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SAXION

# Recovery of cellulose fibres

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# History

**2011: Idea: Waste cotton as feed for the production of virgin fibres**

**2012: start project: 'proof of principle'**
**2012: SaXcell registered as trade mark**

**2014: 1e patent**
**2014: start TFF-project Recovery of cellulose fibres**

**2015: deliverable: 100 kg benchmark**
**2015: start describing 2nd patent**
**2015 (2e half) start new funded project (continuation of RCF)**
**3 x 100 kg (white repeated, coloured, mixed with PET)**

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# From waste→ feed for fibres

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# SaXcell™

# About SaXcell™

- Holistic approach
- What fibre is it?
- Process
- Application
- Volumes

# Trends/developments

- **Growth of world population**
  - Increase till 2050: 7 →9 billion: + >20%

- **Growth of arable land needed**
  - Growth of world population: increasing demand for food
  - Increasing demand for the production of bio-fuels
  - Increasing textile consumption due to increasing wealth

- **Increasing wealth**
  - Increase in demand for textiles (2 – 4% annually, depending on economic developments)
  - Increasing demand for food per capita

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# Why SaXcell™

**Growth of 1 kg cotton needs:**

**8.000 l water**

**400 g fertilizer**

**40 g pesticides**

**Annual cotton production: 25 billion kg**

**EU ambition:**

**resource efficiency**

**reduce dependency of imports**

**Market: Greener**

# Reuse of waste textiles

- **Nowadays reused as:**
  - Garments
  - Insulation
  - Cleaning
  - Incineration
  - Landfill

- **Future:**
  - Strive for increasing reuse as garments
  - Mechanically and chemically recycling
  - Insulation and cleaning
  - Incineration

# Mechanical recycling

- **Texperium/Haaksbergen**
  - **Process:**
    - Collect
    - Sort and select
    - Shredding
    - Spinning (mechanically)

  - **Advantage:**
    - LCA positive
    - Fast process
    - No high investment

  - **DSisadvantage:**
    - Colour
    - Yarn: irregular (slubs)

# Chemical recycling

- **Saxion Enschede/professorship SFM**
  - **Principle:**
    - Preparation of waste as feed stock for reuse
    - Reuse of the cellulose polymer
    - No recycled, but a virgin appearance
  - **Advantage:**
    - LCA positive
    - In mass applicable
    - Mass production possible
    - Producible on existing installed base
    - Price: comparable with viscose/lyocell
  - **Disadvantage:**
    - Still in development phase
    - Market testing necessary

# SaXcell™

- **SaXcell is a regenerated cellulose fibre**

- **Man-made cellulosic fibres: 5,7 billion kg (source: CIRFS, 2013)**

- **Differences when compared to viscose/Tencel**
  - Feed: waste cotton instead of cellulose derived from forestry
  - Chain length: Degree of polymerization

- **Properties:**
  - Hydrophilic
  - Dyeability as viscose or Tencel
  - Strength: higher; wet strength comparable with Tencel
  - Elongation: comparable with viscose/Tencel

# Process steps: From waste to fibre

**Feed: domestic cotton waste**

**Process steps:**

- Collection
- Sorting
- Shredding/grinding
- Definishing
- Decolouration
- Removal small % PET
- Preparing for solubilization
- Solubilization (lyocell or viscose process)
- Wet spinning
- Cutting (staple fibre)

# Process steps-elucidated-1

- **Collection**
  - Per year in EU: 2 billion kg
  - At least 25% suited as feed for SaXcell™

- **Sorting**
  - Separate cotton from the rest
  - Select and remove not suited material
  - Textiles4Textiles

- **Shredding/grinding**
  - Removal of metal parts and accessories (buttons, zippers)
  - Required fibre length: 3 mm

- **Definishing**
  - Mostly mild acidic solution is used to remove water repellent finsig, resins etc. LCR 1:5, no drying required

# Process steps-elucidated-2

- **Decolouring**
  - Removal of colour and print
  - PVC-prints cannot (yet) be used
  - Chemistry: conventional textile chemicals, LCR 1:5, drying not required

- **Removal of small % PET**
  - Probably patented

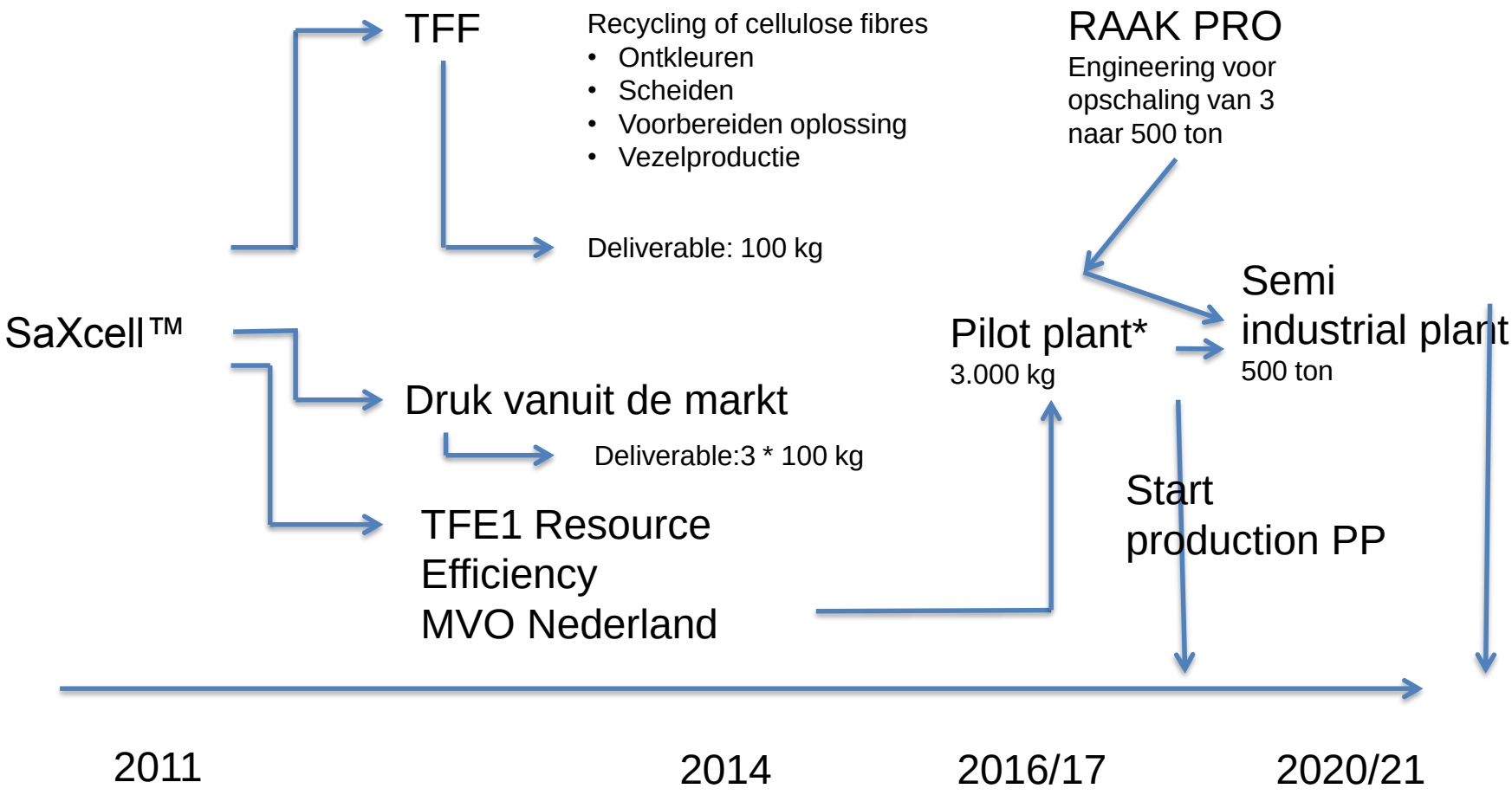
- **Preparing for dissolving**
  - Set required viscosity/enhance solubility
  - Either chemically (conventional) or enzymatically

# Process steps- elucidated-3

- **Solubilizing**
  - Traditional wet spinning-process
  - No extra investment in installed base necessary (>100 mio €)

- **SaXcell™-fibre**
  - As traditional process: known properties
  - Therefor Faster market acceptance expected
  - ‘Green fibre’

# Roadmap


TFF
Recycling of cellulose fibres
• Ontkleuren
• Scheiden
• Voorbereiden oplossing
• Vezelproductie
Deliverable: 100 kg
RAAK PRO
Engineering voor opschaling van 3 naar 500 ton
SaXcell™
Semi industrial plant
500 ton
Pilot plant*
3.000 kg
Druk vanuit de markt
Deliverable:3 * 100 kg
Start production PP
TFE1 Resource Efficiency MVO Nederland
2011
2014
2016/17
2020/21

# Status research-1

**TFF Project: Recovery of cellulose fibres**

- Start: January 2013
- Goal: production of 100 kg fibres for benchmark
- Proof of principle 100 kg scale

**Research subjects:**

- Decolouration
- Adjustment DP
- Prepare for solubilization
- Scale up studies

# Status research-2

**Decolouration**

- Insoluble dyes: >90%  removable in reduction cleaning
- More difficult: reactive dyes. Decolouration possible, molecule is covalent bonded, however likely not to be an issue.
- PVC-prints: not removable. Incineration
- Selection based on type of dye is possible using NIR-scanning technology

**Enhancement solubility**

- Strategy:
  - Enzymatic:
    - Mechanical energy required
    - Mild process conditions
    - Economic feasibility: doubted
  - Conventional chemistry:
    - Acidification
    - Perfect reproducible
    - Cheap process

# Status research-3

**Prepare for dissolution**

- ‘Powdering’
  - Better soluble
  - Improved dosage
- Enzymatic process(low concentration)
- Mild process conditions
- Drying
  - Residual moisture content 10 – 15 %
  - Centrifuge?
  - Slight under pressure (vacuum)

**Scaling up**

- Upscaling from 10 to 100 kg ≠ multiplying by 10
  - Piping, reactor, drying equipment
  - Dosing time is important (gelling)
  - Rheology of the solution: special stirring equipment required

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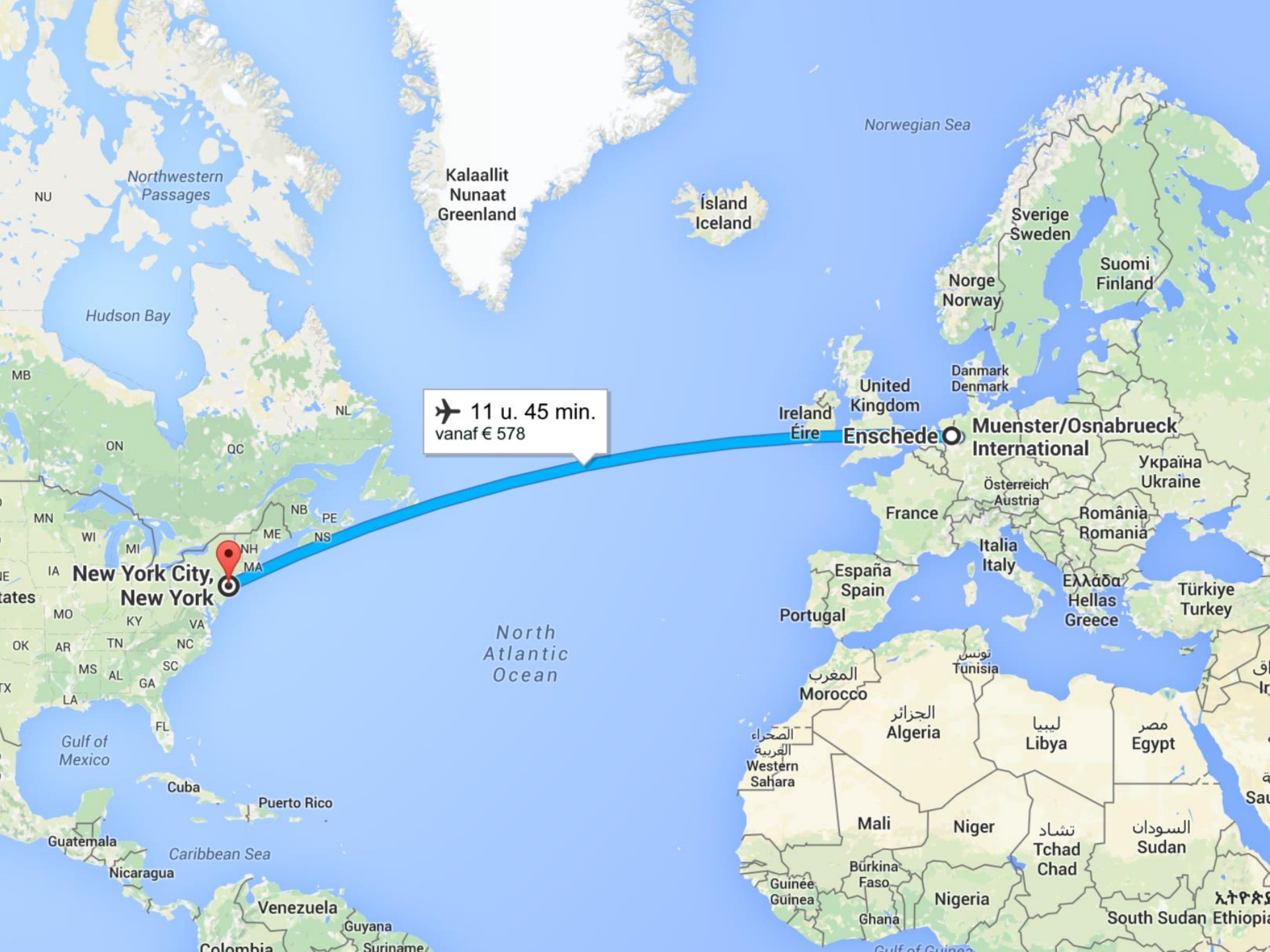
# LET ME INTRODUCE MYSELF!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România Romania
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# SAXCELL™

# **A** REGENERATED CELLULOSE FIBER FROM DOMESTIC COTTON WASTE

# THE STORY

.....

# SAXCELL™

## from waste to valuable feedstock

# AMBITION

TRANSFER WASTE INTO VALUABLE FIBERS

NO INVESTMENT NEEDED FOR INSTALLED BASE

PRODUCT FITS IN EXISTING GARMENT PRODUCTION CHAIN

BROADLY APPLICABLE (LOW COST AND ENVIRONMENTAL EFFICIENT PROCESS)

# MATERIALS: CLOSED LOOP

# PROCESSING: CLOSED LOOP?

# PROCESSING: CLOSED LOOP?

# CHEMICAL RECYCLING

**WHAT**

PREPARE DOMESTIC COTTON WASTE TO BE REUSED
REUSE OF THE CELLULOSE POLYMER
UP-CYCLING

**ADVANTAGE**

LCA IMPROVED (LESS WATER, LESS CHEMICALS, LESS ENERGY)
BROAD APPLICABLE WHITE VIRGIN FIBER
MASS PRODUCTION
PRODUCIBLE ON EXISTING 'INSTALLED BASE'
PRICE: COMPARABLE/SLIGHTLY MORE EXPENSIVE THAN EXISTING PULP

**STATUS**

STILL UNDER DEVELOPMENT
EXTENSIVE MATERIAL TESTING IS STARTING

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# facts and figures

WET SPUN 1,7 DTEX, CUTTING LENGTH: 40 MM

STRENGTH: HIGHER THAN COMPARABLE EXISTING PRODUCTS

ELONGATION: SLIGHTLY BELOW EXISTING PRODUCT, BUT WITHIN REQUIRED RANGE

HYDROPHILIC
DYEABLE
COLOUR YIELD: BETTER THAN EXPECTED

# ARTOFIL/DEURNE: SEPTEMBER 2015

## TECHNICAL YARNS
## OE-SPINNING EQUIPMENT
## NM 17 EN 34/2


JOHAN VAN DEN ACKER/GEMERT

WEAVING MILL
FABRIC CONSTRUCTION:
PLAIN WOVEN FABRIC
210 G/M$^2$
APPLICATION: WOMENS WEAR

# THE TEAM

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TEXTILE CHEMIST

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ORGANIC AND ANALYTIC CHEMIST

GERRIT BOUWHUIS
TEXTILE PROCESS DESIGN/PROJECT LEADER

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