Quang Truong

Food packaging process material's effect on environment and their control measures.

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This thesis aims to interpret the aspects of CO2 emitted by packaging material in food industry, and food ingredients. The emitted GHGs by packaging materials in food industry accounts for a huge percentage in the total amount of GHGs globally. To study this further, Ai-To Foods Oy was selected as case company, the sale data is analysed to emphasize on how tremendous GHGs produced in just packaging process. The thesis also aims to show the environment of Finnish food industry.
This thesis also provides information about food industry in Finland, eco-innovations trend in recent years, giving overall evaluation of food waste impact on environmental issues.

The data was retrieved from a company database to measure the number of sold packages in 2018, and total CO2 was calculated based on sold data. Two hypothesis were postulated, the first hypothesis was that normal materials are in use, total CO2 produced from packaging stage is measured, the second hypothesis was that new material is chosen for packaging process. Hence, it reduces the GHGs. The results were compared and the reduction rate was concluded.

The results indicate that there is a reduction rate in the packaging process. The first stage of long term project is considered successful as GHGs seem to have reduced
and the business overview is positive and sustainable. Further plan would be considered as reducing more GHGs from other part of manufacturing processes.

Keywords	packaging, material, management, carbon footprint

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This was great opportunity to study food packaging waste, and it has been a pleasure to get to know all department members of Metropolia UAS, Environmental Engineering section.

1 Introduction

It is estimated that world population is rising with approximately 80 million (80,700,291) **[1]** every year, hence the global food demand is moving in tandem with growth rate, as are the environmental impacts of agricultural expansion. It was studied that the crops demand per capita measure as caloric or protein content of all crops combined, has significantly increased similarly, the real income per capita has risen since 1960. As a consequences, this forecasts the higher rise between 2005 to 2050, with approximate rate of 100%. (Global food demand and sustainable intensification of agriculture- PNAS 2011) **[2].** Furthermore, if the current trends of greater agricultural intensification in richer nations and greater land extensification in 3rd nations continues, global land loss would be up to 1 billion hectares. Moreover, agriculture already has major impacts on global environment, for instance, the threat to biodiversity from land extensification activities, fertilization and fertilizer cause negative effects on marine, fresh water and terrestrial ecosystems.

It is statistically observed and reported that CO_2 food emission equivalent greenhouse gas is estimated at 3 gigatons, while the Nitrogen emission would be up to 250 megatons by 2050 according to *Food Waste within Food Supply Chains: Quantification and Potential for Change to 2050* **[3]**. Food waste in 3rd countries is unintentional due to lack of awareness, low management of food flow (logistic, packaging, preservation factors), whereas in developed countries food waste is intentional but also due to the lack of awareness, excessive food purchasing factors.

Along with food ingredient emissions , municipal solid waste (MSW) includes thrown away items such as packages, food scraps, and food bags , which form in general, the food packages class in massive production chain. In fact, food is a product class typically consumed regularly by every person, three times every day. Therefore, food packaging accounts for almost two-thirds of total packag-

ing waste by volume, holding up to approximately 50% by weight of total packaging sales, according to *Journal of Food Science, April 2007 [**4**]*.

Therefore, some actions are needed to preserve environments while the food demands for people should still be well met. Food packaging process, therefore, is a major concern for wholesale selling food corporations around the globe. In Finland, in 2018 report has shown that almost 45.8% and 27.1% percent of wholesale food product is in a safe level of inspection-specific results, about 25% need more complied improvement with the minor 2.5% shortcomings detected. (Evira publication, 1/2018) **[5]**. As the sustainable developing food business, more corporations have an eco-friendly strategy. The general situation in food industry in Finland will be shown in this thesis work.

2 Literature review

2.1 Carbon footprint

“A carbon footprint is the total greenhouse gas (GHS) emission caused by measured subject, the emission can be caused directly and indirectly”. The subjects can be individual, organization, products, food products or an event. The carbon footprint is calculated based on the life cycle of the subject, different greenhouse gases (GHGs) may be emitted such as methane and nitrous oxide, which traps heat in the atmosphere.

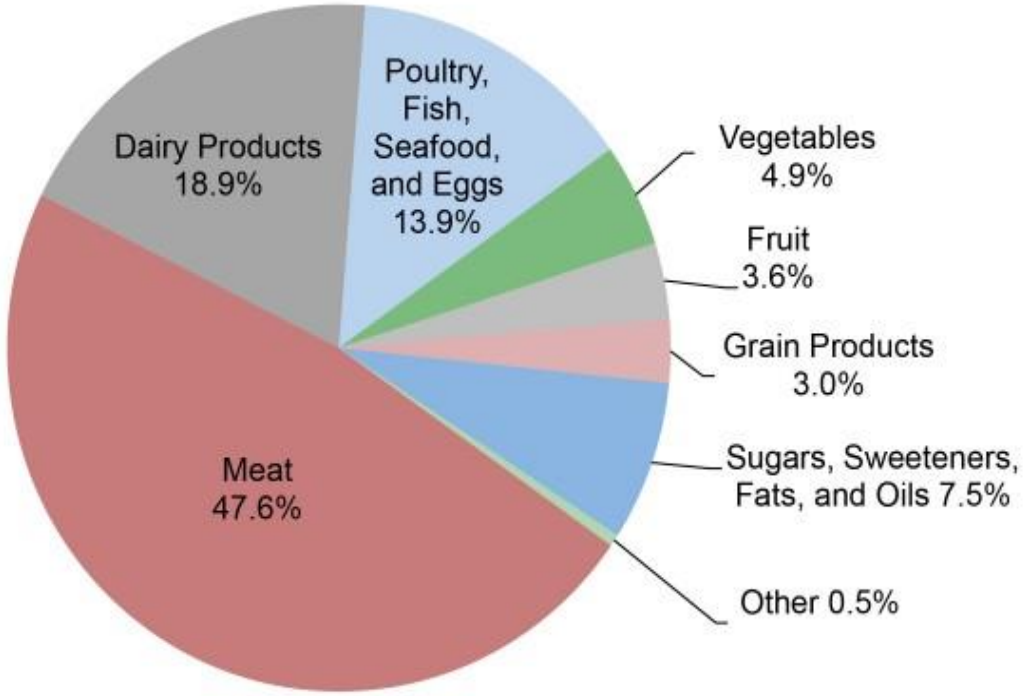

Figure 1. Food carbon footprint data-calculated in U.S 2018.

Facts: Average household in U.S food consumption emits 8.1 metric tons of Co_2e each year, with 84% production of food and 16% consists of food transportation eg packaging, logistics.

Meat products have higher carbon footprints, not only in US but also in the globe, compared to grain or vegetables due to inefficient transformation of plant energy to animal energy.

Organic food has higher price, whereas it requires 30 up to 50% less energy consumption but demand one-third more hours of human labour. **[6]**

2.2 Food packaging

The main principle role of food packaging are to protect food products from outside influences and damage, in order to preserve food in great quality to delivery to customers with nutrition information **[7].** The process is capable of slowing down product deterioration and retain the beneficial effects of processing, maintain or increase quality and safety of food products.

Food packaging is the face of a product, and not only does give an impression to new buyers, but it also is the only product that customers are exposed to experience prior to purchase. Consequently, distinctive or innovative packaging can boost product selling in competitive environment.

2.3 Packaging material

Package design and construction plays significant role in determining the shelf life of a product. The ideal selection of design's material and technologies should be able maintain product quality and freshness during distribution and storage. Common chosen materials are glass, metal, paper, porous kraft paper and wide variety of plastics. In order to cope with environmental issues, food package materials are utilized for their functional or aesthetic properties, and to ensure package quality.

3 Food industry and carbon footprint

3.1 Food ingredients factor

Food industry is believed to be one of the largest contributors to climate change, as GHS emission from food preparing procedures (grow, harvest, transport and store, and possibly process) before it reaches retailer's shelves. Furthermore, due to a growing population, the climate impact is undoubtedly on the rise. In general, the estimated value of carbon emission is based on sources that assess the greenhouse gas emission of food.

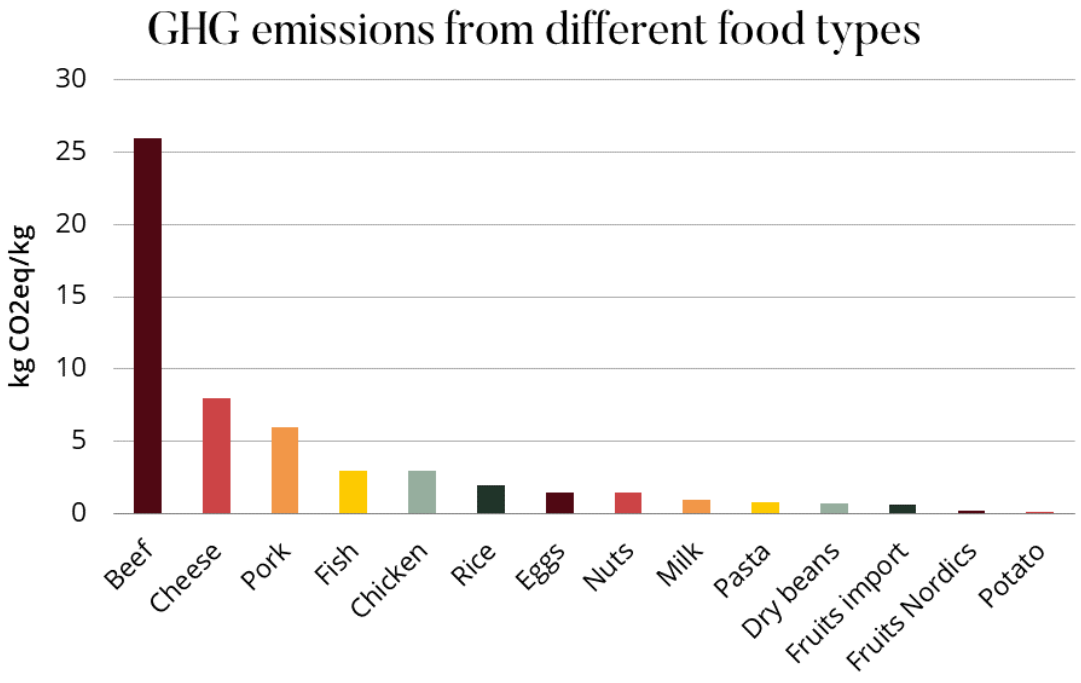

Figure 2. GHG emissions from different food types.

Figure 2 illustrates the carbon footprint on each type of food sources in worldwide, the measure unit is kg CO_2eq/kg.
Beef meat has a significant dominate value compared to other type of food with a value of over 25 kg CO_2eq/kg, vegetables have a very low CO_2 emission value with mostly less than 5 kg CO_2eq/kg. The data is calculated and reported based on Lifecycle assessment, which follow the whole process of producing the food source.

The European Commission has specifically planned to reduce in specific have planned to cut down GHG at least by 20% by 2020 in order to reduce overall emission.

3.2 Packaging materials factor

The second factor that significantly contributes to greenhouse gas (GHS) and food waste is the manufacture process of the raw materials, fabrication of the

packaging system, transport and storage procedure and the use phase, including refurbishment and reuse or end of life disposal.

The materials for food packaging business are mainly paper, stainless steel, high-density polystyrene plastic, non-woven polypropylene plastic due to the price element and endurable quality.

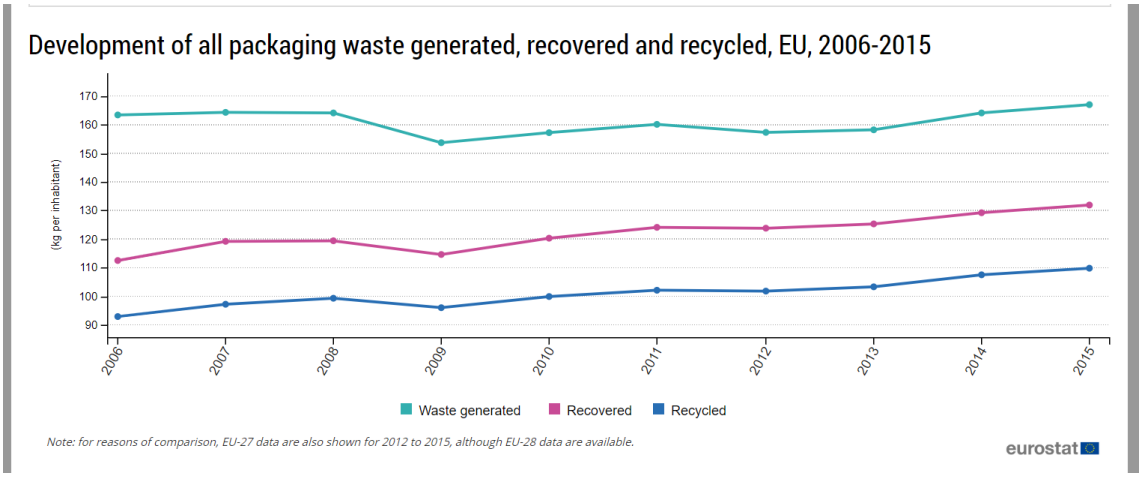

Figure 3. Development of all packaging waste generated, recovered and recycled, EU, 2006-2015

Figure 3 from ec.europa.eu **[8]** shows the statistical data of waste generated from food packaging. It is apparent that there is a huge gap between the recycled, recovered waste compared to average 160 kg per inhabitant of generated waste. On the other hands, packaging waste recycling rate rose steadily throughout every year, showing that Europe is the following Directive 94/62/EC.

> The Directive was amended to provide criteria clarifying the definition of the term 'packaging' and increase the targets for recovery and recycling of packaging waste. In 2005, the Directive was revised again to grant new Member States transitional periods for attaining the recovery and recycling targets.
> In 2013 Annex I of the Directive containing the list of illustrative examples of items that are or are not to be considered as packaging

was revised in order to provide more clarity by adding a number of examples to the list. The latest revision of the Packaging and Packaging Waste Directive occurred on 29 April 2015 with the adoption of Directive (EU) 2015/720 of the European Parliament and of the Council amending Directive 94/62/EC as regards the consumption of lightweight plastic carrier bags.

Sources of packaging wastes are mainly from households with approximately 64% and the rest from industrial and trading level. The recycling rate from households segment obtained around 37,8%, which indicates positive trend in protecting environment.

4 Food business and environment in Finland

Finland has been in advance position in eco-innovation projects in Europe, even though the economy was relatively weak and recovering from an economy collapse in 2008. Food industry also takes part in the eco-innovation trend in Finland.

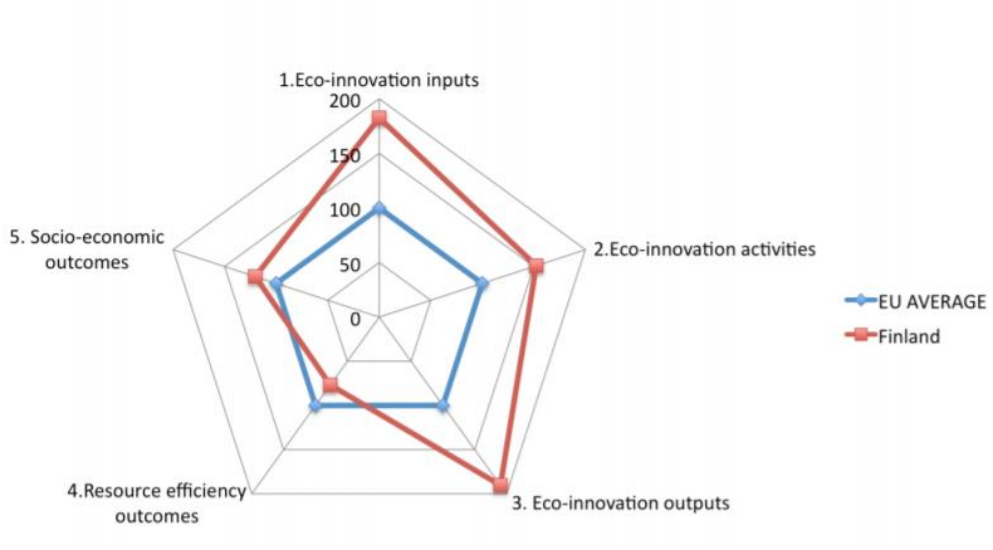

Figure 4. The eco-innovations factors between Finland and Europe.

The figure 4 above indicates component of Finland's eco-innovation compared to Europe **[9].** In general, the resource efficiency component of the eco-innovation score is around 20% lower than the EU average. The main challenges are in material productivity (57% lower than the average) and energy productivity (41% lower). Interestingly, the share of renewable energy in total energy consumption in Finland is relatively large. Finland also emits around 14% more greenhouse gases than an average EU country, corrected for GDP, although the gap has narrowed slightly from 2013. Despite the challenges in resource efficiency and GHG emissions, overall Finland remains a forerunner in eco-innovation performance, and an example of smart planning and organisation of the national eco-innovation system.

A wide variety of restaurants and corporations have joined hands in the effort to reduce the carbon emission from their business. The statistic data have proved that about 70000kg waste is generated from restaurant business every year. In Finland, fortunately with well educated programme, their citizens have strong awareness in protecting environment from basic household level to large scale business, the government has also boosted the warning about climate change and effort in preserving environment. The pioneer in this campaign is Nolla restaurant **[10]** in Helsinki region. The idea of zero-waste restaurant was born out of frustration in the wastefulness of the restaurant industry, "we strongly believe that the contemporary waste management practices of the industry are outdated, and we want to do something about it"-Nolla restaurant stated. The business model is working directly with local and international producers of organic ingredients in order to reinvent, reject and control packaging, which reduces storing and packaging materials. Hence carbon footprint is believed to be decreased.

Another highlight in environmental innovative is switching food sources. In Asia this has been applied to ensure food sources to people from war time until modern days. Fazer introduced breads made from crickets powder in 2017, this was known as an advance step to alternative food sources to human.

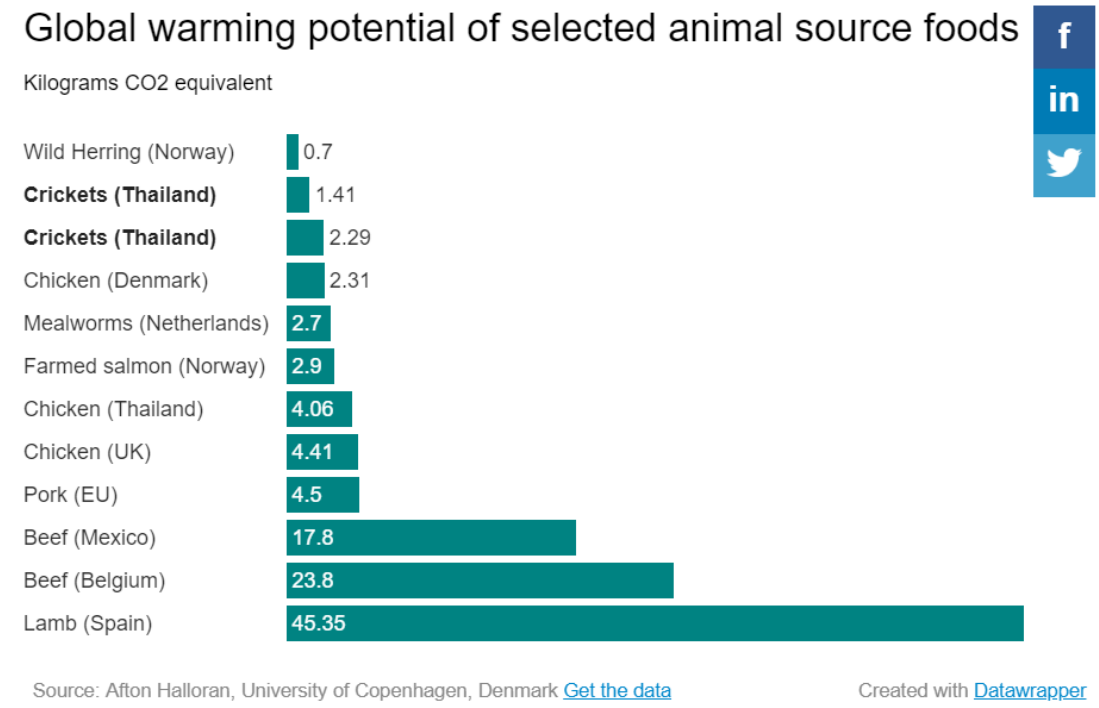

Figure 5. Global warming potential of selected animal source foods

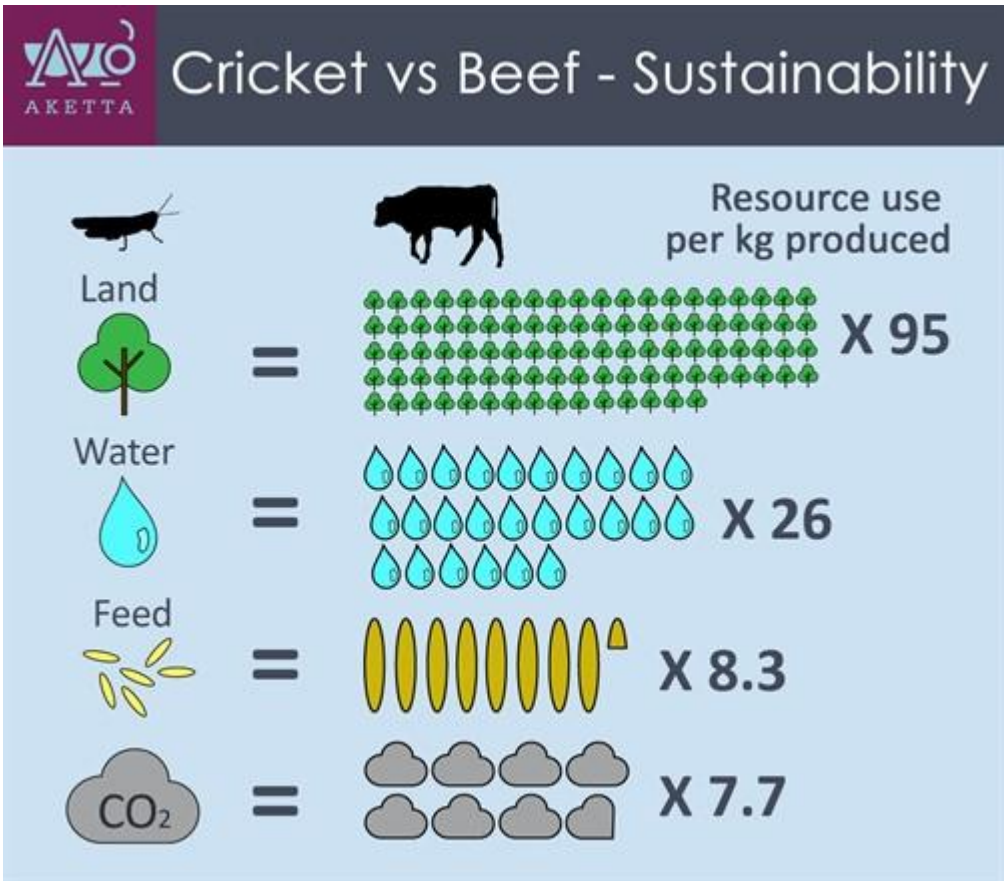

Figure 6. Cricket and Beef sustainability resource

Figure 5 and 6 above show relative comparison between cricket and beef carbon emission, with 7.7 time less CO2 produced and approximately 1.41 kg CO2 equivalents, changing food sources is the key leading to sustainable development for the world. **[11]**

5 Ai-to foods OY roadmap to sustainable development

Ai-To Foods OY is a growing retail food company founded in 2013 by Tuukka Saimen, with net profit calculated up to 2.2 million euros in previous year, 2017. The sale of the company has been strongly increased from 2016 with approximately 31% growth rate to 2015. Company's vision will be concentrating on innovative and international business scale, with high-quality products to customers and also support environment. Ai-To Foods Oy operates on an order-production basic model, which means products are made after retailers have placed their orders to ensure products at its finest quality.

The company has provision in manufacturing green products in period from 2019 to 2025 to satisfy the customer's demand. The roadmap of company aims to follow Directive 2004/12/EC of the European Parliament and of the Council of 11th February, 2004 on packaging and packaging waste **[12]** and local diet trend nowadays, less red meat, more white meat and 0 waste achievement.

> The **revised legislative proposal on waste** sets clear targets for reduction of waste and establishes an ambitious and credible long-term path for waste management and recycling. To ensure effective implementation, the waste reduction targets in the new proposal are accompanied by concrete measures to address obstacles on the ground and the different situations across EU Member States.
>
> Key elements of the revised waste proposal include:

- A common EU **target for recycling 65% of municipal waste** by 2030;

- A common EU **target for recycling 75% of packaging waste** by 2030;
- A binding landfill target to **reduce landfill to maximum of 10% of municipal waste** by 2030;
- A ban on landfilling of separately collected waste;
- Promotion of economic instruments to discourage landfilling ;
- Simplified and improved definitions and harmonised calculation methods for recycling rates throughout the EU;
- Concrete measures to **promote re-use and stimulate industrial symbiosis** –turning one industry's by-product into another industry's raw material;
- Economic incentives for producers to put **greener products on the market** and support recovery and recycling schemes (eg for packaging, batteries, electric and electronic equipment, vehicles)." **[13]**

Once company reaches the goal, expanding business to neighbour area such as Sweden, Estonia, or wider area like Asia is highly considered.

In order to study about food and food packaging emission, this company was chosen to be study case, where data were collected and calculated and summarised the change in reducing carbon footprint cooking procedure and packaging procedure by decreasing high-produced carbon footprint ingredients and switching to eco-friendly packaging materials. The carbon footprint was measured and calculated based on company's library database, which focus on food ingredients carbon emission and packaging materials to conclude the impact on environment.

Sale profits were also taken into account and see how customers react to new friendly environmental products. Fortunately, in Finland with high awareness for environment, the new changes are accepted by customers and the sale rate is stable and steadily higher than previous year.

6 Database and measure methods

The calculations are based on Ai-To Foods 12 months sale data in 2018. The plan was applied from beginning of January, which lasted for a year until beginning of 2019. The second hypothesis where no applied eco-friendly plan was calculated based on real sale data, then the comparison was made in order to emphasize the amount of CO_2 reduced from eco plan. There were two approaches in our plan in reducing GHGs in food ingredients and packaging box materials which are separated in 4 phases. In phase one the list of packaging materials were listed out and carbon footprint were calculated from these materials, in order to explain the details of manufacturing in Ai-To Foods. The overall measurement and calculations was done without carbon footprints from manufacturing processing by packaging machines, cooking batches or employees as the plan would be executed after the eco-friendly products stage was done.

6.1 Packaging materials information

The total revenue in 2018 was estimated at 2.1 million euro (Finder.fi) with average monthly income equals 13000 euro. There are 6 different package boxes for packaging process and delivery with 6 type of food products, which are Ready-to-eat (RTE) small, RTE spring roll, RTE fried mix, Fried food 1.5kg, food 2.5kg and food 3kg corresponding to Category 1 to 6 respectively. The packaging material in this hypothesis is paper board, solid bleached sulphate and plastic rPET. More details about boxes are indicated in table 1 below.

Table 1. Packaging material Information

			Kg CO2 eq per unit	
Material	Category	Net weight (gr) of packaging box	Emission factor data per 1 portion	
paperboard: Solid Bleached	1	10	0,0095	0.957 KG CO2 eq
paperboard: Solid Bleached	2	14	0,0133	
paperboard: Solid Bleached	3	60	0,057	
Plastic rPET	4	20	0,1246	6.231 KG CO2 eq
Plastic rPET	5	90	0,5607	
Plastic rPET	6	90	0,5607	

According to given access data, net weight of package box in categories is weighted with scale, emission data was calculated in kg CO_2eq per 1 product portions. Emission factor formula is based on

Ef (emission factor) = $\frac{weight}{1000}$ x material's emission factor **[14]** . Overall, one package portion produces the highest CO_2 with up to 5.6 kilograms CO_2eq, lowest CO_2 produced by category 1. Material emission factors were taken from environmental paper database https://c.environmentalpaper.org/individual.html **[15]** .The material emission factor can be called M.e, which stands for Material Emission.

The amount of each category products were concluded according to Ai-To foods data on amount of sales for each delivered product to customers each month, in quantity unit (pieces/kpl in Finnish). The monthly sales each month was described in table 2. Each column represented the sold level of each categories. The pieces of delivered products were multiplied by emission factors of materials to give emission factors of each categories products. Total annual emission value is retrieved from SUM() equation from Excel, which is emission factor of packaging material produced during packaging process. Calculated units are in kg CO2.

6.2 GHGs statistical data

First hypothesis is given with the fact that no plan was discussed and applied which all manufacturing process continued with same packaging materials for all categories. The emission from packaging materials was measured and put in the table 2 below. Table 2 indicates total sale and each category, Autumn period to new year witnessed the increase in profit as normally expected.

Table 2. Ai-To Foods Oy Net sale in 2018

		Hinta					
		10	15	12,5	20	25	25
			PACKAGE CATEGORIES SOLD IN EURO				
Months	Monthly order (eur)	1	2	3	4	5	6
1	180000	80000	40000	25000	10000	12000	13000
2	136000	65000	25000	28000	2700	6800	8500
3	145000	68000	35000	30000	5800	4300	1900
4	175000	85000	38000	35000	6000	6500	4500
5	165310	70000	28000	21000	13000	25000	8310
6	145000	95000	23000	10000	3600	8000	5400
7	114500	55000	26000	23000	2000	5600	2900
8	150000	57000	42000	42000	1500	4200	3300
9	170000	98000	25500	42000	1100	3000	400
10	200000	111000	55000	30000	2500	800	700
11	245000	140000	67000	32000	2600	2700	700
12	230000	144000	60000	4100	13000	5600	3300
net profit =	2055810						

Table 3. Number of food portions sold in 2018

Month			Amount of food portion (pieces	Unit		
	1	2	3	4	5	6
Jan	8000	2666,67	2000	500	480	520
Feb	6500	1666,67	2240	135	272	340
Mar	6800	2333,33	2400	290	172	76
Apr	8500	2533,33	2800	300	260	180
May	7000	1866,67	1680	650	1000	332,4
June	9500	1533,33	800	180	320	216
Jul	5500	1733,33	1840	100	224	116
Aug	5700	2800,00	3360	75	168	132
Sept	9800	1700,00	3360	55	120	16
Oct	11100	3666,67	2400	125	32	28
Nov	14000	4466,67	2560	130	108	28
Dec	14400	4000,00	328	650	224	132
	1	2,00	3	4	5	6
	106800	30966,67	25768	3190	3380	2116,4

For each sale number in every category, the value is divided with price information in order to receive the amount of sold portion during each month.

Table 4. Total emitted CO_2 in kilograms unit

			CO2 emitted		kg CO2	
Categories	1	2	3	4	5	6
	76,00	35,47	114,00	62,30	269,14	291,56
	61,75	22,17	127,68	16,82	152,51	190,64
	64,60	31,03	136,80	36,13	96,44	42,61
	80,75	33,69	159,60	37,38	145,78	100,93
	66,50	24,83	95,76	80,99	560,70	186,38
	90,25	20,39	45,60	22,43	179,42	121,11
	52,25	23,05	104,88	12,46	125,60	65,04
	54,15	37,24	191,52	9,35	94,20	74,01
	93,10	22,61	191,52	6,85	67,28	8,97
	105,45	48,77	136,80	15,58	17,94	15,70
	133,00	59,41	145,92	16,20	60,56	15,70
	136,80	53,20	18,70	80,99	125,60	74,01
Total CO2	1014,60	411,86	1468,78	397,47	1895,17	1186,67

Total CO2	1014,60	411,86	1468,78	397,47	1895,17	1186,67
					1 year total	7561,20

The final CO_2 value was calculated by formula

Emission factor Final ($E.F_{final}$) = Food portion x Material Factor (M.e) (Kg CO_2)

Results were calculated in Table 4. It is shown that total CO_2 emission from single-handedly packaging materials was approximately 7,5 tons CO_2.

6.3 Meat factor GHGs

Taking food ingredients into account, using Table 2 with portion numbers of each category, it is possible to measure percentage of ingredients in food according to recipe. The “Food carbon footprint data-calculated in U.S 2018” mentioned in 2.1 gives information that vegetable factors are not important accounting for approximately 5%, as well as the fact people are following “green” diet.

Thus, the vegetables factor is excluded. However, meat carbon footprint is significant influent which is the main ingredients in categories 1, 4 5 and 6. The sale of these categories were variable as the fact that the business model is described before as order-produce procedure. The weight of meat without vegetables were listed out in the table 5 below, the weight of chicken products were also applied to beef products. Everything is measured in grams (gr).

Table 5. Ingredient mass for each category

1	2	3	4	5	6
200	pure vega	pure vega	700	2500	1300

According to the company secretary data in 2018, the total food sold to markets consist of 43.45% of chicken products, 41.23% beef products, and lastly 15.32 is vegan products. The kilogram of chicken products was measured by taking data from Table 2 (portion sold in each category) by SUM() of 12 months of 2018 in Excel. The results are shown in Table 6

Table 6. Total weight of ingredient

	1	2	3	4	5	6
Total portion	106800	30966,67	25768	3190	3380	2116,4

Total chicken/Beef used (kg) is the sum of total portions multiplied with net weight of meat

= (0.2 x 106800) + (0.7 x 25768) + (2.5 x 3380) + (1.3 x 2116) = around 36670.4 kg ~ 36 tons of meat.

With 43.45% chicken product in total, which equal 43.45% of total weight of used meat

= 36670.4 x 43.45 % = 15902 kg

41.23% beef products = 36670.4 x 41.23% = 15089 kg

And lastly vegan products at 36670 – 15902 – 15089 ~~ 5679 kg.

Based on measured value, the GHGs factor for each type of meat is determined by each type of product time with emission factor according to global data

Emission of chicken = 15902 kg x 4 kgCO_2 = 63608 kg CO_2

Emission of Beef = 15089 kg x 25 kgCO_2 = 377225 kg CO_2

6.4 GHGs reduction by Ai-To Foods OY

The reality where our roadmap is applied. The packaging material was changed from solid bleached sulphate to uncoated bleached kraft paperboard. The chosen materials, kraft paper is playing tremendous role in packaging industry. It is believed that the emissions during kraft paper production account for 60% of the total carbon footprint for each individual paper sack. Kraft emission factor is measure at 0.67 kg CO_2 eq per 1 kg.

Table 7. Total CO2 emission by new packaging materials

Categories	1	2	3	4	5	6
	48,00	22,40	72,00	62,30	269,14	291,56
	39,00	14,00	80,64	16,82	152,51	190,64
	40,80	19,60	86,40	36,13	96,44	42,61
	51,00	21,28	100,80	37,38	145,78	100,93
	42,00	15,68	60,48	80,99	560,70	186,38
	57,00	12,88	28,80	22,43	179,42	121,11
	33,00	14,56	66,24	12,46	125,60	65,04
	34,20	23,52	120,96	9,35	94,20	74,01
	58,80	14,28	120,96	6,85	67,28	8,97
	66,60	30,80	86,40	15,58	17,94	15,70
	84,00	37,52	92,16	16,20	60,56	15,70
	86,40	33,60	11,81	80,99	125,60	74,01
Total CO2	640,80	260,12	927,65	397,47	1895,17	1186,67
				Annual total		6494,54

Table 4 indicates the total CO_2 emission by new packaging materials, by substituting Emission Final (E.f) = 0.95 to 0.612 kg CO_2eq into table 1 in 6.2. The value shows that annual total has declined from 7.5 tons down to approx. 6.5 tons. The reduction rate is calculated by formula %

$$= \frac{\Delta(actual\ value - hypothesis\ value)}{hypothesis\ value} \text{ x } 100$$

The result calculated in Excel gave negative value, which indicates the decrease percentage at about 10.73 %.

The measurement was done with categories 1 2 and 3, the sale numbers are recorded higher than in other categories. Thus, eco-friendly packaging boxes are in high demand.

In ingredient factor, new business strategy is now followed, where the old business model was described to be order-making process by email, phone call. In future the sales are expected to stabilize. A contract is believed to be made between the company and distributors (K- market, K city market franchises), and the fixed number of food portions will be delivered monthly. Beef meat is expected to be cut down by 40 percentage in 2019 due to low demand, and main menu will concentrate on chicken, and vegan food. Giving hypothesis where new goal is reached in 2018, the total emission of meat ingredients are total GHGs from beef cut down by 40 percentage, from calculation above in subsection 6.3 meat factor GHGs.

$$E.beef = 377225\ kgCO_2 \times 40\% = 150890{,}223\ kg\ CO_2$$

The 2019 goal is to cut down more GHGs from meat factor, and estimated CO_2 emission would be no more than 37 tons CO_2 in packaging material, and also manufacturing process, and less beef products with cut down at an approximate rate of 40%.

6.5 Green logistics

Besides reducing GHGs in manufacturing process, the company also has a vision for a green logistics strategy, which is described as an attempt to measure and minimize the ecological impact of logistic activities. Private transportation from company is in use for faster market delivery. LTP Oy was chosen to be primary delivery method in 2018. However, in order to meet up with buyer demand, private autos are in use to achieve the goal. The GHGs is also believed to reduce significantly.

For instance, the total distance travelled is chosen at 100 km at once to buyer locations around Uusimaa area. LTP truck class C (approx. 10 – 15 tonnes max load) and private Ai-To Foods truck class M Sprinter (approx. 3.5 tonnes max load) **[16].** The GHGs produced by LTP Oy is considered to be higher due to

transportation weight compared to private company transportation. The investment on logistics is believed to be a cost-effective way to distribute products, and there is also a smaller less carbon footprint from logistics process.

7 Discussion

The thesis emphasizes the packaging importance to environment and food business. Following the fact that packaging products implies creator/seller strategy to impress customers, the packaging box should also be considered to have less negative impact on the environment. Packaging products along with food industry contribute most to human's emission factor, and these can be categorized under food waste. The awareness on environmental issue is on the rise, providers have been turning to use more recycling packaging material, or disposal packaging material to reduce less waste as much as possible.

Food industry is innovating rapidly to grow business sustainably. The manufacturing process can reduce GHGs, some possible methods are applying modern machines in packaging process. GHGs measurement will be kept up to date for GHGs controlling purposes in further time.

From 2019 to 2025, the company is striving to reduce GHGs at greater rate (10% in packaging process), including other processes such as machinery operating process, food storage and logistics, to make business model to be more completed. Further plan can be putting more investment on private transportation, in order to make independent and active logistics. On the rapid business growth, company tries its best to keep product distribution on stable cycle. It is believed to save time and reduce GHGs significantly.

For applying a new plan in packaging material, the company has received great achievement, proving it was a worthy investment. The sales peaked since 2013, and were slightly higher than 2017. Finnish customers reacts positively toward eco-friendly materials.

For the future, more solutions are considered to be applied to the facility; another bright idea can be eco-box supply making. This idea arose from an increase in the importing fee from food box suppliers; main suppliers at the moment in

the Netherlands. The company has a deal to obtain manufacturing process with suppliers, in order to become fully-closed food producing process. It may help business to be less independent on many suppliers, reduce the risk aspect in the lack of production, for instance.

8 Conclusion

In conclusion, Food packaging is also categorised as food waste, which account for a huge percentage in waste management. According to FAO (Food and Agriculture Organization of United Nations), up to one third of total food intended for human consumption is wasted or become a loss throughout its LCA cycle from the farm to consumer circuit. The high level of inefficiency generates both economic costs, which amount to around US $ 1 trillion per year, whereas environmental resource loss is worth around US $ 700 billion per year. It is estimated that approximately 5600 metric tons of greenhouse gas from food loss and food waste in 2009. **[18],** food packaging materials held up to 34 percentage in overall. In Finland, reducing GHGs, food waste and food loss are on the rise, in order to cope with environmental issues, global warming.

Ai-To Foods Oy was taken as a case company to indicate statistical data in an attempt to reduce GHGs from manufacturing product stage by switching to eco-friendly packaging materials. Calculations were done with a database, concentrating on used packaging materials. The results showed that with scale of business at the time being which is less than 5 million euros profit, 7.5 tonnes CO2 are emitted in 2018 from packaging boxes factor itself. By switching to more environmental friendly approach, the GHGs were cut down by 10 %. The first stage of the project is believed to be successful when initial purpose had been achieved. Plus, the eco-friendly is welcomingly feedbacked from buyers and customers, which means no negative impact on The business model.

In further timeline, roadmap related to storage and logistics are discussed to find out a cost-effective method to distribute products and to expand its goal in attempt of reducing GHGs.

9 REFERENCE

[1] Bailey L, Bliese C, Carlson L, Grover D, Wasserman P, World Population Map Activity [Internet], 2014 Sept available from http://populationeducation.org

[2] Tilman D, Balzer C, Hill J and L.Belfort B, Global food demand and the sustainable intensification of agriculture, PNAS 13, 2011 Dec.

[3] Parfitt J, Barthel M, Macnaughton S, Food Waste within Food Supply Chains: Quantification and Potential for Change to 2050, 2011 Sept 10th.

[4] Marsh K, Bugusu B, Journal of Food Science, Food Packaging—Roles, Materials, and Environmental Issues [Internet], page 1 – 3, 2007 April, available from https://onlinelibrary.wiley.com

[5]] Marsh K, Bugusu B, Journal of Food Science, Food Packaging—Roles, Materials, and Environmental Issues [Internet], page 6 – 7, 2007 April, Available from https://onlinelibrary.wiley.com

[6]] Marsh K, Bugusu B, Journal of Food Science, Food Packaging—Roles, Materials, and Environmental Issues [Internet], page 4 – 5, 2007 April, Available from https://onlinelibrary.wiley.com

[7]] Marsh K, Bugusu B, Journal of Food Science, Food Packaging—Roles, Materials, and Environmental Issues [Internet], page 10 – 13, 2007 April, Available from https://onlinelibrary.wiley.com

[8] European Comission, European food Safety Authority, Development of food waste and food recycle [Internet], 2015 May.

[9] Lastunen J, Eco-Innovations in Finland – Eio country Files 2014-2015 [Internet] Available from https://ec.europa.eu/

[10] Nolla Ravintola, Nolla restaurant [Internet] Abertinkatu 3 Helsinki, 2015 July. Available from: https://www.restaurantnolla.com/contact

[11] Singh Y, Journal of Applied Animal Research, Potential of field crickets meal (Gryllus bimaculatus) in the diet of African catfish (Clarias gariepinus) [Internet], 2017 July. Available from https://umexpert.um.edu.my

[12] Official Journal of the European Union, Directive 2004/12/EC of the European Parliament and of the Council of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste - Statement by the Council, the Commission and the European Parliament [Internet], page 3, 2004 Feb 18th Available from https://eur-lex.europa.eu/

[13] Official Journal of the European Union, Directive 2004/12/EC of the European Parliament and of the Council of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste - Statement by the Council, the Commission and the European Parliament [Internet], page 5, 2004 Feb 18th . Available from https://eur-lex.europa.eu/

[14] Kalfas J, Air quality workshop, Emision factor calculator [Internet], page 5 – 10 2016 Feb 11th . Available form http://www.deq.state.ok.us

[15] ENVIRON International Corporation Denver, Carbon Calculator Version 3 , Production Carbon Calculator Emission Calculation Methodology guide [Internet], page 3 – 5, 2013 Dec. Available from http://www.greenproductionguide.com

[16] Wang Y, Huang Z, Liu Y, Yu Q and Ma W, Back-Calculation of Traffic-Related PM10 Emission Factors Based on Roadside Concentration Measurements [Internet], Methodologies, page 3 – 4, 2017 May 24th . Available from https://pdfs.semanticscholar.org

[17] Borma A, Faculty, Practical Application of Science Volume V, Food waste-A global problem [Internet], case study 3 page 10 – 12, 2013 Dec 12th. Available from http://seaopenresearch.eu