



ENOUGH

EUROPEAN FOOD CHAIN SUPPLY
TO REDUCE GHG EMISSIONS BY 2050





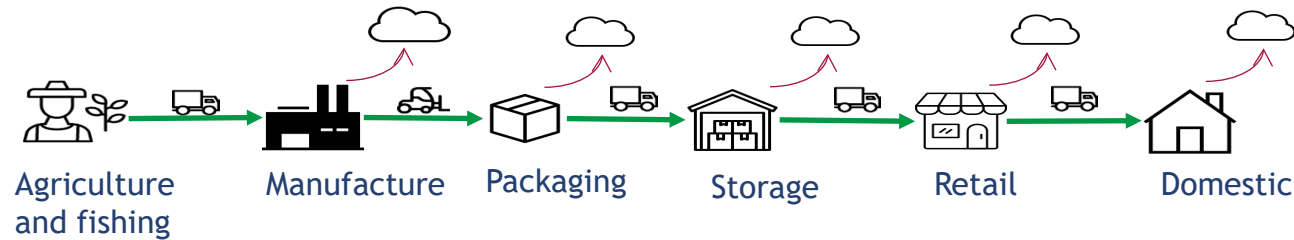
Modelling approaches to identify decarbonisation opportunities

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INRAE

ENOUGH Workshop
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Manchester

A tool to evaluate and optimize GHG emissions of food supply chains



To simulate and analyze GHG emissions

To identify the contribution of every step

To evaluate the impact of logistics (ex: local / long distance), technologies...

To provide insight but also turn it into action by suggesting ways to improve

Public target:

- Stakeholders involved in supply chains
- Researchers, students looking for a simulation tool
- Policy makers
- And more generally everyone interested in

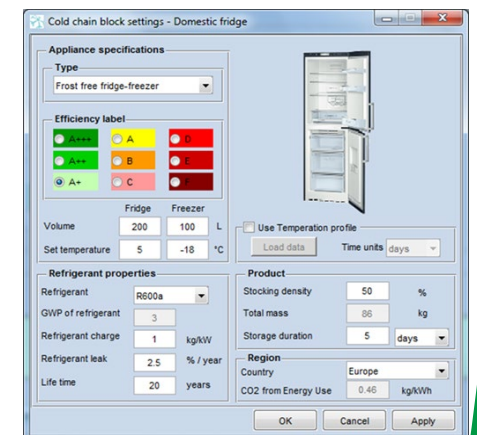
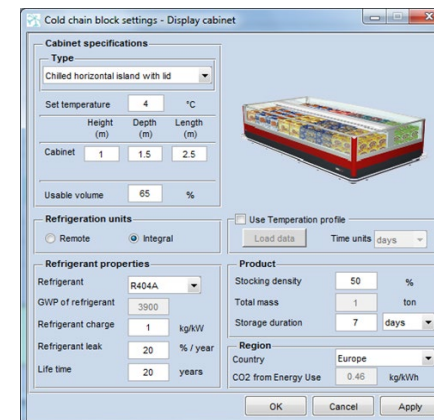
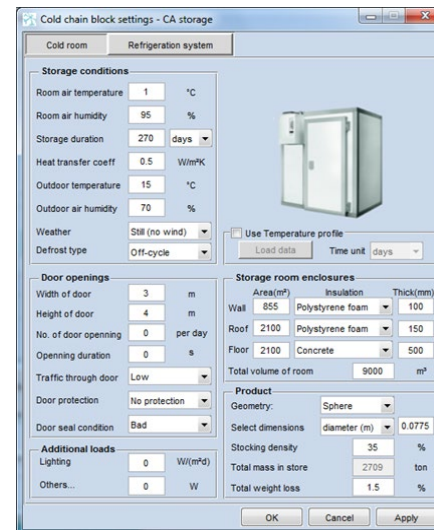
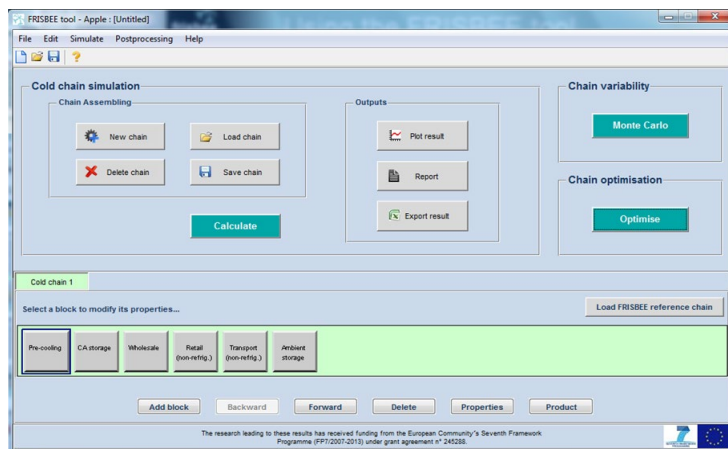


Background

FRISBEE TOOL

A Matlab application for Microsoft Windows

Allows the user to assess food cold chains with 3 criteria:
food quality evolution, energy use and environmental
impact (CO₂ emission)



ENOUGH tool

- A web application to simulate food supply chains and assess greenhouse gas emissions has been developed and is freely available.
- Extending the scope to every food supply chain
 - Food processes (heating...)
 - Transport
 - Packaging
 - Renewable energy sources
 - Enlarged database of products

Simulate food supply chains

Optimizing food quality, energy use and environmental impact

[Take me there](#)

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To develop a web tool to simulate and analyze GHG emissions at the scale of a food supply chain

User interface

Add blocks

Run simulation

The screenshot displays the ENOUGH user interface for a cold chain simulation. The top navigation bar includes links for Administration, Packaging, Products, Simulations, and Logout. The main title is "Colruyt Belgium: apple october retrofits". On the right, there are buttons for Share, Rename, and Simulate. A sidebar on the left lists various cold chain blocks: Apple, ADD A BLOCK, PRE-COOLING, CA STORAGE, REFRIGERATED TRANSPORT, TRANSPORT (NON-REFRIG.), PACKAGING, WHOLESALE, WALK IN COLD ROOM, RETAIL (NON-REFRIG.), DOMESTIC FRIDGE, and AMBIENT STORAGE. The main area shows a flowchart titled "BE apples - 255.0 km - 16.5 day(s)" with a settings gear icon. The flowchart consists of two rows of blocks: Row 1: TRANSPORT (NON-REFRIG.) (15.0°C, 1.0 hour(s), 8.0 km), PRE-COOLING (1.0°C, 0.5 day(s)), PACKAGING (15.0°C, 0.5 day(s)), REFRIGERATED TRANSPORT (2.0°C, 4.0 hour(s), 192.0 km), and WHOLESALE (1.0°C, 3.0 day(s)). Row 2: REFRIGERATED TRANSPORT (2.0°C, 0.25 day(s), 50.0 km), RETAIL (NON-REFRIG.) (18.0°C, 2.0 day(s)), TRANSPORT (NON-REFRIG.) (15.0°C, 0.0833 day(s), 5.0 km), and DOMESTIC FRIDGE (5.0°C, 10.0 day(s)).

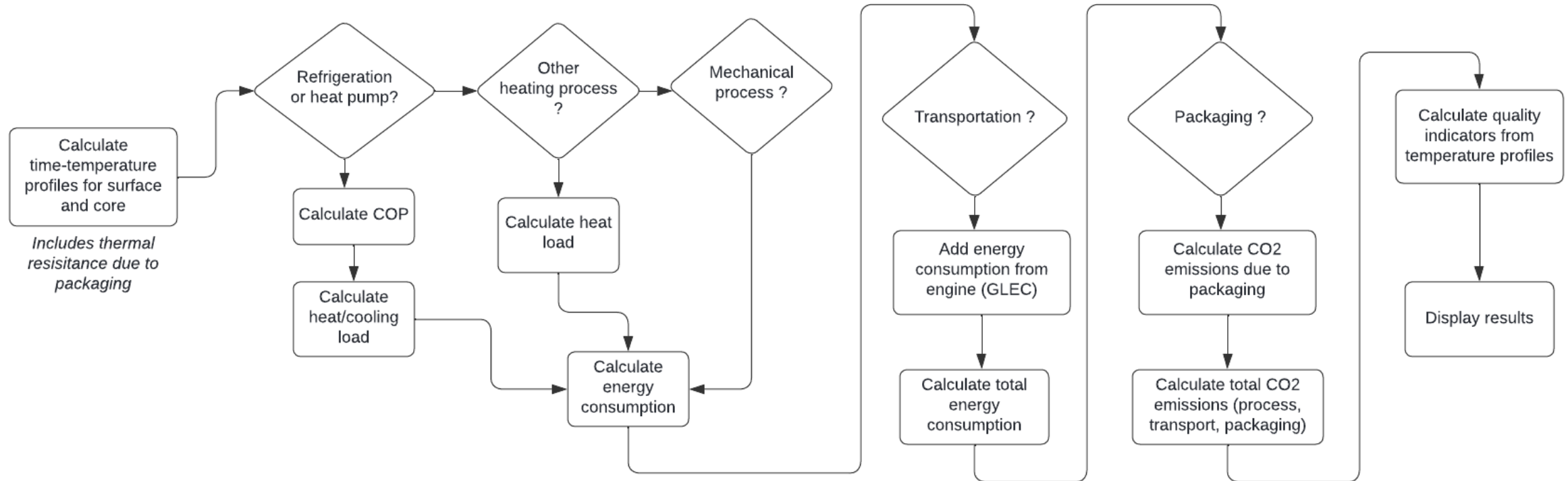
Drag and drop blocks

Add a chain

Modify block properties

The screenshot shows the configuration panel for the "DOMESTIC FRIDGE" block. It has a close button (X) in the top right corner. The panel is divided into sections: "Fridge" with a dropdown menu showing "Refrigerating system", "Fridge specifications", "Type" with a dropdown menu showing "Frost free fridge-freezer", and "Label" with a dropdown menu showing "A+". There is also a small image of a refrigerator.

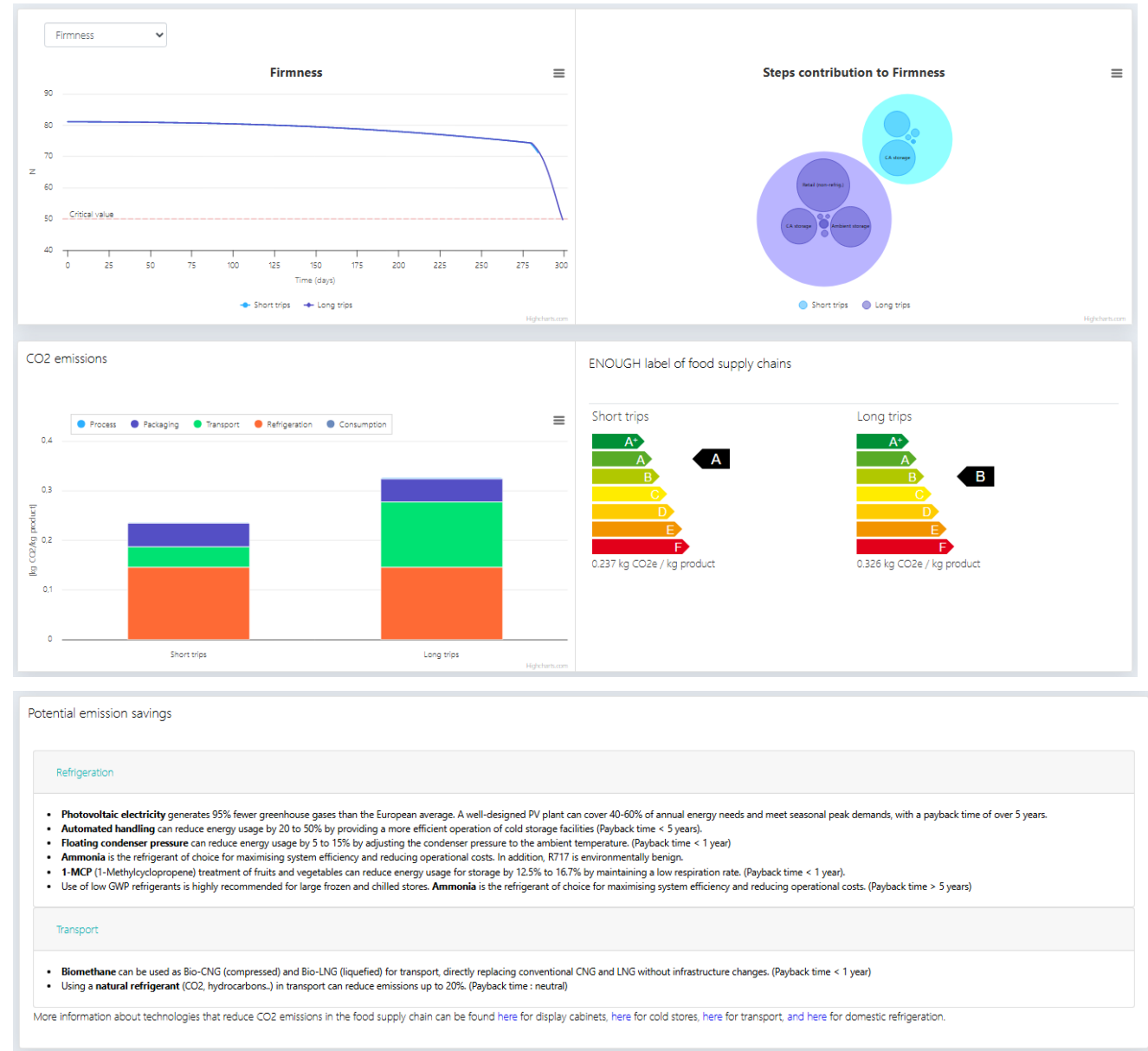
Simulation



Primary data source: Ademe, Agribalyse, GLEC, IPCC, STEP (Inrae), CoolProp

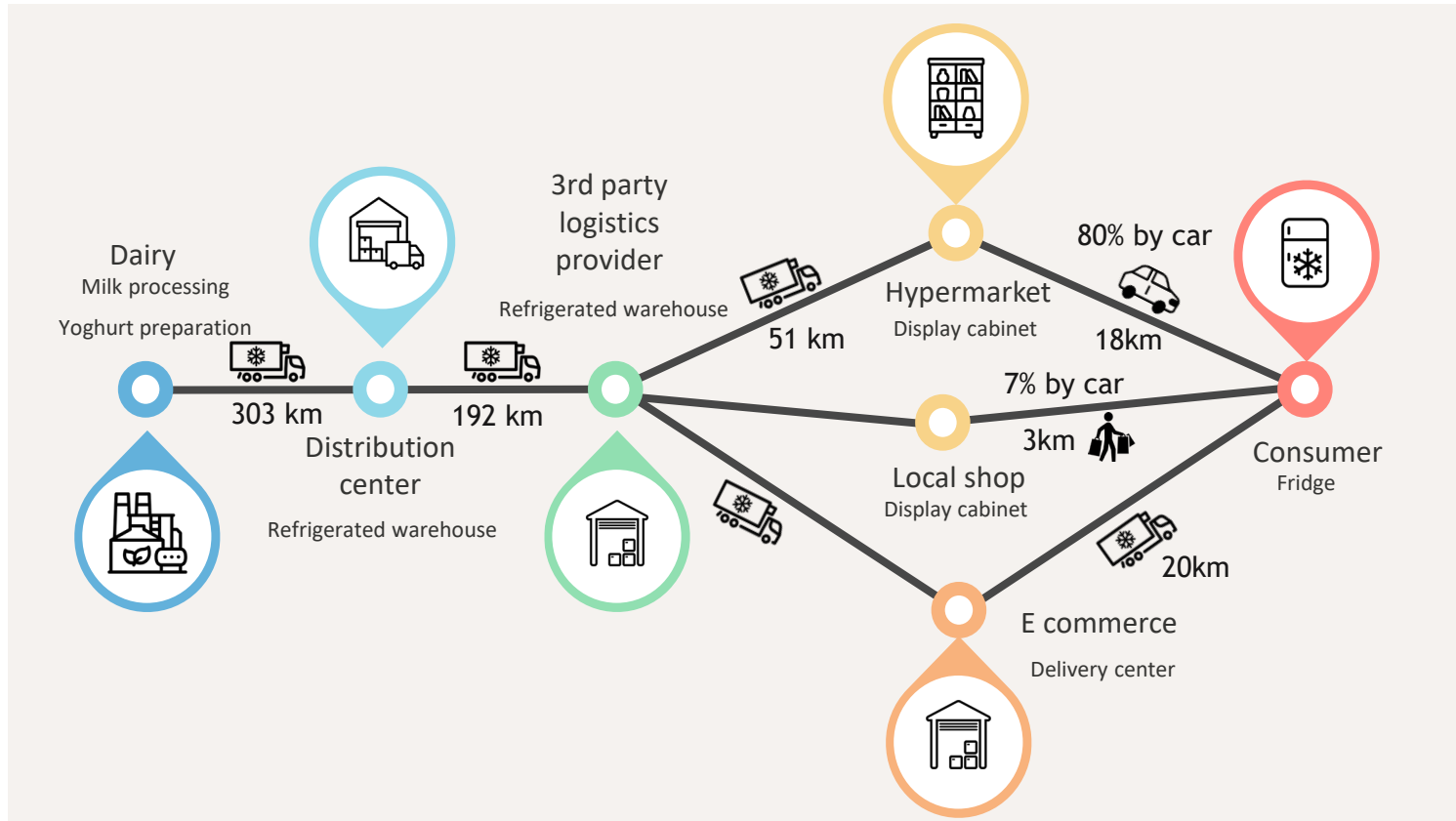
Results

- Energy / kg product
- CO2 eq emissions / kg product
- Product quality
- Exergy efficiency
 - Potential for energy recovery
- Suggestions of decarbonation opportunities
 - Based on WP2 roadmaps



YOGHURT CHAIN

Case study from Radford, Alan, et Techset Comp Ltd. « Assessing Transport Energy Consumption in Two Product Supply Chains ». *International Journal of Logistics* 9, n° 3 (22 février 2011): 237-52. <https://doi.org/10.1080/13675560600859243>.



- Primary data obtained through surveys (type of vehicle, mass transported, distance...)
- Detailed input data in the report :
Rizet, C, et Basile Keita. « Chaînes logistiques et consommation d'énergie: cas du yaourt et du jean », 2005, 92.
- National distribution case study, not very long distances
- Focus on the last delivery: comparison between shops and e-commerce

Yoghurt chain

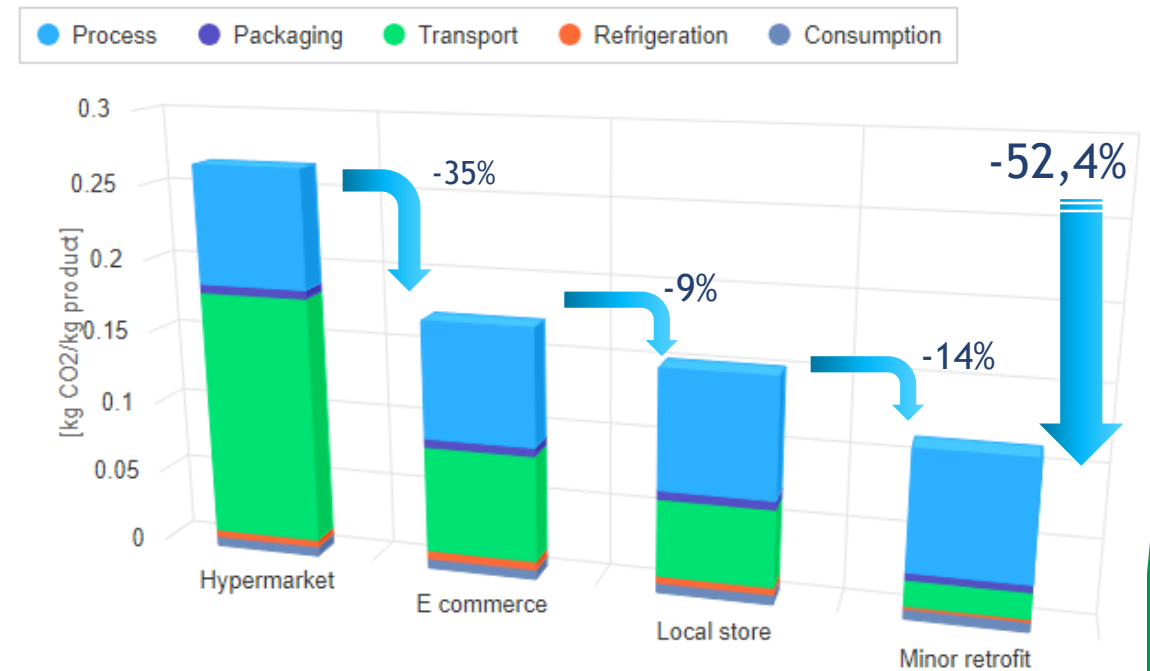
Stages in the logistic chain



RESULTS

Potential emissions savings

- Comparison hypermarket and e-commerce CO2 emissions
 - E-commerce
 - No emissions for retail
 - Mass transported higher (emission intensity)
 - Local store: only 7% by car
- Minor retrofits
 - For cold storage blocks
 - Renewable energy (50% autosufficiency)
 - Floating condenser pressure



Importance of mass transported: emission intensity

Examples for road transport



Articulated truck up to 34 t GvW

Payload : 19-22t

Emission intensity
(diesel): 95 gCO₂/t.km



Rigid truck 7,5-12 t GvW

Payload : 2,5-9t

Emission intensity (diesel):
210 gCO₂/t.km



Van < 3,5 t

Payload 1-2 t

Emission intensity
(diesel): 793 gCO₂/t.km



Consumer car

Mass transported (survey): 30 kg
hypermarket, 15 kg supermarket,
5 kg local shop

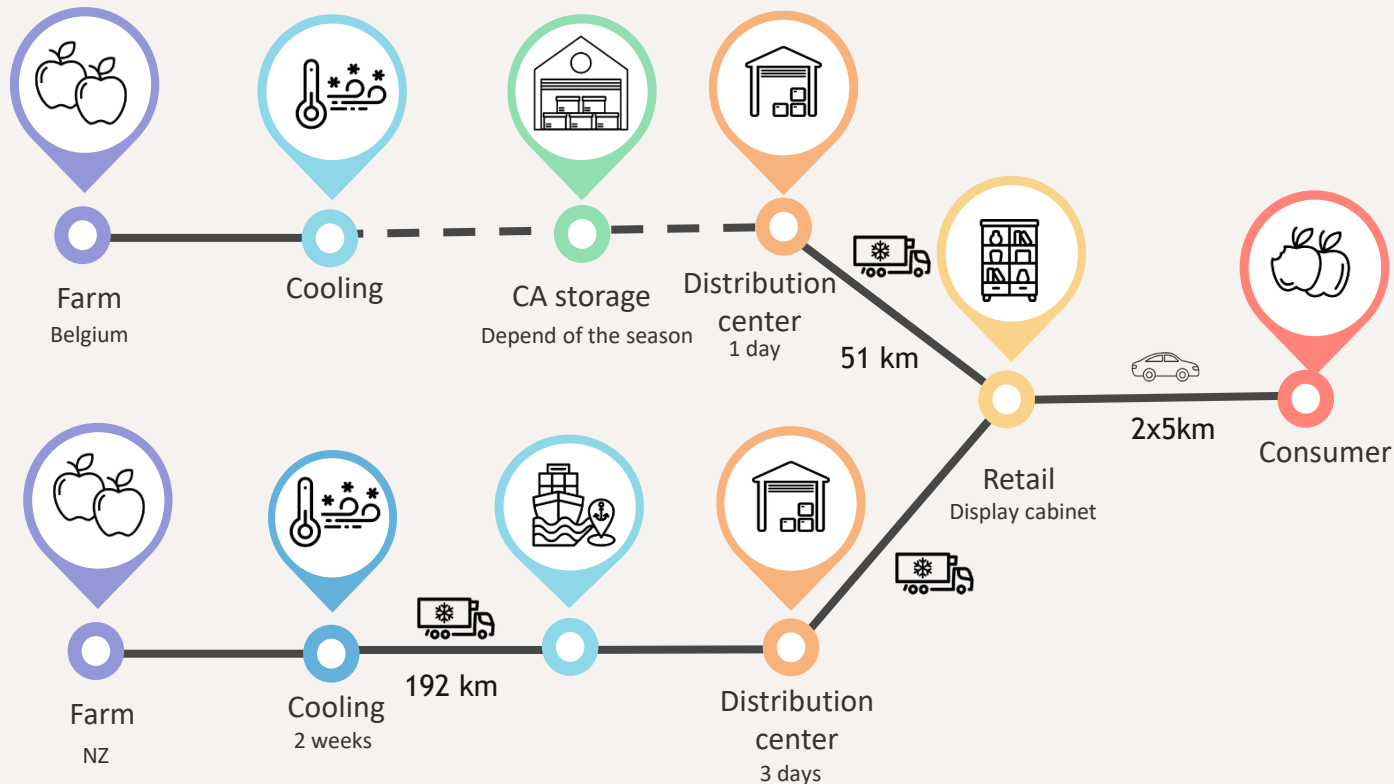
Emission intensity (diesel):
from 3000 to 8000
gCO₂/t.km

Emission intensity

Emissions to
transport 1 ton of
goods over 1 km

APPLE CHAIN IN BELGIUM

Case study from Goossens, Y. et al. « How Origin, Packaging and Seasonality Determine the Environmental Impact of Apples, Magnified by Food Waste and Losses ». *The International Journal of Life Cycle Assessment* 24, n° 4 (1 avril 2019): 667-87. <https://doi.org/10.1007/s11367-018-1522-0>.



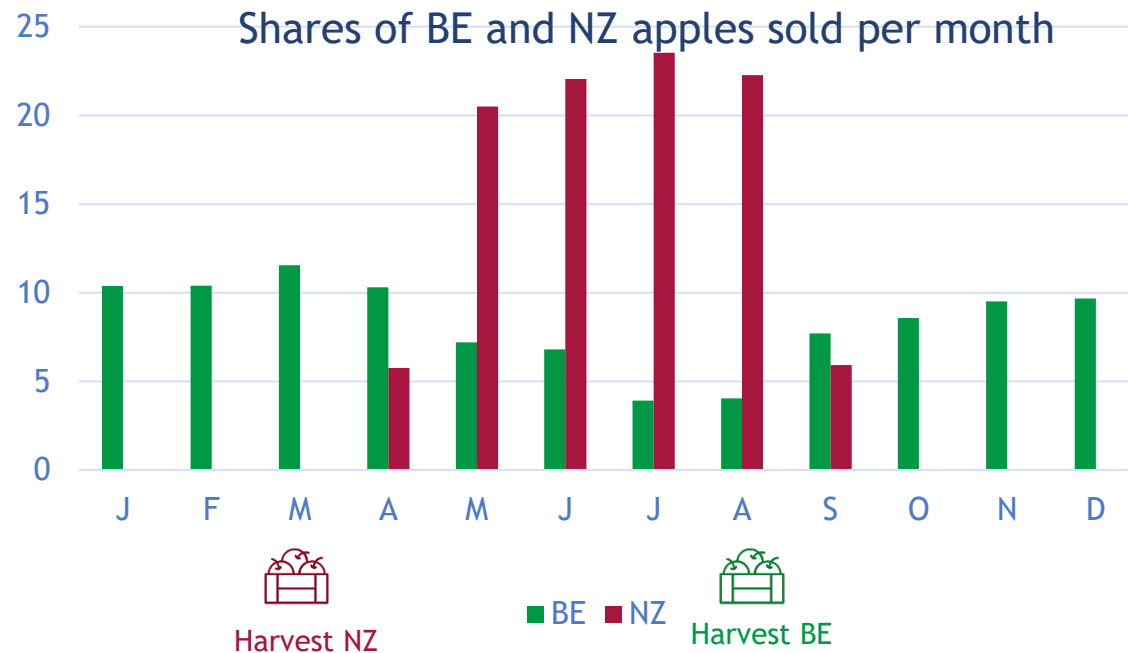
- Primary data obtained from Colruyt group (type of vehicle, mass transported, distance...)
- CA storage only for December and later

Apple chain
Stages in the logistic chain



Case study description

Share of apple sales



Source: Colruyt group

Imported apples: 40% of apples being sold



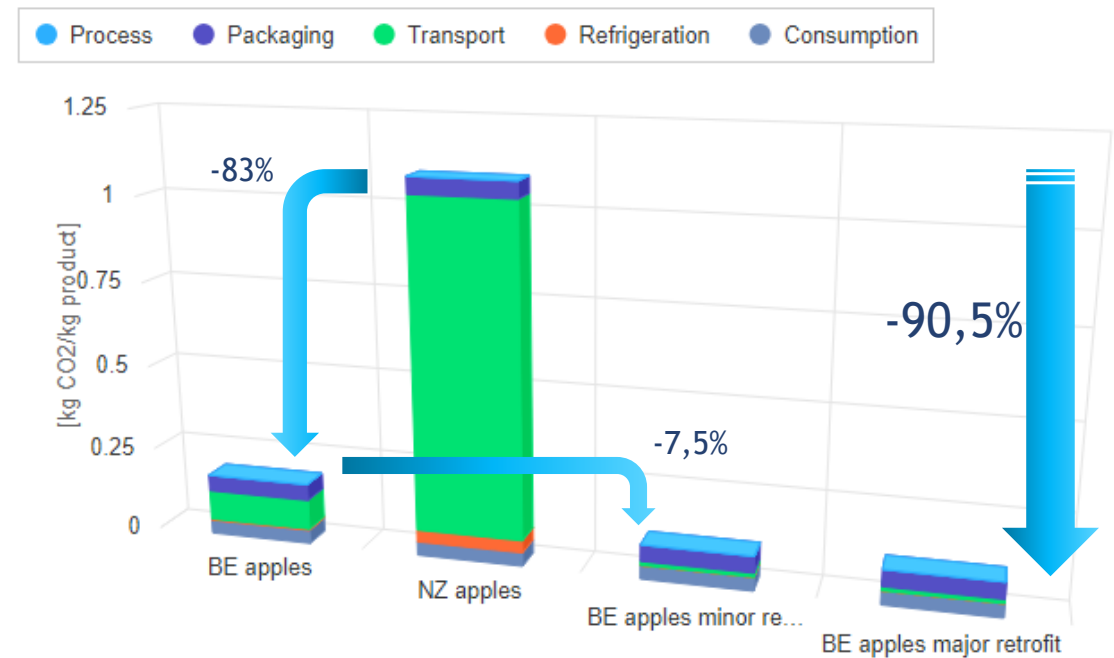
NZ apple: 27554km from Wellington to Antwerp

RESULTS

Potential emission savings

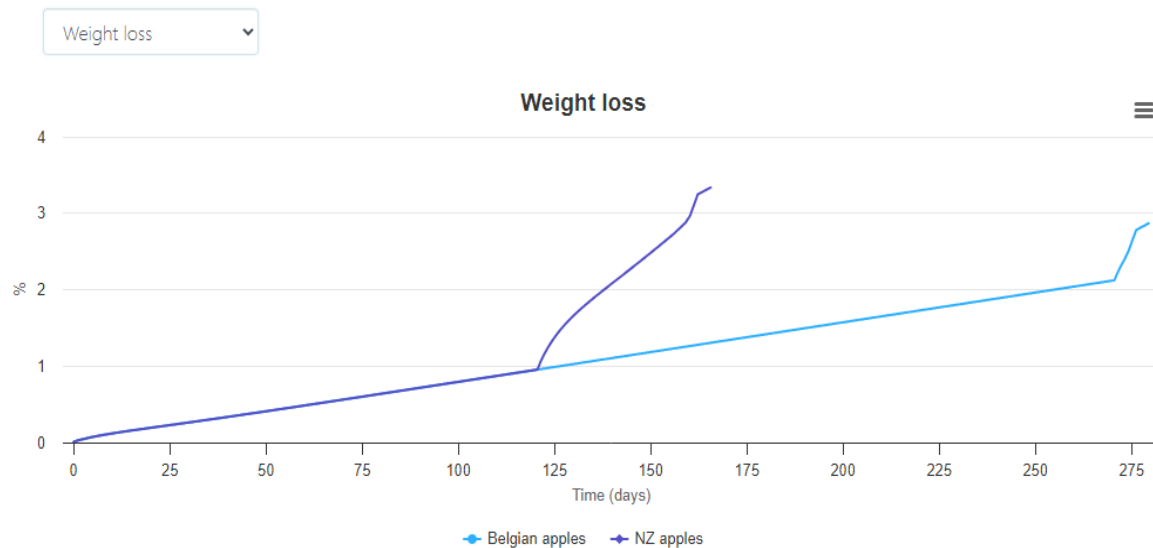
- If minor retrofits
 - For cold storage blocks
 - Renewable energy (50% autosufficiency)
 - Floating condenser pressure
 - For transport
 - Biomethane (large vehicles)
- If major retrofits (or new devices)
 - R744 refrigeration unit
 - Automation handling in warehouse

CO2 emissions

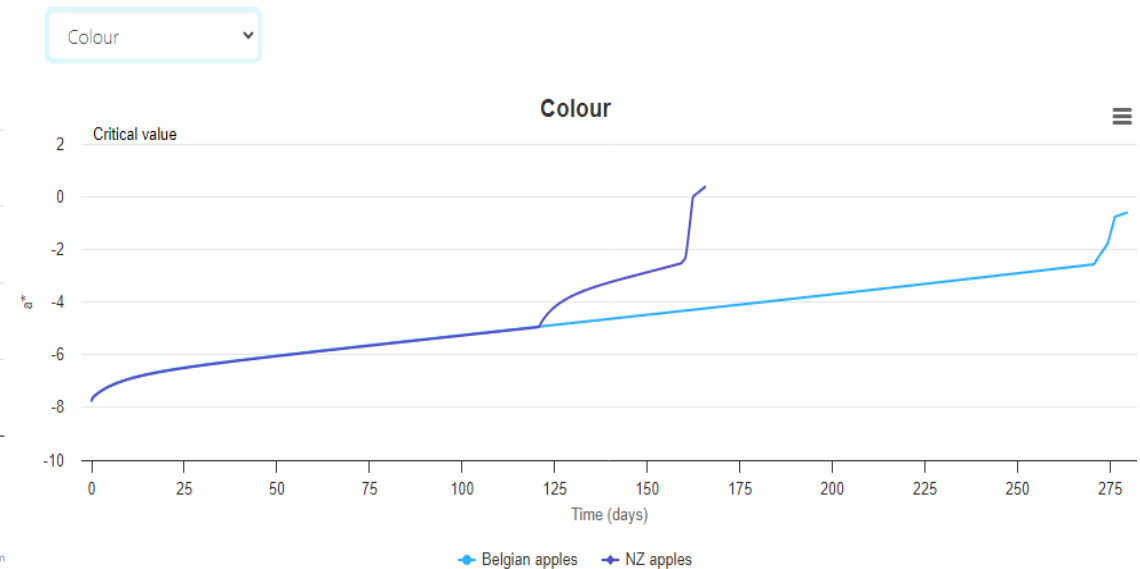
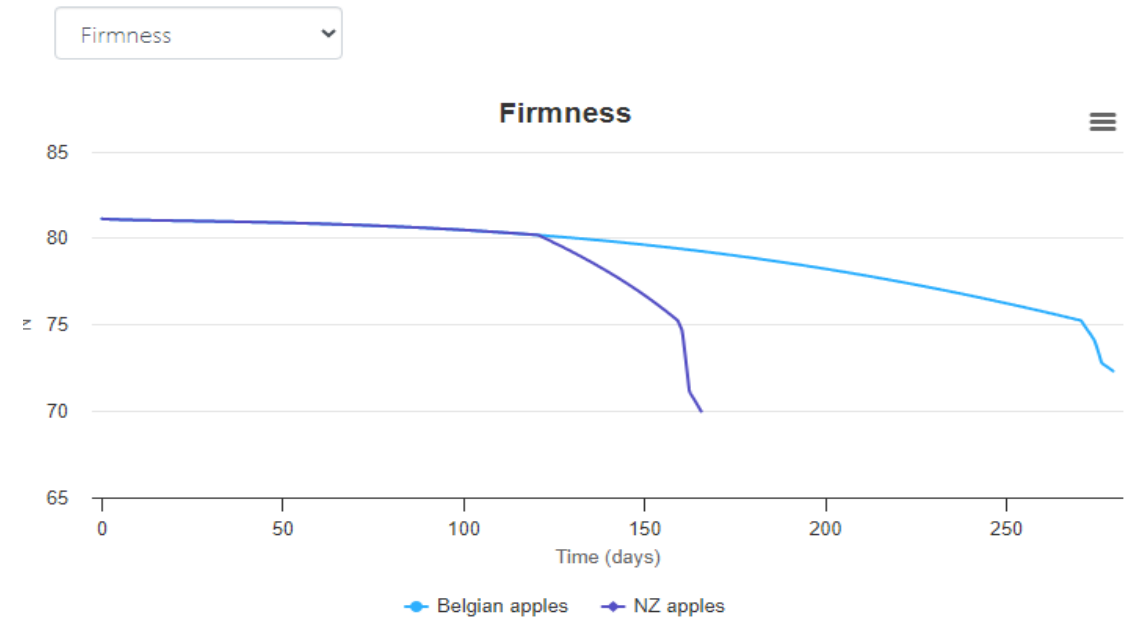


What about quality ?

- Even in the worst case : 9 months of controlled atmosphere storage for local apple (in August)
 - Firmness, colour and weight loss have been found relatively similar



Highcharts.com





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THANK YOU !

enough-emissions.eu