

No-Regret Options and A Roadmap to Reduce APEC FLW by 10 Percent

**Prof. Tony Shih-Hsun Hsu
National Taiwan University
Chinese Taipei
June 12, 2017**

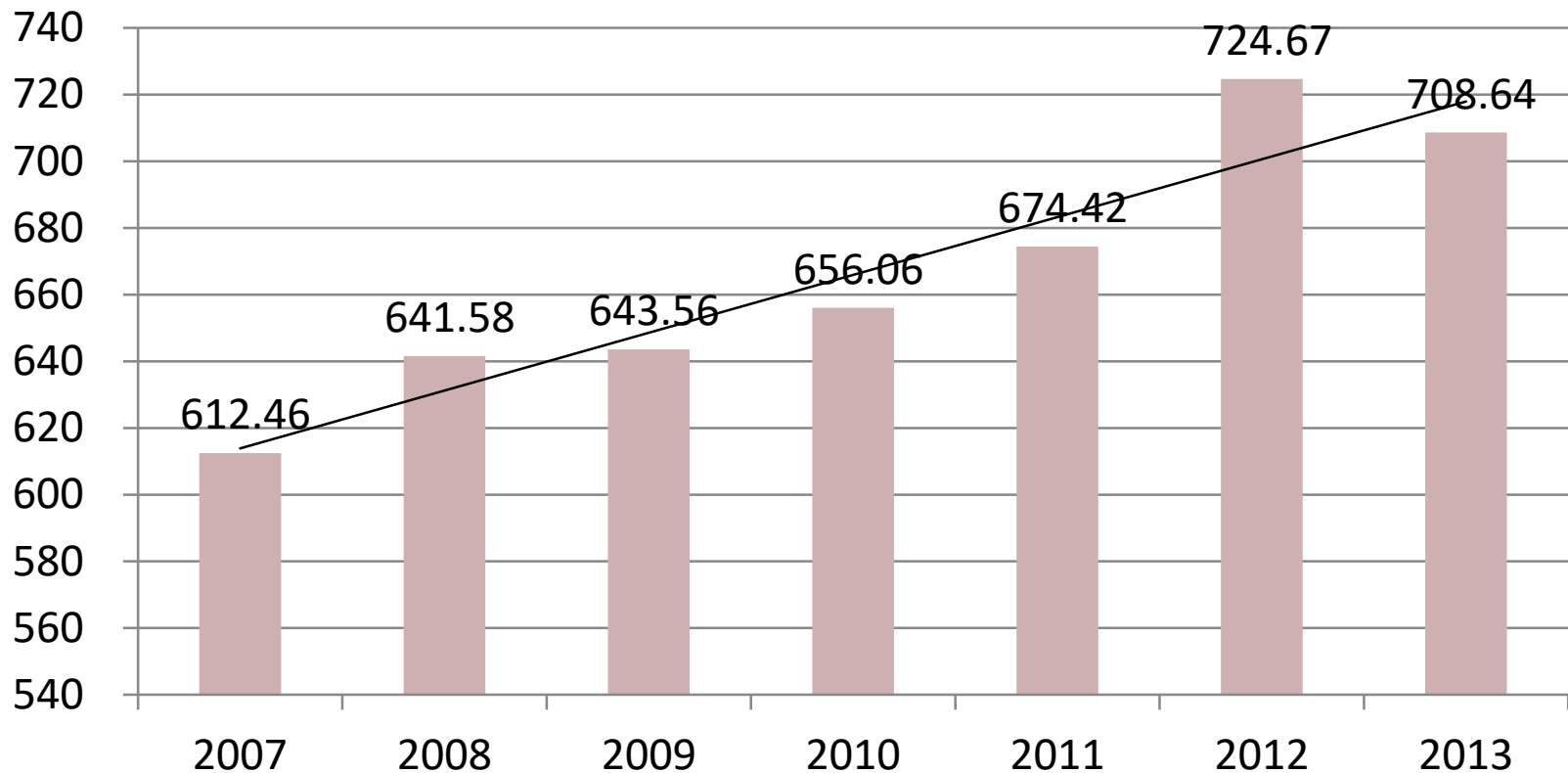
Outline

1. APEC Food Losses and Waste
2. Sustainable Food System Approach
3. No-Regret Options and A Roadmap to Reduce APEC Food Waste
4. APEC Food Waste Prevention Solutions
5. APEC Food Waste Recovery Solutions
6. APEC Food Waste Recycling Solutions
7. What Gets Measured, Gets Managed

APEC Food Losses and Waste

APEC Food Losses and Waste

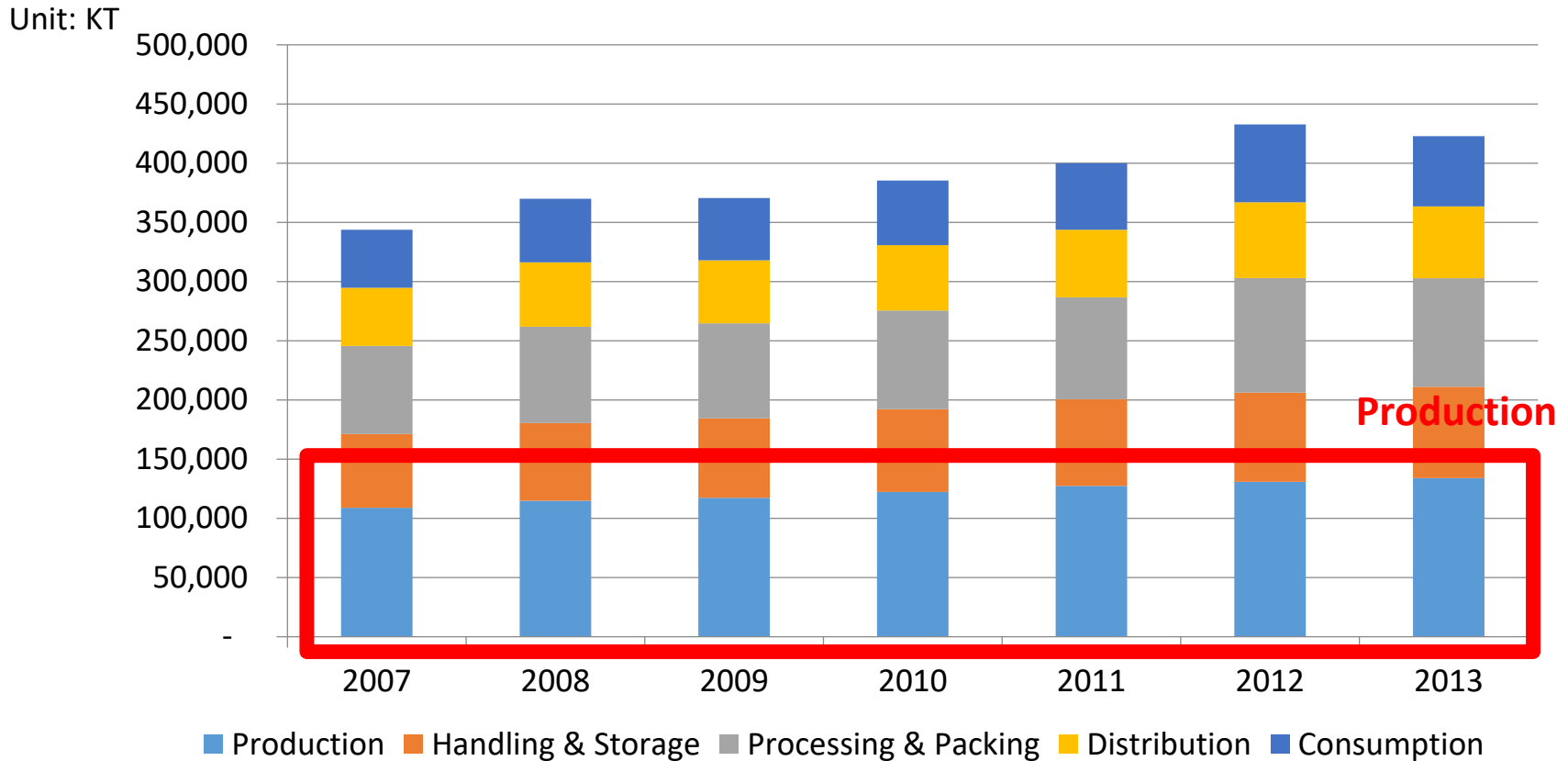
Unit: MT



Source: FAOSTAT, this research

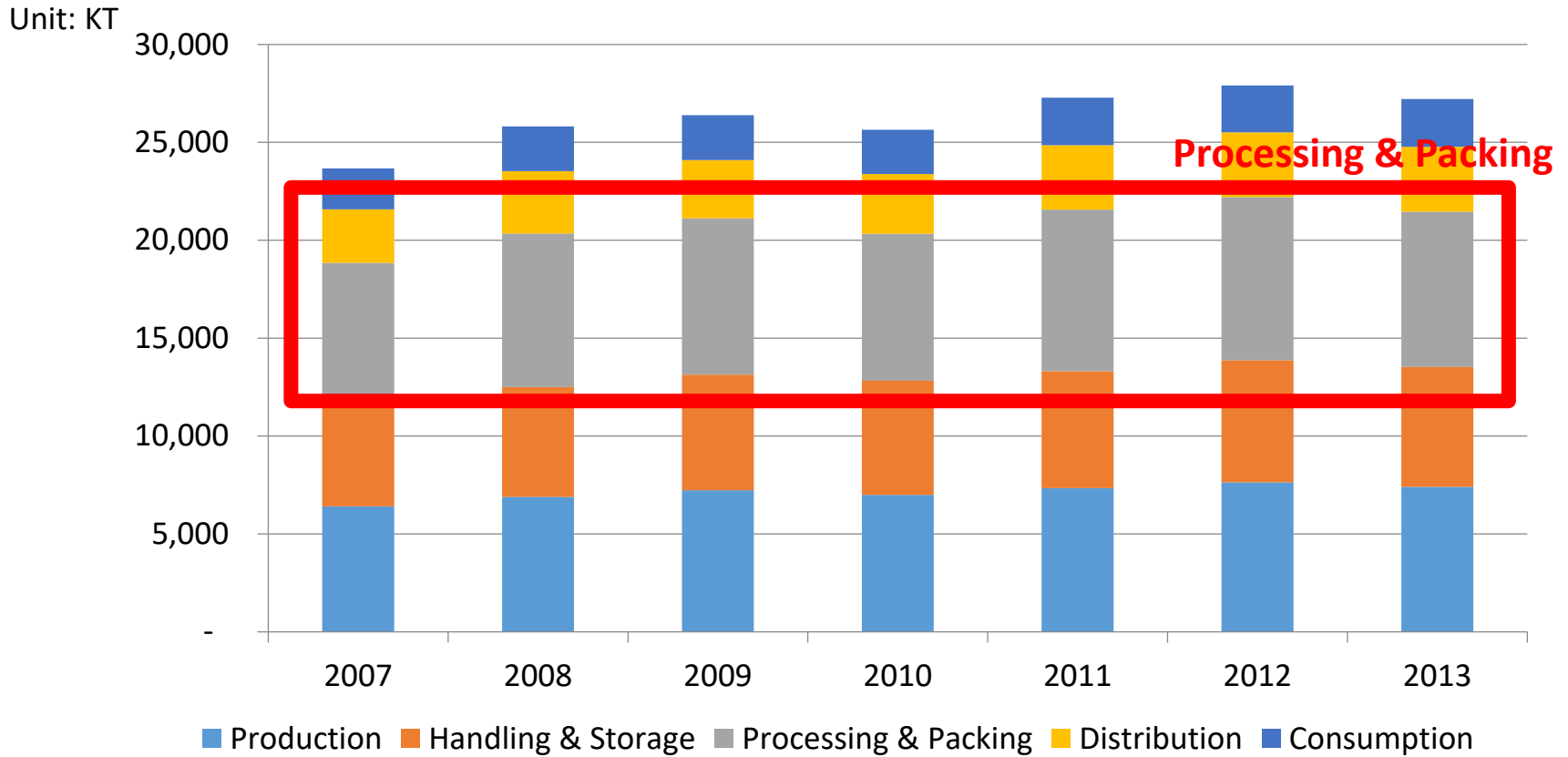
■ Total (APEC)

People's Republic of China



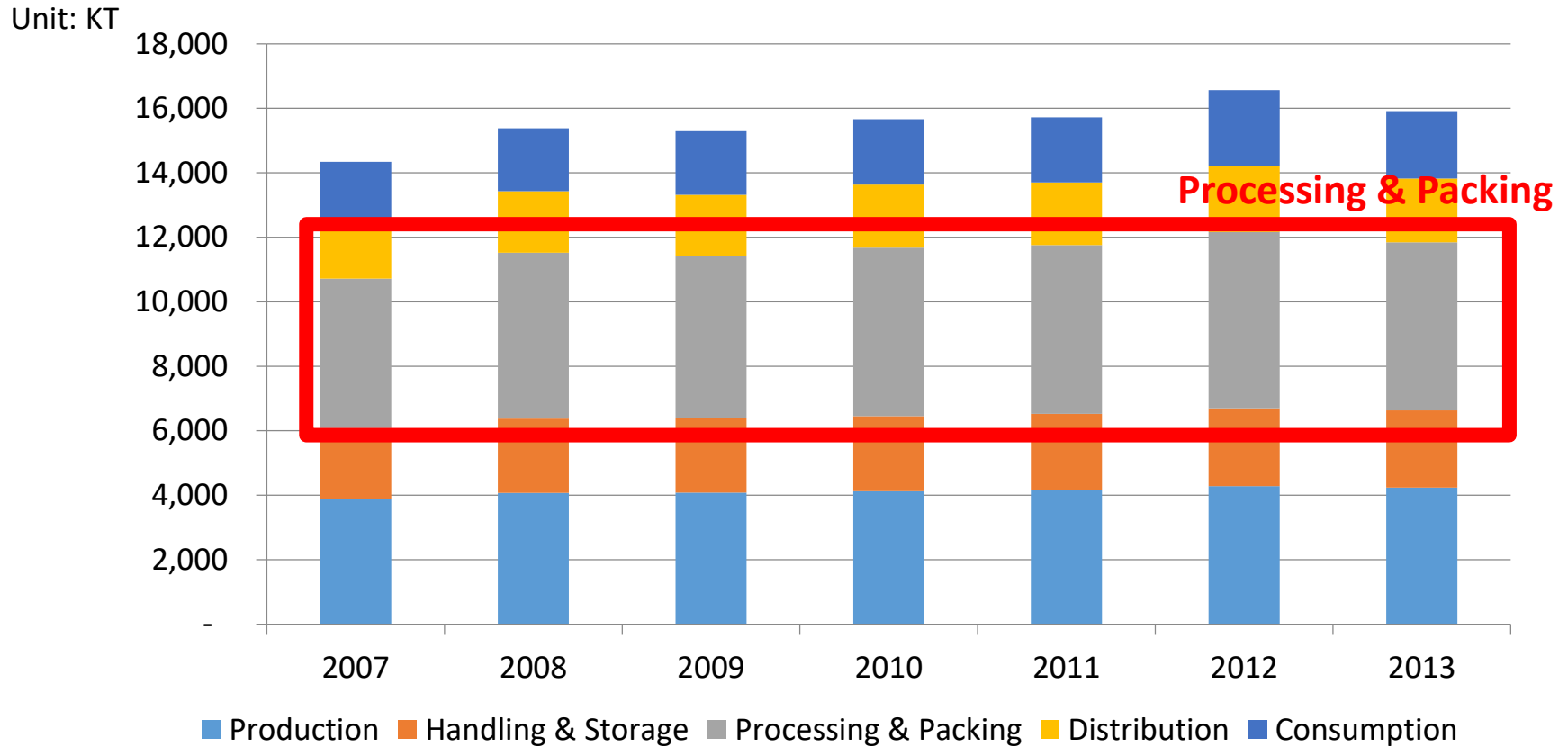
Source: FAOSTAT, this research

Indonesia



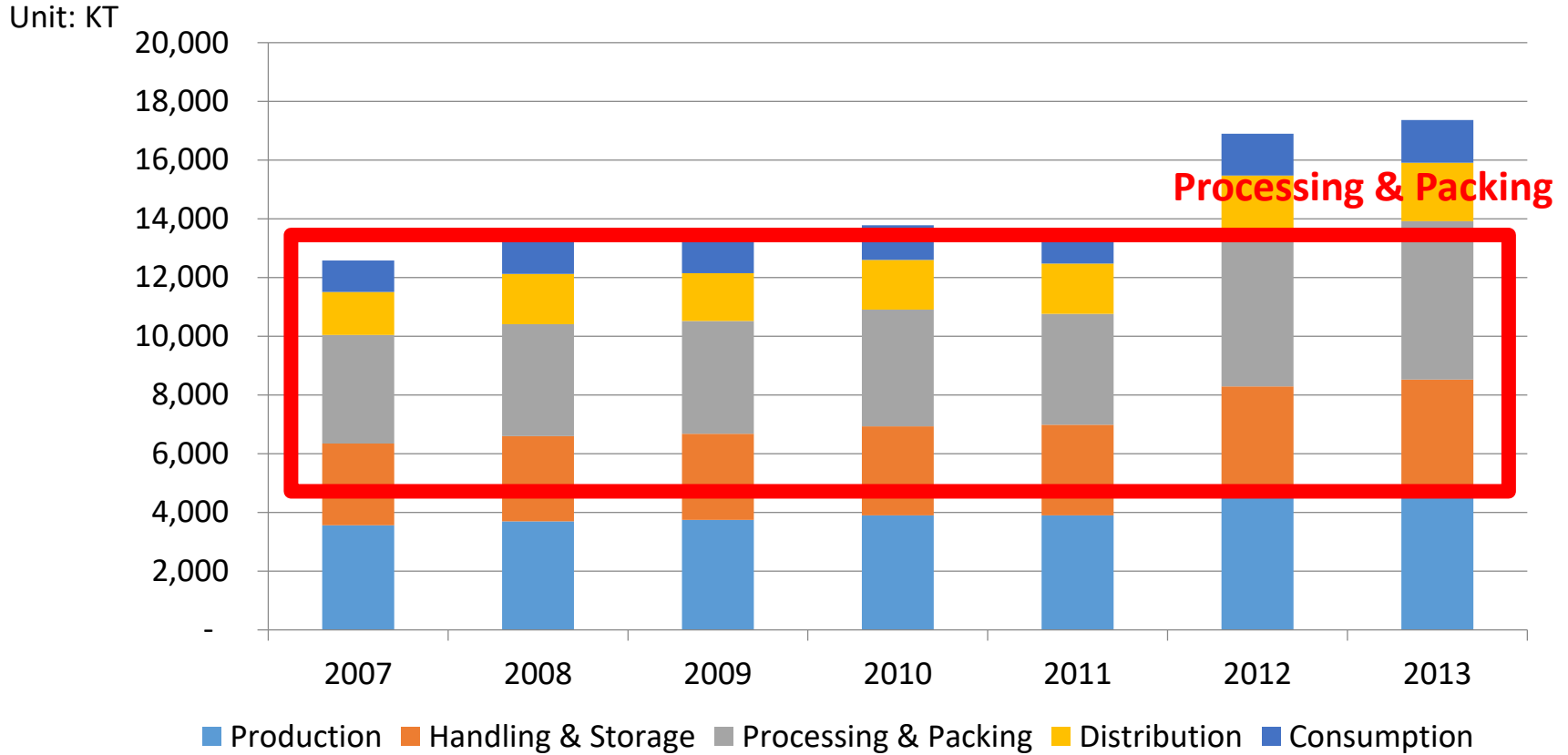
Source: FAOSTAT, this research

The Philippines



Source: FAOSTAT, this research

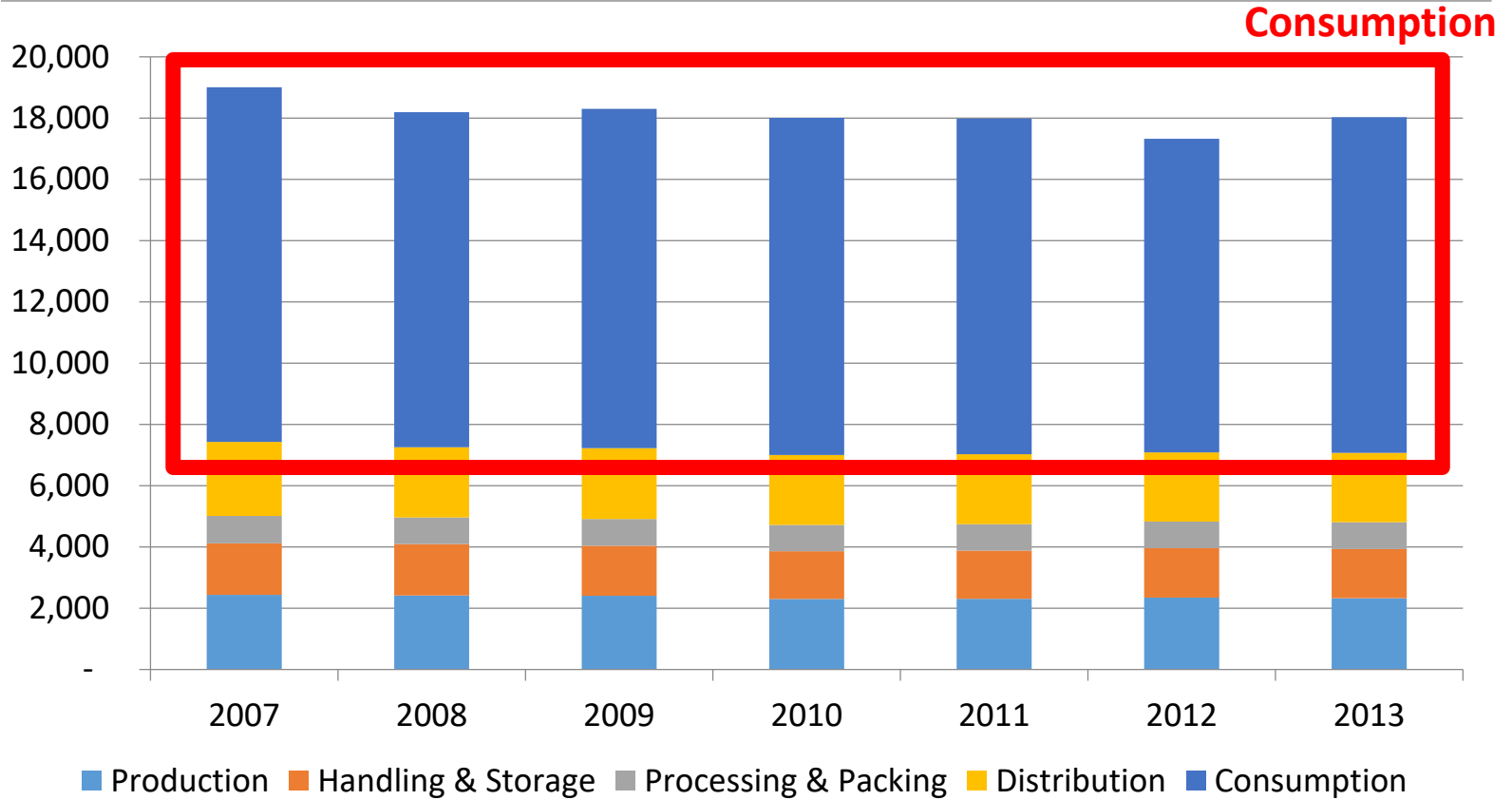
Viet Nam



Source: FAOSTAT, this research

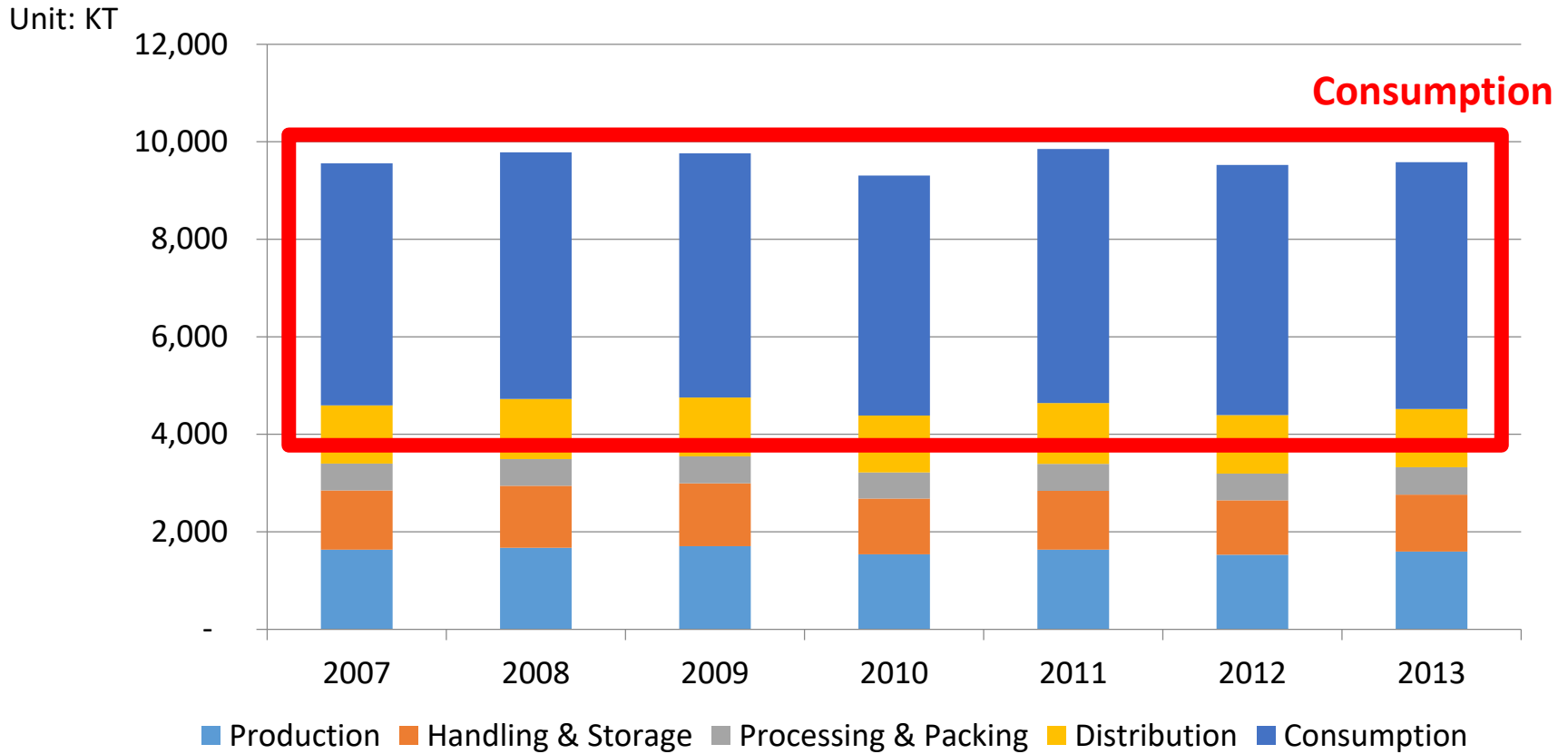
Japan

Unit: KT



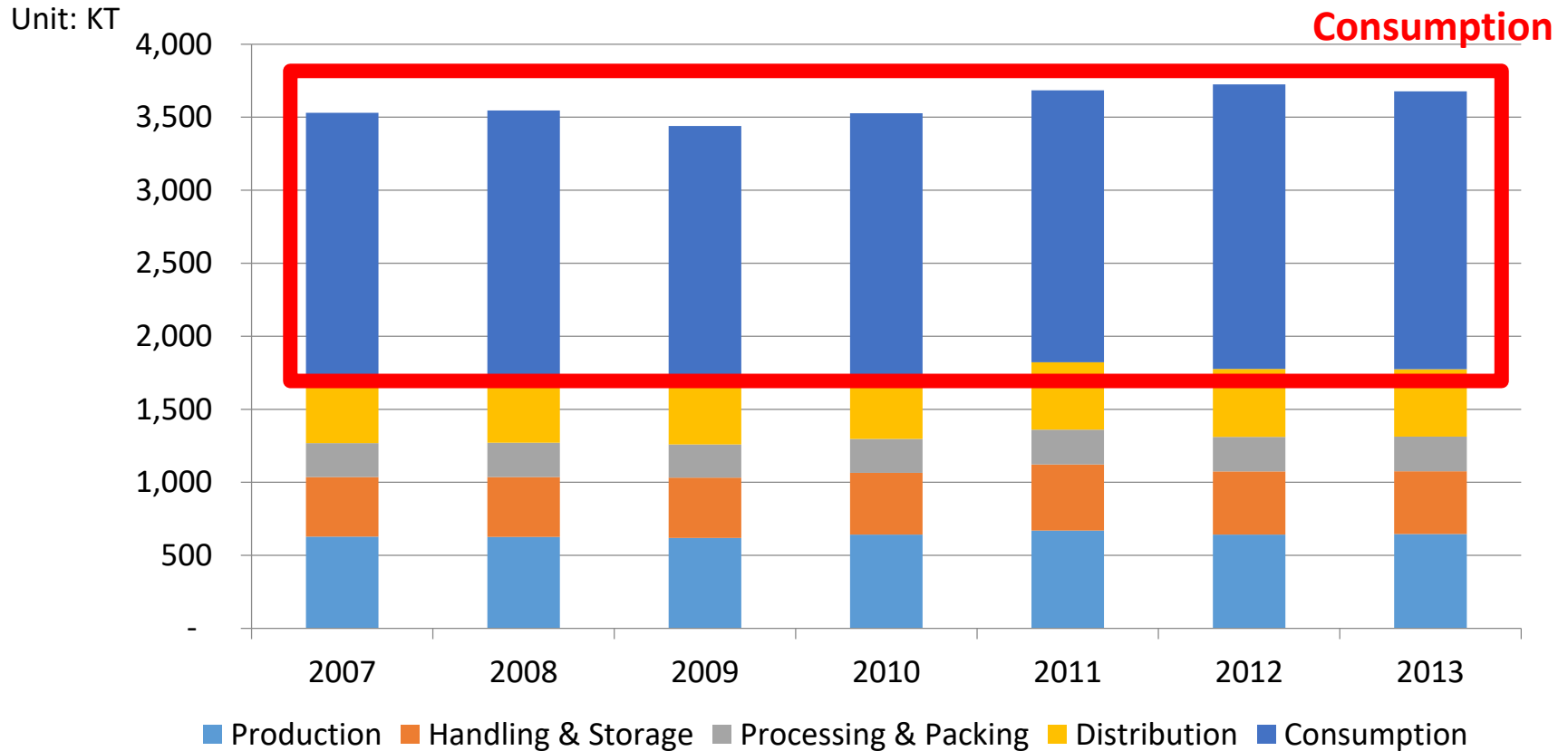
Source: FAOSTAT, this research

Republic of Korea



Source: FAOSTAT, this research

Chinese Taipei



Source: FAOSTAT, this research

The United States

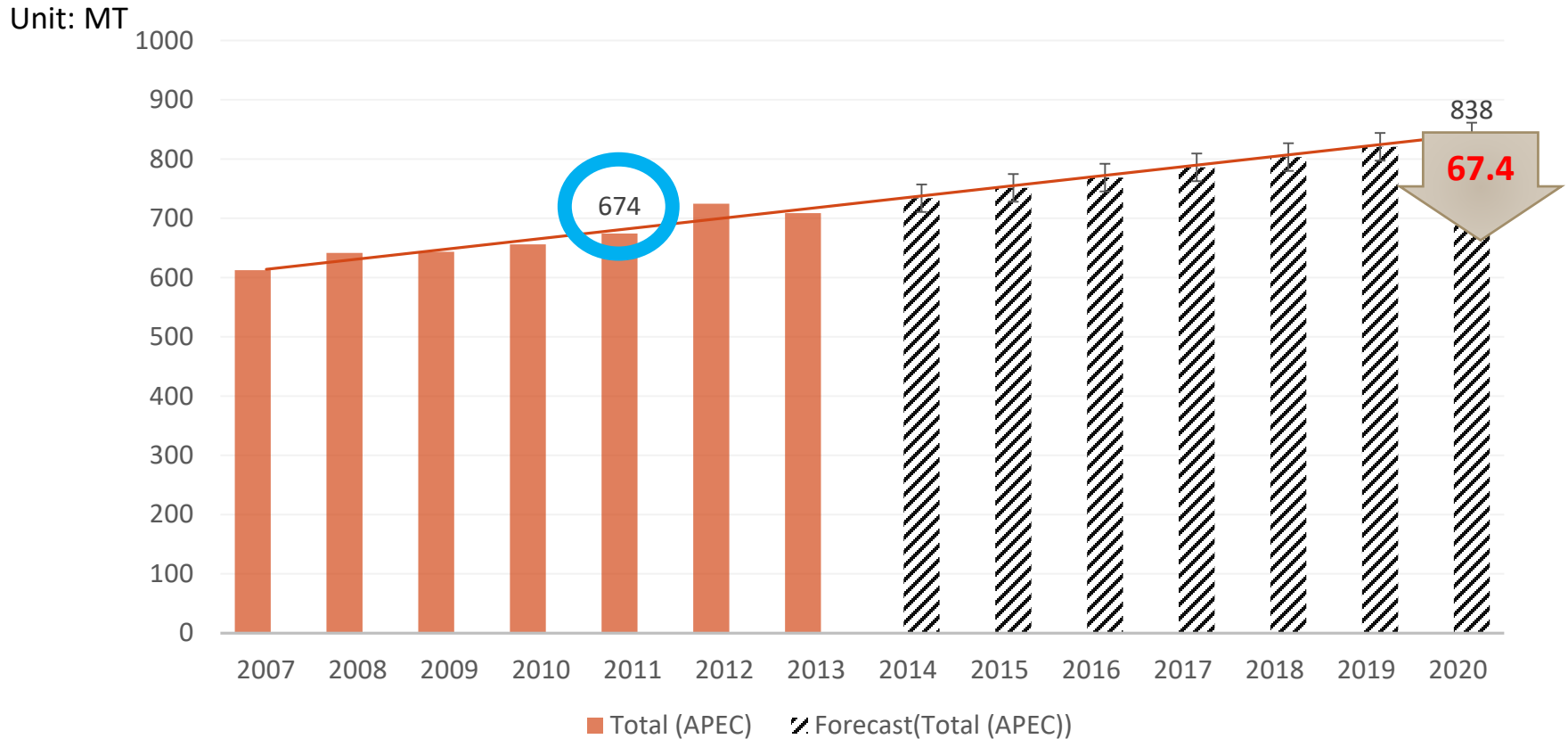


Source: FAOSTAT, this research

APEC Food Security Road Map Towards 2020

- “APEC economies will strive to reduce food loss and waste by 10% compared with the 2011-2012 levels by 2020 in the Asia-Pacific economies aim to advance beyond the *Millennium Development Goals 2015* hunger goals” (APEC Food Security Road Map Towards 2020 as stated in 21st APEC Leaders’ Declaration, October 8, 2013)..
- Chinese Taipei has been implementing the APEC Multi-Year Project on “*Strengthening Public-Private Partnership to Reduce Food Losses in the Supply Chain*” since 2013.

Reduce APEC Food Waste by 10%



Source: FAOSTAT, this research

Sustainable Food System Approach

Definition of Food System

A *food system* gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the **production, processing, distribution, preparation and consumption of food**, and the outputs of these activities, including socio-economic and environmental outcomes.

Adapted from “HLPE, 2014. *Food losses and waste in the context of sustainable food systems*. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014. “

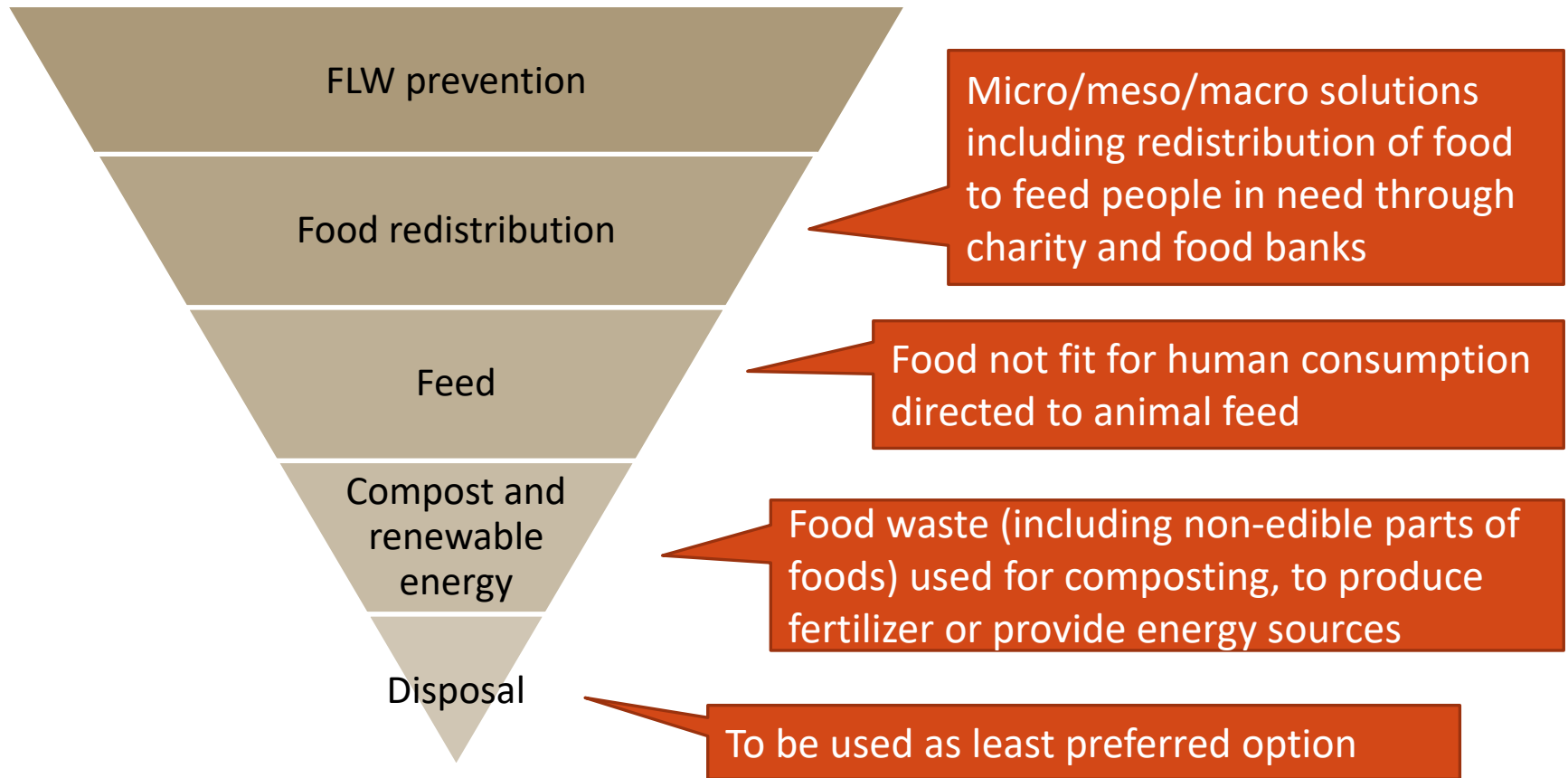
Understanding FLW in a Triple Perspectives

- **A systemic perspective**
 - Considering FLW not as an accident but as an integral part of food systems.
 - along food chains
- **A sustainability perspective**
 - Including the environmental, social and economic dimensions of sustainability
- **A food security and nutrition perspective**

Organizing Causes of FLW and their Solutions in Three Levels

- micro-level (household or individual enterprise)
- meso-Level (food chain)
 - ✓ Organization, coordination and communication between food chain actors
- macro-Level (food system and beyond)
 - ✓ Policies, regulation, infrastructure, enabling environments

A Food-use-not-waste Hierarchy to Minimize FLW



Source: HLPE (2014), adapted from www.feeding5k.org

No-Regret Options and A Roadmap to Reduce APEC Food Waste

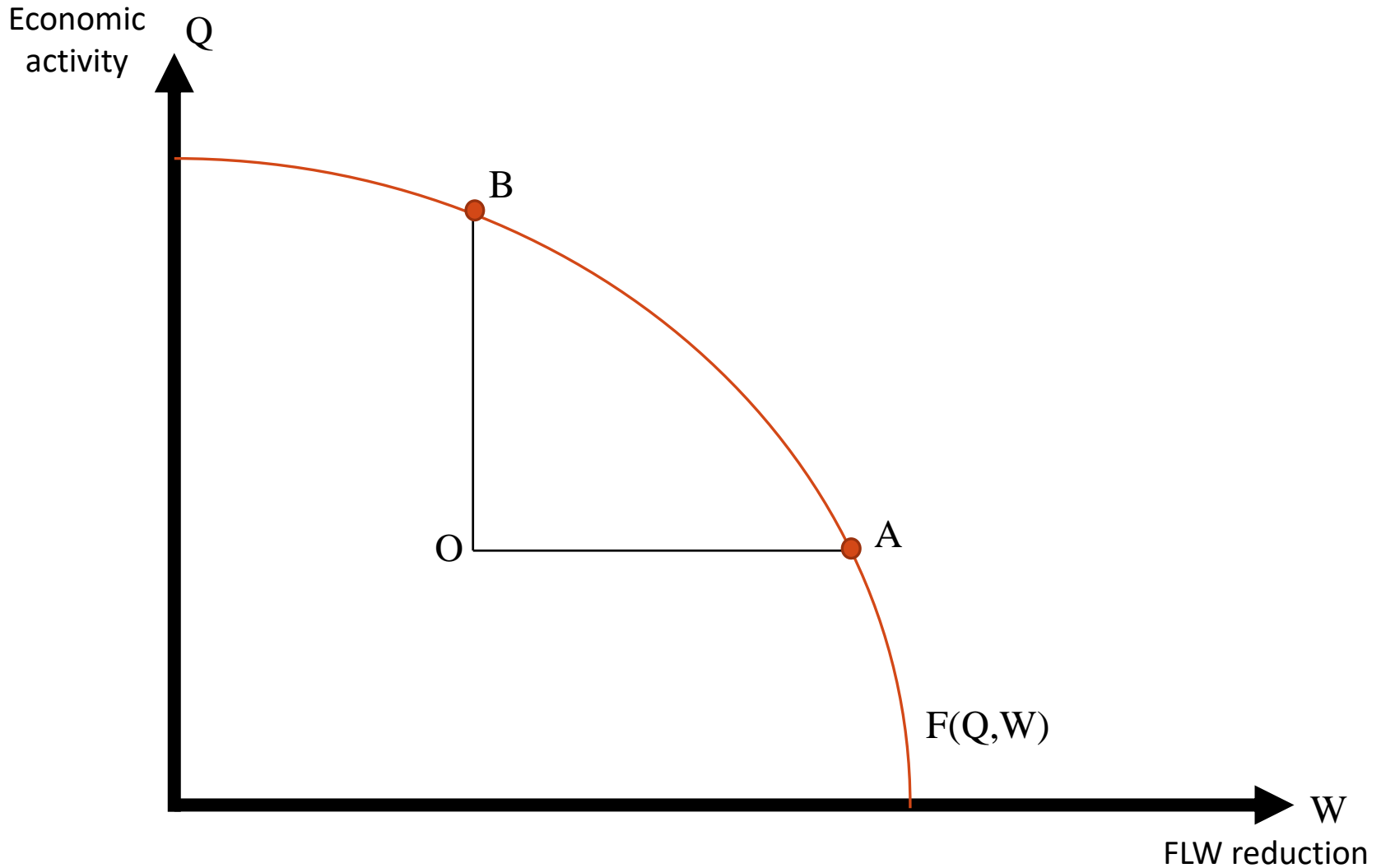


Figure: Trade-off between FLW reduction and economic activity.

No-Regret Options_1

The discussion of “no regrets” potential has triggered an extensive debate, which is particularly well covered in the SAR (IPCC 1996a, Chapters 8 and 9).

If the chosen baseline scenario assumes that the economy is located below the frontier, at a point such as O, there is a potential for combined FLW reduction policies and improvements of the efficiency of resource use, implying a number of benefits associated with the policy.

No-Regret Options_2

"No regrets" options are sometimes known as “options worth doing anyway” or “win-win options”.

No regret options mostly refer to meso-Level (food chain) solutions and macro-Level (food system and beyond) solutions.

The magnitude of such "no regret" potentials depends on the existence of substantial **market or institutional imperfections** that prevent cost-effective FLW reduction measures from occurring.

No-Regret Options_3

ReFED, A Roadmap to Reduce U.S. Food Waste by 20 Percent (2016),

http://www.refed.com/downloads/ReFED_Report_2016.pdf

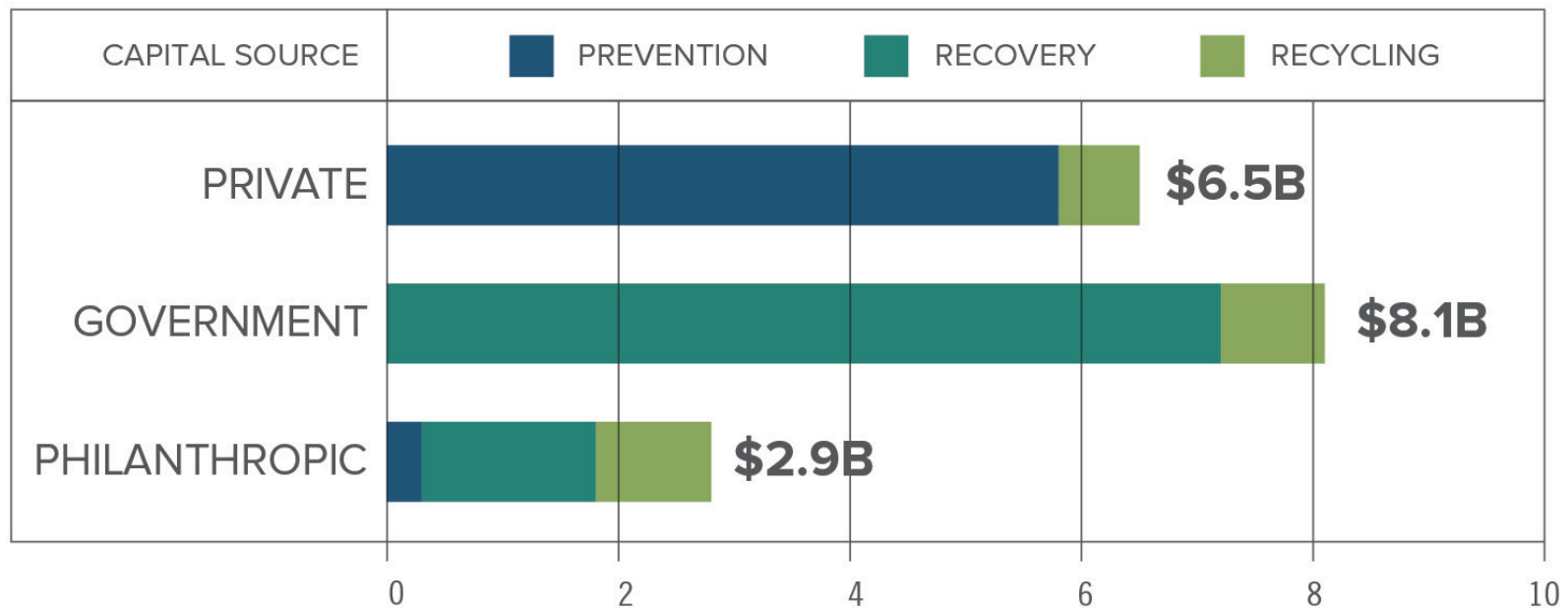
No-Regret Options:

- Having zero or negative net costs.
- No losers, only Winners.

TYPE	SOLUTION
Prevent (12)	Consumer Education Campaigns
	Waste Tracking & Analytics
	Standardized Date Labeling
	Produce Specifications
	Packaging Adjustments
	Smaller Plates
	Secondary Resellers
	Trayless Dining
	Spoilage Prevention Packaging
	Improved Inventory Management
	Manufacturing Line Optimization
	Cold Chain Management
Recover (7)	Donation Tax Incentives
	Standardized Donation Regulation
	Donation Matching Software
	Donation Transportation
	Donation Storage & Handling
	Value-Added Processing
	Donation Liability Education
Recycle (8)	Centralized Composting
	Centralized AD
	Water Resource Recovery Facility (WRRF) with AD
	Commercial Greywater
	Community Composting
	Home Composting
	Animal Feed
	In-Vessel Composting

Financing Needs \$18B

FINANCING NEEDS FOR 20% REDUCTION IN
FOOD WASTE OVER A DECADE



Source: ReFED (2016)

APEC Food Waste Prevention Solutions

Consumer Education Campaigns

Description	Conducting large-scale consumer advocacy campaigns to raise awareness of food waste and educate consumers about ways to save money and reduce wasted food
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 139.3M tons (assumes all households can be targeted)</p> <ul style="list-style-type: none"> • 5-15% reductions in household waste generation can be achieved through various forms of consumer education, including media and other outreach methods (WRAP, assumptions based on ReFED interviews) • 1/3 of total household waste reduction impact due to consumer education can be attributable to media (interview with NRDC) • Of this media-attributable consumer waste reduction impact, 2/3 is specifically driven by consumer campaigns (other 1/3 occurs due to other sources of consumer information) (validated with Advisory Council)
	Diversion potential: 293K tons (calculation)
Diversion Characterization	<p>Food types included: all (assumption)</p> <p>16% grain, 16% meat, 43% produce, 23% milk/dairy, 2% seafood (USDA / calculation)</p>
Financial Costs	<p>Operating costs:</p> <p>\$1392M for various media campaigns, distributed over 10 years</p>
Financial Benefits	<p>Food costs avoided: potential * characterization * food type retail value = \$14.3B per year (calculation)</p>

Waste Tracking & Analytics

Description	Providing restaurants and prepared-food providers with data on wasteful practices to inform behavior and operational changes
Modeling Assumptions	
Diversion Potential	<p>Addressable waste:</p> <ul style="list-style-type: none"> Implementing waste tracking & analytics reduces pre-consumer / kitchen waste by 20-40% (UC Berkeley, Advisory Council)
Diversion Characterization	<p>Food types included: all 25% grain, 20% meat, 50% fruits and vegetables, 3.5% seafood, 1.5% milk/dairy (Advisory Council / USDA)</p>
Financial Costs	<p>Operating costs: \$963M for both institutions and restaurants (calculation)</p> <ul style="list-style-type: none"> Total institutional foodservice cost: \$193M, based on 134K facilities * 80% adoption rate * \$1800/year average product cost Total restaurant cost: \$283M, based on 26762K facilities * 15% adoption rate * \$700/year average product cost Due to waste quantities, institutional waste tracking costs are higher than those for restaurants
Financial Benefits	<p>Food costs avoided: potential * characterization * food type retail value = \$7.4B per year (calculation)</p>

Standardized Date Labeling

Description	Standardizing food label dates and instructions, including eliminating “sell by” dates, to reduce consumer confusion
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 42.8M tons (calculation)</p> <ul style="list-style-type: none"> • 5-10% of consumers will react to label changes and modify behaviors (using private study on consumer cold-water wash habits as a proxy for consumer reaction) <p>Diversion potential: 2140K tons (calculation)</p>
Diversion Characterization	<p>Food types included: all (assumption)</p> <p>16% grain, 16% meat, 43% produce, 23% milk/dairy, 2% seafood (USDA calculation)</p>
Financial Costs	<p>Operating costs: \$53.5M per year for educating consumers about date label changes; actual changing of labels is a low-cost/no-cost effort for manufacturers (assumption validated with Advisory Council members)</p>
Financial Benefits	<p>Food costs avoided: potential * characterization * food type retail value = \$9.7B per year (calculation)</p>

Produce Specifications (Retail)

Description	Accepting and integrating the sale of off-grade produce (short shelf life, different size/ shape/ color), also known as “ugly” produce, for use in foodservice and restaurant preparation and for retail sale
Modeling Assumptions	
Diversion Potential	<p>Addressable opportunity: 8M tons of on-farm loss (calculation)</p> <ul style="list-style-type: none"> • 5-10% of this addressable opportunity represents the net reduction in CI food waste from imperfect produce that restaurants add to existing retail stores as additional inventory <p>Diversion potential: 562K tons (calculation)</p>
Diversion Characterization	Food types included: 100% fruits and vegetables (calculation)
Financial Costs	Operating costs: \$284M per year based on \$0.25 / lb average purchase price for cosmetically imperfect produce in retail
Financial Benefits	Revenue Generated: potential * characterization * discounted retail price = \$1016M per year (calculation)

Produce Specifications (Restaurant and Foodservice)

Description	Accepting and integrating the sale of off-grade produce (short shelf life, different size/ shape/ color), also known as “ugly” produce, for use in foodservice and restaurant preparation and for retail sale
Modeling Assumptions	
Diversión Potential	<p>Addressable opportunity: 11.2M tons of on-farm loss (calculation)</p> <ul style="list-style-type: none"> • 5-10% of this addressable opportunity represents the net reduction in CI food waste from imperfect produce that restaurants substitute for standard existing produce <p>Diversión potential: 856K tons (calculation)</p>
Diversión Characterization	Food types included: 100% fruits and vegetables (calculation)
Financial Costs	Operating costs: \$428M per year based on \$0.25 / lb average purchase price for cosmetically imperfect produce in foodservice (validated with Advisory Council)
Financial Benefits	Food costs avoided: potential * characterization * wholesale price = \$1070M per year (calculation)

Packaging Adjustments

Description	Optimizing food packaging size and design to ensure complete consumption by consumers and avoid residual container waste
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 14.7M tons</p> <p>5-10% of all packaged foods could be optimized through offering additional size options and packaging design improvements, e.g. through smaller containers, pre-portioned servings, etc. (validated with Advisory Council)</p> <p>Diversion potential: 105K tons (calculation)</p>
Diversion Characterization	<p>Food types included: all (assumption)</p> <p>16% grain, 16% meat, 43% produce, 2% seafood, 23% milk/dairy (USDA / calculation)</p>
Financial Costs	<p>Operating costs: \$1470M per year from increased costs of food packaging, based on total addressable waste quantity of 15M tons and \$.05/lb incremental average cost of food packaging modifications (based on studies of consumer food packaging costs and dairy product packaging costs), such as additional material or small container sizes.</p>
Financial Benefits	<p>Food costs avoided: potential * characterization * food type retail value = \$5085M per year (calculation)</p>

Smaller Plates

Description	Providing consumers with smaller plates in self-serve all-you-can-eat (AYCE) dining settings to reduce portion sizes
Modeling Assumptions	
Diversi on	<p>Addressable waste (from plate size): 3130K tons restaurant + 3200K tons institutional, college / university only (calculation)</p> <ul style="list-style-type: none"> Using smaller plate sizes in self-service settings results in smaller consumer portion sizes and can reduce waste by 10-20% (NIH) <p>Diversi on</p> <p>Diversi on</p>
Diversi on	<p>Food types included: all (assumption)</p> <p>16% grain, 16% meat, 43% produce, 23% milk/dairy, 2% seafood (USDA / calculation)</p>
Financial Costs	Investment costs: \$1335M for replacement of dinnerware for smaller plate sizes in AYCE dining settings
Financial Benefits	Food costs avoided: potential * characterization * food type retail value = \$2180M per year (calculation)

Secondary Resellers

Description	Businesses that purchase processed foods and produce directly from manufacturers and distributors for discounted retail sale to consumers
Modeling Assumptions	
Diversion Potential	<p>Growth in existing food recovery channels:</p> <ul style="list-style-type: none"> Existing secondary resellers could double to triple in current market size (Grocery Outlet) <p>Diversion potential: 885K tons diverted (calculation)</p>
Diversion Characterization	<p>Food types included: all (assumption) 22% grain, 7% meat, 40% produce, 30% milk/dairy, 1% seafood (USDA / calculation)</p>
Financial Costs	<p>Investment costs: \$4817M to open 3200 additional stores nationwide at a per-store opening cost of \$16M (assumption based on current discount grocery market and Deloitte retail expert)</p> <ul style="list-style-type: none"> \$16M per-store construction cost based on comparison of discount grocer retail square footage to standard food retail store area and typical grocery store costs of \$26.5M <p>Operating costs: \$6B per year based on 90% of annual revenue (10% overall profit margin assumed based on industry standards)</p> <ul style="list-style-type: none"> Variable costs: \$2007M based on \$17 / lb average selling price of food sold in secondary reseller stores and 17% average food profit margin store-wide Fixed costs: \$3514M (calculation based on total operating costs minus variable food costs)
Financial Benefits	<p>Revenue generated: potential * characterization * food type retail value = \$6.8 (calculation)</p>

Trayless Dining

Description	Eliminating tray dining in all-you-can-eat dining (AYCE) establishments to reduce consumer portion sizes
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 390K tons restaurant + 1390K tons institutional, college / university only (calculation)</p> <ul style="list-style-type: none"> • 90% of AYCE establishments still using trays can go trayless with simple retrofits to tray return system, other facilities are design- or cost-prohibitive (interview with Advisory Council) • Eliminating trays reduces net waste by 25-30% (Aramark) <p>Diversion potential: 85K tons (calculation)</p>
Diversion Characterization	<p>Food types included: all (assumption) 16% grain, 16% meat, 43% produce, 23% milk/dairy, 2% seafood (USDA / calculation)</p>
Financial Costs	<p>Investment costs: \$160M for retrofit of tray return systems in institutions (no cost in restaurant settings except policy change)</p> <ul style="list-style-type: none"> • \$160M for retrofitting tray return systems in college / university AYCE dining settings <p>Operating costs: Minimal; policy / process changes and consumer education (e.g. signage) may be needed (validated with Advisory Council)</p>
Financial Benefits	<p>Food costs avoided: potential * characterization * food type retail value = \$1015M per year (calculation)</p>

Spoilage Prevention Packaging

Description	Using active intelligent packaging, such as ethylene absorbing packaging inserts, to prolong product freshness and slow down spoilage of perishable fruits and meat
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 10M tons fruit, 18M tons meat (calculation)</p> <ul style="list-style-type: none"> • 10-33% of addressable fresh fruit and meat waste can be reduced at the retail level (assumption based on interview with spoilage prevention packaging vendor) • 5-10% of addressable fresh fruit and meat waste can be reduced at the residential level (assumption based on interview with spoilage prevention packaging vendor) • 15% adoption rate for fruit (validated with Advisory Council) • 25% adoption rate for meat (validated with Advisory Council) <p>Diversion potential: 35K tons (calculation)</p>
Diversion Characterization	Food types included: packaged fresh fruit, meat 75% fresh fruit, 25% meat (calculation)
Financial Costs	<p>Operating costs: Assume one spoilage prevention packaging unit needed per 1lb of fruit and 2lbs of meat (validated with Advisory Council), and adoption rates described above:</p> <ul style="list-style-type: none"> • \$900M per year, based on \$.04 per unit spoilage prevention packaging cost (based on interview with spoilage prevention packaging vendor) • Retailers and consumers assumed will split cost of packaging technology, so retailers and consumers each incur \$455M costs per year
Financial Benefits	Food costs avoided: potential * characterization * food type retail value = \$1670M per year (calculation) with an estimated \$1172M accrued to consumers and \$503M accrued to retailers

Improved Inventory Management

Description	Improvements in the ability of retail inventory management systems to track an average product's remaining shelf-life (time left to sell an item) and inform efforts to reduce days on hand (how long an item has gone unsold)
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 4280K tons (calculation)</p> <ul style="list-style-type: none"> • 5-10% of ordering-related perishable shrink can be reduced through store-level inventory planning <p>Diversion potential: 320K tons (calculation)</p>
Diversion Characterization	<p>Food types included: all (assumption) 22% grain, 7% meat, 40% produce, 30% milk/dairy, 1% seafood (USDA / calculation)</p>
Financial Costs	<p>Investment costs: \$1035M one-time to upgrade retailer inventory software systems (market assumption)</p> <p>Operating costs: \$215M to conduct inventory analyses (market assumption)</p>
Financial Benefits	<p>Food costs avoided: potential * characterization * food type retail value = \$610M (calculation)</p>

Manufacturing Line Optimization

Description	Identifying opportunities to reduce food waste from manufacturing / processing operations and product line changeovers
Modeling Assumptions	
Diversion Potential	Diversion potential: 107K tons (calculation)
Diversion Characterization	Food types included: all food types included (assumption) 22% grain, 7% meat, 40% produce, 30% milk/dairy, 1% seafood (USDA / calculation)
Financial Costs	Operating costs: \$20.9M per year based on average cost of \$0.10 per wholesale dollar value of reclaimed food, regardless of method of optimization (interview with Advisory Council)
Financial Benefits	Food costs avoided: potential * characterization * wholesale price = \$209M per year (calculation)

Cold Chain Management

Description	Reducing product loss during shipment to retail distribution centers by using direct shipments and cold chain certified carriers
Modeling Assumptions	
Diversion Potential	<p>Addressable waste (perishable only): 12.3M tons</p> <ul style="list-style-type: none"> • 10% of food waste at point of delivery to retail distribution centers is driven by temperature/cold chain issues during transport; other 90% of distribution center waste is due to quality control, product spoilage, culling, etc. (validated through interview with major food retailer; most delivery rejections fall under a myriad of QC-related reasons) • 5-15% of perishables loss from transport to DCs can be reduced through improved cold chain management involving temperature monitoring technologies, certified cold chain carriers, and minimizing shipment stops (conservative assumption based on interviews with transport providers; hard data is unavailable) <p>Diversion potential: 96K tons (calculation)</p>
Diversion Characterization	<p>Food types included: all except grains (assumption) 9% meat, 52% produce, 37% milk/dairy, 2% seafood (USDA / calculation)</p>
Financial Costs	<p>Operating costs: \$23M per year from use of more expensive transport vendors with additional cold chain technology investments (market assumption based on 10% of value of food costs avoided, validated with Advisory Council)</p>
Financial Benefits	<p>Food costs avoided: potential * characterization * food type retail value = \$187M per year (calculation)</p>

Food Waste Prevent Solutions Data Set

SOLUTION	DIVERSION POTENTIAL (K TONS / YEAR)	ECONOMIC VALUE PER TON DIVERTED	ECONOMIC VALUE (\$M / YEAR)	BENEFIT (\$M / YEAR)	COST (\$M / YEAR)	BUSINESS PROFIT POTENTIAL(\$M / YEAR)	FINANCING COST OVER 10 YEARS (\$M)	GHGS (K TONS / YEAR)	MEALS RECOVERED (M MEALS / YR)	WATER CONSERVATION (BILLION GALS / YR)	JOBS CREATED (PARTIAL LIST)
Consumer Education Campaigns	3,126	24,252	14,173	14,286	-118	0	1,322	12,503	0	1,504	0
Waste Tracking & Analytics	3,056	12,214	6,974	7,376	-401	5,368	476	12,343	0	1,697	0
Standardized Date Labeling	2,130	24,337	9,699	9,741	-43	0	439	8,526	0	1,028	0
Produce Specifications	1,424	5,561	1,483	2,082	-599	1,220	712	2,259	0	209	0
Packaging Adjustments	1,113	18,428	3,827	5,079	-1,252	0	10,020	4,442	0	535	0
Smaller Plates	953	11,492	2,045	2,178	-134	1,686	1,317	3,806	0	460	0
Secondary Resellers	894	1,167	198	6,771	-6,578	155	12,043	2,730	0	310	0
Trayless Dining	444	12,059	1,001	1,017	-16	824	145	1,777	0	214	0
Spoilage Prevention Packaging	385	12,450	894	1,670	-776	91	5,861	1,761	0	236	0
Improved Inventory Management	316	6,391	380	610	-236	300	749	969	0	107	0
Manufacturing Line Optimization	107	9,474	187	209	-16	150	21	326	0	37	0
Cold Chain Management	96	9,720	171	187	-21	139	21	332	0	32	0
Total	3,126	24,252	14,173	14,286	-118	0	1,322	12,503	0	1,504	0

APEC Food Waste Recovery Solutions

Donation Tax Incentives

Description	Expanding federal tax benefits for food donations to all corporations and improving ease of donation reporting processes for tax deductions			
Modeling Assumptions				
Diversion Potential		Farm	Restaurant / Foodservice	Retail
	Total potential food recovery:	<ul style="list-style-type: none"> 22480K tons 	<ul style="list-style-type: none"> 4817K tons (Roadmap analysis) 	<ul style="list-style-type: none"> N/A
	Addressable food recovery: % recovery potential that could be influenced by tax incentives	<ul style="list-style-type: none"> 100% of farm total recovery potential (<i>Roadmap</i> assumption) 22480K tons are influenced by tax incentives 	<ul style="list-style-type: none"> 100% of restaurant total recovery potential (<i>Roadmap</i> assumption) 4817K tons are influenced by tax incentives 	<ul style="list-style-type: none"> N/A
	<ul style="list-style-type: none"> Adoption rate of 100% nationwide (federal tax incentive benefits all businesses) 5-10% addressable volume can be captured across all value stages (validated with Advisory Council) 			
	Diversion potential:	1686K tons	347K tons	N/A
Diversion Characterization	Food types included: all (validated with Advisory Council) 20% grain, 5% meat, 70% produce, 4% milk, 1% seafood (calculation / assumption)			
Financial Costs	Operating costs: \$27M per year for a mix of ongoing policy advocacy and lobbying and subsequent employee awareness and training efforts (extrapolated from historic policy lobbying costs per Food Policy Action)			
Financial Benefits	Food costs avoided: diversion potential * \$1.71 / lb (Feeding America standard value of donated food) = \$5.9B per year (calculation)			

Standardized Donation Regulation

Description	Standardizing local and state health department regulations for safe handling and donation of food through federal policy			
Modeling Assumptions				
Diversions Potential		Farm	Restaurant / Foodservice	Retail
	Total potential food recovery:	<ul style="list-style-type: none"> 22480K tons 	<ul style="list-style-type: none"> 4817K tons 	<ul style="list-style-type: none"> 3745K tons
	Addressable food recovery: % recovery potential not donated due to <i>regulation concerns</i> (ReFED / BSR)	<ul style="list-style-type: none"> 5% of farm total recovery potential (Roadmap assumption) 1525K tons could be donated if regulation is addressed 	<ul style="list-style-type: none"> 11% of restaurant total recovery potential (BSR) 530K tons could be donated if regulation is addressed 	<ul style="list-style-type: none"> 6% of retail total recovery potential (BSR) 225K tons could be donated if regulation is addressed
	<ul style="list-style-type: none"> Adoption rate of 100% nationwide (assuming sweeping policy effort based on federal policy) 50-60% addressable volume can be captured across all value stages (validated with Advisory Council) 			
	Diversions potential:	615K tons	295K tons	2133K tons
Diversions Characterization	Food types included: all (validated with Advisory Council) 24% grain, 15% meat, 48% produce, 10% milk, 3% seafood (calculation / assumption)			
Financial Costs	Operating costs: \$26.5M per year for a mix of ongoing policy advocacy and lobbying costs for legislators (extrapolated from historic policy lobbying costs per Food Policy Action)			
Financial Benefits	Food costs avoided: diversion potential * \$1.71 / lb (Feeding America standard value of donated food) = \$2981M per year (calculation)			

Donation Matching Software

Description	Using a technology platform to connect individual food donors with recipient organizations and reach smaller scale food donations			
Modeling Assumptions				
Diversion Potential		Farm	Restaurant / Foodservice	Retail
	Total potential food recovery:	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 1335K tons (Feeding America) 	<ul style="list-style-type: none"> 320K tons (Feeding America)
	Addressable food recovery: % recovery potential	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 100% (total potential food recovery represents incremental opportunity) 	<ul style="list-style-type: none"> 100% (total potential food recovery represents incremental opportunity)
	<ul style="list-style-type: none"> Adoption rate of 100% nationwide, based on Feeding America's Online Marketplace platform 50% of the food recovery potential estimated by Feeding America is attributable directly to the donation matching software platform; the other 50% relies on additional labor, transportation, or storage and handling outside solution scope (Advisory Council and expert interviews) 			
	Diversion potential:	N/A	670K tons	170K tons
Diversion Characterization	Food types included: all (validated with Advisory Council) 24% grain, 15% meat, 48% produce, 10% milk, 3% seafood (calculation / assumption)			
Financial Costs	Investment costs: \$26.5M for development of software platform, employee/staff training and education			
	Operating costs: \$2675K per year for system maintenance and ongoing training and support (validated with Advisory Council)			
Financial Benefits	Food costs avoided: diversion potential * \$1.71 / lb (Feeding America standard value of donated food) = \$2318M per year (calculation)			

Donation Transportation

Description	Providing small-scale transportation infrastructure for local recovery as well as long-haul transport capabilities				
Modeling Assumptions					
Diversion Potential		Farm	Restaurant / Foodservice	Retail	
	Total potential food recovery:	<ul style="list-style-type: none"> 107K tons 	<ul style="list-style-type: none"> 4817K tons 	<ul style="list-style-type: none"> 3745K tons 	
	Addressable food recovery: % recovery potential not donated due to <i>transportation constraints</i> (ReFED / BSR)	<ul style="list-style-type: none"> 100% of above recovery potential equals a doubling of food currently recovered by Borderlands Food Bank (<i>Roadmap</i> assumption) 	<ul style="list-style-type: none"> 26% of restaurant total recovery potential (BSR) 1257K tons could be donated if transportation is addressed 	<ul style="list-style-type: none"> 27% of retail total recovery potential (BSR) 1012K tons could be donated if transportation is addressed 	
		<ul style="list-style-type: none"> Adoption rate of 40% nationwide (assumption of top MSAs only, validated with external stakeholders) 50-80% addressable volume can be captured across all value stages (validated with Advisory Council) 			
	Diversion potential:	107K tons	267K tons	215K tons	
Diversion Characterization	Food types included: all (validated with Advisory Council) 24% grain, 15% meat, 48% produce, 10% milk, 3% seafood (calculation / assumed adjustment from retail waste characterization based on food type values)				
Financial Costs	Operating costs: \$3750 per ton of food picked up or transported, or \$0.35/lb = \$245M per year, based on Feeding America costs of foodservice vs. retail donations (calculated from related Advisory Council data; these costs are based on associated labor operating costs, and assumes usage of existing physical transportation infrastructure – additional costs to purchase physical capital, e.g. trucks, are not explicitly modeled here)				
Financial Benefits	Food costs avoided: diversion potential * \$1.71 / lb (Feeding America standard value of donated food) = \$1697M per year (calculation)				

Donation Storage and Handling

Description	Expanding temperature-controlled food distribution infrastructure (e.g. refrigeration, warehouses) and labor availability to handle (e.g. process, package) additional donation volumes			
Modeling Assumptions				
Diversion Potential		Farm	Restaurant / Foodservice	Retail
	Total potential food recovery:	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 4817K tons 	<ul style="list-style-type: none"> 3745K tons
	Addressable food recovery: % recovery potential not donated due to <i>food bank storage / refrigeration constraints</i> (ReFED / BSR)	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> 23% of restaurant total recovery potential (BSR) 530K tons could be donated if storage / refrigeration is addressed 	<ul style="list-style-type: none"> 27% of retail total recovery potential (BSR) 1011K tons could be donated if storage / refrigeration is addressed
	<ul style="list-style-type: none"> Adoption rate of 40% nationwide (assumption of top MSAs only, validated with Advisory Council) 50-80% addressable quantity can be captured across all value stages (validated with Advisory Council) 			
	Diversion potential:	N/A	25K tons	25K tons
Diversion Characterization	Food types included: all (validated with Advisory Council) 24% grain, 15% meat, 48% produce, 10% milk, 3% seafood (calculation / assumed adjustment from retail waste characterization based on food type values)			
Financial Costs	Investment costs: \$535M one-time for physical facility construction Operating costs: \$500 per ton of food stored / handled = \$562M per year (validated with Advisory Council)			
Financial Benefits	Food costs avoided: diversion potential * \$1.71 / lb (Feeding America standard value of donated food) = \$1590M per year (calculation)			

Value-Added Processing

Description	Extending the usable life of donated foods through processing methods such as making soups, sauces, or other value-added products			
Modeling Assumptions				
Diversion Potential		Farm	Restaurant / Foodservice	Retail
	Total potential food recovery:	<ul style="list-style-type: none"> 22480 K tons 	<ul style="list-style-type: none"> 4817K tons 	<ul style="list-style-type: none"> 3745K tons
	Addressable food recovery: % recovery potential not donated due to <i>on-site storage / refrigeration constraints</i> (ReFED / BSR)	<ul style="list-style-type: none"> 20% of farm total recovery potential (Roadmap assumption) 4500K tons could be donated if storage / refrigeration is addressed 	<ul style="list-style-type: none"> 19% of restaurant total recovery potential (BSR) 915K tons could be donated if storage / refrigeration is addressed 	<ul style="list-style-type: none"> 18% of retail total recovery potential (BSR) 675K tons could be donated if storage / refrigeration is addressed
	<ul style="list-style-type: none"> Adoption rate of 60% nationwide (assumption of top MSAs only and high-volume farm / food production regions, validated with Advisory Council) 10-20% addressable volume can be captured across all value stages (validated with Advisory Council) 			
	Diversion potential:	450K tons	92K tons	63K tons
Diversion Characterization	Food types included: all (validated with Advisory Council) 18% grain, 10% meat, 65% produce, 6% milk, 1% seafood (calculation / assumed adjustment from retail waste characterization based on food type values)			
Financial Costs	Investment costs: \$400M upfront for capital investments and machinery Operating costs: \$21M per year based on operation, maintenance, and other costs estimated at 5% of initial investment cost (ReFED assumption)			
Financial Benefits	Food costs avoided: diversion potential * \$1.71 / lb (Feeding America standard value of donated food) = \$1579M per year (calculation)			

Donation Liability Education

Description		Educating potential food donors on donation liability laws		
Modeling Assumptions				
Diversions Potential		Farm	Restaurant / Foodservice	Retail
	Total potential food recovery:	<ul style="list-style-type: none"> 22480K tons (Roadmap analysis) 	<ul style="list-style-type: none"> 4817K tons (Roadmap analysis) 	<ul style="list-style-type: none"> 3745K tons (Roadmap analysis)
	Addressable food recovery: % recovery potential not donated due to <i>liability concerns</i> (ReFED / BSR)	<ul style="list-style-type: none"> 10% of farm total recovery potential (Roadmap assumption) 4496K tons could be donated if liability concerns are addressed 	<ul style="list-style-type: none"> 21% of restaurant total recovery potential (BSR) 2023K tons could be donated if liability concerns are addressed 	<ul style="list-style-type: none"> 21% of retail total recovery potential (BSR) 1573K tons could be donated if liability concerns are addressed
	<ul style="list-style-type: none"> Adoption rate of 100% nationwide (assuming sweeping education effort, validated with Advisory Council) Removing liability concern barrier will only address 50% of donation potential; reported liability concerns are overstated as businesses over-attribute reasons for not donating food to liability (assumption validated with Advisory Council and industry experts) 10-20% addressable volume can be captured across all value stages (validated with Advisory Council) 			
	Diversions potential:	160K tons	80K tons	65K tons
Diversions Characterization	Food types included: all (validated with Advisory Council) 24% grain, 15% meat, 48% produce, 10% milk, 3% seafood (calculation / assumption)			
Financial Costs	Operating costs: \$27M per year for a mix of ongoing policy advocacy and lobbying, employee education and training, and awareness campaign costs (extrapolated from historic policy lobbying costs per Food Policy Action)			
Financial Benefits	Food costs avoided: diversion potential * \$1.71 / lb (Feeding America standard value of donated food) = \$878M per year (calculation)			

Food Waste Recover Solutions Data Set

SOLUTION	DIVERSION POTENTIAL (K TONS / YEAR)	ECONOMIC VALUE PER TON DIVERTED	ECONOMIC VALUE (\$M / YEAR)	BENEFIT (\$M / YEAR)	COST (\$M / YEAR)	BUSINESS PROFIT POTENTIAL(\$M / YEAR)	FINANCING COST OVER 10 YEARS (\$M)	GHGS (K TONS / YEAR)	MEALS RECOVERED (M MEALS / YR)	WATER CONSERVATION (B GALS / YR)	JOBS CREATED (PARTIAL LIST)
Donation Tax Incentives	2,050	6,583	2,516	5,904	-3,388	0	38,425	4,678	3,415	589	0
Standardized Donation Regulation	1,033	15,324	2,960	2,981	-21	0	257	3,822	1,723	498	0
Donation Matching Software	803	15,410	2,312	2,318	-5	0	54	2,971	1,338	385	0
Donation Transportation	589	12,278	1,349	1,697	-348	0	3,902	2,178	979	284	8,585
Donation Storage & Handling	551	12,664	1,306	1,590	-284	0	3,104	2,039	921	268	11,481
Value-Added Processing	546	14,896	1,525	1,579	-54	0	578	1,600	915	203	819
Donation Liability Education	305	15,040	851	878	-21	0	257	1,124	508	145	0
Total	5,877	92,195	12,819	16,946	-4,121	0	46,576	18,412	9,800	2,371	20,885

APEC Food Waste Recycling Solutions

Centralized Composting

Description	Transporting waste to a centralized facility where it decomposes into compost
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 42M tons commercial/residential in areas with strong policies or yard waste bans, 72.5M tons commercial in non-policy areas, 56.7M tons outside key MSAs (ReFED generation model)</p> <p>Diversion Potential: 26M tons</p> <ul style="list-style-type: none"> • 10% to 40% commercial uptake in strong policy areas (assumption) • 20% residential uptake in strong policy and yard waste ban areas (assumption) • 5% to 20% commercial uptake in other areas (assumption) • 21% of sites are expected to be ASP, the remainder windrow (calculation)
Financial Costs	<p>Operating costs: \$487M per year</p> <p>Indirect costs: \$1707M per year in collection costs</p> <ul style="list-style-type: none"> • \$67 to \$115 per ton <p>Annual Capital Payments: \$658M</p>
Financial Benefits	<p>Direct revenues: tip fees + compost sales = \$1445M per year (calculation)</p> <p>Avoided disposal costs: avoided trash collection + avoided landfill tip fees = \$1350M per year (calculation)</p>
New Businesses Served	80,000+
New Homes Served	80M

Centralized Anaerobic Digestion

Description	A series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen resulting in two end products: biogas and digestate. There are many different AD technologies, including wet and dry versions, the latter being generally better suited for food waste mixed with yard waste.
Modeling Assumptions	
Diversion Potential	Addressable waste: 18M tons commercial/industrial in areas with strong policies, 51M tons commercial in non-policy areas
	Diversion Potential: 10M tons <ul style="list-style-type: none"> • 25% uptake in areas where policy and other economic drivers are strong (assumption)
Financial Costs	Capital costs: \$4538M Operating costs: \$585M per year <ul style="list-style-type: none"> • \$57 to \$61 per ton Indirect costs: \$780M per year in collection costs <ul style="list-style-type: none"> • \$71 to \$89 per ton Annual Capital Payments: \$445M
Financial Benefits	Direct revenues: tip fees + energy sales + composted digestate sales = \$1345M per year (calculation) Avoided disposal costs: avoided trash collection + avoided landfill tip fees = \$870M per year (calculation)
New Businesses Served	16,000+



Water Resource Recovery Facility with Anaerobic Digestion

Description	Delivering waste by truck or through existing sink disposal pipes to a municipal WRRF, where it is treated with anaerobic digestion; the biosolids can be applied to land for beneficial reuse
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 140M tons residential (ReFED generation model)</p> <p>Diversion Potential: 17M tons</p> <ul style="list-style-type: none"> • 10% to 15% residential uptake in strong policy and yard waste ban areas (assumption) • 15% residential uptake in multifamily buildings
Financial Costs	<p>Capital costs: \$7900M</p> <ul style="list-style-type: none"> • \$89 per ton in amortized annual costs at a WACC of 3.1% <p>Operating costs: \$1040M per year</p> <ul style="list-style-type: none"> • \$55 to \$67 per ton <p>Annual Capital Payments: \$650M</p>
Financial Benefits	<p>Direct revenues: energy sales = \$570M per year (calculation)</p> <p>Avoided disposal costs: avoided trash collection + avoided landfill tip fees = \$1830M per year (calculation)</p>
New Businesses Served	5300+
New Homes Served	267M

Commercial Greywater

Description	An on-site treatment technology, greywater aerobic digesters use combinations of nutrients or enzymes and bacteria to break food organics down until soluble, where it is flushed into the sewage system.
Modeling Assumptions	
Diversion Potential	Addressable waste: 66M tons commercial
	Diversion Potential: 3165K tons <ul style="list-style-type: none"> • 2% to 5% commercial uptake (assumption)
Financial Costs	Capital costs: \$445M total across all areas <ul style="list-style-type: none"> • \$33 per ton in amortized annual costs at a WACC of 6.9% Operating costs: \$29M per year across all areas <ul style="list-style-type: none"> • \$9 per ton
Financial Benefits	Indirect revenues: reduced collection costs = \$48M per year (calculation) Avoided disposal costs: avoided landfill tip fees = \$193M per year (calculation)

Community Composting

Description	Transporting food from homes by truck, car, or bicycle to small, community, or neighborhood-level compost facilities that process 2,500 tons per year on average
Modeling Assumptions	
Diversion Potential	Addressable waste: 44M tons residential in all areas
	Diversion Potential: 900K tons <ul style="list-style-type: none"> • 2% residential uptake (assumption)
Financial Costs	Capital costs: \$340M total across all areas <ul style="list-style-type: none"> • \$82 per ton in amortized annual costs at a WACC of 2.8% Operating costs: \$45M per year across all areas <ul style="list-style-type: none"> • \$52 per ton
Financial Benefits	Direct Revenues: subscription fees + sale of compost + gate fees = \$37M per year (calculation) Avoided disposal costs: avoided collection costs = \$48M per year (calculation)

Home Composting

Description	Keeping a small bin or pile for on-site waste at residential buildings to be managed locally; also known as “backyard composting”
Modeling Assumptions	
Diversión Potential	<p>Addressable waste: Targeted 21M tons residential in all non-policy or yard waste ban areas – although potentially applicable to all 140M tons residential food waste (ReFED generation model)</p> <p>Diversión Potential: 500K tons</p> <ul style="list-style-type: none"> • 2.5% residential uptake (assumption)
Financial Costs	<p>Capital costs: \$2600K total across all areas</p> <ul style="list-style-type: none"> • \$5 per ton for simple equipment <p>Operating costs: \$18M per year across all areas for education and outreach</p> <ul style="list-style-type: none"> • \$36 per ton
Financial Benefits	Avoided disposal costs: avoided collection costs = \$21M per year (calculation)

Animal Feed

Description	Feeding food waste to animals after it is heat-treated and dehydrated and either mixed with dry feed or directly fed
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 19M tons retail/wholesale/industrial waste (ReFED generation model)</p> <p>Diversion Potential: 265K tons</p> <ul style="list-style-type: none"> • 2% retail/wholesale uptake in high policy environments (assumption) • 1% retail/wholesale uptake in other environments (assumption) • 3% industrial uptake (assumption)
Financial Costs	<p>Capital costs: \$31M total across all areas</p> <ul style="list-style-type: none"> • \$16 per ton <p>Operating costs: \$4600K per year across all areas</p> <ul style="list-style-type: none"> • \$18 per ton <p>Indirect costs: \$19M in collection costs</p> <ul style="list-style-type: none"> • \$74 per ton
Financial Benefits	<p>Indirect Revenues: \$5.5M in avoided grain purchasing annually (calculation)</p> <p>Avoided disposal costs: avoided collection costs and landfill tip fees = 28M per year (calculation)</p>

In-Vessel Composting

Description	Composting at small scale at institutions or businesses with heat and mechanical power to compost relatively quickly (less than one month versus more than two months for windrow composting)
Modeling Assumptions	
Diversion Potential	<p>Addressable waste: 12M tons commercial in strong policy areas (ReFED generation model)</p> <p>Diversion Potential: 62K tons</p> <ul style="list-style-type: none"> • 0.5% commercial uptake (assumption)
Financial Costs	<p>Capital costs: \$41M total across all areas</p> <ul style="list-style-type: none"> • \$157 per ton in amortized annual costs at a WACC of 6.4% <p>Operating costs: \$1402K per year across all areas</p> <ul style="list-style-type: none"> • \$22 per ton
Financial Benefits	Avoided disposal costs: avoided collection and landfill tip fees = \$4271K per year (calculation)

Food Waste Recycle Solutions Data Set

SOLUTION	DIVERSION POTENTIAL (K TONS / YEAR)	ECONOMIC VALUE PER TON DIVERTED	ECONOMIC VALUE (\$M / YEAR)	BENEFIT (\$M / YEAR)	COST (\$M / YEAR)	BUSINESS PROFIT POTENTIAL (\$M / YEAR)	FINANCING COST OVER 10 YEARS (\$M)	GHGS (K TONS / YEAR)	MEALS RECOVERED (M MEALS / YR)	WATER CONSERVATION (BILLION GALS / YR)	JOB'S CREATED (PARTIAL LIST)
Centralized Composting	26,960	21	96	2,783	-2,687	252	5,251	13,943	0	0	48,171
Centralized AD	10,084	112	214	1,863	-1,649	230	5,122	6,310	0	0	10,346
Water Resource Recovery Facility (WRRF) with AD	8,762	123	203	1,012	-808	0	4,405	3,897	0	0	535
Commercial Greywater	3,185	177	102	305	-203	0	471	0	0	0	0
Community Composting	894	-182	-32	70	-102	0	385	872	0	0	1,231
Home Composting	519	798	75	96	-16	0	21	284	0	0	0
Animal Feed	262	-278	-16	11	-21	0	37	182	0	0	0
In-Vessel Composting	64	-508	-5	5	-11	0	43	59	0	0	0
Total	50,730	262	637	6,145	-5,497	482	15,736	25,547	0	0	60,284

Summary Results of APEC Reducing FLW by 10% (1)

Type	DIVERSION POTENTIAL (K TONS / YEAR)	ECONOMIC VALUE (\$M / YEAR)	BENEFIT (\$M / YEAR)	COST (\$M / YEAR)	BUSINESS PROFIT POTENTIAL (\$M / YEAR)	FINANCING COST OVER 10 YEARS (\$M)
Prevent	14,045	41,031	51,206	-10,191	9,934	33,126
Recover	5,877	12,819	16,946	-4,121	0	46,576
Recycle	50,730	637	6,145	-5,497	482	15,736
Total	70,651	54,487	74,296	-19,809	10,416	95,438

GHGs Reduced

Diverting food waste for human consumption additionally avoids the greenhouse gas impacts of organic waste disposal. As food waste rots and decomposes in landfills it releases methane gases into the atmosphere. In carbon equivalents, this adds 0.355 kg CO₂e / lb across all food types according to the EPA's Waste Reduction Model (WARM Model).

Solution	kg CO ₂ e / lb Food Waste	Source
AD	0.31	Morris 2014
Compost	0.26	Morris 2014
WWTP	0.22	Morris 2014
Onsite Greywater	0.00	Eureka 2013
Onsite Compost	0.47	Eureka 2013
Community Compost	0.49	Eureka 2013
Backyard Compost	0.21	Eureka 2013
Animal Feed	0.34	Eureka 2013

Figure 24: Recycling Solution GHG Emissions Factors

	Grain Products	Meat	Fruits & Vegetables	Seafood	Milk and Dairy
Production & Transport	0.30	5.73	0.36	2.96	1.27
Disposal	0.36	0.36	0.36	0.36	0.36
TOTAL	.65	6.09	0.72	3.32	1.63

Figure 23: Weighted GHG Emissions (kg CO₂e / lb) by Food Category

Water Conserved

The Roadmap reports water impacts from waste diversion as a “water conserved” figure. While the water inputs to produce an amount of food is a sunk environmental cost, this volume still represents a water savings in terms of gallons that would otherwise have gone to waste with zero benefit to society. Prevention and recovery solutions are assumed to avoid water use embedded in wasted crops, while recycling solutions do not avoid water use.

	Grain Products	Meat	Fruits & Vegetables	Seafood	Milk and Dairy
Water Footprint	1644	8205	604	452	796

Figure 25: Weighted Water Footprint (L / kg) by Food Category

Jobs Created

For these solutions, the costs due to additional labor needed to handle food for donation, transport donated food, or process into value-added goods translate into jobs created. Assuming an average living wage of \$12/hr, and 40 hours worked per year for 50 weeks, a single salaried employee costs \$24,000 a year.

Meals Recovered

When food waste is “recovered” through the seven recovery solutions, it is assumed that all of the tons of food recovered end up feeding people in need through nonprofits and other organizations. Therefore, the *Roadmap* adopts a straight conversion of tons of wasted food avoided into meals saved.

Food recovery is a complex ecosystem where food donations themselves are not all created equal. Depending on the donor organization, donated food may vary widely in nutritional value.

Summary Results of APEC Reducing FLW by 10% (2)

Type	GHGS (K TONS / YEAR)	MEALS RECOVERED (M MEALS / YR)	WATER CONSERVATION (B GALS / YR)	JOBS CREATED (PARTIAL LIST)
Prevent	51,774	0	6,369	0
Recover	18,412	9,800	2,371	20,885
Recycle	25,547	0	0	60,284
Total	95,733	9,800	8,740	81,169

What Gets Measured, Gets Managed

-PETER DRUCKER

Summary

- The Roadmap shows an achievable path for APEC to a 10% reduction of food loss and waste through 27 no-regret solutions. These solutions would divert 71 million tons from landfills and on-farm losses.
- Implementing the Roadmap is projected to generate 81,000 new jobs, recover 9.8 billion meals per year of food donations to nonprofits, reduce 8.7 trillion gallons per year of freshwater use and avoid nearly 96 million tons of greenhouse gas emissions annually.
- The Roadmap will require a 9.5 billion investment per year which will yield an expected 55 billion in social economic value.

Going beyond No-Regrets Policies

EU Data Problems and Guidelines_1

The 2010 European Commission Preparatory Study on Food Waste identified a poor understanding of existing levels of food waste generation across the EU. This finding was replicated more recently by the FUSIONS project (FUSIONS, 2016), with many Member States lacking robust data on the amounts of food waste generated.

The *FUSIONS Quantification Manual* responds to a need for coherent quantification, that in turn enables the development of effective food waste prevention strategies. (Source: Tostivint *et al.*, 2016. p. 3)

EU Data Problems and Guidelines_2

Although food waste prevention efforts can be initiated without having detailed information of the amounts of food waste, food waste quantification would be necessary in order to get a better understanding of the magnitude and location of food waste arisings within the food chain which may inform waste prevention measures. This will, in turn, allow better defining, prioritizing and targeting of prevention efforts, as well as tracking progress in food waste reduction over time. (Source: Tostivint *et al.*, 2016. p. 8)

Food Loss and Waste Accounting and Reporting Standard



Food waste quantification manual to **monitor** food waste amounts and progression

Date: 31.03.16

FLW Standard

FUSIONS Quantification Manual

<ul style="list-style-type: none">• Global• All types of entities (companies, researchers, nations, cities, etc.)• Allows users to define “food loss and waste” in relation to their goals	<ul style="list-style-type: none">• Voluntary• Multi-stakeholder• Consensus based• Uses common terminology to describe components of food waste• Establishes requirements• Provides recommendations and guidance• Suggests but does not prescribe quantification methods	<ul style="list-style-type: none">• EU Member States*• Defines “food waste”
---	--	--

Figure 1 – FLW Standard vs. FUSIONS quantification Manual

Source: Tostivint *et al.*, 2016. p.10

EU Data Problems and Guidelines_3

While the *FLW Protocol* is a broad, multi-user tool, The *FUSIONS Quantification Manual* has a more focused objective: to support EU Member States to quantify their food waste. This focus enables MSs to track progress towards a potential food waste reduction target, using agreed definitions of food waste and supply chain sectors, and to report results in a manner that is coherent with the global Protocol and consistent between MSs. (Source: Tostivint *et al.*, 2016. p. 9)

Conclusions and Suggestions_1

- The *Roadmap* relied on the best available data for developing a baseline of where food is wasted. However, the parameters and coefficients used in this research need further updating, either from ME survey or further research.
- The APEC target of 10% reduction in food loss and waste is set to achieve the *Millennium Development Goals (MDGs)*. However, APEC and Member Economies may be committed to meeting the *Sustainable Development Goals (SDG)*, adopted in September 2015, including a target to halve per capita food waste at the retail and consumer level by 2030, and reduce food losses along the food production and supply chains.

Conclusions and Suggestions_2

- Given the diversity of research that needs to be taken, we suggest that a coordinated entity, e.g., *APEC FLW Center*, ensure that research continually build upon itself. In Europe, FUSIONS (now REFRESH, an EU Horizon 2020 Project) was developed to help coordinate the research agenda.
- An *APEC Food Waste Quantification Manual* like that developed by FUSIONS is indispensable for providing practical guidelines for a standard approach for MEs on how to quantify food loss and waste in different stages of the food supply chain.

Conclusions and Suggestions_3

- Surely such an *APEC Food Waste Quantification Manual* and methodologies should be in harmony with the World Resources Institute's *Food Loss & Waste Protocol Accounting and Reporting Standard* (FLW Protocol, 2015).