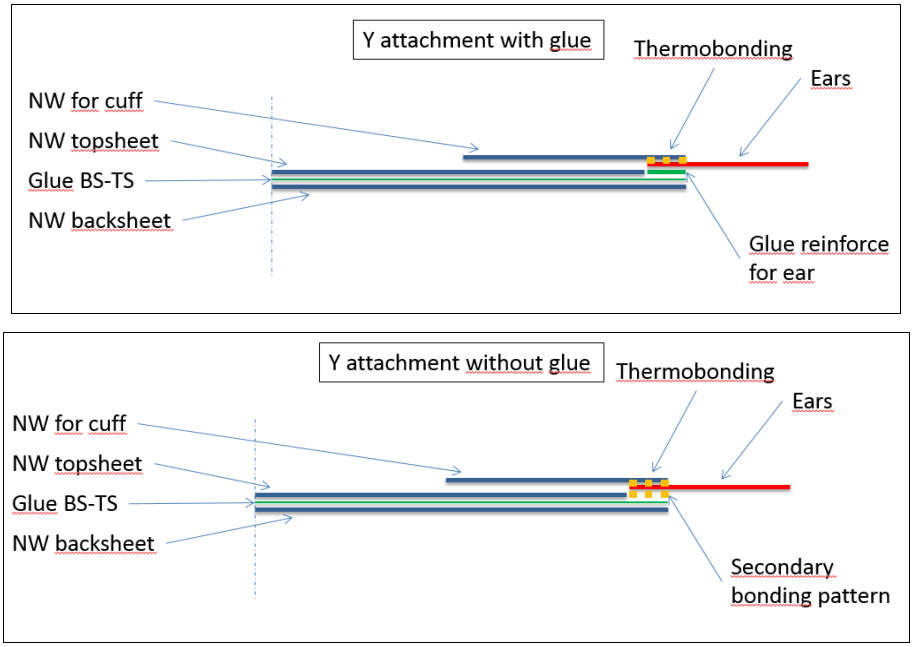


Figure 7 Y attachment: with glue vs without glue

This innovative solution was tested adding a secondary bonding stripe using the hand making test bench. The samples were prepared using the same RMs combination of the test performed on the machine. The quality control revealed that the Y attachment strength made without glue is as strong as the application with glue: in every test executed, the raw material collapsed before that the bonding joint was could be damaged.

Following the summary of the target achieved which matched the expected results:

- The equipment and pilot line design have been defined. In the deliverable "Optimized production process and equipment - Report for back and front ears application.pdf" the final layout and the integration of the equipment in a production line have been reported.
- Engineering specification for the overall ears application process: the pattern design and the reinforcement sealing position were optimized to achieve the best performances in terms of product strength.
- Performance test for each testing iteration has been performed: hybrid production (machine + hand-making), 5 raw materials (2 NW cuffs and 3 RMs for ears), 1 bonding pattern, 50 pieces of demo product were collected and tested (contraction).
- Validation method: side seal strength measured in cross direction > 20N/inch according to the FATER standard procedure.

The test results are annexed to this document ("Side seal cuff 1.xlsx" and "Side seal cuff 2.xlsx"). Attached also an example of the quality control document ("Example -Glueless_BE Strength_Test del 2015 12 15.pdf").

In view of the results achieved, the action B.5 was considered closed.

Documents (Annexes):

- gluless log book (ear).pdf (annexes with the MTR);
- Machine layout for ears test.pdf (annexes with the MTR);
- Side seal cuff 1.xlsx (annexes with the PR);
- Side seal cuff 2.xlsx(annexes with the PR);
- Example -Glueless_BE Strength_Test del 2015 12 15.pdf (annexes with the PR).

Milestones:

- Best solution for back and front ears application (deadline 01/01/2016) – achieved M30.

Deliverables:

- Optimized production process and equipment;

  Report for back and front ears application (deadline 01/01/2016); completed in 23/12/2016 and annexed with the PR;
- Report on test for back and front ears application (deadline 01/01/2016); completed in 23/12/2016 and annexed with the PR.

Results:

The ears glueless application was undoubtedly the development that took less technical effort in terms of analysis of materials and technologies. This doesn't mean that it can be considered less important than the other feature because of the importance that the ears have for the product functionality. The benefits of this improvement can also be found in the possibility to increase the machine performance because of the elimination of a phased application of glue (which becomes increasingly critical speeding up the machine).

5.1.7 ACTION B.6 – In-house testing out house testing and demo

START DATE / END DATE	Foreseen start date: October 2015 Actual start date: October 2015 Foreseen end date: June 2016 Actual end date: December 2016

The action B.6 started in M28 and it ended in M42 (six months after the deadline stated in the GA). The reason of the delay was that, in order to construct the complete demo diapers, all the product features were needed so the schedule of this action was affected by the postponement of the validation steps of the action B.3 and B.4. Furthermore FAM met some difficulties during the samples building in a semi-automatic way on the P7 and needed to change the technical approach during the action itself. Nevertheless the results achieved were perfectly in line with the expectation and what the Glueless consortium declared in the GA.

	Month	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Activity	Name of the activity	Jan 15	Feb 15	Mar 15	Apr 15	May 15	Jun 15	Jul 15	Aug 15	Sep 15	Oct 15	Nov 15	Dec 15	Jan 16	Feb 16	Mar 16	Apr 16	May 16	Jun 16	Jul 16	Ago 16	Sep 16	Oct 16	Nov 16	Dec 16
1	Analysis of the possible technical approaches																								
2	Product design																								
3	Raw material preparation for the product making																								
4	Product assembly																								
6	Quality control																								

Figure 30 Action B.6 - Schedule

The aim of this action was:

1. to realize in a "semi automatic process" the glueless demo diaper;
2. to test the demo diaper performances in a lab scale.

1. At first, the idea was to construct the product on a testing machine as follow:
   - NW topsheet + ADL (B.1) lamination in the test stand off-line: reels of premade raw material have been prepared using the glueless test stand on the basis of the product design: ADL length=250mm and pitch=488mm;
   - Absorbent Core (B.3) built in the test stand off-line;
   - Backsheet + FT (B.4) lamination in a test stand off-line: during the validation of the second pattern, reels of premade raw material will be made on the basis of the product design: FT length 40mm and pitch=488mm;
   - The elastic entrapment (B.2), the ears attachment (B.5) and the whole product construction (B.6) will be made on the machine; the elastic entrapment process has been integrated in the machine layout and it has been adapted to the process constrain. In the image below the layout.

The Glueless team scheduled one week for this activity on a P7 machine in M38. Despite the high number of iterations performed, to assembly the product in this way, it was not possible to unwind the

reels of ADL+ topsheet and absorbent core to feed the machine without damaging the product integrity. Samples made in this way would have been unusable for the final quality control foreseen. For this reason, in order to construct final demo diapers, the R&D engineers of FAM decided to build them in hand making. This technique is used by the key players of the AHP market (FATER included) to validate new product features before building the machine itself and this led FAM to change approach in order to achieve the results foreseen for this action.

Once designed the product template, FAM found the best external partner for the construction of the diaper needed for the test (200 samples were constructed).

Glueless handmade product					
Item	**Product feature**	**Raw material**	**Raw material code**	**Grammage**	**Unit**
1	Cuff	NW cuff	Fibertex H0101302	13	gsm
2	Cuff	Elastic yarn for cuff	Lycra HyFit	800	dtex
3	TS + AQL	NW topsheet	UNION	12	gsm
4	TS + AQL	AQL	Texus AB3350	50	gsm
5	Core	NW for core	Fitesa IC3EG 500	10	gsm
6	Core	Cellulose	WYF15H2702317	359	g/ml
7	Core	AGM	Evonik FAVOR SXM 9165BB		
8	FE	NW for FE	Fitesa IC3EW	10	gsm
9	BE	NW for BE	Fibertex COMFORT Hx0101300	24	gsm
10	BE	Elastic film for BE	ExtraFlex™ CEX-802	54	gsm
11	BS + LZ	NW BS	Fitesa IC3EW	13	gsm
12	BS + LZ	Poly BS	Poligof PA000NE180200000	18	gsm
13	BS + LZ	NW for LZ	Sandler SAWASOFT 2628	50	gsm
14	BS + LZ	Elastic yarn for leg	Lycra HyFit	800	dtex
	glue application(machine)		Enkel Disposmelt CS 22		
	glue application(hand-making)		3M 924 EU		

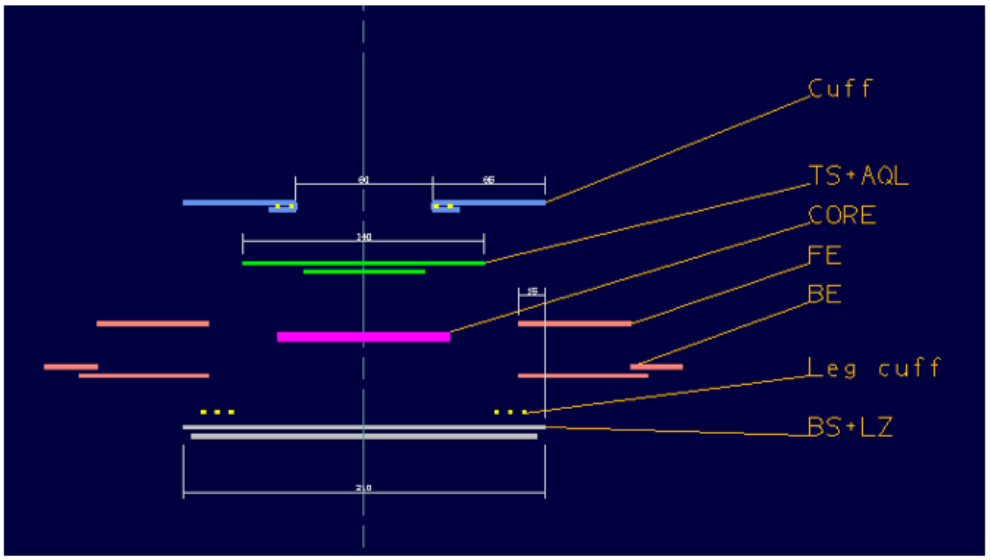


Figure 31 Hand made product raw material list

2. In this action FAM and FATER completed the whole product performance assessment started in the actions previously accomplished. Following a summary of the results:
    - In the actions B.1, B.2, B.3, B.4, B.5, FAM demonstrated the possibility to reduce the amount of glue in the diaper (66%) through tests which confirmed that it's possible to eliminate glue in 5 sub-products of the diaper. Furthermore, FAM and FATER performed technological tests which validated the performance of each Glueless feature

developed on the basis of the harmonized methods for the nonwovens and related industries.

- In the actions C.1 and C.2 UNIMAN, on the basis of the results and measurements carried out by FAM on the standard and Glueless processes, conducted environmental performance tests and demonstrated the possibility to achieve the 10% of energy reduction thanks to the glue savings.

The details of the whole analysis is reported in the reference actions description of the present final report and in the related deliverables.

The last assessment stage, performed in action B.6, was to validate the technological performances of the assembled product. This step was necessary to deeply analyze those aspects of the diaper which are evaluable just once it is completely construct:

- wearability;
- tapes attachment and detachment when the diaper is stressed by the final user;
- absorbent core breaking;
- product soling.

The differences between the trials test (made in actions from B.1 to B.5) and the consumer test (made in the present action) are:

- Trials are crucial to evaluate overall product performance. They are needed to weight the objective results obtained according to consumer expectations by lab testing. User trials should be the predominant tool in terms of product ranking based on product performance;
- Consumer tests should be used to complement the results of user trials and to evaluate specific product properties. Laboratory objective performance tests should be linked with the subjective evaluation of the product.

FATER planned the final quality control once the demo diaper was ready (M42). FATER's team decided to arrange a consumer test as final validation in order to improve the effectiveness of the results and to carry out useful feedback for the glueless product development. Furthermore, the glueless diaper performances were simultaneously compared with one of the best benchmark diaper (Pampers: same size and design) with the aim to compare numbers achieved in the same condition. The test was made using 50 demo diapers randomly selected.

Figure 32 Consumer test: Glueless product vs Pampers

The final results showed that the assembled Glueless diaper performs as well as the benchmark product so the glue reduction does not affect the whole performance under the users point of view. The detail of results are reported in the deliverable "Technical performance report of the final selected demo-diaper prototypes" and in the annex "Summary PPT#55 LIFE12ENVIT00423 – GLUELESS".

It is very important to notice that, even though the outcomes of this analysis are mostly qualitative, the consumer test is the most severe validation method used by the AHP producers proposed by EDANA because it simulates the most stressful and real conditions for a baby diaper without neglecting functionality aspects.

Following the list of the main results achieved in this action:

- Final demo-diaper realized: 200 products constructed for test and dissemination purpose;
- Technological tests performed on each Glueless feature (detailed result are reported in the reference actions B.1-5) and glue reduction target on the diaper achieved (66%);
- Environmental performance analysis done for the product construction process (detailed result are reported in the reference actions C.1 and C.2) and energy saving target achieved for the whole process ("cradle to gate" approach);
- Technical performance control on the final demo-diaper done: consumer test done to better evaluate the product performance in terms of fluid handling, wearability, and resistance under stress. The tests results demonstrated that the Glueless diaper performances are comparable to the best benchmark diaper.

The details of the results above listed are reported in the deliverables "Technical performance report of the final selected demo-diaper prototypes" (B.6) and in the annex "Summary PPT#55 LIFE12ENVIT00423 – GLUELESS".

Milestones:

- Final demo diaper (deadline 01/07/2016) – achieved in M41.

Deliverables:

- Technical performance report of the final selected demo-diaper prototypes (deadline 01/07/2016) - completed on 23/12/2016 and annexed with the present FR;

Annexes:

- Summary PPT#55 LIFE12ENVIT00423 – GLUELESS
- Glueless_Raw_material_list
- Example of questionnaire according to the EDANA method.

Results:

FAM has collected over the years a lot of experience in the construction of machines starting from product specifications given by the customers who run privately performance tests. For this reason, the construction of hand-made products and consumer tests have been activities entirely new even for the R&D team within the glueless project development. Nevertheless, finding the right partners for the construction of the product and using the knowledge and methodologies offered by FATER for the quality control of the diapers, this action was completed reaching completely the results foreseen. The difficulty encountered in the construction of the product in a "semi-automatic way" was an unforeseen technical limitation difficult to predict which, in any case, did not have impact in the achievement of the final result. It is also important to note that the construction of the product in hand-making has allowed the realization of appropriately designed samples for future activities of dissemination.

5.1.8 **ACTION C.1 – Life Cycle Analysis (LCA)**

START DATE / END DATE	Foreseen start date: November 2014 Actual start date: November 2014 Foreseen end date: June 2016 Actual end date: September 2016

Activity	Name of the activity	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16
1	Literature review (scientific papers, industry reports, materials technical sheets, EU datasets and web resources)																										
2	Definition of the LCA goal and scope (system boundaries, definition of analytical scenarios, sensitivity assessment)																										
3	Life cycle inventory analysis (data collection, visit to FAM premises, data validation, analysis of ecoinvent and GaBi unit processes)																										
4	Life cycle impact assessment (LCA modelling using GaBi and CCaLC software, electricity mix upgrading, calculation of glueless savings at different levels and market penetration)																										
5	Interpretation of the results (critical analysis and comparison to relevant LCA studies to validate the representativeness of the ouctomes, paper writting)																										

Figure 33 Action C.1 - Schedule

This action started in November 2014 and finished in September 2016. The LCA study was carried out according to the guidelines provided by the ISO 14040/44 standards for LCA (2006a; 2006b). The following activities related to LCA were carried out and completed successfully:

1) literature review;

2) definition of the goal and scope of the LCA;

3) life cycle inventory analysis;

4) life cycle impact assessment; and

5) interpretation of results.

The following gives an overview of each of the above activities.

1) An extensive literature review was carried out to get an overview of the standard production chain of disposable diapers, including the identification and analysis of relevant LCA studies. The literature review helped with the background data collection in the next step.

2) Definition of the goal and scope of the study: The goal of the study was to evaluate life cycle environmental impacts of the Glueless processes being developed as part of the project and compare them to the standard processes. The scope of the study was from 'cradle to grave' (see Figure 34). The

functional unit (unit of analysis) was defined as the manufacture of 1,000 disposable (single-use) baby diapers.

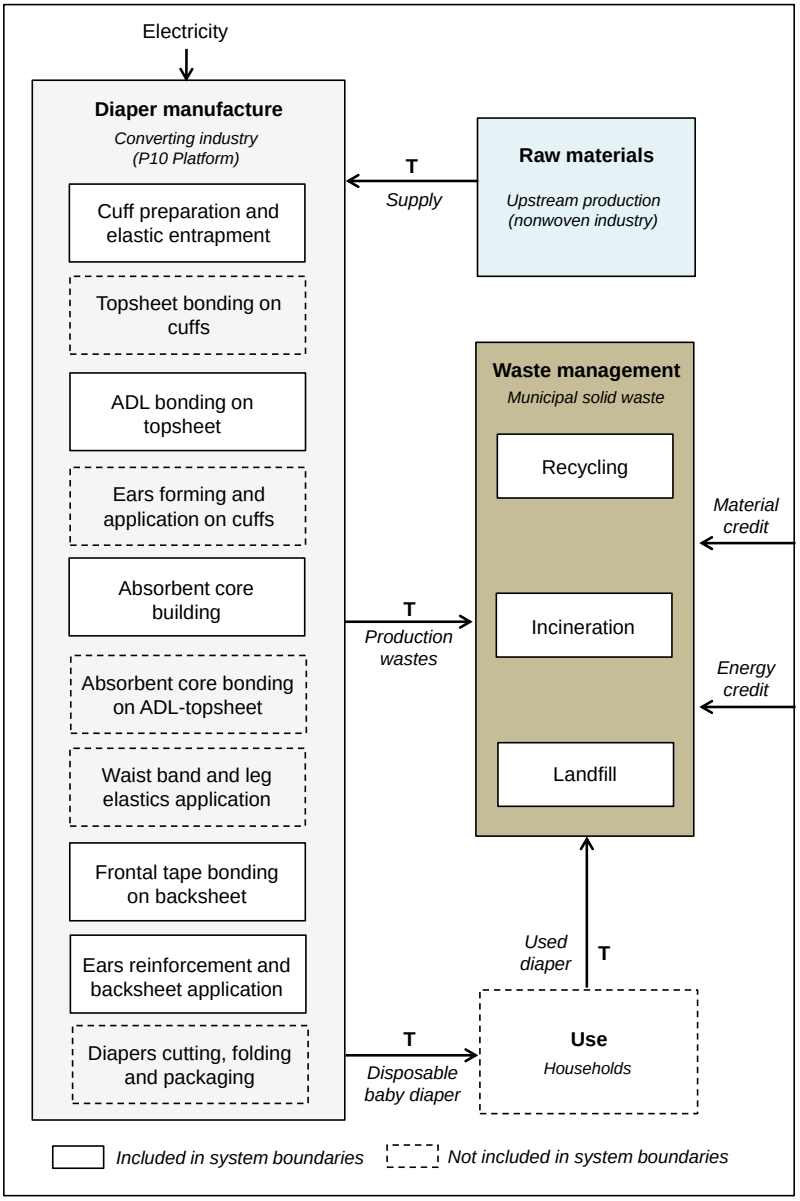


Figure 34 System boundaries for the LCA study

3) Life cycle inventory analysis: A data collection procedure and template were developed to quantify relevant inputs and outputs related to the different unit processes and the life-cycle stages of standard and glueless disposable baby diapers. The life cycle stages for which the data were collected include the raw materials, diaper manufacture, transport and waste management. However, only the unit processes (and the related diaper parts) where glue bonding can be substituted by alternative bonding were considered as part of the system boundaries.

The data related to the diaper manufacturing were provided by FAM. A visit to FAM premises in September 2015 allowed the researchers to get additional knowledge of the whole manufacturing chain related to standard and glueless diapers and to collect further information and LCI data that

would be used later to validate the representativeness and consistency of the results. Data related to the transport requirements and waste management from gate-to-grave were collected from the scientific literature. The latter literature included relevant LCA studies on disposable baby diapers, which were mostly focused on comparing disposable and reusable baby diapers, analyzing the environmental benefits of using bio-materials and synthetic components for diaper manufacturing, or evaluating changes in the environmental performance of the products by encouraging sustainable waste management of used diapers, such as composting or recycling. Further data were collected from industrial reports (corporate social responsibility reports from Proctor and Gamble, Kimberly-Clark or Ontex) as well as the reports published by the Joint Research Centre of the European Commission (eco-labelling of AHPs), EUROSTAT (waste management) and EDANA (i.e. sustainability reports). The composition of some raw materials used in diaper manufacturing was determined by analysing material technical and risk assessment sheets. LCA databases, such as Ecoinvent (SCLCI 2010) and GaBi (Thinkstep 2016) were systematically reviewed to identify relevant background information.

4) Life cycle impact assessment (LCIA): The LCA modelling was carried out in GaBi v7.2 (Thinkstep 2016). Two key environmental impacts were considered: global warming potential (GWP) and primary energy demand (PED). As GaBi is a proprietary software and not available in the public domain, the systems under study was also modelled in the free-of-charge CCaLC tool (CCaLC 2016) to aid dissemination of the project outputs, thus increasing the impact.

The annual environmental savings in the GWP and PED from the glueless manufacturing of disposable baby diapers were calculated at different levels: P10 production platform, a diaper manufacturing plant, Italy and the EU, by using appropriate production volumes, electricity mixes and waste management options.

5) Interpretation of the results: A summary of the most relevant LCA findings are highlighted below:

- Glueless diaper manufacturing reduces material requirements by 23% (by 9.2 kg/1,000 diapers), which also reduces the equivalent amount of waste from disposal of diapers. Consequently, the GWP and PED of glueless diapers are respectively 10.4% (9.5 kg of CO_2 eq./1,000 diapers) and 24.8% (752.3 MJ/1,000 diapers) lower than the GWP and PED of the standard products.
- The annual manufacture of diapers using a single P10 glueless platform reduces material requirements and waste generation by up to 2.1 kt, and avoids the emission of 2.1 kt of CO_2 eq. and the primary energy consumption of 169 TJ.
- Glueless innovations implemented at the level of the absorbent core building determine over 95% of material and PED savings and 89% of GWP savings.
- The extrapolation of the results at the local and regional levels indicate that the manufacture of glueless diapers in Italy (1.8 billion diapers/year) can save 16.6 kt of materials, 17.1 kt of CO_2 eq. and 1.3 PJ of primary energy per year. The equivalent savings at the EU level (20.8 billion diapers/year) are 192 kt of materials, 184 kt of CO_2 eq. and 16 PJ of primary energy. The annual GWP savings at the EU level are equivalent the annual GHG emissions of the Falkland Islands (Malvinas), whereas the PED savings would be equivalent to satisfy 87% of the annual

electricity production in Italy currently generated from biomass (ENTSO-E 2015). In other words, GWP savings could compensate the annual greenhouse gas emissions of 92,257 households in the EU, whereas PED savings would compensate the annual final energy consumption of 269,665 EU households. The material savings are equivalent to avoiding the annual generation of municipal solid waste by approximately 405,000 people. Focusing on the resource and environmental savings at the EU level associated with glue removal alone, glueless innovations can contribute to save up to 13.5 kt of glue, 6.7 GWh, 55.5 kt of CO_2 eq. and 1.4 PJ of primary energy consumption.

- The LCA findings have demonstrated that the glueless manufacture of disposable baby diapers can contribute to significant resource and environmental savings, which have exceeded the project expectations. Thus, the implementation of glueless technology can actively contribute to meeting the energy and resource efficiency goals defined by the EU2020 strategy (EC 2010; EC 2011) through the improvements in the material and energy efficiency and the related minimisation of GHG emissions.

Following the summary of the target achieved which matched the expected results:

- The LCI data related to glueless diapers has demonstrated that FAM glueless innovations contributed to reduce glue consumption by 66% (more than 65% foreseen in the proposal). The absolute amount of glue saved strictly depends on the glue-content of diapers.
- The LCI data related to glueless diapers has demonstrated that FAM glueless innovations contributed to reduce annual manufacturing energy consumption by 10% and this is perfectly in line with the expectation foreseen in the GA.
- The LCA results indicate that the total life cycle greenhouse gas savings related to FAM innovations are equivalent to 2.1 kt of CO2 eq. per production facility (225 million diapers/year). Considering the CO2 savings related to glue removal-only it would be equivalent to 0.61 kt/y that is anyway higher than the amount estimated in the action description (200 ton/yr).

Deliverables:

- Environmental performance report of the novel product (deadline 01/07/2016) (done in 16/09/2016).

Annexes

- Environmental performance report of the novel product-appendix.

5.1.9 **ACTION C.2 – Socio-economic impact assessment**

START DATE / END DATE	Foreseen start date: January 2016 Actual start date: January 2016 Foreseen end date: June 2016 Actual end date: December 2016

	Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Activity	Name of the activity	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16
1	Literature review (scientific papers, industry reports, materials technical sheets, EU datasets and web resources)																										
2	Definition of the LCA goal and scope (system boundaries, definition of analytical scenarios)																										
3	Life cycle inventory analysis (data collection and data validation)																										
4	Life cycle cost analysis (modelling and calculation of glueless cost savings at different industrial levels)																										
5	Interpretation of the results (critical analysis to validate the ouctomes)																										

Figure 35 Action C.2 - Schedule

A cradle-to-grave life cycle cost analysis (LCC) of standard and glueless disposable baby diapers was carried out as part of this action, following the same step-by-step process described above for the LCA study:

- The same goal and scope, functional unit and the system boundaries were considered.
- The cost data were collected for the raw materials and their packaging and transport and diaper manufacturing (including labor, maintenance and energy costs). The cost data for the raw materials and manufacturing were provided by FAM. The costs of the manufacturing equipment were confidential were thus not included in the LCC analysis. The costs related to the transportation of wastes and waste management (including incineration, landfilling and recycling) were sourced from scientific literature, industrial reports and websites and allocated properly to each unit process (or diaper part) based on mass contribution to the total weight of the diapers.
- The LCC modelling was performed in the CCaLC tool in order to make the results available for the public domain. In addition to the costs, value added analysis was also performed
- Finally, the potential cost savings at the product, average production facility and at the EU28 level were calculated to validate the cost savings goal of the project.

A summary of the most relevant LCC findings is given below:

- The cost per 1000 standard diapers is equivalent to €99.95, whereas the LCC of the manufacture of 1,000 glueless disposable diapers are equivalent to €89.5. Thus, glueless diaper manufacturing can save €10.5/1,000 diapers compared to the standard production process. The raw materials account for over 90% of the LCC of disposable baby diapers. Thus, raw materials are not only the most environmentally-relevant hotspots but also the costly industrial requirements. As a result, the costs related to the stages of diaper manufacturing, transport operations and waste management are almost negligible (≤3% each).

- The LCC indicate therefore that the economic savings related to glueless diapers are mostly determined by the higher resource efficiency of the products. The analysis also suggests that if glueless technology is widely implemented in Europe, it would bring multiple economic benefits for the AHP sector and the diaper industry, both in terms of industrial cost reduction and business competitiveness. At the level of a single production facility, the estimated annual economic savings correspond to €2.4 million that could rise to €7.1 million per average production facility. The full implementation of glueless diaper technology in Italy would provide €18.8 million savings, whereas cost savings at the level of the EU28 might be equivalent to €218.3 million.
- Annual cost savings related to glue removal alone through the manufacturing of glueless diapers are equivalent to €486,000 per production facility. Manufacturing energy savings related to glueless diaper production are equivalent to €76,000 per production facility. Consequently, annual cost savings due to glue removal and lower manufacturing energy consumption sum **€562,000 per production facility**.

Furthermore several questionnaires were provided to AHP producers in order to collect useful feedbacks about the Glueless features appeal under the market point of view. The details are described in the dissemination action paragraph (5.2) and in the annex section (Questionnaire).

Deliverables:

- Market analysis and LCC report (deadline 01/07/2016) - done 16/09/2016.

5.2 Dissemination actions

5.2.1 **Objectives**

The objective is to showcase to the wide Absorbent Hygiene Products (AHP) production sector the importance of eco-compatible innovations for reducing petrochemical based glue and the possibility to have concurrent positive improvements in terms of technological, environmental and cost-effective results.

Moreover, Fameccanica will stimulate a wide audience, such as the scientific community and European industrial stakeholders from different sectors of the AHP production industry, in order to provide tangible outstanding available results by the GLUELESS project.

5.2.2 **Dissemination: overview per activity**

START DATE / END DATE	Foreseen start date: July 2013 Actual start date: July 2013 Foreseen end date: June 2016 Actual end date: December 2016

5.2.2.1 NOTICE BOARDS

- Fameccanica has displayed during the project life different version of the notice boards that have been displayed during during the exhibitions and conferences, one (#1) at the beginning of the project, one ("totem fiera") at the IDEA14 exhibition, plus one (#2) updated version at the beginning of 2015, IDEA16 Exhibition in Boston (May 2016) and the last version updated with the project results during the Final Conference (November 2016) – Annex to the present report Notice board 3.pdf.

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Notice board #1 *Notice board "totem fiera"* *Notice board #2* *Notice board #3*

Figure 36 Notice boards

Notice boards have been displayed in the key areas of the FAM company, like main entrance, R&D Labs, Technical Department entrance, etc. as well as at Partners premises.

R&D Lab1

Main entrance

R&D Lab3

R&D Lab2

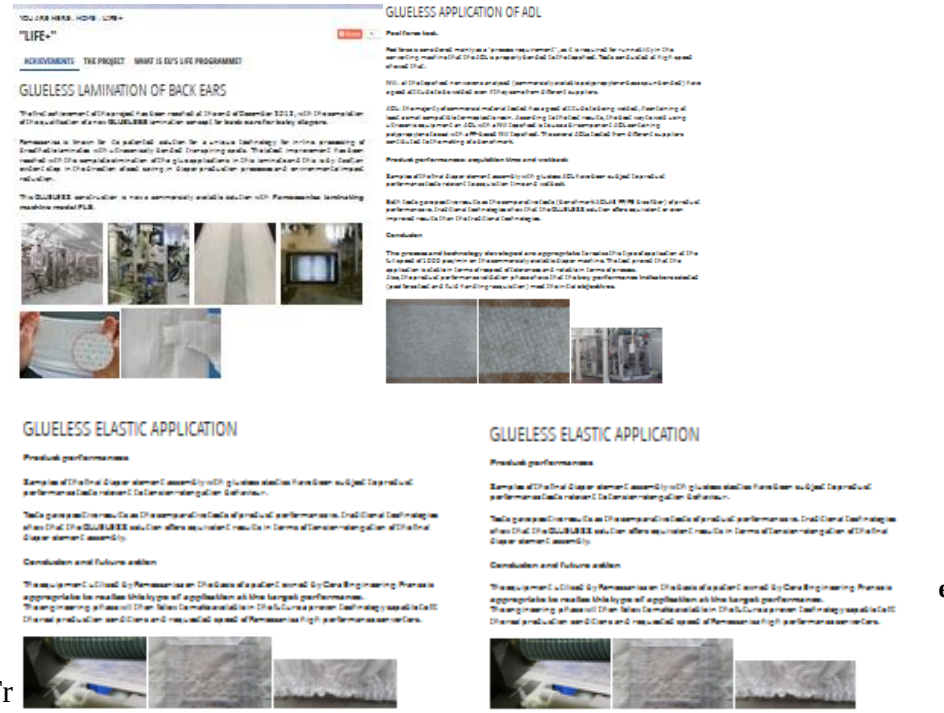
Tech. Dept. Entrance

Mr. Francesco D'Aponte, Ms. Adisa Azapagic, Ms. Simona Andreea Popa, Mr. Valerio Valenti, Mr. Diego Gualieri during the kick-off event at University of Manchester on December 10th, 2014

Figure 37 Notice boards displayed

5.2.2.2 WEBSITE

The Fameccanica Life+ website, from November 2013 to November 2016, had the following graphic structure:



Fr **e** user-friendly, with a more appealing visual. Here are some images of the new Glueless website:

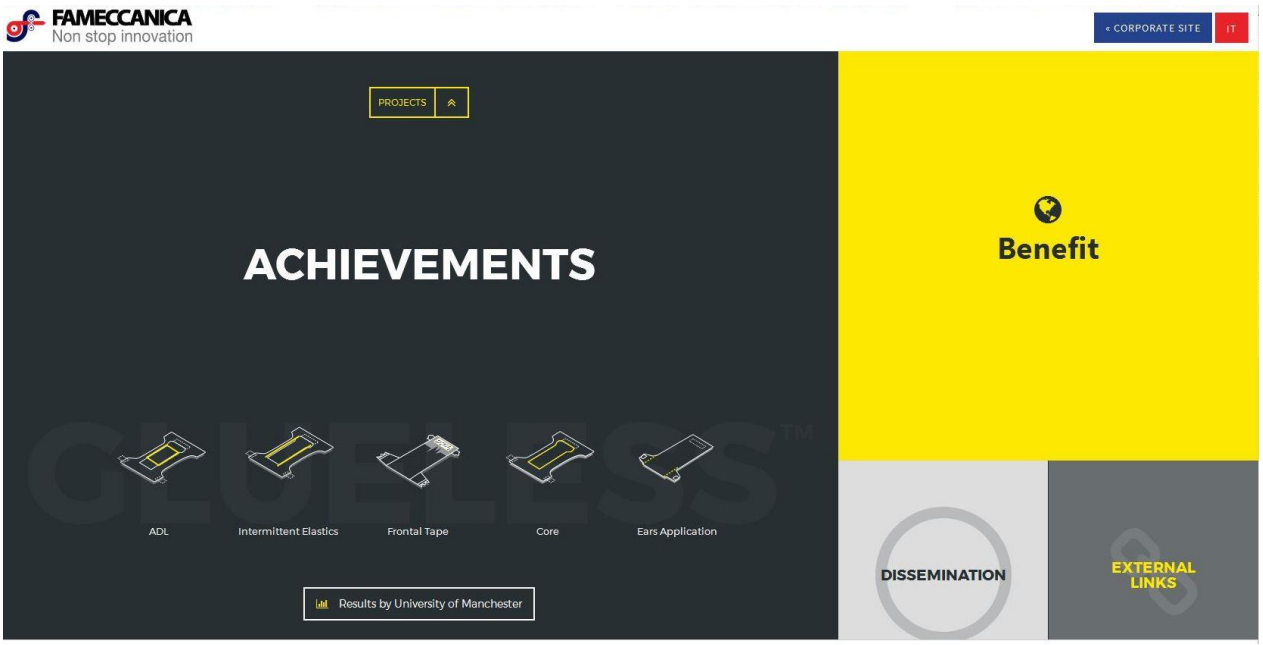


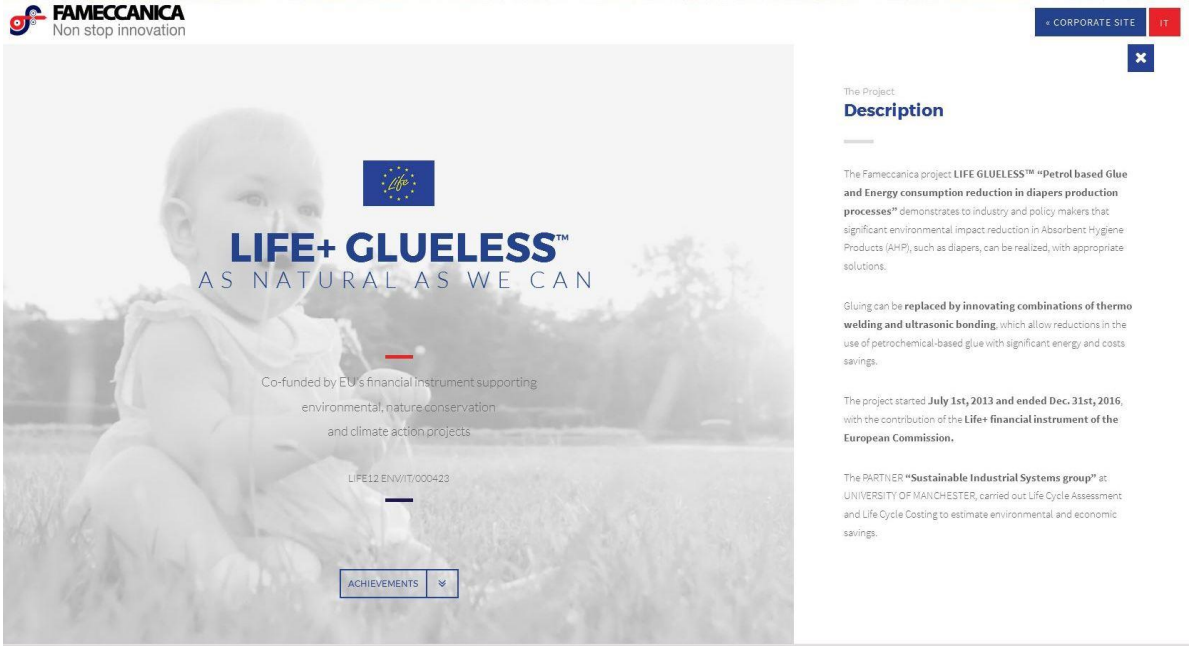
Figure 38 Glueless website new graphic structure

The website has the aim to make available a selection of key information to the audience and demonstrate the process steps already achieved.

The website is periodically updated and includes links to the newsletters, key events, and networking.

It has been also modified in accordance to the indications received, as examples:

- It now shows the complete title of the project on the most visible area in the home page
- It now shows the "Achievements" on the home page



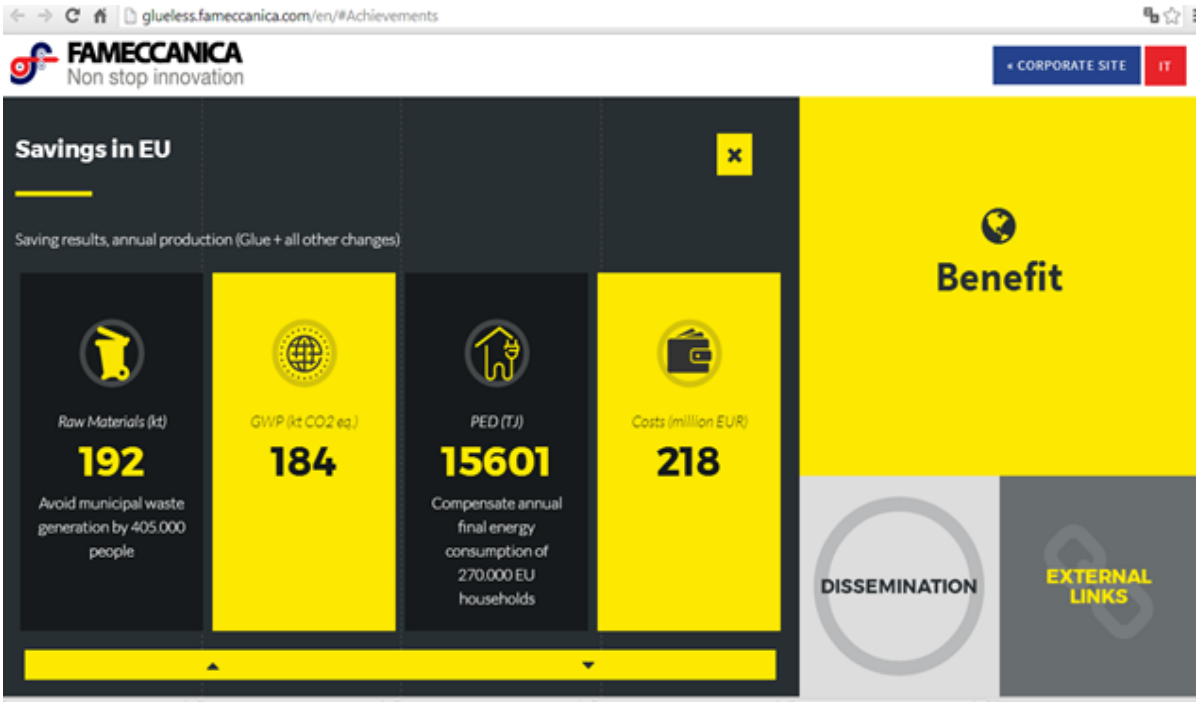


Figure 39 Glueless new website

During the project life, the website has received more than 1.661 accesses from outside the company, vs. the initial target of 200 in the 1st year, 300 in the 2nd year and 500 in the 3rd year.

The project is visible at the following address, inside the Fameccanica Corporate website: glueless.fameccanica.com/en

In addition, the project is visible through the website of the University of Manchester, as follows: http://www.sustainable-systems.org.uk/project.php?item=30

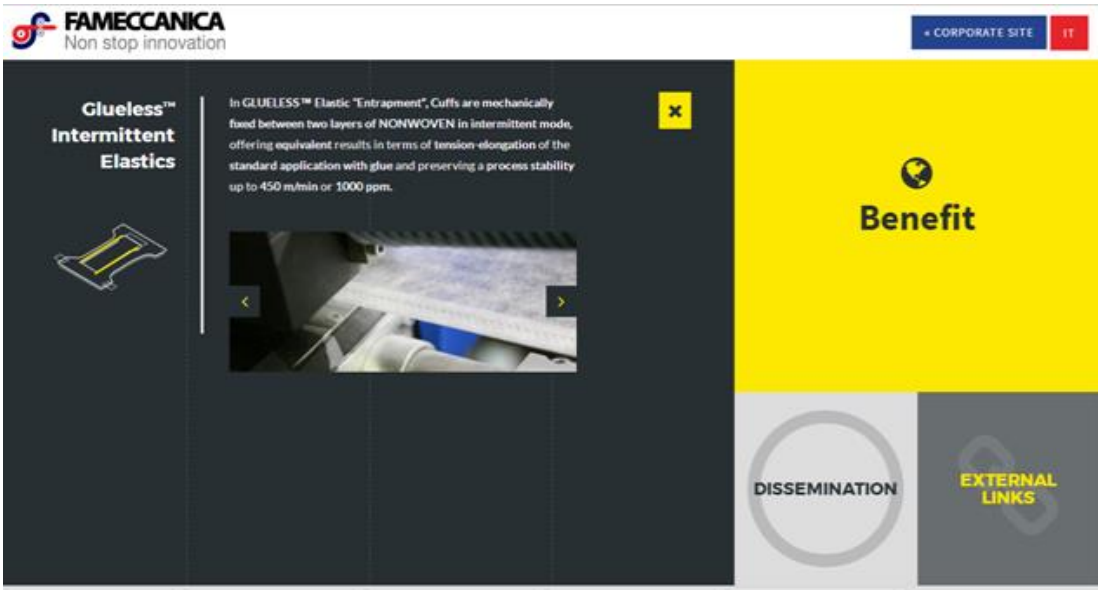
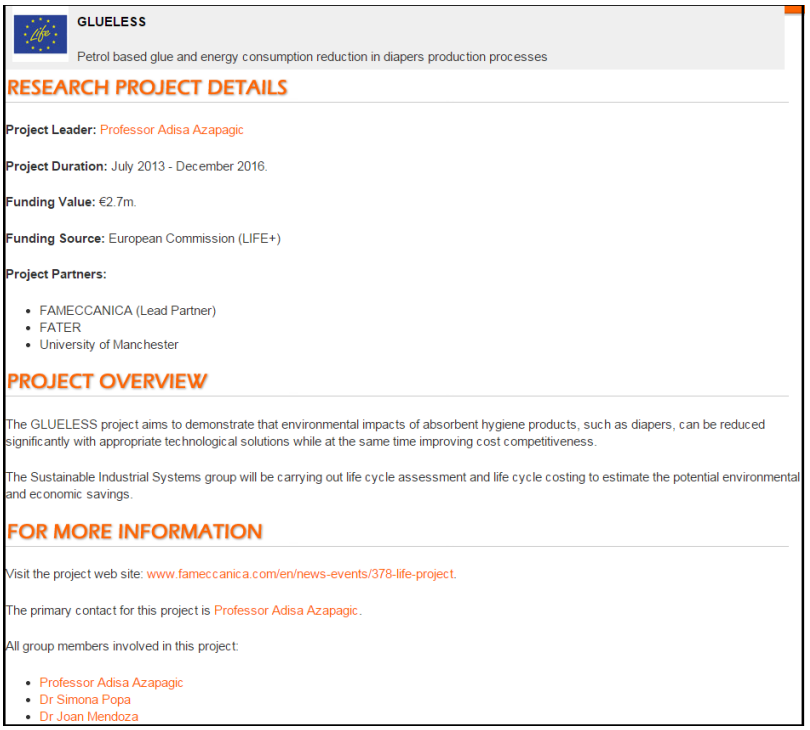


Figure 40 Glueless new website – elastic application page

*UNIMAN*The Glueless LIFE+ project is also visible through the UNIMAN website: http://www.sustainable-systems.org.uk/project.php?item=30.



GLUELESS

Petrol based glue and energy consumption reduction in diapers production processes

RESEARCH PROJECT DETAILS

Project Leader: Professor Adisa Azapagic

Project Duration: July 2013 - December 2016.

Funding Value: €2.7m.

Funding Source: European Commission (LIFE+)

Project Partners:

- FAMECCANICA (Lead Partner)
- FATER
- University of Manchester

PROJECT OVERVIEW

The GLUELESS project aims to demonstrate that environmental impacts of absorbent hygiene products, such as diapers, can be reduced significantly with appropriate technological solutions while at the same time improving cost competitiveness.

The Sustainable Industrial Systems group will be carrying out life cycle assessment and life cycle costing to estimate the potential environmental and economic savings.

FOR MORE INFORMATION

Visit the project web site: www.fameccanica.com/en/news-events/378-life-project.

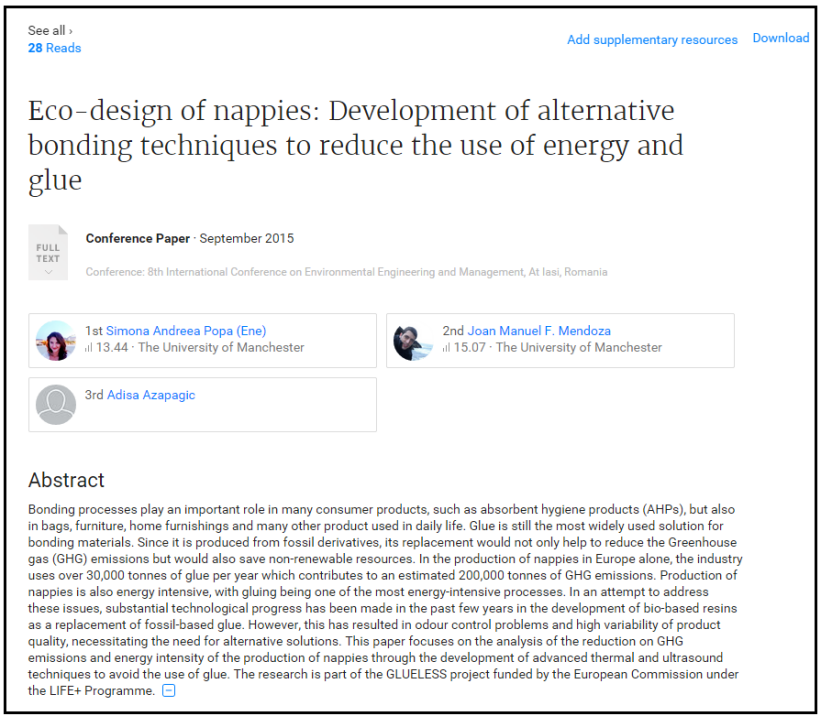
The primary contact for this project is Professor Adisa Azapagic.

All group members involved in this project:

- Professor Adisa Azapagic
- Dr Simona Popa
- Dr Joan Mendoza

Figure 41 Glueless on UNIMAN website

Additionally, the project was also disseminated in ResearchGate through the conference paper presented in the 8th International Conference on Environmental Engineering and Management in Iasi, Romania.



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28 Reads

Add supplementary resources Download

Eco-design of nappies: Development of alternative bonding techniques to reduce the use of energy and glue

FULL TEXT

Conference Paper · September 2015

Conference: 8th International Conference on Environmental Engineering and Management, At Iasi, Romania

1st Simona Andreea Popa (Ene)
13.44 · The University of Manchester

2nd Joan Manuel F. Mendoza
15.07 · The University of Manchester

3rd Adisa Azapagic

Abstract

Bonding processes play an important role in many consumer products, such as absorbent hygiene products (AHPs), but also in bags, furniture, home furnishings and many other product used in daily life. Glue is still the most widely used solution for bonding materials. Since it is produced from fossil derivatives, its replacement would not only help to reduce the Greenhouse gas (GHG) emissions but would also save non-renewable resources. In the production of nappies in Europe alone, the industry uses over 30,000 tonnes of glue per year which contributes to an estimated 200,000 tonnes of GHG emissions. Production of nappies is also energy intensive, with gluing being one of the most energy-intensive processes. In an attempt to address these issues, substantial technological progress has been made in the past few years in the development of bio-based resins as a replacement of fossil-based glue. However, this has resulted in odour control problems and high variability of product quality, necessitating the need for alternative solutions. This paper focuses on the analysis of the reduction on GHG emissions and energy intensity of the production of nappies through the development of advanced thermal and ultrasound techniques to avoid the use of glue. The research is part of the GLUELESS project funded by the European Commission under the LIFE+ Programme.

Figure 42 Glueless on research gate

The results of LCA and LCC will also be disseminated through scientific papers to be submitted to international peer-reviewed journals. Consequently, they will be available to academics, the industry and the general public through the Science Direct, SCOPUS, Web of Knowledge portals, including LinkedIn and ResearchGate.

Furthermore, the results are also disseminated through the CCaLC model available in the public domain.

5.2.2.3 NEWSLETTER

Fameccanica has issued Project newsletters every three months and made available in electronic format on the website and in printed version to the Fameccanica management people with internal mailboxes.

In addition, the newsletters have been distributed in printed version in the main reception of Fameccanica, as well as in the entrance of the Technical Department building, with visibility and possibility to get printed copies to all visitors, like Customers, Suppliers and external contractors.

All the newsletter issues available are visible on the website and they are attached to the present document.

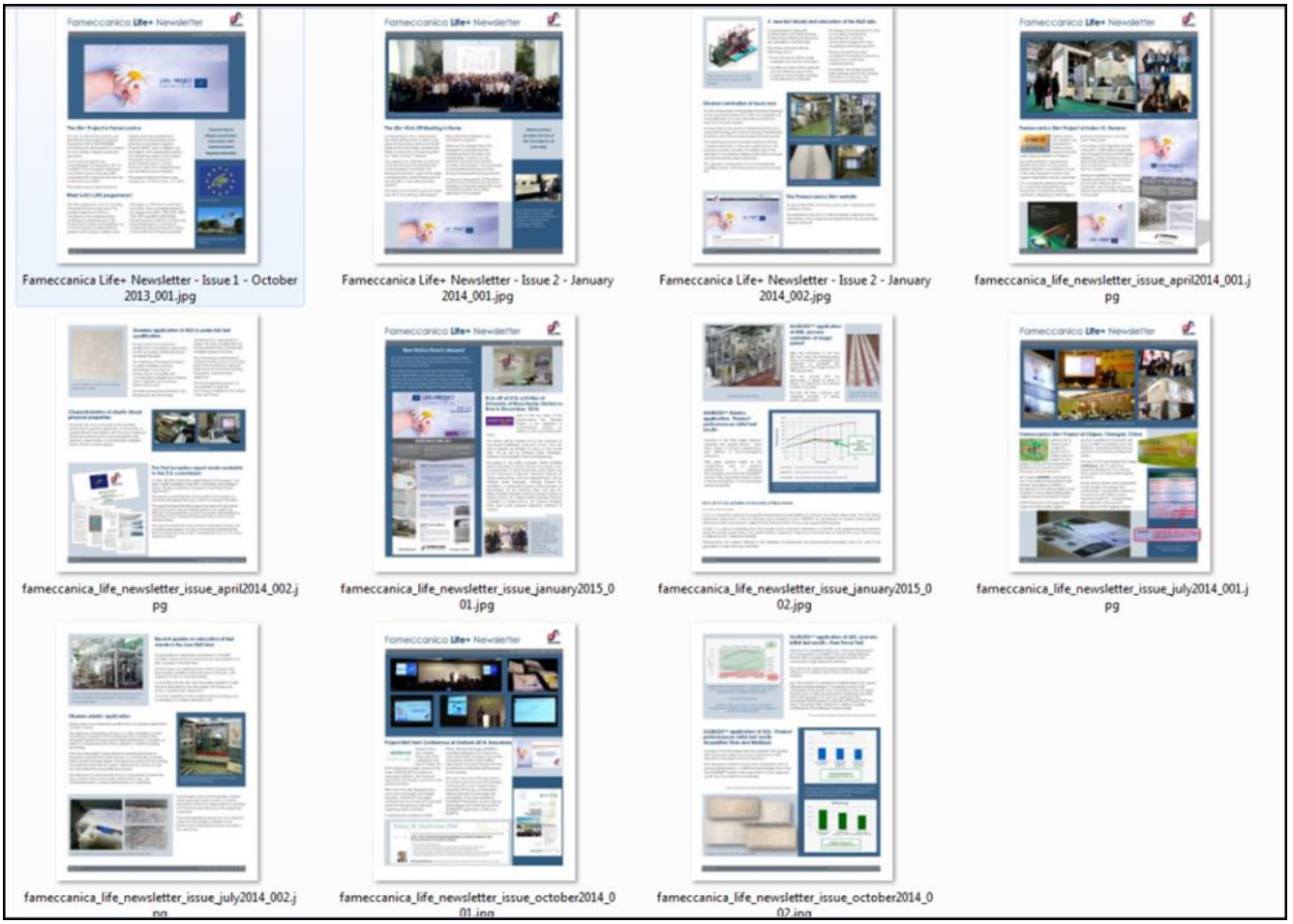


Figure 43 Glueless newsletters

5.2.2.4 CONFERENCES AND EXHIBITIONS: general information

Fameccanica took benefit from conferences / events / exhibitions communication channels already in use in the Absorbent Hygiene products industry within Europe territories and globally in all other world regions. It is a matter of fact in the industry and a result of a long-term experience in the

industry that a possible "in-house" happening, like a conference held inside Fameccanica facilities, would turn in a low-affluence event. It is quite common in the industry that AHP producers tend to be present to as many as possible events all-over the world among the key-ones described below, with the aim to understand trends/innovations/opportunities being developed worldwide.

Today, Fameccanica and, in general, the AHP industry can benefit of the contribution of the following organizations for conference, exhibition, networking and other tools for the industry:

EDANA:

acronym of European Disposables and Nonwovens Association, it is an international association serving the nonwovens and related industries, based in Brussels, Belgium. EDANA is the organizer of exhibition "INDEX" held every three years in Geneva and of the conference "OUTLOOK" held every year in a different European city. It is very active in supporting Sustaibility actions.

More details at: http://www.edana.org/ and http://www.index14.ch/en/

INDA:

it is an american Association of the Nonwoven Fabrics Industry, based in un North Carolina, USA. INDA is the organizer of exhibition "IDEA" held every three years in Miami, USA and of the conference "Insight+Vision" held every year in a different city in USA. In the past Insight and Vision were separate conferences; now they merged into a unique event.

More details at: http://www.inda.org and http://www.inda.org/idea13/

CNHPIA:

acronym of China National Household Paper Industry Association, it is very active in China, one of the largest AHP manufacturing countries. CNHPIA is the organizer of CIDPEX exhibition and conference event (China International Disposable Paper Expo) held every year in a different city in PRC.

More details at: http://www.cnhpia.org/en/ and http://www.cnhpia.org/en/conference.htm

5.2.2.5 CONFERENCES AND EXHIBITIONS: events overview

During the project life, Fameccanica participated in the events as follows:

1. Index14 exhibition in Geneva, April 8-11, 2014.

The Index exhibition, organized by EDANA association of nonwovens-related industries, is considered as one of the most important events in the hygiene disposable industry worldwide.

It is a recognized global meeting point for companies representing the nonwovens and related industries worldwide, displaying a wide range of products and services, and is held every three years.

According to the organizer, this year, more than 12,500 visitors made their way through the doors of the Palexpo exhibition centre in Geneva, keen to see the 586 exhibitors (an increase of 10% on the previous edition in 2011), from 41 countries.

During the exhibition, Fameccanica introduced its Life+ Project through one-to-one meetings with its Customers, and through visual totem display stands and leaflets distributed to the public.

Fameccanica booth at Index 14 and Life+ Project display stand

2. CIDPEX14 exhibition and conference in Chengdu, China, May 14-16, 2014.

On May 14-16, Fameccanica caught the opportunity of Cidpex event to present its Life+ project in China at the International Exhibition & Convention Center, in Chengdu, Sichuan province.

The Cidpex exhibition, organized by the China National Household Paper Industry Association (CNHPIA), is recognized as the global largest event targeted to tissue paper/disposable hygiene products business in China. In 2014 it became the largest tissue paper and disposable hygiene products exhibition in the world, with about 66.000 m2 exhibition area, 600 Exhibitors, welcoming 20.000 among domestic and overseas professional visitors. During the exhibition, Fameccanica introduced its Life+ Project through one-to-one meetings with its Customers, and through visual prints displayed inside and outside the stand and with leaflets distributed to the public.

On May 14-15 it also hosted the Cidpex conference, with 41 high level speeches divided into two themes: tissue paper and disposable hygiene products.

At this venue, Fameccanica presented its Life+ project. The project first achievement - the glueless lamination of back ears with Fameccanica machine model FLS - was presented, plus a selection of key recent innovations for the hygiene industry.

5.2.2.6 CONFERENCES AND EXHIBITIONS: Midterm Conference

Fameccanica Life+ Glueless Project Mid Term Conference was held on Friday 26th, 2014 in Barcelona, Spain, as part of the wider OUTLOOK 2014 Conference organized by Edana, the European association serving the nonwovens and related industries.

With more than 400 delegates from across the nonwovens and related industries, OUTLOOK™ was again confirmed as one of the most important events for the personal care and hygiene products industries. The presence of over 400 delegates exceeded the target of 50-100 foreseen in the G.A.

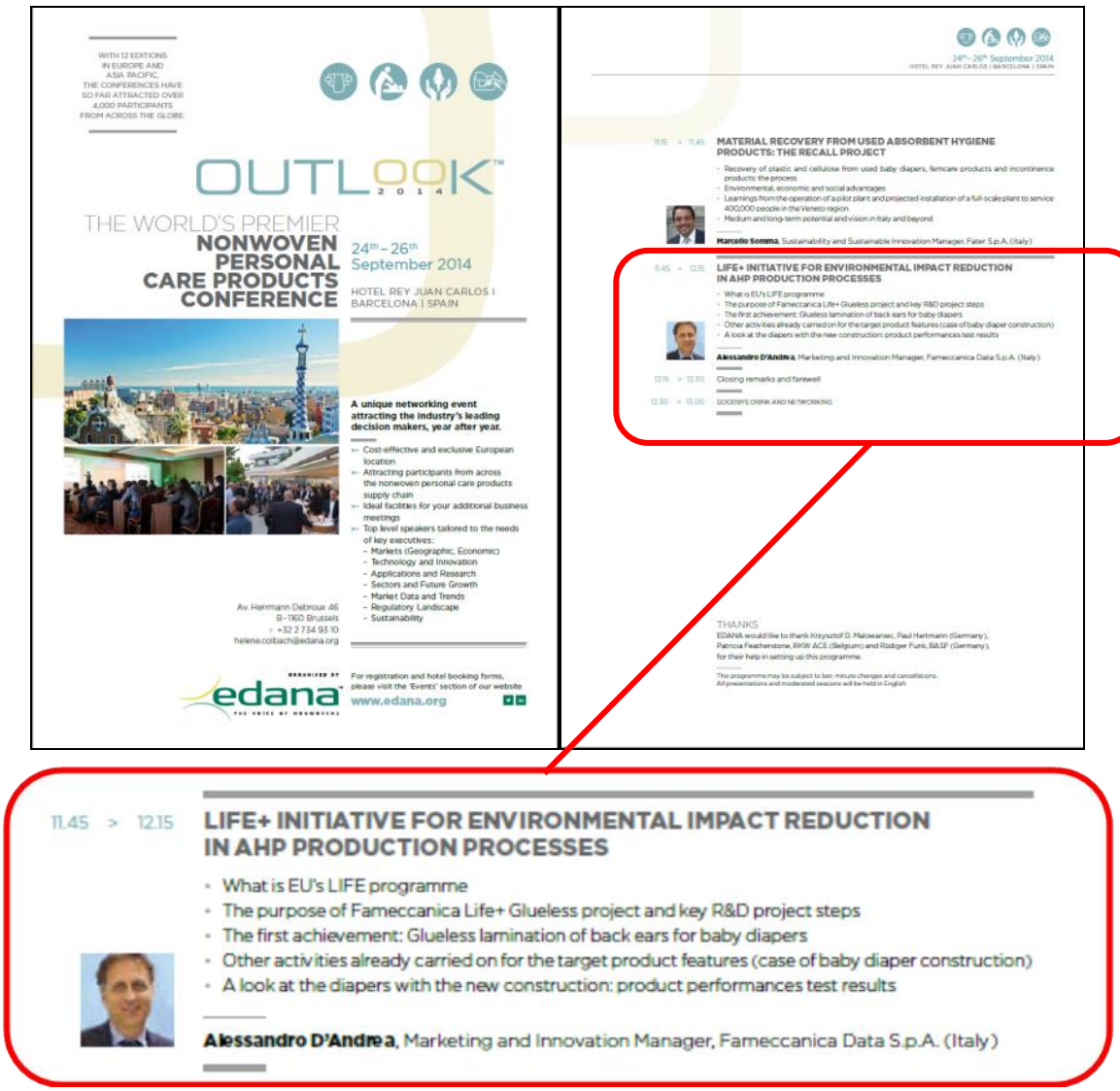


Figure 448 Outlook conference @ Barcellona

Fameccanica presented all the key achievements already reached at that stage, like completion of the step pertaining GLUELESS™ lamination of back ears for baby diapers, plus initial test results of GLUELESS™ application of ADL and ELASTICS.

Extract from the presentation (see also attachments for full presentation):

Figure 45 Extract from presentation at Outlook 2014

The paper of each conference including the Fameccanica's one has been provided by Edana to all participants in electronic form at the end of the event.

5.2.2.7 CONFERENCES AND EXHIBITIONS: Final Conference in USA

Hygienix is one of the most important events for Absorbent Hygiene and Personal Care Markets. Fameccanica attended the Conference on October 24th – 27th, 2016 in Orlando – Florida (USA).

The speech was about the key objectives of the Fameccanica Life+ Glueless™ project and the R&D steps it took to achieve them. Besides, the end results of the single features were presented. Now they are ready for application on diapers of the future, reducing environmental impact. Conference proceedings (including those of other presenters) and high resolution photos of the Hygienix 2016 conference and exhibition are attached in the present Final report.

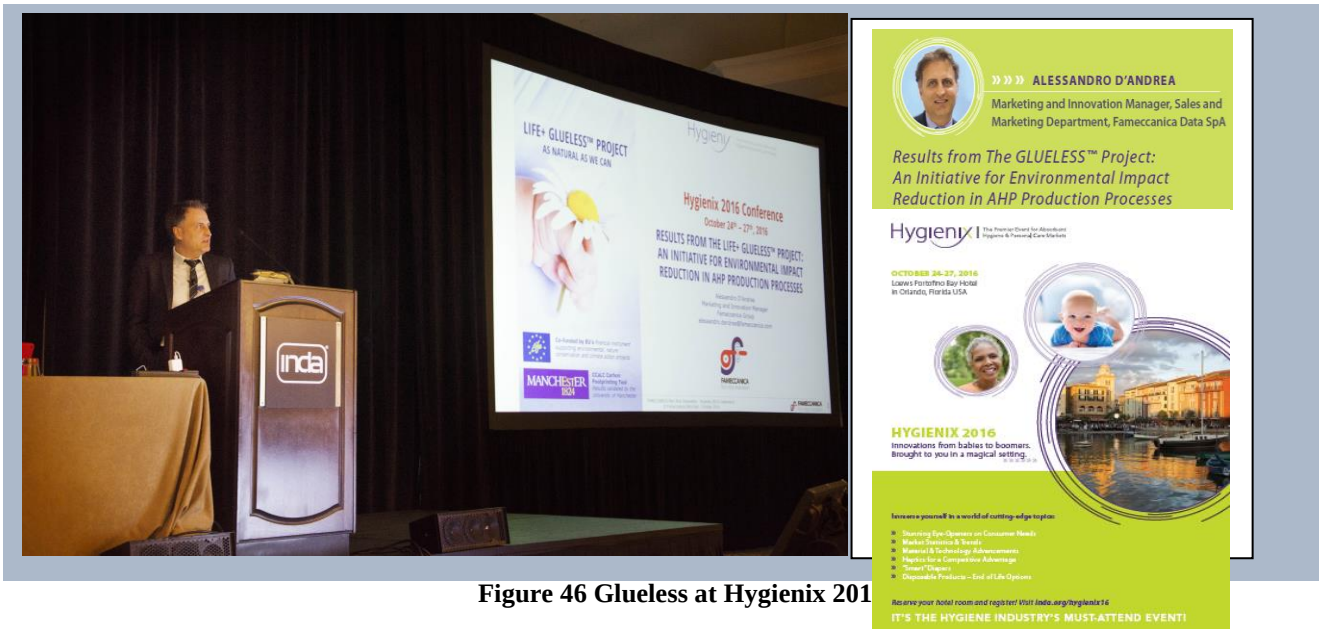


Figure 46 Glueless at Hygienix 201

5.2.2.8 CONFERENCES AND EXHIBITIONS: Final Conference in Europe

On November 30th, 2016 Fameccanica attended the Conference "Financing Innovation", organized by CONFINDUSTRIA Pescara – Chieti, with its President *Gennaro Zecca* and the "Innovating Services Section" President *Alessandro Addari*. The meeting was about Horizon 2020, as a new European Financial Instrument for Innovating Companies.

The Fameccanica Sales & Marketing Director *Ettore Paolini* spoke about the growth of the Company, with the focus on Internationalization and Innovation.

Francesco D'Aponte, Design & R&D Director, explained the Life Programme and the objectives of Glueless™ project.

"Fameccanica has identified five Glueless™ processes to produce important elements of baby diapers - explained Alessandro D'Andrea, Marketing & Innovation Manager - and for each of the features, defined the technical proposal, carried out the design of the product, process and laboratory prototype equipment. It subsequently created the diaper samples with the same specifications of performance

(high speed) of the production machines normally sold by the company. For the majority of applications, Fameccanica filed patent applications".

"Thanks to an efficient collaboration with the University of Manchester - added Diego Gualtieri, R&D Project Manager - the studies conducted to estimate the potential environmental and economic savings, confirmed that Glueless™ project has great potential in achieving sustainability objectives, as defined by the EU 2020 strategy."

"The experience of Fameccanica - concluded Addari – also confirms how collaborations between universities and enterprises are important. As vice-president of Confindustria Chieti-Pescara with responsibility for Research and Innovation, I have promoted the establishment of a team aimed to develop these synergies, identifying research areas of interest for companies of our territory ".

Figure 47 Final conference – Confindustria di Pescara

Conference proceedings (including those of other presenters) and high resolution photos of the Confindustria 2016 conference and exhibition are attached in the present Final report.

5.2.2.8 BROCHURES

At the project beginning, Fameccanica has prepared the first brochure in English and printed it in the quantity of 2.000 pcs. This has been distributed as follows:

- 500 distributed at INDEX 14
- 500 distributed at CIDPEX 14
- 500 distributed at OUTLOOK 14
- 500 available and distributed in Fameccanica factory to the different clients and stakeholders

Figure 48 Glueless brochure

> *Note: In addition, Fameccanica has dedicated a special area for Life+ project in the new Company Profile brochure at chapter "Sustainability" and in the new Baby Diaper Machinery Catalogue at chapter FLS Lamination System. Both these catalogue will be funded with Fameccanica marketing budget (i.e.* ***not funded with Life+ Projet budget****).*

A new version of brochures was prepared, displayed and distributed to the public in the occasion of IDEA16 Exhibition in Boston (May 2016) and the conferences HYGIENIX in Orlando – Florida (USA) and CONFINDUSTRIA in Pescara (ITALY).

This is the last version of the brochure, also available on the project website.

Figure 49 Glueless brochure – last version

High resolution files of the brochures are visible in the Attachment folder:

This new, second brochure has been printed in the quantity of n. 2.700, distributed as follows:

- 500 at IDEA 16
- 150 at HYGIENIX 16
- 40 at CONFINDUSTRIA 16
- 2010 are available and are going to be distributed in Fameccanica factory to the different clients and stakeholders and in the next dissemination activities.

All details regarding the brochures' versions and the distributed quantities have been provided in the deliverable "Preparation of brochures and final poster" (Annex to the present report).

5.2.2.9 ADVERTISING ON MARKET SECTOR MAGAZINES

The project Life+ Glueless continued to advertise the project on the magazines in our sector, such as METissue magazine - which is printed in Lebanon and targets the Middle East and Asian markets. This is a continuation of what already mentioned in the MID TERM REPORT LIFE12 ENV/IT/000423.

NOTE: all expenses pertaining to the publishing of the above mentioned article, have been funded with the Fameccanica marketing budget (i.e. **not funded** with Life+ Project budget).

On issue 30/2016 (jan-feb-mar 2016) of METissue we ran an editorial reporting our latest innovations and a dedicated portion about Glueless application of elastics and Glueless lamination of diapers back ears.

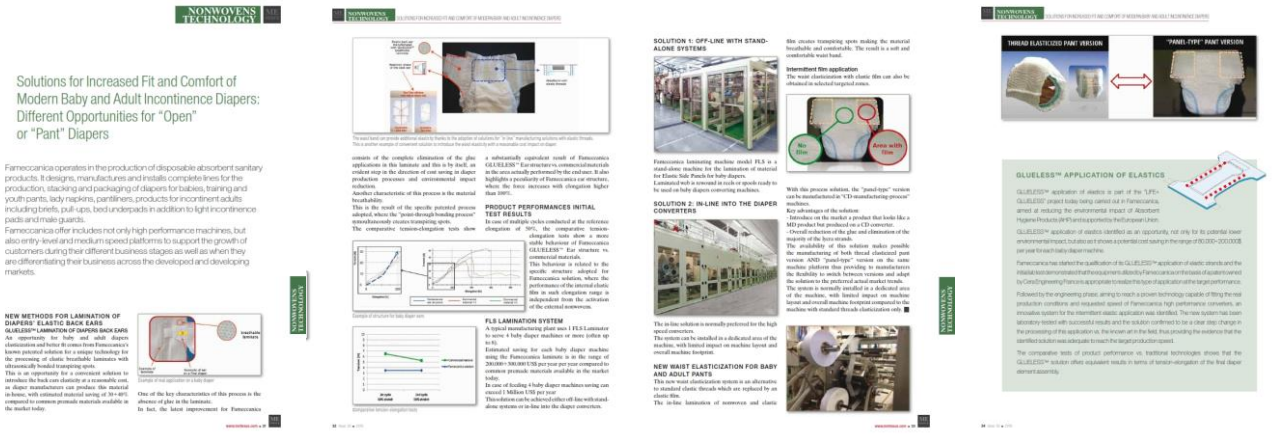
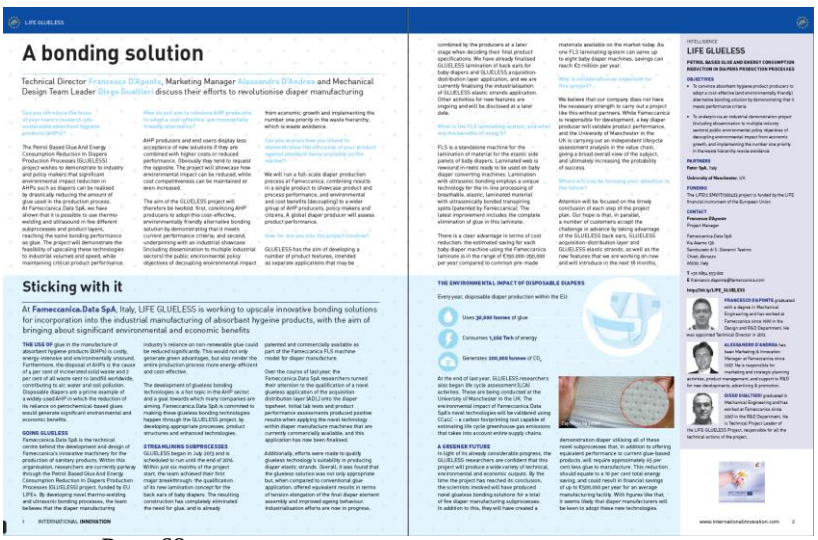


Figure 50 Example of advertisement

Also, as anticipated in the Mid-Term Report, an article dedicated to the Glueless Life+ project was published on International Innovation magazine by Research Media Ltd. for publication, a British-based magazine.

Paper copies have then been issued by the publisher and made available to the public. Several copies have been sent to Fameccanica and made available to the visitors. A special request was done to the publisher to directly deliver the copies to the major Fameccanica Customers in Europe. In particular, Fameccanica provided



detailed addresses to deliver to them via standard mail to 8 European companies with names of the key decision makers (CEOs, Compeny Owners, Managing Directors, etc.) as identified by our Sales Managers (the identified persons, are, in fact, persons that our company and know personally). Details are given in the Attachments.

5.2.2.10 PRESS RELEASES

A press release has been prepared in January 2014 and sent to the key industry magazines, to a list of local and international stakeholders and to Fameccanica key Customers. As a result of this dissemination, it is currently possible to have visibility on the following electronic magazines and associations websites:

- http://www.nonwovens-industry.com/contents/view_breaking-news/2014-01-30/the-life-project-and-fameccanica/
- http://www.inda.org/the-life-project-and-fameccanica/
- http://www.fibre2fashion.com/news/technical-textiles-news/newsdetails.aspx?news_id=154937
- http://www.globalne.ws/Latest/D/4028810e43d6e5db0143e4751a0c5183/The-Life+-Project-and-Fameccanica

5.2.2.11 MAILING LIST

Provided visibility of all the key documents in the website, it has been decided that Fameccanica will not use “Mailing-List” systems. This is quite common in our business, as the “one-to-one” relationship where the personal contact with each of the Customer has created a common attitude to avoid “server-automatically generated” Mailing Lists as they are considered impersonal.

It is worth to mention that on September 11, 2014 and September 25, 2014, during the yearly meeting dedicated to sharing of innovations, Fameccanica presented the Life+ Glueless project to the key executives of 2 of the 3 biggest worldwide AHP producers worldwide, accounting in Europe MORE than 50% of the market share. Documentation of the presentations is available in Fameccanica servers and is not provided as attachment of the present document, as covered by confidentiality agreements between the parties.

5.2.2.12 Questionnaire

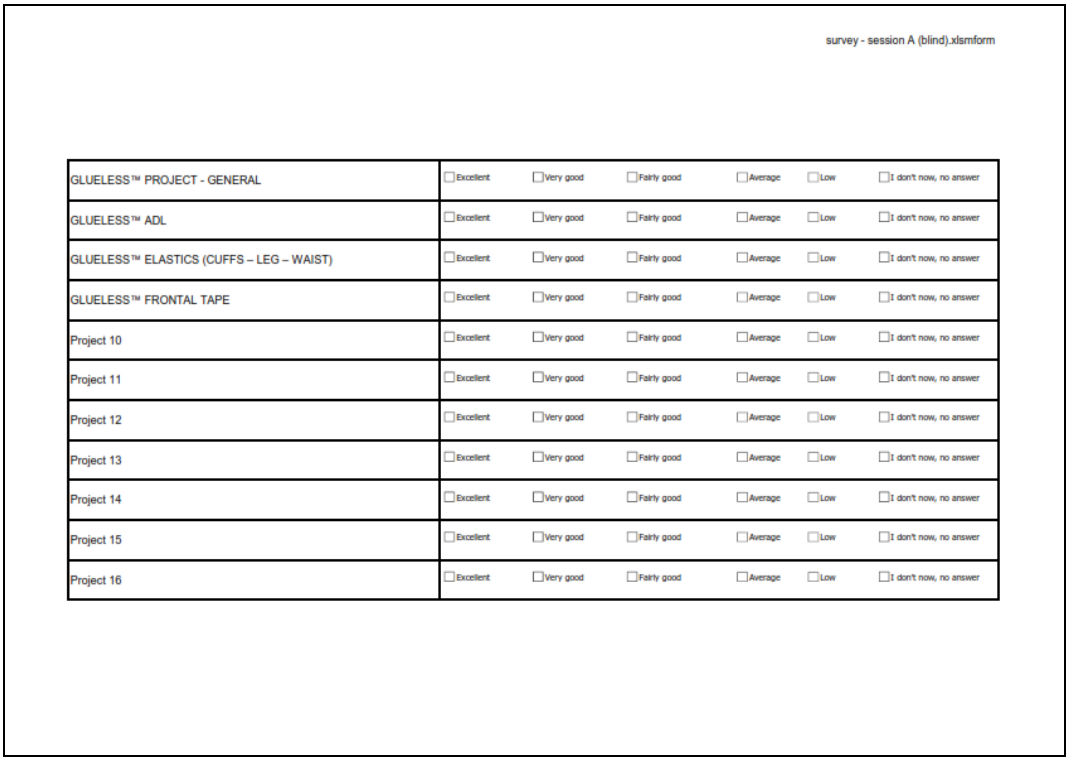
Fameccanica has proposed questionnaires to several of its Customers during the presentations, and during the Innovation meetings. Also, questionnaires have been presented after the final conferences in Confindustria.

In particular, the feedback can be summarized as follows:

- some Customers are reluctant to fill questionnaires and consider the feedback appropriate only after they have completed their internal procedures to evaluate technical opportunities

- neverthless, we received a number of questionnairs filled, even if the number was lower than the initial targets (which was estimated initially in 30 feedbacks).
- when we presented the Glueless project among several other innovation opportunities, we received a very positive feedback.
- the feedback received after the final Conference in Confindustria was more related to the project in general, as well as on knowledge of the Life+ project, rather than for the project details.

First set of questionnaires (example of form adopted):



survey - session A (blind).xlsmform

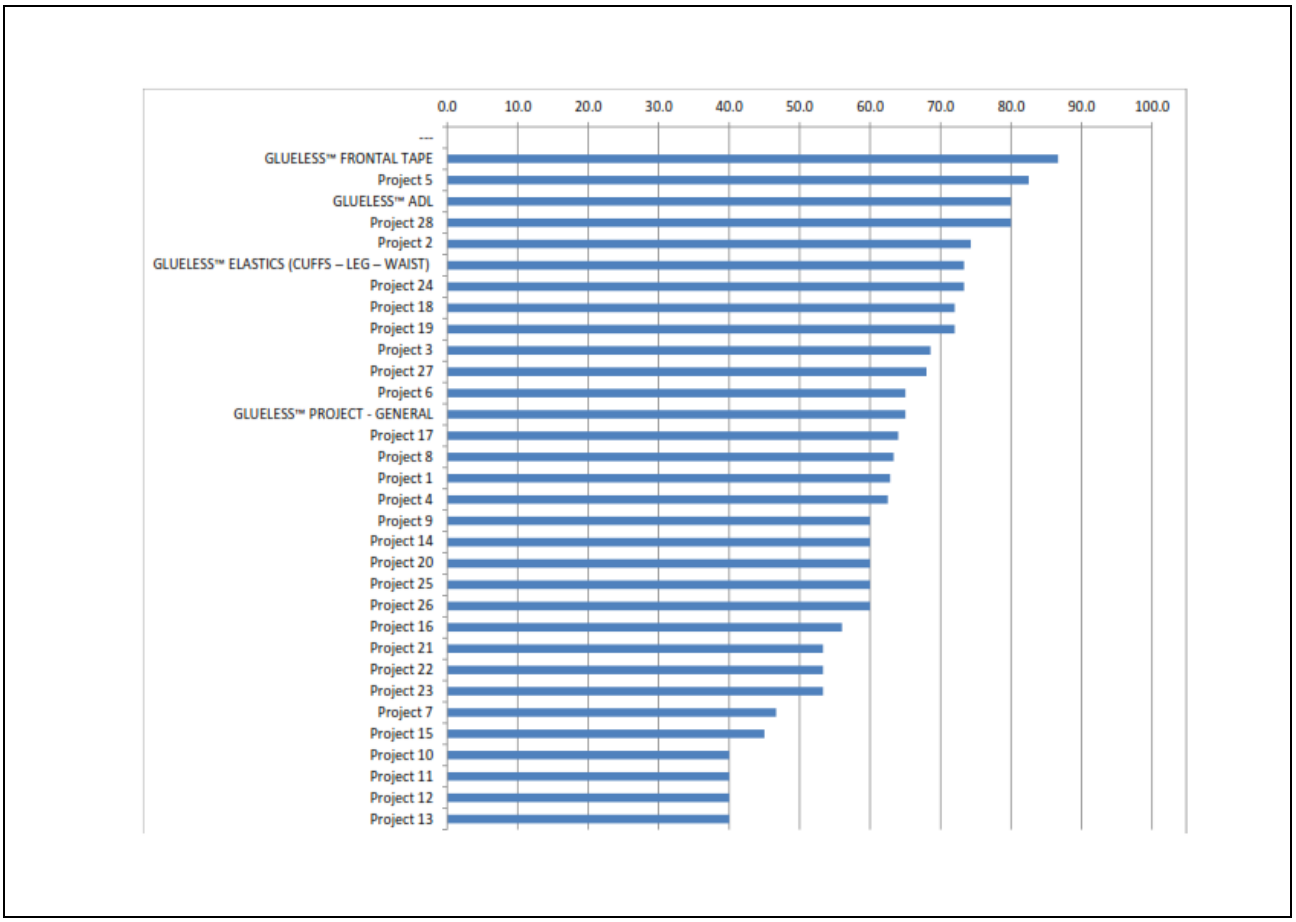
GLUELESS™ PROJECT - GENERAL	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ ADL	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ ELASTICS (CUFFS – LEG – WAIST)	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ FRONTAL TAPE	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project 10	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project 11	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project 12	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project 13	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project 14	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project 15	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project 16	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer

Results from First set of questionnaires (8 answers received):

survey - session A (blind).xlsm!rating

		CompilerA1	CompilerA2	CompilerA3	CompilerA4	CompilerA5	CompilerA6	CompilerA7	CompilerA8
Project 1	62.9	4	2	2	0	4	3	4	3
Project 2	74.3	5	4	3	0	3	3	4	4
Project 3	68.6	2	4	3	4	4	3	0	4
Project 4	62.5	2	4	5	4	3	4	2	1
Project 5	62.5	5	4	4	5	2	4	5	4
Project 6	65.0	2	2	3	4	2	3	5	5
Project 7	46.7	0	2	3	0	3	4	1	1
Project 8	63.3	0	2	3	0	3	3	5	3
Project 9	60.0	3	3	2	5	2	3	0	3
GLUELESS™ PROJECT - GENERAL	65.0	3	4	3		3			
GLUELESS™ ADL	60.0	4	0	4		4			
GLUELESS™ ELASTICS (CUFFS – LEG – WAIST)	73.3	3	0	4		4			
GLUELESS™ FRONTAL TAPE	66.7	5	0	4		4			
Project 10	40.0	2	0	2		2			
Project 11	40.0	0	0	2		2			
Project 12	40.0	0	0	2		2			
Project 13	40.0	2	4	1		1			
Project 14	60.0	3	0	3		3			
Project 15	45.0	2	3	2		2			
Project 16	56.0	3	2	4	3	2			
Project 17	64.0	4	3	4	2	3			
Project 18	72.0	4	3	4	4	3			
Project 19	72.0	4	3	4	4	3			
Project 20	60.0	0	3	0	3	3			
Project 21	53.3	0	3	0	2	3			
Project 22	53.3	0	3	0	2	3			
Project 23	53.3	0	3	0	2	3			
Project 24	73.3	0	3	0	5	3			
Project 25	60.0	0	3	0	0	3			
Project 26	60.0	0	3	0	3	3			
Project 27	66.0	3	4	3	3	4			
Project 28	60.0	4	0	4	0	0			
–	#DIV/0!								

Graphic Results from First set of questionnaires:



Second set of questionnaires (example of form adopted):

survey - session B (blind).xlsmform

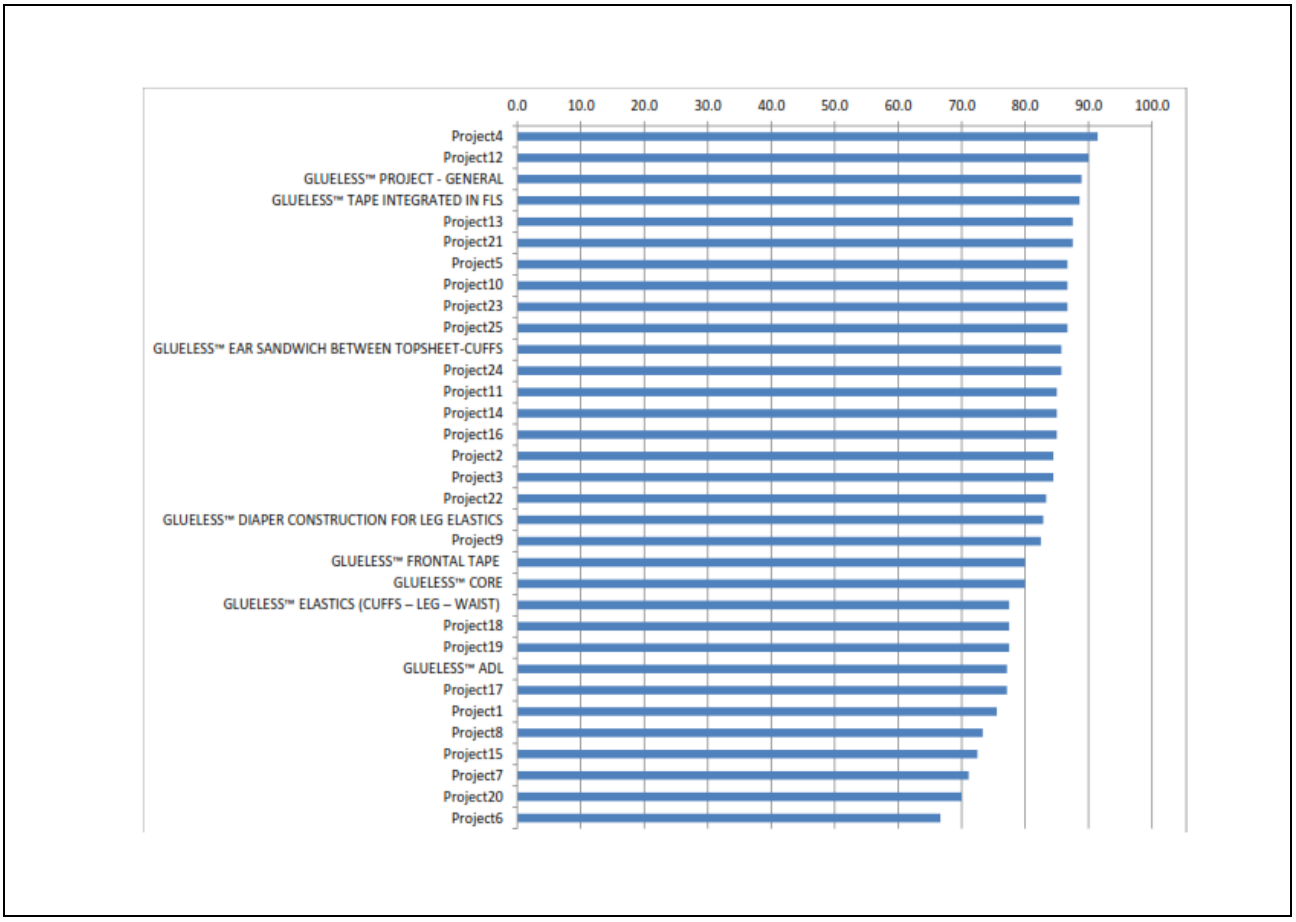
Project9	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project10	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
Project11	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ PROJECT - GENERAL	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ ADL	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ ELASTICS (CUFFS – LEG – WAIST)	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ DIAPER CONSTRUCTION FOR LEG ELASTICS	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ FRONTAL TAPE	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ CORE	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ EAR SANDWICH BETWEEN TOPSHEET-CUFFS	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer
GLUELESS™ TAPE INTEGRATED IN FLS	☐ Excellent	☐ Very good	☐ Fairly good	☐ Average	☐ Low	☐ I don't now, no answer

Results from Second set of questionnaires (9 answers received):

survey - session B (blind) alamrating

		Compiler1	Compiler2	Compiler3	Compiler4	Compiler5	Compiler6	Compiler7	Compiler8	Compiler9
Project1	75.6	3	4	4	4	4	5	4	3	3
Project2	84.4	4	5	4	4	4	5	4	4	4
Project3	84.4	5	4	4	4	4	5	3	4	5
Project4	91.4	4	5	4	5	0	5	4	0	5
Project5	86.7	5	5	4	4	3	5	4	4	5
Project6	66.7	3	4	3	3	2	5	3	3	4
Project7	71.1	3	4	3	4	3	4	3	4	4
Project8	73.3	3	3	3	4	2	4	4	5	5
Project9	82.5	3	5	5	3	5	0	4	4	4
Project10	86.7	4	5	5	3	5	4	4	5	4
Project11	85.0	0	4	5	5	3	4	5	5	3
GLUELESS™ PROJECT - GENERAL	88.9	4	5	5	4	5	4	4	5	4
GLUELESS™ ADL	77.1	0	5	3	4	4	0	4	4	3
GLUELESS™ ELASTICS (CUFFS – LEG – WAIST)	77.5	2	5	4	4	5	0	4	4	3
GLUELESS™ DIAPER CONSTRUCTION FOR LEG ELASTICS	82.9	0	5	5	4	4	0	4	4	3
GLUELESS™ FRONTAL TAPE	80.0	2	5	4	4	5	0	4	4	4
GLUELESS™ CORE	80.0	4	5	5	4	2	0	4	5	3
GLUELESS™ EAR SANDWICH BETWEEN TOPSHEET-CUFFS	85.7	0	5	5	4	5	0	4	4	3
GLUELESS™ TAPE INTEGRATED IN FLS	88.6	0	5	5	4	5	0	4	4	4
Project12	90.0	5	5	5	5	4	4	4	4	
Project13	87.5	4	5	4	4	3	5	5	5	
Project14	85.0	4	5	4	5	4	4	4	4	
Project15	72.5	3	4	3	5	3	3	4	4	
Project16	85.0	5	5	4	5	2	5	3	5	
Project17	77.1	0	4	3	4	4	4	3	5	
Project18	77.5	4	4	4	5	4	2	4	4	
Project19	77.5	4	4	3	5	4	3	4	4	
Project20	70.0	4	4	2	4	4	3	3	4	
Project21	87.5	5	4	4	5	4	4	5	4	
Project22	83.3	3	5	5	4	0	4	4	0	
Project23	86.7	4	5	5	4	0	4	4	0	
Project24	85.7	3	5	5	4	5	4	4	0	
Project25	86.7	4	5	5	4	0	4	4	0	
Project26	80.0	0	4	5	0	4	3	4	0	

Graphic Results from Second set of questionnaires:



Questionnaires at Final Conference at Confindustria:

- 13 questionnaires filled
  - 11 rated Glueless Project "Excellent" or "Very Good" (5 or 4 in a scale 1 to 5), while 2 answered "I don't not know".
  - 9 answered that they did not know Life+ initiative from the EU before the conference, while 3 answered that they already knew and 1 did not answer.

5.2.2.13LAYMAN'S REPORT

The Layman's report has been prepared (in English and Italian version) at the end of the project according to the EC requirement (the deliverable annexed to the present report). It has been printed (1000 copies) and published on the project website. It contains summary of project objectives, description of the methodology implemented, achieved results and assessment of the environmental and economic benefits including transferability of the project results.

Figure 51 Laymans Report image

5.2.2.14 Dissemination results summary

Following the list of the results achieved:

- Project website done in two versions
- 3 Notice boards done
- 2000 Brochures done and made available
- 13 newsletters done
- No mailing list, substituted by publishing on the website plus the "innovation meetings with key AHP producers"
- 30 questionnaire filled by AHP producers
- Midterm workshop conference done
- Final conference done
- Poster for final conference done
- Laymans's report done

Deliverables:

- LIFE-GLUELESS final workshop conference (deadline: 01/07/2016; done: 23/12/2016);
- Notice board 3 (deadline: 01/06/2016; done: 01/06/2016);
- Preparation of brochures and final poster (deadline: 01/07/2016; done: 23/12/2016);
- Layman's report (deadline: 01/07/2016; done: 07/12/2016);
- After-LIFE Communication Plan (deadline: 01/07/2016; done: 23/12/2016);
- Newsletters.

5.2.3 ACTION E.3 – Networking with other projects

START DATE / END DATE	Foreseen start date: July 2013 Actual start date: July 2013 Foreseen end date: July 2016 Actual end date: December 2016

The action E.3 started in M1 and it ended in M42 (6 months later the date foreseen in the GA). The end date of the action and the related deliverable were rescheduled for 31/12/2016 (a new deadline was communicated in the Progress report) in order to let the Consortium continue the implementation of the networking activities until the end of the project.

The following indicators of progress of the action were considered during the implementation of the project, according to the indications provided with the GA: number of projects selected, number of actors contacted, number of beneficiaries of other projects involved in each meeting and participation of project partners to other networks.

In order to implement efficiently this action, the following sources to find potential EU projects, were used:

- LIFE Programme Database: http://ec.europa.eu/environment/life/project/Projects/index.cfm
- Cordis Database: http://cordis.europa.eu/projects/home_it.html
- CIP Eco Innovation Database http://ec.europa.eu/environment/eco-innovation/projects/

Thanks to the above mentioned databases, but also to different conferences / workshops / meetings done by the partners during the project, about 16 projects have been selected.

During the project lifespan the networking opportunities were identified and the project's representatives contacted various previous and present projects.

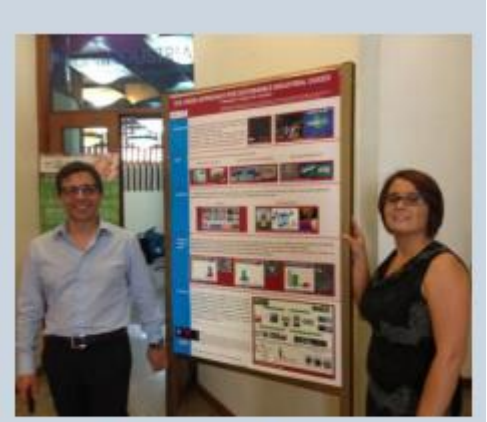
Generally, the first contact was an email with the presentation of the Glueless project and the invitation to network. After, the phone contacts followed in order to find synergies. Finally different face-to-face meetings with projects beneficiaries were organized.

The active networking relationships have been established by GLUELESS Consortium with the following projects:

BIO-MIMETIC - FP7-ENVIRONMENT REF. 282945

NEW BIO-INSPIRED PROCESSES AND PRODUCTS FROM RENEWABLE FEEDSTOCKS - www.biomimetic-eu-project.eu.

The networking contacts and activities started at the GLUELESS project's beginning when the first presentations and phone calls were done. The Project Coordinator, Francesco D'Aponte and the Dissemination Manager, Alessandro D'Andrea (from FAM), FATER and UNIMAN partners were invited and participated in the final Workshop, seminar and SME training organized in Latina 25/06/2015 by the BIO-MIMETIC partners. During the workshop, the GLUELESS partner UNIMAN organized a training event for SMEs with respect to CCaLC. The BIO-MIMETIC case study has been developed by UNIMAN using the CCaLC LCA tool for SMEs and made freely available to the SME community as a dissemination action. The deliverable regarding that workshop was shared with GLUELESS team and it is attached to the present deliverable (Annex 1 BIO-MIMETIC Workshopseminar-and-SMEs-training). The project link has been published on the GLUELESS website.



Mr. Francesco D'Aponte (Fameccanica) with the Bio-Mimetic workshop coordinator Ms. Patrizia Circelli (Ciaotech)

VIRGIN - LIFE12 ENV/IT/000611

Highly-efficient ValorIsation of AHP waste thRough a novel combination of Autoclave and GasIficatioN - http://www.virgin-life12.eu/website/it/

The GLULELESS project presentation, newsletters have been sent. The representatives of both projects have shared in details the purpose of projects and the implementation strategy through face to face meeting. The website project link has been published on the GLUELESS website.

RECALL – CIP Eco-Innovation

REcycling of **C**omplex **A**HP waste through a first time app**L**ication of patented treatment process and demonstration of sustainable business model https://sites.google.com/a/fater.it/recall-en/

The associated Beneficiary Fater is also partner in the Recall project. Consequently the exchange of information between the two project teams has been implemented. Both beneficiaries Fater and FAM participated in Outlook Edana 2014 (24-26/09/2014 in Barcelona, Spain) – Nonwoven Personal Care Products Conference – a networking event (Annex 3 outlook-2014-final-programme). During that event (26/09/2014) both project have been presented (Annex 4. Economic and environmental benefits estimated through LCA and LCC (EU Glueless project)) and received a very positive feedback from the audience (450 participants) during the networking time foreseen.

Sustainable Industrial Systems http://www.sustainable-systems.org.uk/

It is a research group at The University of Manchester led by Professor Adisa Azapagic (the representative UNIMAN, the GLUELESS Associated Beneficiary). She has a large network of project implemented and managed by UNIMAN and her constant networking is important also for the GLUELESS project (exchange of experience and best practices, exchange of some deliverables, meeting with other projects representatives to disseminate the project results and to share some information regarding LCA analysis. Thanks to the Professor Azapagic the project GLUELESS has been connected and entered in the group of the following research projects:

GreenPREG - CIP Eco-Innovation

Innovative Green Fibre Composites" http://www.greenpreg.com/

The GreenPREG project's coordinator demonstrated interest in GLUELESS project, especially in the LCA analysis. The here attached presentation of the GLUELESS project was prepared and sent on 29/11/2016 to the GreenPREG coordinator (Annex 2. Greenpreg presentation.pdf) by UNIMAN partner in order to share the results of the activities methodology.

Other project involved in the networking activities (email, exchange information, meetings):

Highly Efficient Ovens (HEO) - LIFE11 ENV/IT/103 http://www.highefficientoven.eu/

BIOCHEM – ECO-Innovation http://www.biochem-project.eu/

CSEF (not EU funded) www.foodenergy.org.uk.

4CU (not EU funded) www.4cu.org.uk.

Designing sustainable supply chains (not Eu funded);

At the project end, UNIMAN prepared a summary document of the main LCA and LCC findings in order to share with the above mentioned EU projects and disseminate the results from the Glueless project in order to intensify networking relations and activity. This document was shared with other projects via e-mail. Moreover, the link to the GLUELESS project website has been added to the

above mentioned group.

Finally, some phone calls and/or email exchange and share of the website project link were done with the following projects:
ECOREMED - LIFE11/ENV/IT/275 http://www.ecoremed.it/,
ENERGY WASTE - LIFE09 ENV/GR/000307 www.energywaste.gr,
URWASTECH - LIFE10 ENV/ES/530 http://urwastech.eu/,
LIFECOGENERATION – LIFE12 ENV/PL/000013 http://lifecogeneration.pl/
Progetti Life 2012 (http://www.minambiente.it/pagina/progetti-life-2012)

Thanks to the networking activities done during the GLUELESS project, the Consortium started to build a challenging network with some interesting partners.
It is worth mentioning also that SIS has contacted EDANA in late 2015 asking for LCI data during the development of the C.1 (LCA) task. Even if the data collection process was not very successful due to confidentiality issues associated with EDANA LCI and LCA data, UNIMAN communicated EDANA the goal and scope of the Glueless project as well as offered the possibility to share the final results with them at the end of the project. Researchers from UNIMAN will share with EDANA the LCA and LCC papers once published in scientific journals.
Finally, the successful development of the Glueless project thanks to dynamic, friendly and efficient teamwork as well as the relevance of the project outcomes has recently fuelled the development of a new R&D proposal written by FAM and UNIMAN for application to an EU funding grant. It allowed both partners to extend the partnership network where the knowledge and outcomes generated through the development of the Glueless project will be used as baseline to start working in a new sustainability-based industrial project.

The networking activities were implemented with success and the objective to create an extended network getting in contact with at least 4 EU initiatives has been fully reached.
Deliverable:

- Networking with other EU projects (deadline 15/06/2015) (done in 23/12/2016).

5.2.4 **ACTION E.4 – After-LIFE Communication Plan**

START DATE / END DATE	Foreseen start date: April 2016 Actual start date: April 2016 Foreseen end date: June 2016 Actual end date: December 2016

This activity has been implemented according to the GA and without problems. The After-LIFE Communication Plan has been prepared at the end of the project in both Italian and English versions and it is available in electronic and paper format ("After-LIFE communication plan" annexed to the present report). It contains a brief presentation of the project results, the dissemination activities done during the project and it sets out how the beneficiaries plan to continue applying, disseminating and communicating the results of the project after its end.

5.3 Evaluation of project implementation

The Glueless project wishes to demonstrate the possibility to reduce the amount of glue used for the diapers production. FAM defined five processes where the glue applications could be substituted with ultrasonic or thermo mechanical bonding technology. Every process has been analyzed and implemented applying the working methods usually used in the research and development activity (brainstorming, design reviews, FMEA and learning plans). They allowed to reach the results above described in line with timing and costs foreseen.

Following a table in which the results achieved and the objectives are compared.

Action	Task	Foreseen in the revised proposal	Achieved	Evaluation
A.1	Analysis for the ADL application	Definition of the primary raw materials and patterns design: • 2 sonotrode shapes; • 5 sonotrode position; • 5 raw materials.	• 2 sonotrode shape selected; • 1 position of the sonotrode identified; no changes of the position are required to optimize the process; • 5 raw materials selected.	This task was completed successfully.
A.1	Analysis for the elastic application	Optimization of the engineering solution and bonding technology: • 4 sonotrode	• 2 sonotrode shape selected (1 CERA design and 1 AURIZON design); further shapes have	This task was completed successfully.

		shapes.	been selected in the implementation action B2; • 4 RMs selected, and not foreseen in the GA, in order to define their influence on the process.	
A.1	Analysis for the core building	Optimization of the engineering solution and bonding technology: • 3 sealing shapes.	• 3 sealing shapes selected (more than 3 shapes were analyzed).	This task was completed successfully and the results achieved are in line with those foreseen in the GA.
A.1	Analysis for the frontal tape application	Definition of the primary raw materials: • 3 raw materials.	• 9 raw materials selected • 4 bonding patterns selected (2 standard + 2 for the patent concept), and not foreseen in the GA, in order to define their influence on the process.	This task was completed successfully and the results achieved are in line with those foreseen in the GA.
A.1	Analysis for the ears application	Definition of the primary raw materials and patterns design: • 4 sealing patterns; • 2 raw materials.	• 4 raw materials selected for ears; • 2 bonding patterns selected	This task was completed successfully and the results achieved are in line with those foreseen in the GA.
B.1	Ultrasonic welding technology for application of the ADL	Industrialization of the ADL bonding process with ultrasonic technology in order to move the system up to 450 m/min solving any process limitation. Expected results: • Equipment and pilot line; • Engineering specification for the process; • Performance test; • Optimized production process and equipment; • Selection of the final RMs (5); • Disaster check test.	• Equipment and pilot line defined; • Engineering specification for the process defined; • Performance test for the first pattern design done. • Performance test for the second pattern design done. • Disaster check test successfully completed • Best combination of raw materials found (more than 5 raw materials selected)	FAM employed an efficient troubleshooting method in order to learn the ultrasonic technology limitation and to validate the best process setup for both the bonding patterns design. The results achieved were in line with expectations and the performance target foreseen in the GA. This action can be considered successfully completed.
B.2	Elastic application	Optimization of the	• Equipment and pilot	FAM validated the

		ultrasonic technology, patented by CERA France to entrap the elastic strands, to bring the system up to the production speed of 700ppm. Expected results: • Equipment and pilot line; • Engineering specification for the process; • Performance test; • Optimized production process and equipment; • Disaster check test.	line defined; • Engineering specification for the process defined; • Performance test for more than two patterns done. • Optimized production process and equipment defined; • Disaster check test performed with both ultrasonic and thermomechanical technologies	elastic entrapment process using both ultrasonic and thermomechanical technologies. The test done showed a good process stability and reliability at the target speed. On the basis of the results achieved this action can be considered successfully completed.
B.3	Core building	Execution of two activities for the realization of the core section of the product: 1. Hand made core prototype building; 2. Design and realization of the prototype for the core construction in line. Expected results: • Equipment and pilot line; • Engineering specification for the process; • Performance test; • Optimized production process and equipment; • Selection of the final RMs (3); • Disaster check test; • Specific performance for the core structure.	• Hand made core prototype built and validated; • Equipment and pilot line defined; • Engineering specification for the process defined. • Performance test done with the best asset; • Final RM selected (more than 3); • Disaster check test done; • Specific performance for the core structure defined • Optimized production process and equipment designed.	FAM fully met the first target developing an efficient technology to easily construct core sections of the product. Moreover FAM achieved the foreseen results in terms of product quality (defined in action A.1 in collaboration with FATER). The final product design will be the glueless reference for the marketplace. On the basis of the results achieved this action can be considered fully completed.
B.4	Frontal tape application	Definition of the best bonding technology to guarantee the correct	• Equipment and pilot line defined; • Engineering	This task was completed successfully. Both

		application of the frontal tape over the backsheet material without glue. Expected results: • Equipment and pilot line; • Engineering specification for the process; • Report on performance test; • Selection of the final raw materials (3); • Report indicating the performance of the process; • Disaster check.	specification for the process defined. • performance test and report done; • Selection of the final raw materials done (more than 3); • Report indicating the performance of the process done. • Disaster check test done with the specifications defined in the GA.	the bonding patterns tested allowed to achieve good results in terms of product quality at target speed. The innovative loop frontal tape developed within this task will be implemented in the future machine as main glueless FT feature.
B.5	Ears application	Definition of the best raw materials selection to ensure the best application of the back and front ears without the addition of glue as support. • Engineering specification for the process; • Report on performance test; • Selection of the final raw materials (2); • Optimized production process and equipment.	• Engineering specification for the process defined; • Report on performance test done; • Selection of the final raw materials done: 3 back ears, 1 front ear and 2 NW for cuff. • Optimized production process and equipment defined and designed.	FAM fully achieved the results foreseen for this task thanks to the learnings carried out during the glueless project. The technical solution found was at same time simple but effective and efficient.
B.6	In-house testing out house testing and demo	Final demo diaper realization in a semiautomatic process and performance test made by FAM and FATER using main customer methods. Expected results: • Final prototype (50-100 pieces) of demo diapers • Report on technological and environment performance test	• Final prototype (200 pieces) of demo diapers constructed • Report on technological and environment performance test done • 66% glue reduction achieved • 10% energy reduction achieved	FAM and FATER fully achieved the results foreseen in the proposal in terms of final demo-diaper construction and validation. FAM and UNIMAN confirmed that the glueless approach can reduce the amount of glue used .

		• 65% glue reduction 10% energy reduction		This task can be considered successfully completed.
C.1	Life cycle analysis (LCA)	Validation of environmental savings related to the process innovation: - 65% glue savings (20 kt/year in the EU) - 10% less manufacturing energy (33 GWh/year in the EU) - Life cycle environmental performance	Achieved savings related to glue-removal only: - Glue savings: 66% (13.5 kt for 20.8 billion diapers/year and 16 kt considering 24 billion diapers/year) -Energy reduction: 10% (6.7 GWh for 20.8 billion diapers/year and 7.7 GWh considering 24 billion diapers/year) - Gas savings related to FAM innovations are equivalent to 2.1 kt of CO2 eq. per production facility Achieved savings related to the whole life cycle assessment: - Material savings: 23% (192 kt for 20.8 billion diapers/year and 222 kt considering 24 billion diapers/year) -Energy reduction: 10% (6.7 GWh for 20.8 billion diapers/year and 7.7 GWh considering 24 billion diapers/year)	This task was completed successfully.
C.2	Life cycle costing (LCC)	- €0.5 million/year per production facility -Report on life cycle cost performance.	Achieved savings related to glue-removal only: -Cost savings (glue removal + lower manufacturing energy): €562,000/year per production facility (225million diapers) Achieved savings related to the whole life cycle assessment: -Cost savings (all LCA): €2.4million/year per production facility (225million diapers)	This task was completed successfully.
D.1	Dissemination	To showcase to the	• Project website done	For the

		wide AHP production sector the importance of eco-compatible innovations for reducing glue: • Project website • Notice boards • Brochures • Newsletters (every three months) • Mailing list • Midterm workshop conference • Questonnaire • Final conference • Poster for final conference • Layman's report	in two versions • 3 Notice boards done • 2000 Brochures done and made available • 13 newsletters done • No mailing list, substituted by publishing on the website plus the "innovation meetings with key AHP producers" • Midterm workshop conference done • Questionnaire done • Final conference done • Poster for final conference done • Layman's report done	dissemination activities the whole consortium completed all the activities foreseen in the GA and made a great job to showcase the innovation so that the glueless project is already known by the FAM customer and not only.
E.1	Project management	Expected results • Implementation of the project • Communication with EU	• Implementation of the project performed; • Communication with EU continuously done.	The project management guaranteed the project success thanks to the continuous control of every single action
E.2	Project monitoring	Expected results • Internal monitoring report; • Report to be delivered to the commission; • Inception report; • Mid term report; • Progress report • Final report.	• Internal monitoring reports done; • Report to be delivered to the commission submitted; • Inception report submitted; • Mid term report submitted; • Progress report submitted; • Final report (present document).	FAM efficiently monitored the whole glueless project.
E.3	Networking with other projects	• Networking with other projects	• Networking projects identified. Exchange of information with 4 projects done	This task was in line with the initial objectives and can be considered completed.

Looking at the results achieved during the whole project, it has been clear that the ultrasonic and thermo mechanical bonding technology can potentially substitute, in the 5 applications analyzed, the glue standard applications. Further analysis must be performed in order to understand the effects of the bonding application on the product functionality and aesthetics.

It is important to underline that all the results achieved and the innovations developed by FAM have been conveyed to AHP producers through the dissemination channels in order to showcase:

- Glueless equipments design fully integrated in the FAM's converting machine as a technology ready for the market;
- Advantages coming from the use of glueless features compared with the standard applications with glue in terms of production cost savings and less environmental impact;
- High performances machines able to produce disposable diapers at the fastest speed reachable nowadays by convertings line.

Furthermore thanks to one-to-one meetings and questionnaire received by the key customers FAM collected important feedbacks which demonstrated that the glueless technology convinced the marketplace about the economic and technical potentialities of a more sustainable production.

5.4 Analysis of long term benefits

The aim of the Glueless project is to optimize the product construction reducing the amount of glue in order to achieve environmental, economic and social benefits which can be evaluated under a qualitative or quantitative point of view. Following the result of the long terms benefits analysis made by the Glueless consortium is listed in 6 bullet points.

1. Environmental benefits
   a. Direct /quantitative environmental benefits:
   - it was demonstrated that using a glue free technology for the product building is possible to save over 65% glue without changing the diaper performances in terms of absorbency and wearability;
   - all the Gluelss feature developed within the project can bring to a 10% of energy saving considering the whole production process.

   b. Relevance for environmentally significant issues or policy areas:
   The LIFE-GLUELESS project is fully in line with the major EU policy guidelines and targets as stated in recent policy documents: Europe 2020 and the EU 2050 roadmap and Kyoto as reported in the G.A.

2. Long-Term benefits and sustainability
   a. Long-term / qualitative environmental benefits

In order to determine the magnitude of the environmental savings related to the manufacture of glueless diapers, the results not only were scaled up to different levels (production platform, industrial plant, Italian and the EU) but different market penetration scenarios were considered to calculate the cumulative savings by 2020 at the EU level. Following, the main findings from the study are presented and their contribution to the EU resource efficiency agenda is discussed:

Figures below present the GWP and PED savings that can be achieved in the EU through the deployment glueless diaper manufacturing innovations over the period 2016-2020. Market A refers to the implementation of one P10 glueless production platform per year. It can be considered a conservative scenario of low penetration of the glueless technology. Market B refers to the annual implementation of four P10 glueless production platforms. It can be considered a scenario of gradual technology penetration where an entire industrial plant implements glueless manufacturing technology. In Market C, the EU production volume of glueless diapers is considered to increase by 8.6% annually, which would correspond to satisfy the annual production volume of an entire country, such as Italy. In Market D, the EU production volume of glueless diapers is considered to increase by 14% annually. This scenario reflects the potential environmental savings by manufacturing glueless diapers in the most relevant EU producer countries (UK, France, Germany, Poland, Italy and Spain). Finally, market E is as a radical scenario where the manufacture of glueless diapers increases by 20% annually in order to satisfy 100% of the EU production volume of diapers by 2020. Further information and descriptions about the case scenarios can be found in the LCA paper developed as part of the project.

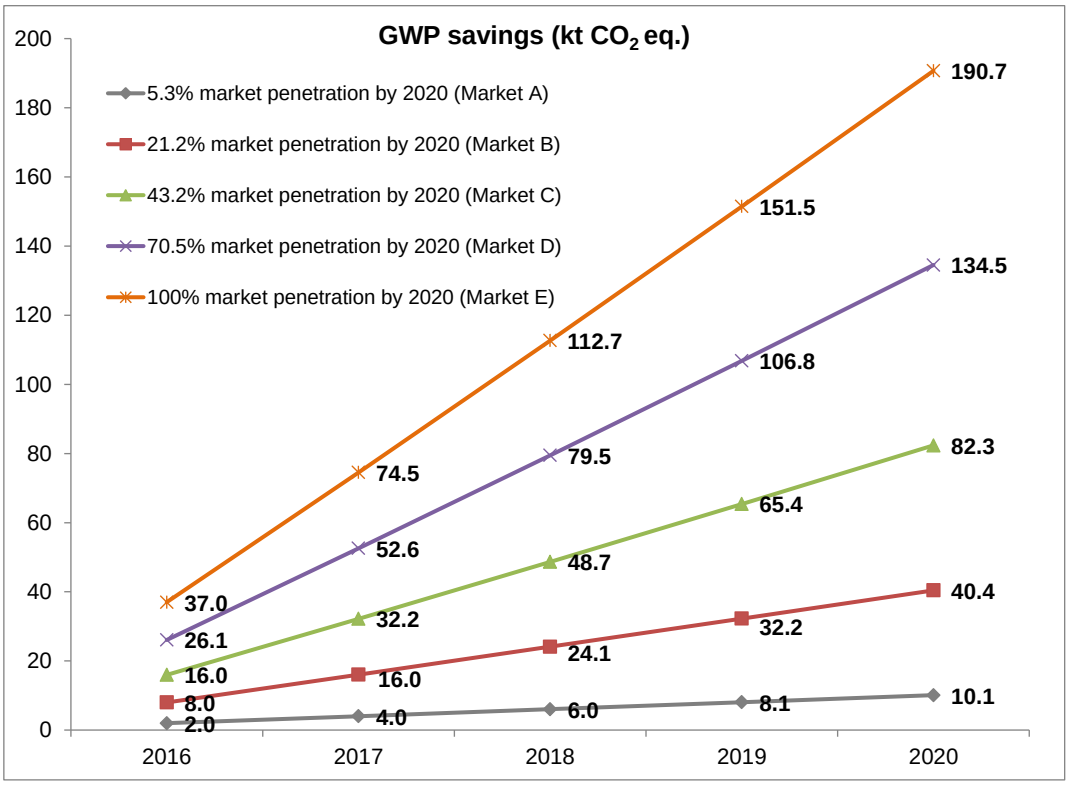


Figure 52 Annual GWP savings according to the market penetration of the glueless disposable baby diaper manufacturing technology in the EU

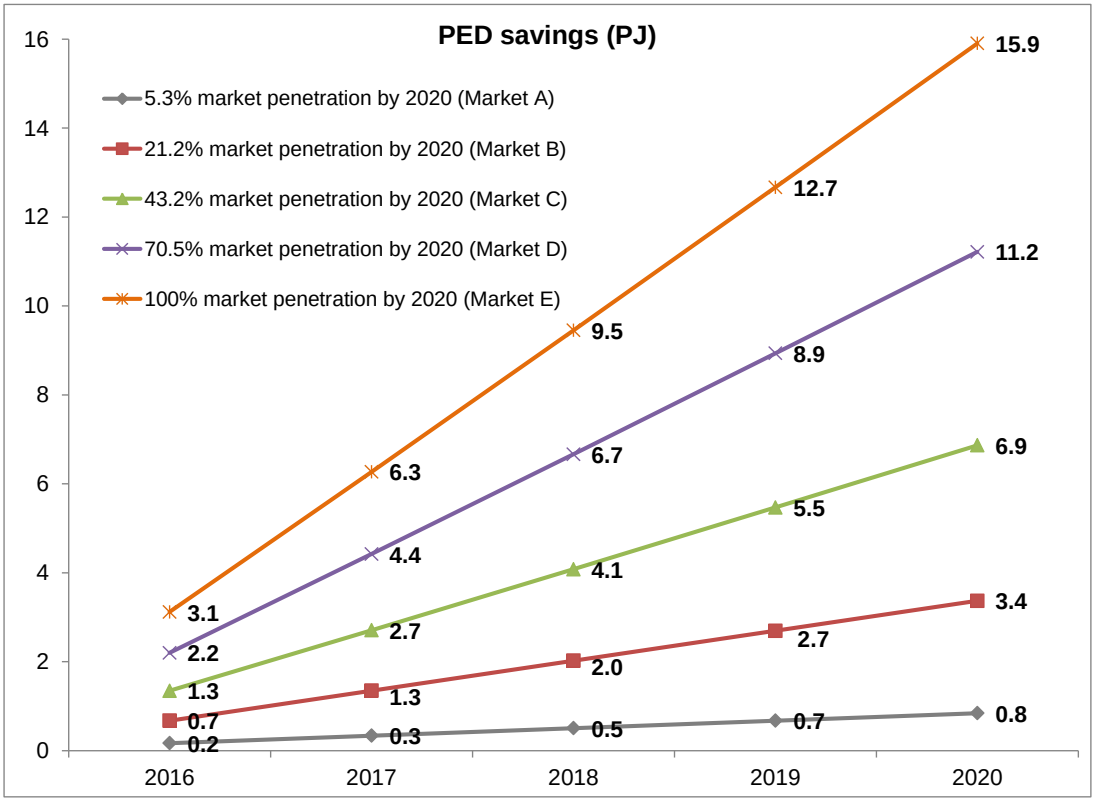


Figure 53 Annual PED savings according to the market penetration of the glueless disposable baby diaper manufacturing technology in the EU

The annual GWP and PED savings by manufacturing glueless diapers at the EU level could account for a minimum of 2.0 kt of CO_2 eq. and 0.2 PJ of primary energy (2016) to a maximum of 191 kt of CO_2 eq. and 16 PJ of primary energy (2020), depending on the market penetration of the glueless technology. Consequently, the cumulative GWP savings by 2020 could range from 30.2 kt (Market A) to 566.4 kt (Market E). These GWP savings would be equivalent to compensate the annual GHG emissions by 15,100 to 283,330 households in the EU. Regarding the indicator of PED, the cumulative savings by 2020 could range from 2.5 PJ (Market A) to 47.4 PJ (Market E), which would be equivalent to compensate the final energy consumption by 43,700 to 819,500 households in the EU. These findings suggest that even if a low market penetration of glueless diaper manufacturing technology is considered (i.e. Market A), GWP and PED savings by 2020 can be substantial. Consequently, glueless diaper manufacturing can contribute actively to meeting the energy and climate sustainability goals defined by the EU 2020 strategy (EC 2010).

Regarding raw materials savings, manufacturing glueless diapers with OAC could reduce annual material requirements from 2.1 kt (Market A) up to 196.1 kt (Market E). Consequently, the cumulative raw material savings by 2020 could range from 31.2 kt to 584.4 kt. These raw materials savings would be equivalent to avoid the annual generation of municipal waste by 65,600 to 1,230,330 people. Thus, glueless diaper manufacturing can contribute notably to the EU resource efficiency goals (EC 2011).

b. Long-term / qualitative economic and social benefits

As energy and environmental challenges become more urgent, business opportunities from green

growth also increases. For that reason, nations around the world, citizens and industries alike are increasingly moving into green technology developments. Environmental problems are becoming more and more also a social problem and our society has to learn to reduce, reuse and recycle, in order to avoid related environmental and health problems, while capturing emerging economic opportunities.

In the LIFE-GLUELESS project the partners in fact wish to show how a "green" innovation can satisfy end-user needs by high technological performance at a competitive (even reduced) cost, strengthening the competitive position of both the suppliers (FAM) and user (FATER and other AHP producers) while generating a positive sustainability impact throughout the value chain, from avoiding carbon intensive glue production down the value chain, to energy efficient and cheaper AHP production processes, towards reduction of non-biodegradable.

The LIFE-GLUELESS project will have multiple economic benefits for the AHP sector, both in terms of cost reduction and in terms of innovation related competitiveness.

Considering material costs, a >65% reduction of glue leads to significant cost reduction in the production costs of AHP products. A kilogram of glue corresponds to 3,5 €. For an average facility (considering speed of production process 700 ppm and two shifts per day) daily savings can reach a value of 2000 €, this means an important 500k€ cost reduction on yearly basis for a single production facility, meaning an estimated 70M € cost reduction for the total Europe market.

These cost reductions will be further increased, taking into account the energy savings realized by the Innovations.

c. Continuation of the project actions by the beneficiary or by other stakeholders.

The intense dissemination activities performed allowed FAM to inform the AHP producers about the progress of the developments of the glueless features and to understand the potential appeal of this technology applied to the production of diapers. For tasks like elastic entrapment it was even possible to start collaborations with customers to integrate the equipment on production machines even before the conclusion of the project itself. The applications of the ADL and the FT with ultrasonic technology have been evaluated as the best innovations made by FAM during the last years by key customers during the innovation meetings and so they are promising for future applications on converting machines. These feedbacks coming from the customers are the main information which let FAM understand that the continuation of the Glueless project actions is concrete and is perfectly in line with the market needs as foreseen in the GA of the project.

Through FAM's strong European clients network in AHP market, there will be the opportunity to straightforwardly deploy commercial interest to further expand applications once initial market barriers would have been overcome. In addition FAM will also focus its attention in promoting the project results towards other international partners for pressing worldwide AHP industries' challenge related with constant research and development of novel, highly-efficient technologies for a more

sustainable world. The know how achieved during the project development will allow to extend the glueless concept to other product features which now are assembled with glue. Future research and development activities will explore the replication potential of the proposed technology also in other AHP industrial sectors (e.g. feminine hygiene sector).

3. Replicability and demonstration

FAM and the whole consortium worked hard during the project in order to validate technical concepts and to confirm the expectations in terms of decrease of glue, energy production saving, environmental impact optimization and costs reduction. Furthermore every single feature developed was thought in order to be easily integrated on both new and existing machines. This approach will help to exponentially improve the possibility to replicate the benefits given by every single glueless process not only for the future converting platform but also for the old machines already producing in the customers' plants.

Thanks to the analysis made by UNIMAN and experimental measurements made by FAM it is important to point out that the potential savings and gas emission reduction achievable by the elimination of glue in the diaper can be easily demonstrated and disseminate by the AHP producers and this aspect will lead to a growing interest in glueless technology considering that the marketplace is always moving towards a more "green production".

4. Best practice lessons

During the last 42 months the Glueless consortium had the possibility to study and find unexplored solutions which allowed to gain a very strong know how about the bonding technologies (FAM), the environmental effects of the glue reduction and raw materials in general (UNIMAN) and the product performances changes related to the standards (FATER). The result of this analysis has become the main instrument to evaluate and demonstrate with "numbers" the advantages and savings coming from the choice of a more sustainable production. The achievement of this type of result was possible because all the activities were carefully planned and the consortium was perfectly managed by the project coordinator who interlaced the inputs and outputs coming from each actor efficiently and effectively. With this approach FAM and the whole consortium learned that a good technical team is not enough to succeed but it must be fine coordinated in order to gather the best result by each partner.

Technically speaking a further practice lesson come out from the project. FAM, completing the action B.6, improved its know how in terms of hand making of diapers. This technic is not so common within the machines manufacturers even if it was the only way to construct the final demo diaper and validate the glueless concepts. To demonstrate the importance of this achievement it is important to note that after this experience FAM took advantage of this method to construct two further products to show up the FAM innovations to the customers and this

5. Innovation and demonstration value

When the Glueless project started, alternatives for the environmentally unfriendly gluing process, such as thermo-welding and ultrasonic, existed but however were not widely used by AHP producers and machine builders, due to three issues that LIFE-GLUELESS will tackle:

- The thermo-welding and ultrasonic process was perceived lower performance by AHP producers for High-Speed process of consumer products.
- The glue has always been considered a component of relatively limited importance from a cost point of view.
- A part of societal costs related to environmentally less friendly parts of the value chain (e.g. waste, or CO2 impact of used resources), typically did not impact AHP producers economically.

Starting from the fact that trends towards the principle of "Extended Producer Responsibility" and Social Corporate Responsibility lead to increased awareness and an upstream shift of responsibility, from a community to a manufacturer, the Glueless consortium started to work on the project with the aim to demonstrate the possibility to achieve the proposed results.

At the end of the project it was possible, not only to find out the advantage coming from the use of such technologies compared with the standard applications with glue, but also to demonstrate that the product and process performances are in line with the references on the AHP market. Furthermore it was shown the bonding technologies can be used to optimize the product design in order to save additional raw material thanks to specific patterns design (see elastic entrapment and FT application).

Through a very deep analysis, the Glueless consortium demonstrated that the state of the art of the technology is now ready to reduce the amount of glue in the AHP products just optimizing the process design and improving furthermore the performance level of the machine.

It's important to underline that the lab tests outcomes achieved and the future validations on industrial scale can be also taken as reference not only by the AHP producers but also by the whole sector of nonwoven in which the glue is widely used, increasing exponentially the environmental and socio-economic impact of the project on the entire market.

The achievement of this project will facilitate the way for manufacturers toward increasingly stringent environmental policies which gives priority to the waste hierarchy without affecting their economic growth and finally demonstrating that economic and social objectives can be moved by a single motor which is the technological development.

6. Long-term indicators of the project success.

The first and the main long term indicator of the project success will be for sure the number of Glueless feature that will be integrated on the production machines in the next years, but not only: the successful development of the Glueless project thanks to dynamic, friendly and efficient teamwork

as well as the relevance of the project outcomes has recently fuelled the development of a new R&D proposal written by FAM and UNIMAN for application to an EU funding grant. It allowed both partners to extend the partnership network where the knowledge and outcomes generated through the development of the Glueless project will be used as baseline to start working in a new sustainability-based industrial project.