

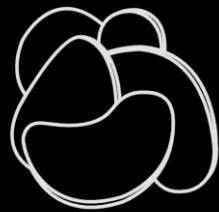
**Welcome to the new Home of  
Pulsed Electric Fields!**





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Pulsed Electric Field Systems  
Benefits For Chips & French Fries





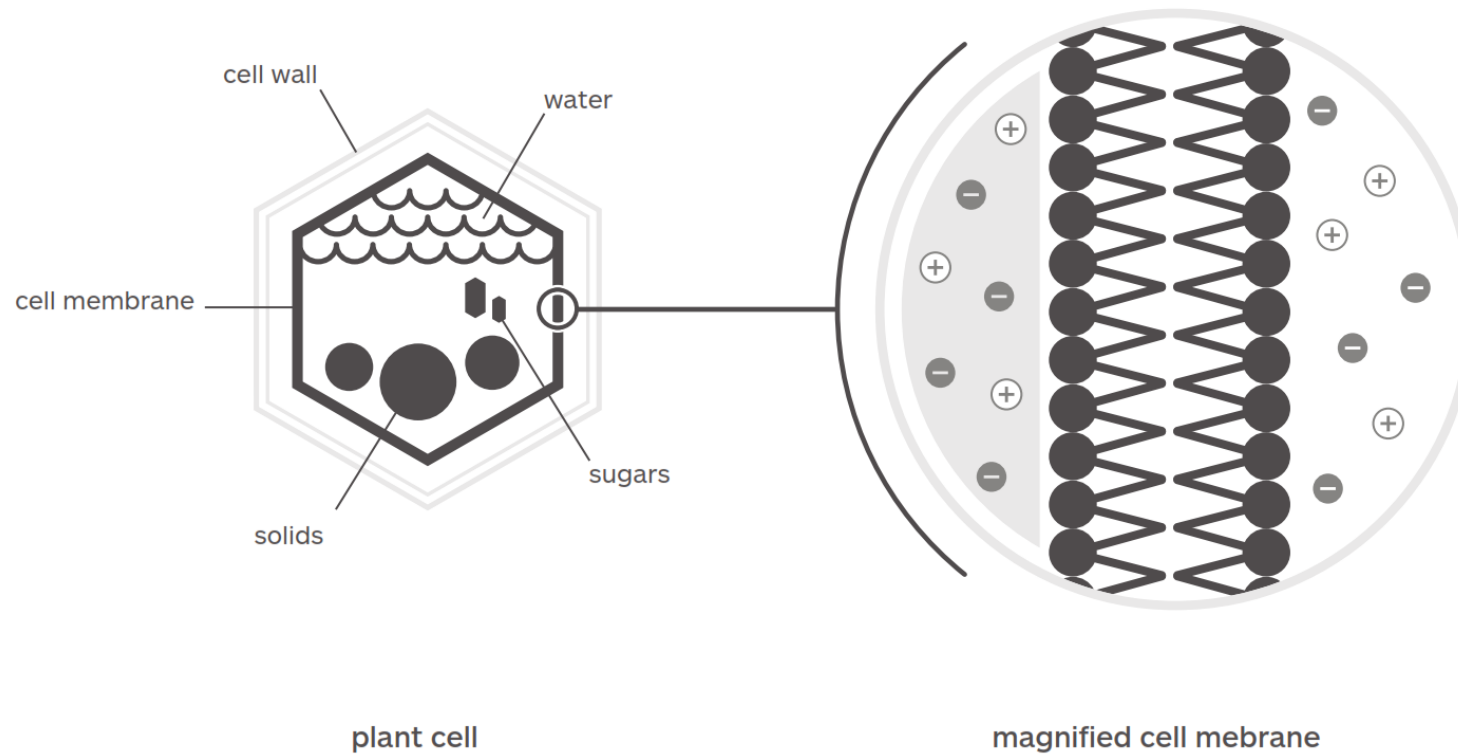
HOW PEF  
WORKS

PEF  
BENEFITS

PEF  
SYSTEMS

SUMMARY

## Plant cell electroporation How Elea PEF Advantage™ works



Average plant cell size is 50-100  $\mu\text{m}$  with a cell membrane thickness of 5 nm.

Cell membrane with lipid bilayer separating cytoplasm and extracellular fluid. Both containing charged particles.

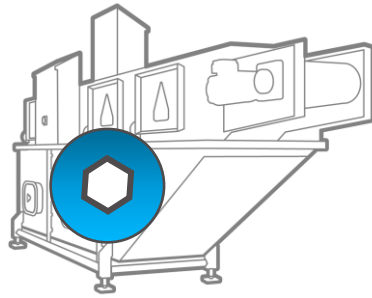


## HOW PEF WORKS

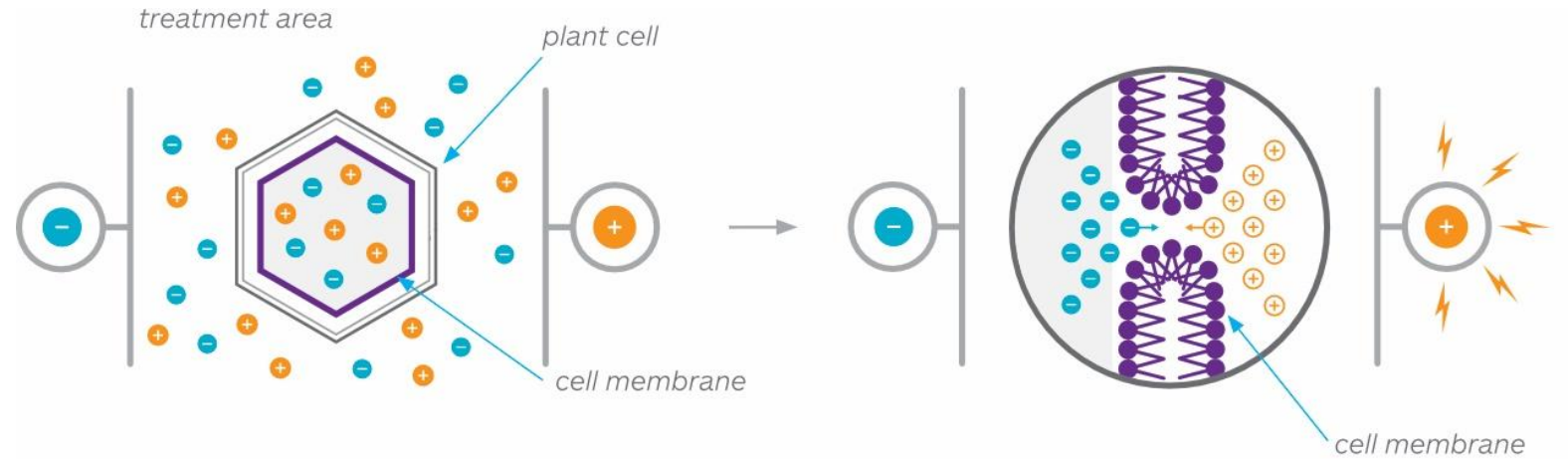
PEF  
BENEFITS

PEF  
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SUMMARY

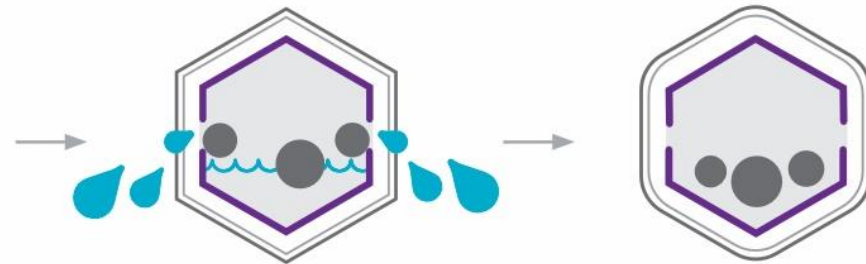


Elea PEF Advantage belt system



Plant cell between electrodes

Electroporation: polarisation of ions on the cell membrane and poreformation



Leakage of cell juice. Big solids remain in the cell (depending on treatment intensity)

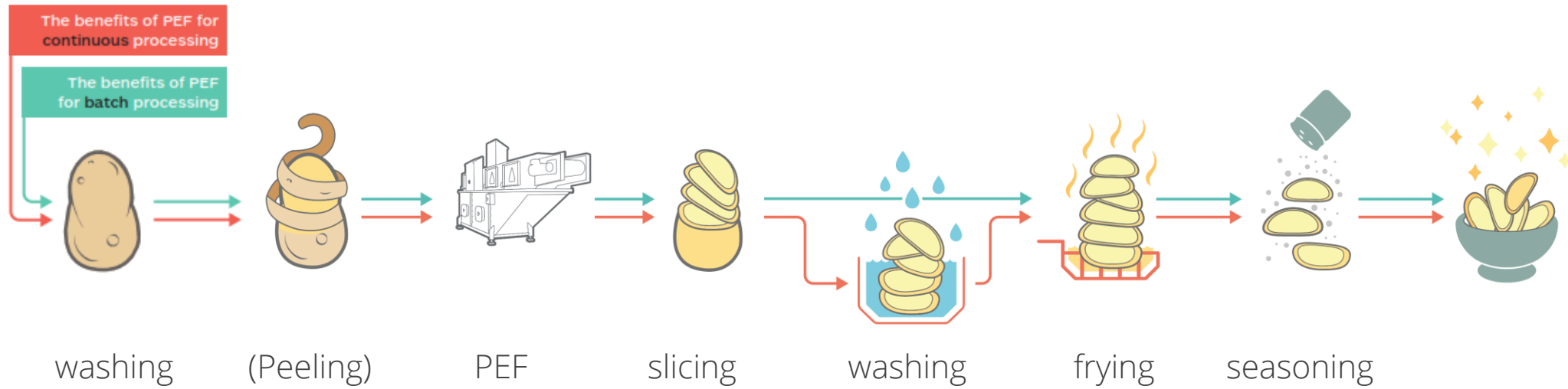
Soft, malleable cell structure

perfect  
precondition  
for snack  
processing



# PEF IMPLEMENTATION IN CHIPS PROCESSING

Seamless integration and small footprint



PEF added as a pre-treatment before slicing

*Smoother cut, even browning*



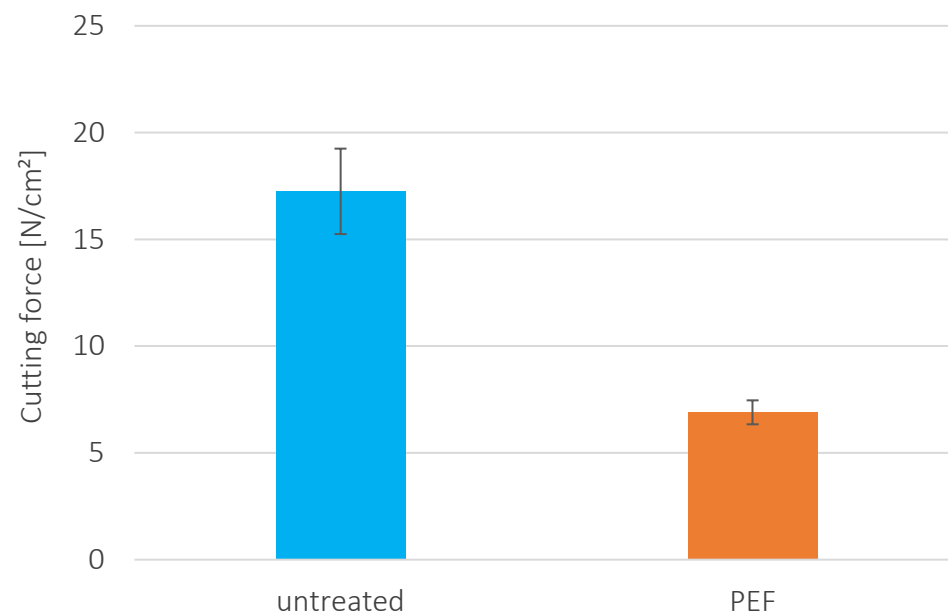
HOW PEF  
WORKS

**PROCESS  
BENEFITS**

PEF  
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SUMMARY

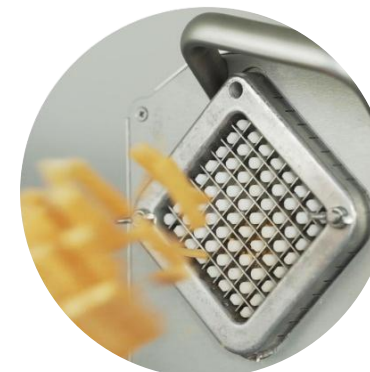
## Cutting force reduction with PEF



up to 50 %



Elea cutting  
force device  
CutControl™  
with pressure  
sensor



Untreated,  
hard to cut



PEF treated,  
cuts smoothly



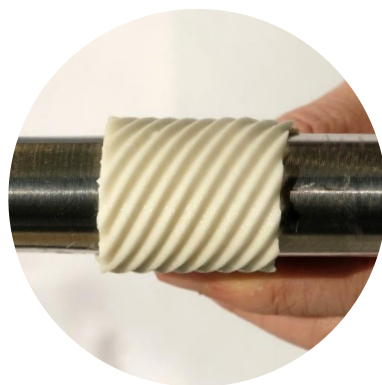
HOW PEF  
WORKS

**PRODUCT  
BENEFITS**

PEF  
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SUMMARY

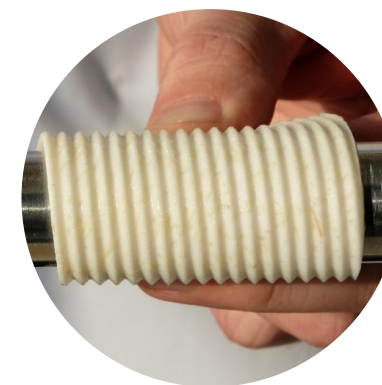
V-cut  
on veggie  
chips slices



Taro

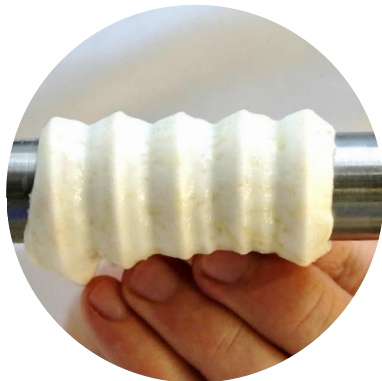


Purple sweet potato



Cassava/Maniok

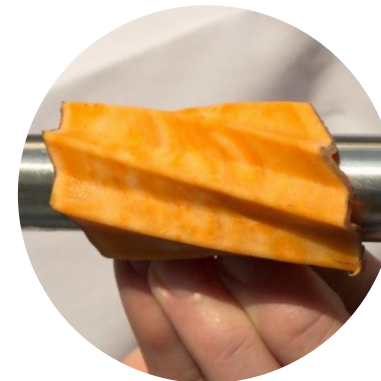
Deep-ridge-cut  
on veggie  
chips slices



Maniok/Cassava



Purple sweet potato



Sweet potato

**Flexible and reliable slices due to tissue softening**



HOW PEF  
WORKS

**PROCESS  
BENEFITS**

PEF  
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SUMMARY

## Longer knife durability

Due to a softer product, the knife durability can be increased

Up to 60% less knives needed

The harder the product the more beneficial to you.

Sweet potato, cassava/manioc, taro...

2h

PEF

6h





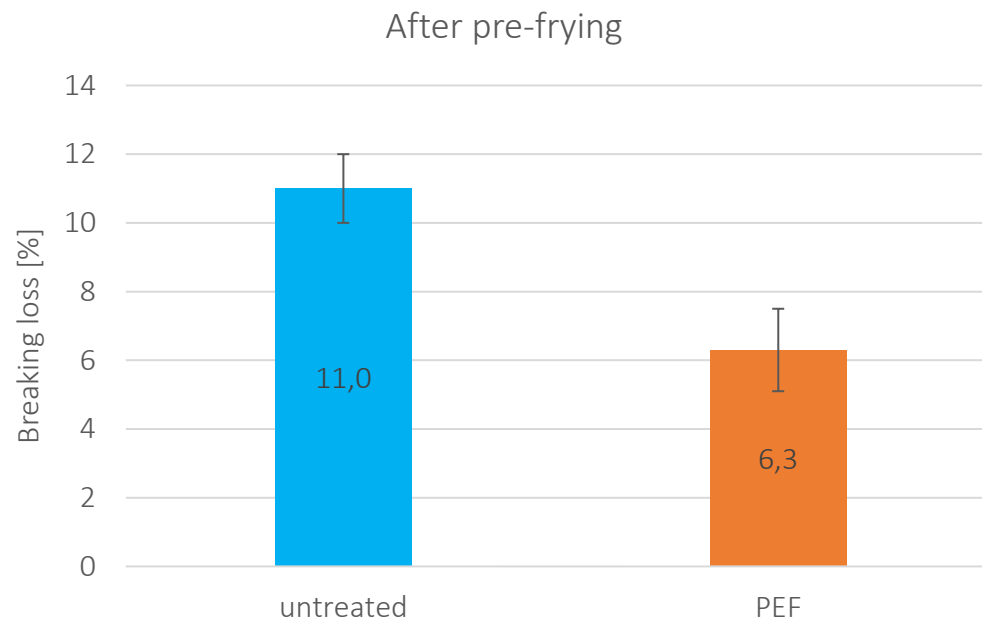
HOW PEF  
WORKS

**PRODUCT  
BENEFITS**

PEF  
SYSTEMS

SUMMARY

## Less breaking losses



up to 50 %



PEF

untreated

no separation of crust  
and overall better appearance



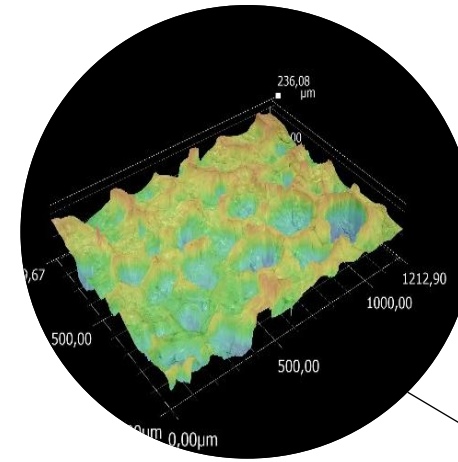
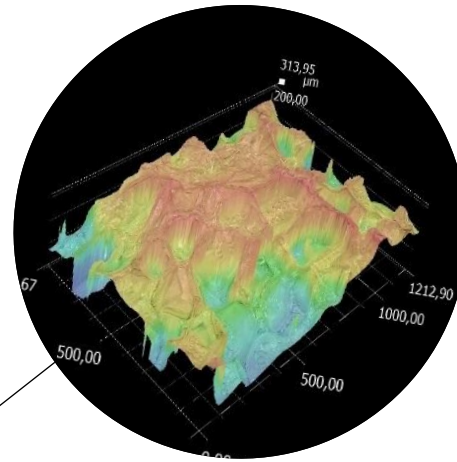
HOW PEF  
WORKS

**PROCESS  
BENEFITS**

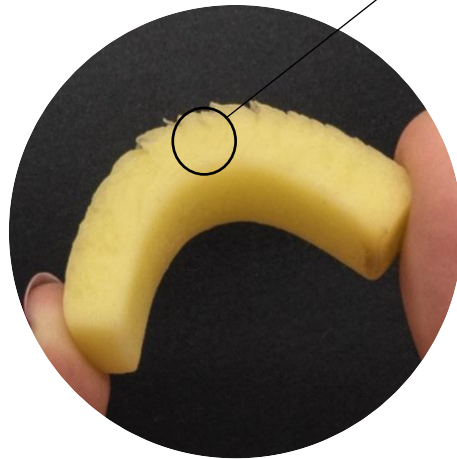
PEF  
SYSTEMS

SUMMARY

## Improved cutting, smoother cutting surface

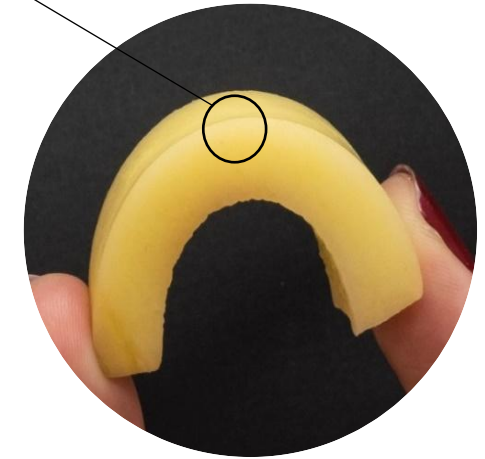


Topographic surface of raw sliced potato



untreated

**>10%**  
less starch leakage  
into the process water



PEF



HOW PEF  
WORKS

**PROCESS  
BENEFITS**

PEF  
SYSTEMS

SUMMARY

## Yield increase

Smoother cut and softer product

Less starch leakage

Less breakage

Less doubles

Less fines

**1,5%+  
yield increase  
in total  
with PEF**





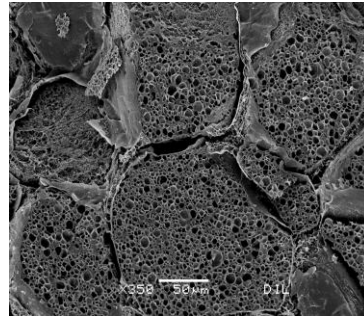
HOW PEF  
WORKS

**PRODUCT  
BENEFITS**

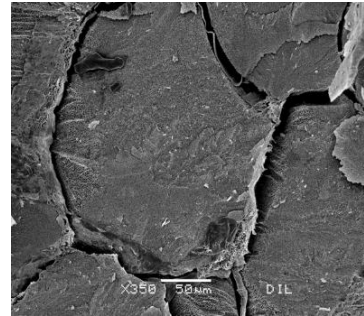
PEF  
SYSTEMS

SUMMARY

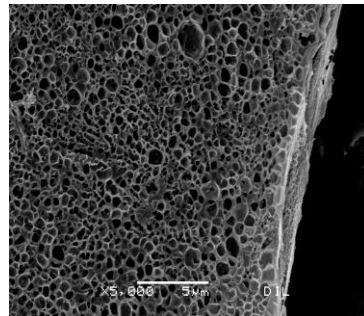
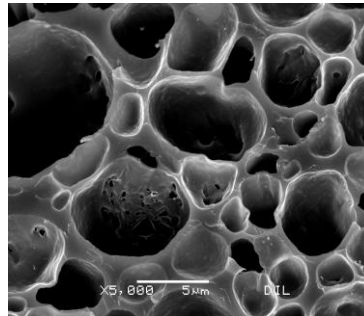
Scanning electron microscopy images of potato slices.  
Captured at equal magnification



untreated

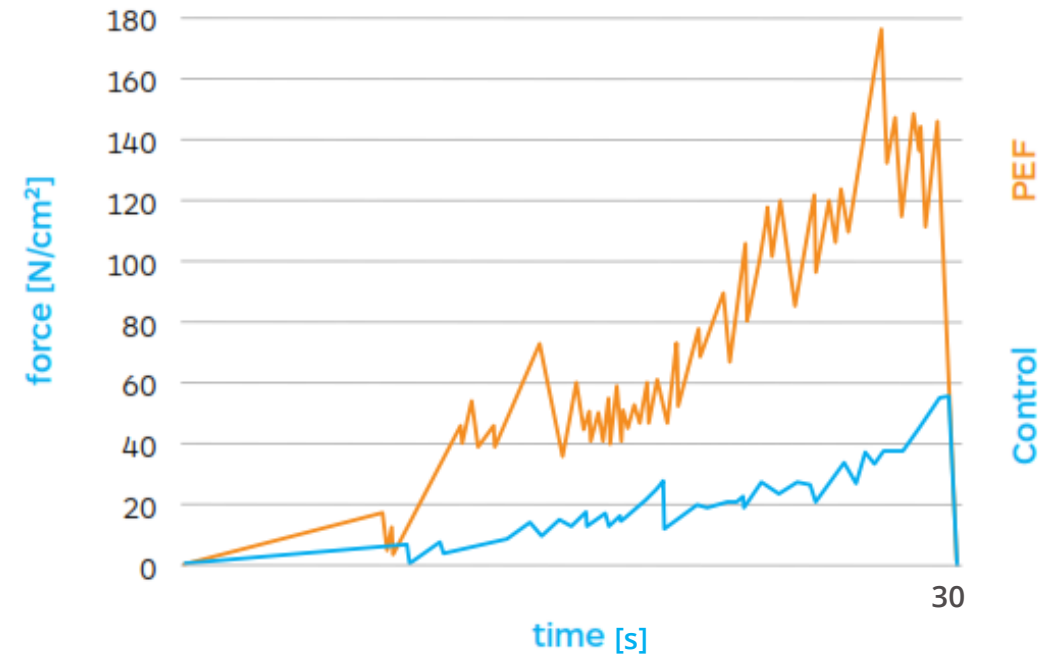


PEF



# Crunch

Kramer shear cell to measure crunchiness



Improved texture and crispiness



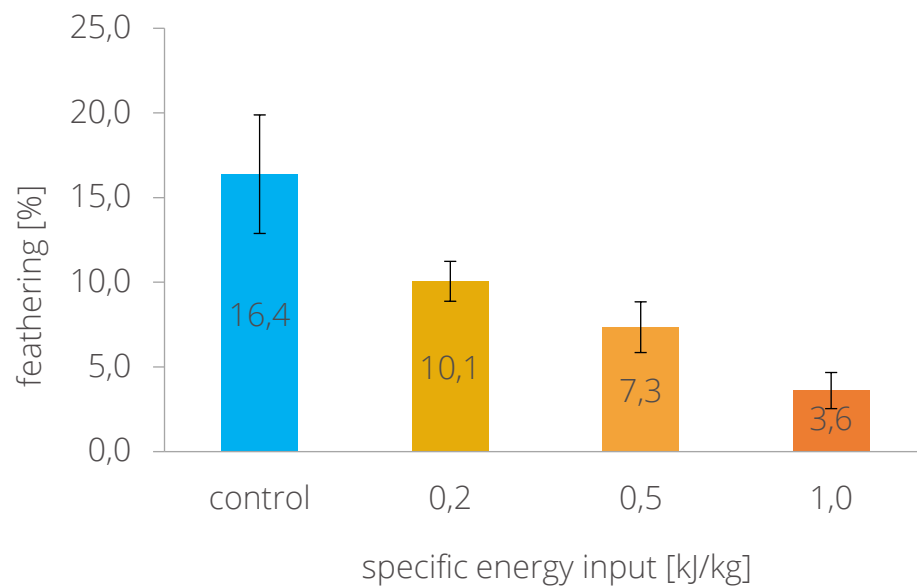
HOW PEF  
WORKS

**PRODUCT  
BENEFITS**

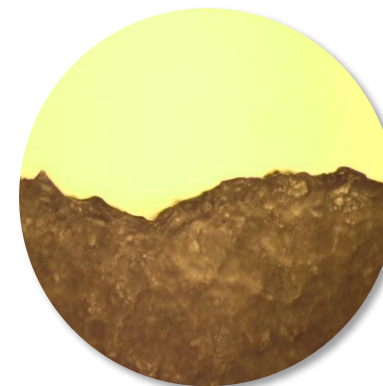
PEF  
SYSTEMS

SUMMARY

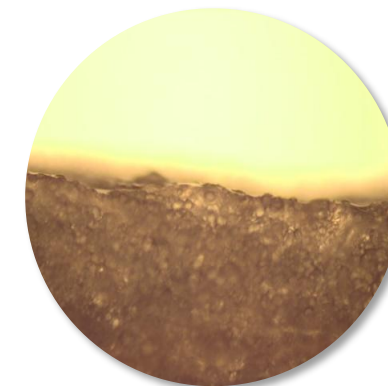
## Less feathering



## Potato surface



untreated



PEF

The smoother cut enables

**less feathering**  
**even coloured product**  
**better adhesion of seasoning**





HOW PEF  
WORKS

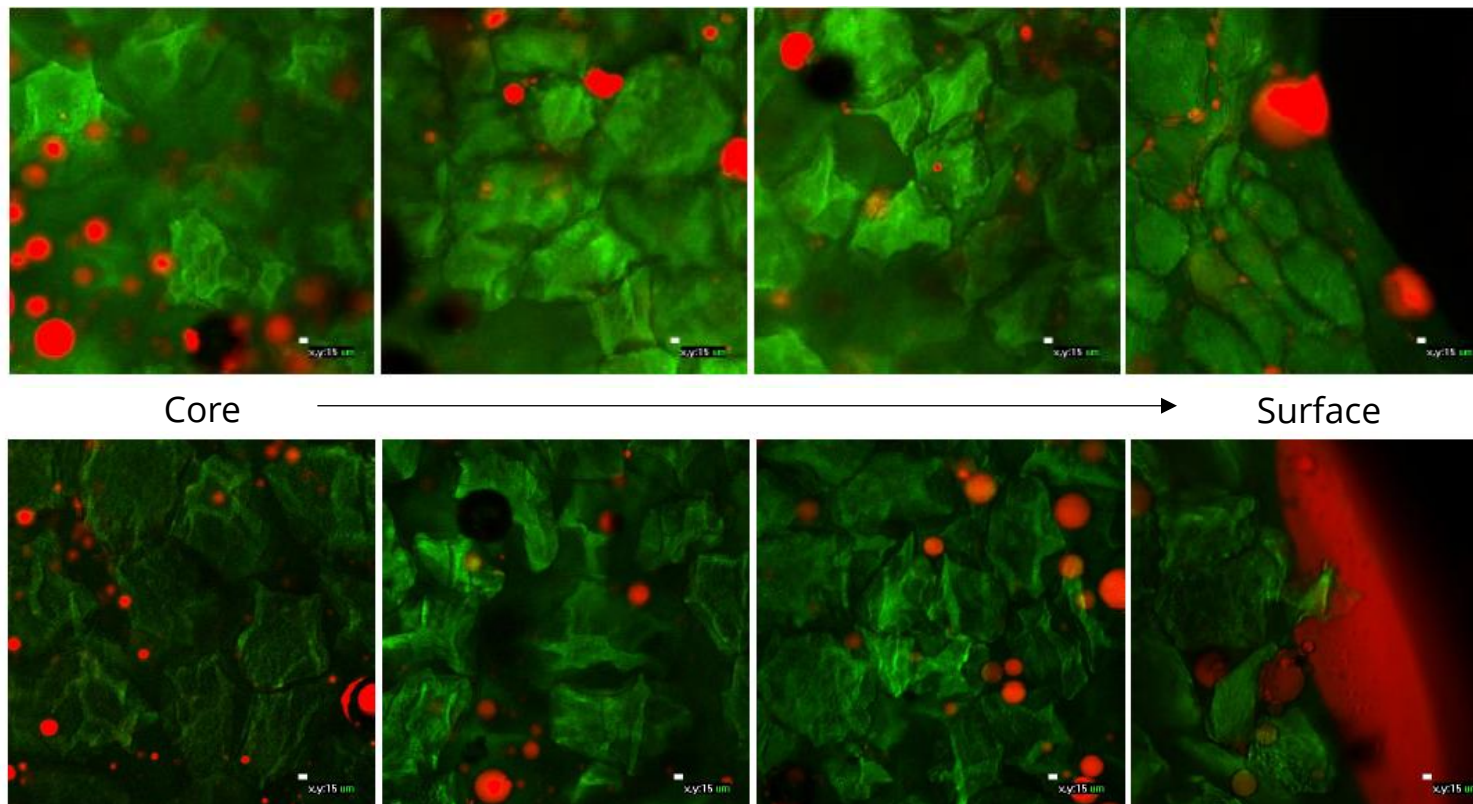
**PRODUCT  
BENEFITS**

PEF  
SYSTEMS

SUMMARY

## Reduced oil content

Confocal Laser Scanning pictures of chips



PEF

Red=oil  
Green=protein

Untreated



HOW PEF  
WORKS

**PRODUCT  
BENEFITS**

PEF  
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SUMMARY

## Reduced oil content

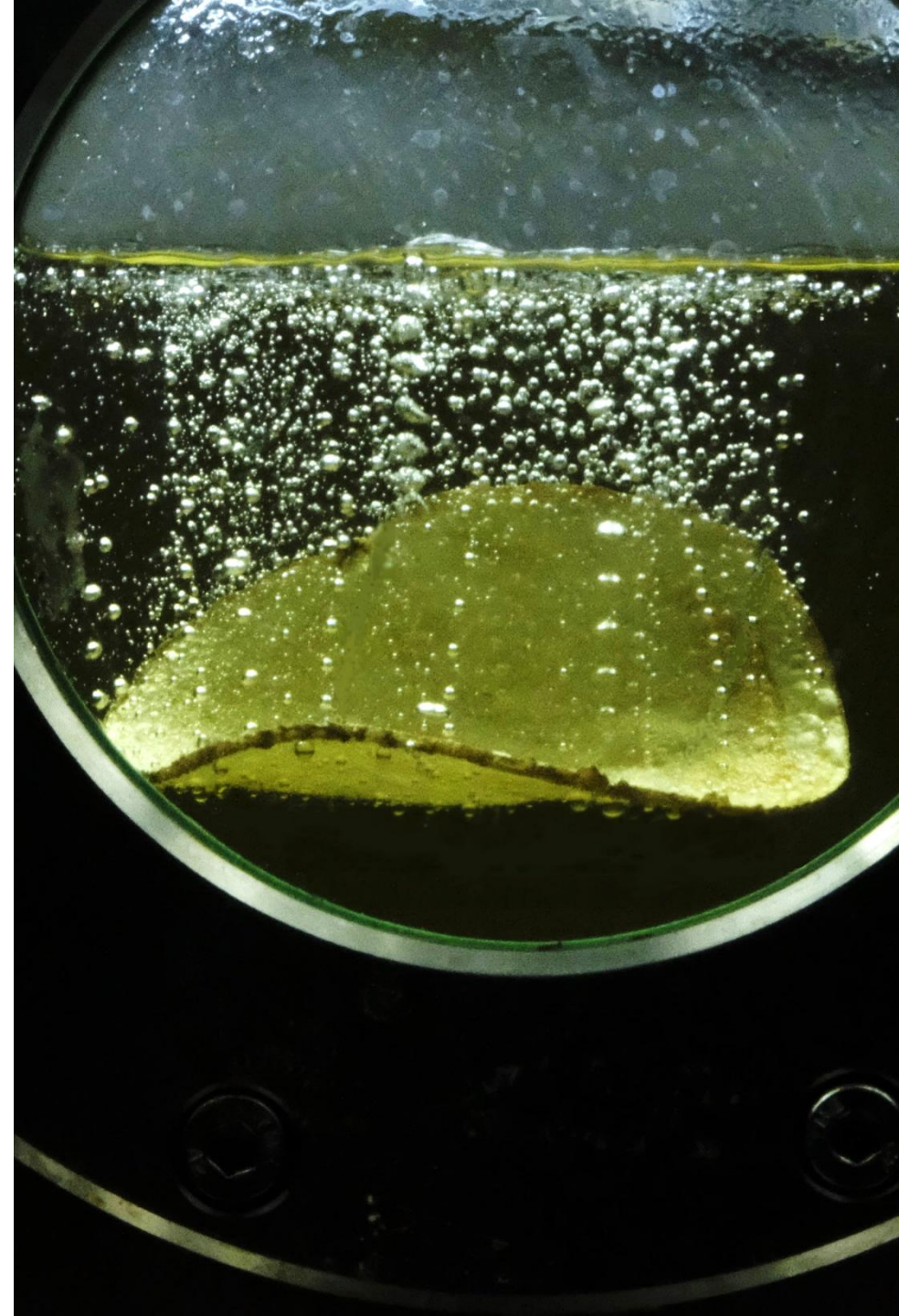
untreated

33%

PEF

30%

A smooth cut results into a smaller  
surface area and less oil uptake





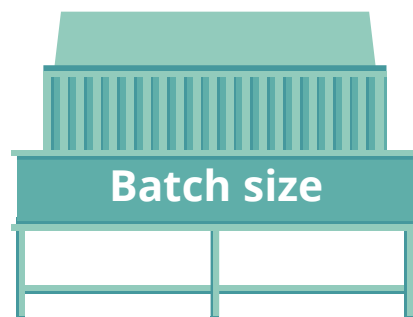
HOW PEF  
WORKS

**PROCESS  
BENEFITS**

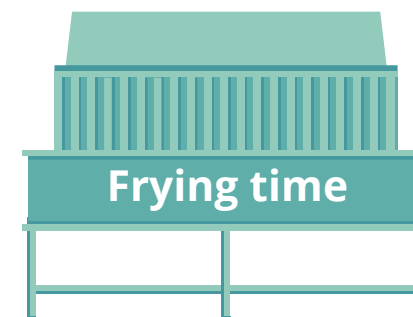
PEF  
SYSTEMS

SUMMARY

## More capacity for batch frying



+5%



-10%

+15%

increase in line capacity can be achieved



HOW PEF  
WORKS

**PRODUCT  
BENEFITS**

PEF  
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SUMMARY

## Vast colour retention of PEF treated veggie chips



Orange & purple  
sweet potato



Sweet potato &  
golden beetroot



Purple sweet potato &  
carrot

**Possible by frying profile optimization due to PEF pre-treatment**

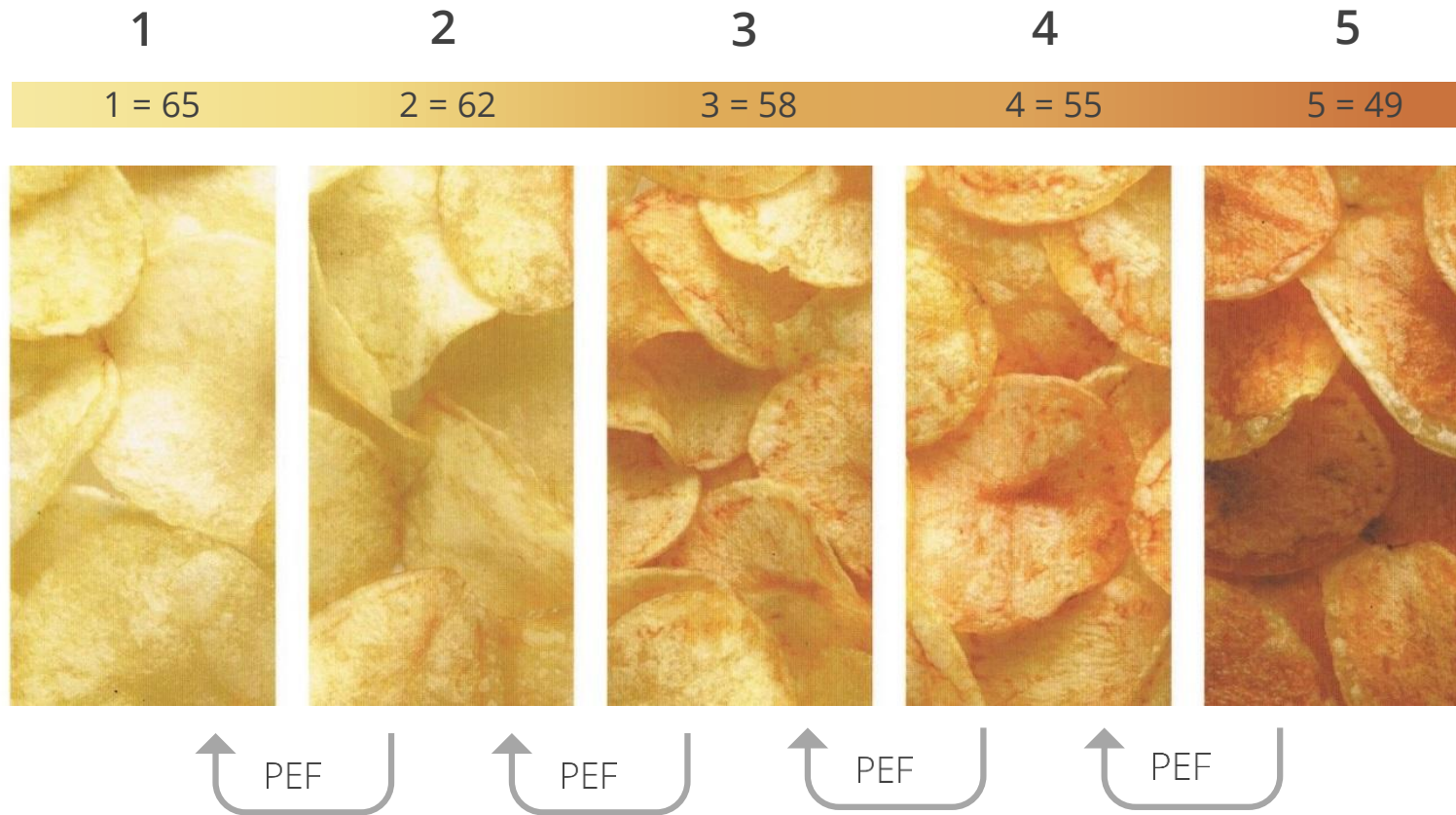


HOW PEF  
WORKS

**PRODUCT  
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PEF  
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SUMMARY



## COLOUR IMPROVEMENT OF PEF TREA- TED CHIPS

Fry color chart for  
potato chips  
(British Potato Council)

*Colour grades  
from 1 to 5*

***Best: 1-2***

*Approximate L values for  
colour grades*

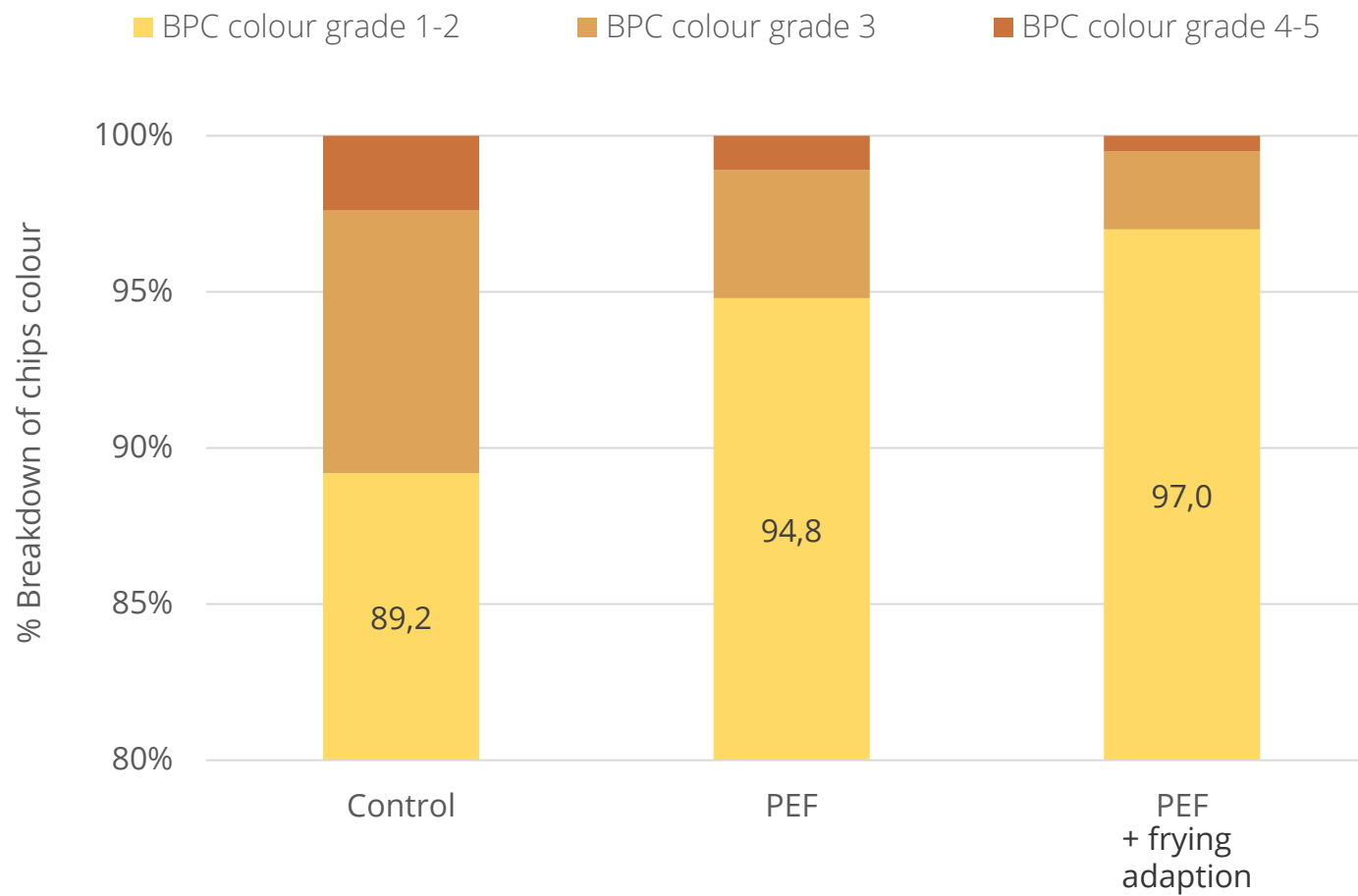


HOW PEF  
WORKS

**PRODUCT  
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PEF  
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SUMMARY



COLOUR  
IMPROVEMENT  
OF PEF TREA-  
TED CHIPS

**+8% of  
grade 1-2 chips  
with PEF**

*Colour grades from 1 to 5*

*Best: 1-2*



HOW PEF  
WORKS

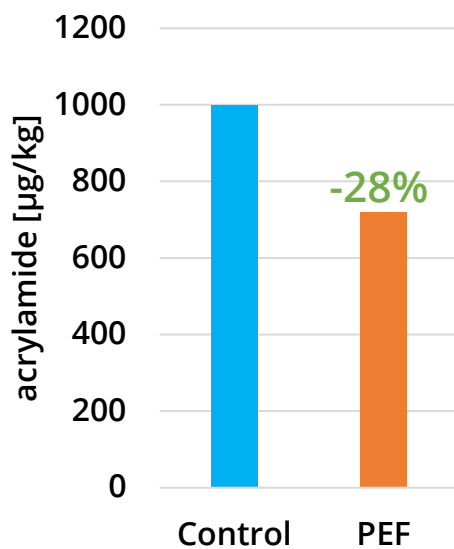
**PRODUCT  
BENEFITS**

PEF  
SYSTEMS

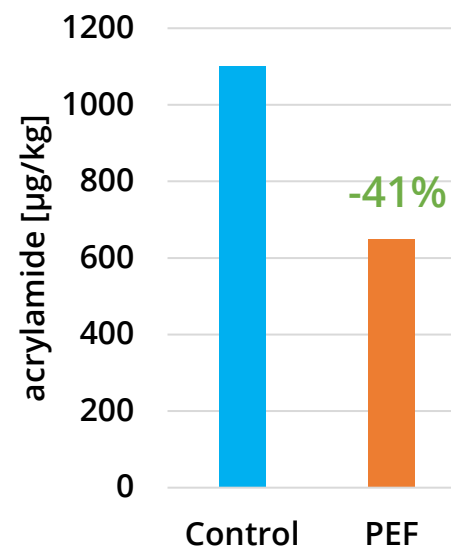
SUMMARY



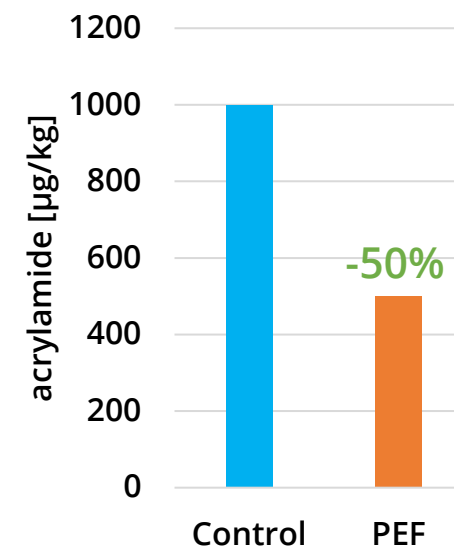
BEEETROOT



CARROT



SWEET  
POTATAO



VAST ACRYLAMIDE REDUCTIONS IN PEF TREATED VEGGIE CHIPS

# SUSTAINABILITY ASPECTS

Example: 5,1 t/h raw material potato chips line, 5.120 production hours per year

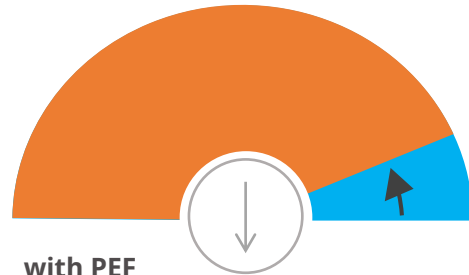


PEF help manufacturers to save money, resources and the environment

*Oil savings and increased product yield*

## Oil usage

1,736 t/year

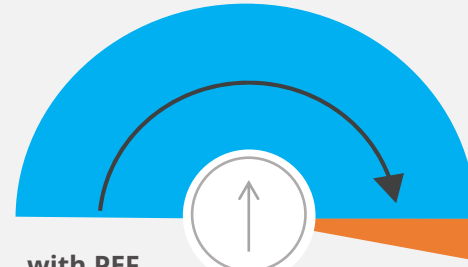


with PEF  
1,562

-174 t/year

## Yield increase

5,785 t/year



with PEF  
5,852

+67 t/year

## Yield increase

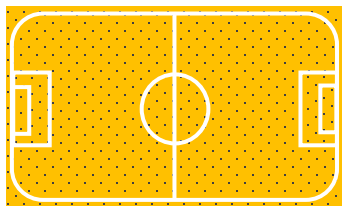
equivalent to 27 matches free 25g-chips bags for all supporters in Camp Nou stadium (Barcelona)



x 27

## Oil saved

equivalent to 178 football field sized rape seed fields



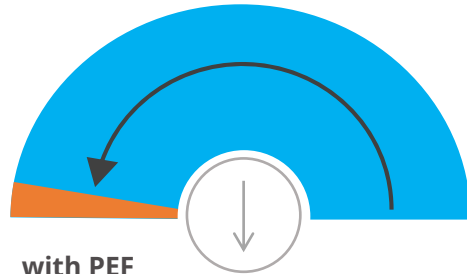
x 178

# SUSTAINABILITY ASPECTS

Example: 26 t/h raw material French fries line, 7.700 production hours per year

## Energy consumption

11.206.000 kWh/year

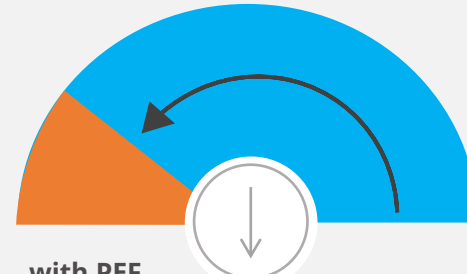


with PEF 300.000

-10.906.000 kWh/year

## Water usage

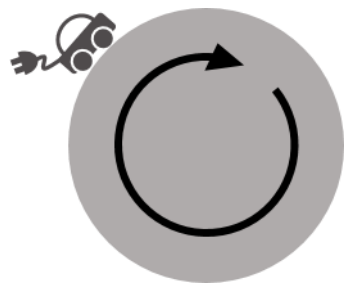
30.000 m<sup>3</sup>/year



with PEF 6.000

-24.000 m<sup>3</sup>/year

**Energy saved**  
to drive around the globe with an electric car 1.363 times



x 1.363

**Water saved**  
to fill 171.429 bath tubs



x 171.429



PEF help manufacturers to save money, resources and the environment

*huge water and energy savings*



HOW PEF  
WORKS

PEF  
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PEF  
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SUMMARY

# ELEA CUT CONTROL & PEF CONTROL

Precise process control and optimised treatment conditions



Helps to identify seasonal variation and to develop and control the optimum PEF treatment parameters. Robust measurement devices to be used at line or in labs.



HOW PEF  
WORKS

PEF  
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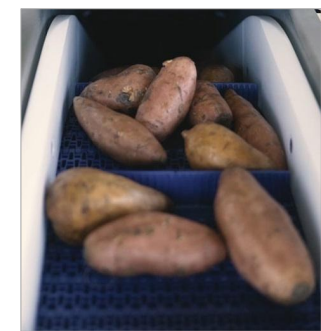
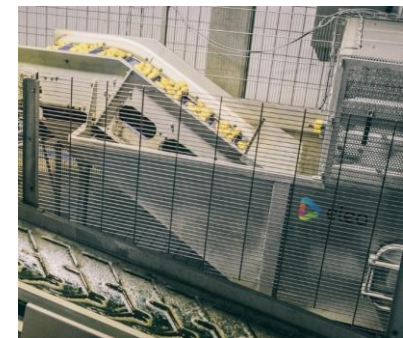
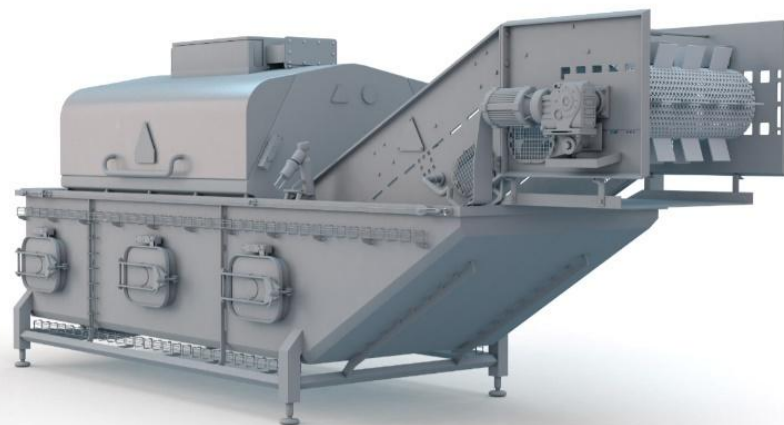
# ELEA PEF ADVANTAGE™ BELT SYSTEMS

Optimal solution for the treatment of tubers, roots,  
vegetables and fruits

Available in five versions: PEF Advantage B 1 mini, B1, 10, 100, 1000

1 t – 100 t per hour processing capacity

Quick start-up, low energy (1 kWh/t raw material)  
and water (30 l/t raw material) consumption





HOW PEF  
WORKS

PEF  
BENEFITS

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SUMMARY

OUR ELEA PEF SYSTEMS ARE DESIGNED AND BUILT BY  
US AT OUR SPECIALIST FACILITY IN GERMANY.



**The Elea PEF Advantage B 1000**  
Up to **70 - 100 t/h** of solid products.



**The Elea PEF Advantage B 10-100**  
Up to **18 - 28 t/h** of solid products.



**The Elea PEF Advantage B 10**  
Up to **12 t/h** of solid products.



**The Elea PEF Advantage B 1 mini and B 1**  
Up to **3 - 7.5 t/h** of solid products.

All capacities subject to process requirements.



HOW PEF  
WORKS

PEF  
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**PEF  
SYSTEMS**

SUMMARY

# PEF ADVANTAGE™ BELT ONE

All-in-one compact PEF belt system

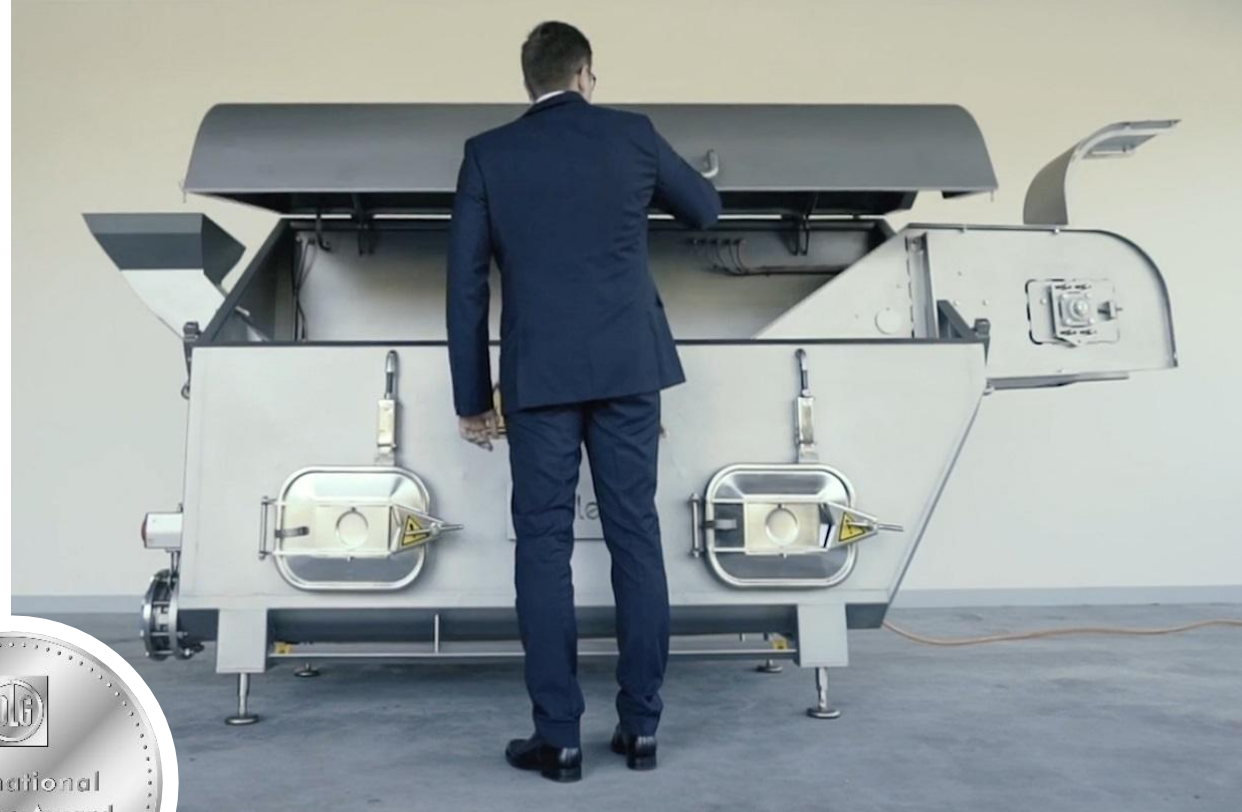
Compact design with generator and  
treatment belt in one compact system

Small footprint

Up to 7,5 t/hour (raw material)

Perfect fit for the smaller production line

Optimal for small chips and drying lines





HOW PEF WORKS

PEF BENEFITS

PEF SYSTEMS

SUMMARY



# PEF SYSTEMS GALLERY

250+ Elea PEF units in industrial use





HOW PEF  
WORKS

PEF  
BENEFITS

PEF  
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**SUMMARY**

## PULSED ELECTRIC FIELD BENEFITS FOR CHIPS AT A GLANCE

Reduce costs, increase yield, control colour, improve quality and develop new product opportunities with Elea PEF

- Opportunity for new shapes and cuts and harder to process raw materials.
- Reduced starch loss with cutting improvement for continuous processing.
- Improved slicing for longer knife durability and less waste and breakage.
- Greater capacity and reduced clusters for batch frying.
- Up to 50% cutting force reduction.
- Better colour and less browning.
- Improved texture and crispiness.
- Energy & water savings.
- Better flavour adhesion.
- Reduced oil uptake.





HOW PEF  
WORKS

PEF  
BENEFITS

PEF  
SYSTEMS

**SUMMARY**

## PULSED ELECTRIC FIELD BENEFITS FOR FRENCH FRIES AT A GLANCE

Reduce costs, increase yield, control colour, improve quality and develop new product opportunities with Elea PEF:

- Opportunity for new shapes and cuts and harder to process raw materials.
- Reduced starch loss with cutting improvement for continuous processing.
- Improved slicing for longer knife durability and less waste and breakage.
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