2004
2020

Halfway the energy transition

THE DUTCH TRANSITION SUCCESS STORY

Paper and Board Industry
THE DUTCH TRANSITION SUCCESS STORY
# CONTENTS

PREFACE

SUMMARY

1 INTRODUCTION

1.1 Background: Transitions within a Transition

2 A SUCCESSION OF STEPS AND FOOTPRINTS

2.1 The great leap

2.2 The triple jump and series of footprints

3 THE THREE MAIN FOOTPRINTS

3.1 Energy footprint

3.2 Innovation footprint

3.3 Transition footprint

4 ENDING THE TRIPLE JUMP: FROM THE SANDPIT ONWARDS
PREFACE

The Dutch "Energy Transition" project is, as an innovative national/sectoral innovation concept with practical goals, acknowledged as pioneering and world class. The Dutch paper industry has also received accolades for its proactive stance.

Now the project is at the midpoint; one stage is ending, and the next stage should be planned. An evaluation of what has been achieved is a natural part of the discussion. The Koninklijke VNP (Royal Netherlands paper and board association) asked Pöyry to conduct an independent evaluation in the form of a wide-scope assessment of achievements springing out of the paper industry Transition. We have done so, and with excellent help from VNP in getting access to information created our view of the project's success so far. Our view is presented in this report.

Helsinki, February 2014

Petri Vasara
Dr.Tech., Global Practice Head

Katja Salmenkivi
Principal, Head of Chemicals and Biomaterials
SUMMARY

Energetic transition into the new millennium
At the start of the new millennium, The Fourth Dutch National Environmental Policy Plan (NMP4) appeared on the stage. One of its key elements was setting a target to achieve a transition to a sustainable energy system. Managed by the Ministry of Economic Affairs (Ministerie van Economische Zaken) the transition blossomed into concrete actions, among which the Dutch paper industry’s “Energy Transition in the Paper Chain” was a forerunner.

Goals and increasing ambition
The Transition’s goal is to halve energy consumption per end product in the paper value chain in 2020 compared to 2006. As is the case with successful processes, the appetite grew during the work, and the ambitions expanded beyond just direct measures to reduce energy consumption. It was realised that transitions in materials consumption, economy and innovation were essential.

The original goal of energy consumption reduction has for the paper industry been uncommonly successful among Dutch sectors. However, as the process continues, materials, economy and innovation became an integral part of the success.

Lastly, it should not be forgotten that the phase of the transition finishing now is not the end: a fourth goal is defining the implementation and execution of the results in the next phase.

The great leaps in a triple jump
The Transition progresses from energy through materials to economy and innovation can be seen as a “triple jump”, a set of footprints, a path towards the goal. This can actually be seen as a “virtuous cycle” of footprints: innovation and overall transition have a positive impact on energy, which boosts innovation and overall transition. Finally, the boundaries between energy, innovation and economy have begun to melt away – which is what a transition also should achieve.

SAVED, MOVED, NOTED, PAVED
In the footprints, there is also a transition: from the SAVED energy footprint focusing on energy savings through the MOVED innovation footprint emphasising moves in innovative projects and collaboration and the NOTED transition footprint examining the impact on networks of collaboration and growth of knowhow across sectors during the process. All this leads to a PAVED ground for the next phase of the Transition.
THE ENERGY FOOTPRINT

The energy footprint is on one hand, a single overall savings number; on the other hand, much more – a whole series of operations, innovation and knowhow increase. The importance of both energy saving through materials efficiency and value chain efficiency grew through the process, and progress overall and by measure was monitored.

Process efficiency measures deal with energy management and behaviour, installation and buildings and process measures, and value chain efficiency measures with distribution optimisation, working together on location, optimisation of product functions, life cycle optimisation and saving materials. Between 2006-2011, value chain efficiency was between 60 and 92% of the total savings. Within the value chain efficiency measures, especially material savings and optimisation of products and their re-use have been significant in their impact. For 2011, we have a 22% savings cake to divide. Note the success in “saving materials”.

Is the process on track? In practice, the original target can be translated as halving energy consumption inside the paper industry and in the part of the chain that directly builds on paper actions and that paper can influence and creating potential for the other value chains through e.g. joint projects. To examine the progress, we project a line with annual savings reaching 50 percent in 2020, and put in measured results 2006-2012. Given annual fluctuations, the last three years (2010-2012) show that the industry can indeed be said to be on track. In 2011, it was above the target, a fluctuation in 2012 brought it slightly below.

To make the savings more concrete, we can use an example. The paper industry saved enough energy in 2011 that, assuming it was all electricity, one could use it to power approximately half a million Dutch households (3.3 MWh/ hh/a in 2008, World Energy Council).

----

<table>
<thead>
<tr>
<th>Savings development 2006-2011:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit TJ/a</td>
</tr>
<tr>
<td>Energy from waste and biomass</td>
</tr>
<tr>
<td>Process measures</td>
</tr>
<tr>
<td>Other value chain</td>
</tr>
<tr>
<td>Saving materials</td>
</tr>
</tbody>
</table>

2011

- 909
- 479
- 2114
- 3048

Optimisation of products and re-use

Renewable energy
Value chain efficiency
Process efficiency

On track? Savings progressing towards 50% in 2020

ANNUAL ENERGY SAVINGS IN %

- 2006: 3%
- 2007: 5%
- 2008: 2%
- 2009: 11%
- 2010: 16%
- 2011: 22%
- 2012: 27%
- 2013: 31%
- 2014: 33%
- 2015: 37%

PERCENTAGE OF TARGET REACHED
**THE INNOVATION FOOTPRINT**

An energy footprint is supported by verified measurements and goals. In attempting to quantify an innovation footprint, we find that many candidate criteria are more difficult to measure. Research footprints have been done, but research is not the same as innovation. There is no similar innovation project to benchmark against, and the duration has been too short to verify innovation results.

The big point is that the Transition is more than just energy metering, and that a wide array of events has been set in motion, which has the potential to grow with increasing leaps.

Key elements, two legs to stand on, in all the practical creativity have been five programs and six roadmaps established by the Dutch paper industry during the Transition. The programs divided the field into manageable subtasks, which still were connected intricately. The roadmaps point a practical road forward.

**FROM THE INNOVATION CASEFILES**

Six cases have been selected as representative of innovation in Transition that combines energy, directly and indirectly through e.g. material savings and cooperation in the value chain.

**Example: Tomato board**

In cooperation with the horticulture sector fibers from tomato crops are used in the production of cardboard boxes in which tomatoes are packaged.

Apart from other fibers (agriculture residues) plant components are also used in paper and board products for additional functionality.

Hence, we have an entire ecosystem, with the tomato is red and flushed with activity from:
- packaging itself for transport, and via becoming bioplastics for the consumer
- providing active compounds for capture in a biorefinery
- supplying COD from remaining plant juices for the production of e.g. coating for paper (for horticultural magazines writing about tomatoes) or for film for packaging (for tomatoes)

---

<table>
<thead>
<tr>
<th>Innovation cases</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THE GRASBOX</strong></td>
<td>番茄板</td>
<td><strong>FATTY ACIDS FROM EFFLUENT</strong></td>
<td><strong>HEMP FIBRES</strong></td>
<td><strong>BIOPLASTICS FROM SIDESTREAMS</strong></td>
<td><strong>HEMP FIBRES</strong></td>
<td><strong>PAPER REJECTS AS COMPOSITES</strong></td>
</tr>
<tr>
<td><strong>TO TOMATO BOARD</strong></td>
<td><strong>Energy savings through new materials use (grass).</strong></td>
<td><strong>Energy savings by using waste streams.</strong></td>
<td><strong>Energy savings in chain by recovering valuable side-stream raw materials others produce separately.</strong></td>
<td><strong>Energy savings in materials chain by using side streams to replace production elsewhere.</strong></td>
<td><strong>Energy savings by CO2-efficient raw material.</strong></td>
<td><strong>Energy savings through using waste for valuable products.</strong></td>
</tr>
</tbody>
</table>

---

**Tomato board ecosystem**

- **fibres**
- **leaves**
- **tomato**
- **juices**
- **waste water compounds**
- **active compounds**
THE TRANSITION FOOTPRINT

The whole Transition is more than the sum of its parts - and that is more than a cliché.

The process leads from mill, to the whole industry, via the value chain to society, and the Transition footprint consists of steps and impacts in many directions. To bring this to light, one can look at impact on mills, impact on the Dutch paper industry, impact on the paper value chain, impact on other value chains, impact on the biorefinery cluster and impact on knowledge.

SPECIAL SUCCESS: IMPACT ON THE BIOREFINERY CLUSTER

Many breakthrough innovations are the results of partnerships and cooperation between companies from various sectors. The biggest challenge is finding the mutual language for cooperation.

The biorefinery cluster is a work in progress, used as an example outside the Netherlands of the most advanced ways to join sectoral interests. The origins lie in the paper sector and the agricultural sector. Paper industry and biomass is a familiar story; for the Dutch agricultural sector, starch is an example of one key resource. The first meeting was in 2006. A large step was the joining of the chemical industry in 2010 – a very significant player in the Netherlands. Building the biobased economy took a leap forward in 2012 – and currently the biobased industries public-private partnership BRIDGE is about to take flight. Having agriculture and chemicals as partners was not enough – in 2012 the horticultural sector joined. Now, the paper industry is joined by three of the most important sectors in the Netherlands. The story continues – and as it already ties in several absolutely key Dutch sectors as has a strong European dimension, it should be seen as exceeding expectations.

The impact on knowledge is easy to prove: more than 130 projects, cooperation between paper mills, inside different chains, upstream, downstream and across clusters. A very significant networking activity upstream, downstream and cross-stream has been ongoing during the Transition.

Hence, in our assessment, the development on mill, Dutch paper industry and biorefinery cluster level has been remarkable and exceeds expectations. The total paper chain impact meets expectations, and in the impact across sectors a good start has been made that needs to be expanded upon.

Now we have given a glimpse into the numbers in SAVED energy, MOVED and mobilised resources in innovation, and seen what has been NOTED across sectors about the Dutch paper industry. How is the ground PAVED for the next phase of the Transition process?
ENDING THE TRIPLE JUMP: NEXT STEPS

Now, the first triple jump energy-innovation-transition is ending. During that jump (2006-2013) a lot has happened: the industry is on track in energy savings, innovative projects, roadmaps and plans for 2013-2016 exist. At the same time, these actions have strengthened the paper industry’s foothold in the chain, across sectors and clusters – and also internal networking. Steps have been taken, elements are in place. Taking our three footprints and their acronyms: in 2006-2013 the industry has SAVED energy, MOVED industry thinking, NOTED the current “springboard” state which has PAVED the road for a “network effect”.

WHAT SHOULD HAPPEN NEXT?

1. Continue on track towards 50% savings

The march towards the goal of 50% reduction in energy per end product in 2020 is on track, and needs to continue. The actors in the paper industry are up to speed and the early stages of the learning curve have been passed.

2. Choose next steps in savings measures

In materials saving and process efficiency, many of the currently available and developed methods have been used. Next steps are needed.

3. Start the demonstration project phase

For the next steps, a rich portfolio of projects have been done or are continuing. Now, the stage of demonstration projects based on the projects is at hand.

4. Use the established network in the paper chain and across sectors for expansion in collaboration

In the paper chain and across sectors, the groundwork and structures for collaboration projects has been laid. Now, the “network effect” must be used. The network effect is the effect that one additional user of a good or service has on the value of that product to other users in the network. Once a critical level of users/participants in the network is achieved, benefits multiply.

5. Make strategic decisions on actions divided into Dutch and European levels

Apart from measures in the Netherlands with Dutch participants, there is a European dimension exemplified by the biobased industries public-private partnership BRIDGE. The time for strategic choices between actions on a Dutch and European level is here.

It is time for a great leap. Again.
1. INTRODUCTION

1.1 BACKGROUND: TRANSITIONS WITHIN A TRANSITION

What is the Energy Transition?
At the start of the new millennium, The Fourth Dutch National Environmental Policy Plan (NMP4) appeared on the stage. One of its key elements was setting a target to achieve a transition to a sustainable energy system. As a consequence, in March 2001, the Ministry of Economic Affairs (‘Ministerie van Economische Zaken’) applied its mandate in energy and innovation policy and became the ‘transition manager’. Starting with a stakeholder consultation, the transition blossomed into concrete actions, among which the Dutch paper industry’s “Energy Transition in the Paper Chain” was a forerunner. This paper industry initiative led to an ongoing program and process to implement defined goals. This report looks at the stage of this implementation in mid-2013 and roads ahead. Henceforward, we will call the “Energy Transition in the Paper Chain” simply “Transition” – capitalised, as befits a significant process.

What was to be the result?
To begin with, the Transition was aimed at halving energy consumption per end product in the paper value chain in 2020. As is the case with successful processes, the appetite grew during the work, and the ambitions expanded beyond just direct measures to reduce energy consumption.

What was actually achieved?
What actually happened was a transition – and a series of transitions within the transition. That is, within the overall goal of energy, it was realised that transitions in materials consumption, economy and innovation were essential.

The original goal of energy consumption reduction has for the paper industry been uncommonly successful among Dutch sectors. However, as the process continues, materials, economy and innovation became an integral part of the success.

Lastly, it should not be forgotten that phase of the transition finishing now is not the end: a fourth goal is defining the implementation and execution of the results in the next phase.

It is essential to note that no change of overall goal took place. It just transpired that with increased understanding of the whole, new transitions inside the transition became necessary to reach the original goal. Thus,
• to reach reductions in energy consumption, a focus on direct energy efficiency proved in many cases inferior to savings in materials consumption. Likewise,
• a strict industrial process focus on energy and materials proved inferior to a simultaneous transition in economy and innovation.

Figure 1 is an abstraction of what happened: in what is to come we will document it with cases, success stories and numbers.
2. A SUCCESSION OF STEPS AND FOOTPRINTS

2.1 THE GREAT LEAP

Every journey begins with a single step. The energy transition for the paper chain began as a long jump, as in its original signature video clip from 2005. A long jumper knows approximately where he will end up, and during the jump gets a feel for what the end result will be. The jumper leaves footprints in the pit where he lands.

For the Transition, the jump started as a battle against climate change. The carbon footprint has in many cases become almost a symbol of practical work on reducing greenhouse gas emissions. However, the land footprint and water footprint have also figured as sustainability tools. It stood to reason that an energy or carbon footprint could illustrate part of what the Transition achieved.

The Transition progress from energy through materials to economy and innovation can be seen as a set of footprints, a path towards the goal. This can actually be seen as a “virtuous cycle” of footprints: innovation and overall transition have a positive impact on energy, which boosts innovation and overall transition (Figure 2).

It began with “reducing energy consumption per end product in the paper value chain by 50%” as the goal. It then turned out that through reducing materials use by e.g. 10% one could save more than 10% in energy: a “materials footprint” took over. Then, realisation dawned that energy and materials including water should be regarded as a total resource footprint. From a focus on just reduction in energy consumption, the emphasis on economy and then innovation became apparent. Finally, the boundaries between energy, innovation and economy have begun to melt away – which is what a transition also should achieve.

Similarly, as in Figure 3, what happens in the paper industry is like the heel, what happens in the paper chain outside the paper industry the ball of the foot and the toes the directions that keep balance; in this case, the toes are a set of carefully crafted Transition roadmaps created by the paper industry in the process.

---

**CARBON FOOTPRINT**

A carbon footprint was defined by Championne as “the total sets of greenhouse gas (GHG) emissions caused by an organization, event, product or person.”

A more workable definition is found in the journal Carbon Management (Wright, Kemp, and Williams): “A measure of the total amount of carbon dioxide (CO2) and methane (CH4) emissions of a defined population, system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest. Calculated as carbon dioxide equivalent (CO2e) using the relevant 100-year global warming potential (GWP100)”

---

**Figure 2** | Transition as a “virtuous cycle” of footprints

**Figure 3** | Heel, step, toes
2.2 THE TRIPLE JUMP AND SERIES OF FOOTPRINTS

However, it turned out that the Transition was more like a triple jump: longer, tougher on the legs and more technically demanding. Likewise, the steps in the Transition gave a growing feeling for the right direction – and the next steps to take. A triple jump consists of, obviously, three parts:

• the **hop**: where the jumper must take off and land on the same foot. If the focus is on purely energy, it is obvious that the Transition must land on “the energy foot”.

• the **step**: where the jumper lands on the opposite foot. If one realises that a broadened focus is needed, one lands leaving a different footprint.

• the **jump**: where the jumper goes all out and lands with both feet in the landing area. Obviously, the Transition must land in lowered energy consumption and, having achieved the goal, with a new plan. The triple jumper does not end up standing still, looking around in the sand pit.

**FIGURE 4 | Transition triple jump: Energy, Innovation, Transition – followed by Implementation**

IT TURNED OUT THAT THE TRANSITION WAS MORE LIKE A TRIPLE JUMP: LONGER, TOUGHER ON THE LEGS, AND MORE TECHNICALLY DEMANDING.
3. THE THREE MAIN FOOTPRINTS

As described above, the Transition is also a story of expanding horizons from energy to innovation and a broader view of the transition itself. This is mirrored by the energy, innovation and transition footprints.

3.1 ENERGY FOOTPRINT

THE MAIN ENERGY OUTCOMES IN PROPORTION

The energy footprint is
• On one hand a single overall savings number
• On the other hand much more – a whole series of operations, innovation and knowhow increase

On the previous pages, we have outlined how, during the Transition process, the realisation of the importance of both energy saving through materials efficiency and value chain efficiency grew. This is shown likewise very efficiently by Figure 5. In it, the amount and distribution of different types of measures is shown.

If we define process efficiency measures as energy management and behaviour, installation and buildings and process measures, and value chain efficiency measures as distribution optimisation, working together on location, optimisation of product functions, life cycle optimisation and saving materials, it turns out that, between 2006-2011, value chain efficiency was between 60 and 92% of the total savings. Within the value chain efficiency measures, especially material savings and optimisation of products and their re-use have been significant in their impact. For 2011, we have a 22% savings cake to divide as in Figure 6. Note the significant results with materials.

Within the value chain efficiency measures, two significant types of measures have been the optimisation of products and their re-use and saving materials or resources. The significance of the former has been rising over time. In absolute terms, this can be seen in Figure 5. Figure 7 presents the development of the relative share of these two over time. This is a quite logical development, given that savings in materials often present less initial challenges than optimisation of products and re-use.
Using the heel/toe analogy we have a light step on the heel and the weight of the savings on the ball (Figure 8). It should be noted that a savings rule of thumb “one third in the paper sector, two thirds outside” has been used. Figure 8 does not in itself contradict that – it is based on certain boundaries in how we classify energy savings measures, and the boundaries are getting closer, other divisions could be used.

Are we on track?
Of course, it is of the greatest interest to see whether the Transition is on track for the original goal. Can energy consumption be halved by 2020? First, we have to open up the definition of the target.

**DEFINITION OF TARGET**

‘Halving the energy consumption per end product in the paper value chain’ has been the original and, of course, still valid overall target. In practice, halving can be defined as:

- the impact of the energy savings inside the paper industry and the value chain that directly builds on paper actions and that paper can influence;
- creating potential for the other value chains through e.g. joint projects (e.g. “Sustainable Book”, see later)

It is important to examine what can be directly influenced by the paper industry, inside its own facilities or in a direct logical sequence from the paper industry to its clients – not everything that the paper industry’s clients do is related to the paper industry (Figure 9).

To examine the progress, we project a line with annual savings reaching 50% in 2020, and put in measured results 2006-2012. Given annual fluctuations, the last three years (2010-2012) show that the industry can indeed be said to be on track. In 2011, it was above the target; a fluctuation in 2012 brought it slightly below (Figure 10).
MAKING SAVINGS MORE CONCRETE: FROM TERAJOULES TO EVERYDAY PHENOMENA

The total energy savings obtained in the Dutch paper industry through process and value chain efficiency measures were approximately 5,900 TJ (1.650 GWh) in 2011. To make this number easier to grasp, let us move from TJ to concrete examples.

Providing electricity for Dutch households
The paper industry saved enough energy in 2011 that, assuming it was all electricity, one could use it to power approximately half a million Dutch households (Figure 11; 3.3 MWh/hh/a in 2008, World Energy Council).

Water traffic
Assuming that all the energy saved by the paper industry would be fuel, it would be enough to transport more than five thousand barges each with a cargo of 3,000 tonnes from one end to the other end of the Rhine (Figure 12).

The savings clock: Spreading the light
If the savings from the Dutch paper industry in 2011 could be used to provide lighting, it would take 18 hours of savings to light up the entire Dutch land area for an hour (Figure 13).

FIGURE 11 | Energy savings in the paper industry in 2011 and Dutch households
500,000 out of the total 7,600,000 Dutch households could be powered by 2011 energy savings in the paper industry

FIGURE 12 | Energy savings in the paper industry in 2011 and Rhine barges
5,000+ barges ... of 3,000 tonnes cargo ... from Rotterdam to the end of the Rhine

FIGURE 13 | Spreading the light: Savings clock

SPREADING LIGHT
In one second, the Dutch paper industry saved 52 kWh in 2011
The new Philips TLED gives 200 lumen/watt, so the savings could be used to produce 10,450 lumen for an hour
In one second, the savings light up 0.5 km²
In one minute and 43 seconds, the savings could light up De Hoge Veluwe National Park (54 km²) for an hour
In about 18 hours of savings, the whole land mass of the Netherlands could be lit for an hour
SPIDERY ENERGY FOOTPRINT: SAVED

How should we try to summarise the many dimensions of results in one figure? What has been SAVED? It is best to have a time series where all the numbers are fully comparable, i.e. data from the transition period. The period 2006 to 2011 is the current “equal comparison” set of data. We could then look at participation, progress in total and progress in value chain and process efficiency.

Participation (criteria S, A): how many of the mills have implemented measures in the two groups value chain and process efficiency?

This gives two criteria: one that deals with the proportion of mills that have implemented savings in the value chain (S = Proportion of mills doing Savings in value chain) and another that deals with process efficiency implementation (A = Proportion of mills Active in process efficiency measures). A suitable scaling for these criteria would be from 0 to 100, with the number being the percentage of mills qualifying.

Progress in the sum total (criterion V): how much has been saved related to the 2020 goal?

V stands for “Value of total savings”. Now, how do we reasonably transform that to the same 0..100-axis? Let’s assume that the total goal of halving should be reached by 2020. We can calculate an annual target percentage for each year 2006..2020 by having a linear progress from 0% to 50%. If the target for the year is 25%, and we have reached 22%, the index would be 100*22/25 = 88.

Progress in value chain and process efficiency (criteria E, D): how much has been accomplished in value chain and process efficiency measures?

Here, the problem is that we don’t have a specific goal for either – and sustainable energy is the third component in savings. But, let’s accept this imperfection and link these criteria to the total savings. That is, for E (Energy saved in process measures) and D (Savings Done by process measures), we have the same annual goal as for total savings above, but the sum can maximally be 100 and this only if the amount of sustainable energy is zero. If the savings in E or D are 15% and 5%, and the annual target is 25%, we have the values 100*15/25 = 60 and 100*5/25 = 20.

In the end, the big picture on what has been saved comes from the S, A, V, E, D criteria. The table at the right encapsulates the above, with 2006 and 2011 numbers.

<table>
<thead>
<tr>
<th>LETTER</th>
<th>MEANING</th>
<th>SCALING</th>
<th>2006 absolute (TJ/y)</th>
<th>2011 absolute (TJ/y)</th>
<th>2006 %</th>
<th>2011 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Proportion of mills doing Savings in value chain</td>
<td>From 0 to 100; 100% all mills</td>
<td>-</td>
<td>-</td>
<td>53%</td>
<td>100%</td>
</tr>
<tr>
<td>A</td>
<td>Proportion of mills Active in process efficiency measures</td>
<td>From 0 to 100; 100% all mills</td>
<td>-</td>
<td>-</td>
<td>16%</td>
<td>84%</td>
</tr>
<tr>
<td>V</td>
<td>Value of total savings</td>
<td>Scaled so that 50% of 2011 total consumption is 100 (i.e. how much of 50% savings goal for 2011 reached overall)</td>
<td>837</td>
<td>6834</td>
<td>5%</td>
<td>45%</td>
</tr>
<tr>
<td>E</td>
<td>Energy saved in value chain measures</td>
<td>Scaled so that 50% of 2011 total consumption is 100 (i.e. how much of 50% savings goal for 2011 reached by value chain measures)</td>
<td>709</td>
<td>5429</td>
<td>5%</td>
<td>35%</td>
</tr>
<tr>
<td>D</td>
<td>Savings Done by process measures</td>
<td>Scaled so that 50% of 2011 total consumption is 100 (i.e. how much of 50% savings goal for 2011 reached by process measures)</td>
<td>129</td>
<td>496</td>
<td>1%</td>
<td>3%</td>
</tr>
</tbody>
</table>

1For 2012, division not yet available / 2For 2012, division not yet available / 3For 2012, division not yet available
Now we have given a glimpse into the numbers in SAVED energy. In the meantime, what has MOVED in innovation?

**FIGURE 14 | Energy: Spidery footprint SAVED**

Overall, activity is commendable (S and A) and at 100% for both in 2012. Progress from 2006 has been considerable.

- **For process efficiency**, from 16% of mills doing measures in 2006 we have advanced to 84% in 2011 (and 100% in 2012).
- **For value chain measures**, we have advanced from 53% of active mills in 2006 to 100% in 2011 (and 2012). Full score, 100%, in 2012 for both the activities above.
- **For total savings**, we think as follows: in 2011, 23782 TJ/y were consumed by the industry and 6834 TJ/y saved – altogether a "no-savings-total" of 33782 + 6834 = 30616 TJ/y. If 50% of the total had been saved, the saved amount would be half of 30616 TJ/y = 15308 TJ/y. Then we would be at the final Transition goal. How large a percentage of that goal did we reach totally, and how much of it did value chain measures and process measures contribute? We come up to 45% for the total (6834 divided by 15308), and 35% for value chain measures (5429 divided by 15308) and 3% for process efficiency measures (496 divided by 15308), with the balance being the utilisation of sustainable energy (remaining 7 percent). Since we do not split the target, the value chain and process part may as well be compared to the total.

---

Overall, activity is commendable (S and A) and at 100% for both in 2012. Progress from 2006 has been considerable.
3.2 INNOVATION FOOTPRINT

WHAT IS AN INNOVATION FOOTPRINT?

An energy footprint is supported by verified measurements and goals, as we have said. The Transition is not just energy indicators, it is a whole of savings, innovation and transition. In attempting to quantify an innovation footprint, we find that many candidate criteria are more difficult to measure. Moreover, data have not been collected to the same extent as for energy savings. Finally, many new development projects in the Transition have yet to show results; the time period so far is too short for that. Based on experience and Transition circumstances, an innovation footprint for the Transition was created.

As in Figure 15, we should concentrate on projects and their networks. We have three key problems:

- Research footprints have been done, but research is not the same as innovation
- There is no similar innovation project to benchmark against
- The duration has been too short to verify innovation results

As solutions, we propose:

- Establishing own “pioneering” criteria
- Working using cases and qualitative results

The big point is that the Transition is more than just energy metering, and that a wide array of events has been set in motion, which has the potential to grow with increasing leaps.

STEPPING FORWARDS: PROGRAMS AND ROADMAPS

Key elements, two legs to stand on, in all the practical creativity have been five programs and six roadmaps established by the Dutch paper industry during the Transition (Figure 16). The programs divided the field into manageable subtasks, which still were connected intricately. The roadmaps point a practical road forward.

Numbers for the amount of projects and participants exist. To complement those, a set of chosen innovation casefiles is highly useful. The choice of projects to present has to be subjective: even if one wanted to do a cost/benefit/savings analysis and put all the projects on the same playing field, it is simply too early in the lifetime of the projects to have final data.

Hence, the choice here attempts to bring in projects showing the breadth of work inside the Transition. The process has truly expanded into innovative directions that also generate energy savings; e.g. the purely and directly technical process energy efficiency measures have been left in the Energy Footprint. This does not mean that they would not be innovative – they simply are more in line with what was expected, whereas the casefiles show new directions evolving during the process.

HOW DO THE CASEFILES LINK TO THE INNOVATION FOOTPRINT?

The numbers available for indices do not contain any assessment of how innovative the projects are. So, one could have a multitude of very conventional projects with many participants, and get an impressive score. For such numbers to be credible, it has to be established that there is a richness of innovative projects. This is the purpose of the casefiles. There could have been many more, but even this amount covers a very broad spectrum of innovative projects.

---

**Figure 15 | Research and Transition innovation footprint**

**Figure 16 | From programs to roadmaps**
THE TRANSITION IS MORE THAN JUST ENERGY METERING, A WIDE ARRAY OF EVENTS HAS BEEN SET IN MOTION, WHICH HAS THE POTENTIAL TO GROW WITH INCREASING LEAPS.

FROM THE INNOVATION CASEFILES

Six cases (Figure 17) have been selected as representative of innovation in Transition that combines
- energy, directly and indirectly through e.g. materials savings
- cooperation in value chain
- intersectoral cooperation

![Figure 17 | Innovation cases](image)

**CASE 1: THE GRASBOX**

![Figure 18 | Grasbox index card](image)

**The Grasbox is a solid Dutch invention in the area of alternative raw materials. It is solid board made from natural grass (up to 25%) in combination with regular paper for recycling. It has a positive impact on the CO2 balance and is applicable in areas such as meat and poultry, filing and archive, fish, financial, flowers, agriculture, leisure parks, retail – wherever natural packaging from grass is welcome.**
In cooperation with the horticulture sector fibers from tomato crops are used in the production of cardboard boxes in which tomatoes are packaged.

Apart from other fibers (agriculture residues) plant components are also used in paper and board products for additional functionality.

Hence, we have an entire ecosystem, with the tomato is red and flushed with activity from:
- packaging itself for transport, and via becoming bioplastics for the consumer
- providing active compounds for capture in a biorefinery
- supplying COD from remaining plant juices for the production of e.g. coating for paper (for horticultural magazines writing about tomatoes) or for film for packaging (for tomatoes)

While the construction of the tomato board case could be argued to be not quite up to the genius of M.C. Escher, it has some very interesting aspects outlined in Figure 20.

The tomato board ecosystem actually encapsulates many of the best integrated features of the Transition innovations, as in Figure 21.
Process water as a goldmine

It is popular to talk about what a goldmine forests are as sources of paper products, chemicals and advanced biofuel raw material. However, “liquid gold”, waste water in mills is also a goldmine. Starches and other components from paper for recycling are dissolved in the process water and will be naturally converted into fatty acids. These can be isolated from the water or in the water microbiologically be converted to bio plastics (PHA; PolyHydroxyAlkanoates) which can be used as packaging material, foil or laminate. The paper industry's processes produce fatty acids that other industries desperately seek.

Hemp as Dutch cotton

Traditionally cotton fibers are used for banknotes and art paper. Hemp is being tested as a full replacement fiber source for these high end applications. The impact on energy and CO2 is estimated to be positive.

From paper sludge to bioplastic

The cellulosic part of paper sludge can be hydrolyzed and fermented to lactic acid - and lactic acid can be turned into PLA bioplastic which is being used as packaging material (foils and cups) – and even as the “3D ink” for 3D printers.

Energy savings

in materials chain by using sidestreams to replace production elsewhere.

Paper rejects contain wood fibre and conventional plastics. Thus, paper rejects are a good source for conversion to Wood Plastic Composites (WPCs).

Composites (e.g. wood/plastic, wood/glass) are not new, but enjoying a new rise.

Energy savings through using waste for valuable products.

Paper rejects as Wood Plastic Composites

As paper rejects consist of wood fiber and conventional plastics, by extrusion they can be converted into Wood Plastic Composites. WPC’s are used in deck floors, fences and traffic bollards.

Cotton and hemp are ancient raw materials for many uses. Cotton is globally suffering from pesticides and water use.

Energy savings by CO2-efficient raw material.

Artists’ paper and banknotes are traditional high-end cotton end uses.

Hemp is tested as a full substitute for cotton in these areas.

When other sectors desperately seek fatty acids, the paper industry already makes them.

Energy savings in chain by recovering valuable side-stream raw materials others produce separately.

Paper for Recycling-components(e.g. starch) dissolve in process water and convert to fatty acids.

Paper for recycling-components in the process water could also be converted to bioplastics, followed by recovery.

Lactic acid, in turn, can be made into PLA bioplastic which is used in packaging.

The cellulosic part of paper sludge is actually a promising raw material instead of a problem.

Energy savings in materials chain by using sidestreams to replace production elsewhere.

It can e.g. be hydrolysed and fermented to lactic acid.

Lactic acid, in turn, can be made into PLA bioplastic which is used in packaging.
CASE SUMMARY

Mapping the innovation cases on the axes "value added" and "material savings" is a difficult exercise – a techno-economic analysis would have to be made (and also made publicly available) on each.

However, Figure 26 has value as it puts the innovation cases in a joint framework – and gives a foretaste of what a presentation of the tens of projects in Transition will result in.

PROJECT LIBRARY

Out of the quite numerous projects, let’s pick out a “bookshelf library” of connected projects for use later in the Transition footprint (Figure 27).

SPIDERY INNOVATION FOOTPRINT: MOVED

For the energy footprint, we had the SAVED criteria. How should we try to summarise innovation in the Transition? What has MOVED? Again, we have to keep in mind the difficulty of meaningful and simple numbers for innovation. We are in the midst of a Transition, with the wheels in motion but far from the end destination.

We could here look at the total project portfolio (analogous to “total savings” in the Energy Footprint), participation (as we did in the Energy footprint), and also the financial impact of savings from energy on innovation.

The total project portfolio (criterion M): how many projects, on average, are active or have been active during the Transition?

The amount of projects by itself does not guarantee quality but indicates activity. Moreover, a certain part of innovation projects always fail. Without enough projects, very few successes can be expected. In the MOVED criteria, M stands for “Mass of innovation projects” (average over areas, see Figure 28).

Participation (criteria O, V, E): how large is participation expressed as projects by mill, average number of partners and cross-sectoral participation?

O is for “Opening mills outwards” i.e. mills’ average project participation; V is “Value in networking (the average number of partners in a project); and E is “Enabling cross-sectoral resources” (percentage of cross-sectoral projects).

Innovation enabled by energy savings (criterion D): if we used the money saved in energy costs in the transition, how much innovation could we finance?

D is for “Development enabled by savings”. In the latter, we have calculated the monetary value of the energy savings, assumed a certain average development project cost and arrived at how many new projects would be enabled by energy savings.

In the end, the big picture on what has been moved into innovation through the Transition progress comes from the M, O, V, E, D criteria.
**SOME COMMENTS ON THE CALCULATIONS**

- There are no “obvious and unequivocal” ways to scale the chart dimensions 0..100. Pragmatism and estimations have to be used.
- For the portfolio of projects M, we now have an average of 31 projects per area (Figure 28, as for all other criteria). Is this superb, optimal, too many, too few? The underlying assumption is that with 23 mills and cross-sectoral partners in five areas, it is possible to deal with this amount of projects without losing focus. Actually, perhaps some strategic, lightweight projects with completely new partners could be added. Hence, an interpolation from 0..100 from 0 to 40 projects per area.
- For O, how many projects per mill, with the current index at 1.34, one has to ponder strategically? The resources available to especially smaller mills are very limited. However, for networking purposes and the growth of the whole innovation process, a “lighter” listening-in participation would be beneficial. Hence, an interpolation 0..100 from 0 to 3 projects/mill.
- For V, value in networking i.e. the average number of partners, a similar reasoning as for projects per mill leads to the same scaling as for O.
- For E, “Enabling cross-sectoral resources”, i.e. the percentage of cross-sectoral projects, the figure is already very high. However, with a goal of spreading innovation impact, burden and knowhow and learning from other sectors, there is no reason not to have full cross-sectoral participation as goal (100).
- For D, “development enabled by savings”, we have calculated the monetary value of the energy savings, assumed a development project cost of 500,000 EUR (expert estimate) and arrived at how many new projects are enabled by savings. The estimate for monetised energy savings ranges from 54.3 to 81.4 million Euro. The upper limit gives 163 projects enabled. As the savings are on track, it makes sense to only increase the target somewhat, to 200 projects (100 million Euro).

**FIGURE 29 | Innovation: Spidery footprint MOVED**

Now we have given a glimpse into the numbers in SAVED energy and MOVED and mobilised resources in innovation. Now, what has been NOTED across sectors about the Dutch paper industry Transition process?
3.3 TRANSITION FOOTPRINT

WHAT IS THE TRANSITION FOOTPRINT?

The whole Transition is more than the sum of its parts - and that is more than a cliché.
The process leads from mills to the whole industry and society, and the Transition footprint consists of steps and impacts in many directions (Figure 30).

CLIMBING UP TOWARDS THE TRANSITION

The following criteria were picked as parts of the Transition footprint:

- impact on mills
- impact on the Dutch paper industry
- impact on the paper value chain
- impact on other value chains
- impact on the biorefinery cluster
- impact on knowledge

Many of these can be touched upon by referring to items presented earlier in the Energy and Innovation footprints. However, new additions appear.

The measurability of criteria goes one step down from the Innovation footprint, and is far from the Energy footprint. However, what we are showing here is the Big Picture – something that can easily be lost in just tables of numbers.

If we have to have a scale, so as to have three “footprint charts”, a suitable scale linked to the goals could be

- 100 = A wider Transition process and results than originally envisioned
- 66  = Well meets original Transition goals
- 33  = Is a start, but is something that needs to be expanded in the next phase
- 0   = Fails expectations

Such a scale is of course subjective, but evidence has been presented in this report, more can be had by diving deeper – there is a foundation of facts for the story.

One cannot benchmark against a future that didn’t happen. So, what we can do is look at what new developments happened. Since what is looked at here comes under the Transition umbrella, it is reasonable to assume the impact of the Transition. Likewise, the question is whether developments have worked to save energy, work across the paper value chain and across clusters, and whether preconditions for going further have been successfully put in place.
IMPACT ON MILLS

A combination of practical implementation at mills, joint development inside the paper industry and cross-chain and cross-cluster work has, as previous chapters have shown, had a marked impact on the Dutch mills’ activities.
• the energy savings from the mills have been looked at
• the different types of measures for mill energy saving have been classified and measured
• the evolution of the different measures at mills including materials saving and renewable energy have been charted
• the amount of innovation projects of different types the mills have participated in has been analysed
• Cooperation networks for mills and cross-sectorial cooperation have been measured

Looking at the evidence from the Energy and Innovation footprints, it is easy to argue that all original goals have been met, and that a wider process than originally envisioned has taken place at mill level.

IMPACT ON THE DUTCH PAPER INDUSTRY

For the Dutch paper industry perspective, the success in mills is obviously one component. What we also need to consider is
• the five successful programs
• the six roadmaps
• the results in pure energy saving being on track
• the new elements in the overall joint strategy e.g. regarding material savings
• the success in creating innovation projects (see e.g. the casefiles in the Innovation footprint section) that combine marketable products and energy savings

and it becomes likewise easy to argue for a wider process than originally envisioned.
IMPACT ON THE PAPER VALUE CHAIN

A reasonable method here is to pick in representative projects creating direct impact or potential in different parts of the paper industry value chain.

Sustainable Book in the project library
Among Transition coalitions seeking to achieve better cooperation in the paper chain, it is natural to look for significant projects dealing with magazines, books, and packaging of various types. As an example of a success, a collaboration project called “Sustainable Book” covers the graphic chain and the results offer potential for 50% energy savings. Of course, this potential has to be actively embraced by book printers and publishers.

“Sustainable Book”, if widely taken into use by book media, would revolutionise the impact of book printing and selling, and offer an even better dynamic duo of endproducts “printed books/e-books”. However, the paper industry cannot “force” adoption of this project or even joint further development – that has to occur with the other party actively willing it.

In the paper value chain, packaging and cartonboard have been the subject of many pioneering projects in Transition. The project areas have been examined. Here, there is definite participation from the paper chain end users and mid-stage players. The question to answer is: does this exceed expectations, meet them or fall below the target? In our opinion, the growing ambition level and actual projects implemented and ongoing well defend a meeting of the expectations. However, the amount of success in the paper chain, while needing partner activity, does perhaps not merit to be evaluated as widely exceeding expectations.

IMPACT ON OTHER VALUE CHAINS: MANY POTENTIAL LENDERS FROM THE PAPER INDUSTRY PROJECT LIBRARY

During the Transition, the paper industry has created a large portfolio of projects interconnected by topics and players. From that portfolio, a pick was made as a potential attractive “lending library” for other value chains (Figure 31).

What’s in place is a varied portfolio of projects with potential interest and results for a variety of sectors (Figure 32) – some of which are already linked in.

This is an ideal situation to expand into a much wider network of impact, with gains for both the paper industry and a variety of chains.
Chemicals, petrochemicals and fuels are drawn in by several related projects. Machinery and equipment makers find potential in process projects. E.g. tags bring in retail, logistics and consumer electronics. New materials have potential for the agro and horti sector. “Sustainable Book” and others are for media; numerous packaging projects bring in food and cosmetics. Finally, energy is behind the whole Transition.

So, a groundwork has been laid for expansion in the next phase. Thus, it seems prudent to here put the results as a good start, but something that needs to be expanded in the next phase of the Transition.

**IMPACT ON THE BIOREFINERY CLUSTER**

**Intersectorial cooperation**

Many breakthrough innovations are the results of partnerships and cooperation between companies from various sectors. The biggest challenge is finding the mutual language for cooperation, when the sectors are as varied as in Figure 33.

The Dutch biorefinery cluster is a work in progress, used as an example outside the Netherlands of the most advanced ways to join sectoral interests. The origins lie in the paper sector and the agricultural sector. Paper industry and biomass is a familiar story for the Dutch agricultural sector, starch is an example of one key resource. The first meeting was in 2006 (Figure 34). A large step was the joining of the chemical industry in 2010 – a very significant player in the Netherlands. Building the biobased economy took a leap forward in 2012 – and currently the biobased industries public-private partnership BRIDGE is about to take flight. Having agriculture and chemicals as partners was not enough – in 2012 the horticultural sector joined. Now, the paper industry is joined by three of the most important sectors in the Netherlands. The story continues – and as it already ties in several absolutely key Dutch sectors as has a strong European dimension, it should be seen as exceeding expectations.
IMPACT ON KNOWLEDGE AND UPSTREAM CROSS-STREAM DOWNSTREAM IMPACT FLOW

The impact on knowledge is easy to prove: 150+ projects, cooperation between paper mills, inside different chains, upstream, downstream and across clusters.

Upstream cross-stream downstream: Impact Flow
A very significant networking activity upstream, downstream and cross-stream has been ongoing during the Transition. We have 150 projects, which can be categorised into seven groups (Figure 35).

Slopes for the project groups
We have three different “slopes”:

• cross-stream orientation: new raw materials, integrated biorefineries and sidestream valorisation are strongly focussed on cross-sectorial cooperation

• downstream orientation: new products, production and conversion technologies and related projects are strongly “leaning downstream”

• upstream orientation: energy-related projects are the only ones that lean upstream

All this makes sense: biomass processing is a cross-sectorial interest; new products and conversion link up to consumers; and energy has been focusing upstream – the chance for transition is to expand this downstream.

Overall, the “Transition stream is flowing strongly downstream”, as in Figure 36.
SPIDER Transition Footprint: Noted

The Transition footprint noted is notably more qualitative than especially the energy footprint. The exceeds/meets/a start-scale is used. The criteria are N for “New impacts on mills”; O for “Overall impact on paper industry”; T for “Total paper chain impact”; E for “Evolved cross-sectoral ties” and, finally, D for “Developing biorefinery cluster”.

Hence, in our assessment, the development on mill, Dutch paper industry and biorefinery cluster level has been remarkable and exceeds expectations. The total paper chain impact meets expectations, and on the impact across sectors a good start has been made that needs to be expanded upon.

Now we have given a glimpse into the numbers in saved energy, moved and mobilized resources in innovation, and seen what has been noted across sectors about the Dutch paper industry. How is the ground paved for the next phase of the transition process?

**Figure 3.7 | Transition: Spidery footprint noted**

The industry is on track in energy savings, expanding pure energy projects downstream is one chance for the transition.
4. ENDING THE TRIPLE JUMP: FROM THE SANDPIT ONSWARDS

We started with the “Transition Man” in 2005 and his jump to something more than anticipated: not just energy but also innovation and activities across clusters and sectors.

Now, the first triple jump energy-innovation-transition is ending. During that jump (2006-2012) a lot has happened: the industry is on track in energy savings, innovative projects, roadmaps and plans for 2013-2016 exist. At the same time, the projects have strengthened the paper industry’s foothold in the chain, across sectors and clusters – and also internal networking. Steps have been taken, elements are in place (Figure 38).

The work in the Transition projects has given output in three streams:

- **cross-cluster orientation:**
  new raw materials, integrated biorefineries and sidestream valorisation are strongly focussed on cross-cluster cooperation

- **downstream orientation:**
  new products, production and conversion technologies and related projects are strongly “leaning downstream”

- **upstream orientation:**
  energy-related projects are the only ones that lean upstream

Expanding pure energy projects downstream is one chance for the Transition.

Taking our three footprints and their acronyms: in 2006-2012 the industry has SAVED energy, MOVED industry thinking, NOTED the current “springboard” state which has PAVED the road for a “network effect”.  

**Figure 38 | Steps taken, elements in place**

**Figure 39 | “Leap 2014”**
WHAT SHOULD HAPPEN NEXT?

1 Continue on track towards 50% savings

The march towards the goal of 50% reduction in energy per end product in 2020 is on track, and needs to continue. The actors in the paper industry are up to speed and the early stages of the learning curve have been passed.

2 Choose next steps in savings measures

In materials saving and process efficiency, many of the currently available and developed methods have been used. Next steps are needed.

3 Start the demonstration project phase

For the next steps, a rich portfolio of projects have been done or are continuing. Now, the stage of demonstration projects based on the projects is at hand.

4 Use the established network in the paper chain and across sectors for expansion in collaboration

In the paper chain and across sectors, the groundwork and structures for collaboration projects have been laid. Now, the “network effect” must be used. The network effect is the effect that one additional user of a good or service has on the value of that product to other users in the network. Once a critical level of users/participants in the network is achieved, benefits multiply.

5 Make strategic decisions on actions divided into Dutch and European levels

Apart from measures in the Netherlands with Dutch participants, there is a European dimension exemplified by the biobased industries public-private partnership BRIDGE. The time for strategic choices between actions on a Dutch and European level is here.

This document is not intended to enumerate the choices above, it only presents what has been achieved in the Transition so far. However, the evidence of success is so convincing, that we firmly believe that with the right regulatory and financial support, the success can continue and multiply in the next Transition phase.

It is time for a great leap. Again.