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Assessing the potential of the cold chain sector to reduce GHG emissions through food waste reduction

Benefits of implementing cold chains in emerging economies

Presentation of the methodology and the results

September 2015

The issues at stake

Key issue at stake: Business opportunities

- **Demonstrate the environmental benefits** of developing cold chains in emerging economies through the reduction of food waste, for **external communication** purposes
- **Expand the market** within developing countries

Objective of the study

Establish the relationship between:

- Development of cold chains in emerging economies,
- Reduction of food loss and waste (FLW), and
- Reduction of FLW carbon footprint through food waste reduction, balanced against additional emissions from increased energy consumption and use of refrigerants.

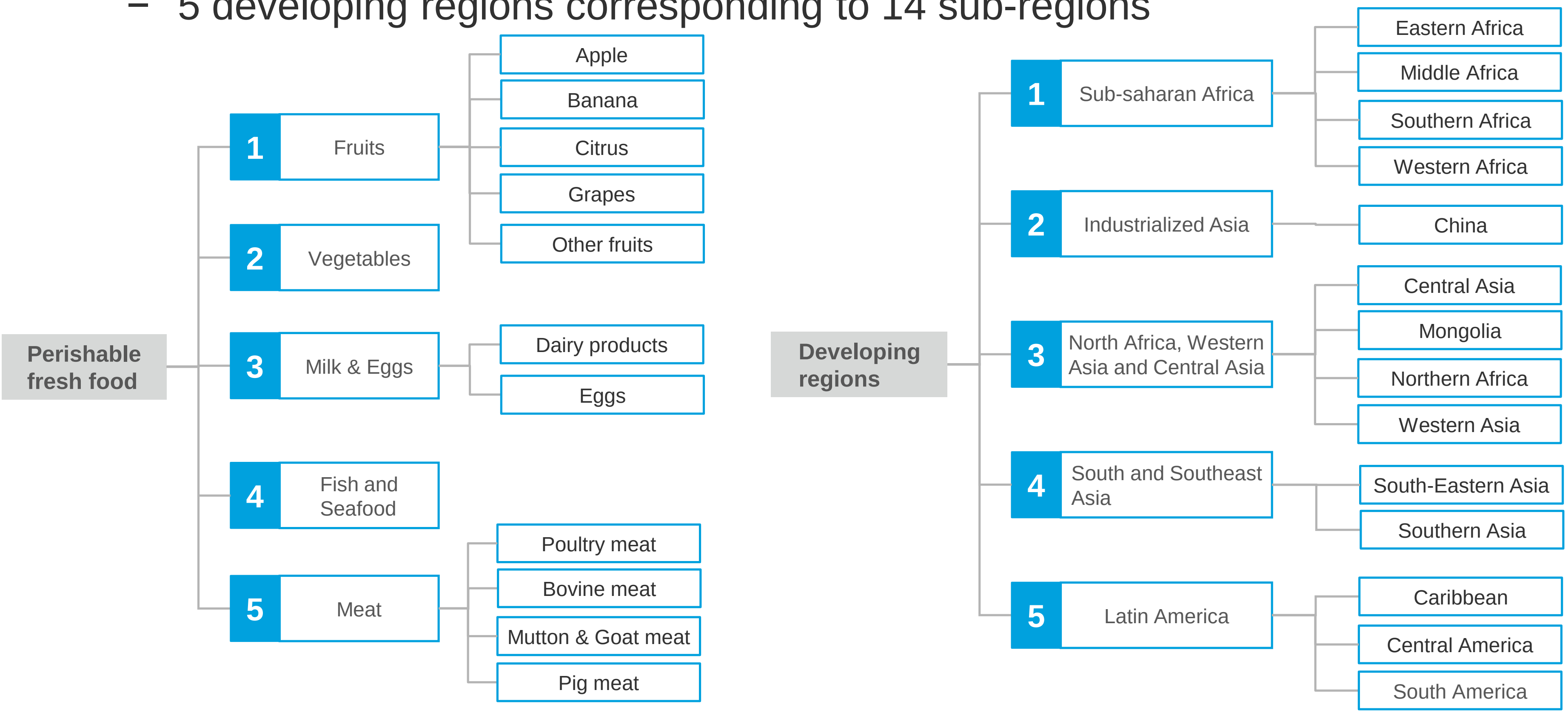
Co-benefits

- Improvement of **brand value** and **reputation**
- **Societal responsibility** with regards to food security in developing countries and environmental impacts of the activity
- **Visibility** as a proactive actor in the field

Scope

Considering to the aim of the study, the scope was limited to perishable fresh food and developing regions of the world

- The data collection covered :
  - 5 perishable fresh food commodities corresponding to 12 product groups
  - 5 developing regions corresponding to 14 sub-regions



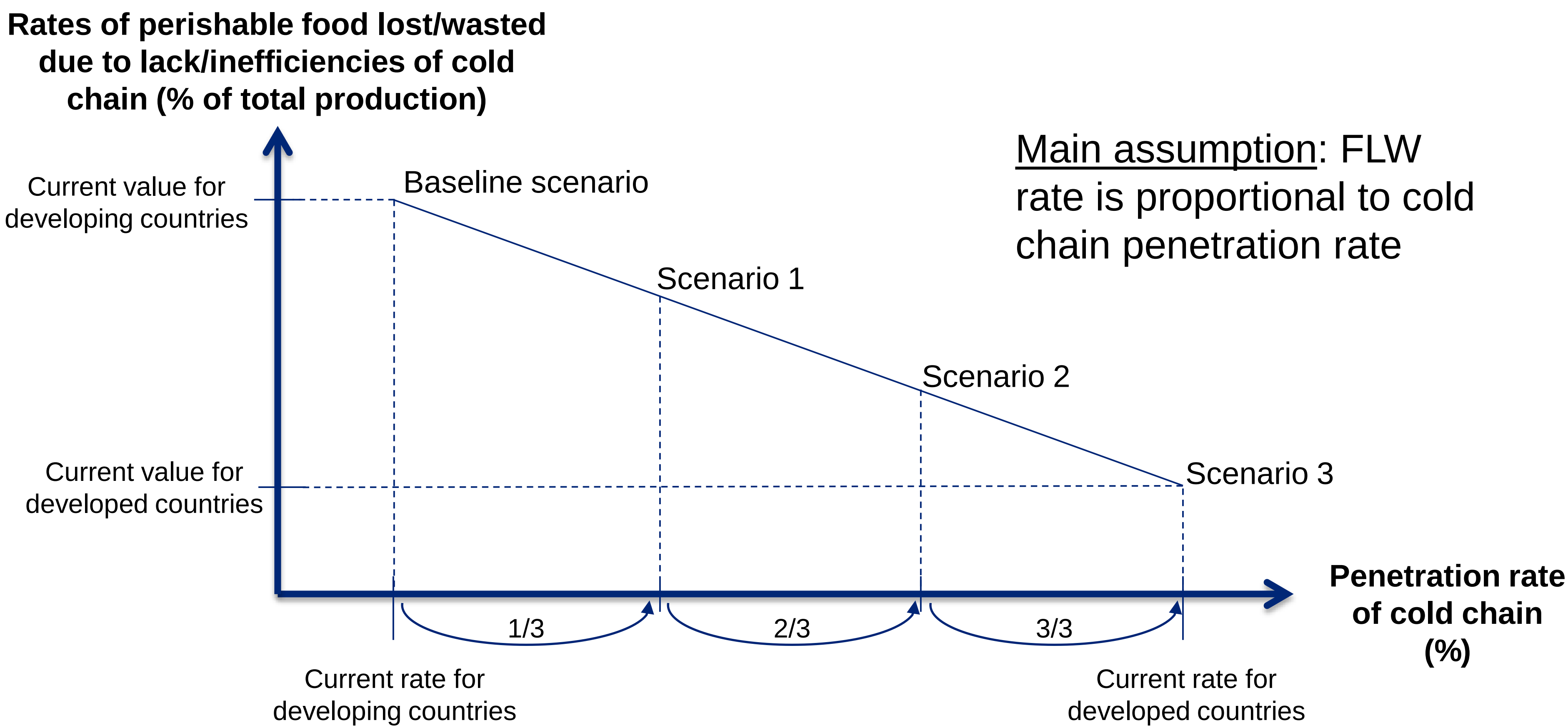
Description of methodology

A three-step approach to estimate the potential GHG emissions 'savings' through the development of cold chain

Steps	Tasks
1. Definition of scenarios	• Characterise the **baseline** scenario and the 3 **prospective scenarios** with increasing market penetration rates of cold chains in developing countries
2. Estimation of the gross GHG emissions 'savings'	• Model, for these 3 scenarios, how the development of the cold chain sector could help reduce the carbon footprint of FLW • Estimate resulting GHG emissions 'savings' for the 3 scenarios
3. Estimation of additional GHG emissions from transport and storage	• Model, for these 3 scenarios, the increase of transportation distances and energy consumption due to the use of refrigerated trucks and cold storage • Estimate the supplementary GHG emissions due to cold storage and transport

Definition of the 3 prospective scenarios

The scenarios are based on the difference of the average penetration rates of cold chains in developing and developed countries



Main assumption: FLW rate is proportional to cold chain penetration rate

Estimation of GHG emissions ‘savings’ through food waste reduction

Calculation of the carbon footprint of FLW for a scenario

- The figure below describes the methodology for calculating GHG emissions “embedded” in FLW for each product group and each region
- For an individual scenario, the total FW carbon footprint is the sum of the carbon footprints for all food categories in all regions

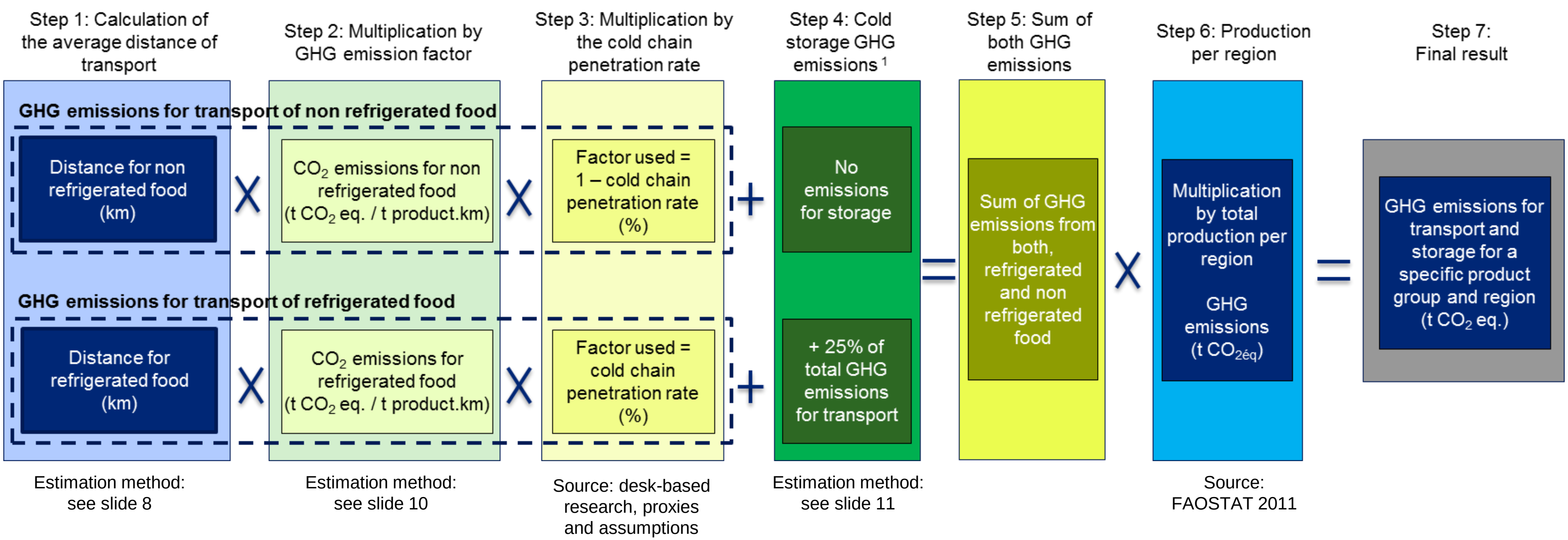
Step 1:Total food production		Step 2: Multiplication by FLW rates		Step3: Multiplication by GHG emission factors		Step 4: Final result
Total food production for a region (tons)	X	Share of perishable food losses attributable to a lack of cold chain (%)	X	GHG emissions of food over its life cycle (t CO_2 eq. / t food)	=	GHG emissions of FLW due to a lack of cold chain (t CO_2 eq.)
Source: FAOSTAT 2011		Source: Calculated scenarios		Source: FAO FWF study 2013		

- This calculation is done for the baseline scenario (current situation) and for the 3 prospective scenarios (progressive increase in cold chain penetration rates)
- The total GHG ‘savings’ for a given prospective scenario is the difference between GHG emissions for the baseline scenario and the GHG emissions for this scenario

Estimation of additional GHG emissions from transport and storage

Calculation of total GHG emissions for a scenario

- The figure below presents the methodology for calculating GHG emissions for transport and storage for each product group and each region
- For an individual scenario, the total GHG emissions are the sum of GHG emissions for all food categories in all regions



- The additional GHG emissions from transport and storage are defined as the difference between GHG emissions for a prospective scenario and GHG emissions for the baseline scenario.

Estimation of additional GHG emissions from transport

Calculation of the average distance of transport

- Estimation of the maximum distance of transport is based on:
  - The maximum time of conservation: for example, fresh fish can be stored for 2 weeks at 0°C but only a few hours at 30°C[1]
  - Specific cases studies whenever available: for example, in Western Asia, "*non-refrigerated vehicles are used for transporting produce over distances for up to 850 km*"[2]

- Calculation of the average distance of transport is based on:
  - The percentage of people living on coastal area for fish transport
  - The urbanization rate for all other products

- Average distances were compared with the few data available in order to adjust certain values when necessary.

Sources:

1 – The Postharvest Education Foundation, 2013. Use of cold chains for reducing food losses in developing countries

2 – FAO & Asian Productivity Organization, 2006. Postharvest Management of Fruit and Vegetables in the Asia-Pacific Region

Estimation of additional GHG emissions from transport

GHG emission factors (EF) for refrigerated and non-refrigerated transport

- For non-refrigerated food, a unique GHG EF for transport is used:
  - Representative of lorry with 16 tons of load
  - GHG emissions = 1.03 kg CO_2 eq./km[1]
- For refrigerated food, a new EF for transport is calculated, based on:
  - GHG emissions for a lorry of 16 tons of load
  - Additional emissions due to overconsumption of diesel for the refrigeration system: +21% diesel consumption[2]
  - Additional GHG emissions due to refrigerants production and leakage[3]:
    - R404A refrigerant used for calculation
    - Composition of R404A : 44% R125, 52% R143A and 4% R134A
    - Refrigerant leakage: 14% per year
  - Calculated GHG emissions = 1.29 kg CO_2 eq./km

Sources:

1 – Data from EcoInvent database

2 – ADEME (French Environment and Energy Agency) 2012

3 – Data from University MINES, 2009. Inventory of emissions from refrigerants

Estimation of additional GHG emissions from storage

GHG emission for the refrigerated storage systems along the chain

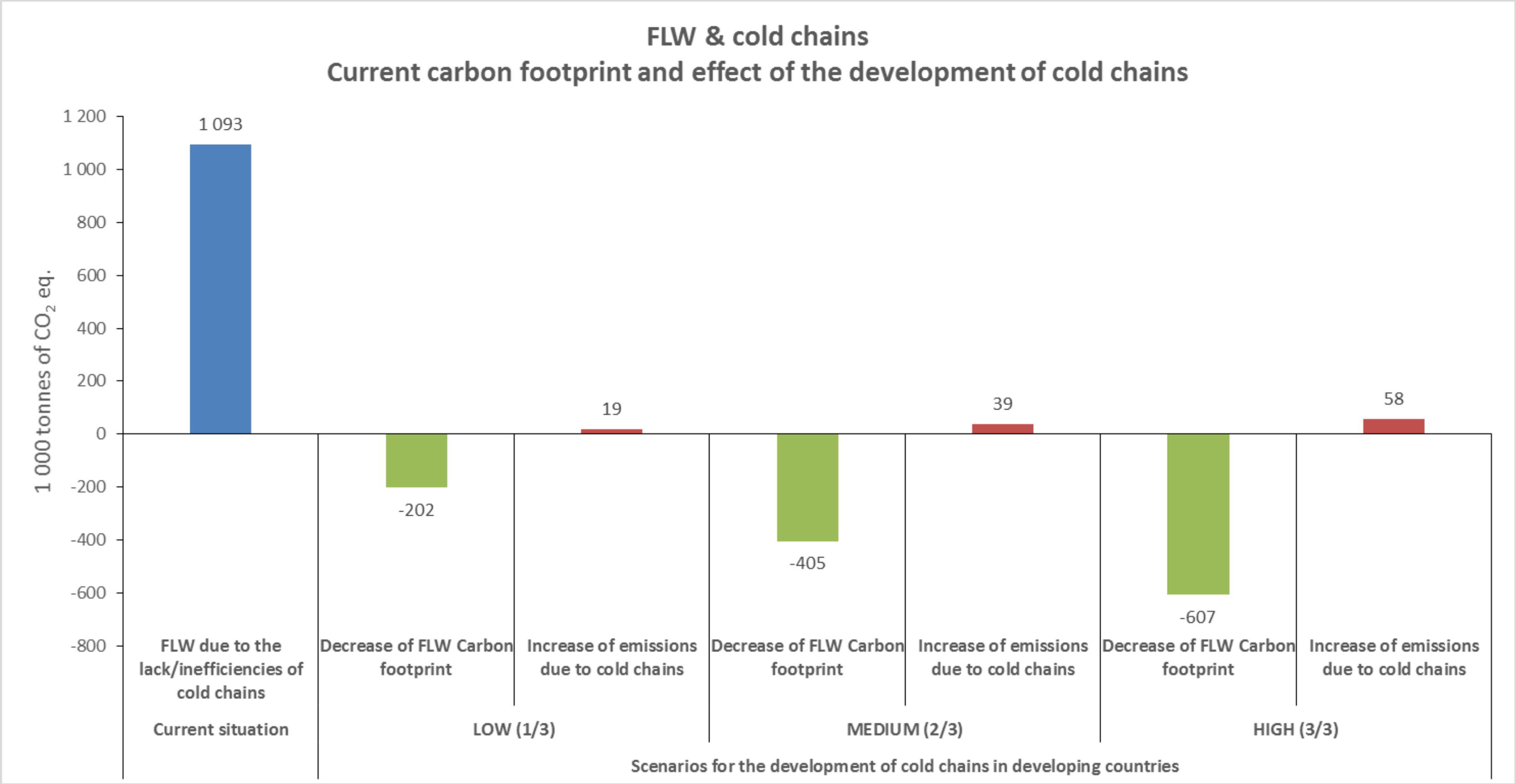
- It is assumed that there are no GHG emissions due to storage in case of non-refrigerated food chain.
- Moreover, due to the lack of information, the energy consumed by pre-cooling equipment in packhouse facilities was not taken into account.
- According to a study carried out by the FRPERC, the total energy consumed by UK cold storage for refrigeration represents 19% of the total energy used in refrigerated transport for UK[1].
- Using this figures the calculated emissions related to energy used for cold storage represent about 25% of the emissions related to the energy used for refrigerated transport (based on GHG emissions factors for electricity and diesel representative of Europe).
- This ratio enabled the team to use the calculated emissions factor for refrigerated transport as a basis for the emissions related to storage within cold chains.

Source:

1 – Food Refrigeration and Process Engineering Research Centre (FRPERC), 2008. Energy use in food refrigeration - Calculations, assumptions and data sources

Results from the model (1/3)

According to the model used, in all prospective scenarios, the decrease of FLW carbon footprint from cold chain expansion clearly outbalances the newly created emissions, by a factor 10 approximately.

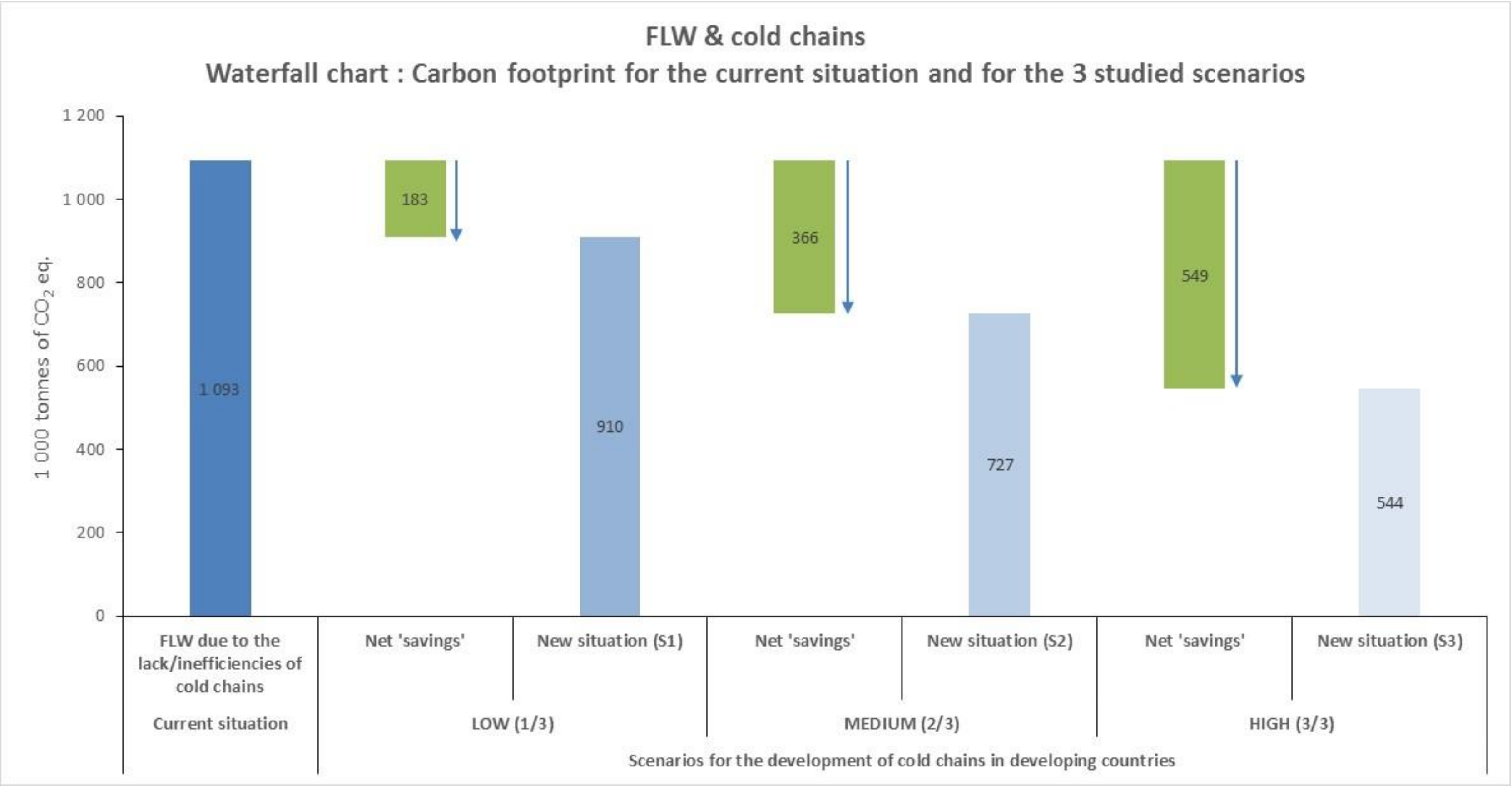


The total amount of food wastage in 2011 has generated about 1 Gtons of CO_2 equivalent, an amount comparable to the total GHG emissions of road transportation in the EU (0.9 Gt)[1].

Source:
1 – UNFCCC Annual GHG emissions for road transportation in 2012.

Results from the model (2/3)

According to the model used, net GHG ‘savings’ are observed for the 3 prospective scenarios

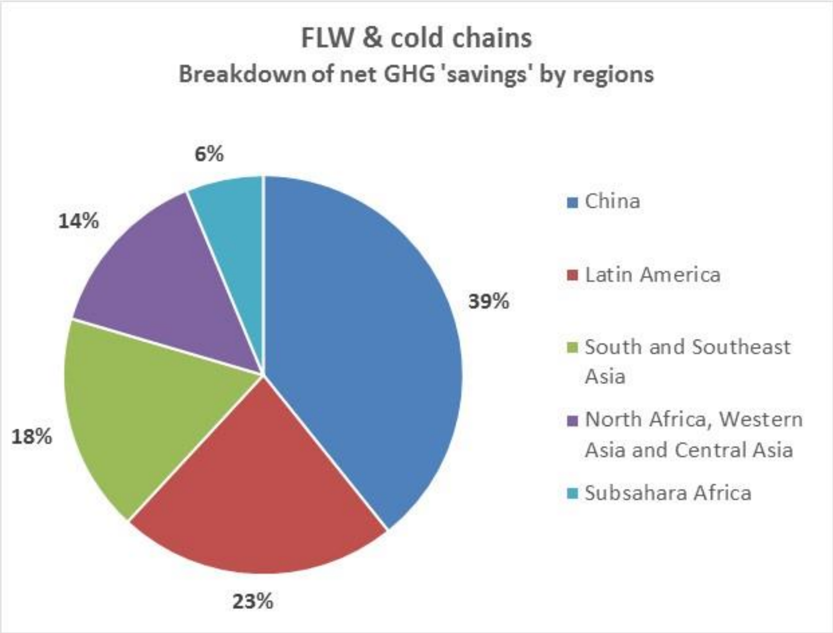


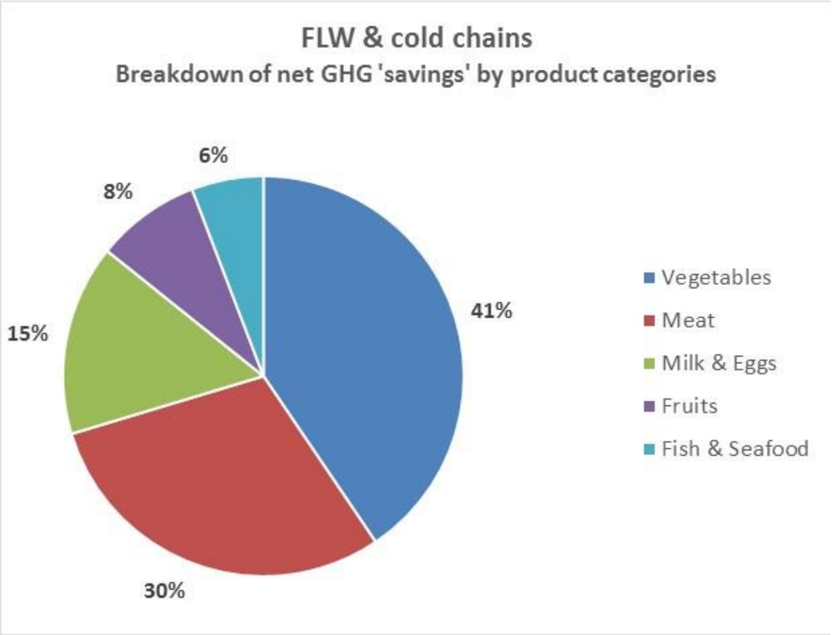
In scenario 1, the net GHG ‘savings’ would represent circa 180 Mtons of CO_2 eq. In scenario 3, the net ‘savings’ would represent circa 550 Mtons of CO_2 eq. As an illustration of the magnitude of these results, they can be compared to the total emissions of France – i.e. circa 450 Mtons of CO_2 eq. in 2012[1].

Source:
1 – European Environment Agency (EEA), June 2014

Results from the model (3/3)

Breakdown of net GHG 'savings' by regions / product categories





Discussion on the model

The model does not consider potential rebound effects

- Under the time limitations of the project, a simple, but inclusive model was used. The team used relevant data when available, but otherwise used proxies and assumptions.
- The model does not consider:
  - Potential rebound effects of cold chain development such as the possible evolution of consumer behaviour – for example, as a result of the easier market access of goods, there may be an increased supply and demand of CO_2 intensive foods, such as red meat.
  - Additional infrastructures (roads, buildings, etc.) needed
  - Potential increase of exportations
- By not incorporating these factors in the model, it is important to note that the increased emissions as a result of cold chain development may be underestimated

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