

Low-carbon Consumption Potential Analysis of Metropolitan Residents



Carbonstop

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1. Introduction and explanation

This report aims to estimate low-carbon consumption potential of the first-tier and second-tier cities that have more than 10 million people in China. The scope includes clothing, food, housing, transport and daily commodities. The calculation will be based on scientific calculation method and reasonable assumption to obtain individual and city level carbon emission reductions. In addition, the calculation chooses the data from first-tier and second-tier cities firstly. If the data is not available, some typical cities' data will be used as substitution.

2. Estimation of low-carbon consumption potential

Clothing-at least 79.34kg CO₂e reductions per person per year

The carbon emission of per garment changes due to different materials and production. For example, it generates 25.701kgCO₂e for one-kilogram polyester^[1], 32.3 kgCO₂e for one pair of cotton jeans and 10.75 kgCO₂e for a 3/4 sleeve shirt^[2]. In this report, emission of one cotton t-shirt made in China, which is 8.423kgCO₂e^[3], is used as a representative example to calculate the emission reduction.

According to the data from National Bureau of Statistics and China National Garment Association (CNGA), average clothing purchases in China are 29.46 garments^[4]. If the total number of purchased clothing reduces by 10% (approximately 3 garments) per person in 2020, the carbon emission reduction will be 24.81kgCO₂e. If the total number of purchased clothing reduces by 15% per person in 2030, the carbon emission reduction will be 37.22kgCO₂e.

Clothing renting is one of the emerging sharing economy. It mainly provides services to white-collar females^[5]. Clothing renting is able to reduce the clothing purchase. If one can buy one less garment by renting clothing, the carbon emission reduction will be 8.42kgCO₂e in 2020. If one can buy five less garments by renting clothing, the carbon emission reduction will be 42.12 kgCO₂e in 2030.

Besides, some fast-fashion brands have their own accounting and reporting of their greenhouse gas(GHG) emission and determined their goals to reduce these carbon emissions. Total carbon

emission of C&A was 5,678,204tCO₂e in 2018, which is 12% lower than the emission of 2016^[6]. H&M reduced their emission of operation by 11% and aimed to become carbon neutral in 2040 in their supply chain^[7]. Uniqlo’s parent group Fast Retailing emitted 3,248,156 tCO₂e in fiscal year of 2017-2018, and prepared to reduce by 10% emission per unit area of the stores in 2020^[8]. However, only less than 15 percent signatories of Fashion Industry Charter for Climate Action have included their supply chain-related emissions in their Scope 3 emissions, and only less than 30 percent signatories disclosed their goal of carbon emission in 2030^[9]. The fashion industry has low-carbon potential but it is hard to give an estimation due to insufficient disclosure of carbon emission.

Table 1 Clothing

Actions	2020	2030	unit
Less purchases of clothing	Reduce by 10%	Reduce by 15%	
	24.81	37.22	kgCO ₂ e/person·a
Clothing renting*	1 less garment	5 less garments	
	8.42	42.12	kgCO ₂ e/person·a
Choose brands with climate targets	--	--	--
Total	24.81-33.23*	37.22-79.34*	kgCO₂e/person·a

*applicable for certain people

Food-at least 160.63kg CO₂e reductions per person per year

Based on the information from Chinese Nutrition Society, 40-74 gram of meat per day is able to provide sufficient nutrition for human^[10]. Meanwhile, according to the research from Scarborough et al.^[11], if one person chooses not to eat meat a day of every two weeks, the carbon emission reduction will be 128.71 kgCO₂e every year in 2030. If one person chooses not to eat meat a day of a week, the carbon emission reduction will be 128.71 kgCO₂e every year in 2030. Besides, one high meat-eaters (>=100 g/d) eat less meat and become medium(50-99g/d) and low (<=50g/d) meat-eaters, the carbon emissions will reduce by 584-945.35 kgCO₂e (average 764.675 kg CO₂e).

Disposal of food waste can generate carbon emissions. The case study from Carbonstop indicated that food waste at home was 40g per person one day while the WWF report^[12], average food waste of restaurant and dining hall is 93g per person. Based on current proportion of incineration and

landfill, if one can reduce 25% food waste, carbon emissions will reduce 15.96kg CO₂e in 2020. If one can reduce 50% food waste, carbon emissions will reduce 31.92kg CO₂e in 2020.

Table 2 Food

Actions	2020	2030	Unit
No meat one day per week	50%	100%	
	64.36	128.71	kgCO ₂ e/person-a
Dietary change*	764.675	764.675	kgCO ₂ e/person-a
Reduce food waste	Reduce food waste by 25%	Reduce food waste by 50%	
	15.96	31.92	kgCO ₂ e/person-a
Total	80.32-844.995*	160.63-925.305*	kgCO₂e/person-a

*applicable for certain people;

*dietary change refers to high-meat eaters (≥ 100 g meat/day) become medium-meat (50-99 g/day) and low-meat (≤ 50 g) eaters.

Housing-at least 456.71kg CO₂e reductions per person per year

In the housing field, electricity is the most significant carbon emission contributor. The average household electricity use is 610.8kWh per person per year^[13]. If everyone can save 5% electricity, the carbon emission will reduce 18.63 kgCO₂e per person in 2020. If everyone can save 5% electricity, the carbon emission will reduce 37.26 kgCO₂e per person in 2030.

If electricity reform enables the users to choose their own electricity providers, except for the 5% electricity saving, one chooses 50% of the electricity is from renewable energy, the carbon emission will reduce 177.01 kgCO₂e. if one person saves 10% electricity first and totally chooses the renewable energy for data providing, the carbon reduction will be 335.38 kgCO₂e.

Energy-saving appliance, level 1 and 2 on the China Energy Label, emits less greenhouse gas. To be specific, a high efficient air conditioner reduces 353.46kg CO₂e compared to a common one, and the emission reductions for high efficient refrigerator, washing machine and television are 100.31 kgCO₂e, 109.92 kgCO₂e and 57.6 kgCO₂e respectively^[14]. Considering the family size and current usage of energy-saving household appliance^[13], if 50% of non-energy-saving appliance users change their

appliance to be energy-saving ones, the carbon emission will reduce 42.03kgCO₂e in 2020, if all non-energy-saving appliance users change their appliance to be energy-saving ones, the carbon emission will reduce 84.07 kgCO₂e in 2020.

Table 3 Housing

Actions	2020	2030	Unit
Saving electricity	5%	10%	
	18.63	37.26	kgCO ₂ e/person·a
Renewable power	50%	100%	
	177.01	335.38	kgCO ₂ e/person·a
Energy-saving appliance	50%	100%	
	42.03	84.07	kgCO ₂ e/person·a
Total	237.67	456.71	kgCO₂e/person·a

Note: The calculation of these three aspects may be partially doublecounting.

Transport-at least 440.26kg CO₂e reductions per person per year

The average travel distance of private car is 31.3km per day in Beijing^[15]. Except for the car plate-based restriction requirements that non-driving one day of a week, if car owners choose low-carbon transport (40% bus, 40% subway, 15% bicycle, 5% walking) rather than driving cars, then the annual carbon emissions will reduce 274.24 kgCO₂e. In terms of average family size and car ownership ratio^[13], average carbon emission reductions are 44.35 kgCO₂e in 2020. Moreover, if 75% of all cars are electric cars in 2030, car owners normally drive 5 days in a week, carbon emissions reduce 100.24kgCO₂e per person per year.

Carbon emission of long distance travel varies depends on the vehicles. According to the statistics from Civil Aviation Administration of China^[16], passenger transport volume of 2018 was 1071.232 billion RPK (Revenue Passenger Kilometers), and the passenger volume is 611.835 million, so the average flight distance was 1751.13km. In addition, calculation based on annual report of Beijing transportation shows that the average flight distance of Beijinger is 8670.15 km^[15]. If 10% of long distance flight travel is replaced by trains, annual carbon emissions will reduce 147.83 kgCO₂e per person in 2020. If 20% of long distance flight travel is replaced by trains, annual carbon emission will

reduce 295.67 kgCO₂e per person in 2030.

Table 4 transportation

Actions	2020	2030	Unit
Less driving & more electric cars	Less driving one extra day per week	75% electric cars + Less driving	
	44.35	144.59	kgCO ₂ e/person-a
Train over flight	10%	20%	
	147.83	295.67	kgCO ₂ e/person-a
Total	192.18	440.26	kgCO₂e/person-a

Note: the calculation of emissions from electric cars does not include electricity from renewable sources.

Daily commodities-at least 34.71kg CO₂e reductions per person per year

One plastic bag generates 40gCO₂e^[17]. Before plastic limits orders, daily consumption of plastic bags was 2 billion and the plastic limits orders reduced the usage by two-thirds of the total amount. Therefore, the plastic bag consumption of one person is at least 175 every year. If people reduce the use of plastic bags by 50%, carbon emissions will reduce 3.50 kgCO₂e per person in 2020. If people reduce the use of plastic bags by 50%, carbon emissions will reduce 7.00 kgCO₂e per person in 2030.

The use of disposable chopsticks is popular in food delivery. If users choose no disposable chopsticks for their delivery food, less use of one pair of chopsticks can reduce 16gCO₂e^[18]. In terms of the data from 2018-2019 Online Take-out Industry Analysis Report^[19], more than 54.3% people in first-tier and second-tier cities order delivery food and average use of tableware is 2.23^[19,20]. In the results, if 50% online orders of food need no disposable chopsticks, carbon emissions will reduce by 3.55kgCO₂e in 2020. If all online orders of food need no disposable chopsticks, carbon emissions will reduce by 3.55kgCO₂e in 2030. Moreover, the disposable meal boxes can be replaced by low-carbon boxes. Even though paper meal boxes have fewer environmental impacts than plastics ones, there is no significant low-carbon benefit. Biodegradable plastics have the potential to reduce the carbon emissions. For instance, one 20g plastic meal box emits 0.76kg more CO₂e than the biodegradable meal box. The calculation is based on the former cases, and more research is required in the use of biodegradable

materials in food packaging. If biodegradable meal boxes expand to 10% of current food delivery market, carbon emissions will reduce by 0.67 kgCO₂e per person in 2020. If biodegradable meal boxes expand to 20% of current food delivery market, carbon emissions will reduce by 1.34 kgCO₂e per person in 2030.

Logistics develops fast in recent years with the boom of e-commerce. People start to concern the environmental impacts of packaging of the deliveries. One green packaging has an average carbon emission reduction of 40g^[21]. Green packaging includes eco packing bag (bio-based plastic and biodegradable plastic) and packing box without tape. Besides, packing bag “return boxes plan” will reduce 37g CO₂e emission for each reused or recycled box^[22]. Everyone got average 36.5 parcels in 2018 and the figure for first-tier and second-tier residents would be higher. The statics brief also illustrated the parcel amount of Beijing, Shanghai and Guangzhou, and the roughly estimation of parcel amount was 200 per person. If 25% of all parcel are green parcels and 25% packing boxes can be reused at least once, the carbon emissions will reduce 3.76 kgCO₂e. If 50% of all parcel are green parcels and 50% packing boxes can be reuse at least once, the carbon emissions will reduce 7.52kgCO₂e.

Recycling of garbage is likely to reduce carbon emissions compared with the use of new raw materials. Even though the processing and final products might be different, the average reductions can reveal its potential. If everyone can sort 5kg paper, 0.5kg plastic and 1kg cloth as recycle garbage and garbage can be recycled eventually, carbon emissions will reduce 5.875 kgCO₂e in 2020. If the recycled garbage doubled, emissions will reduce 11.75kgCO₂e in 2030.

Table 5 daily commodities

Actions		2020	2030	Unit
Less disposables	Less plastic bags	Reduce by 50%	Reduce by 100%	
		3.50	7.00	kgCO2e/Person-a
	Reduce disposable chopsticks	50% food delivery without chopsticks	100% food delivery without chopsticks	
		3.55	7.10	kgCO2e/person-a
Replace disposable plastic meal boxes with biodegradable meal boxes	10% replacement	20% replacement		
	0.67	1.34	kgCO2e/person-a	
Packaging & recycled garbage	Green packaging + carton reuse	25%	50%	
		3.76	7.52	kgCO2e/Person-a
	Recycled garbage	Average level	1.5*average level	
5.875		11.75	kgCO2e/Person-a	
Total		17.355	34.71	kgCO2e/Person-a

3. Conclusion

The results show that a resident of first-tier or second-tier city with more than 10 million people can reduce at least 1129.53kg CO₂ if he/she tends to choose low-carbon consumption. It is notable that calculation is specific for certain level of city, so the estimation is not reasonable for the whole country. One city with 10 million people can reduce 11.2953 million ton CO₂e if all the residents take their actions. In the field of clothing, less purchases of garment and clothing renting can bring lower carbon emissions. In the field of food, better choices of meat and vegetables and less food waste contribute to lower carbon emissions. As for housing, saving electricity, choosing high energy-efficiency appliance and renewable energy sourced electricity will make a difference. Low-carbon transportation, such as less driving one day in a week, electric cars and trains (instead of air flight) for some long distance trip. In addition, less use of plastic bags and disposable chopsticks, low-carbon meal boxes and packaging for parcels, reuse of cartons and recycle useful garbage can reduce carbon

emissions in the field of daily commodities.

Table 6 2030 total low-carbon potential

category	Low-carbon activities	Low-carbon potential	Threshold of 2030 potential		Unit
clothing	Less purchases	37.22	37.22	79.34*	kgCO ₂ e/ person·a
	Clothing renting*	42.12			
	Choose brands with climate targets	-			
food	No meat one day per week	128.71	160.63	925.31*	
	Dietary change*	764.68			
	Reduce food waste	31.92			
housing	Saving electricity	37.26	456.71		
	Renewable power	335.38			
	Energy-saving appliance	84.07			
transport	Less driving & 75% electric cars	144.59	440.26		
	Train over flights	295.67			
Daily commodities	Less disposables	15.44	34.71		
	Packing & Garbage	19.27			
Total			1129.53	1936.33	

Appendix

Appendix1 Carbon Emission Factors

Activity	Emission Factor	Unit	Source
Electricity	0.6101	kgCO ₂ e/kWh	National Development and Reform Commission
Cotton shirt	8.324	kgCO ₂ e/garment	Reference ^[3]
Dietary-high meat eater	7.26	kgCO ₂ e/day (2000 kcal)	Reference ^[11]
Dietary-medium meat eater	5.66	kgCO ₂ e/day (2000 kcal)	Reference ^[11]
Dietary-low meat eater	4.67	kgCO ₂ e/day (2000 kcal)	Reference ^[11]
Dietary-fish eater	3.94	kgCO ₂ e/day (2000 kcal)	Reference ^[11]
Dietary-vegetarian	3.85	kgCO ₂ e/day (2000 kcal)	Reference ^[11]
Dietary-vegan	2.94	kgCO ₂ e/day (2000 kcal)	Reference ^[11]
Disposable chopsticks	0.04	kgCO ₂ e/pair	Report ^[18]
Food waste disposal	1.314	kgCO ₂ e/kg	Carbonstop calculation
Bus in Beijing	0.0365	kgCO ₂ e/km. passenger	Report ^[23] +Carbonstop calculation
subway	0.0376	kgCO ₂ e/km. passenger	DEFRA
flight	0.18277	kgCO ₂ e/km. passenger	DEFRA
train	0.01226	kgCO ₂ e/km. passenger	DEFRA
Plastic bag	0.04	kgCO ₂ e/purchase	Reference ^[17]

Appendix2 Carbon Emission Reduction Per Unit

Activity	Emission Factor	Unit	Source
Energy-saving air condition	-353.46	kgCO2e/a	Carbonstop calculation
Energy-saving refrigerator	-100.31	kgCO2e/a	Carbonstop calculation
Energy-saving washing machine	-109.92	kgCO2e/a	Carbonstop calculation
Energy-saving television	-57.6	kgCO2e/a	Carbonstop calculation
Carton reuse	-0.037	kgCO2e/a	Reference ^[22]
Green packaging	-0.030	kgCO2e/a	Carbonstop calculation
recycling-paper	-0.419	kgCO2e/kg	Reference+ Carbonstop calculation
recycling-clothing	-3.5	kgCO2e/kg	Reference+ Carbonstop calculation
recycling-plastic	-0.525	kgCO2e/kg	Reference+ Carbonstop calculation

Reference

- [1] Zhao N. Carbon footprint assessment and low carbon measure of the polyester textile [D]. Donghua University, 2012.
- [2] Wang L. Research and demonstration of carbon footprint and water footprint of textiled and clothing[D]. 东华大学, 2013.
- [3] Wang C, Wang L, Liu X, et al. Carbon footprint of textile throughout its life cycle: a case study of Chinese cotton shirts[J]. Journal of Cleaner Production, 2015, 108: 464-475.
- [4] <http://data.chinabaogao.com/fuzhuang/2019/01243956392019.html>.
- [5] <https://www.yi23.net/events/12>.
- [6] <http://sustainability.c-and-a.com/sustainable-supply/clean-environment/climate/>.
- [7] H&M Group Sustainability Report 2018, https://sustainability.hm.com/content/dam/hm/about/documents/en/CSR/2018_sustainability_report/HM_Group_SustainabilityReport_2018_FullReport_en.pdf.
- [8] Fast Retailing Sustainability Report 2019, https://www.fastretailing.com/eng/sustainability/report/pdf/sustainability2019_en_11.pdf - page=1&pagemode=thumbs&zoom=80.
- [9] KPMG. Sustainable fashion : Committing to a sustainable future through the Fashion Industry Charter for Climate Action[R]. 2019.
- [10] <http://dg.cnsoc.org/upload/images/source/20160519164035385.jpg>.
- [11] Scarborough P, Appleby P N, Mizdrak A, et al. Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK[J]. Climatic change, 2014, 125(2): 179-192.
- [12] WWF, Institution of geographic science and natural resources research, Research on food waste of Cities in China. 2018.
- [13] <http://www.stats.gov.cn/tjsj/ndsj/2018/indexch.htm>.
- [14] Carbonstop, EF. Research Report of Energy-conservation appliances and carbon emission reduction on 2018 “Double 11” [R]. 2018.
- [15] Beijing Transport Institute. 2019 Beijing Transport Annual Report [R]. 2019.
- [16] Civil Aviation Administration of China. Statistical Bulletin of Civil Aviation Industry Development in 2018 [R]. 2019.
- [17] Yaros C C B R. Life Cycle Assessment for Three Types of Grocery Bags[J], 2007.
- [18] PRCEE. Research report on public low-carbon lifestyle in the context of Internet. [R]. 2019.

[19] iiMedia. 2018-2019 ChinaOnline Take-out industry analysis report [R].

http://www.sohu.com/a/314486023_800248.

[20] CNNIC. Statistical report on internet development in China [R]. 2019.

[21] China Environmental Protection Foundation, Cainiao Logistics, dt caijing. 2018 Research report on green logistics development in China [R], 2018.

[22] Cainiao Logistics. Research report on carbon emission reductions of Cainiao' s carton re-use [R]. 2018.

[23] Beijing Puplic Transportation Cooperation. CSR report 2018 [R]. 2019.