Global polyethylene terephthalate (PET) plastic supply chain resource metabolism efficiency and carbon emissions co-reduction strategies

SUPPORTING INFORMATION

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S1 Country region

Table S1 The ISO country ID and abbreviation of country names (ISO 3166-1 alpha-2).

Region	Abbreviation	Country Names	Country ID
Europe	EU	Austria	040
		Belgium	056
		Bulgaria	100
		Cyprus	196
		Czech Republic	203
		Croatia	191
		Denmark	208
		Estonia	233
		Finland	246
		France	250
		Germany	276
		Greece	300
		Hungary	348
		Ireland	372
		Italy	380
		Latvia	428
		Romania	642
		Lithuania	440
		Luxembourg	442
		Malta	470
		Netherlands	528
		Poland	616
		Portugal	620
		Slovakia	703
		Slovenia	705
		Spain	724
		Sweden	752
		United Kingdom	826
		Norway	578
		Switzerland	756
Australia	AU	Australia	036
America	US	United States	840
China	CH	China	156
Brazil	BR	Brazil	076
Mexico	MX	Mexico	484
South Africa	ZA	South Africa	710
India	IN	India	356
Indonesia	ID	Indonesia	360
Japan	JP	Japan	392
Thailand	TH	Thailand	764
Korea	KR	Korea	410

S2 Data for baseline scenario

S2.1 PET resin production

The resin production sources by country are as shown in Table S2.1.

Table S2.1 PET resin production by country

Country	Reference
China	[1,2]
America	[3]
Europe	[4]
Japan	[5]
Brazil	[6]
India	Estimated with PTA[7]
Thailand	Estimated with PTA[7]
Korea	[8]
Indonesia	Estimated with PTA[7]
Australia	[9]
Mexico	[10]
South Africa	Estimated with PTA[7]

S2.2 PET products manufacturing

PET resin, through processes such as injection molding, extrusion, and fiber production, can be made into products such as PET bottles, PET films, and PET fibers for use. The proportions of different products manufactured are shown in Table S2.2.

Table S2.2 Manufacturing proportion of PET products by country

Country	Type	Reference
China	PET bottle	[11,12]
	PET fibre	[13,15]
	PET film	[11,12]
	other	[11]
America	PET bottle	[14]
	PET fibre	[14]
	PET film	[14]
	other	[14]
Europe	PET bottle	[15]
	PET fibre	[16]
	PET film	[15]
	other	[15]
Japan	PET bottle	[17]
	PET fibre	[5]
	PET film	[17]
	other	[17]

Brazil	PET bottle	[7]
	PET fibre	[7]
	PET film	[7]
	other	[7]
India	PET bottle	[18]
	PET fibre	[19]
	PET film	[18]
	other	[18]
Thailand	PET bottle	[7]
	PET fibre	[7,13]
	PET film	[7]
	other	[7]
Korea	PET bottle	[20]
	PET fibre	[21]
	PET film	[22]
	other	[7]
Indonesia	PET bottle	[7]
	PET fibre	[7]
	PET film	[7]
	other	[7]
Australia	PET bottle	Use global data to approximate
	PET fibre	Use global data to approximate
	PET film	Use global data to approximate
	other	Use global data to approximate
Mexico	PET bottle	[7]
	PET fibre	[7]
	PET film	[7]
	other	[7]
South Africa	PET bottle	Use global data to approximate
	PET fibre	Use global data to approximate
	PET film	Use global data to approximate
	other	Use global data to approximate

S2.3 PET demand anal growth rate

We have collected the consumption growth rates of PET products in various countries, as shown in Table S2.3.

Table S2.3 Growth rate of PET product demand by country

Country	Products	Reference
Europe	PET bottle	[23,24]
	PET film	[15,25,26]
	PET fibre	[27]
	other PET product	[15,25]
Korea	PET bottle	[26]
	PET film	[22]
	PET fibre	[21]
	other PET product	[28]
japan	PET bottle	[5]
	PET film	[22]
	PET fibre	[22]
	other PET product	[22]
America	PET bottle	[26]
	PET film	[22]
	PET fibre	[29]
	other PET product	[16]
China	PET bottle	[30]
	PET film	[30]
	PET fibre	[30]
	other PET product	[30]
Thailand	PET bottle	[26]
	PET film	[22]
	PET fibre	[29]
	other PET product	[22]
India	PET bottle	[26]
	PET film	[22]
	PET fibre	[18]
	other PET product	[22]
Indonesia	PET bottle	[26]
	PET film	[22]
	PET fibre	[29]
	other PET product	[22]
Mexico	PET bottle	[26]
	PET film	[22]
	PET fibre	[29]
	other PET product	[22]
Brazil	PET bottle	[26]
	PET film	[22]
	PET fibre	[29]
	other PET product	[22]

South Africa	PET bottle	[26]
	PET film	[22]
	PET fibre	[29]
	other PET product	[22]
Australia	PET bottle	[9]
	PET film	[9]
	PET fibre	[9]
	other PET product	[9]

S2.4 Collection

The collection rate is defined as, $\frac{\text{kg PET products in collection source−separated}}{\text{kg total use waste}}$

The collection rates are shown in Table S2.4.

Table S2.4 Collection rates of PET products by country

Country	Type	Reference
China	PET bottle	[11]
	PET fibre	[31]
	PET film	[11]
America	PET bottle	[32]
	PET fibre	[31]
	PET film	[33]
Europe	PET bottle	[15,25]
	PET fibre	[31]
	PET film	[34–36]
Japan	PET bottle	[17]
	PET fibre	[31]
	PET film	[17]
Brazil	PET bottle	[37]
	PET fibre	[31]
	PET film	[37]
India	PET bottle	[38]
	PET fibre	[31]
	PET film	[38]
Thailand	PET bottle	[39]
	PET fibre	[31]
	PET film	[39]
Korea	PET bottle	[40,41]
	PET fibre	[31]
	PET film	[40,41]
Indonesia	PET bottle	[38]
	PET fibre	[31]
	PET film	[38]
Australia	PET bottle	[9,42]
	PET fibre	[31]
	PET film	[9,42]

Mexico	PET bottle	[43]
	PET fibre	[31]
	PET film	[43]
South Africa	PET bottle	[44]
	PET fibre	[31]
	PET film	[44]

S2.5 Sorting

Material Recovery Facilities (MRFs, also known as sorting plants) and recycling plants are two key stages in the plastic mechanical recycling value chain. MRFs receive collected waste and further sort it into specific streams (e.g, bales)[45].

The sorting rate was defined at，$\frac{\text{kg PET in bales}}{\text{kg PET products in MRF}}$

The 80% average sorting rate for PET bottles in the BAU (Business as Usual) scenario is based on a broad literature review, where the values we found range between 70% and 98%. [46–56]。

S2.6 Recycling

The recycling rate was defined at，$\frac{\text{kg of PET flakes}}{\text{kg PET in the bales input}}$

The recycling efficiencies of various countries are shown in Table S2.5:

Table S2.5 Recycling efficiency by country

Country	Reference
China	[57]
America	[55]
Europe	[15,34,36,58,59]
Japan	[60]
Brazil	[61]
India	[38]
Thailand	[62,63]
Korea	[40,41,64]
Indonesia	[38]
Australia	[65]
Mexico	[55]
South Africa	[44]

S2.7 Disposal

We simulated two different final disposal methods: incineration and landfill. The incineration and landfill rates of various countries are shown in Table S2.6. We assume that all incineration plants can recover electricity from combustion (except for

open burning), and Table S2.7 shows the electricity recovery efficiencies by countries.

Table S2.6 Incineration and landfill rates

Country	reference
China	[11,66,67]
America	[33]
Europe	[34]
Japan	[68]
Brazil	[37,69,70]
India	[38,71]
Thailand	[62,63,72]
Korea	[41,73]
Indonesia	[38]
Australia	[9]
Mexico	[74]
South Africa	[44,75]

Table S2.7 Incineration efficiency

Country	Reference
China	[76]
America	[77]
Europe	[46]
Japan	[78]
Brazil	[79]
India	[80]
Thailand	[81]
Korea	[82]
Indonesia	[83]
Australia	[84]
Mexico	[85]
South Africa	[86]

S2.8 Energy

The composition of energy is informed by the forecasts for each country as outlined in the GECO 2018 report[87]. We have adopted these projections, aligning with the Nationally Determined Contributions (NDC) policies, to accurately depict the anticipated shifts in the energy structures of various nations.

S2.9 Trade data

The trade data in this paper primarily originates from the United Nations Trade Database[88], which compiles 58 specific PET trade commodities with their trade codes and PET contents, as shown in Table S2.8. In the database, the commodity trade flow from Country A to Country B is reported twice: once as Country A imports into Country B (reported as imports) and once as exports from Country A to Country B

(reported as exports). In theory, these should be equal, but in practice, they often differ. We analyze the trade by using the average of the reported import and export data.

Table S2.8 PET commodity codes and contents

Type	Code	Comments
PET resin	390761	1
	390769	1
PET bottle	392330	0.64
PET film	391910	0.12
	391990	0.12
	392062	1
	392099	0.12
	392119	0.3
	392190	0.12
	392063	0.12
	392069	0.12
PET fibre	550120	1
	550320	1
	550620	1
	550921	0.85
	550922	0.85
	550951	0.65
	550952	0.33
	550953	0.33
	550959	0.33
	550390	0.85
	550510	0.85
	551211	0.85
	551219	0.85
	551311	0.33
	551312	0.65
	551313	0.33
	551321	0.33
	551323	0.65
	551331	0.65
	551339	0.65
	551341	0.33
	551349	0.33
	551411	0.33
	551412	0.65
	551419	0.65
	551421	0.65
	551422	0.65
	551423	0.33
	551429	0.33

	551430	0.65
	551441	0.33
	551442	0.65
	540110	0.33
	540233	1
	540247	1
	540262	1
	551512	0.33
PET fibre	551519	0.33
	551449	0.33
	540220	1
	540246	1
	540252	1
	540419	1
	551511	0.33
	551513	0.33
	551443	0.33
PET waste	3915	S2.9

Table S2.9 Plastic waste content

Country	**Proportion of plastic types (PE:PS:PVC:PET:PP:other)**	**Reference**
China	0.170:0.019:0.145:0.233:0.140:0.293	[89]
Japan	0.231:0.073:0.158:0.037:0.221:0.280	[90]
America	0.386:0.083:0.038:0.118:0.185:0.190	[91]
Europe	0.298:0.066:0.102:0.074:0.193:0.267	[34]
Thailand	0.462:0.048:0.041:0.183:0.266:0	[92]
Indonesia	0.462:0.048:0.041:0.183:0.266:0	[92]
Korea	0.462:0.048:0.041:0.183:0.266:0	[92]
Mexico	0.462:0.048:0.041:0.183:0.266:0	[92]
Other Countries	0.462:0.048:0.041:0.183:0.266:0	[92]

S3 Data used in remaining scenario

In this chapter, we will describe how the data from S0 is modified in each scenario and the basis for these modifications.

S1: Improvement of Collection

Various countries have introduced policies regarding PET plastic recycling by the year 2030. The European Union has issued directives such as the Packaging and Packaging Waste Directive (PPWD) and the Single-Use Plastics (SUP) Directive, indicating targets for plastic packaging recycling to reach 50% by 2025 and increase to 55% by 2030. It also mandates a collection target for PET bottles to reach 77% by 2030. Additionally, this directive introduces mandatory requirements for the recycled content of PET bottles. The relevant organizations in the United States (federal, non-governmental, environmental, industrial) have committed to increasing the PET bottle recycling rate to 50% by 2030. Japan has announced plans to reduce disposable plastic waste generation by 25% by 2030 and achieve a reuse/recycling rate of plastic containers at 60%[93]. By 2035, Japan aims to achieve a 100% utilization rate for all plastic waste, including energy recovery. To address the plastic waste issue, South Korea has set a goal of transitioning to a "plastic-free society" [73]. This plan aims to reduce plastic waste by 20% by 2025, increase the recycling rate to 70%, and recycle 30% of the materials[41].The Australian Packaging Covenant Organisation (APCO) has proposed the Australian Packaging Covenant. At the national level, Australia has also announced plans to achieve a 70% plastic packaging recycling rate, a 50% average recyclable content for packaging, and to gradually phase out problematic and unnecessary single-use plastic packaging. The Mexican PET Plastic Association (MexBeb) has pledged to recycle 80% of PET by 2030.India is the only Asian country to have issued a plastic pact, committing to achieve 100% plastic recycling. On a global scale, according to the Plastic Cycle Industry Alliance's Green Action White Paper (2022) (The abbreviation for the White Paper), advancements in global waste plastic recycling and regeneration technologies, coupled with increased capacity, are expected to result in a global waste plastic recycling rate of 50% by 2030. We assumes that the collection rates of PET bottles and PET films are calculated based on the commitments of each country. For countries that have not made relevant commitments, calculations are made based on the White Paper. The specific data is shown in the table S3.1.

The recycling and reuse of PET fiber textiles are the most challenging among discarded PET products, due to the presence of numerous impurities, dyes, moisture

content, and gel particles [31]. The recycling rate of PET fiber is only 14.40%. Because PET fiber is considered low-quality recycled material, significant development of chemical recycling processes for PET fiber is needed to achieve large-scale recycling. However, most relevant chemical research currently remains at the laboratory stage, with a considerable distance from practical application. Therefore, we assume that the recycling rate of fibers remains unchanged from 2020 to 2030.

Table S3.1 Change of collection rate in 2020-2030

Year	Europe			Korea			Japan		
	Bottles	**Films**	**Fibre**	**Bottles**	**Films**	**Fibre**	**Bottles**	**Films**	**Fibre**
2020	0.65	0.7	0.144	0.8	0.43	0.144	0.92	0.68	0.144
2021	0.675	0.717	0.144	0.809	0.457	0.144	0.927	0.695	0.144
2022	0.7	0.734	0.144	0.818	0.484	0.144	0.934	0.71	0.144
2023	0.725	0.751	0.144	0.827	0.511	0.144	0.941	0.725	0.144
2024	0.75	0.768	0.144	0.836	0.538	0.144	0.948	0.74	0.144
2025	0.775	0.785	0.144	0.845	0.565	0.144	0.955	0.755	0.144
2026	0.8	0.802	0.144	0.854	0.592	0.144	0.962	0.77	0.144
2027	0.825	0.819	0.144	0.863	0.619	0.144	0.969	0.785	0.144
2028	0.85	0.836	0.144	0.872	0.646	0.144	0.976	0.8	0.144
2029	0.875	0.853	0.144	0.881	0.673	0.144	0.983	0.815	0.144
2030	0.9	0.87	0.144	0.89	0.7	0.144	0.99	0.83	0.144
Year	**America**			**China**			**Thailand**		
	Bottles	**Films**	**Fibre**	**Bottles**	**Films**	**Fibre**	**Bottles**	**Films**	**Fibre**
2020	0.266	0.19	0.144	0.91	0.37	0.144	0.25	0.25	0.144
2021	0.2894	0.221	0.144	0.914	0.383	0.144	0.275	0.275	0.144
2022	0.3128	0.252	0.144	0.918	0.396	0.144	0.3	0.3	0.144
2023	0.3362	0.283	0.144	0.922	0.409	0.144	0.325	0.325	0.144
2024	0.3596	0.314	0.144	0.926	0.422	0.144	0.35	0.35	0.144
2025	0.383	0.345	0.144	0.93	0.435	0.144	0.375	0.375	0.144
2026	0.4064	0.376	0.144	0.934	0.448	0.144	0.4	0.4	0.144
2027	0.4298	0.407	0.144	0.938	0.461	0.144	0.425	0.425	0.144
2028	0.4532	0.438	0.144	0.942	0.474	0.144	0.45	0.45	0.144
2029	0.4766	0.469	0.144	0.946	0.487	0.144	0.475	0.475	0.144
2030	0.5	0.5	0.144	0.95	0.5	0.144	0.5	0.5	0.144
Year	**India**			**Indonesia**			**Mexico**		
	Bottles	**Films**	**Fibre**	**Bottles**	**Films**	**Fibre**	**Bottles**	**Films**	**Fibre**
2020	0.9	0.6	0.144	0.31	0.31	0.144	0.6	0.6	0.144
2021	0.905	0.623	0.144	0.329	0.329	0.144	0.62	0.62	0.144
2022	0.91	0.646	0.144	0.348	0.348	0.144	0.64	0.64	0.144
2023	0.915	0.669	0.144	0.367	0.367	0.144	0.66	0.66	0.144
2024	0.92	0.692	0.144	0.386	0.386	0.144	0.68	0.68	0.144
2025	0.925	0.715	0.144	0.405	0.405	0.144	0.7	0.7	0.144
2026	0.93	0.738	0.144	0.424	0.424	0.144	0.72	0.72	0.144
2027	0.935	0.761	0.144	0.443	0.443	0.144	0.74	0.74	0.144
2028	0.94	0.784	0.144	0.462	0.462	0.144	0.76	0.76	0.144
2029	0.945	0.807	0.144	0.481	0.481	0.144	0.78	0.78	0.144
2030	0.95	0.83	0.144	0.5	0.5	0.144	0.8	0.8	0.144

Year	Brazil			South Africa			Australia		
	Bottles	Films	Fibre	Bottles	Films	Fibre	Bottles	Films	Fibre
2020	0.564	0.045	0.144	0.289	0.15	0.144	0.228	0.228	0.144
2021	0.5776	0.0905	0.144	0.3101	0.185	0.144	0.2752	0.2752	0.144
2022	0.5912	0.136	0.144	0.3312	0.22	0.144	0.3224	0.3224	0.144
2023	0.6048	0.1815	0.144	0.3523	0.255	0.144	0.3696	0.3696	0.144
2024	0.6184	0.227	0.144	0.3734	0.29	0.144	0.4168	0.4168	0.144
2025	0.632	0.2725	0.144	0.3945	0.325	0.144	0.464	0.464	0.144
2026	0.6456	0.318	0.144	0.4156	0.36	0.144	0.5112	0.5112	0.144
2027	0.6592	0.3635	0.144	0.4367	0.395	0.144	0.5584	0.5584	0.144
2028	0.6728	0.409	0.144	0.4578	0.43	0.144	0.6056	0.6056	0.144
2029	0.6864	0.4545	0.144	0.4789	0.465	0.144	0.6528	0.6528	0.144
2030	0.7	0.5	0.144	0.5	0.5	0.144	0.7	0.7	0.144

S2：Improvement of Sorting

Long-term studies on various plastic recyclers have shown that sorting efficiency at these facilities increases by 1% each year[46]. This finding has been adopted as an assumption for our analysis, as detailed in the table S3.2.

Table S3.2 Change of sorting rate in 2020-2030

Year	Sorting rate	Year	Sorting rate
2020	0.8	2025	0.86
2021	0.81	2026	0.87
2022	0.82	2027	0.88
2023	0.83	2028	0.89
2024	0.84	2029	0.9
2025	0.85	2030	0.91

S3：Improvement of recycling

Long-term studies on various plastic recyclers have shown that recycling efficiency at these facilities increases by 0.5% [46]. Consequently, we've incorporated this finding into our assumptions, as detailed in the table S3.3.

Table S3.3 Change of recycling efficiency in 2020-2030

Year	Europe	Korea	Japan	America	China	Thailand
2020	0.88	0.68	0.705	0.655	0.835	0.6
2021	0.885	0.685	0.71	0.66	0.84	0.605
2022	0.89	0.69	0.715	0.665	0.845	0.61
2023	0.895	0.695	0.72	0.67	0.85	0.615
2024	0.9	0.7	0.725	0.675	0.855	0.62
2025	0.905	0.705	0.73	0.68	0.86	0.625
2026	0.91	0.71	0.735	0.685	0.865	0.63
2027	0.915	0.715	0.74	0.69	0.87	0.635
2028	0.92	0.72	0.745	0.695	0.875	0.64
2029	0.925	0.725	0.75	0.7	0.88	0.645
2030	0.93	0.73	0.755	0.705	0.885	0.65

Year	India	Indonesia	Mexico	Brazil	South Africa	Australia
2020	0.7	0.7	0.807	0.8	0.767	0.925
2021	0.705	0.705	0.812	0.805	0.772	0.93
2022	0.71	0.71	0.817	0.81	0.777	0.935
2023	0.715	0.715	0.822	0.815	0.782	0.94
2024	0.72	0.72	0.827	0.82	0.787	0.945
2025	0.725	0.725	0.832	0.825	0.792	0.95
2026	0.73	0.73	0.837	0.83	0.797	0.955
2027	0.735	0.735	0.842	0.835	0.802	0.96
2028	0.74	0.74	0.847	0.84	0.807	0.965
2029	0.745	0.745	0.852	0.845	0.812	0.97
2030	0.75	0.75	0.857	0.85	0.817	0.975

S4：Improvement of incineration with energy recovery

As countries increasingly prioritize plastic waste resource utilization and waste reduction, the quantity of landfilling is expected to decrease. The changes in the incineration and landfill rates for various countries are shown in the table S3.4.

Table S3.4 Change of incineration and landfalling rate in 2020-2030

Year	Europe		Korea		Japan		America	
	INC rate	LF rate	INC rate	LF rate	INC rate	LF rate	INC rate	LF rate
2020	0.64	0.36	0.76	0.24	0.885	0.115	0.19	0.81
2021	0.6573	0.3427	0.768	0.232	0.8965	0.1035	0.217	0.783
2022	0.6746	0.3254	0.776	0.224	0.908	0.092	0.244	0.756
2023	0.6919	0.3081	0.784	0.216	0.9195	0.0805	0.271	0.729
2024	0.7092	0.2908	0.792	0.208	0.931	0.069	0.298	0.702
2025	0.7265	0.2735	0.8	0.2	0.9425	0.0575	0.325	0.675
2026	0.7438	0.2562	0.808	0.192	0.954	0.046	0.352	0.648
2027	0.7611	0.2389	0.816	0.184	0.9655	0.0345	0.379	0.621
2028	0.7784	0.2216	0.824	0.176	0.977	0.023	0.406	0.594
2029	0.7957	0.2043	0.832	0.168	0.9885	0.0115	0.433	0.567
2030	0.813	0.187	0.84	0.16	1	0	0.46	0.54
Year	China		Thailand		India		Indonesia	
	INC rate	LF rate	INC rate	LF rate	INC rate	LF rate	INC rate	LF rate
2020	0.51	0.49	0.15	0.85	0	0.7	0	0.42
2021	0.539	0.461	0.165	0.835	0.03	0.7	0.03	0.448
2022	0.568	0.432	0.18	0.82	0.06	0.7	0.06	0.476
2023	0.597	0.403	0.195	0.805	0.09	0.7	0.09	0.504
2024	0.626	0.374	0.21	0.79	0.12	0.7	0.12	0.532
2025	0.655	0.345	0.225	0.775	0.15	0.7	0.15	0.56
2026	0.684	0.316	0.24	0.76	0.18	0.7	0.18	0.588
2027	0.713	0.287	0.255	0.745	0.21	0.7	0.21	0.616
2028	0.742	0.258	0.27	0.73	0.24	0.7	0.24	0.644
2029	0.771	0.229	0.285	0.715	0.27	0.7	0.27	0.672
2030	0.8	0.2	0.3	0.7	0.3	0.7	0.3	0.7

Year	Mexico		Brazil		South Africa		Australia	
	INC rate	LF rate	INC rate	LF rate	INC rate	LF rate	INC rate	LF rate
2020	0.05	0.95	0	1	0	1	0.35	0.65
2021	0.075	0.925	0.03	0.97	0.03	0.97	0.372	0.628
2022	0.1	0.9	0.06	0.94	0.06	0.94	0.394	0.606
2023	0.125	0.875	0.09	0.91	0.09	0.91	0.416	0.584
2024	0.15	0.85	0.12	0.88	0.12	0.88	0.438	0.562
2025	0.175	0.825	0.15	0.85	0.15	0.85	0.46	0.54
2026	0.2	0.8	0.18	0.82	0.18	0.82	0.482	0.518
2027	0.225	0.775	0.21	0.79	0.21	0.79	0.504	0.496
2028	0.25	0.75	0.24	0.76	0.24	0.76	0.526	0.474
2029	0.275	0.725	0.27	0.73	0.27	0.73	0.548	0.452
2030	0.3	0.7	0.3	0.7	0.3	0.7	0.57	0.43

S5：Ban the export of waste

More and more countries are banning the trade of waste, so we assume that by 2030, each country will manage its waste domestically without exporting it.

S6：Committing 100% to Strict Closed-Loop

Many companies and PET associations have expressed support for a closed-loop PET recycling system. A 100% closed loop entails that bottles are recycled into bottles, fibers into fibers, and films into films. If the secondary recycling market becomes saturated, excess materials are assumed to be landfilled.

S7：100% to fibers

100% recycling into fibers, the polyester industry becomes the sole end-market. When the demand for secondary PET saturates the polyester market, excess PET will be landfilled. For instance, this alternative scenario illustrates the prevalence of cheap primary materials flooding the PET market.

Below, we have established six comprehensive scenarios, taking into consideration the growth in PET demand.

S8：Improved waste management system + increasing demand

Combining scenarios S1-S5, and maintaining the growth rate of PET demand as experienced in 2020.

S9: Improved waste management system + constant demand（S9）

Combining scenarios S1-S5, and ensure that PET demand remains constant as it was in 2020 .

S10: Improved waste management system +100% to strict closed-loop + increasing demand（S10）

Combining scenarios S1-S5+S6, and maintaining the growth rate of PET demand

as experienced in 2020.

S11: Improved waste management system +100% to strict closed-loop + constant demand（S11）

Combining scenarios S1-S5+S6, and ensure that PET demand remains constant as it was in 2020 .

S12: Improved waste management system +100% to fibers + increasing demand（S12）

Combining scenarios S1-S5+S7, and maintaining the growth rate of PET demand as experienced in 2020.

S13: Improved waste management system +100% to fibers + constant demand（S13）

Combining scenarios S1-S5+S7, and ensure that PET demand remains constant as it was in 2020 .

S4 Life cycle assessment data

The data for the lifecycle processes mainly include PET resin production, PET product manufacturing, sorting and recycling, and incineration processes. Due to a lack of relevant lifecycle data in some countries, we harmonize the data based on the electricity and heat factors of each country. Table S4 provides the sources of lifecycle data.

Table S4 Sources of lifecycle data

Process	Description	Reference
PET resin production	Polyethylene terephthalate, granulate, amorphous {RER}| production | Cut-off, U	[94]
	Polyethylene terephthalate, granulate, amorphous {CA-QC}| production | Cut-off, U	[94]
	Polyethylene terephthalate, granulate, amorphous {Row}| production | Cut-off, U	[94]
	The production data of PET amorphous resin in the United States are from relevant literature.	[95]
	Only the heat and electricity are calculated, heat=1.29MJ, Electricity=0.189	[46]
Manufacturing	Stretch blow moulding {RER}| stretch blow moulding | Cut-off, U	[94]
	Stretch blow moulding {CA-QC}| stretch blow moulding | Cut-off, U	[94]
	Stretch blow moulding {RoW}| stretch blow moulding | Cut-off, U	[94]
	Extrusion, plastic film {RER}| extrusion, plastic film | Cut-off, U	[94]
	Extrusion, plastic film {CA-QC}| extrusion, plastic film | Cut-off, U	[94]
	Extrusion, plastic film {RoW}| extrusion, plastic film | Cut-off, U	[94]
	Fibre, polyester {IN}| polyester fibre production, finished | Cut-off, U	[94]
	Fibre, polyester {RoW}| polyester fibre production, finished | Cut-off, U	[94]
Sorting & Recycling	Sorting data for Europe are from relevant literature.	[96]
	Sorting data for America are from relevant literature.	[55]
	Waste polyethylene terephthalate, for recycling, sorted {CH}| treatment of waste polyethylene terephthalate, for recycling, unsorted, sorting | Cut-off, U	[94]
	Waste polyethylene terephthalate, for recycling, sorted {RoW}| treatment of waste polyethylene terephthalate, for recycling, unsorted, sorting | Cut-off, U	[94]
	polyethylene terephthalate production, granulate, amorphous, recycled {US} | Cut-off, U	[94]

Sorting & Recycling	Polyethylene terephthalate, granulate, amorphous, recycled {CH}| polyethylene terephthalate production, granulate, amorphous, recycled | Cut-off, U	[94]
	Polyethylene terephthalate, granulate, amorphous, recycled {Europe without Switzerland}| polyethylene terephthalate production, granulate, amorphous, recycled | Cut-off, U	[94]
	Polyethylene terephthalate, granulate, amorphous, recycled {RoW}| polyethylene terephthalate production, granulate, amorphous, recycled | Cut-off, U	[94]
Incineration	Waste polyethylene terephthalate {GLO}| treatment of waste polyethylene terephthalate, open burning | Cut-off, U	[94]
	Waste polyethylene terephthalate {CH}| treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U	[94]
	Waste polyethylene terephthalate {RoW}| treatment of waste polyethylene terephthalate, municipal incineration | Cut-off, U	[94]

S5 Data uncertainty assessment

Due to the scarcity of government and industry statistical records for the PET lifecycle data[97], it is inevitable that certain data or parameters need to be estimated, which may introduce some uncertainty to this study. Generally, emission factors show minimal fluctuation, resulting in relatively minor effects on the conclusions. Additionally, this study conducts sensitivity analyses on uncertain parameters (such as PET recycling rates, landfilling, incineration, emissions, etc.) and explores the impact of variations (increasing or decreasing by 10%) in these parameters on the results[98] (see Table S5). The research indicates that when these parameters vary within 10%, the changes in the results of this study are also within 10%, indicating that variations or uncertainties in these parameters have little effect on the research findings.

Table S5 Sensitivity and uncertainty analysis

Items	Production	PET fibre	PET bottles	PET films	PET other	Sorting	Mechanical recycling	Incineration
GHG after 10% increase in key parameters	271.18	158.97	91.34	9.18	3.31	27.52	44.37	63.47
Original value	246.53	144.52	83.04	8.34	3.01	25.02	40.33	57.7
GHG after 10% reduction of key parameters	221.87	130.07	74.73	7.51	2.71	22.51	36.3	51.93
Change rate of GHG after 10% increase	0.099987831	0.099986161	0.09995183	0.100719	0.099668	0.09992	0.100173568	0.1
Change rate of GHG after 10% reduction	-0.100028394	-0.099986161	-0.1000723	-0.09952	-0.09967	-0.10032	-0.099925614	-0.1

S6 Results by country

S6.1 Results for MFA

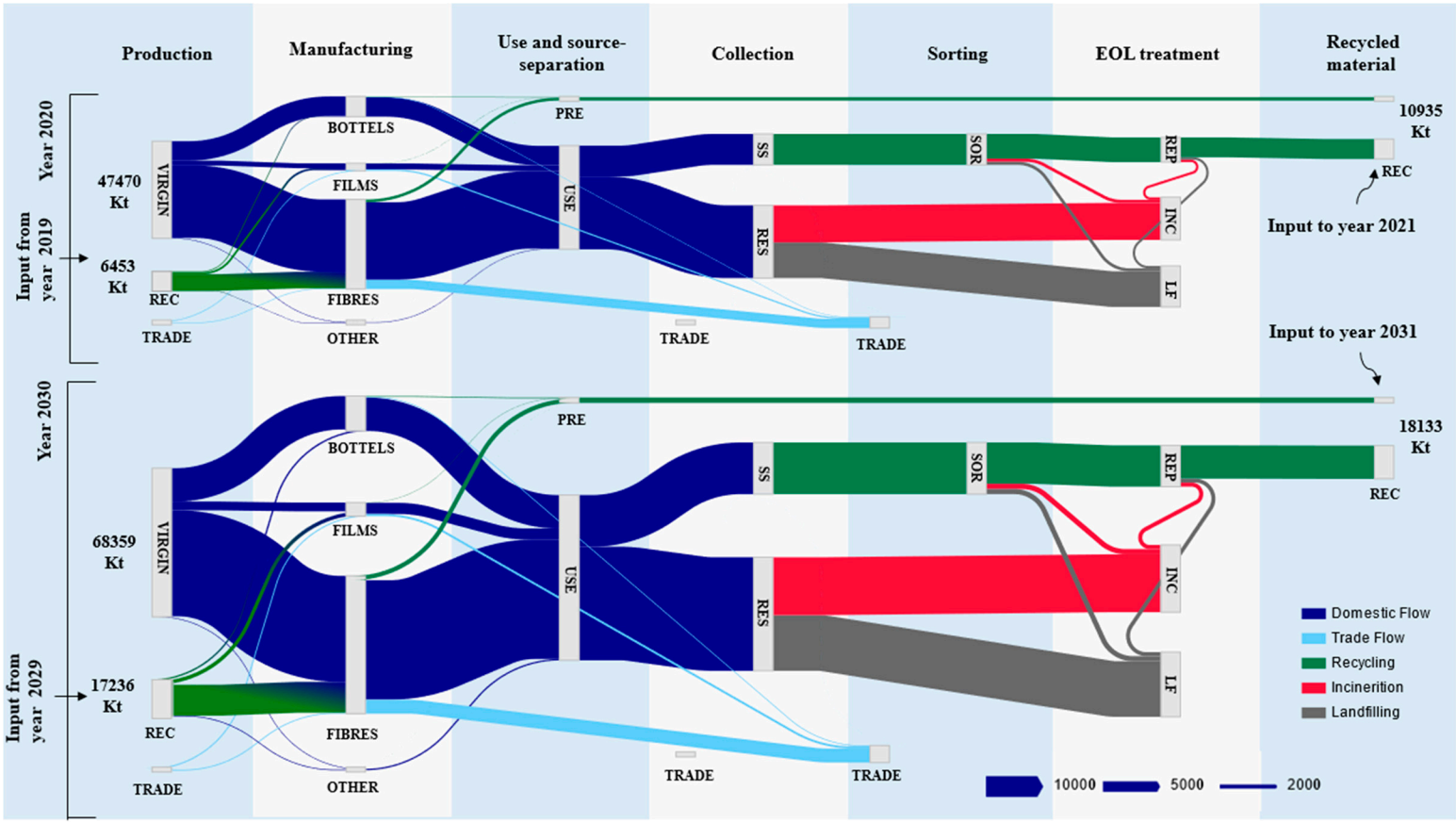


Figure S1.1 Sankey diagram for S0 in year 1 and year 30 in China.

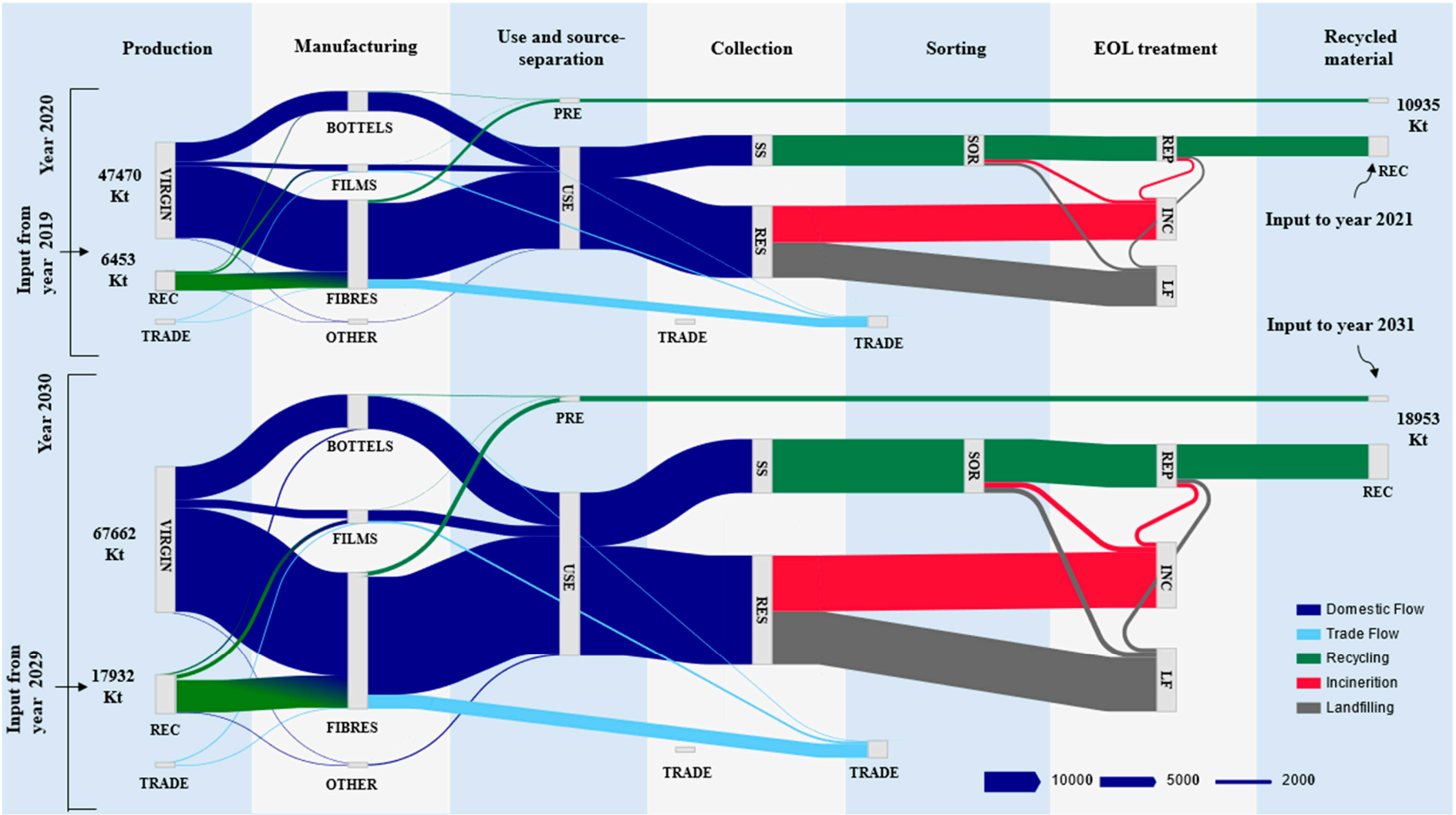


Figure S1.2 Sankey diagram for S1 in year 1 and year 30 in China.

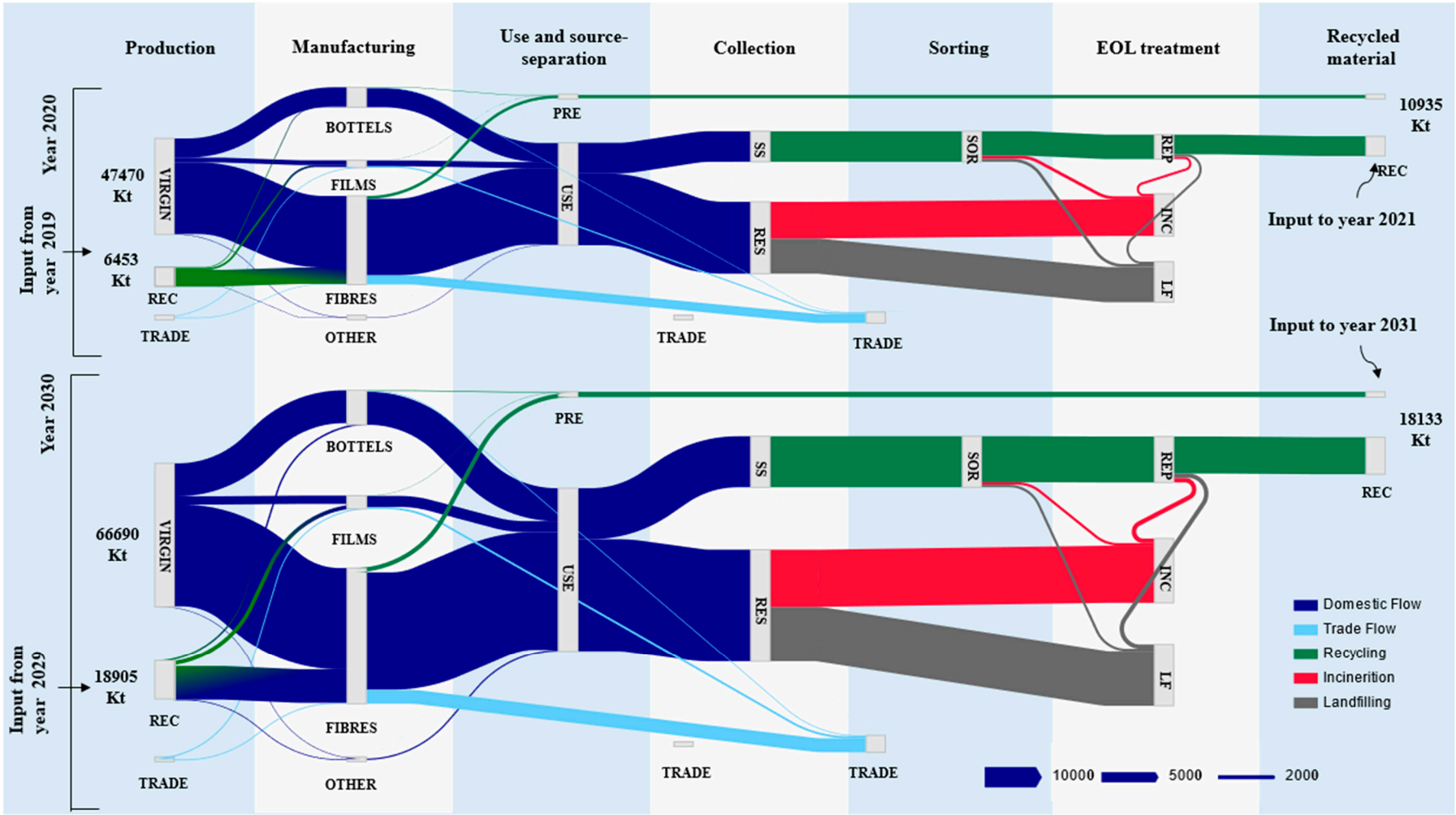


Figure S1.3 Sankey diagram for S2 in year 1 and year 30 in China.

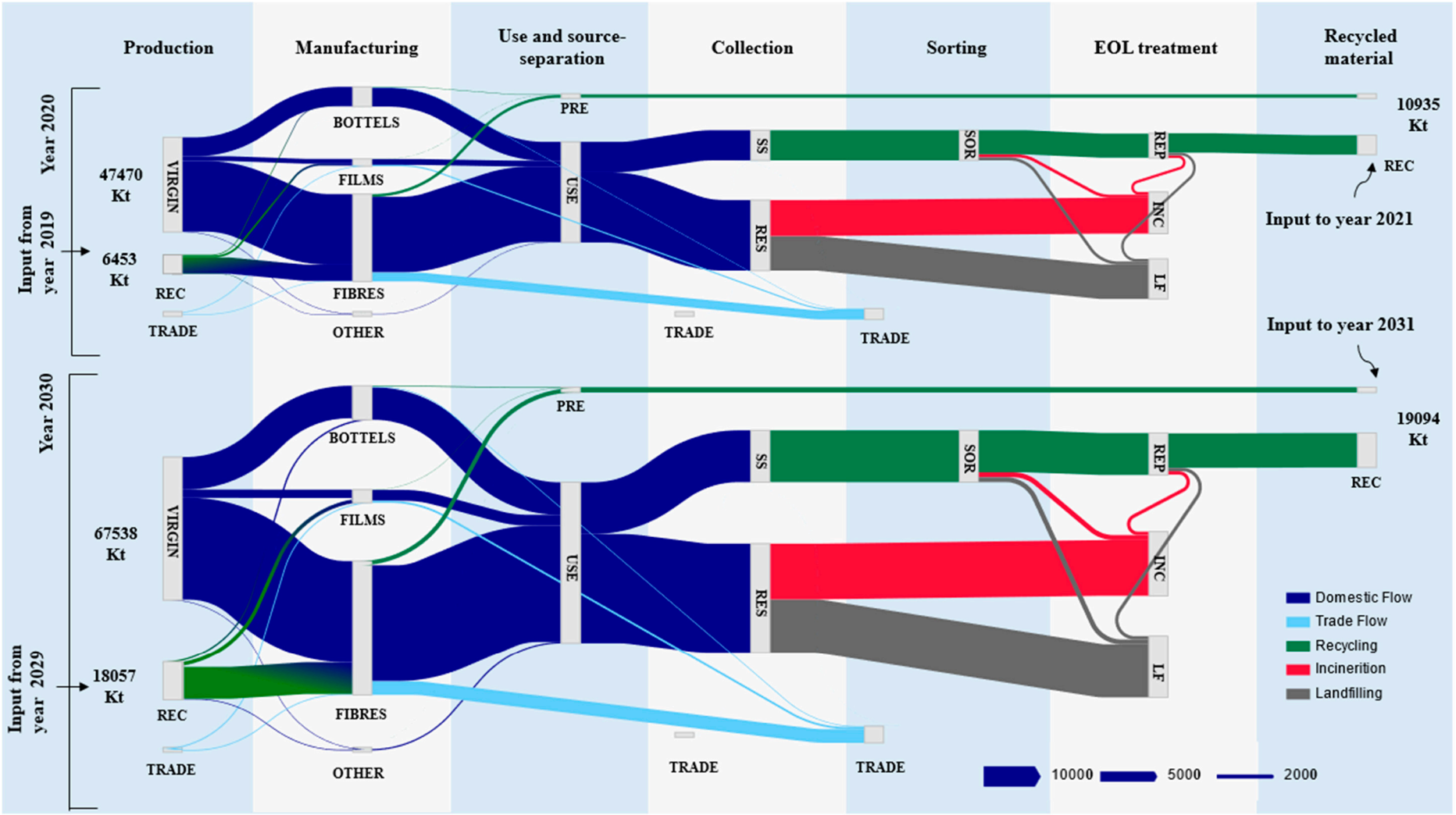


Figure S1.4 Sankey diagram for S3 in year 1 and year 30 in China.

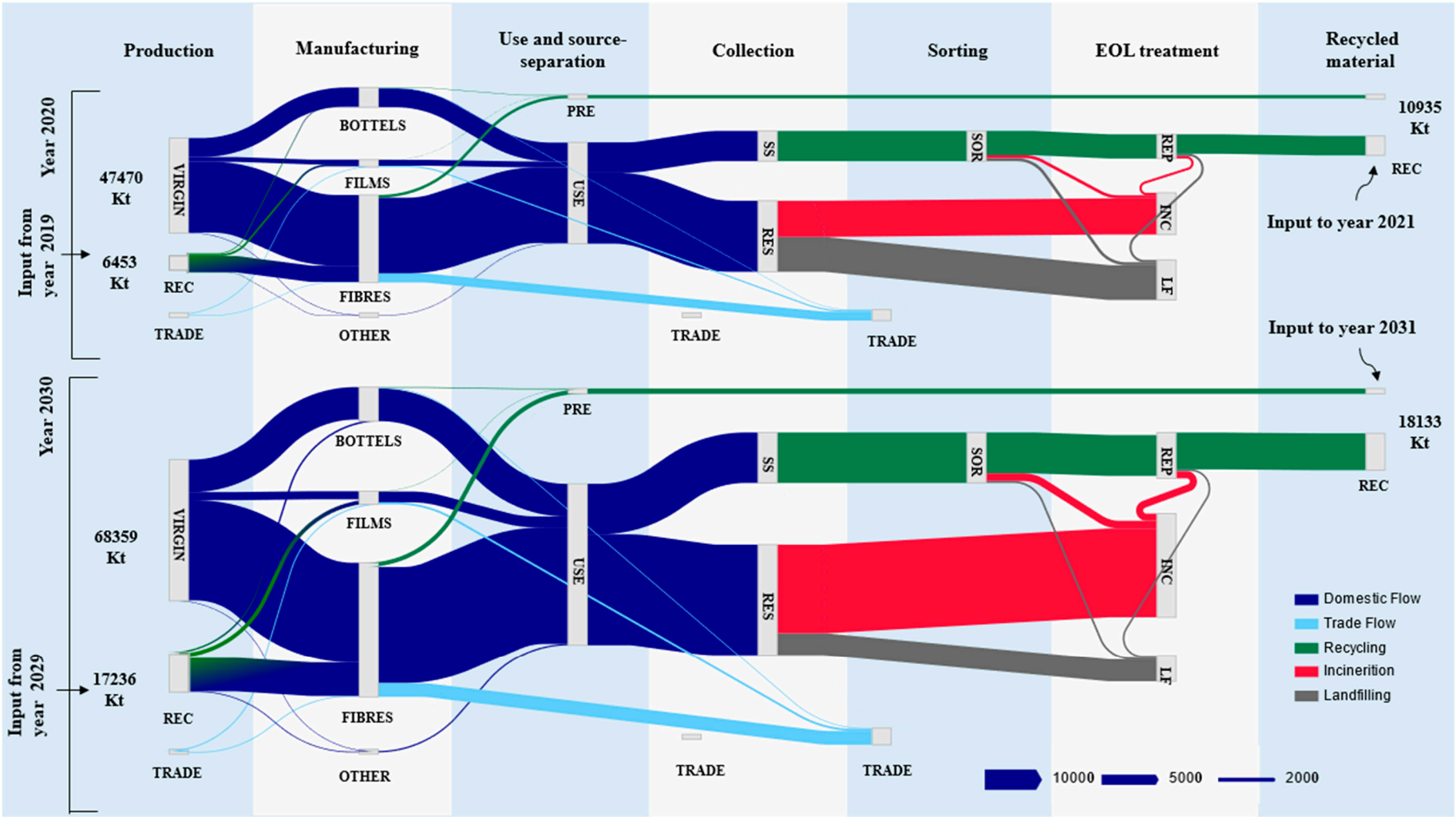


Figure S1.5 Sankey diagram for S4 in year 1 and year 30 in China.

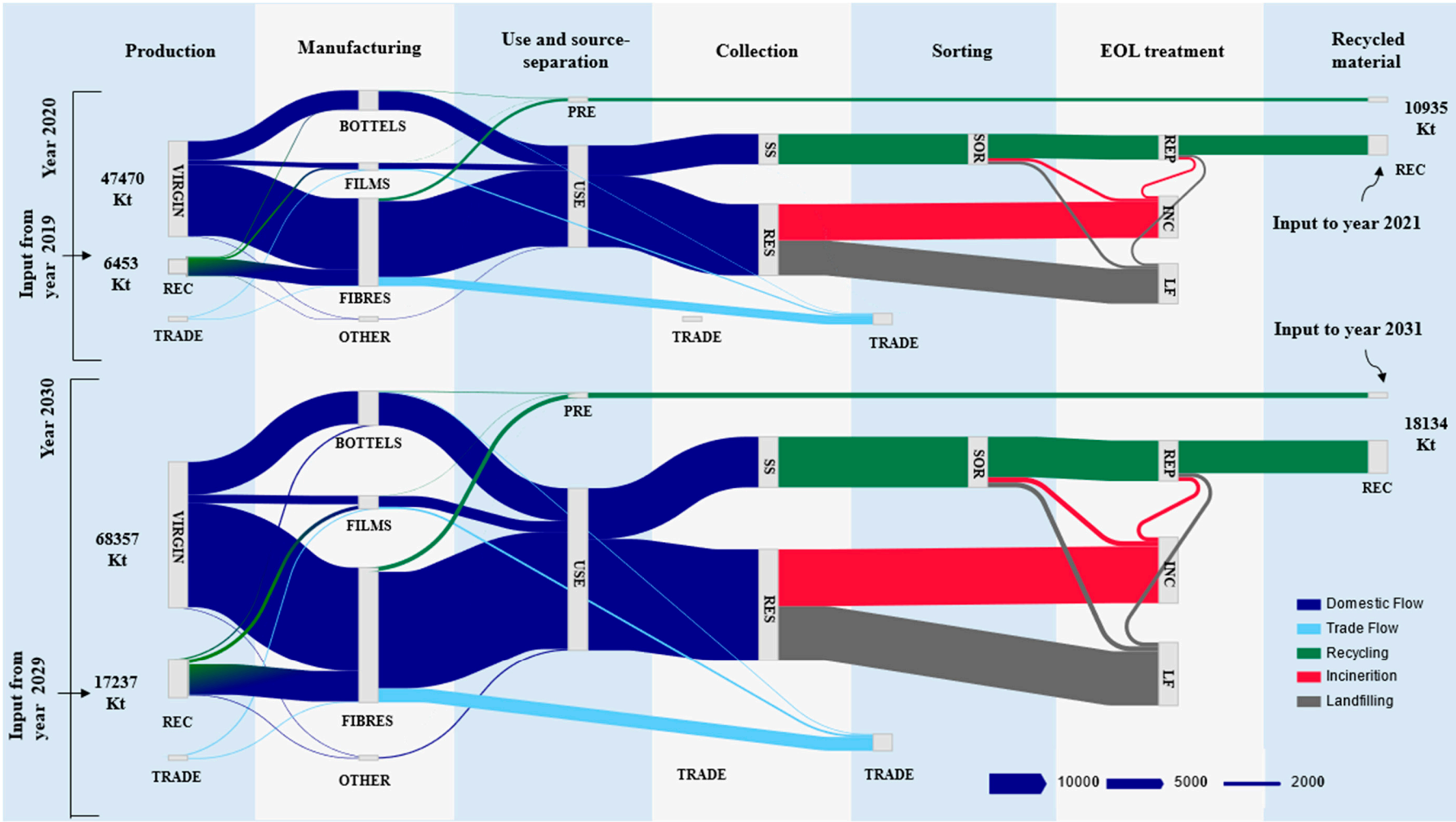


Figure S1.6 Sankey diagram for S5 in year 1 and year 30 in China.

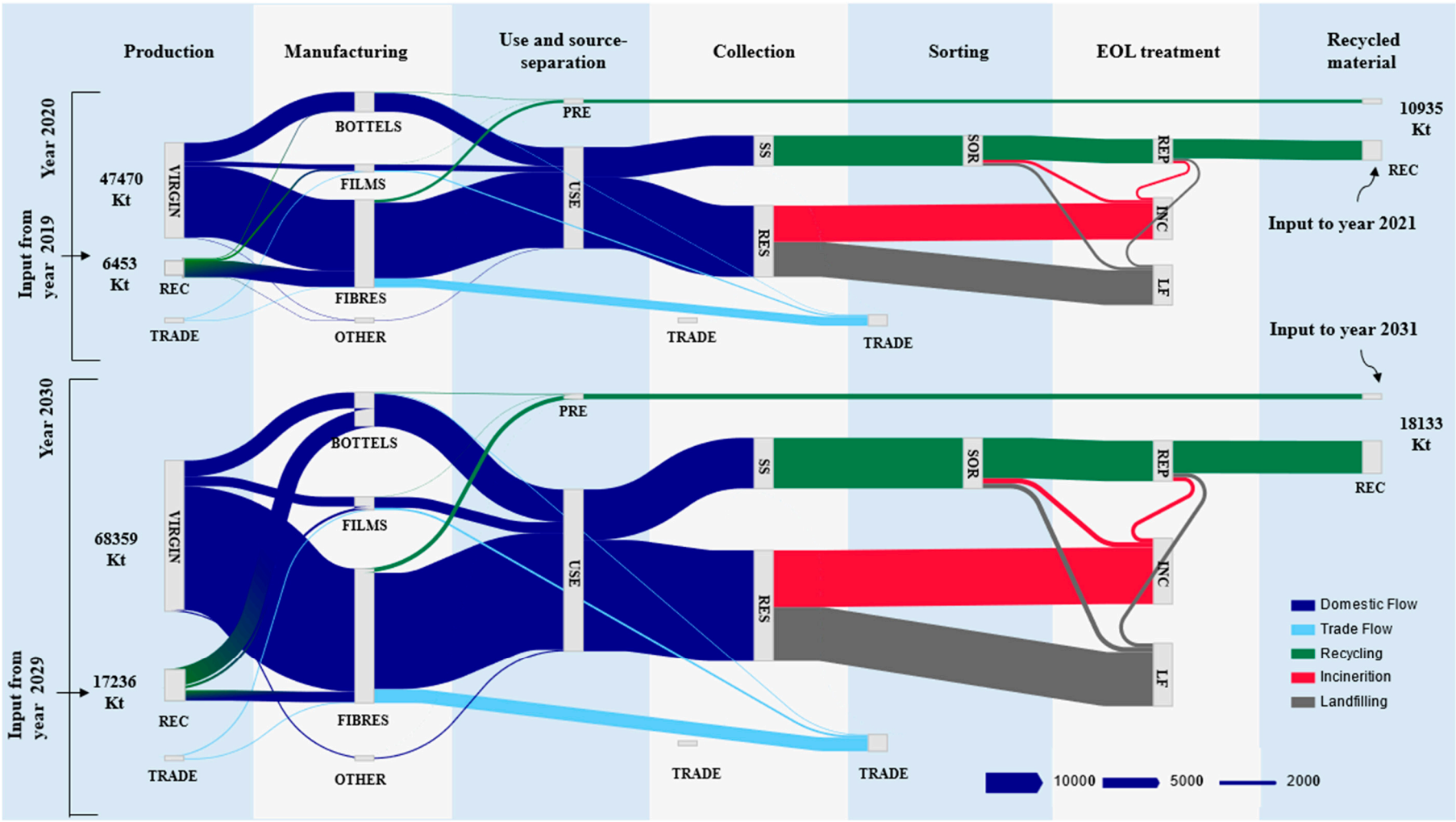


Figure S1.7 Sankey diagram for S6 in year 1 and year 30 in China.

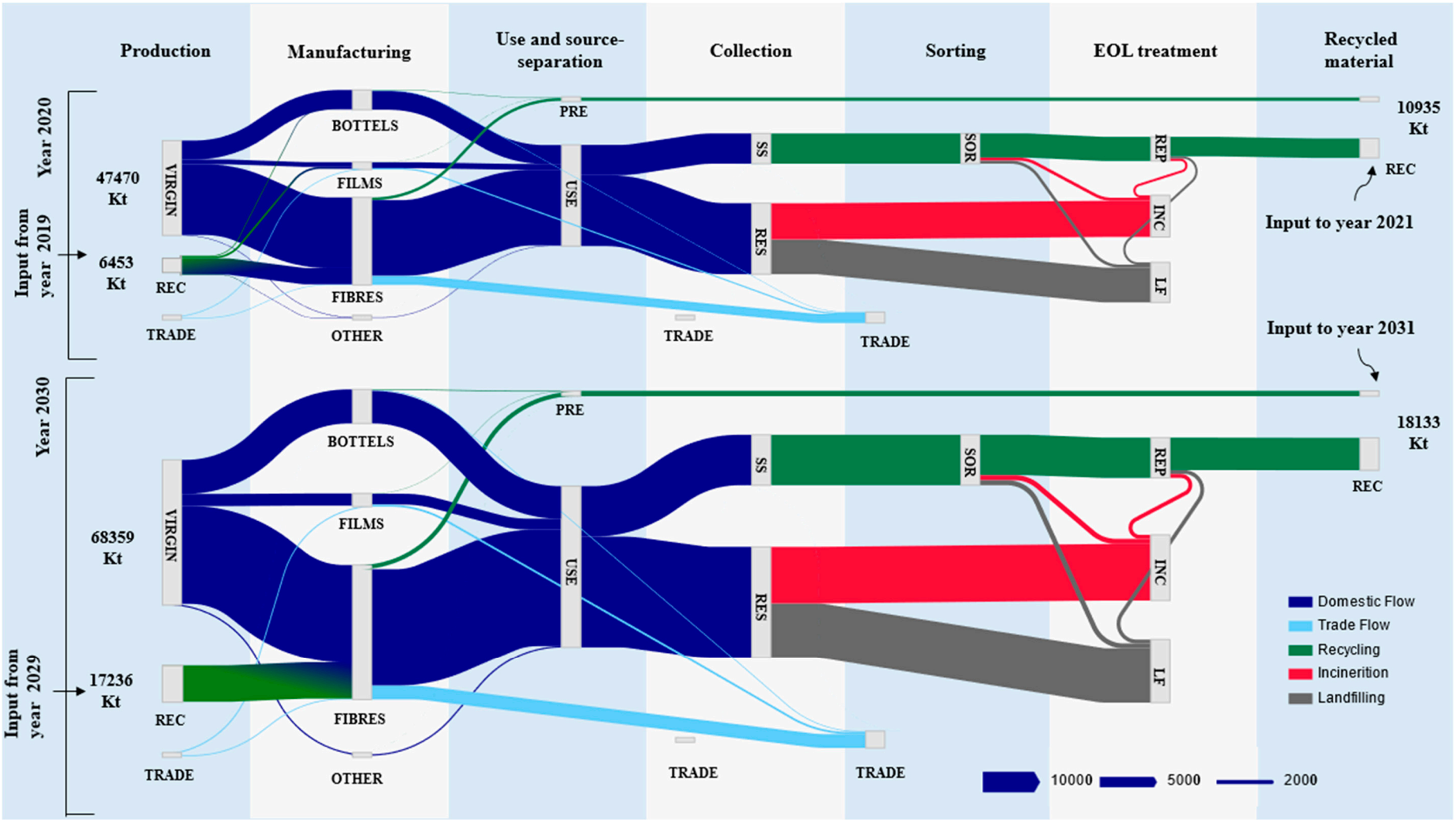


Figure S1.8 Sankey diagram for S7 in year 1 and year 30 in China.

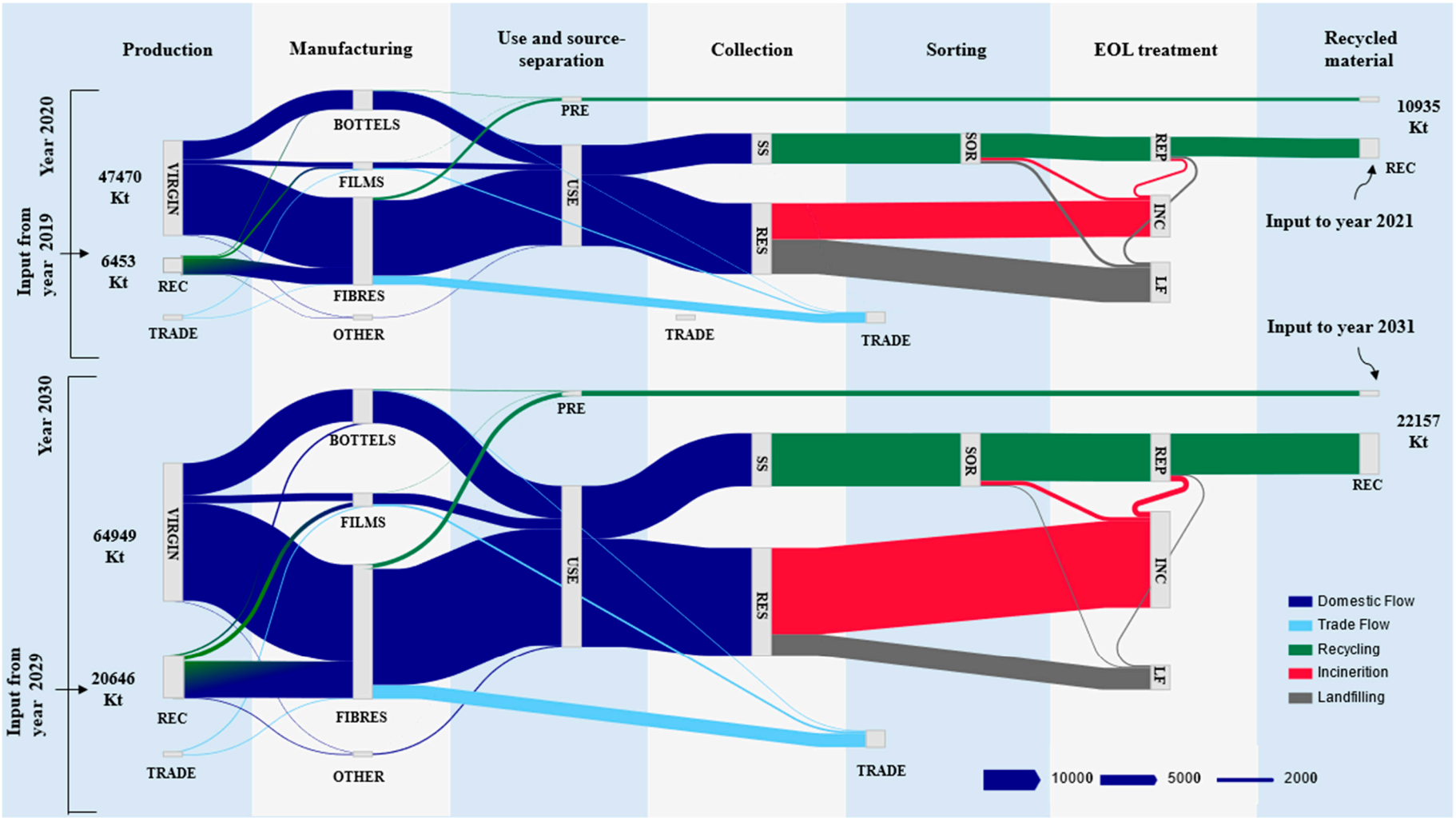


Figure S1.9 Sankey diagram for S8 in year 1 and year 30 in China.

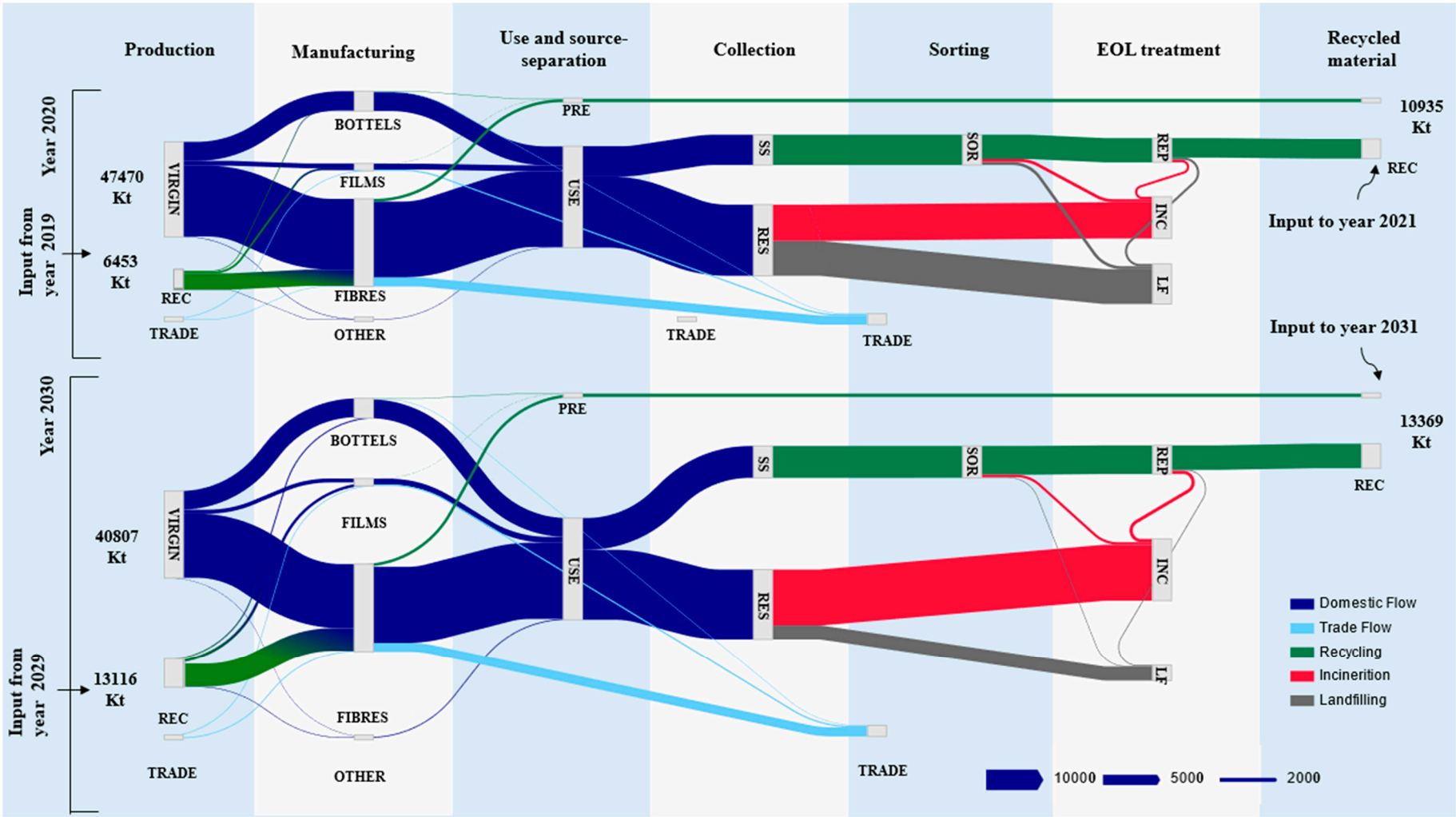


Figure S1.10 Sankey diagram for S9 in year 1 and year 30 in China.

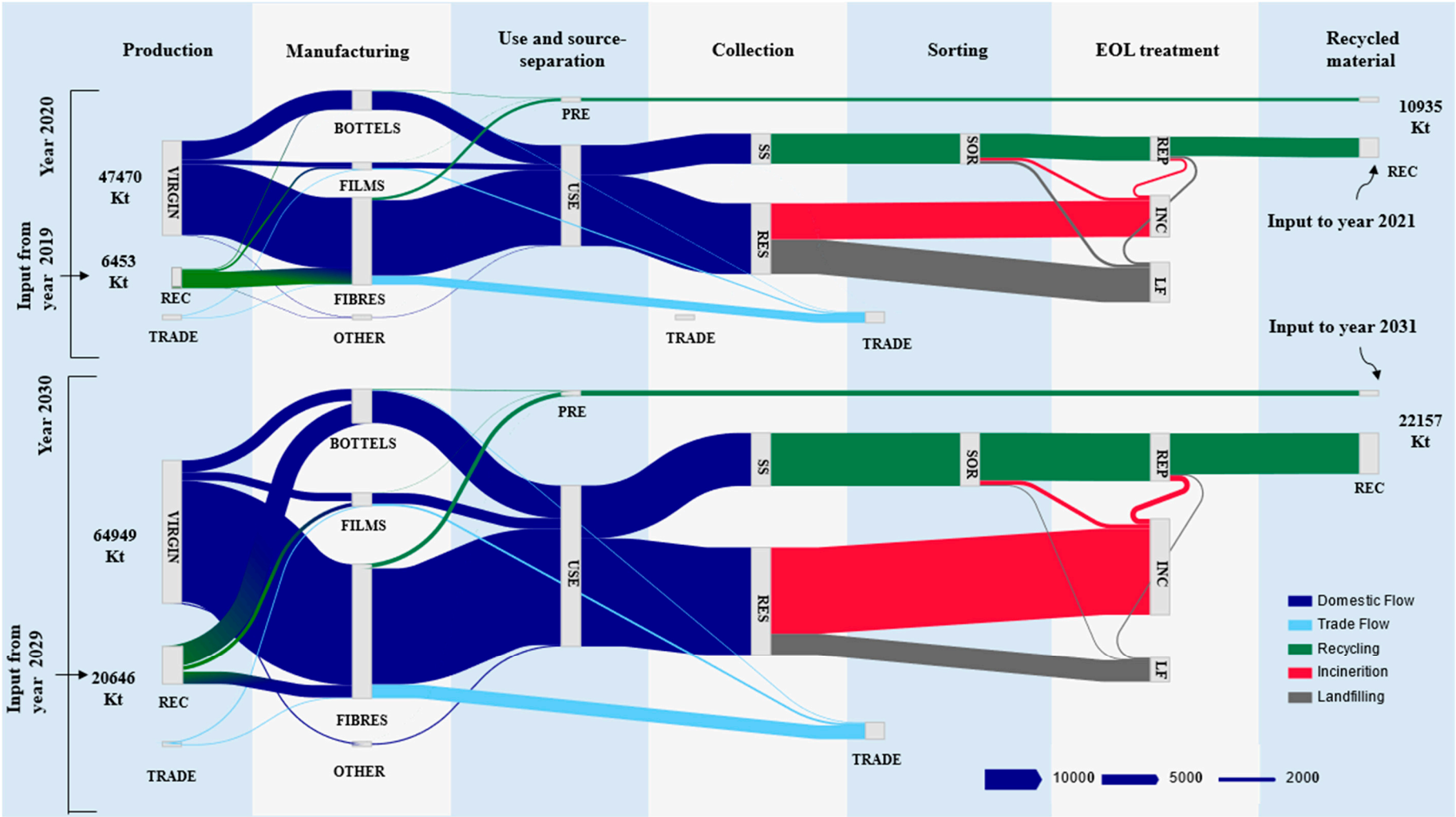


Figure S1.11 Sankey diagram for S10 in year 1 and year 30 in China.

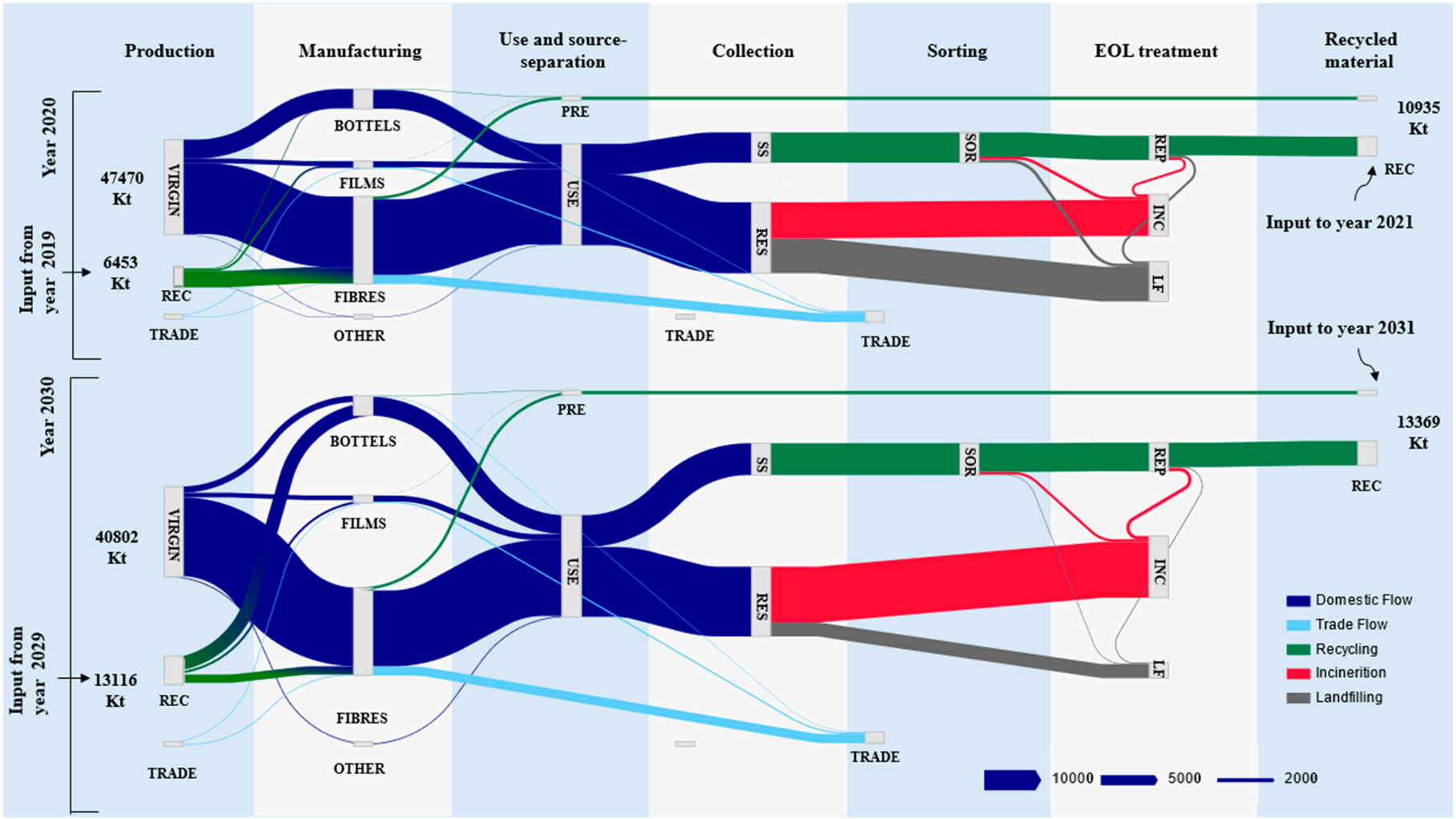


Figure S1.12 Sankey diagram for S11 in year 1 and year 30 in China.

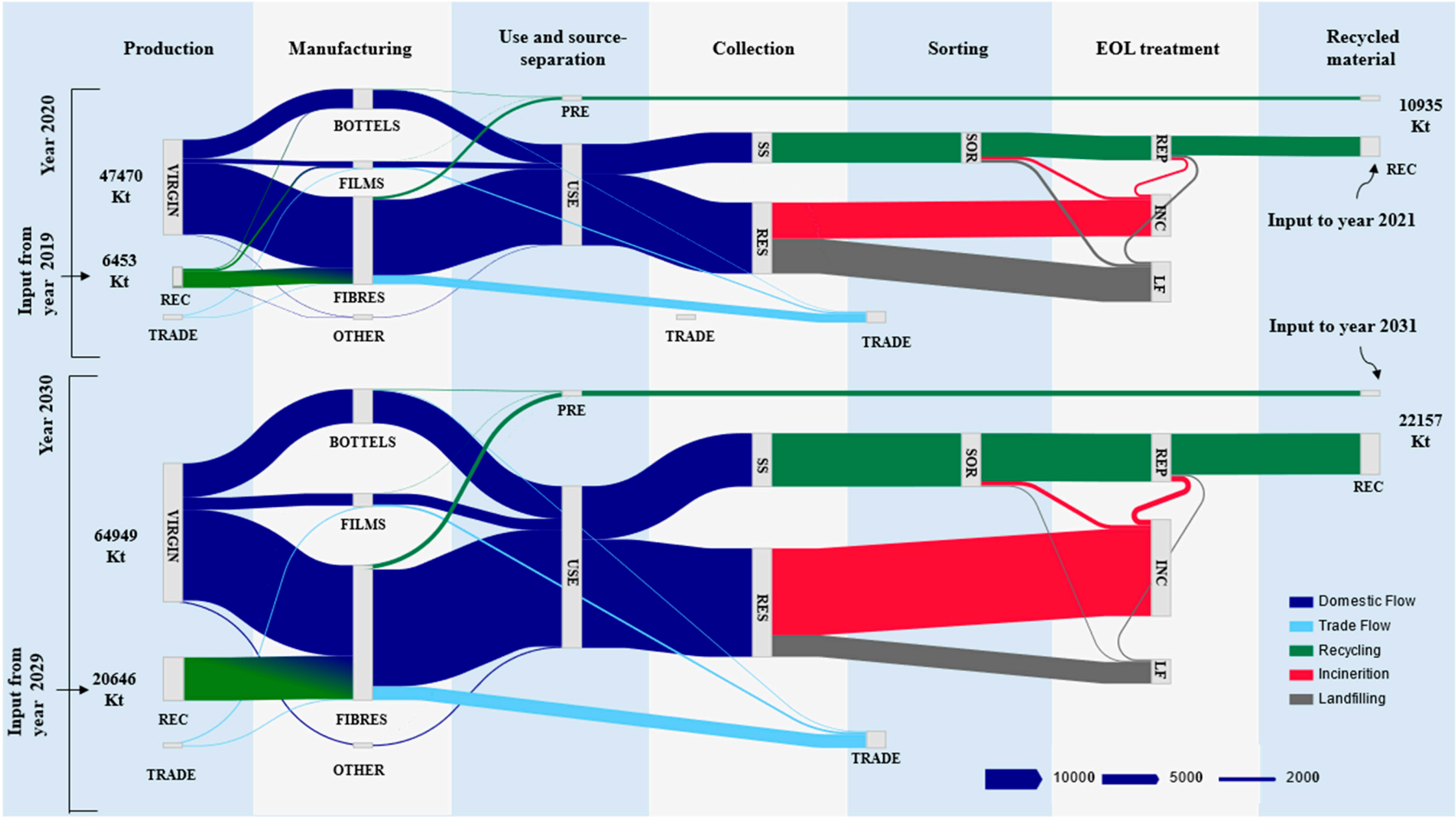


Figure S1.13 Sankey diagram for S12 in year 1 and year 30 in China.

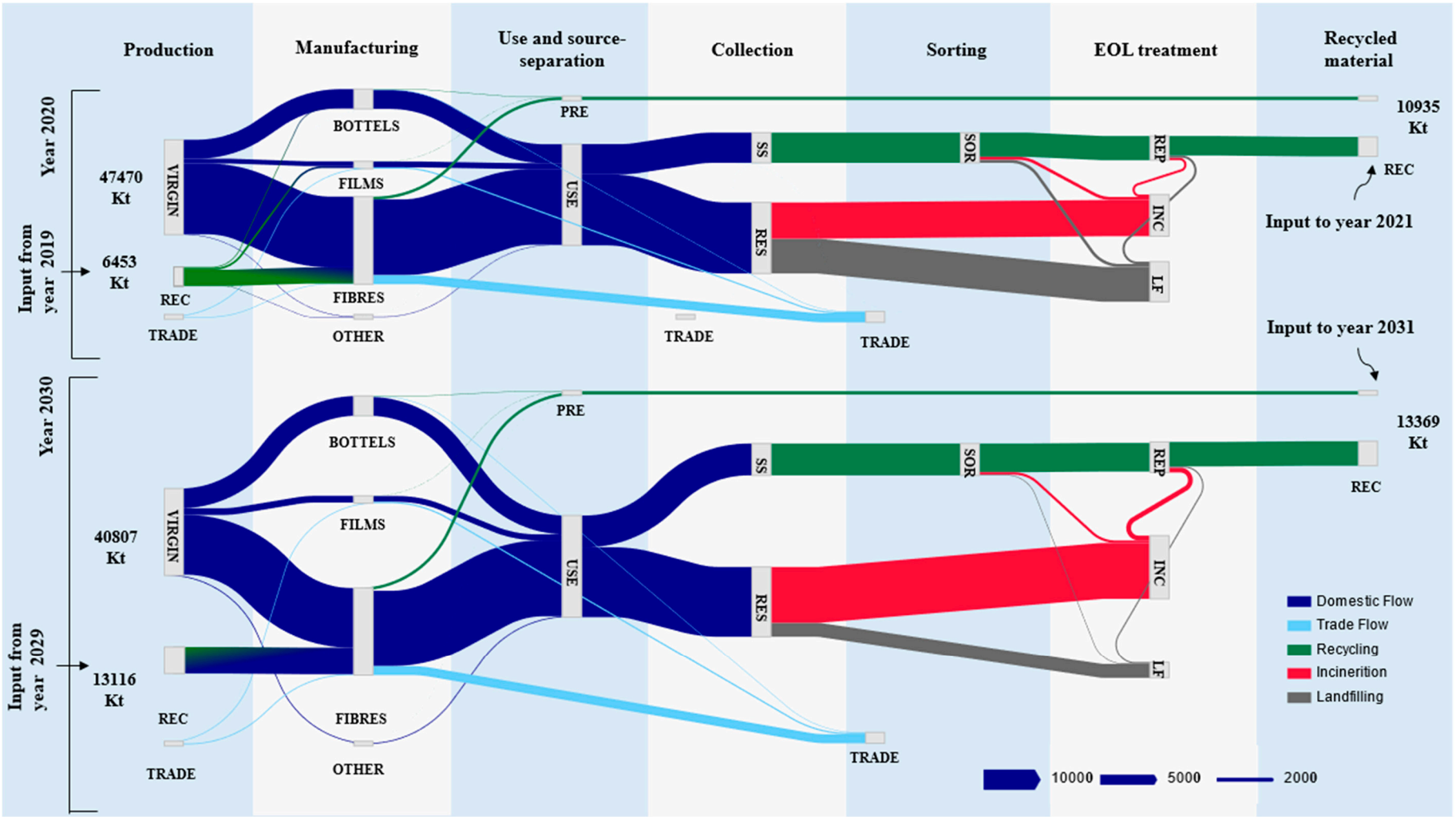


Figure S1.14 Sankey diagram for S13 in year 1 and year 30 in China.

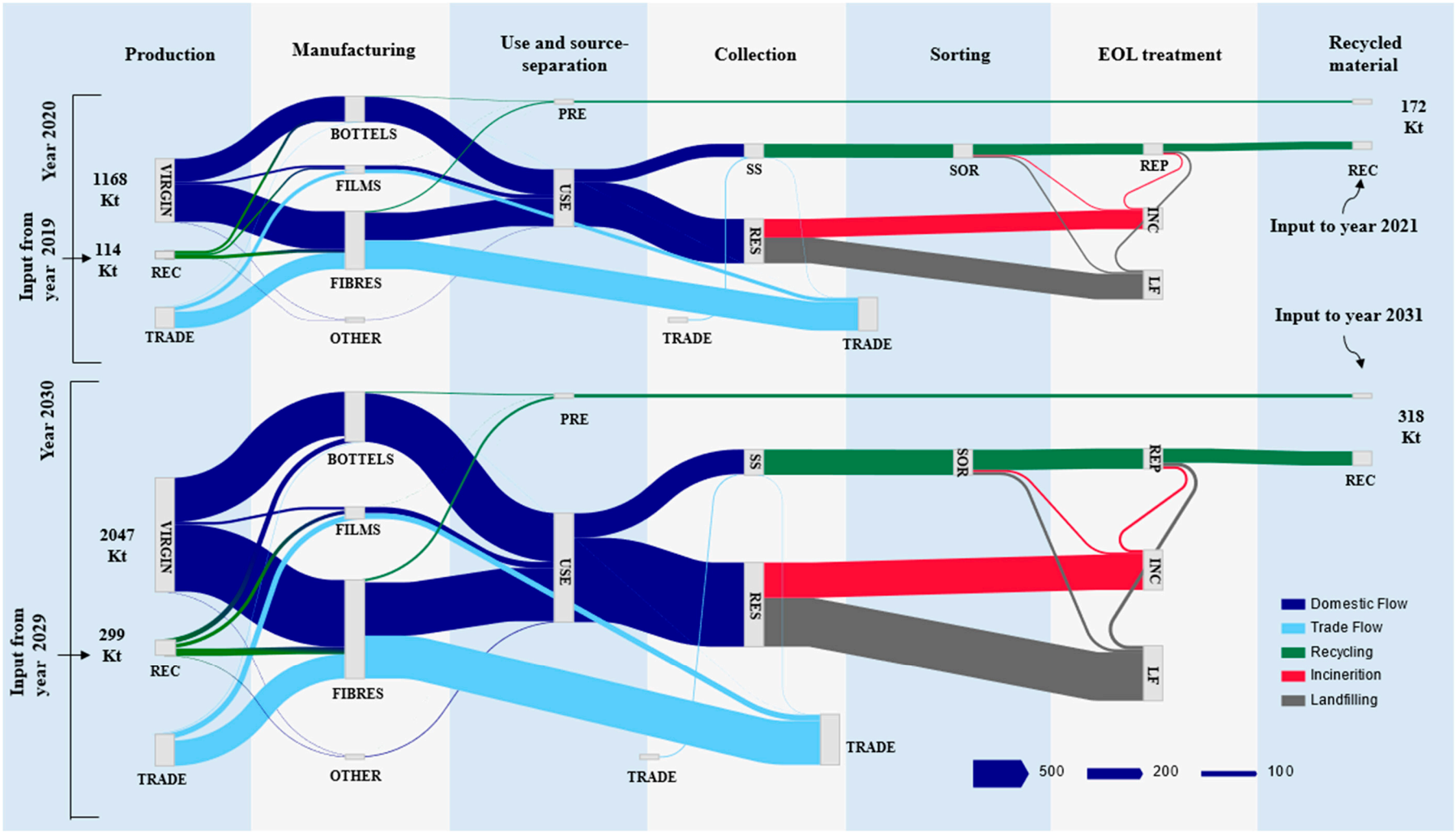


Figure S1.15 Sankey diagram for S0 in year 1 and year 30 in Indonesia

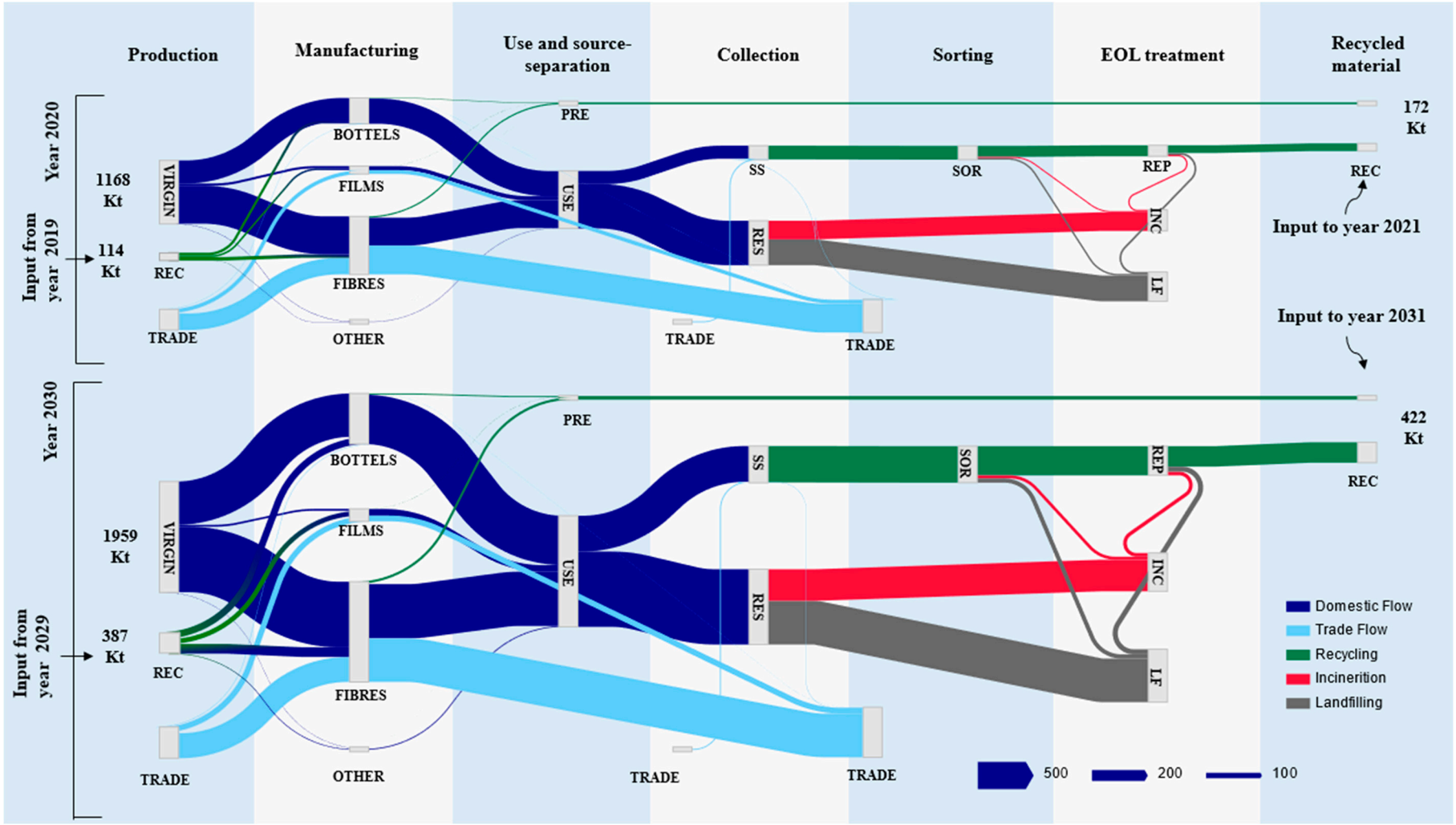


Figure S1.16 Sankey diagram for S1 in year 1 and year 30 in Indonesia.

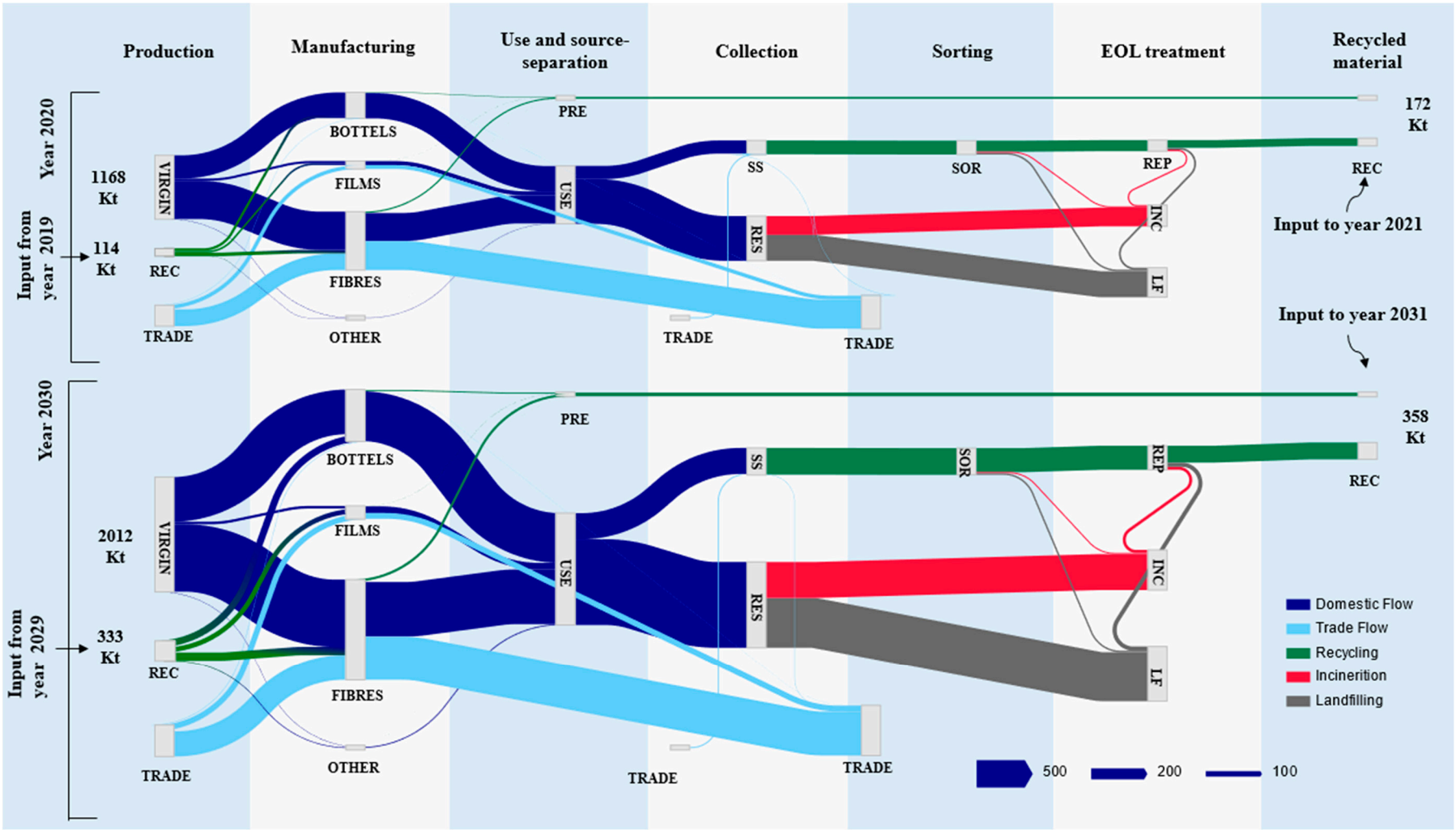


Figure S1.17 Sankey diagram for S2 in year 1 and year 30 in Indonesia.

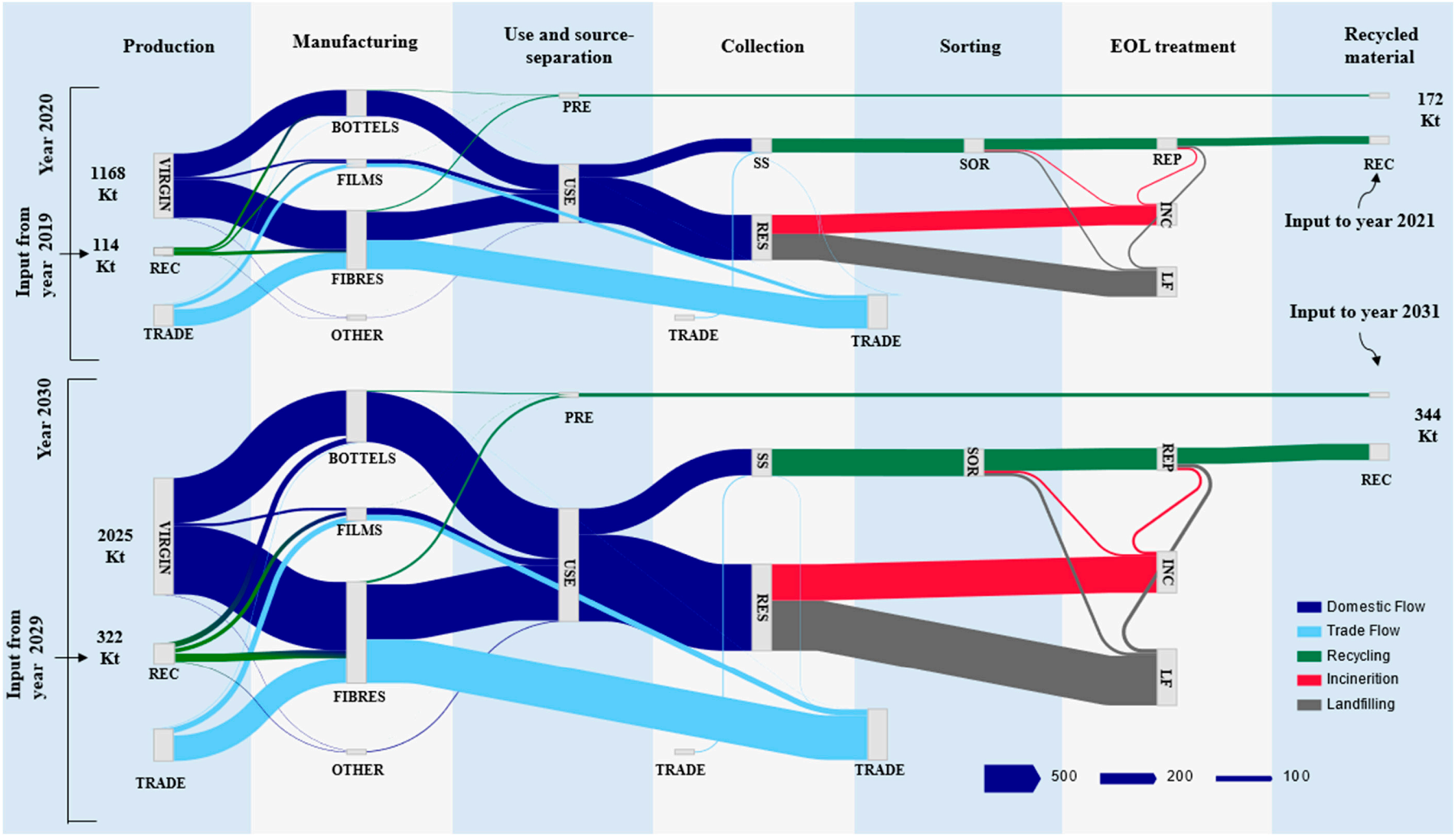


Figure S1.18 Sankey diagram for S3 in year 1 and year 30 in Indonesia.

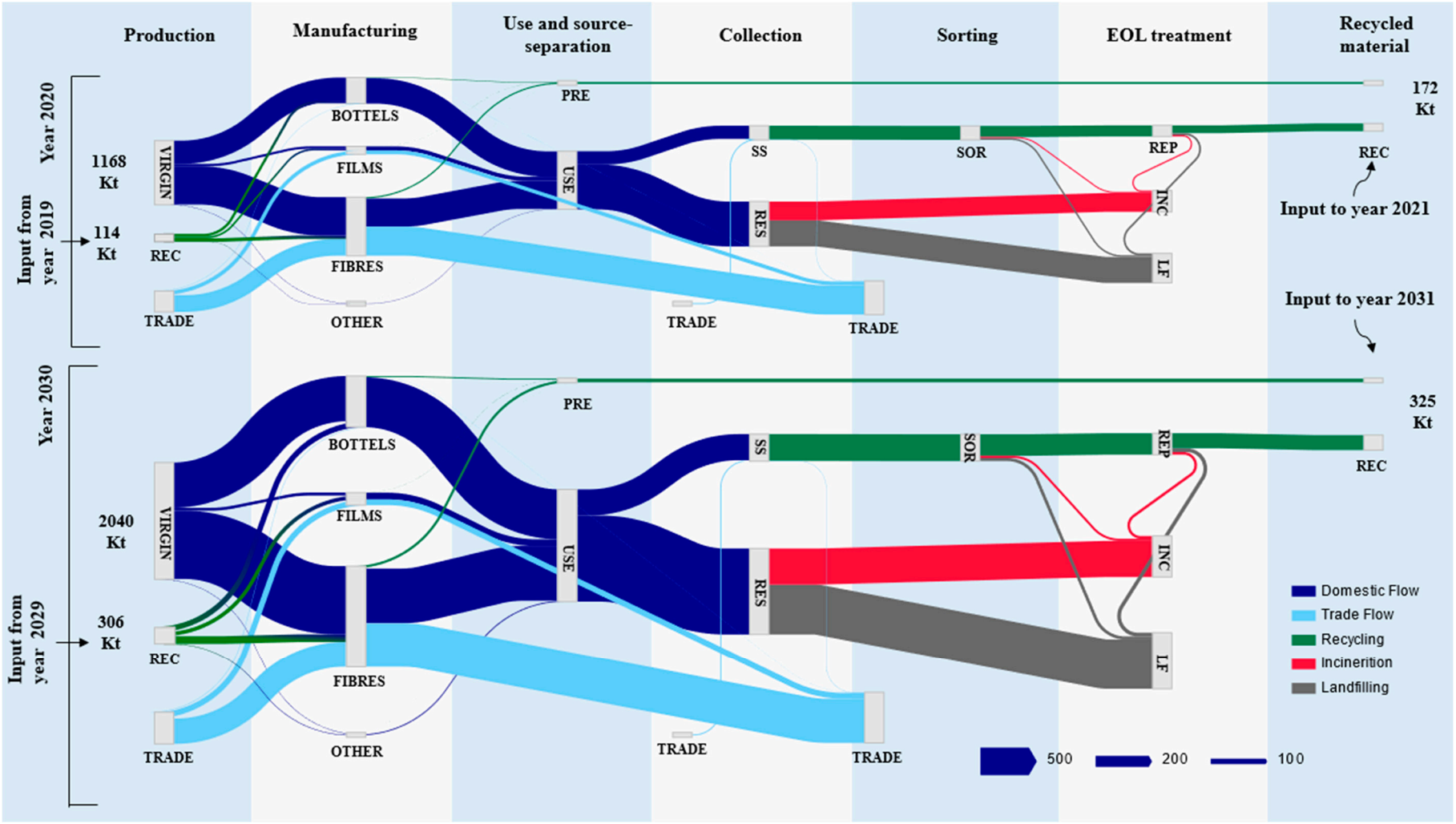


Figure S1.19 Sankey diagram for S4 in year 1 and year 30 in Indonesia.

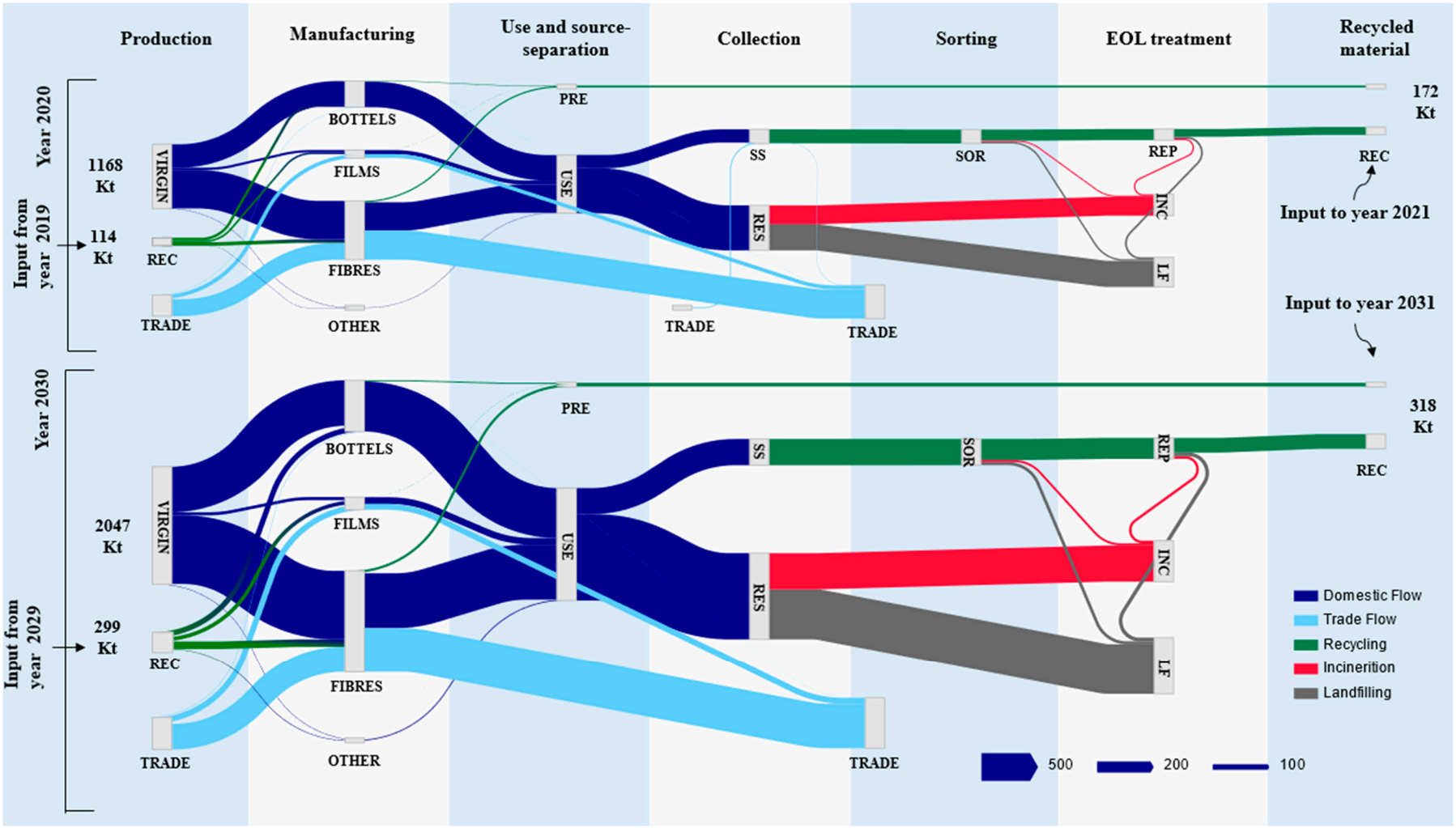


Figure S1.20 Sankey diagram for S5 in year 1 and year 30 in Indonesia.

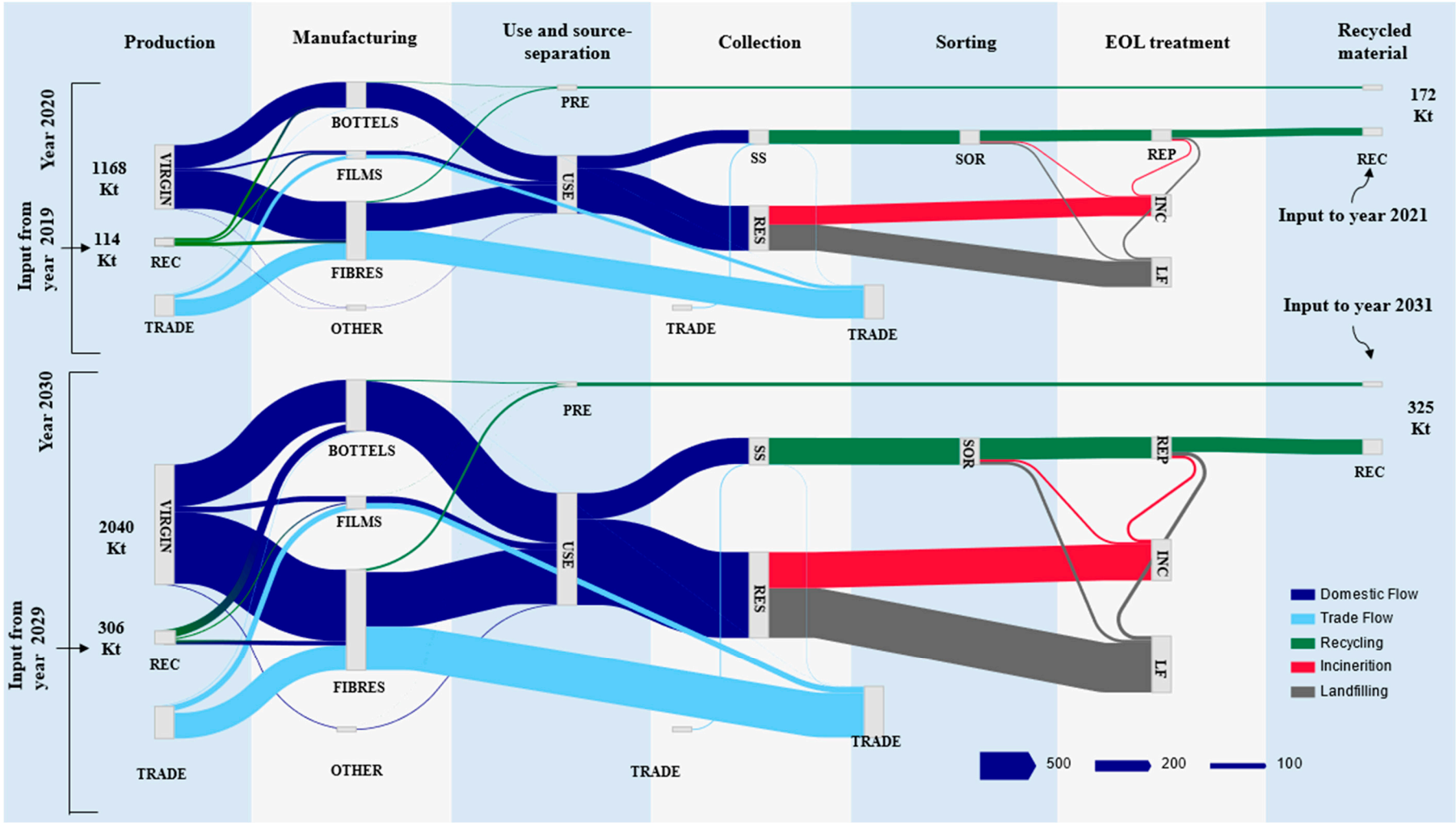


Figure S1.21 Sankey diagram for S6 in year 1 and year 30 in Indonesia.

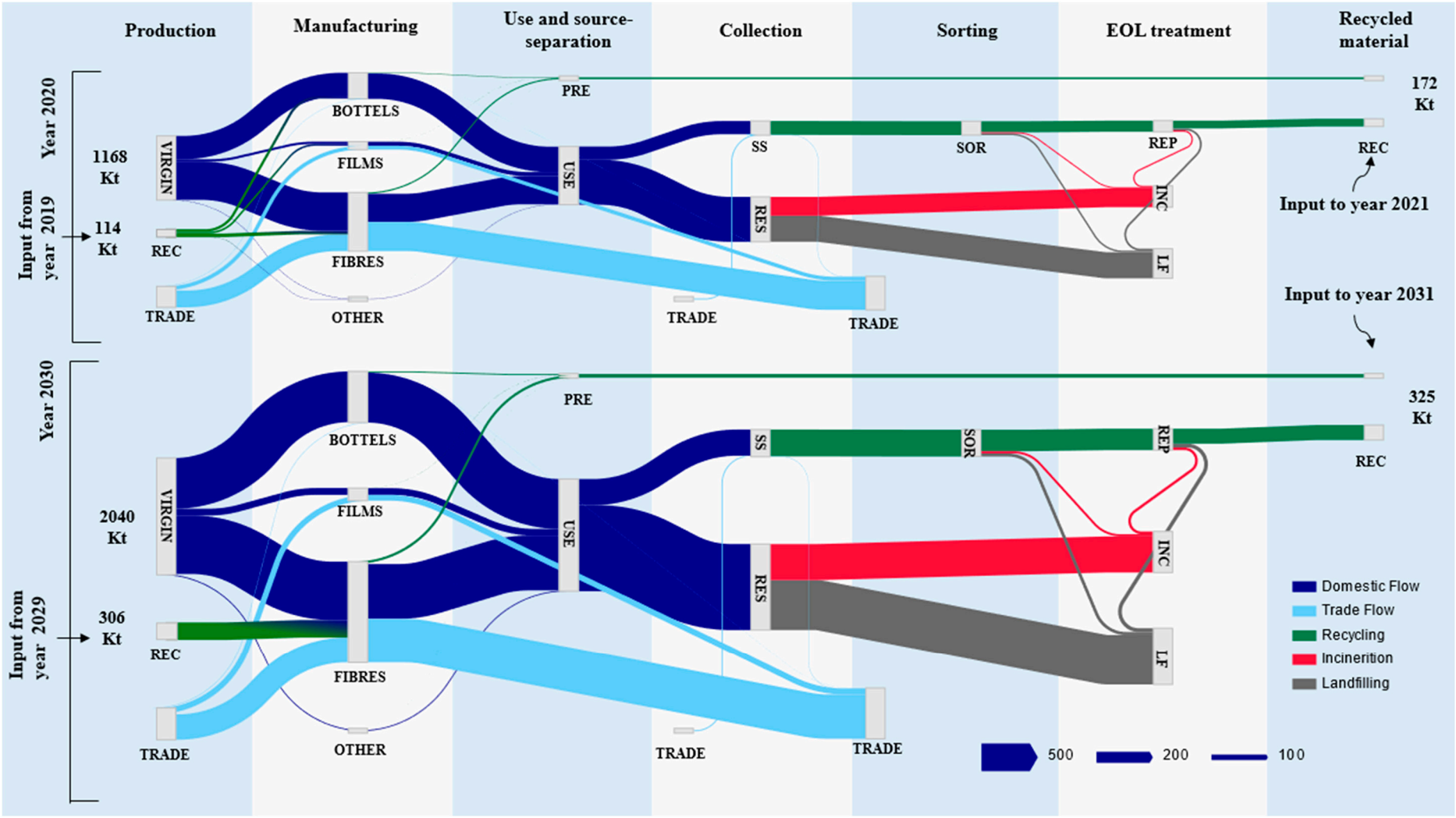


Figure S1.22 Sankey diagram for S7 in year 1 and year 30 in Indonesia.

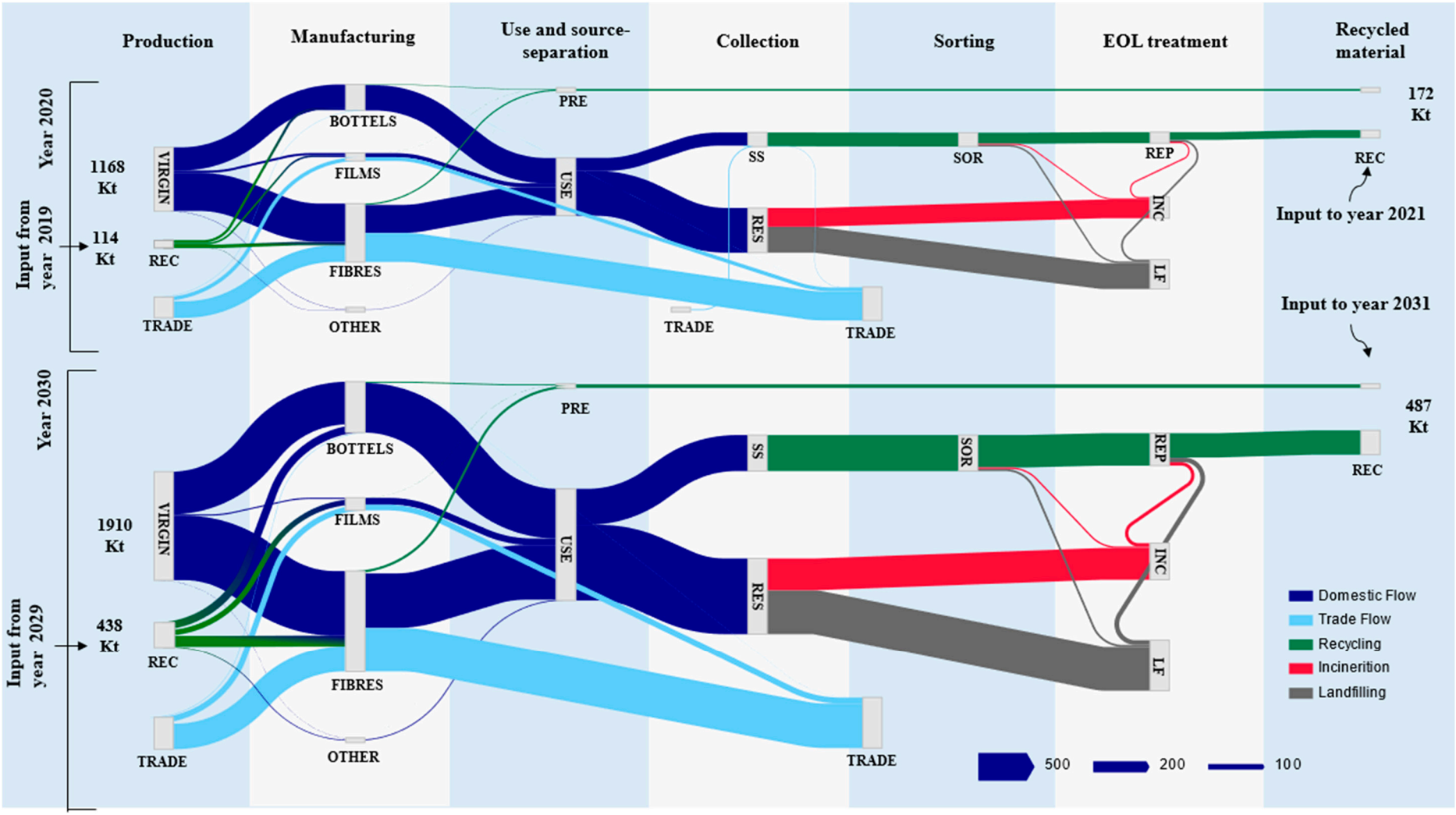


Figure S1.23 Sankey diagram for S8 in year 1 and year 30 in Indonesia.

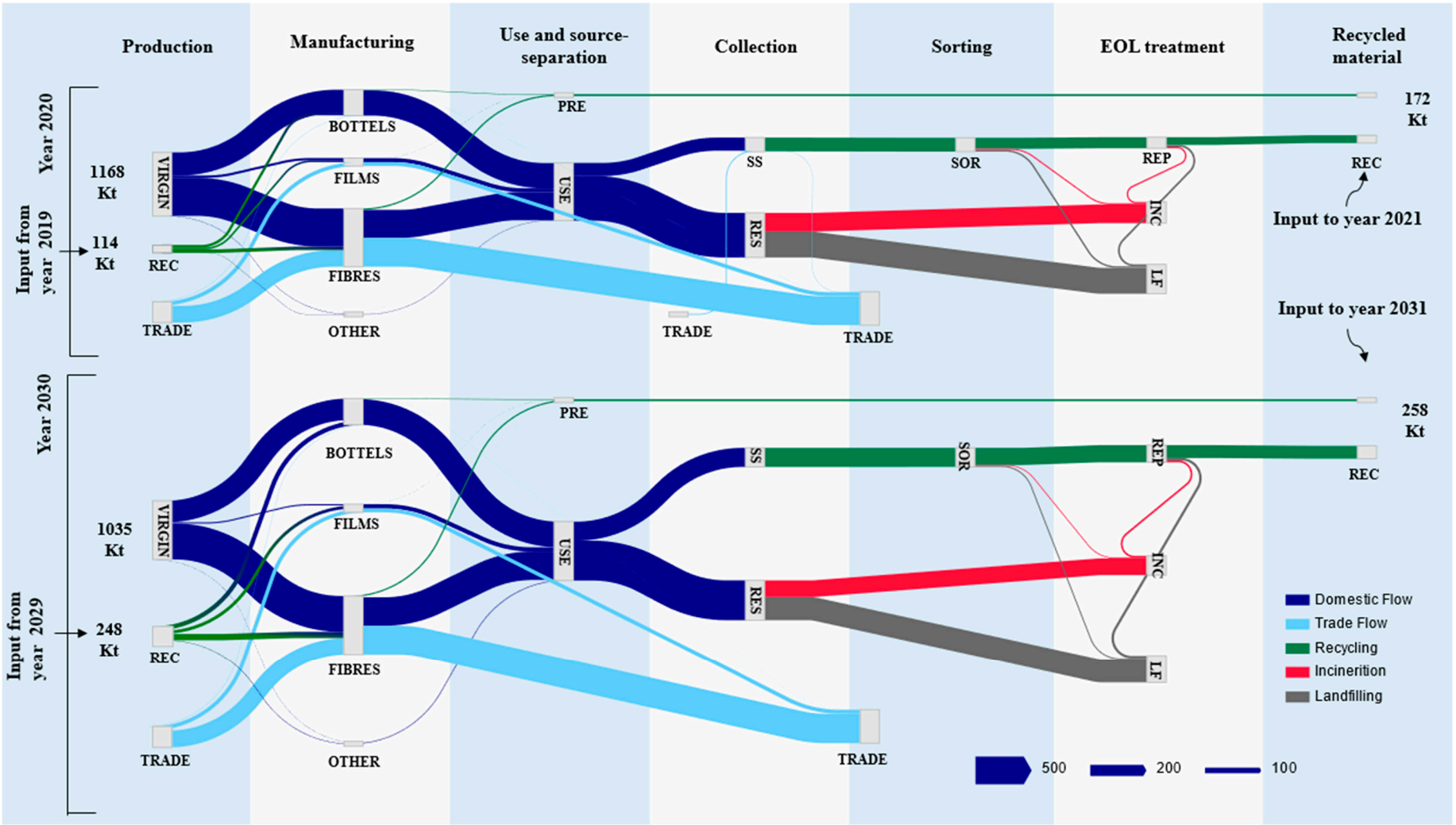


Figure S1.24 Sankey diagram for S9 in year 1 and year 30 in Indonesia.

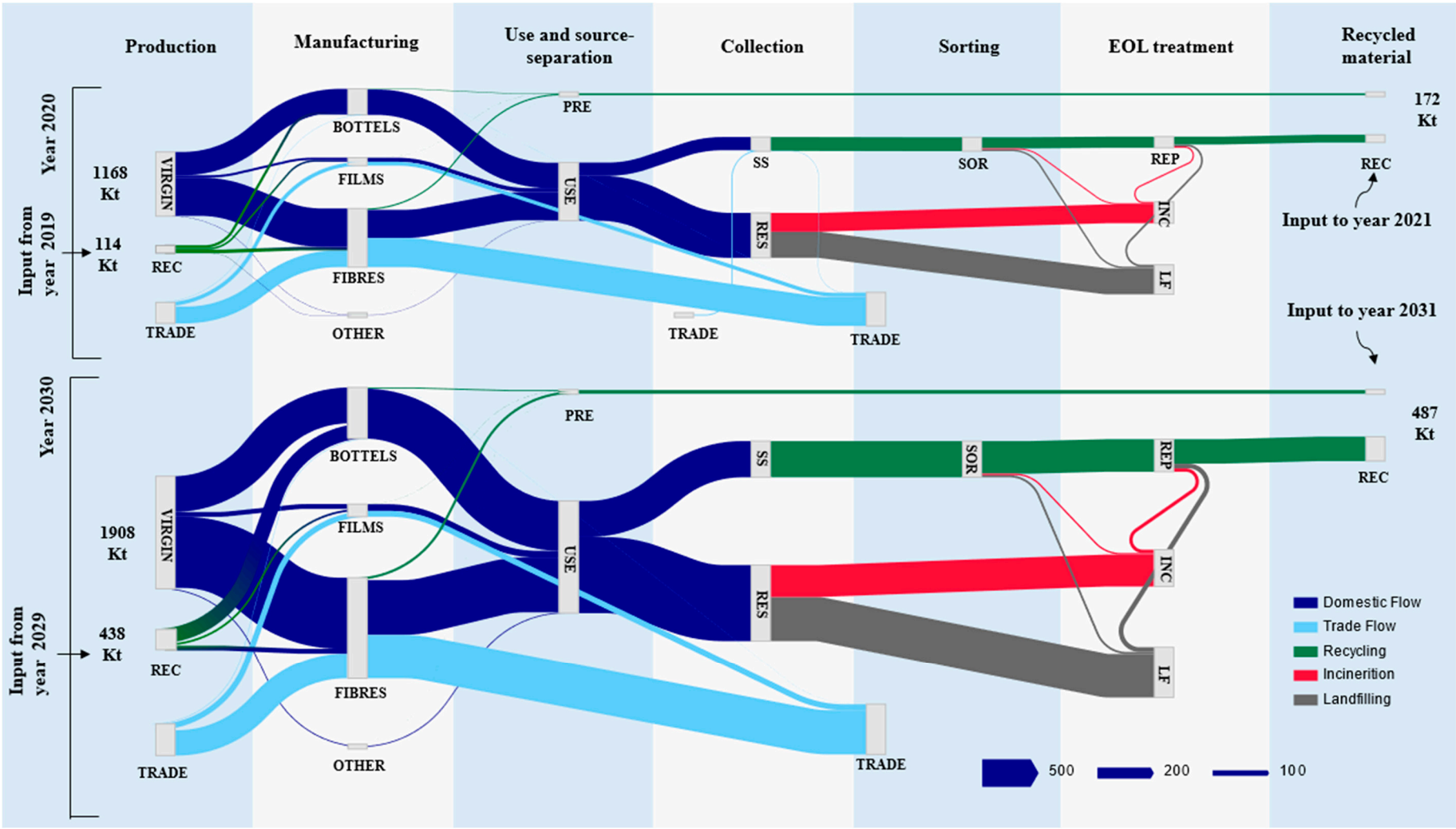


Figure S1.25 Sankey diagram for S10 in year 1 and year 30 in Indonesia.

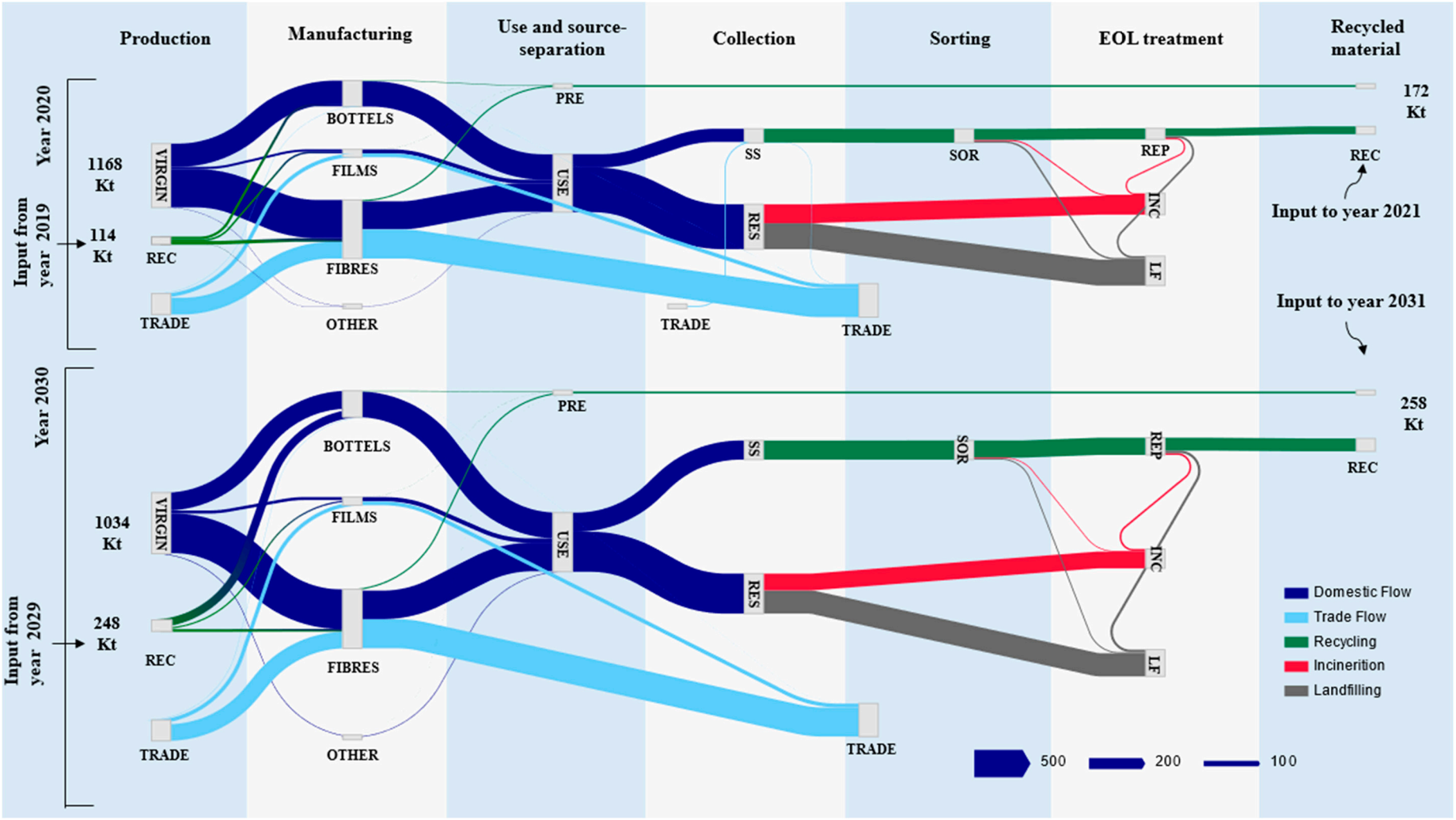


Figure S1.26 Sankey diagram for S11 in year 1 and year 30 in Indonesia.

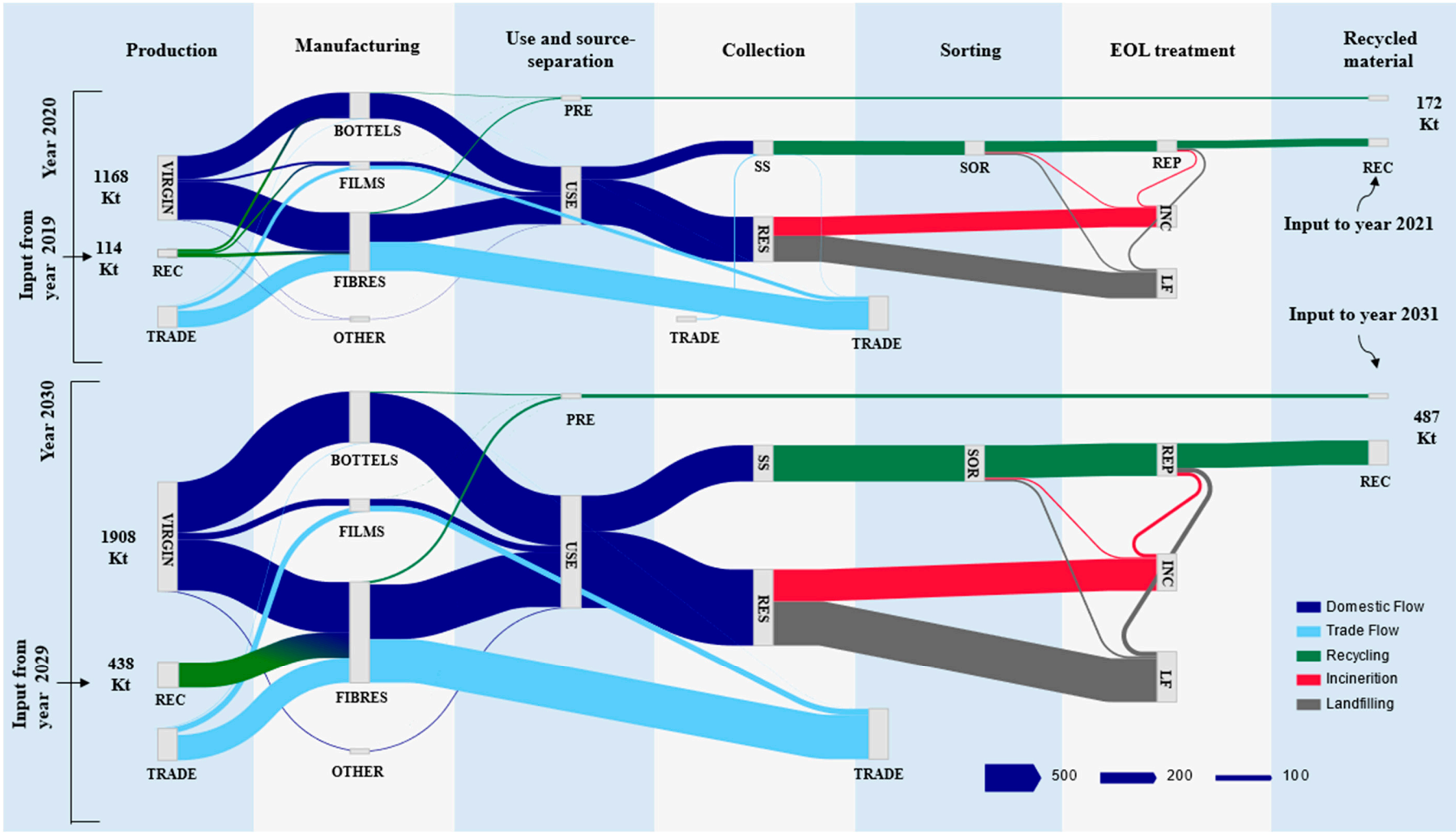


Figure S1.27 Sankey diagram for S12 in year 1 and year 30 in Indonesia.

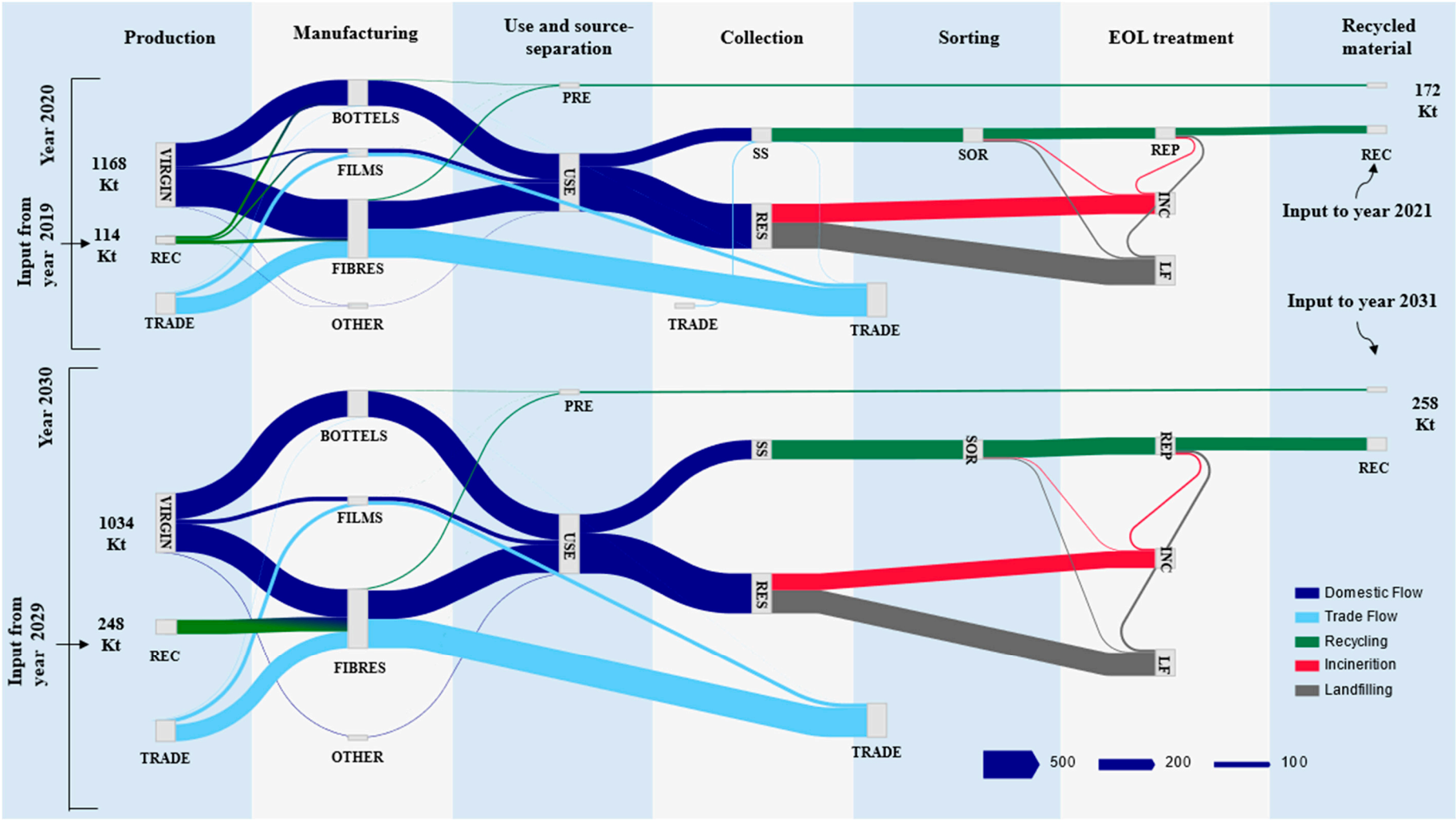


Figure S1.28 Sankey diagram for S13 in year 1 and year 30 in Indonesia.

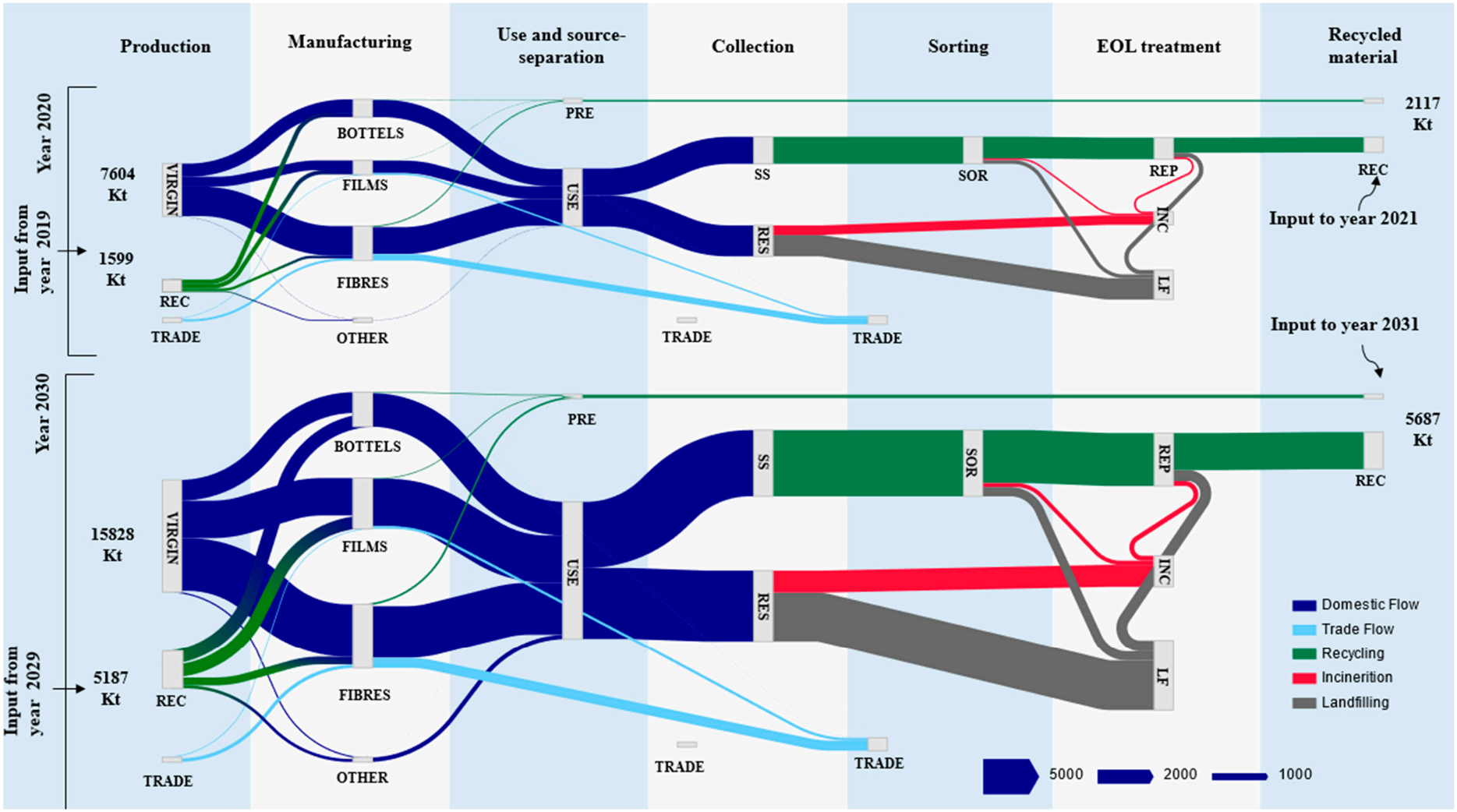


Figure S1.29 Sankey diagram for S0 in year 1 and year 30 in India.

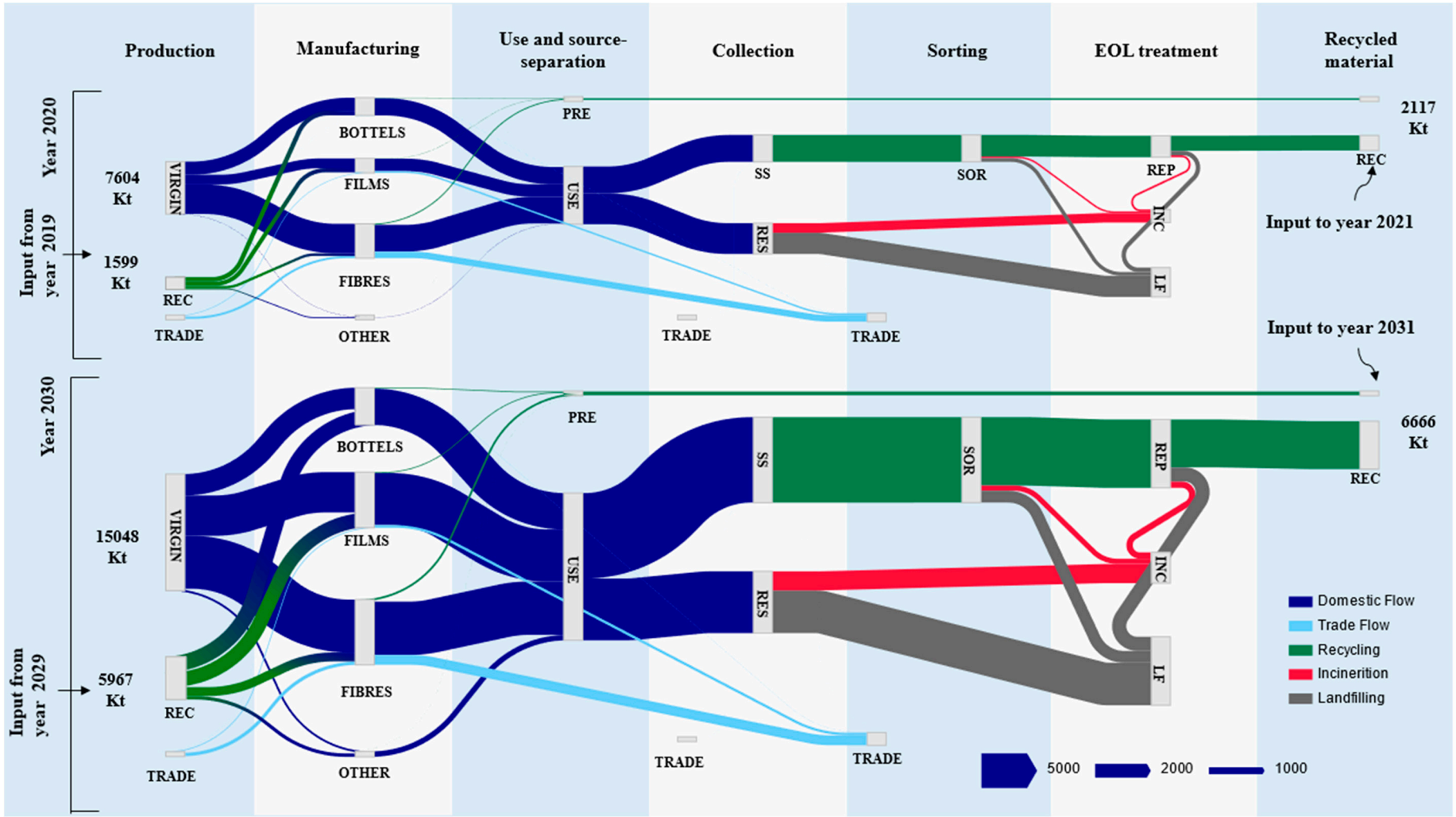


Figure S1.30 Sankey diagram for S1 in year 1 and year 30 in India.

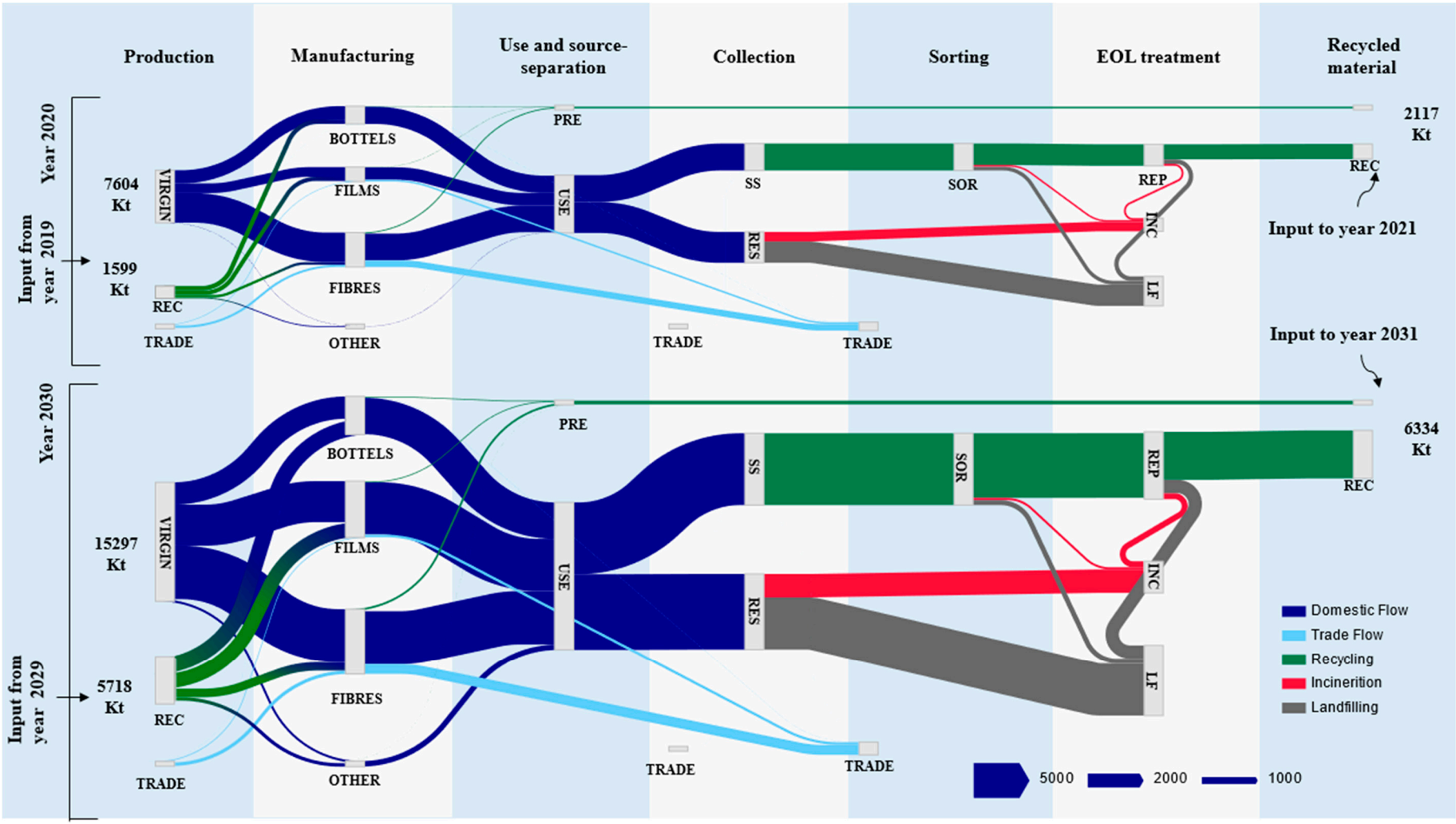


Figure S1.31 Sankey diagram for S2 in year 1 and year 30 in India.

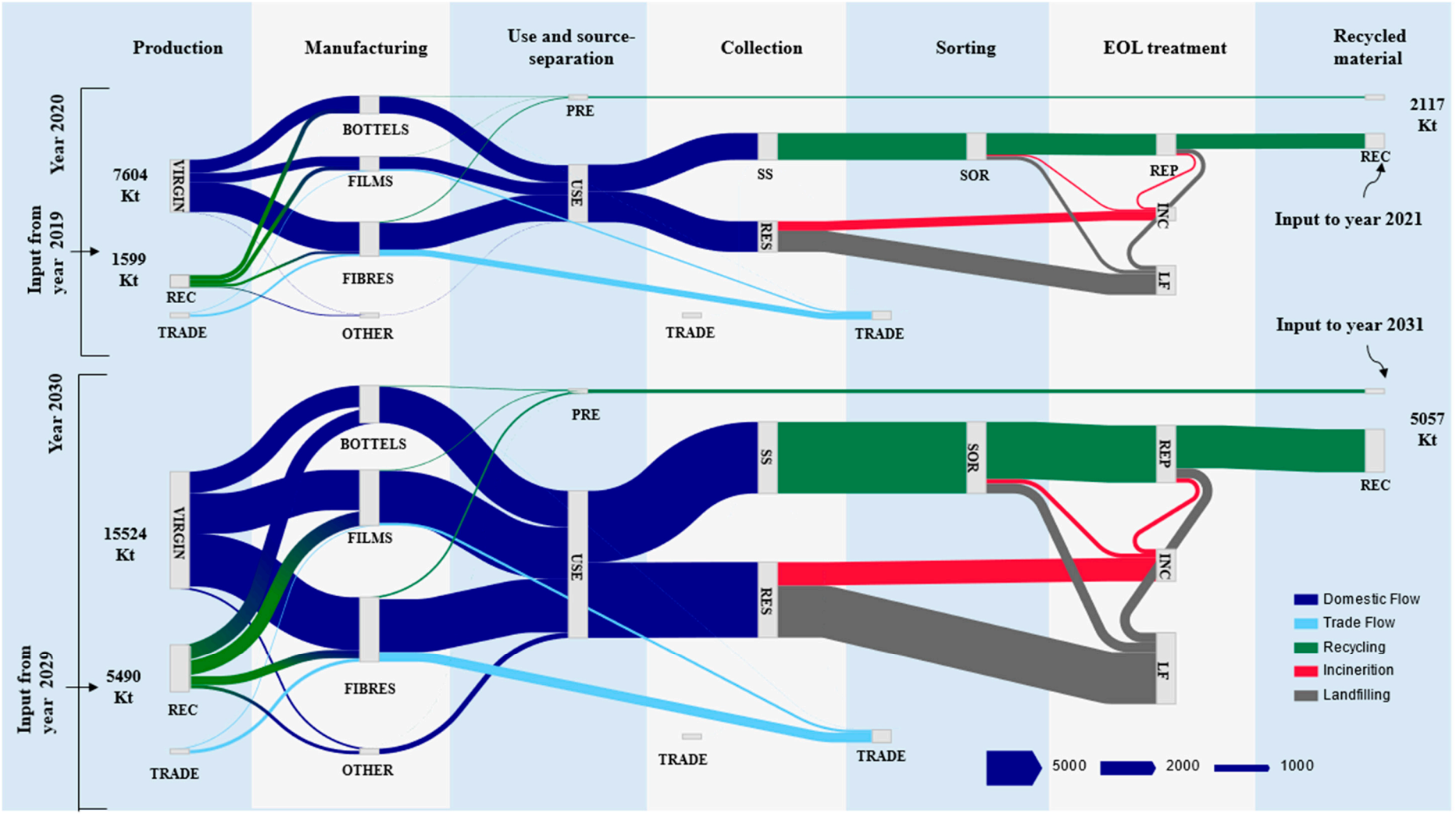


Figure S1.32 Sankey diagram for S3 in year 1 and year 30 in India.

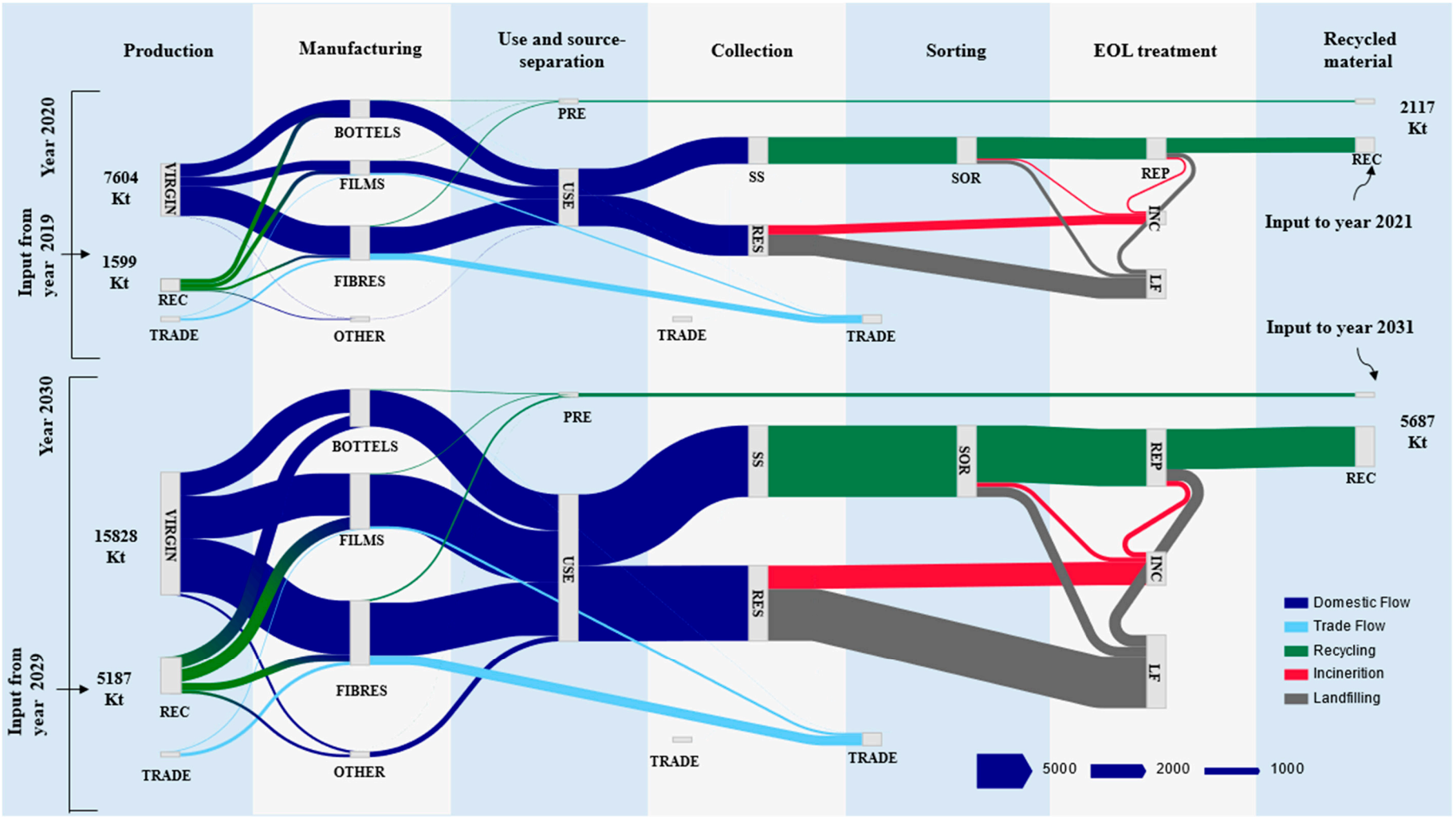


Figure S1.33 Sankey diagram for S4 in year 1 and year 30 in India.

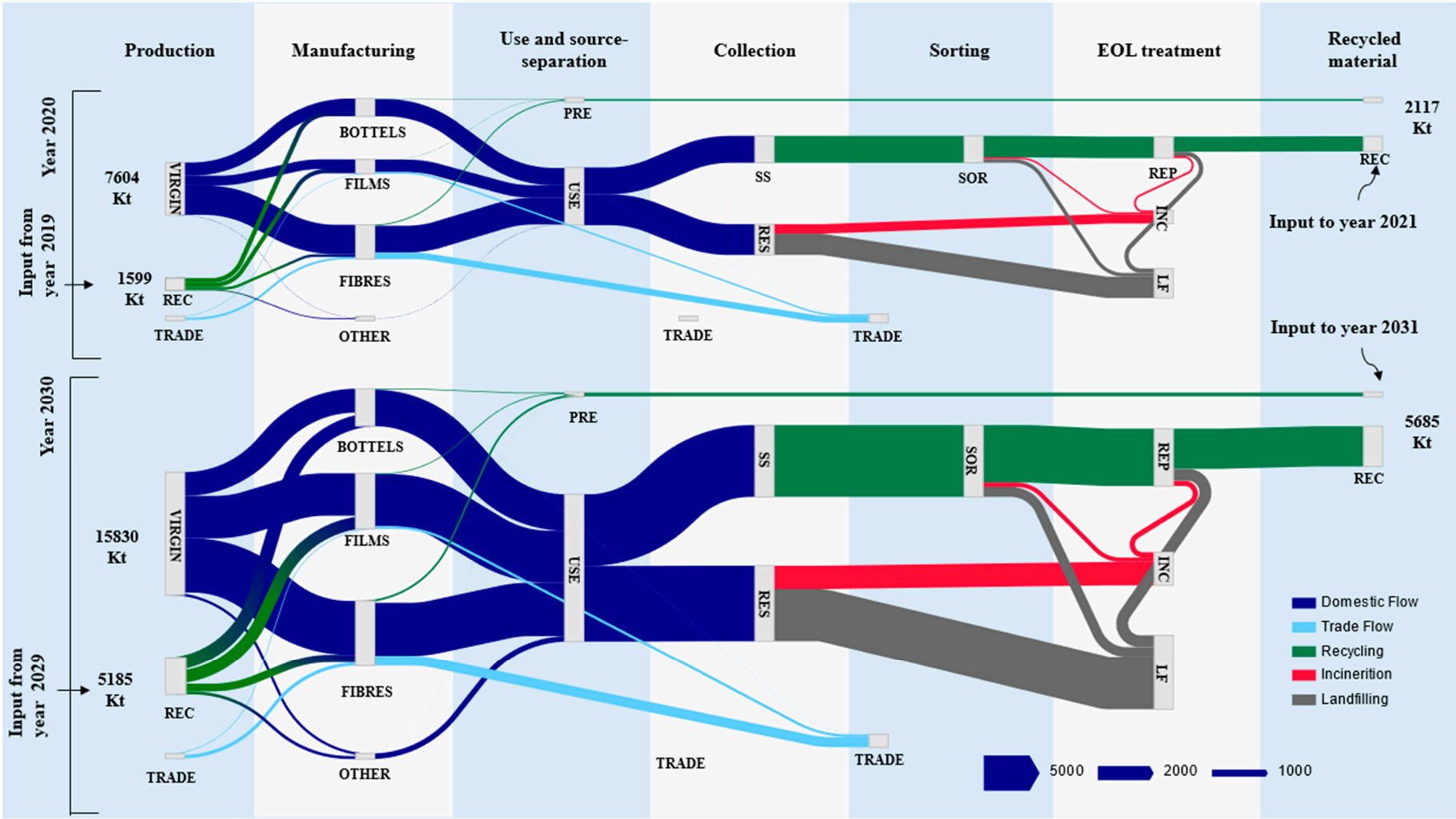


Figure S1.34 Sankey diagram for S5 in year 1 and year 30 in India.

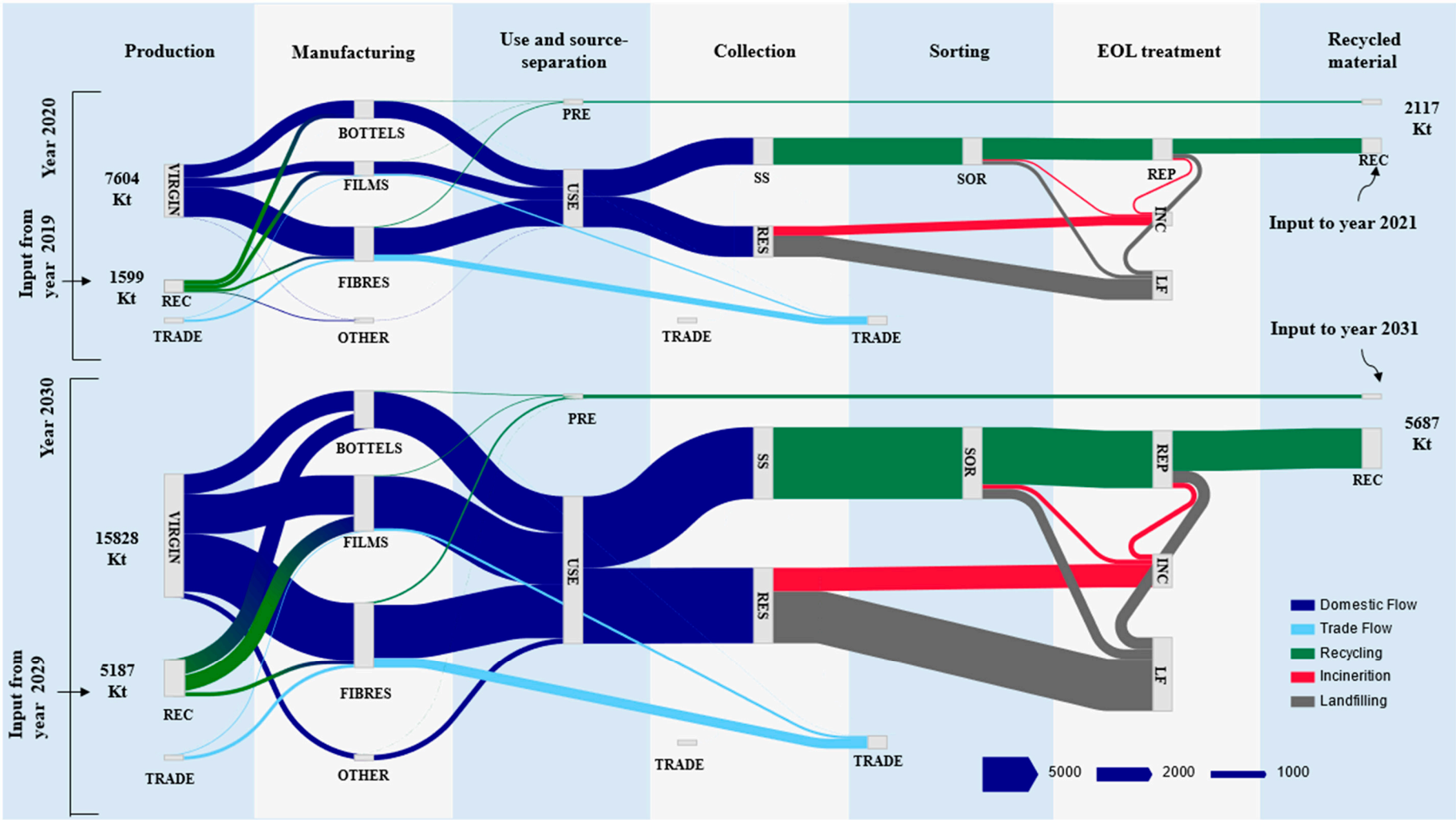


Figure S1.35 Sankey diagram for S6 in year 1 and year 30 in India.

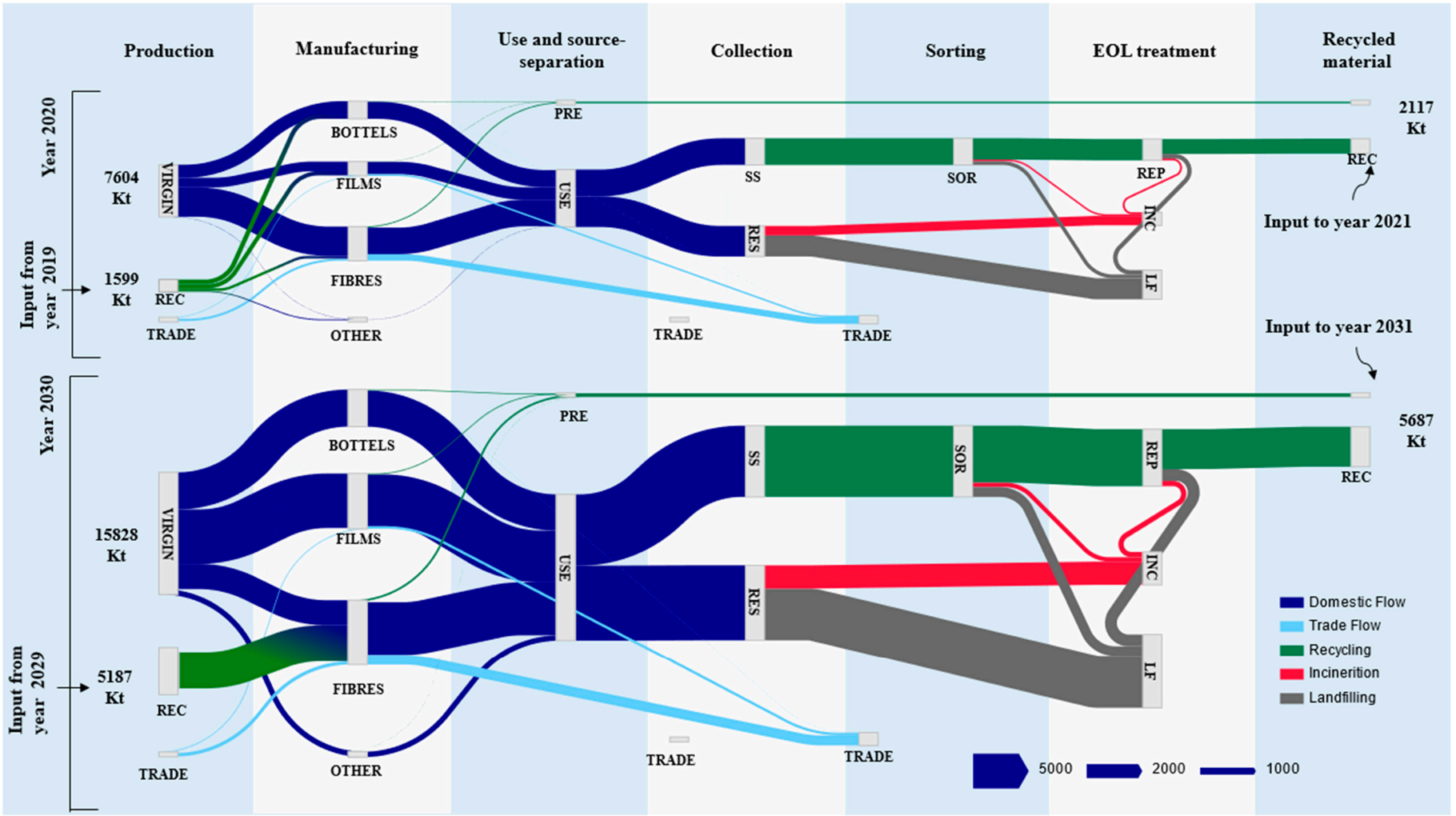


Figure S1.36 Sankey diagram for S7 in year 1 and year 30 in India.

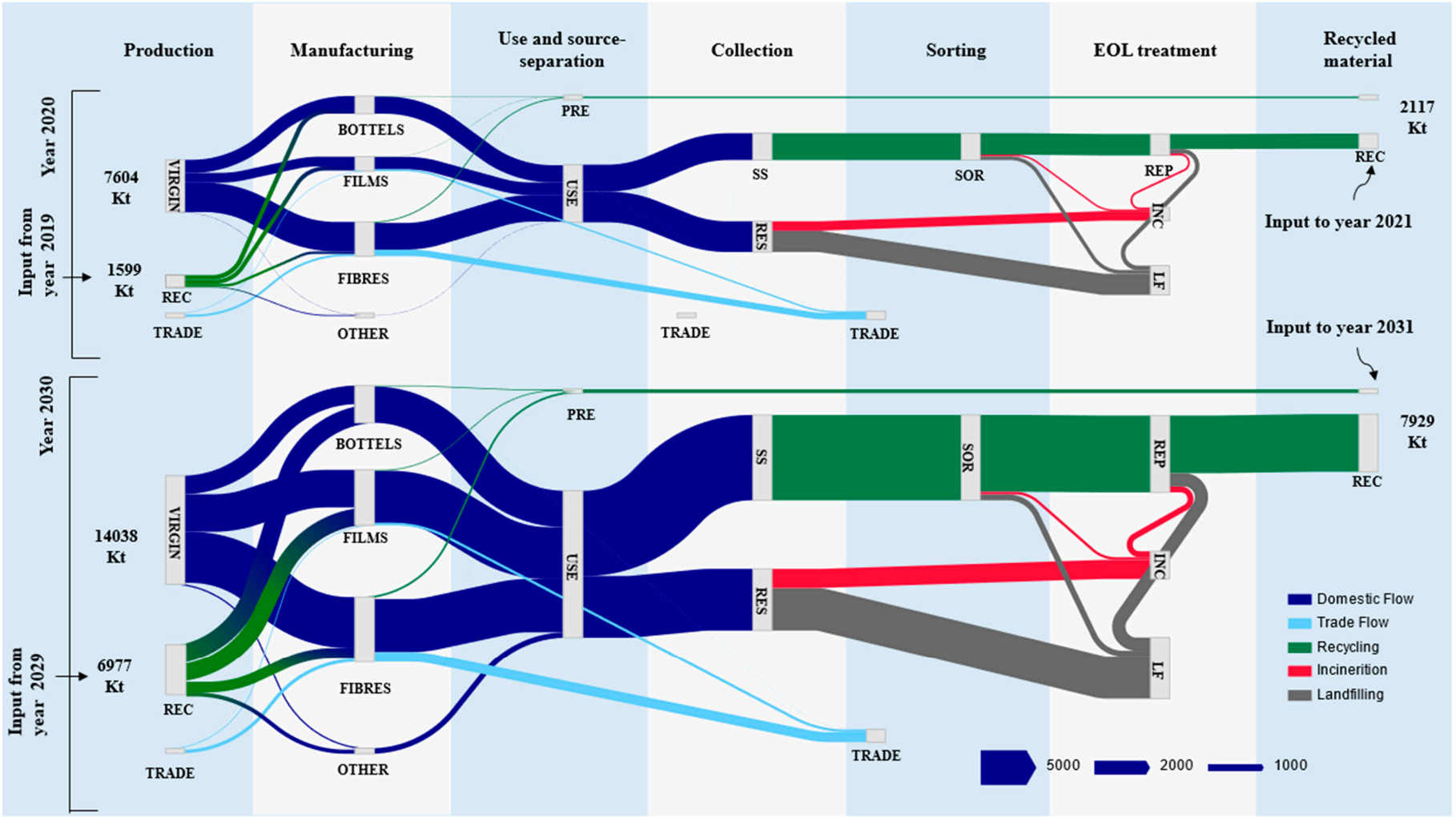


Figure S1.37 Sankey diagram for S8 in year 1 and year 30 in India.

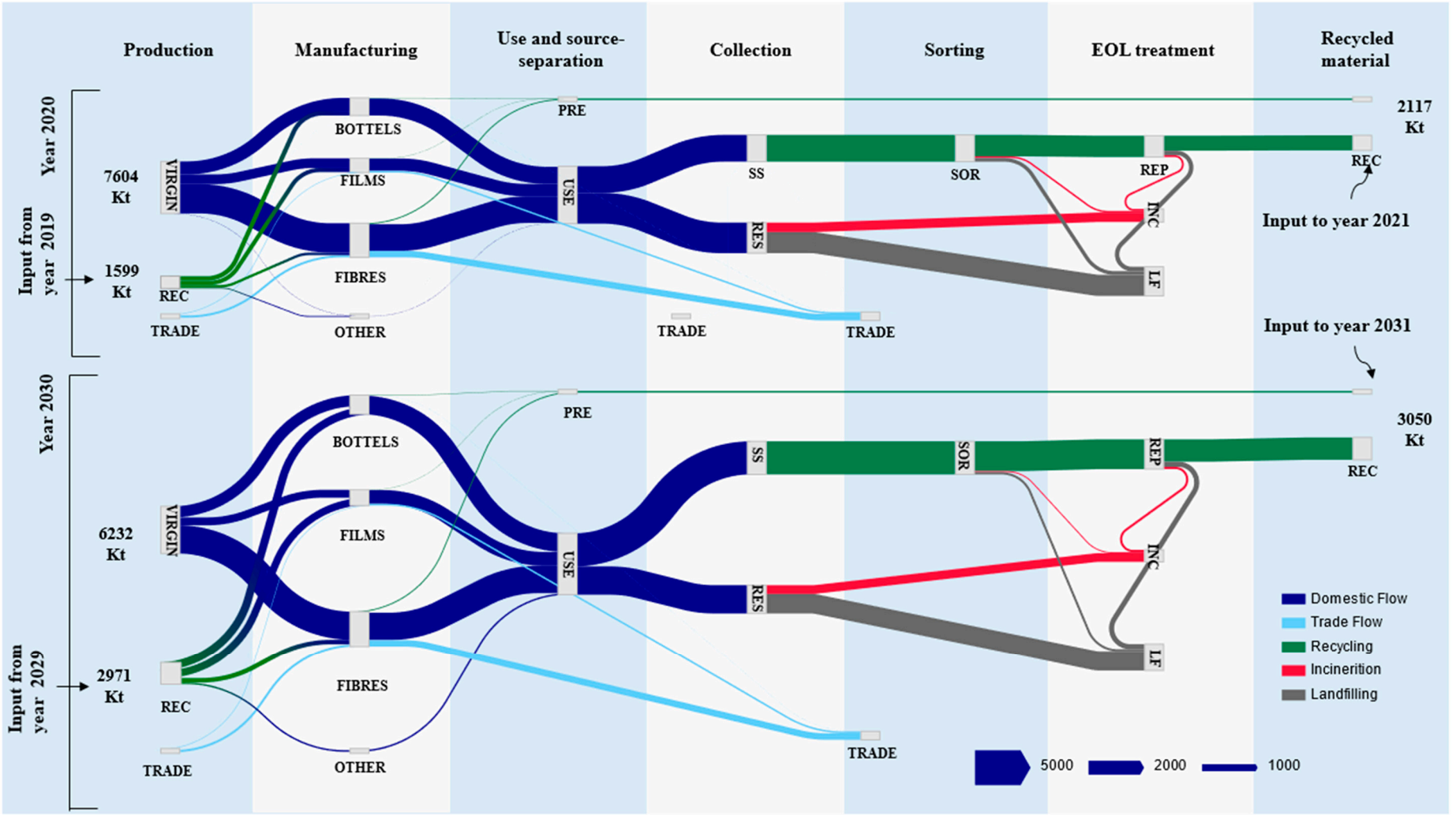


Figure S1.38 Sankey diagram for S9 in year 1 and year 30 in India.

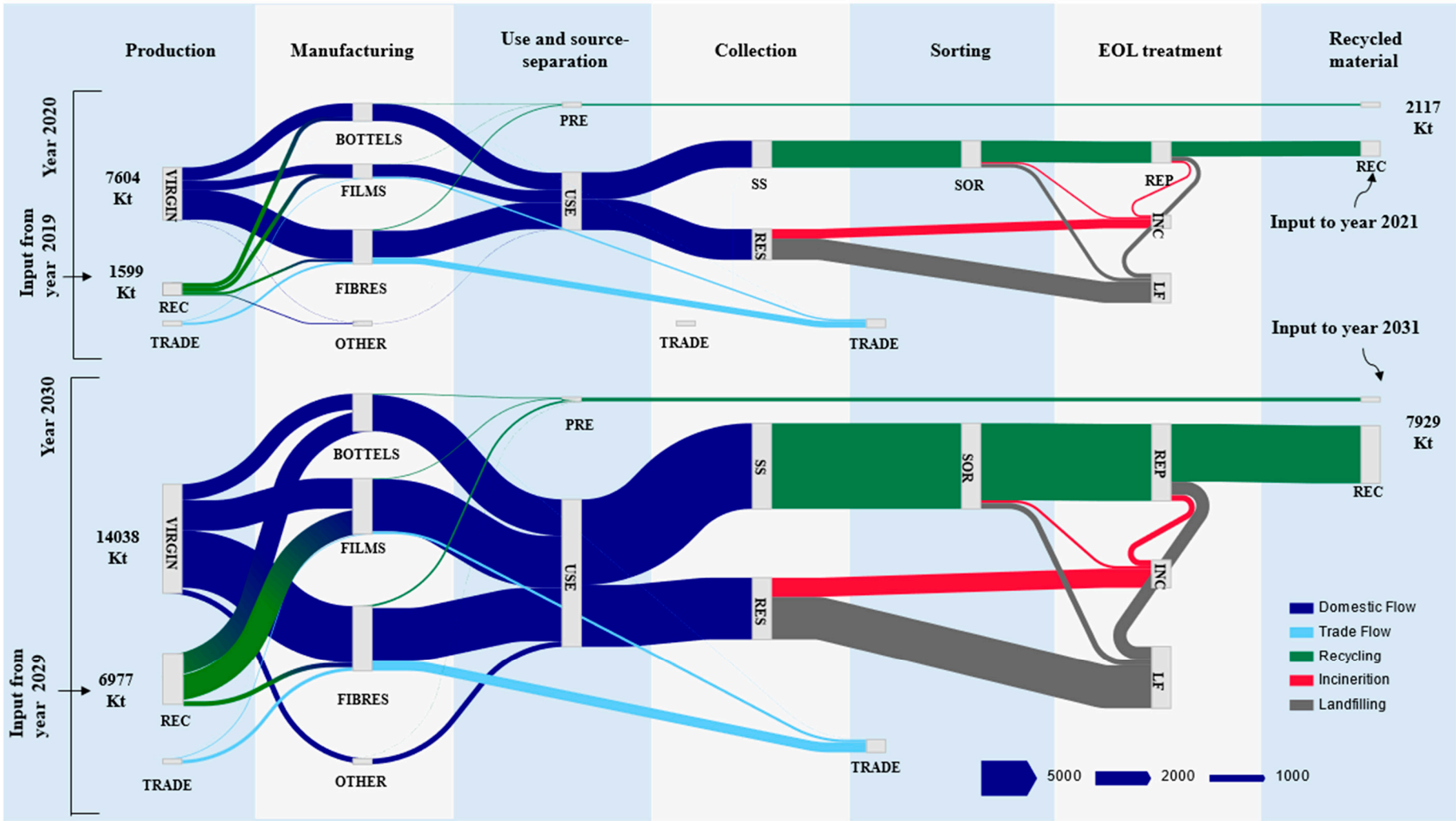


Figure S1.39 Sankey diagram for S10 in year 1 and year 30 in India.

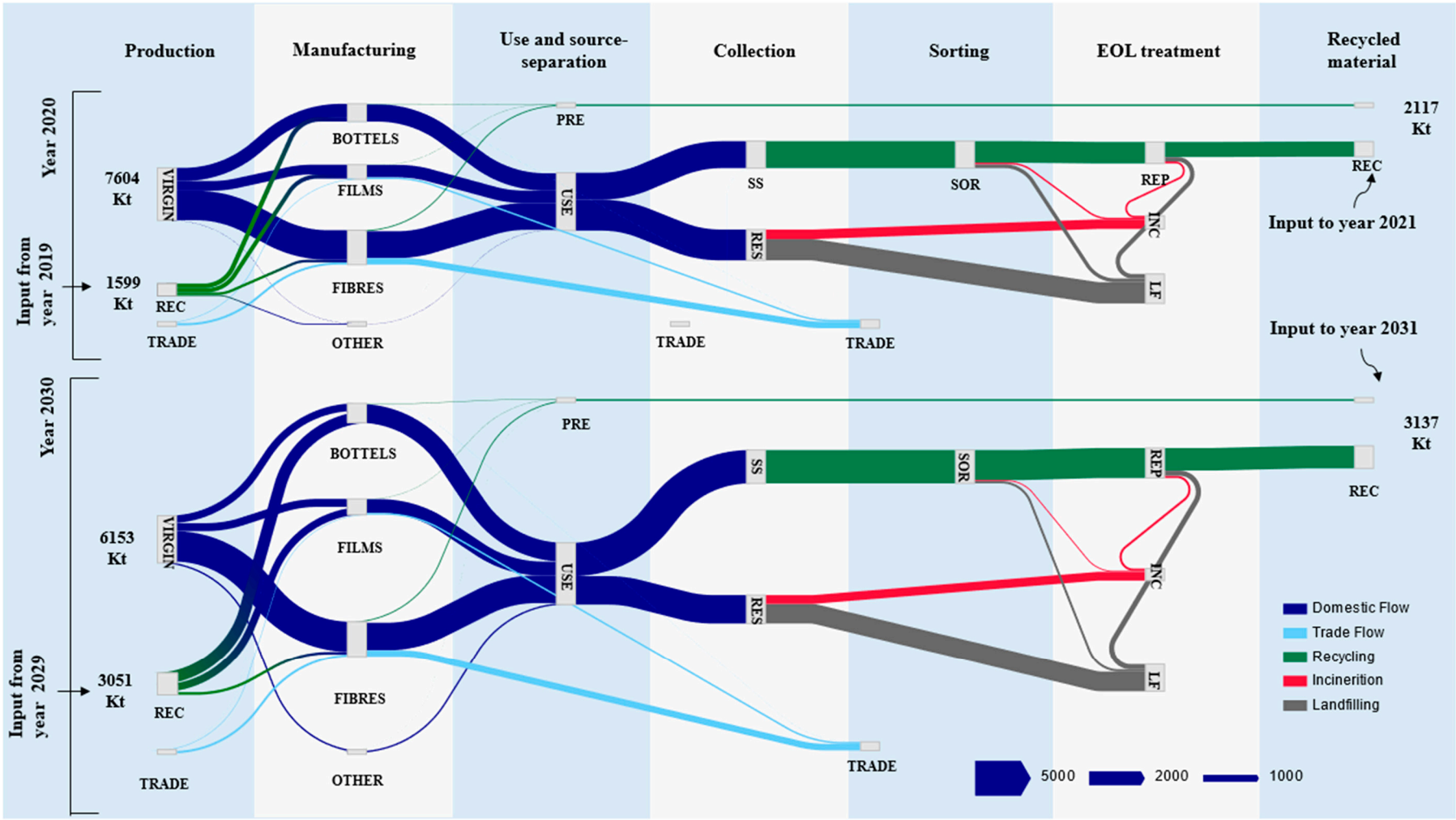


Figure S1.40 Sankey diagram for S11 in year 1 and year 30 in India.

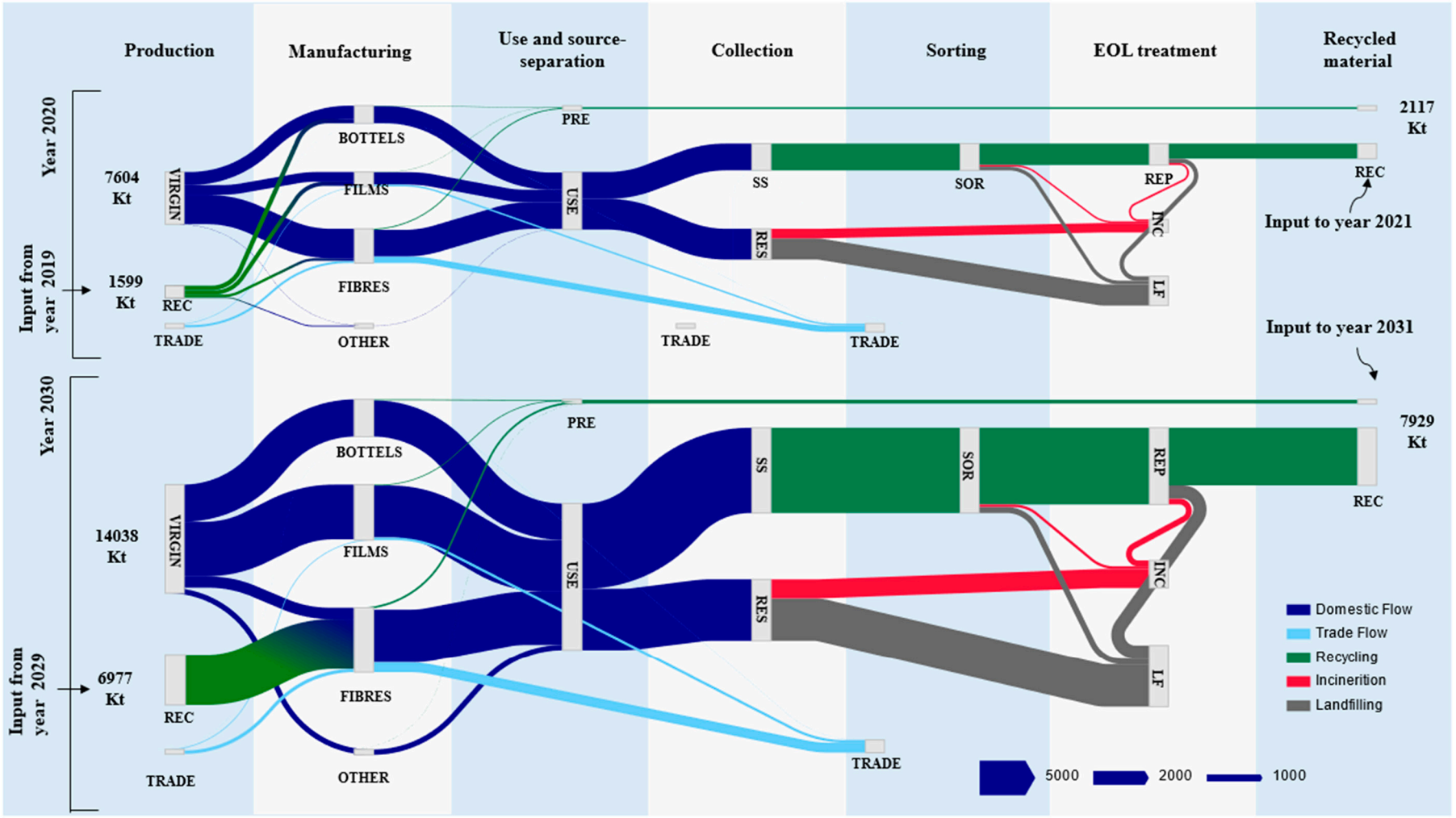


Figure S1.41 Sankey diagram for S12 in year 1 and year 30 in India.

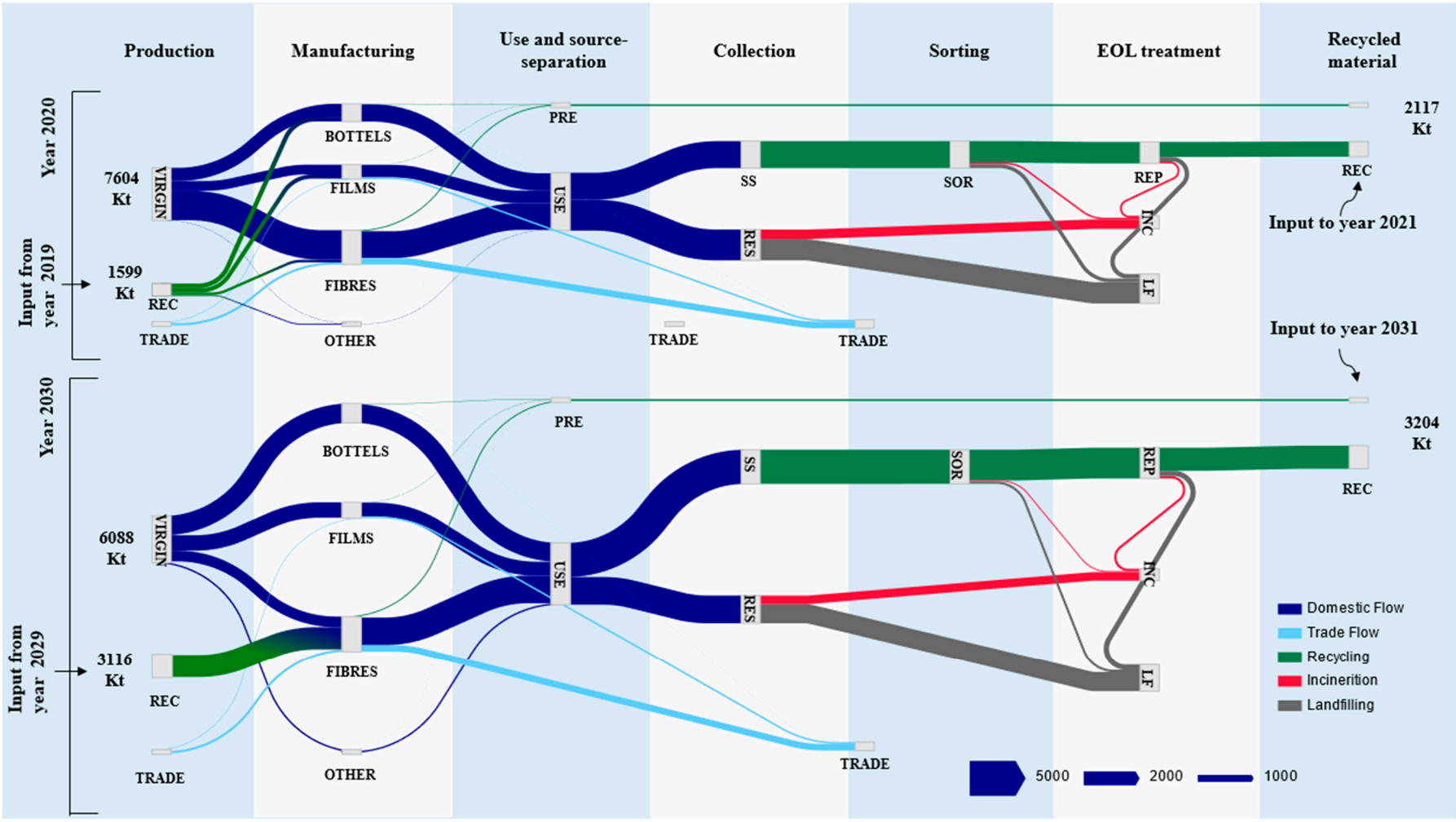


Figure S1.42 Sankey diagram for S13 in year 1 and year 30 in India.

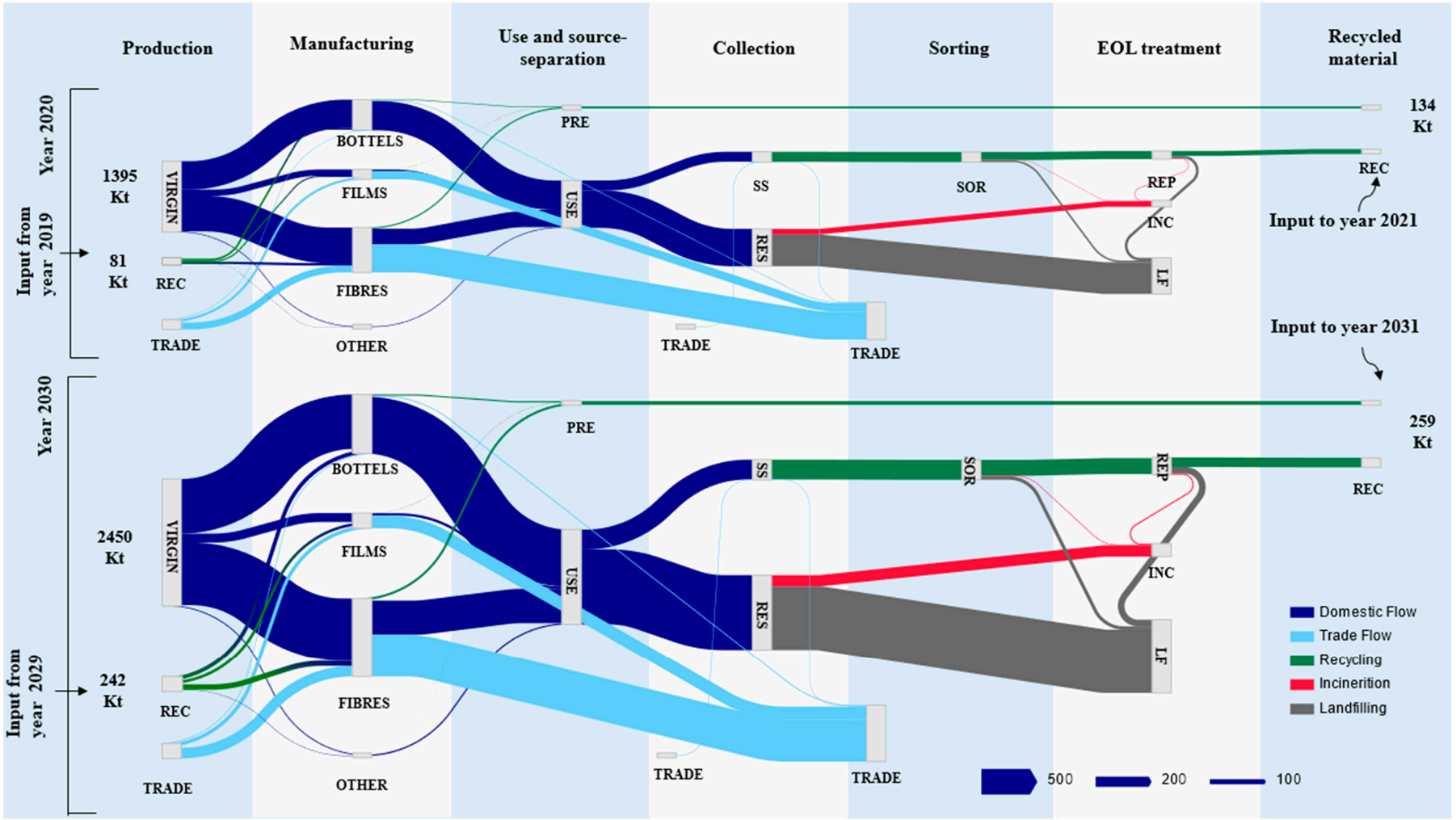


Figure S1.43 Sankey diagram for S0 in year 1 and year 30 in Thailand.

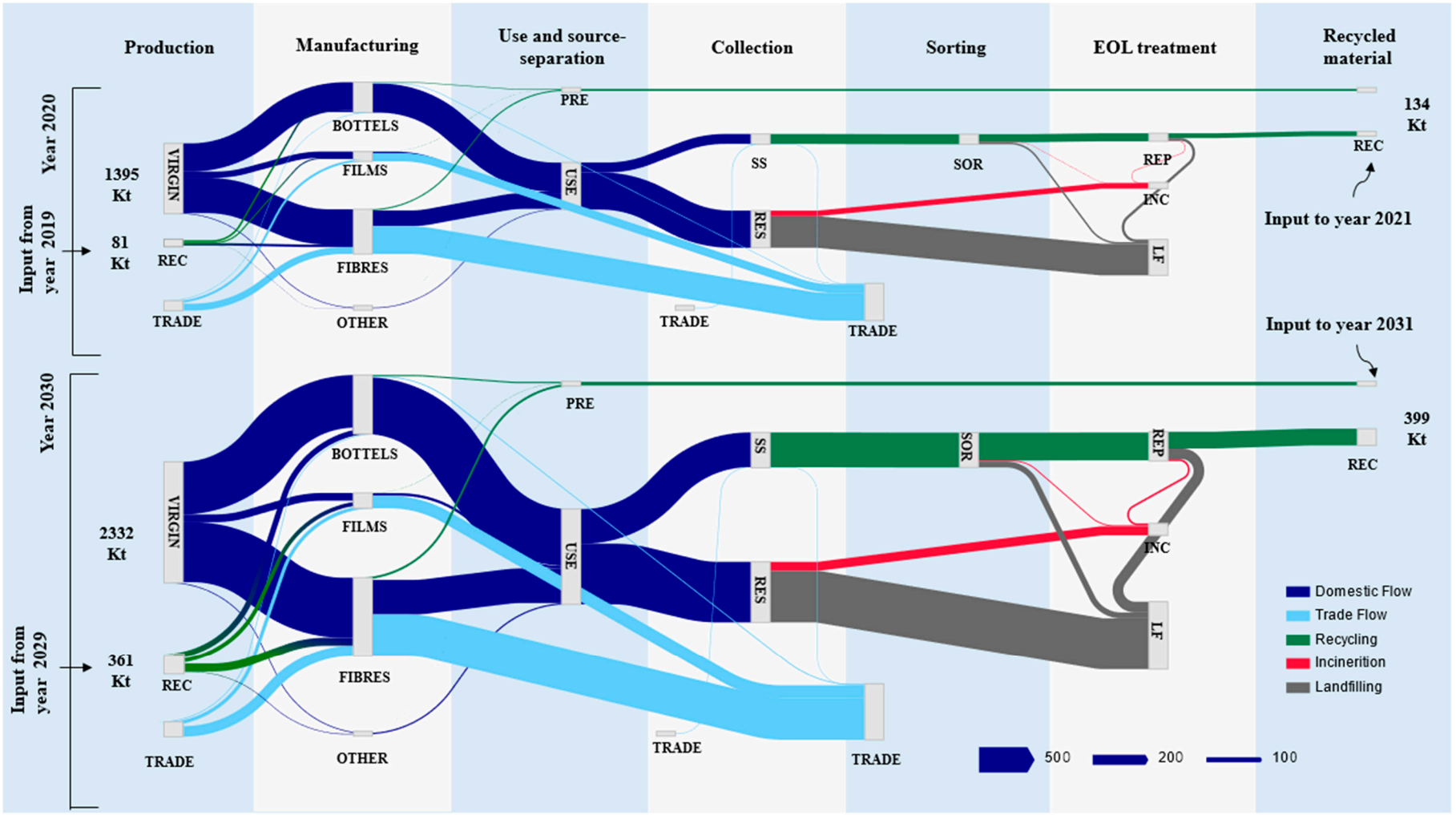


Figure S1.44 Sankey diagram for S1 in year 1 and year 30 in Thailand.

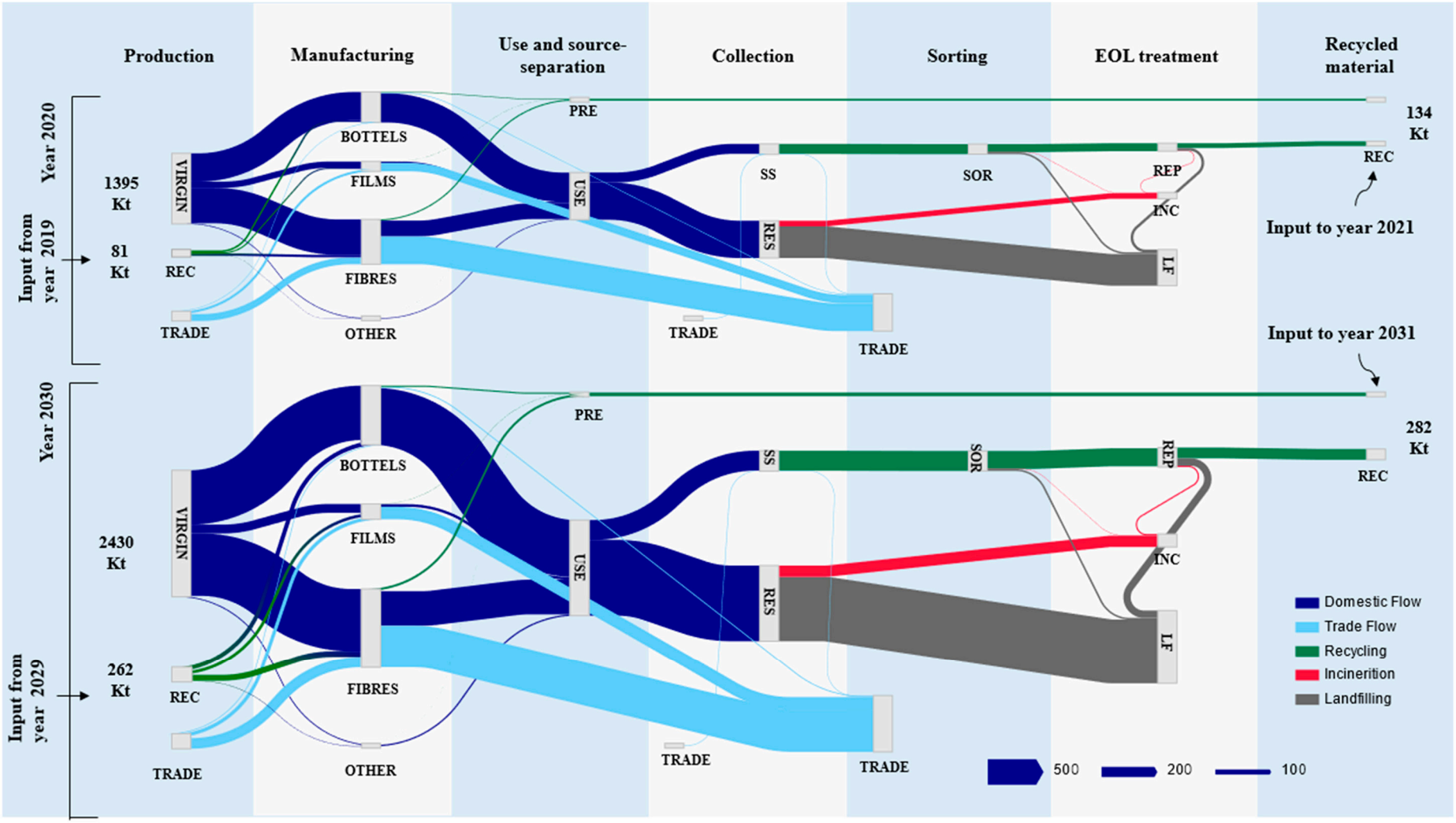


Figure S1.45 Sankey diagram for S2 in year 1 and year 30 in Thailand.

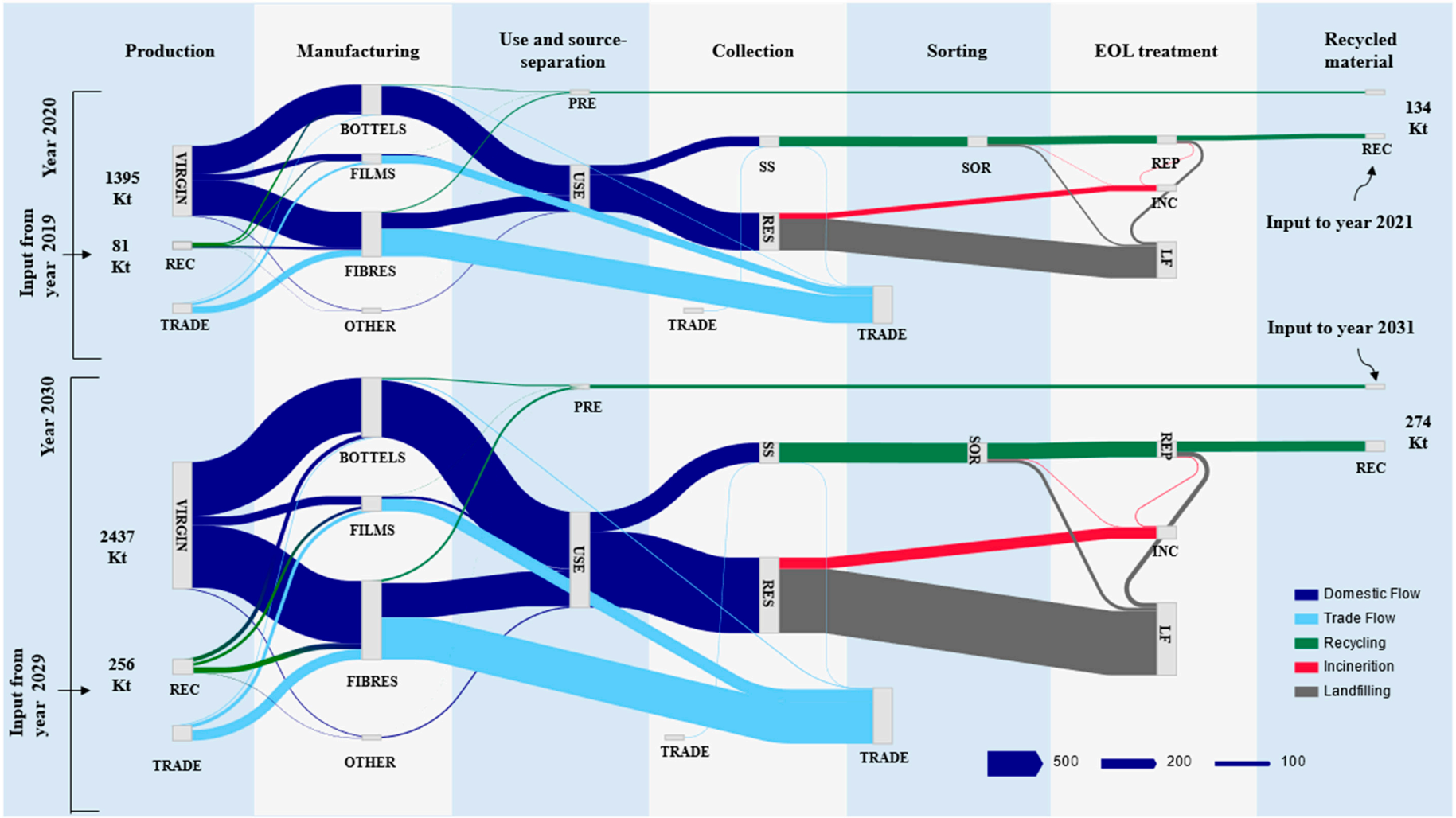


Figure S1.46 Sankey diagram for S3 in year 1 and year 30 in Thailand.

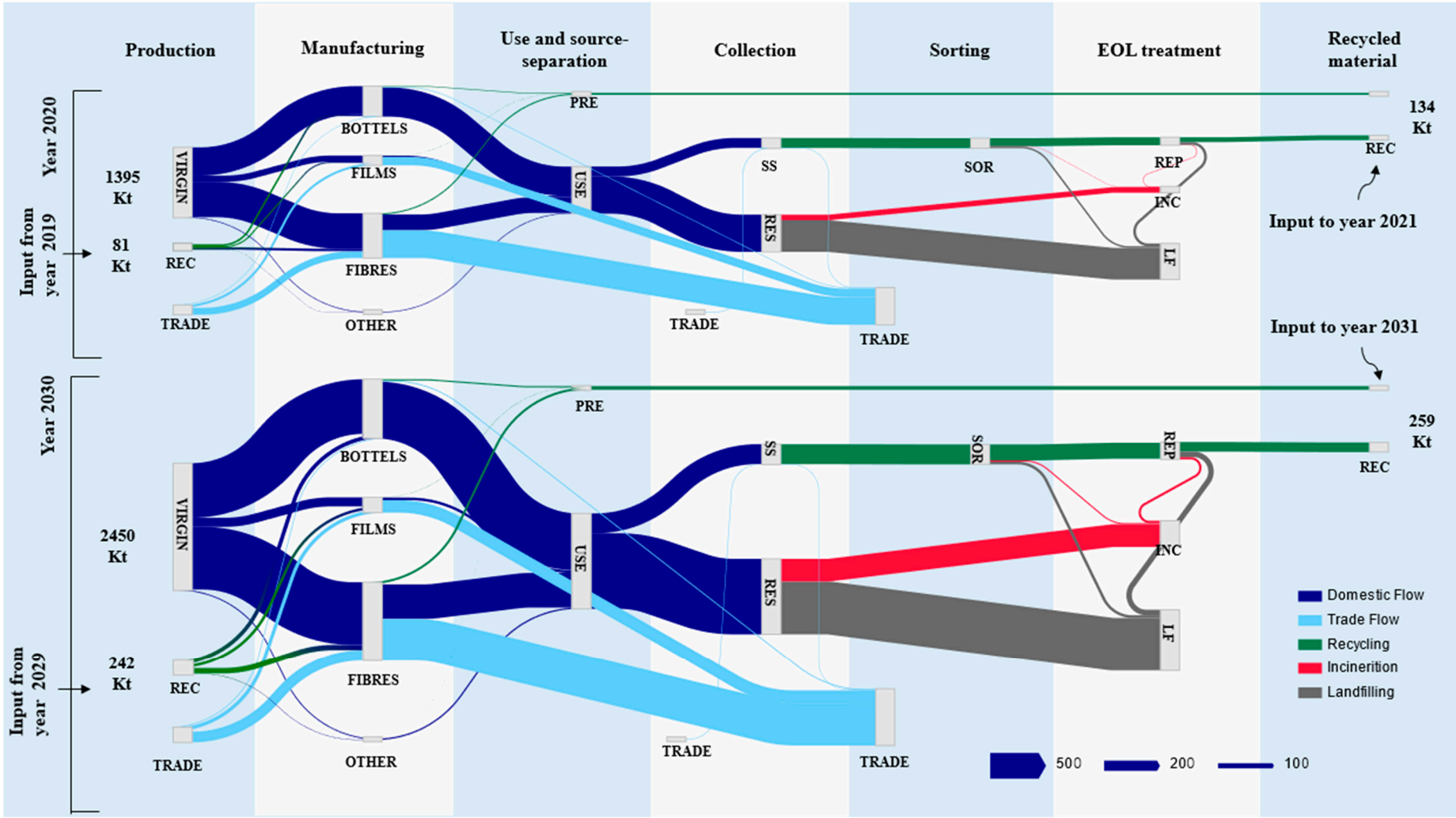


Figure S1.47 Sankey diagram for S4 in year 1 and year 30 in Thailand.

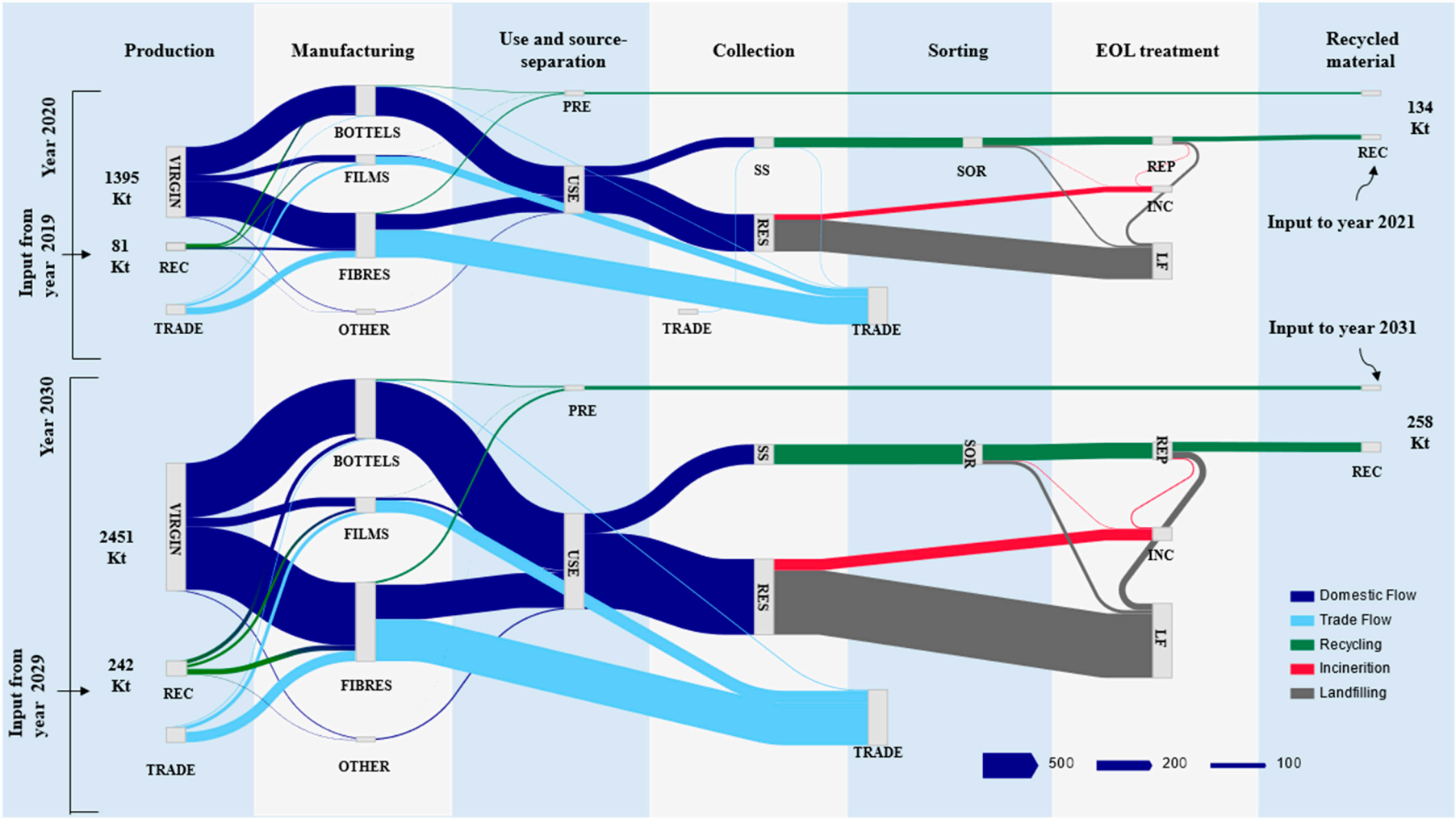


Figure S1.48 Sankey diagram for S5 in year 1 and year 30 in Thailand.

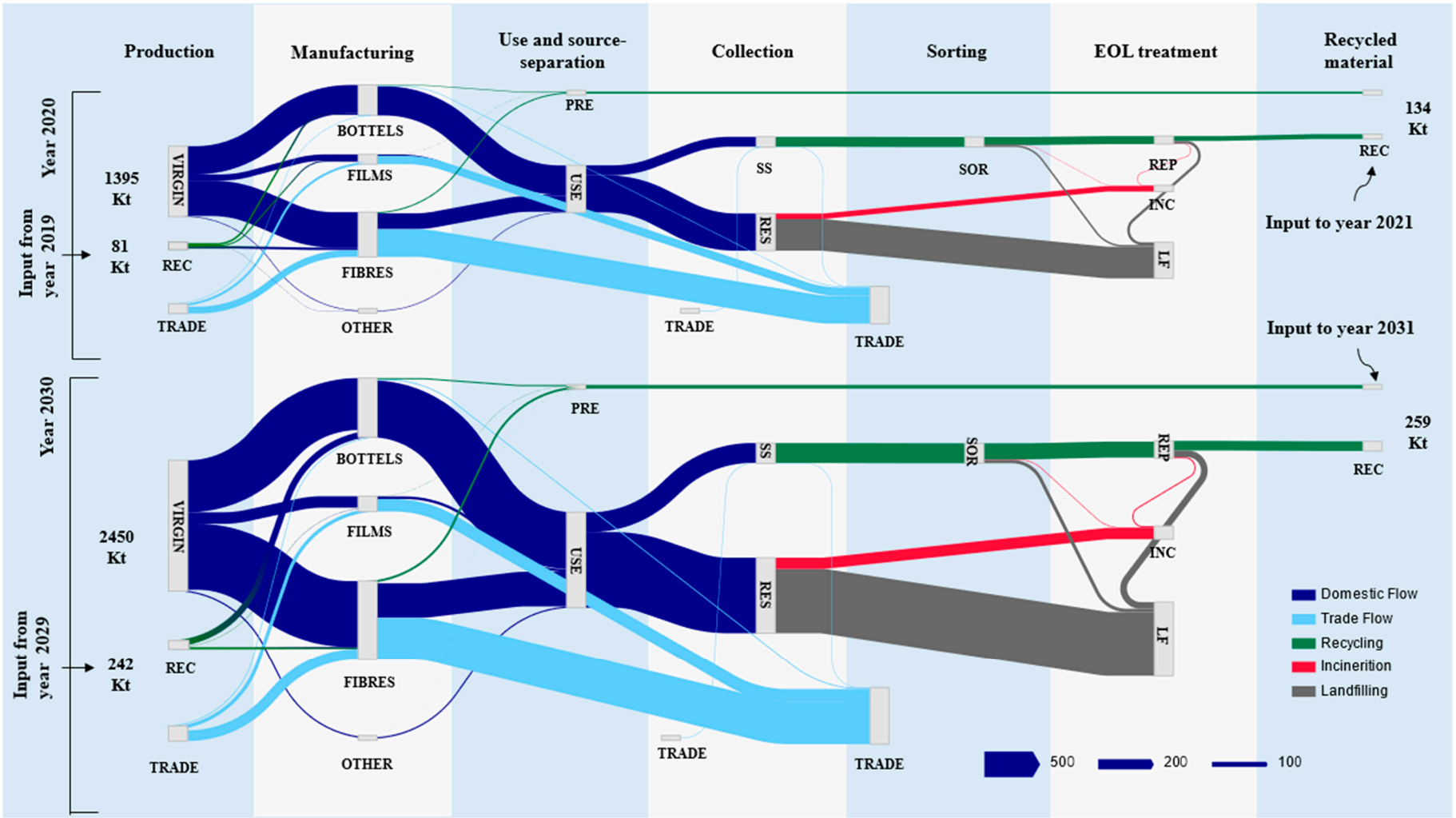


Figure S1.49 Sankey diagram for S6 in year 1 and year 30 in Thailand.

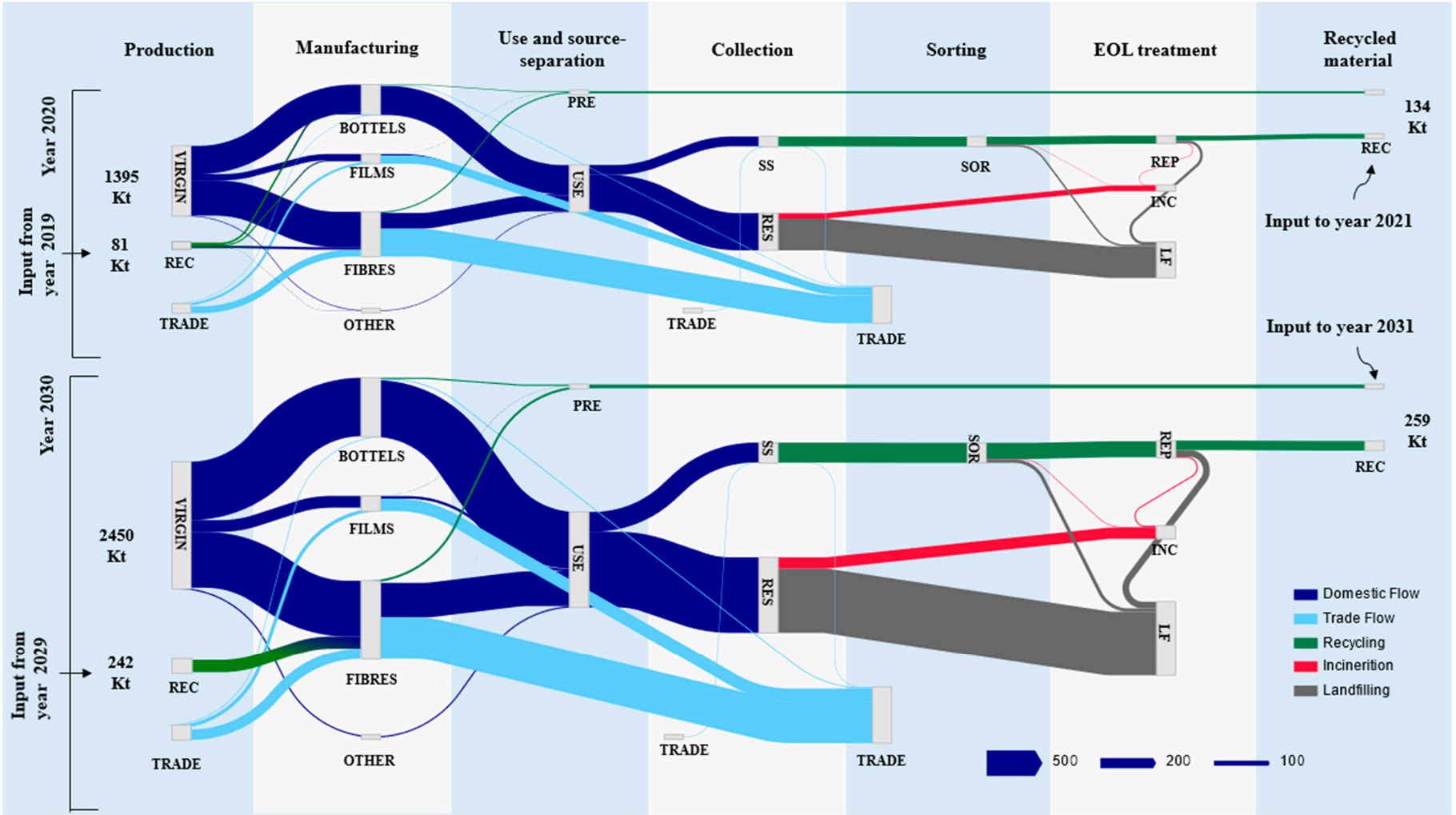


Figure S1.50 Sankey diagram for S7 in year 1 and year 30 in Thailand.

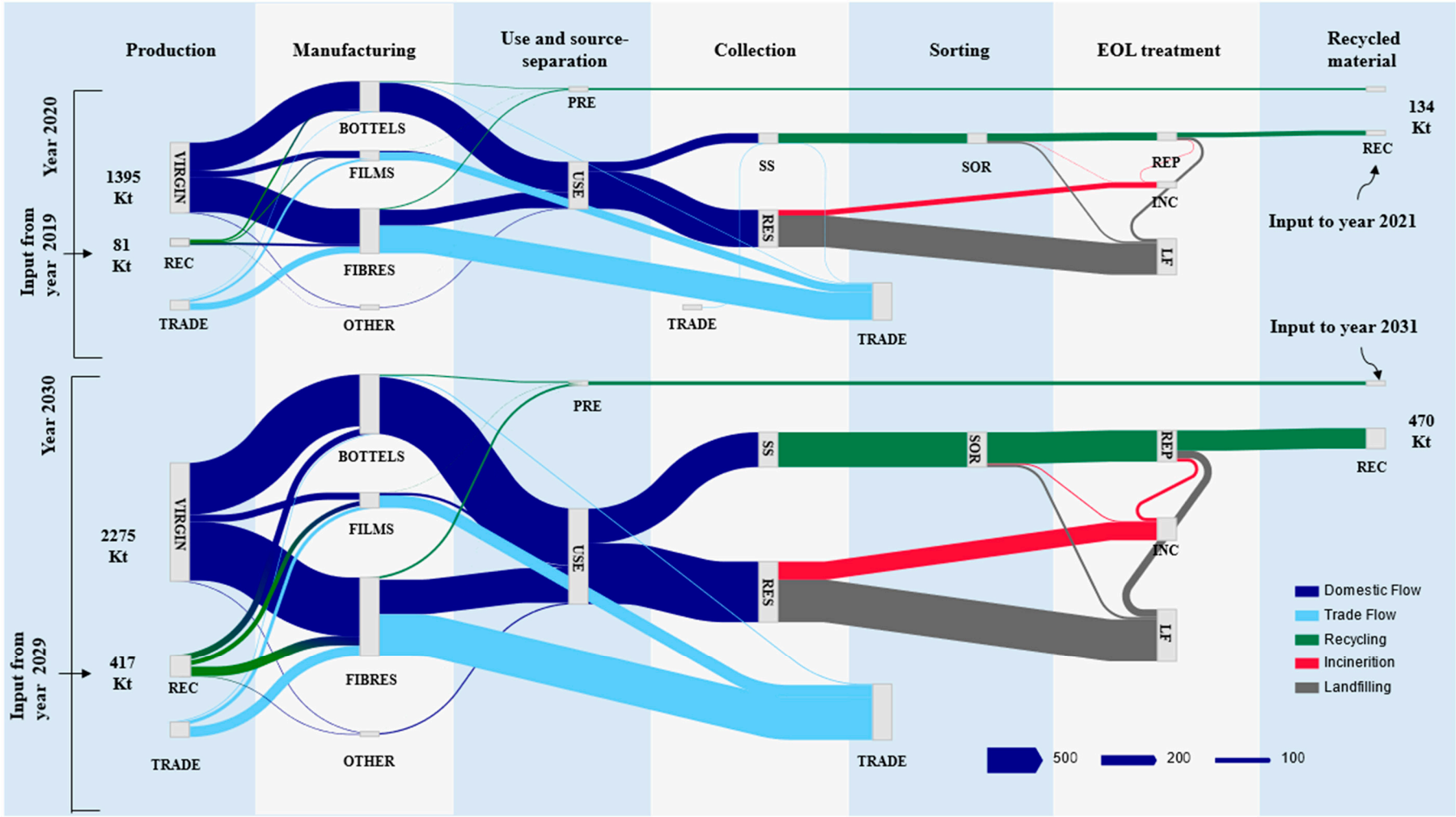


Figure S1.51 Sankey diagram for S8 in year 1 and year 30 in Thailand.

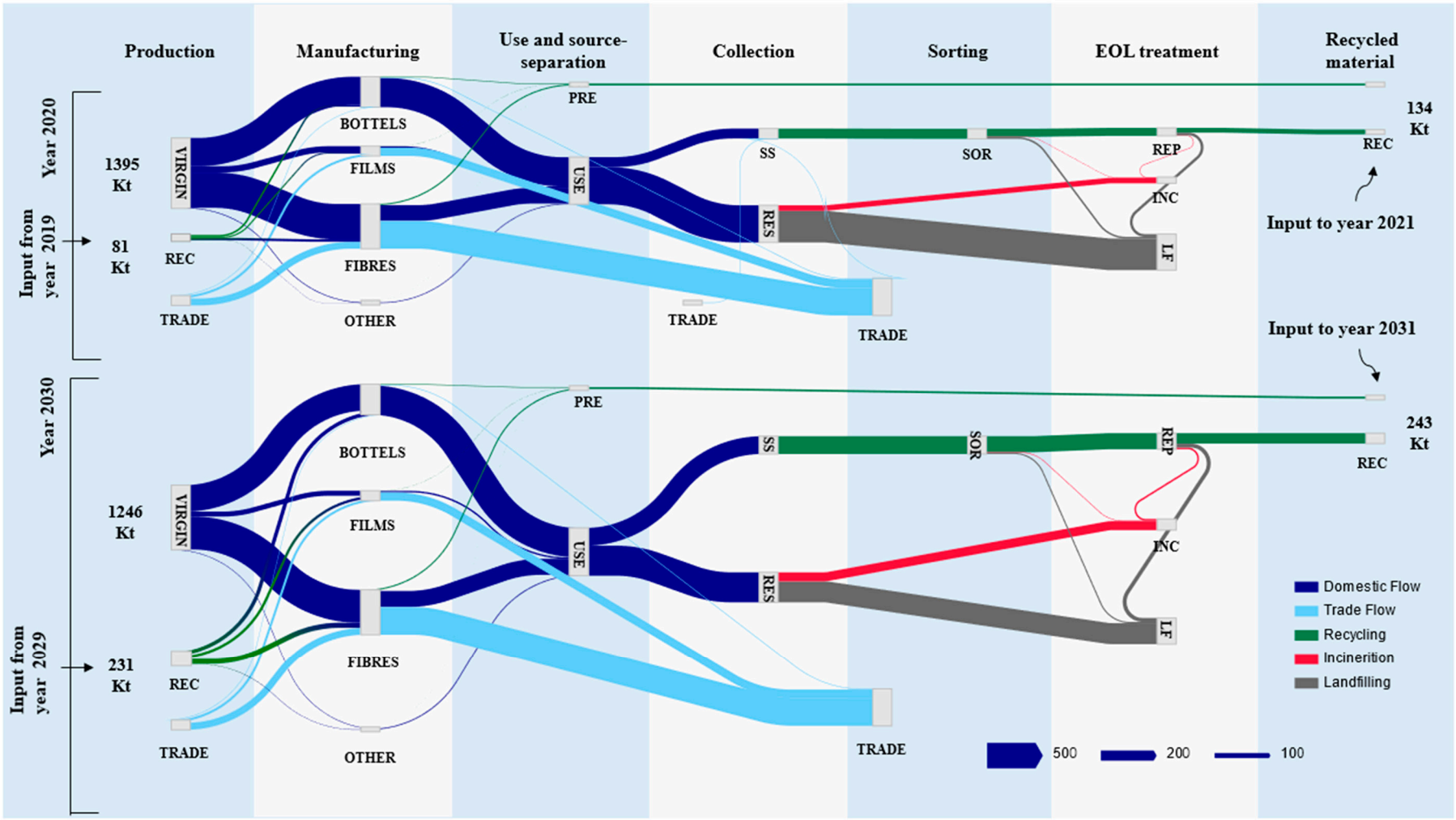


Figure S1.52 Sankey diagram for S9 in year 1 and year 30 in Thailand.

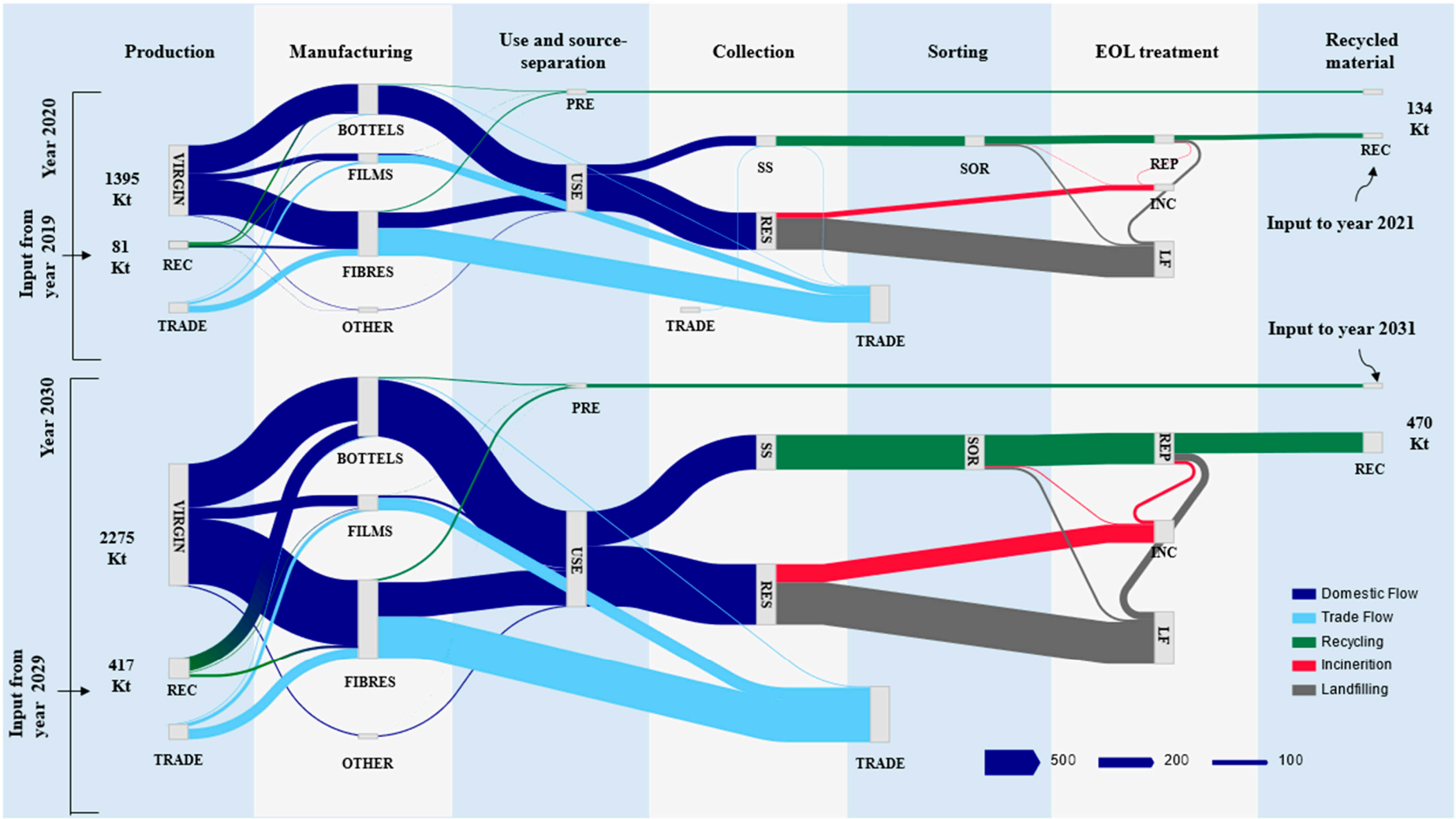


Figure S1.53 Sankey diagram for S10 in year 1 and year 30 in Thailand.

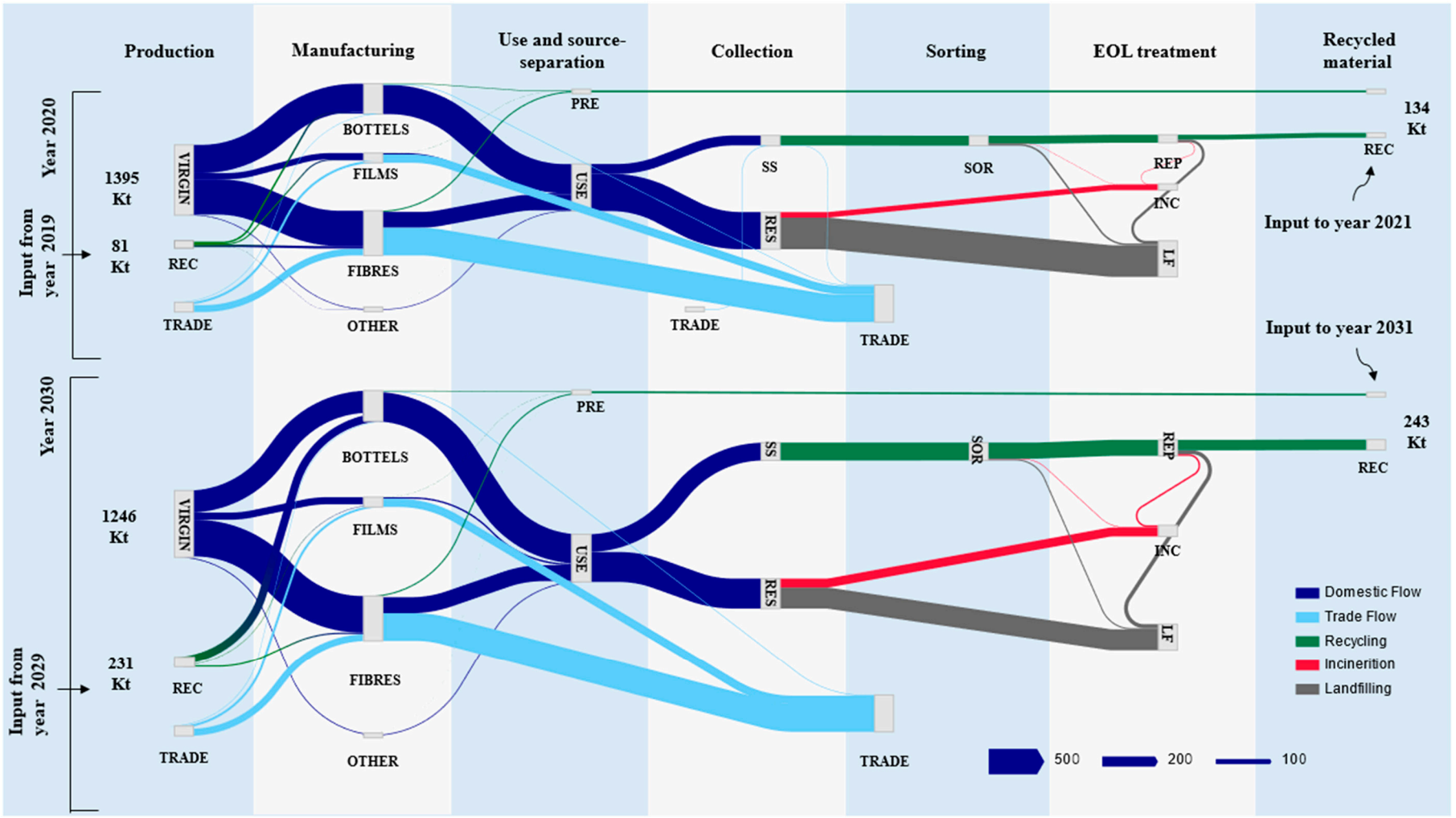


Figure S1.54 Sankey diagram for S11 in year 1 and year 30 in Thailand.

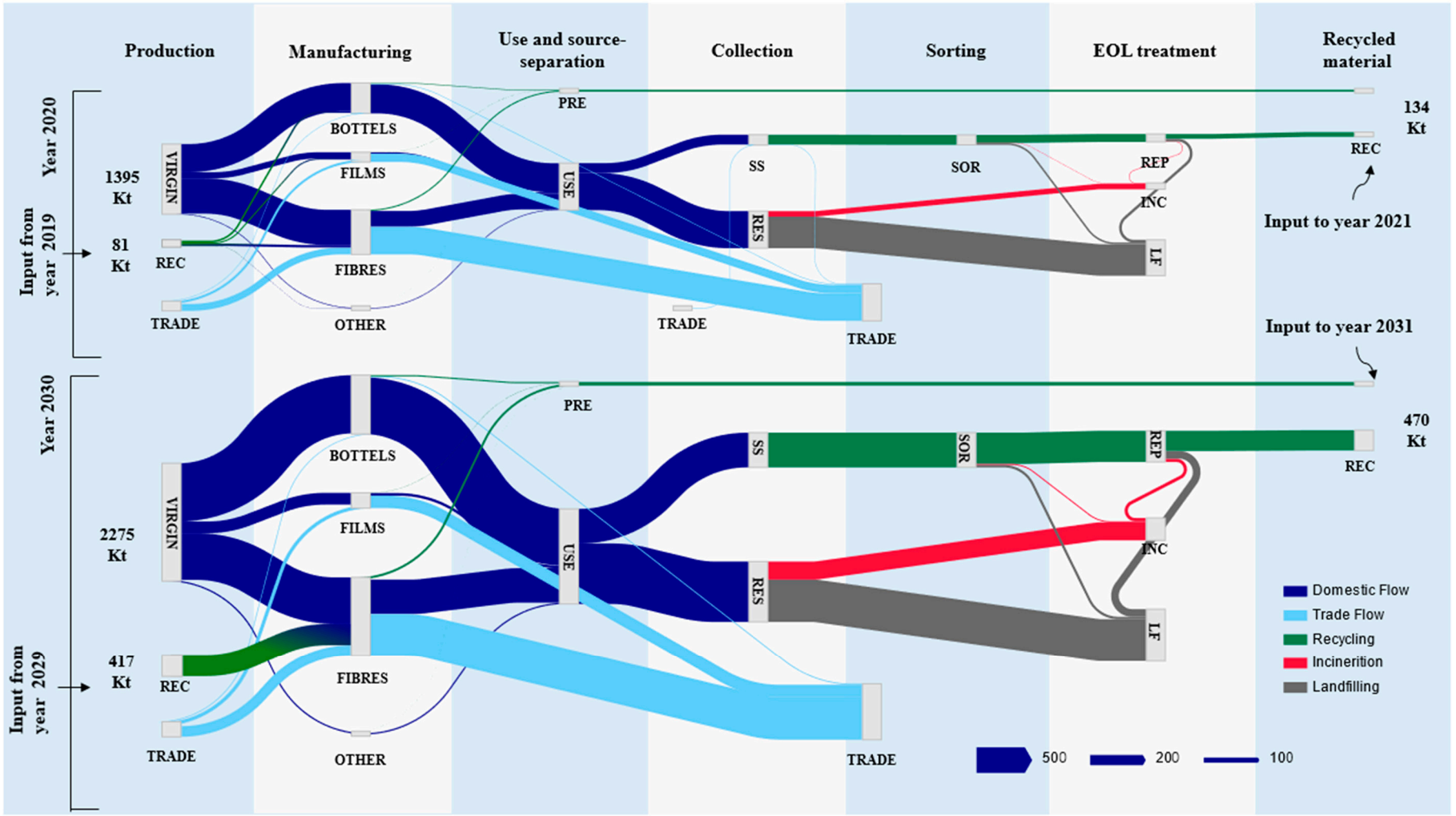


Figure S1.55 Sankey diagram for S12 in year 1 and year 30 in Thailand.

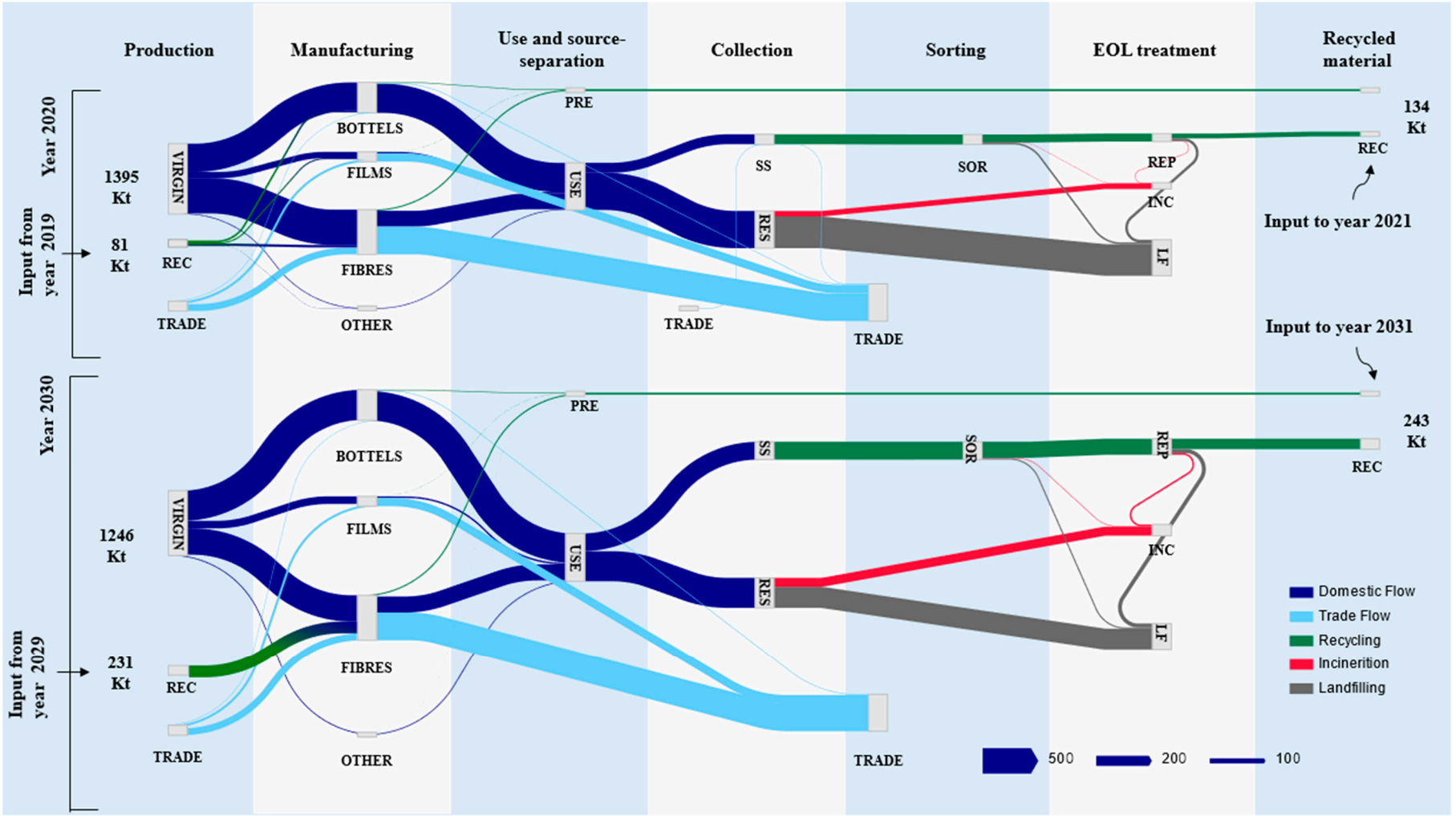


Figure S1.56 Sankey diagram for S13 in year 1 and year 30 in Thailand.

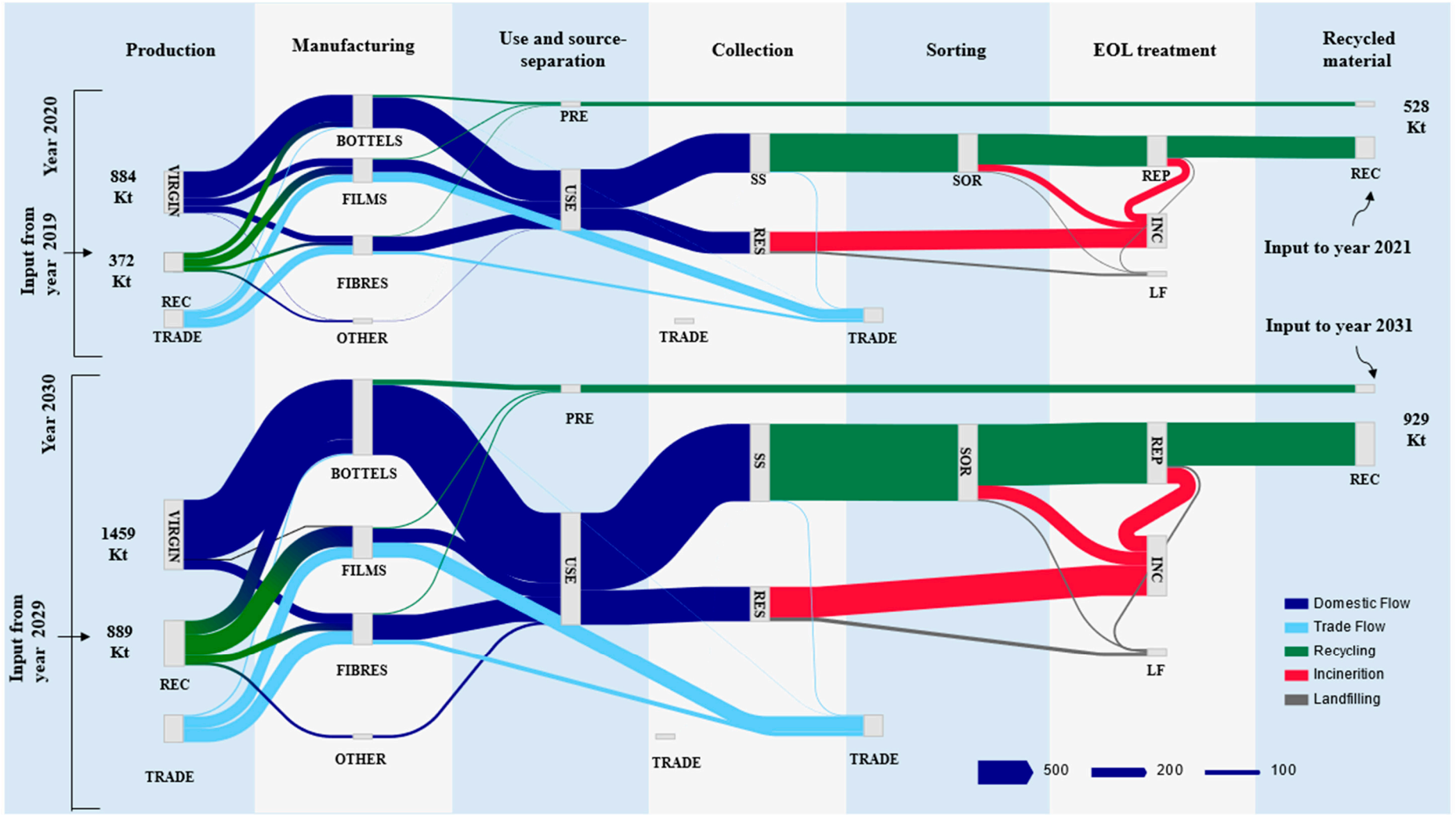


Figure S1.57 Sankey diagram for S0 in year 1 and year 30 in Japan.

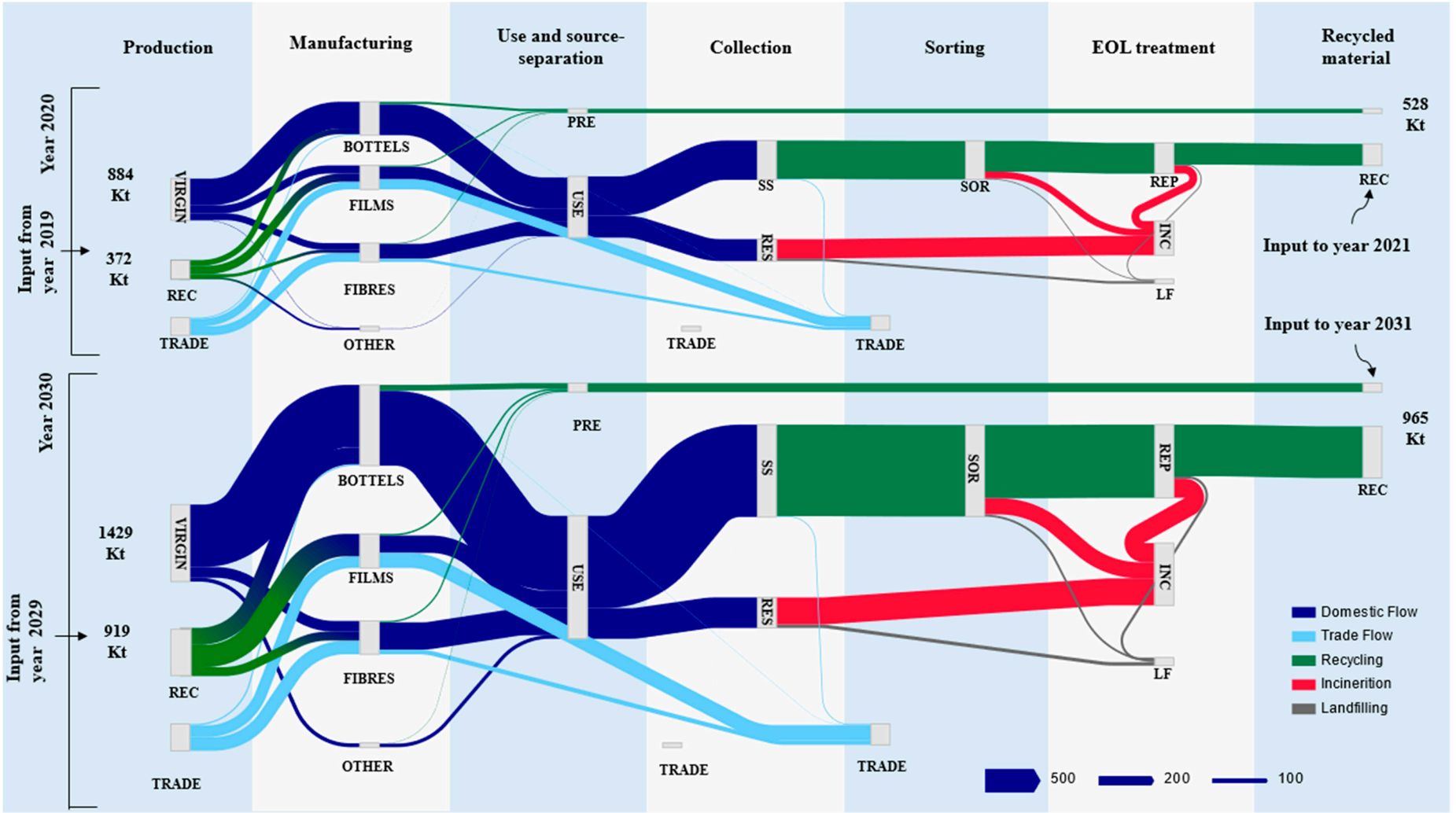


Figure S1.58 Sankey diagram for S1 in year 1 and year 30 in Japan.

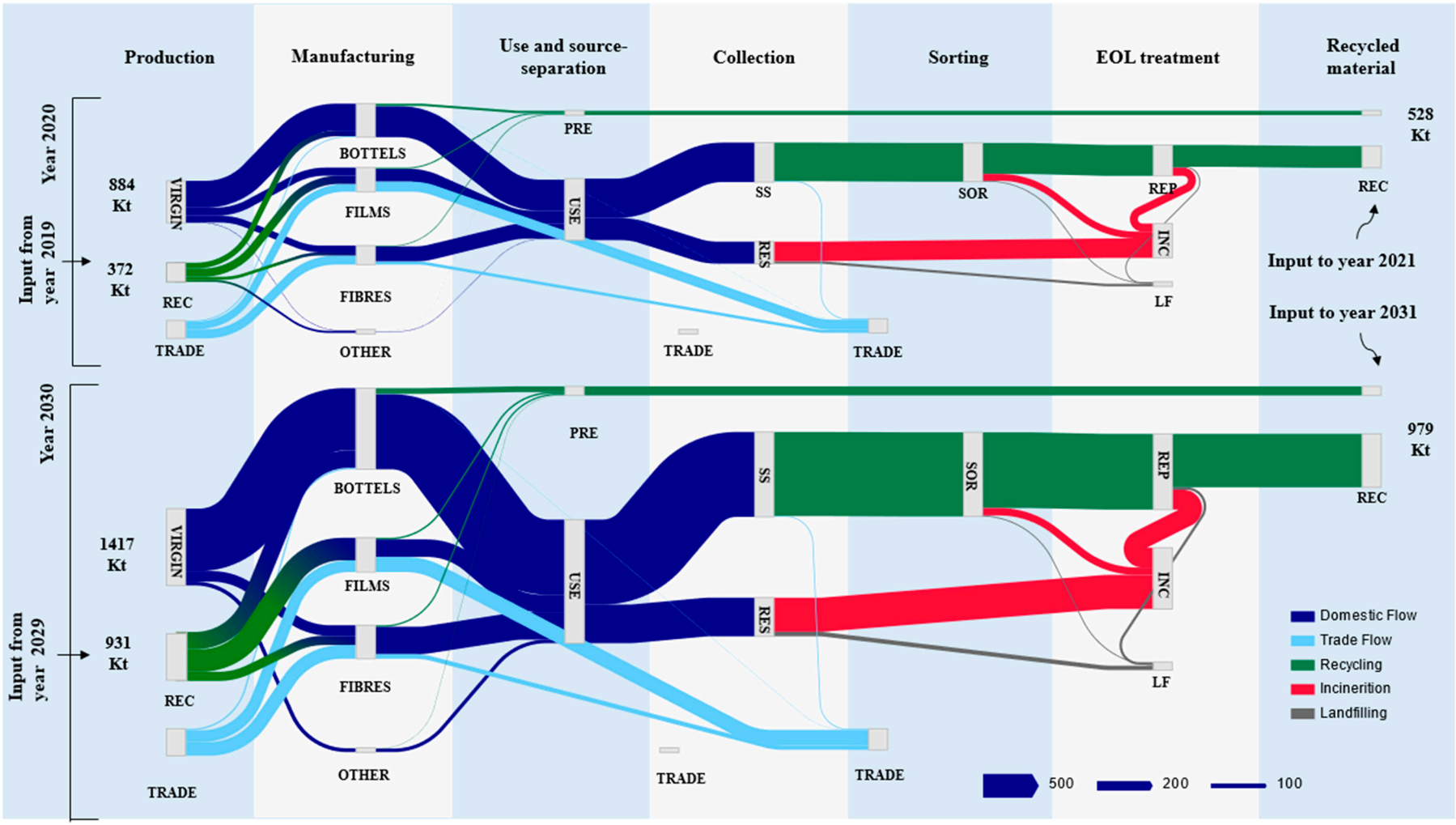


Figure S1.59 Sankey diagram for S2 in year 1 and year 30 in Japan.

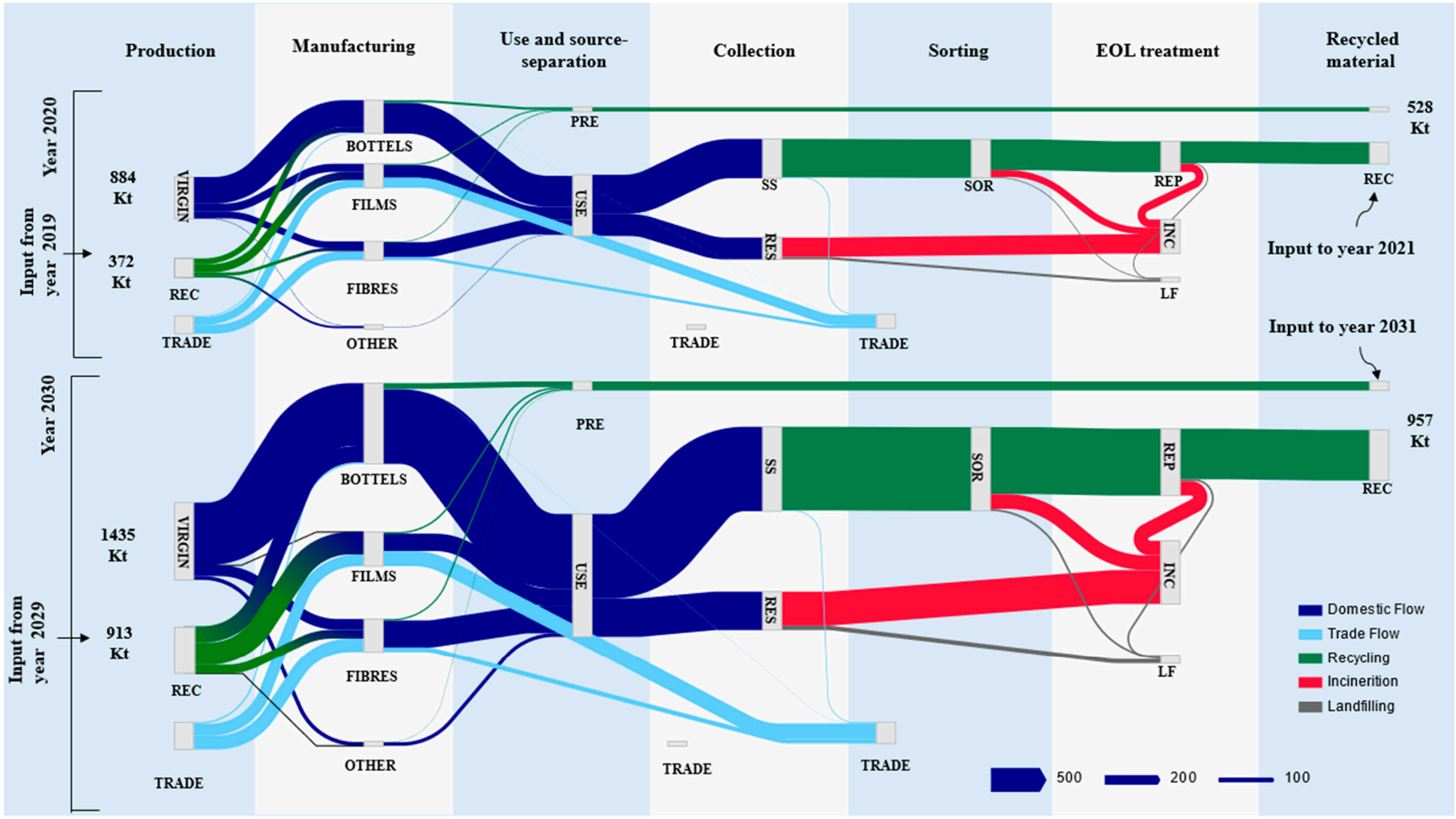


Figure S1.60 Sankey diagram for S3 in year 1 and year 30 in Japan.

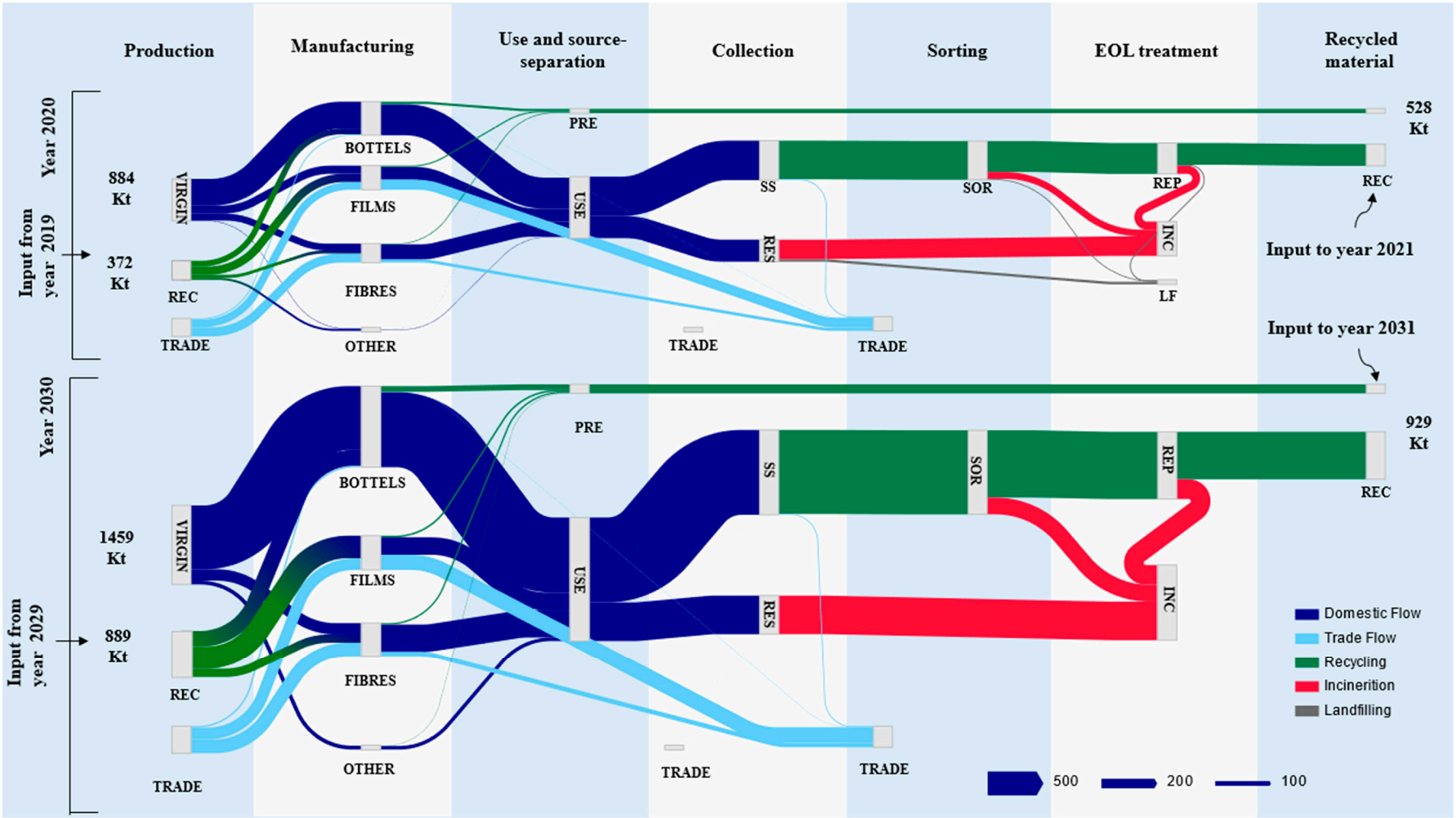


Figure S1.61 Sankey diagram for S4 in year 1 and year 30 in Japan.

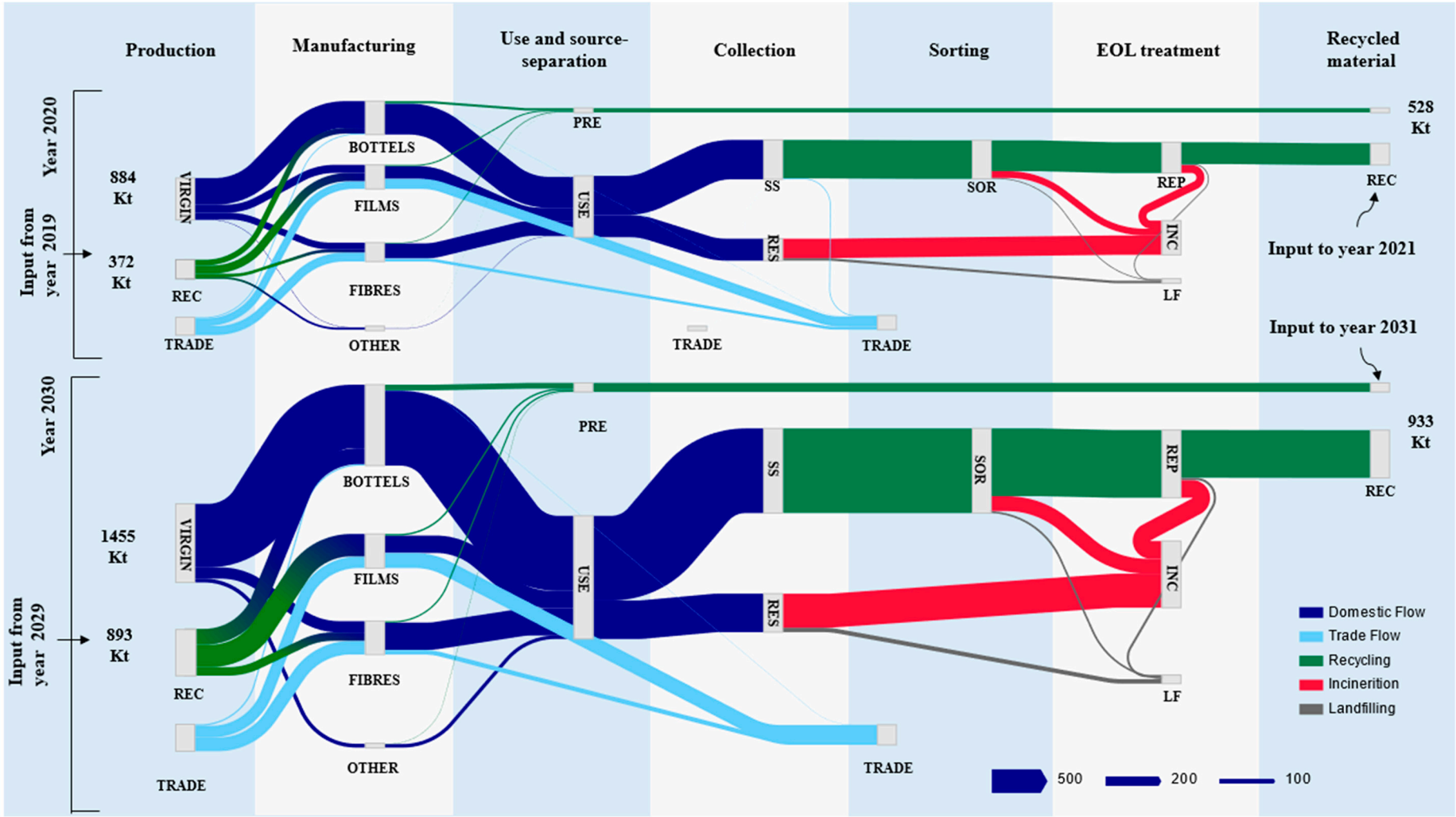


Figure S1.62 Sankey diagram for S5 in year 1 and year 30 in Japan.

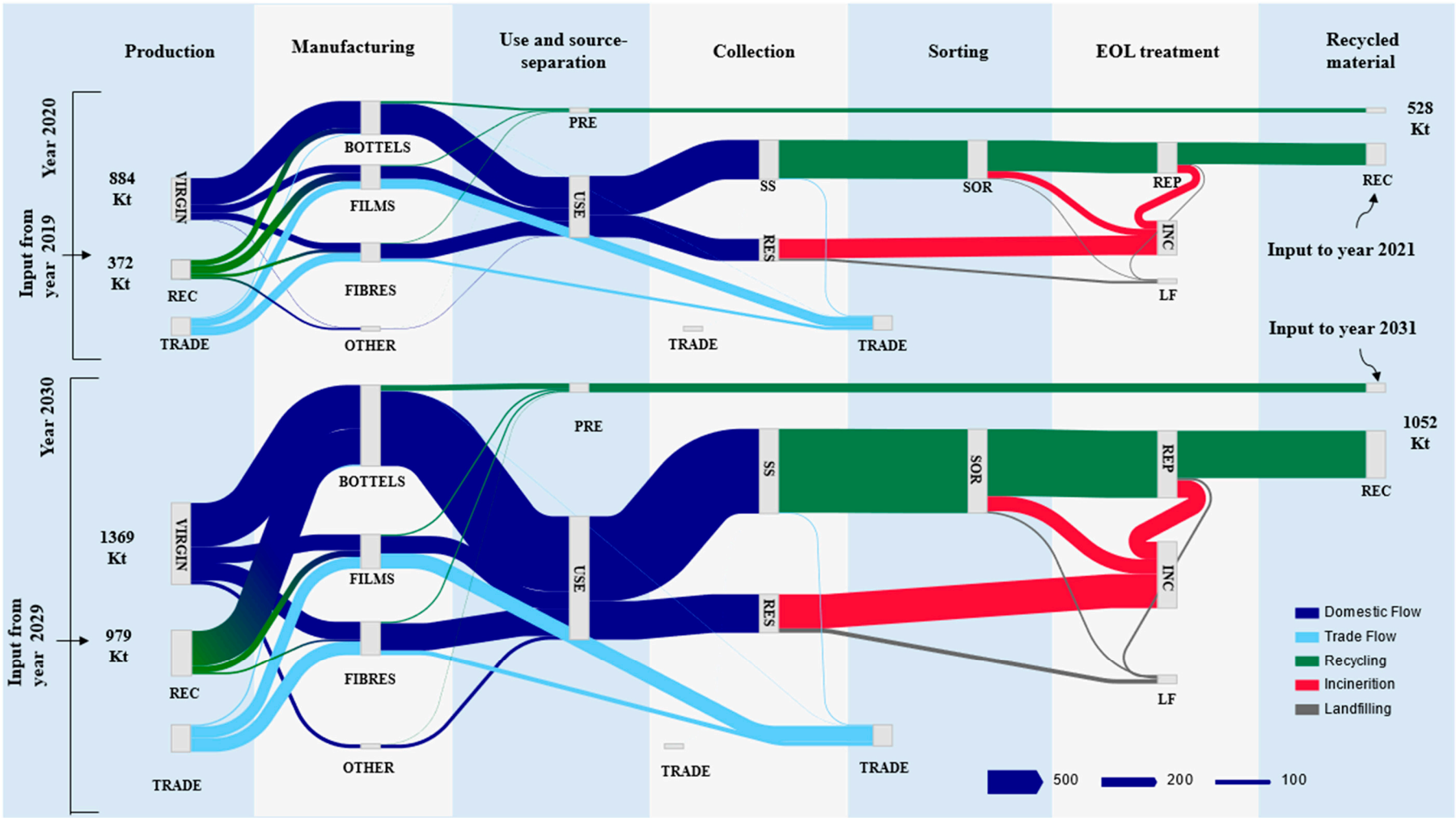


Figure S1.63 Sankey diagram for S6 in year 1 and year 30 in Japan.

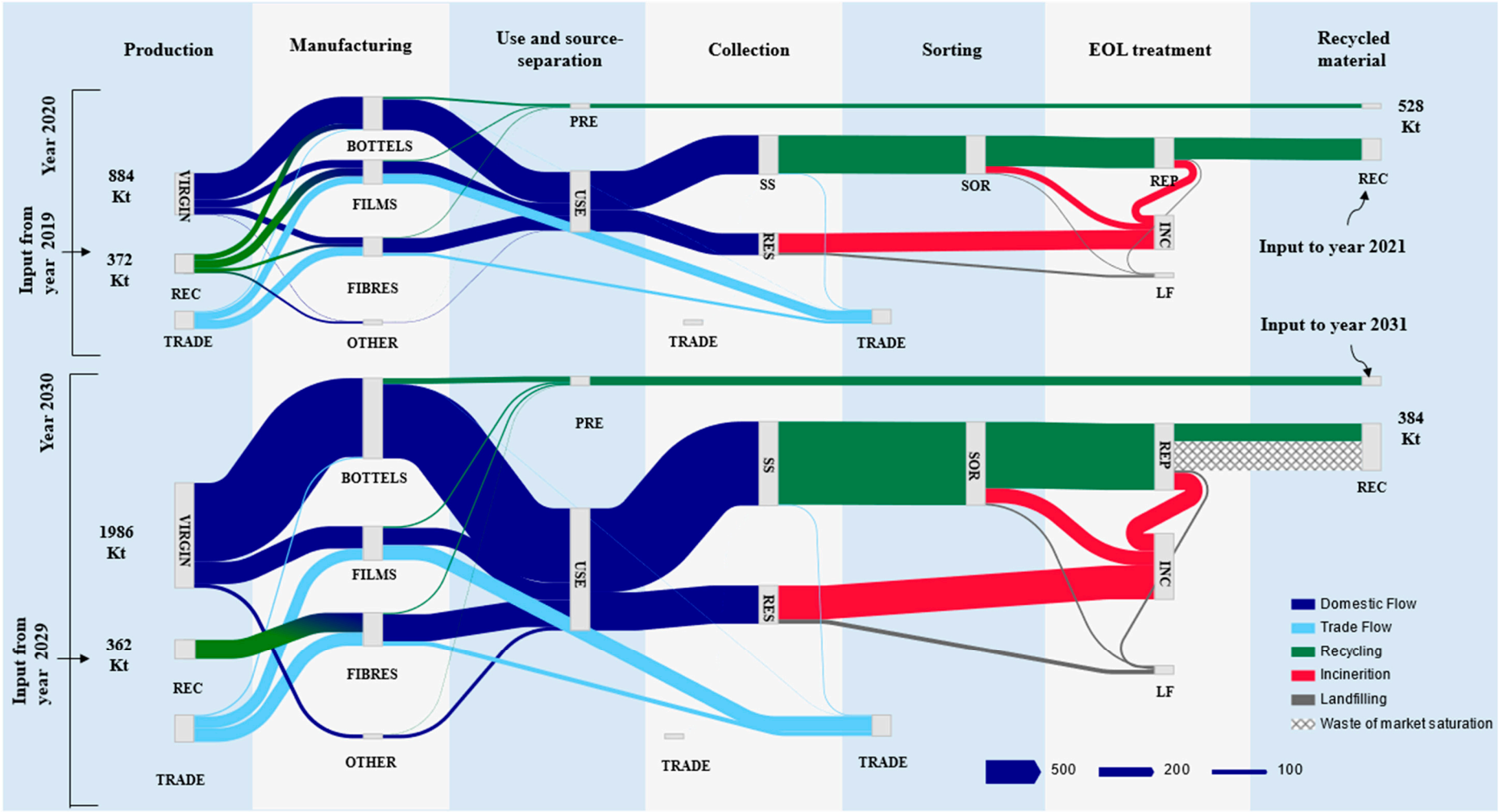


Figure S1.64 Sankey diagram for S7 in year 1 and year 30 in Japan.

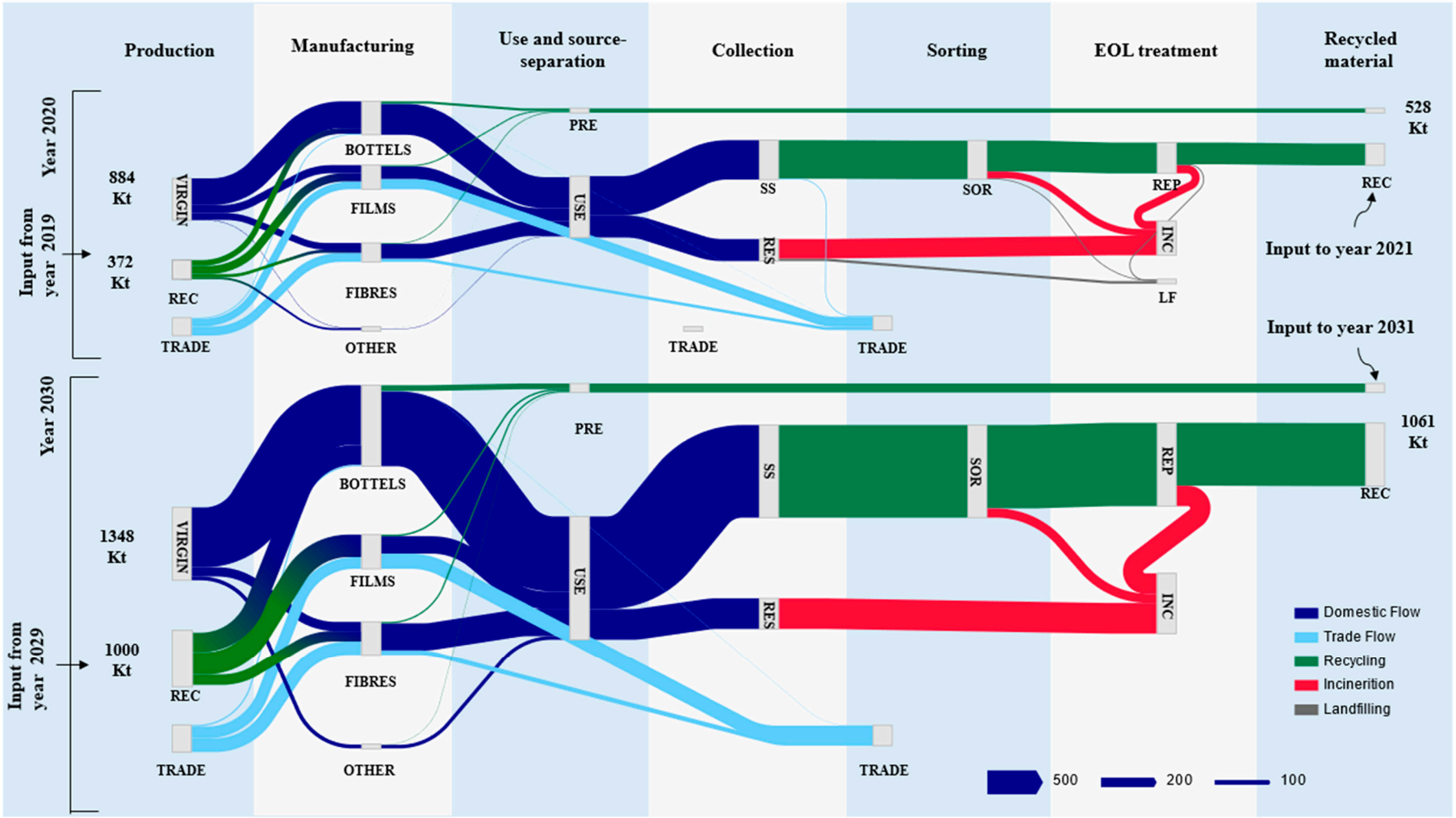


Figure S1.65 Sankey diagram for S8 in year 1 and year 30 in Japan.

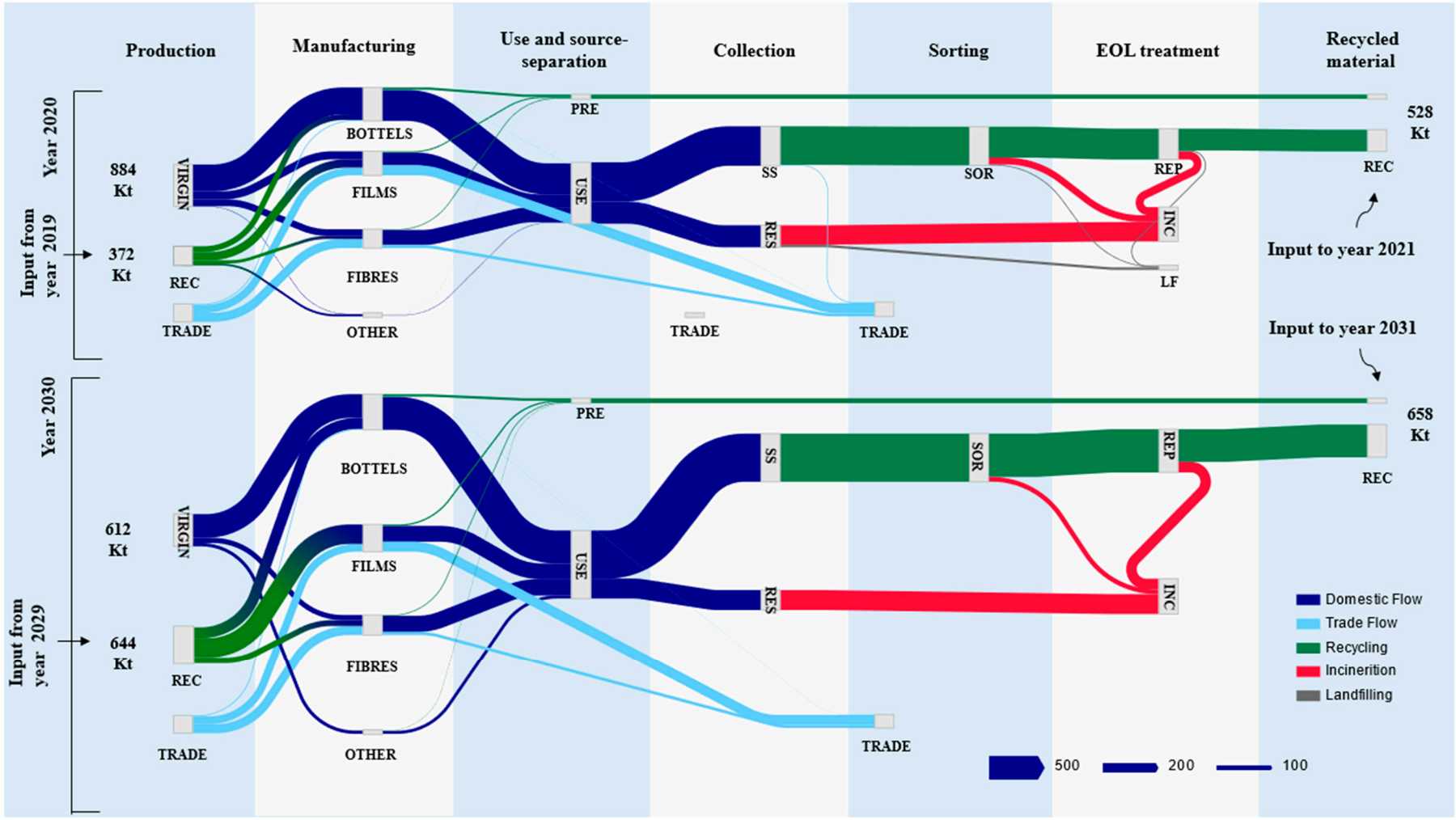


Figure S1.66 Sankey diagram for S9 in year 1 and year 30 in Japan.

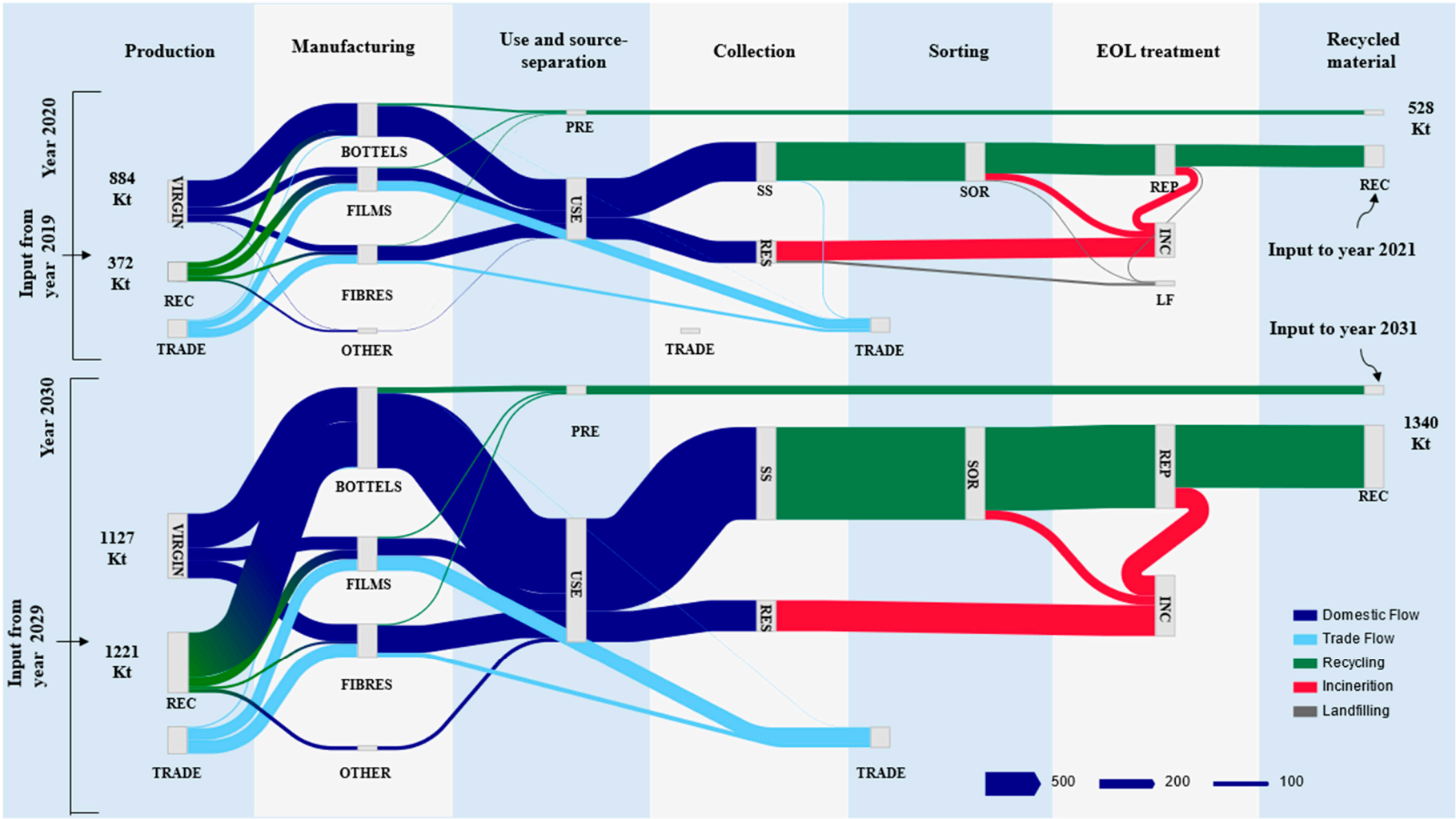


Figure S1.67 Sankey diagram for S10 in year 1 and year 30 in Japan.

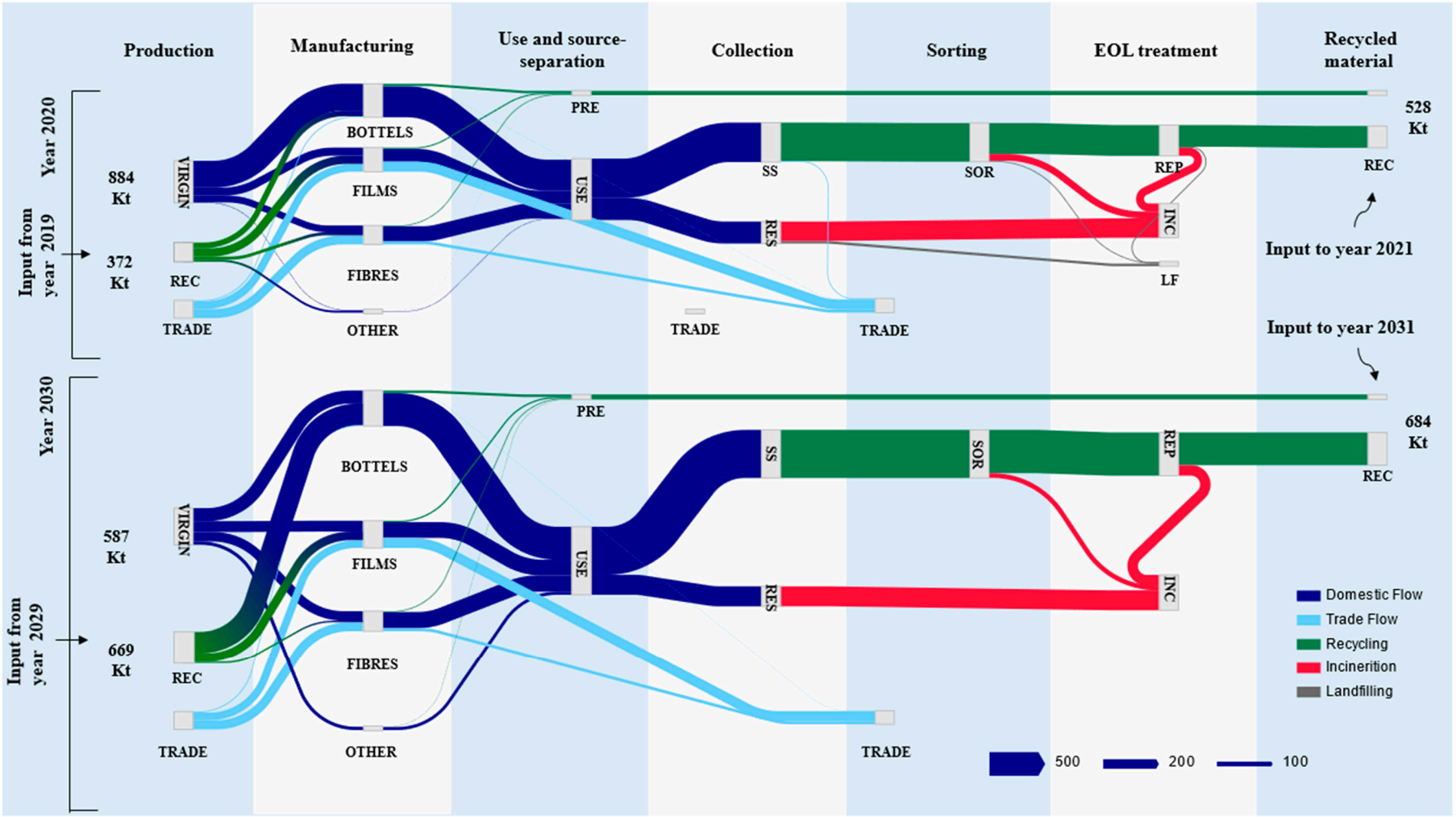


Figure S1.68 Sankey diagram for S11 in year 1 and year 30 in Japan.

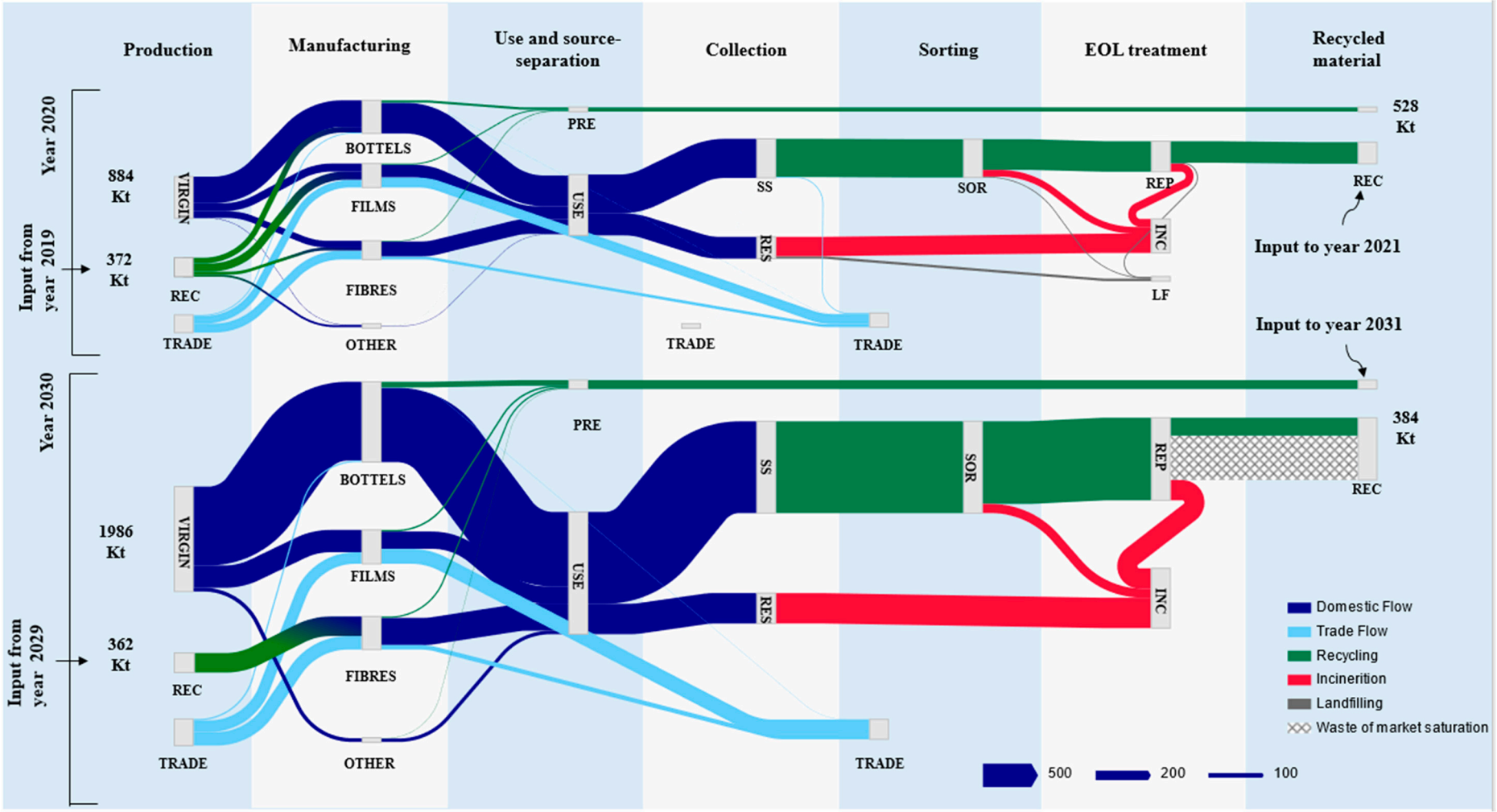


Figure S1.69 Sankey diagram for S12 in year 1 and year 30 in Japan.

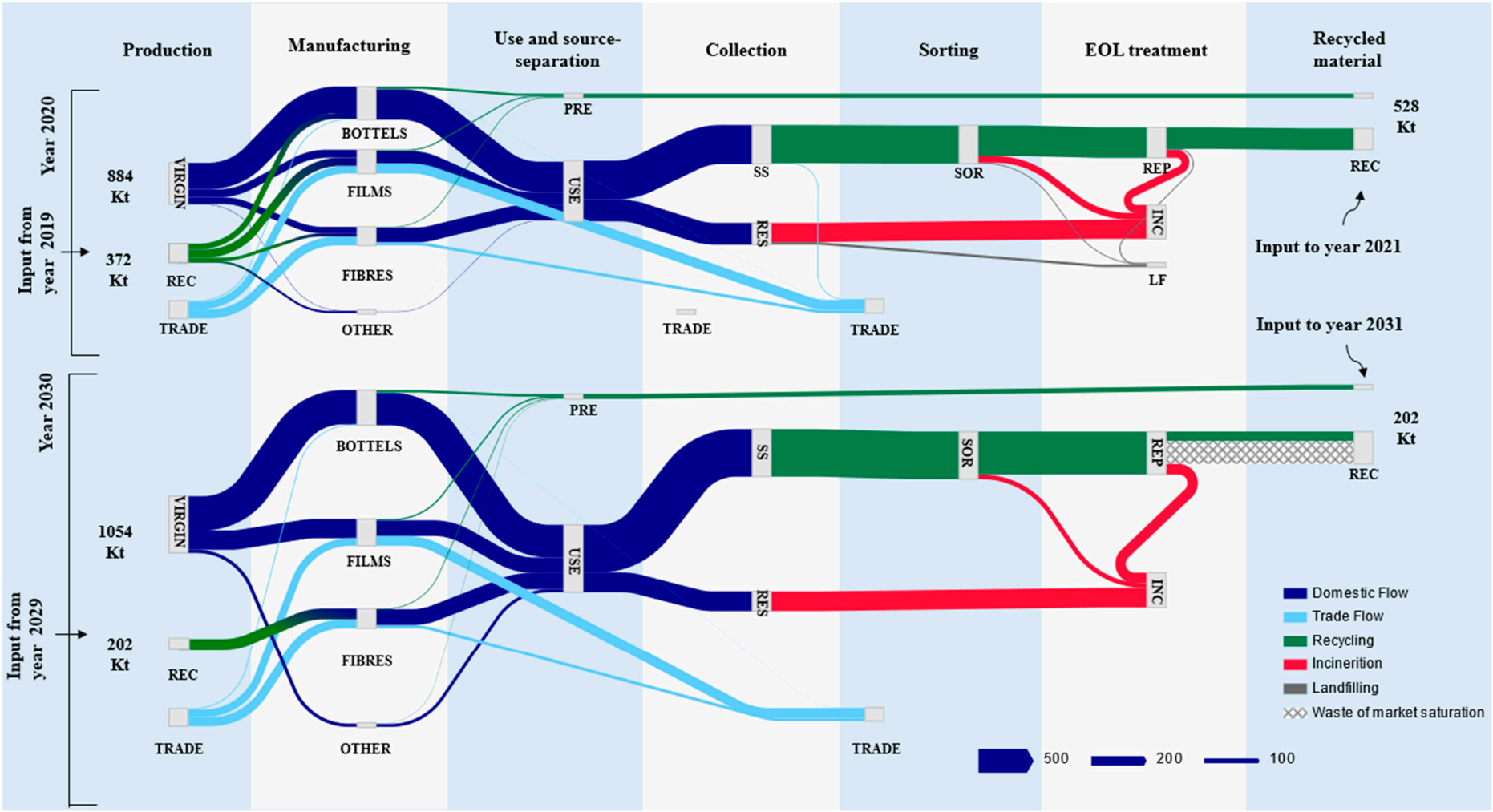


Figure S1.70 Sankey diagram for S13 in year 1 and year 30 in Japan.

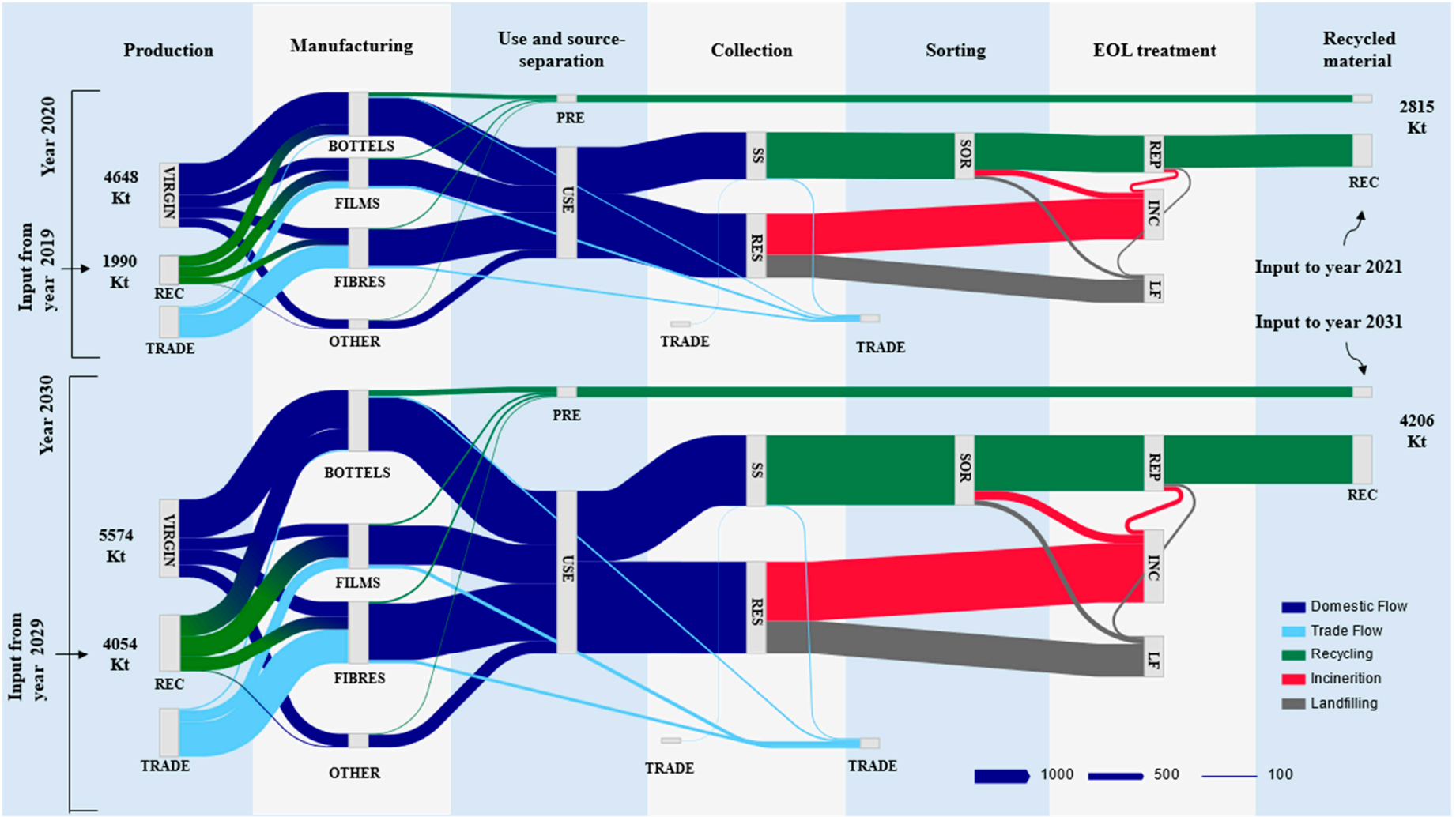


Figure S1.71 Sankey diagram for S0 in year 1 and year 30 in Europe.

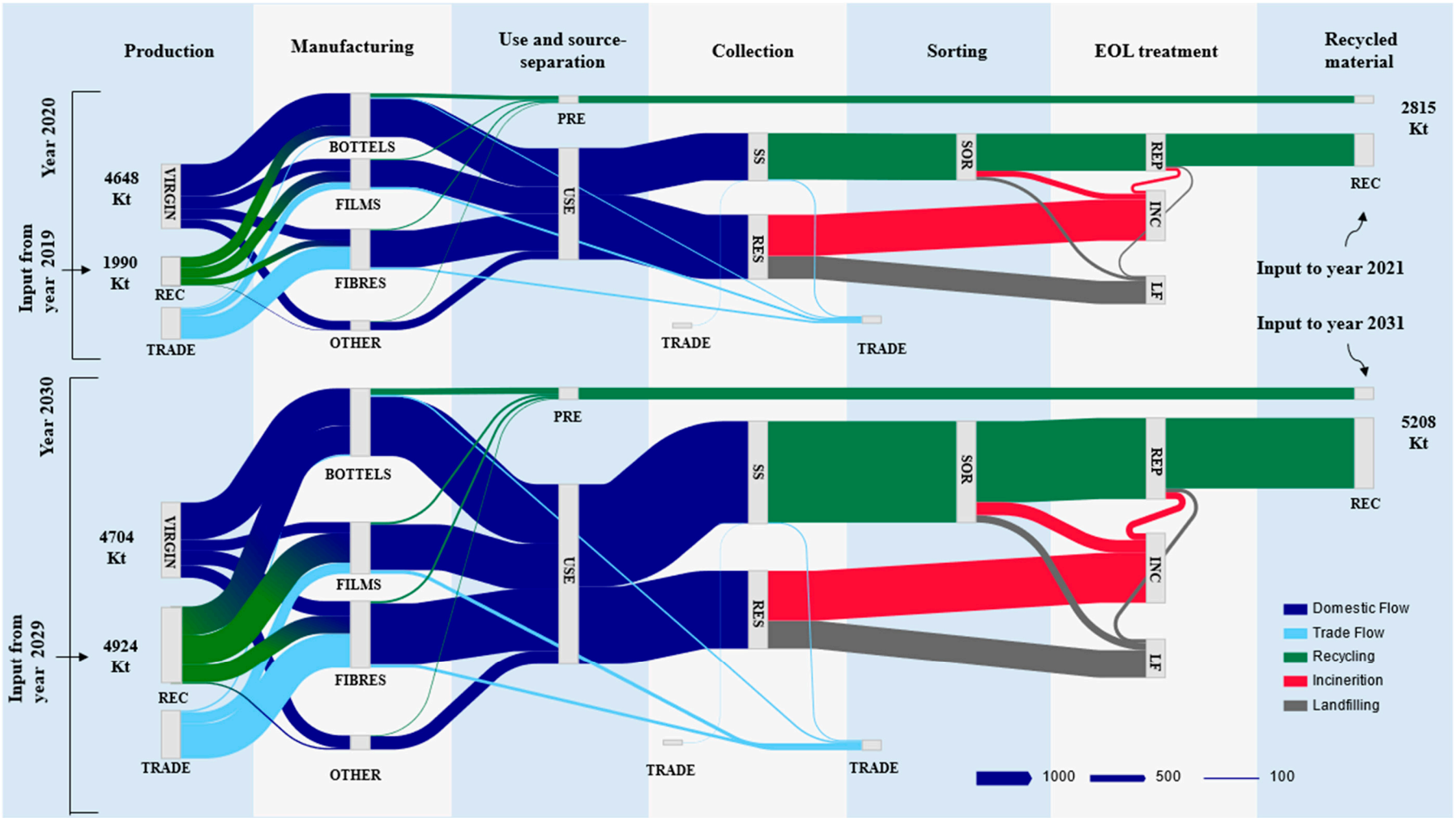


Figure S1.72 Sankey diagram for S1 in year 1 and year 30 in Europe.

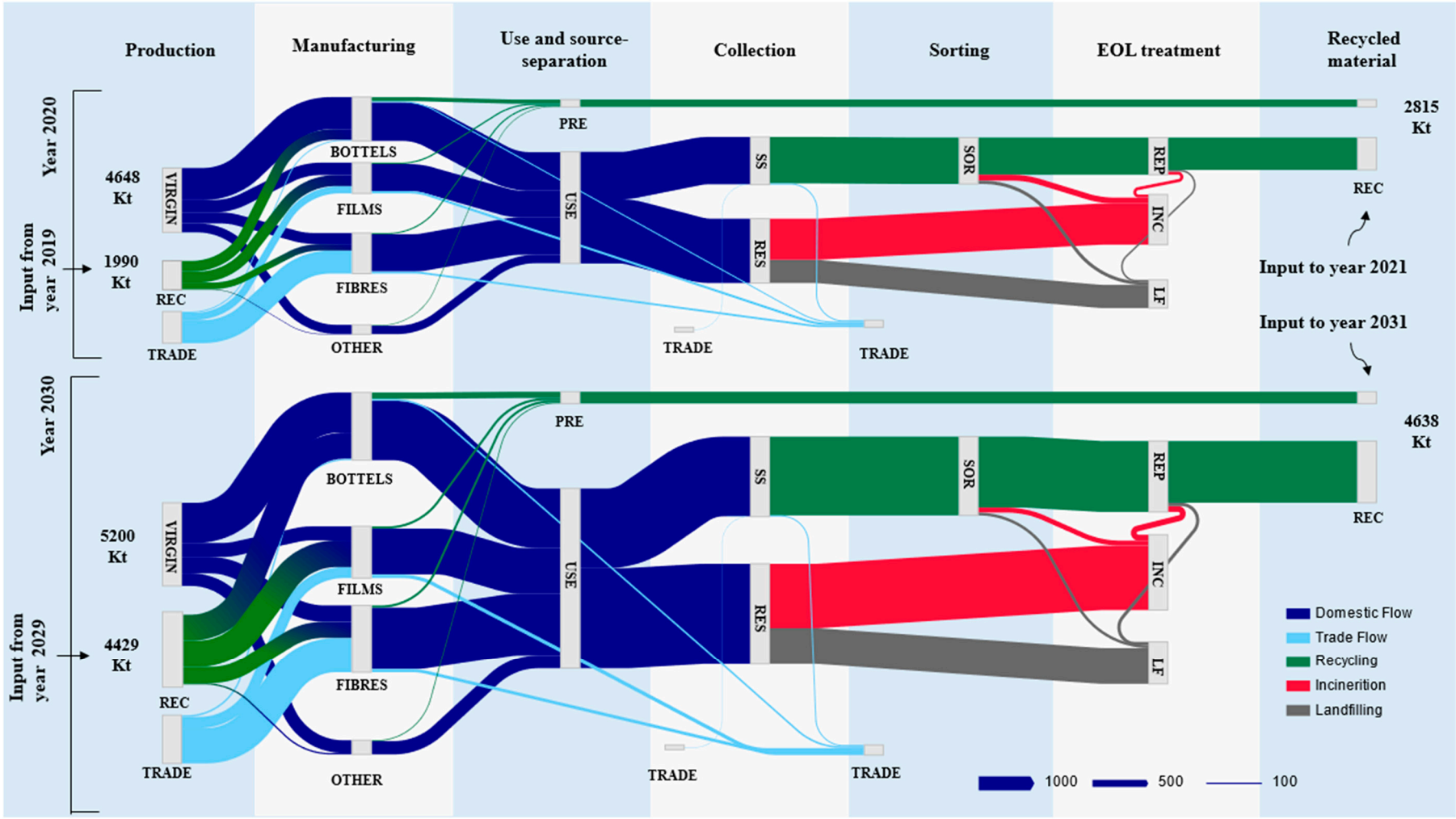


Figure S1.73 Sankey diagram for S2 in year 1 and year 30 in Europe.

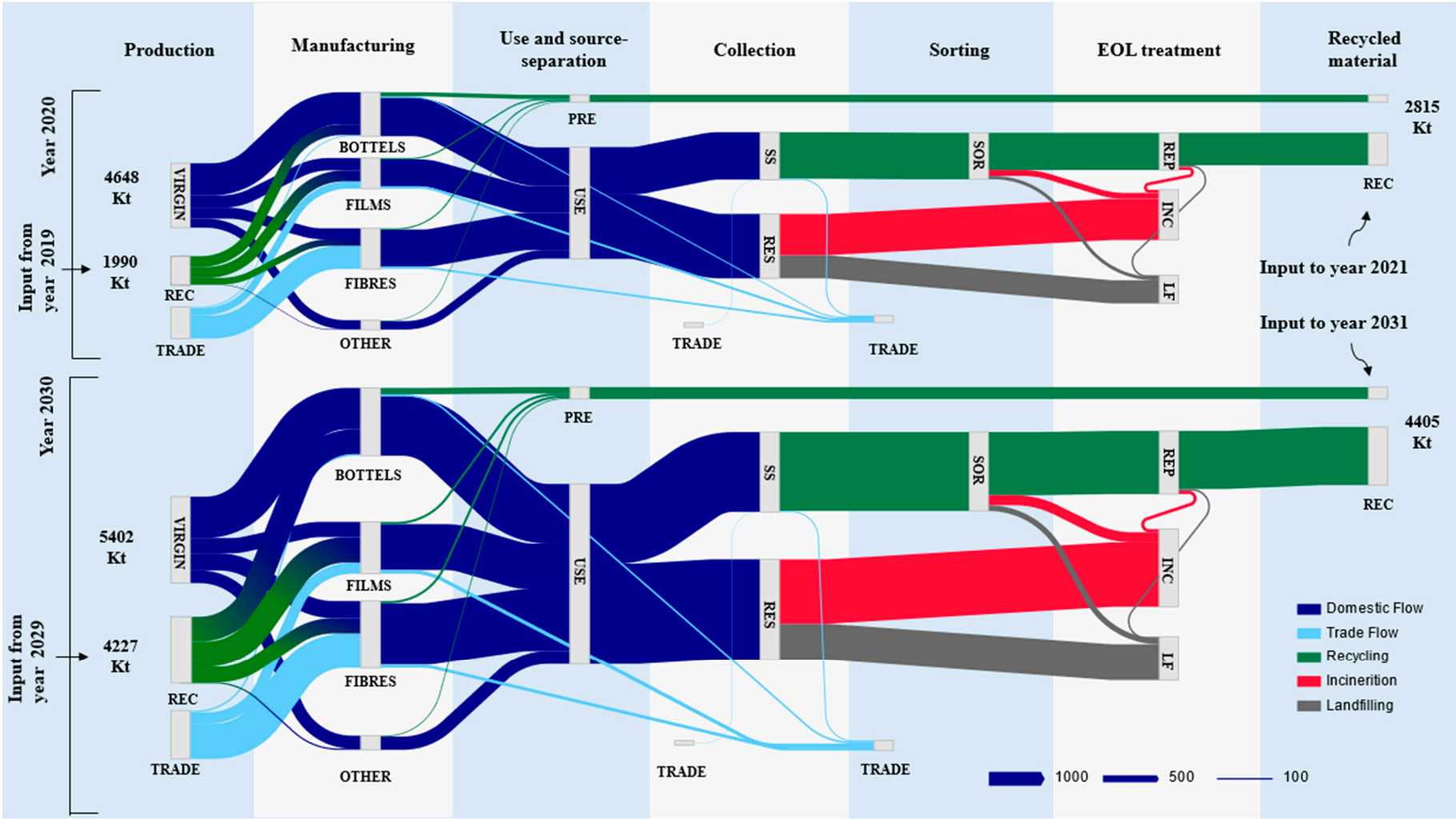


Figure S1.74 Sankey diagram for S3 in year 1 and year 30 in Europe.

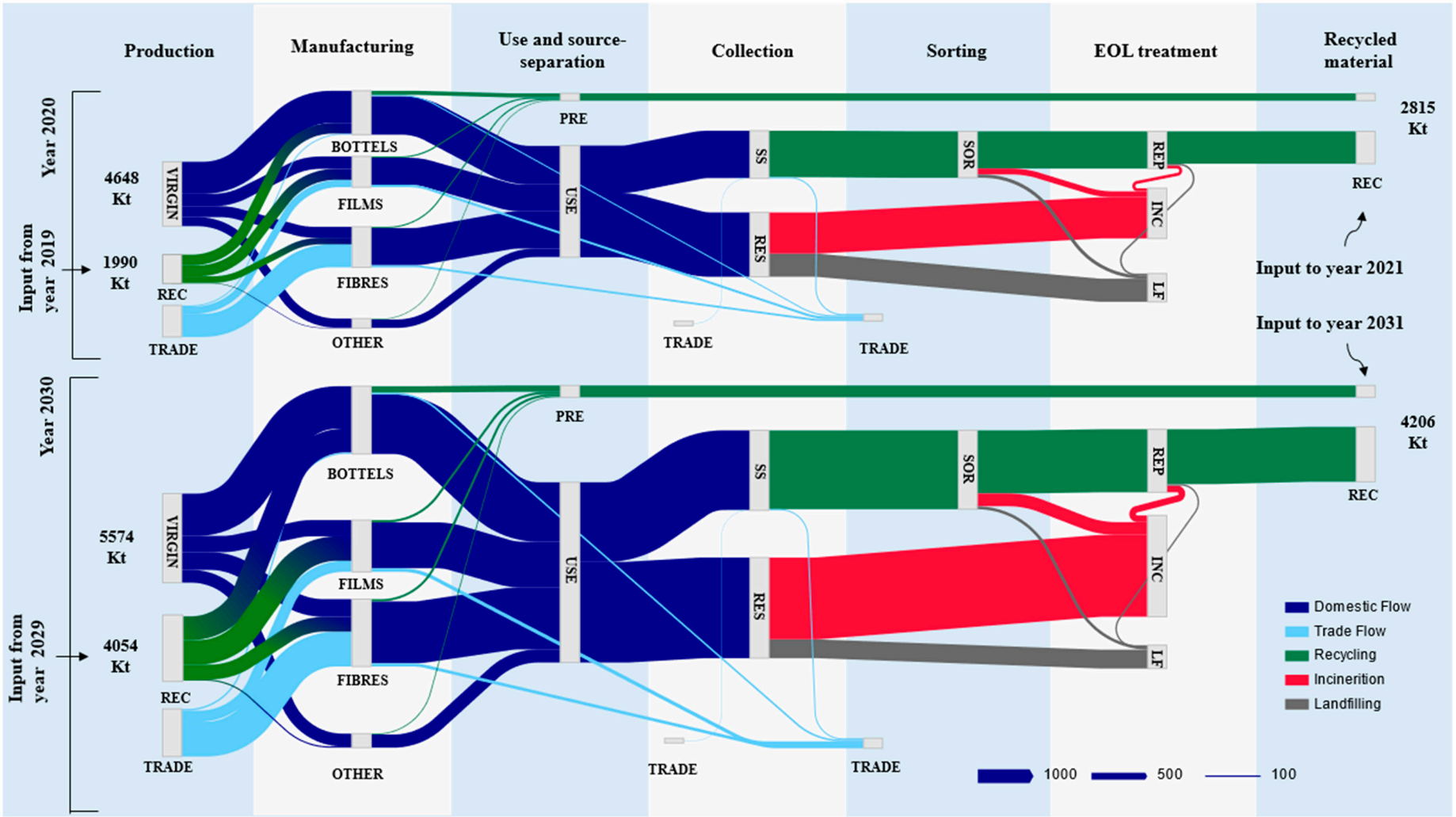


Figure S1.75 Sankey diagram for S4 in year 1 and year 30 in Europe.

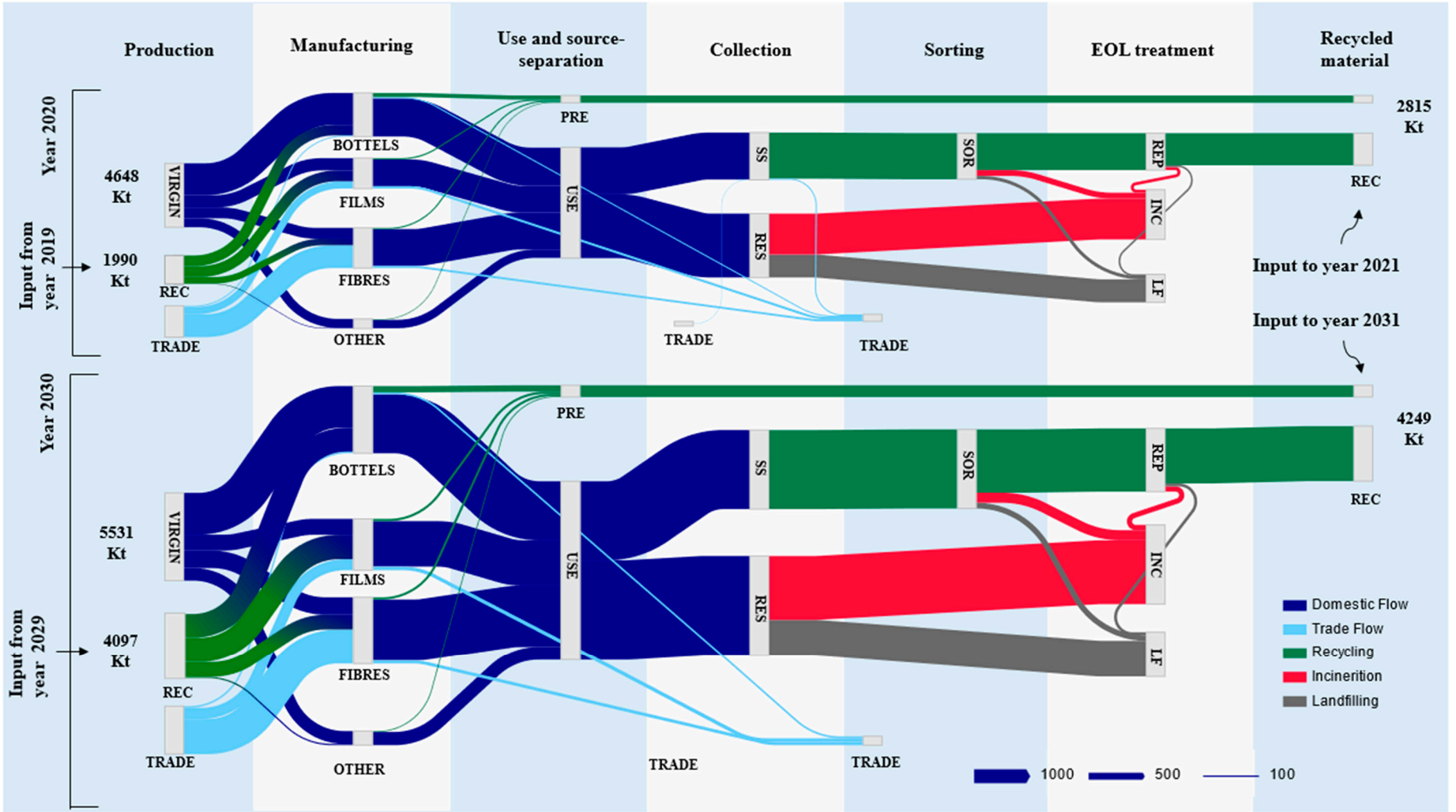


Figure S1.76 Sankey diagram for S5 in year 1 and year 30 in Europe.

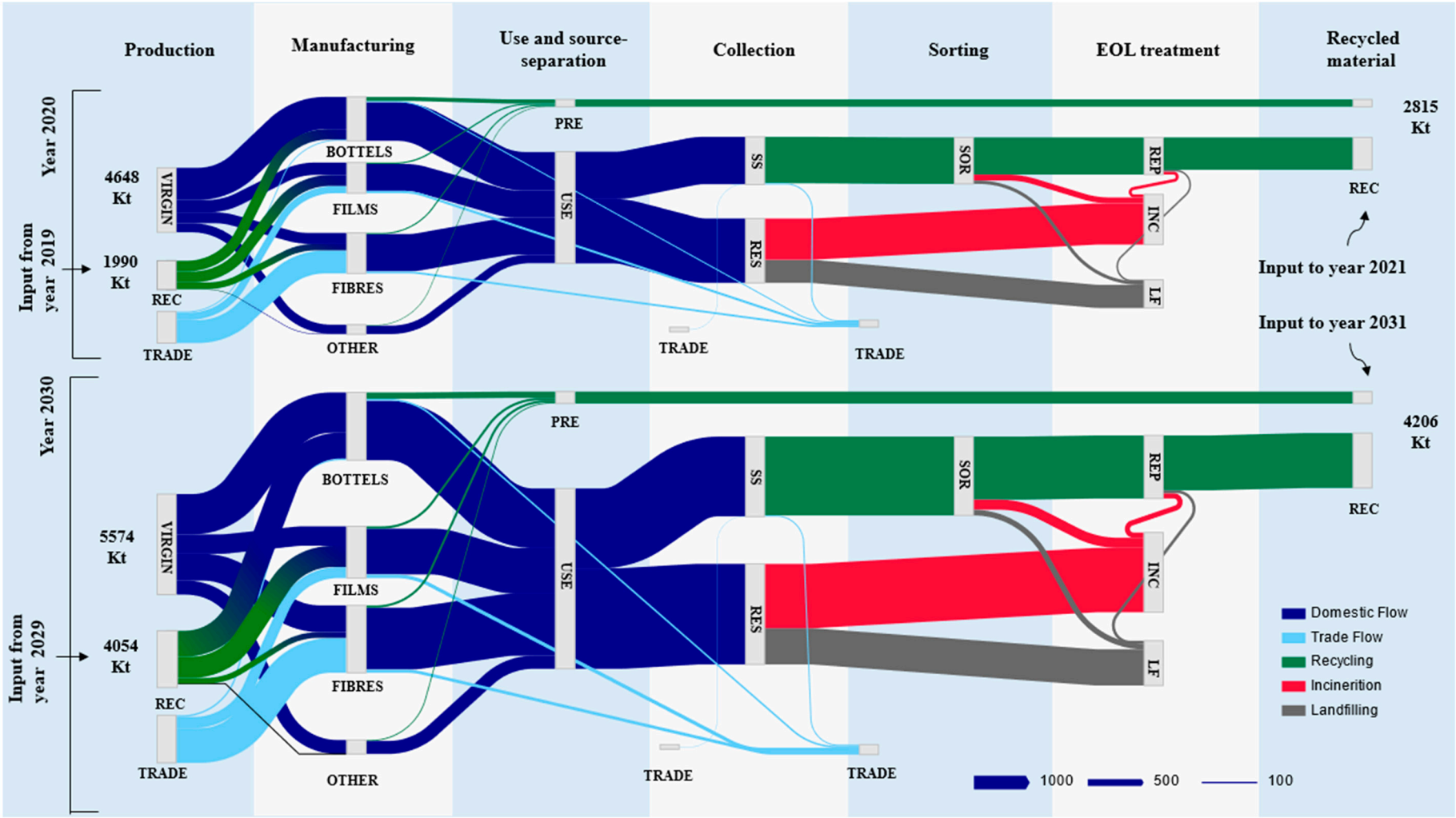


Figure S1.77 Sankey diagram for S6 in year 1 and year 30 in Europe.

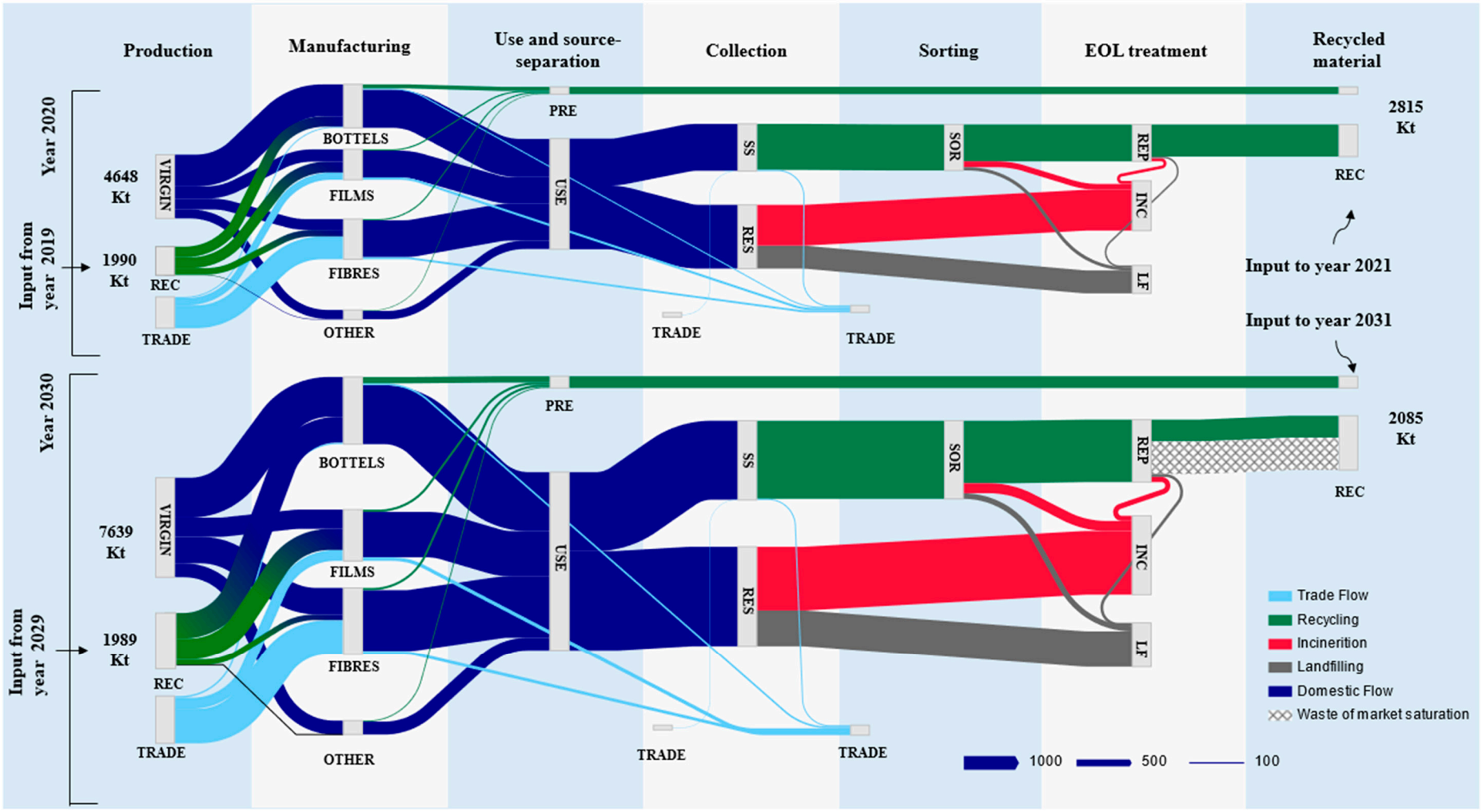


Figure S1.78 Sankey diagram for S7 in year 1 and year 30 in Europe.

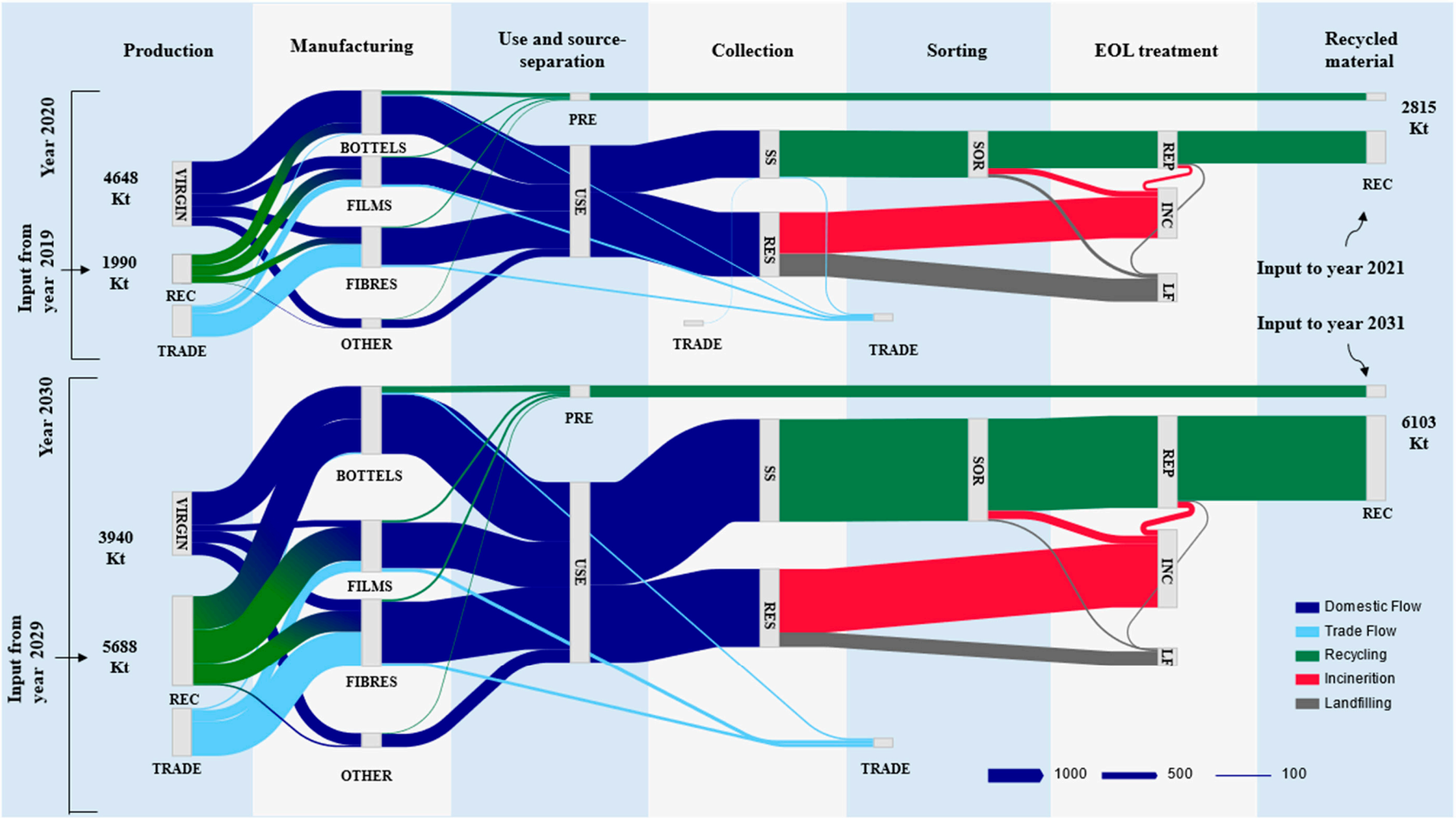


Figure S1.79 Sankey diagram for S8 in year 1 and year 30 in Europe.

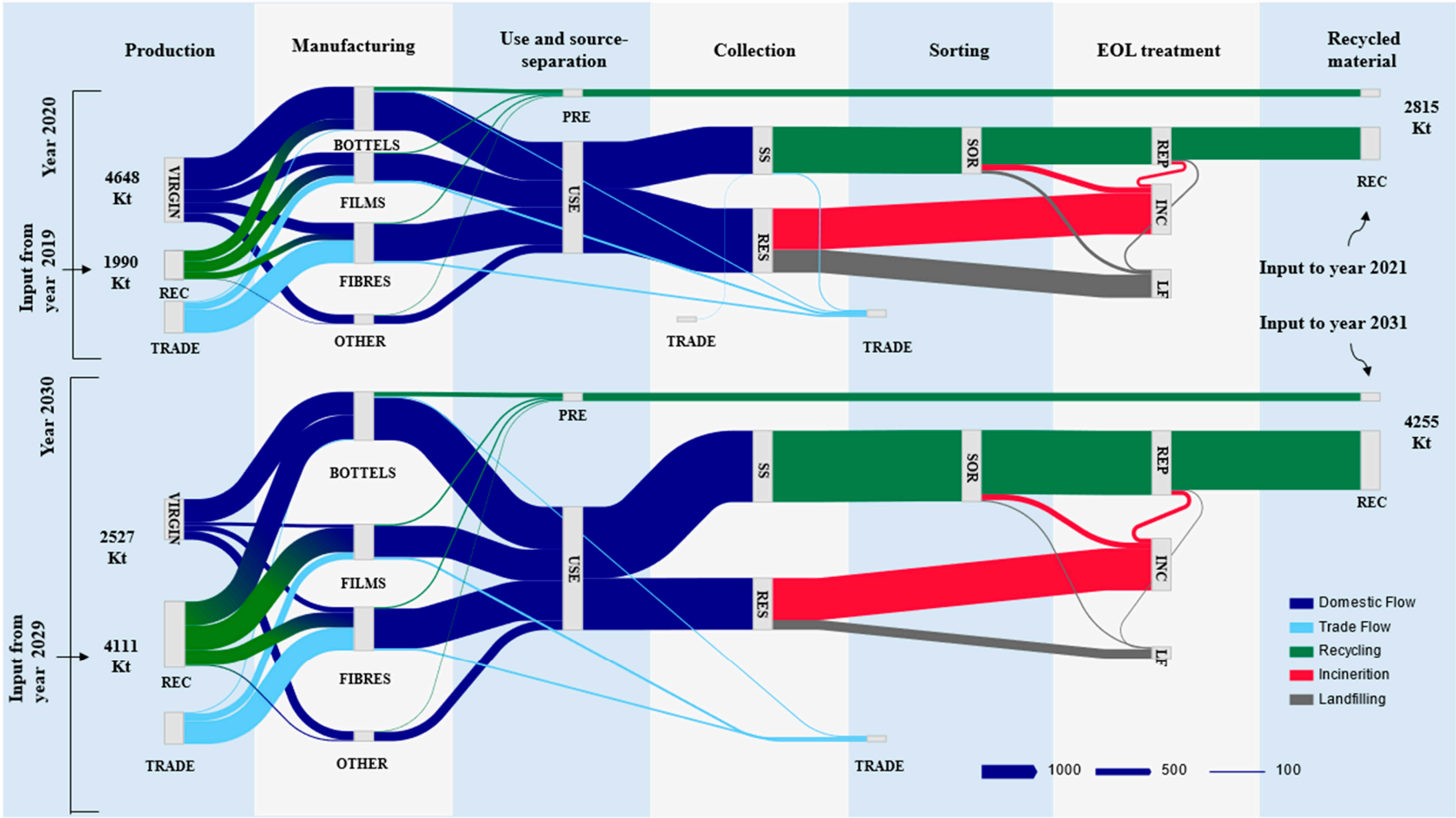


Figure S1.80 Sankey diagram for S9 in year 1 and year 30 in Europe.

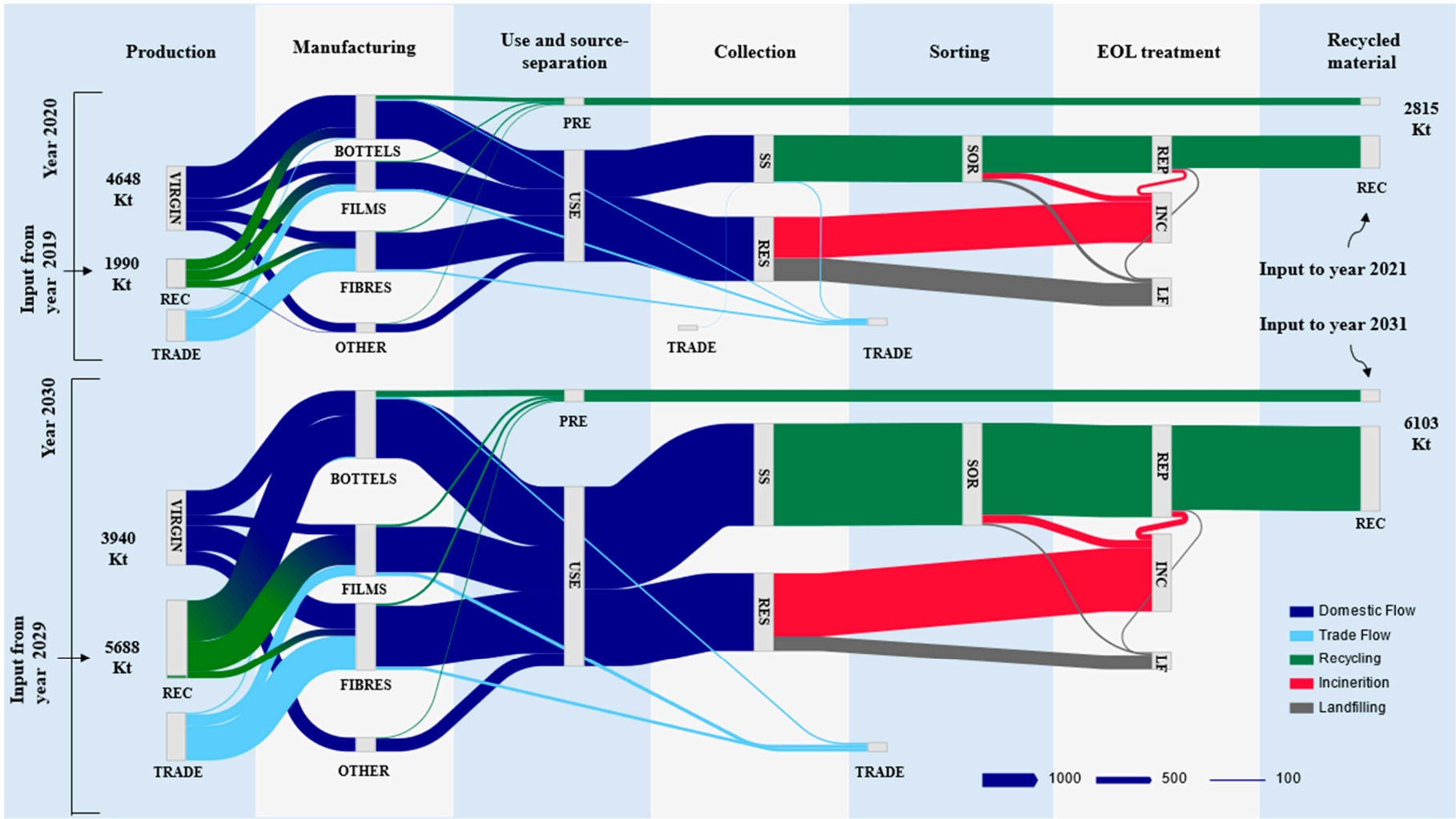


Figure S1.81 Sankey diagram for S10 in year 1 and year 30 in Europe.

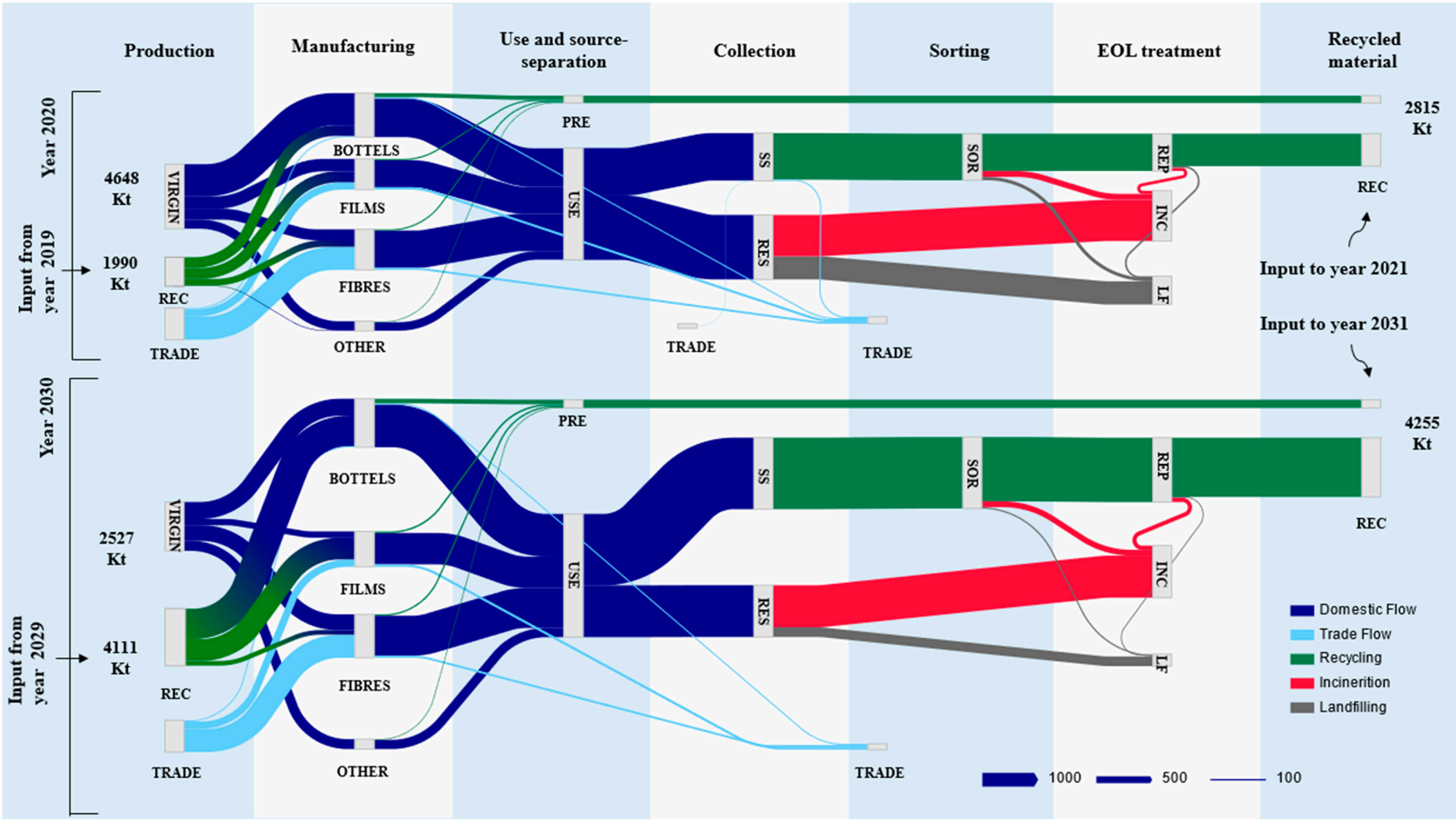


Figure S1.82 Sankey diagram for S11 in year 1 and year 30 in Europe.

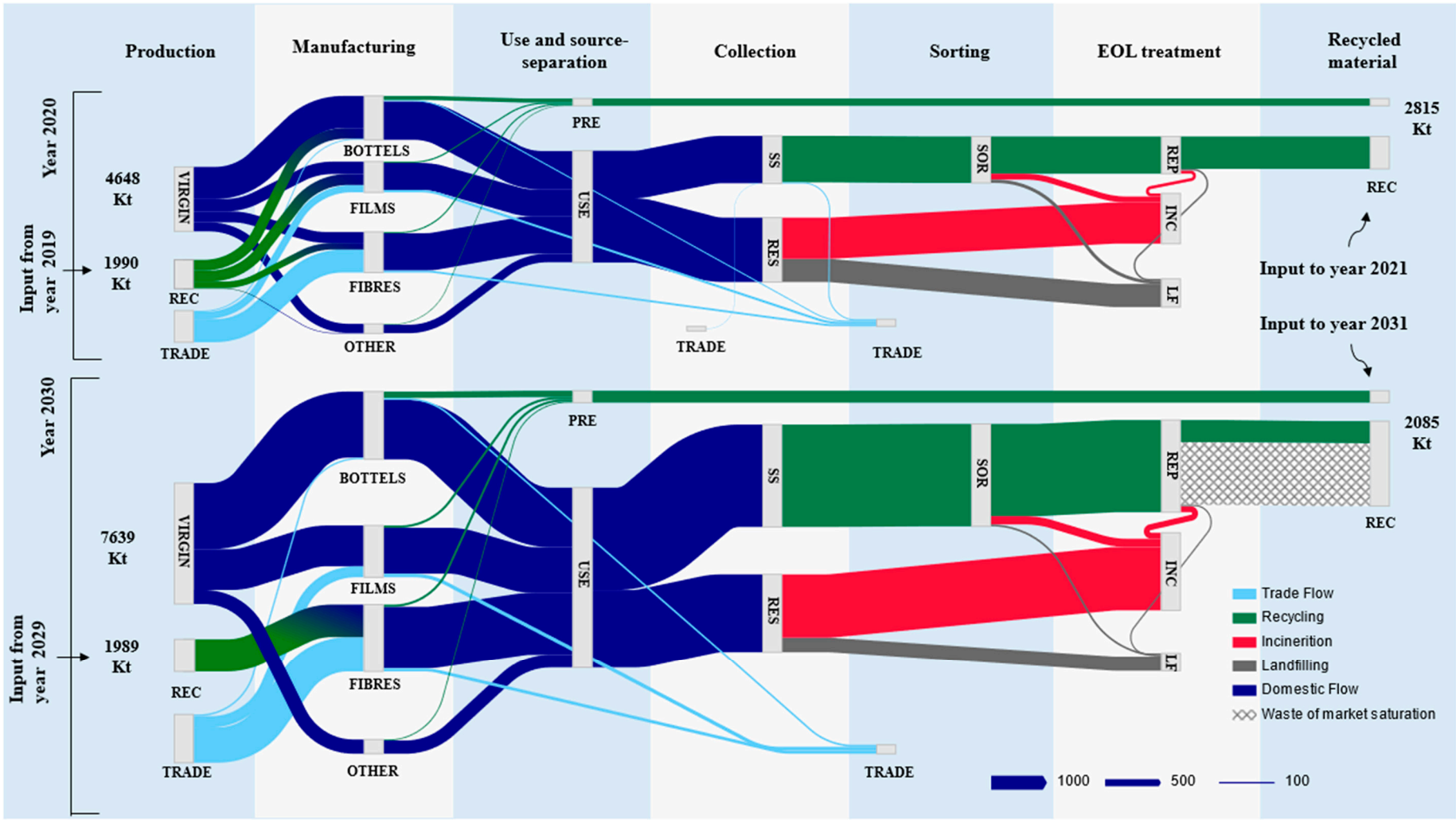


Figure S1.83 Sankey diagram for S12 in year 1 and year 30 in Europe.

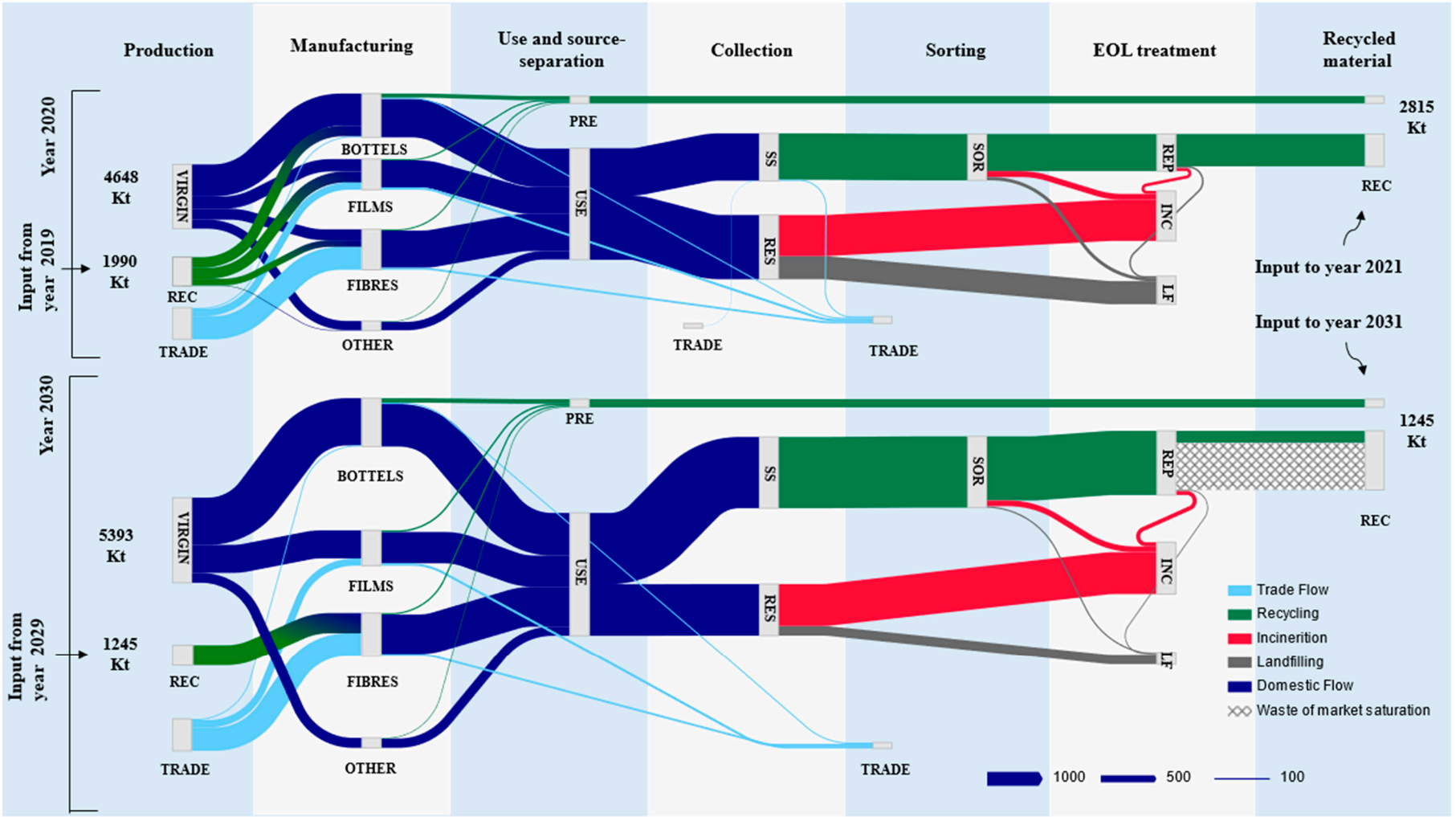


Figure S1.84 Sankey diagram for S13 in year 1 and year 30 in Europe.

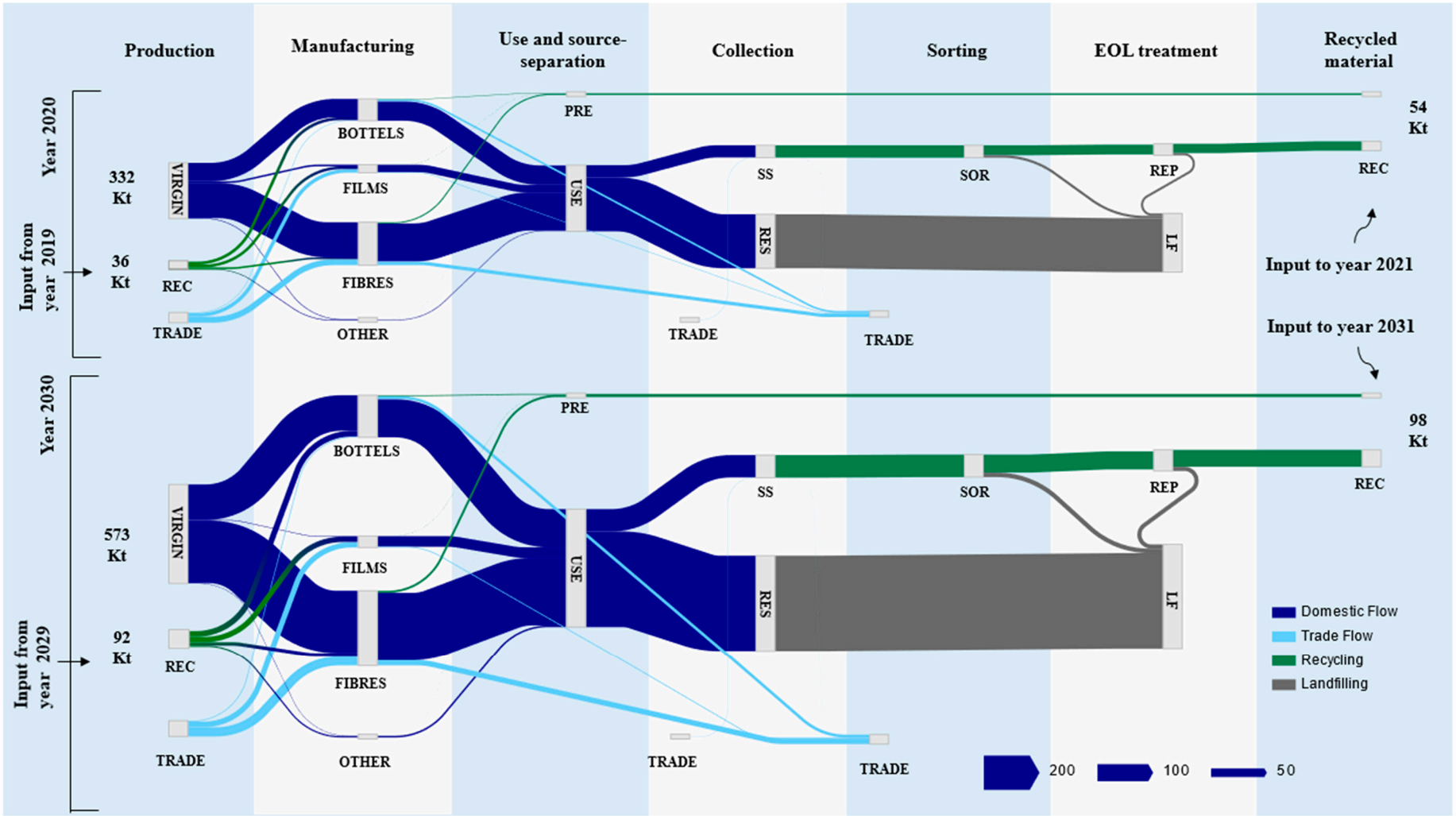


Figure S1.85 Sankey diagram for S0 in year 1 and year 30 in South Africa.

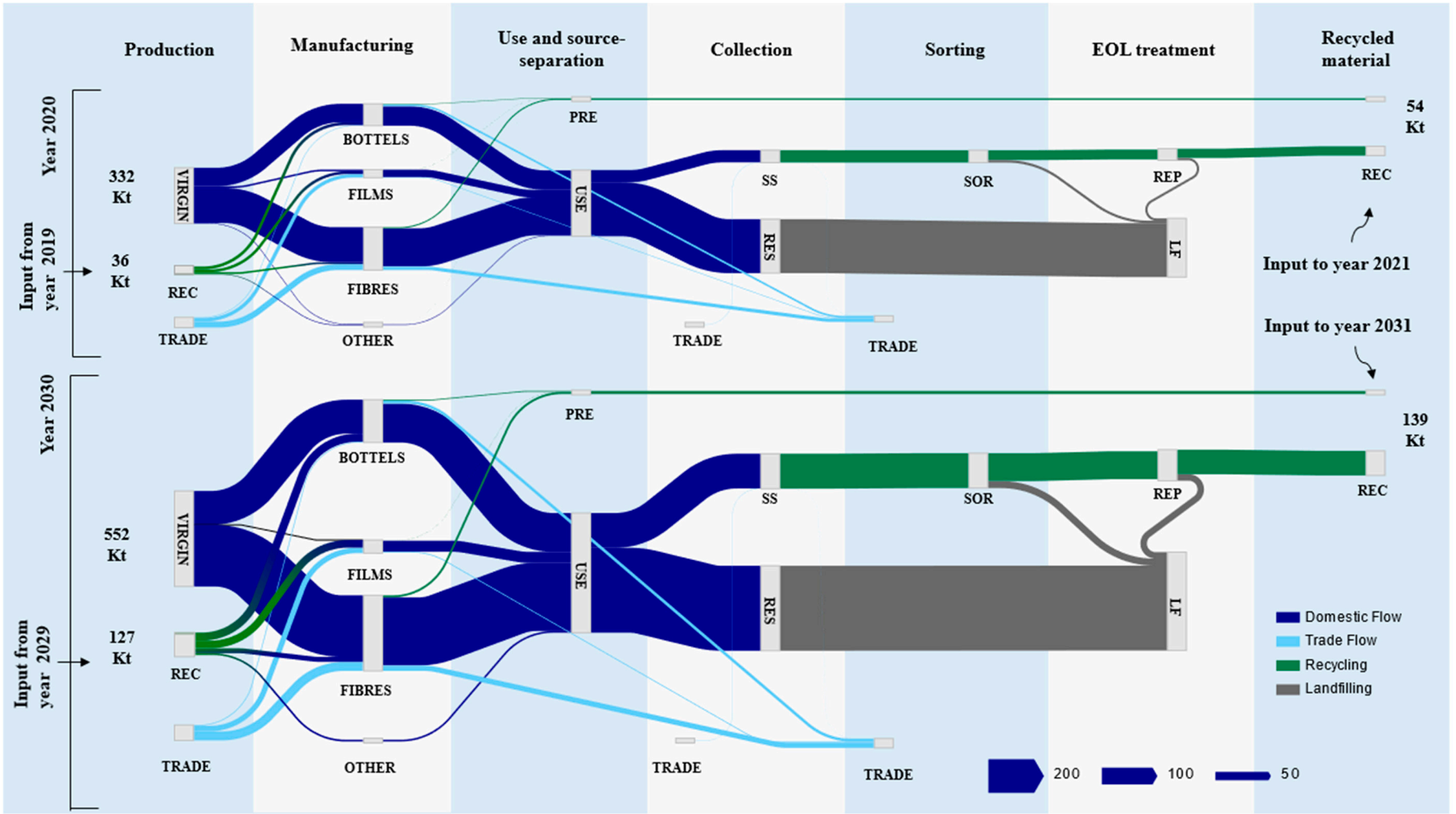


Figure S1.86 Sankey diagram for S1 in year 1 and year 30 in South Africa.

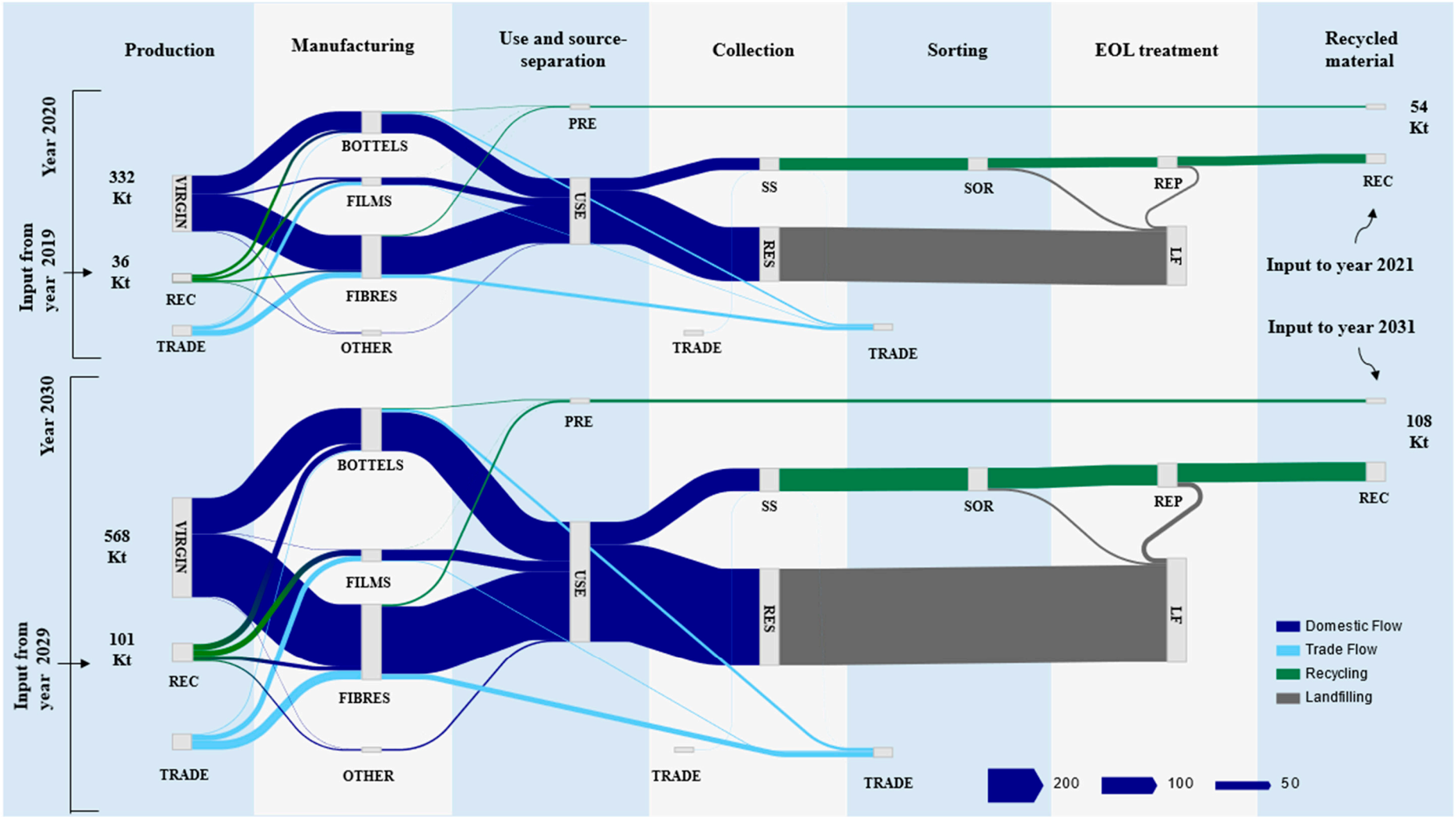


Figure S1.87 Sankey diagram for S2 in year 1 and year 30 in South Africa.

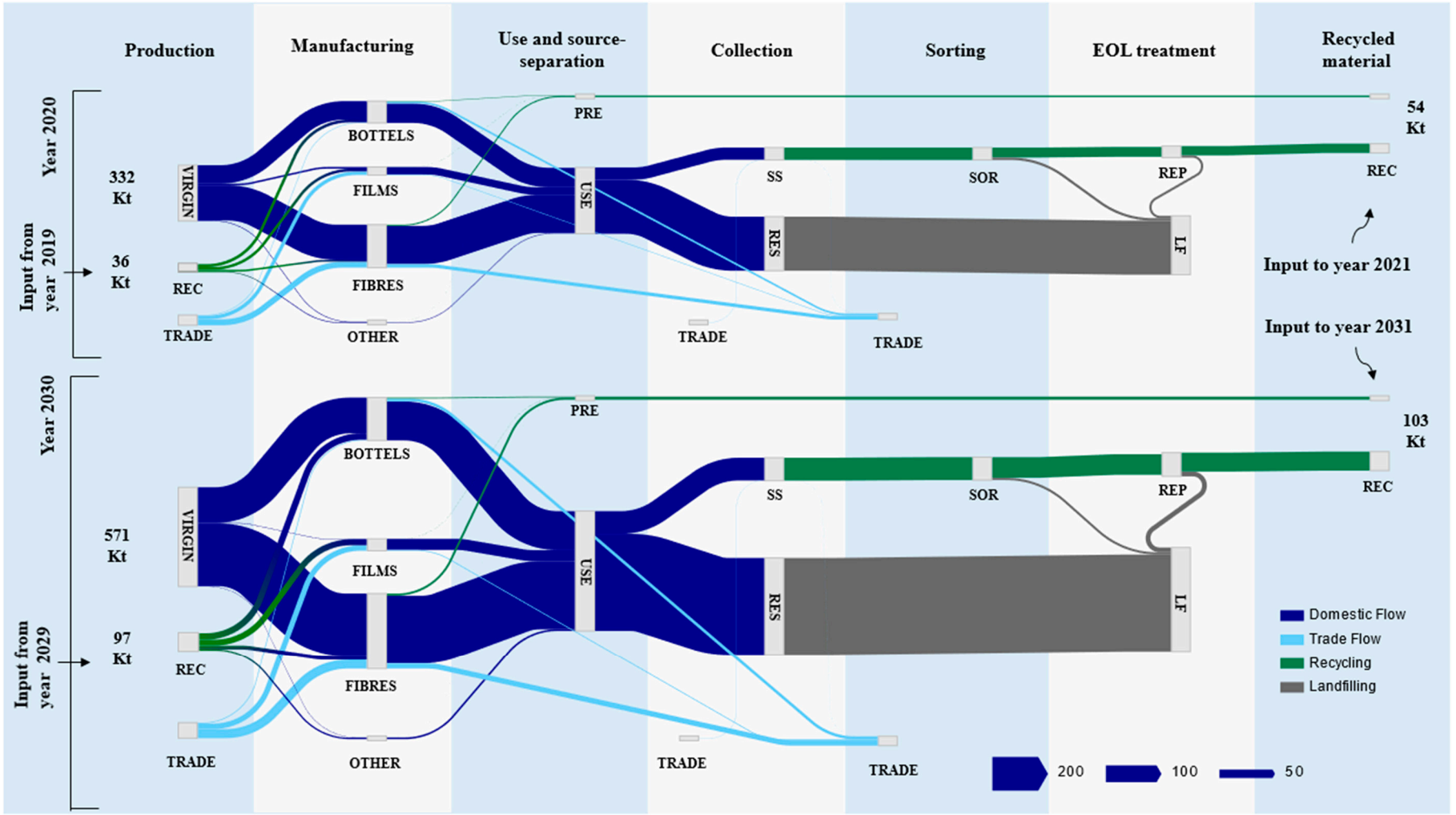


Figure S1.88 Sankey diagram for S3 in year 1 and year 30 in South Africa.

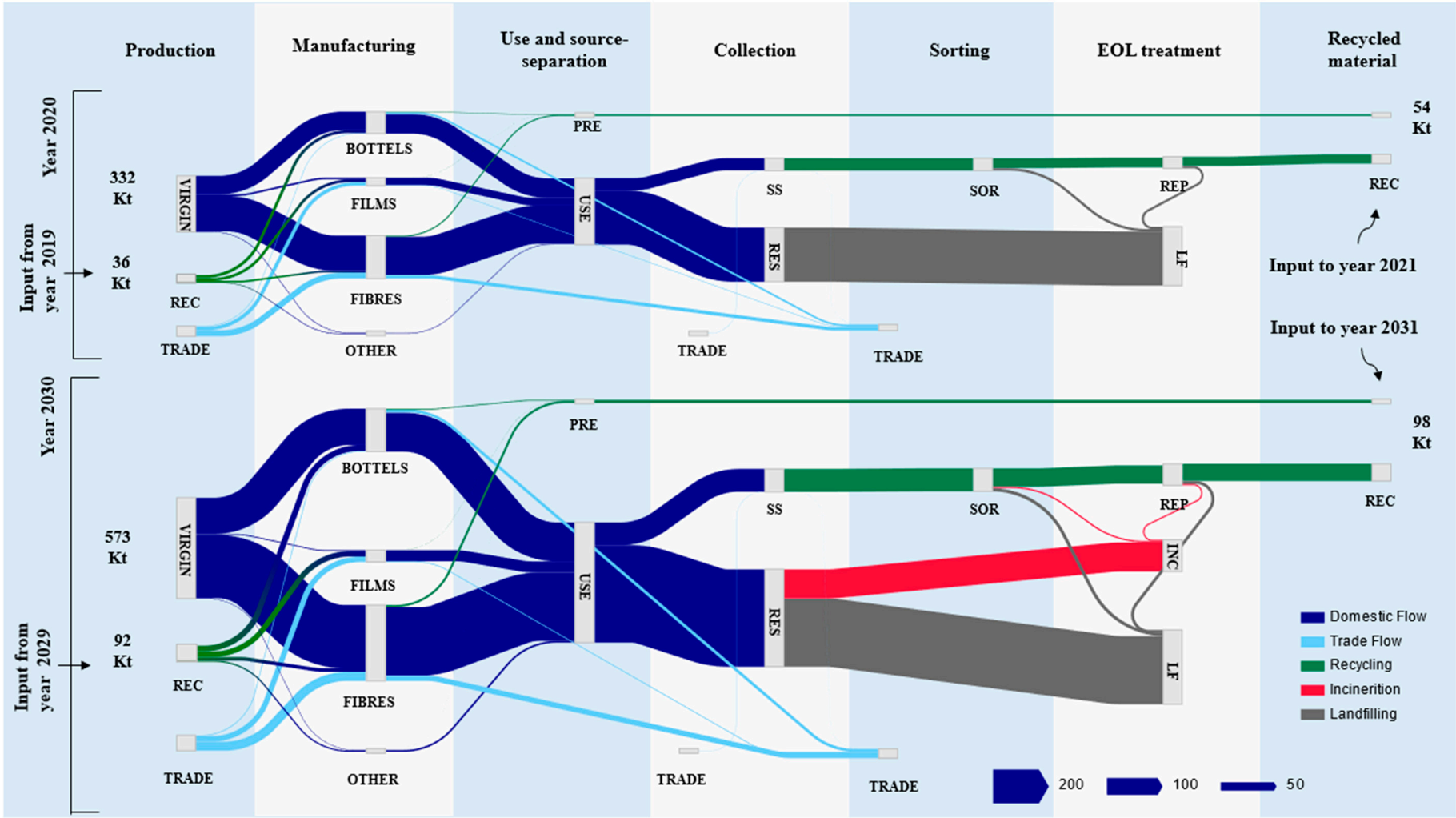


Figure S1.89 Sankey diagram for S4 in year 1 and year 30 in South Africa.

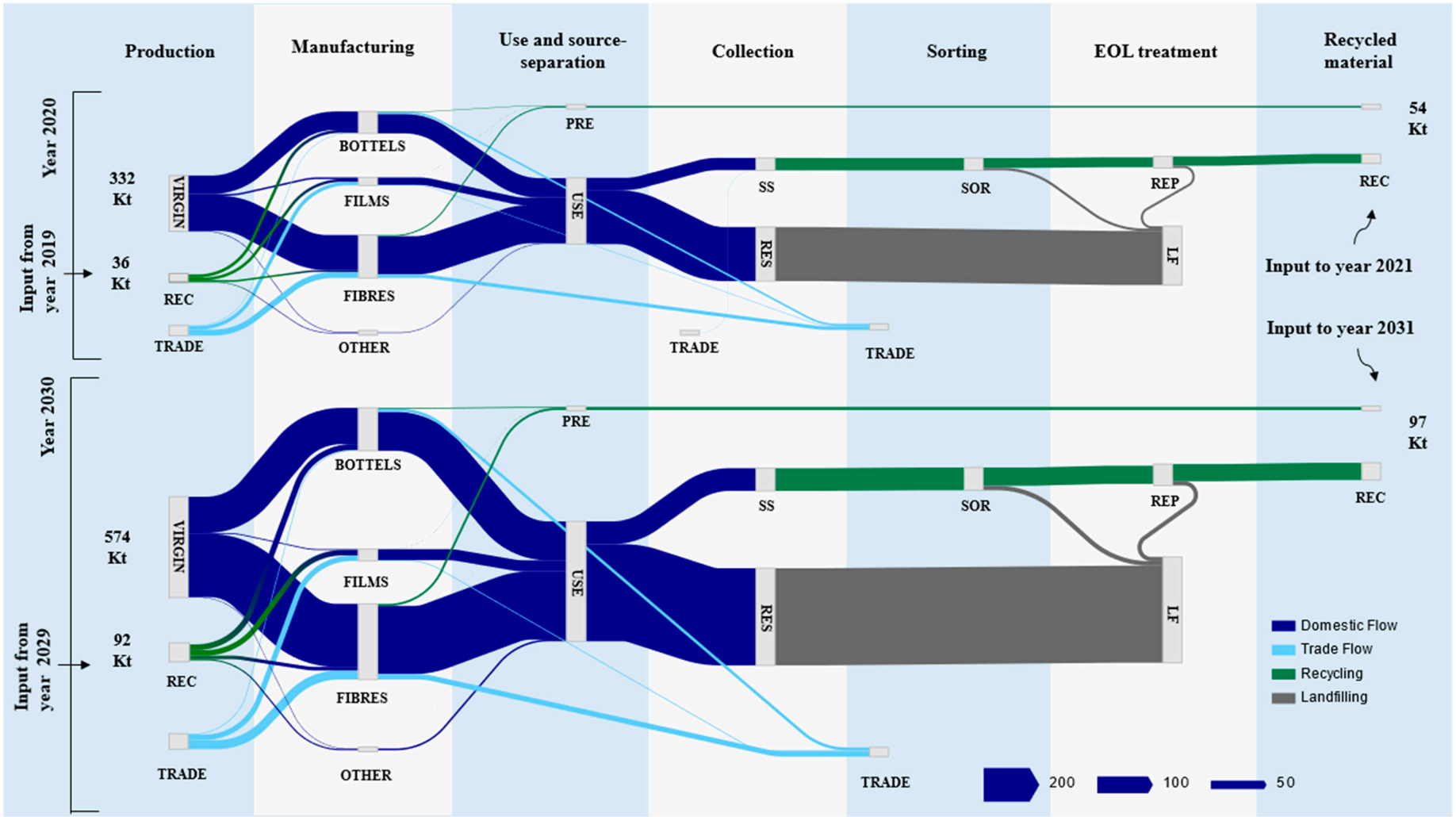


Figure S1.90 Sankey diagram for S5 in year 1 and year 30 in South Africa.

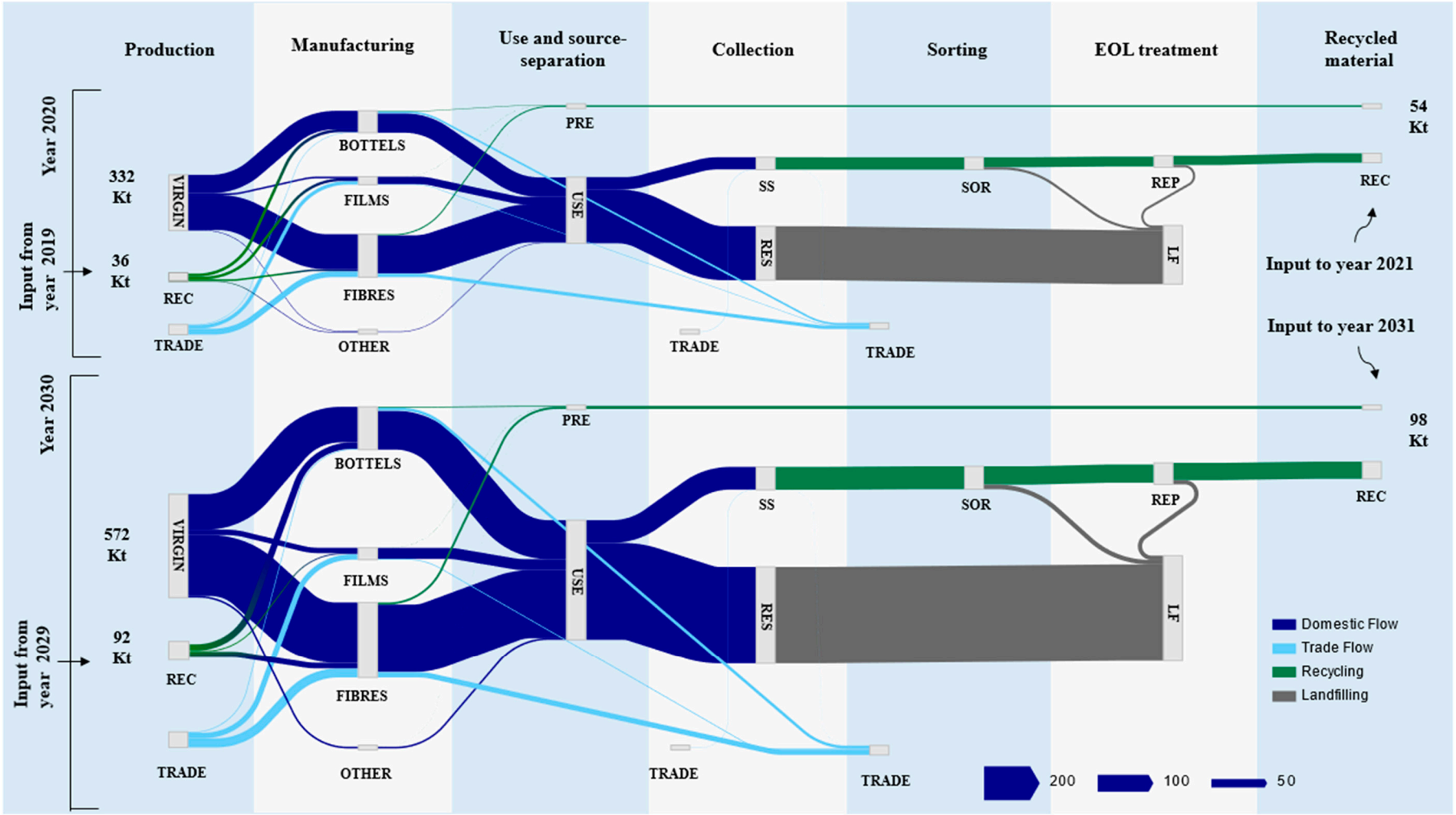


Figure S1.91 Sankey diagram for S6 in year 1 and year 30 in South Africa.

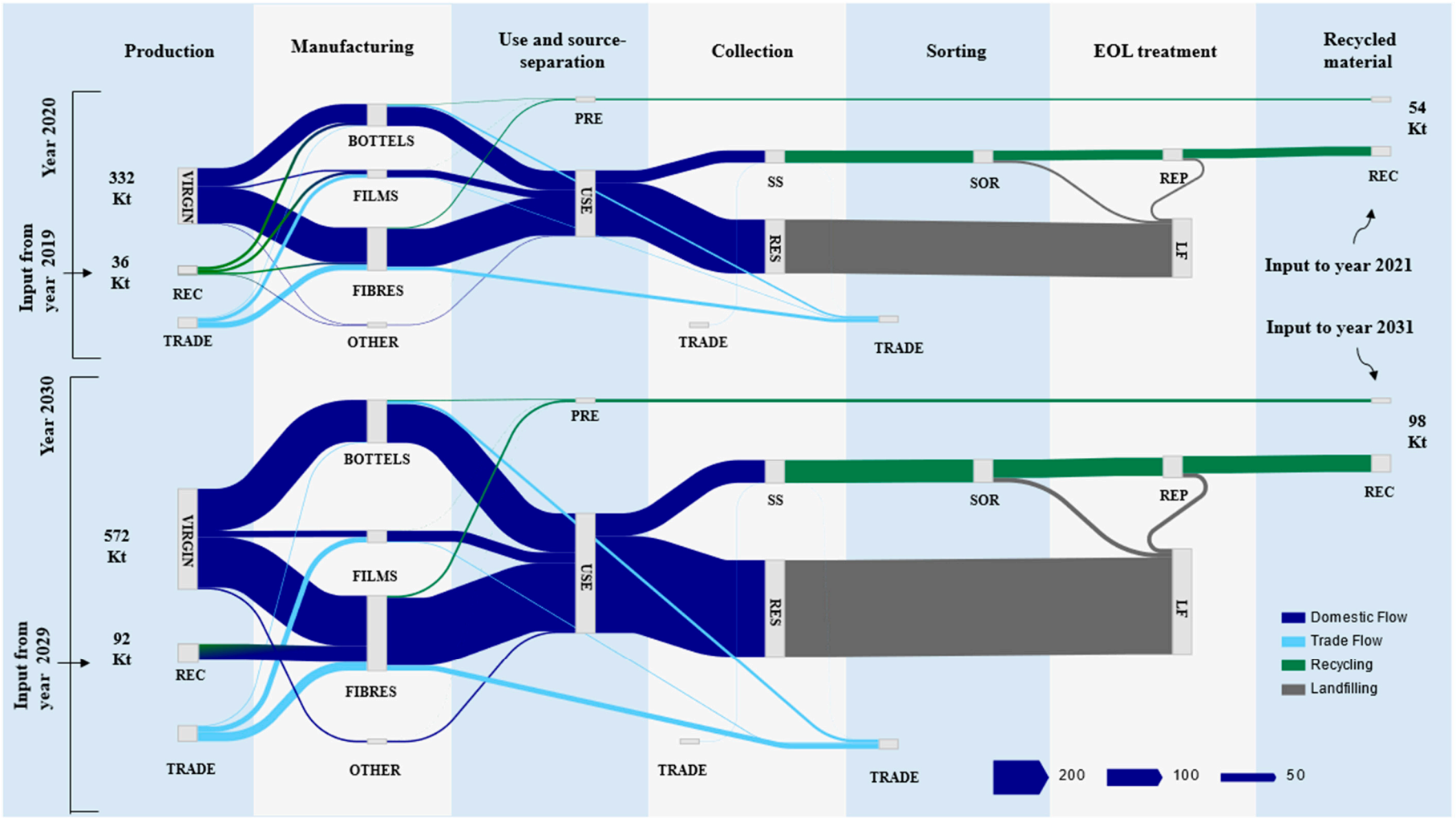


Figure S1.92 Sankey diagram for S7 in year 1 and year 30 in South Africa.

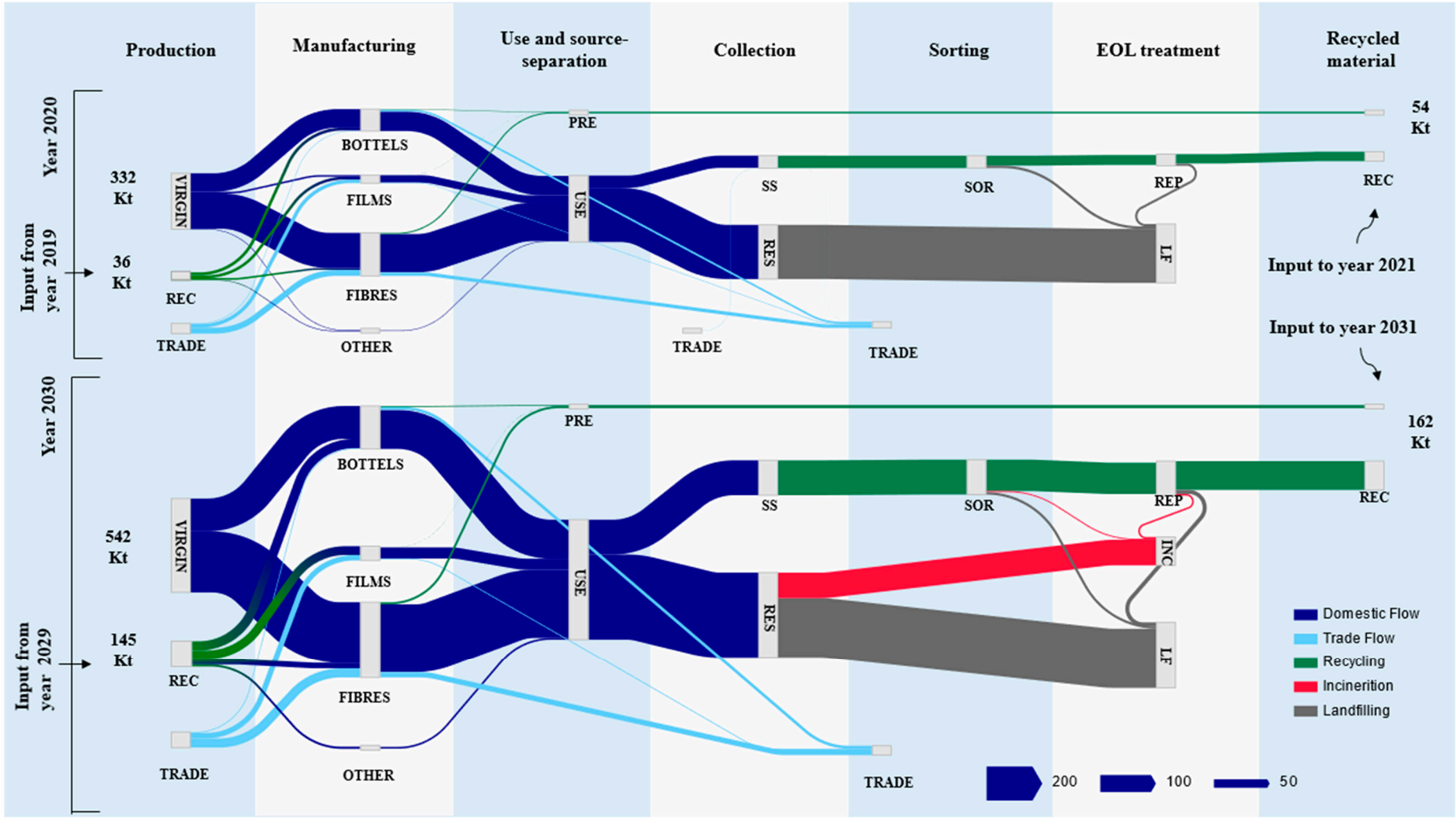


Figure S1.93 Sankey diagram for S8 in year 1 and year 30 in South Africa.

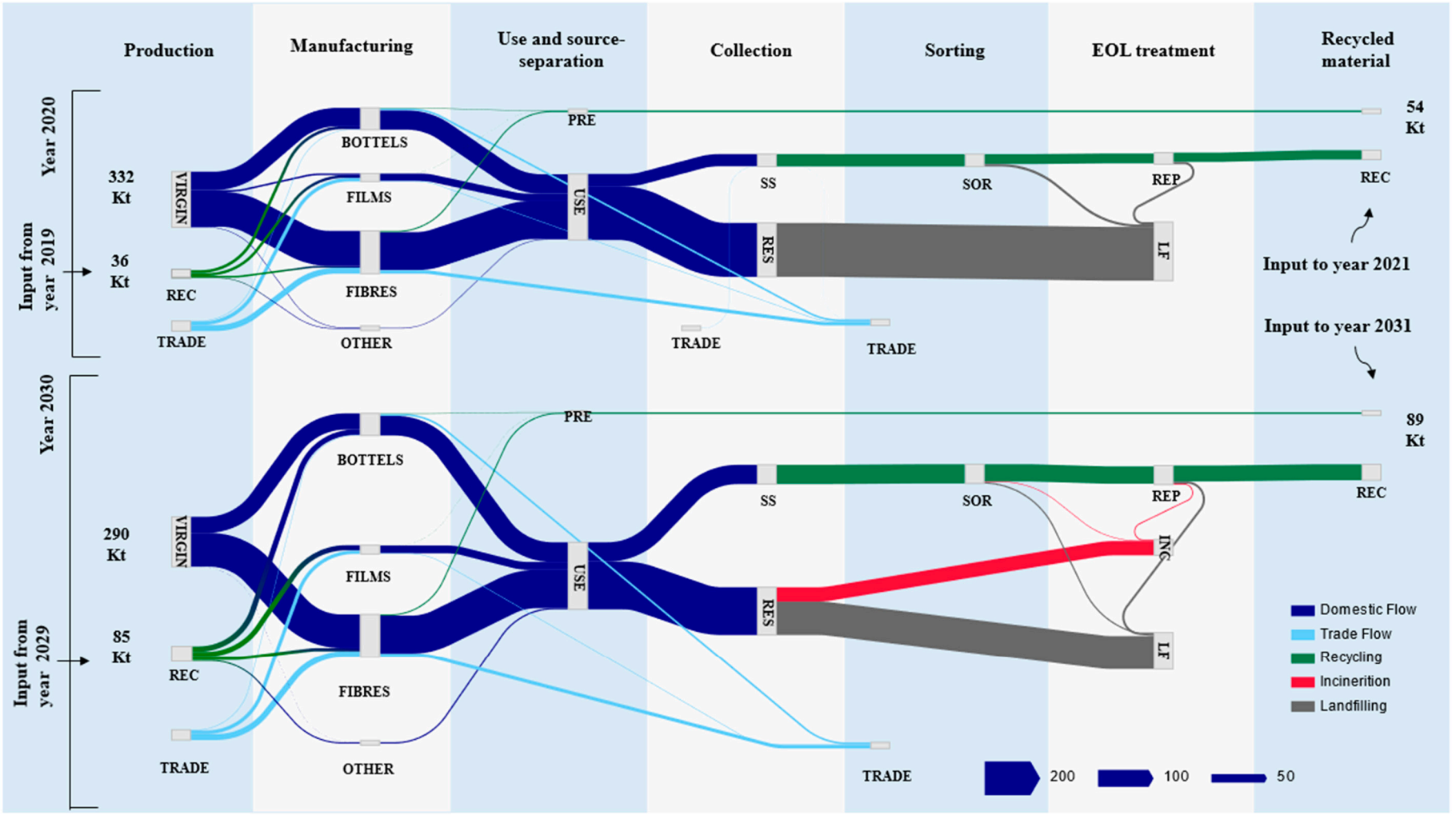


Figure S1.94 Sankey diagram for S9 in year 1 and year 30 in South Africa.

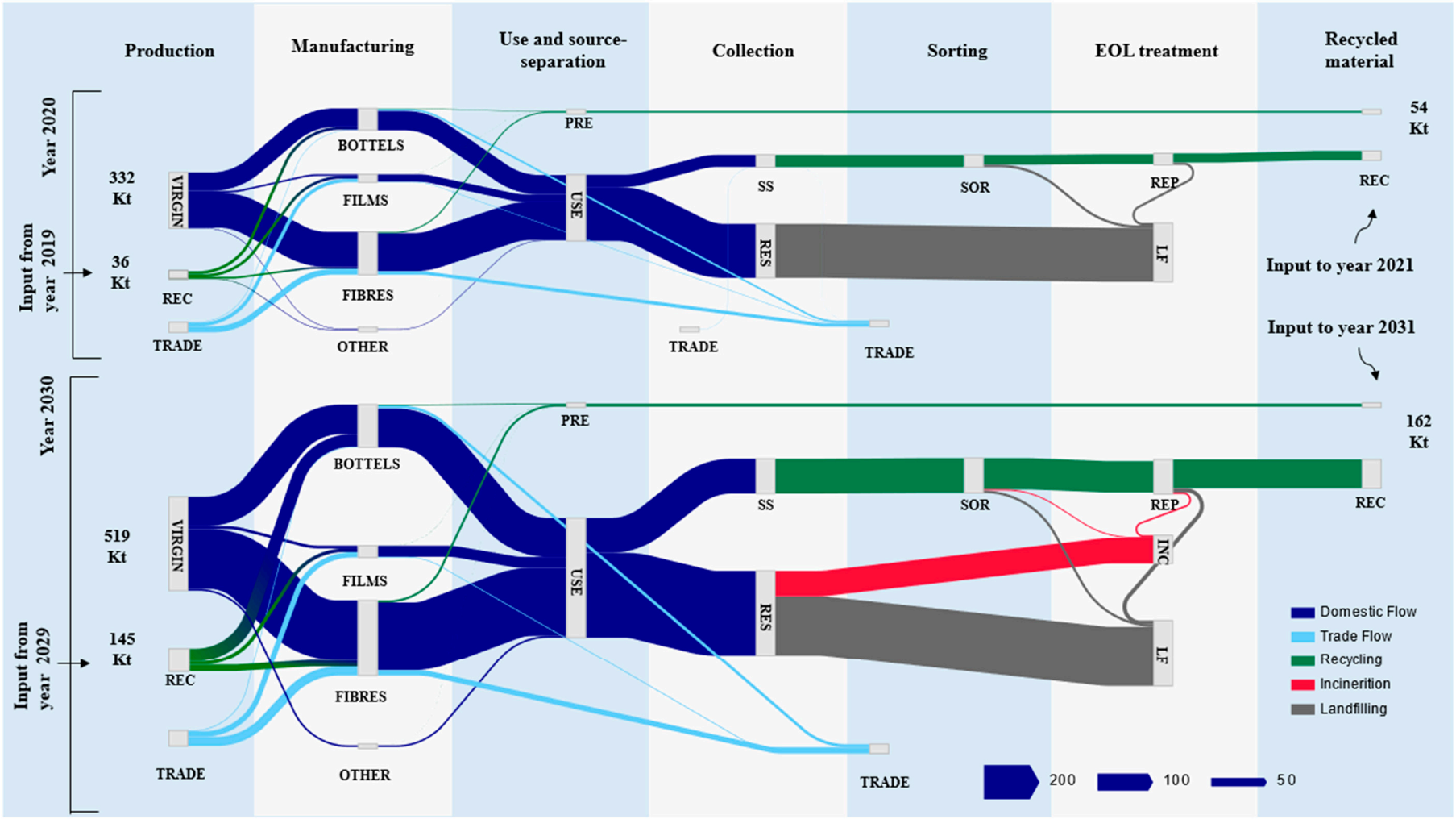


Figure S1.95 Sankey diagram for S10 in year 1 and year 30 in South Africa.

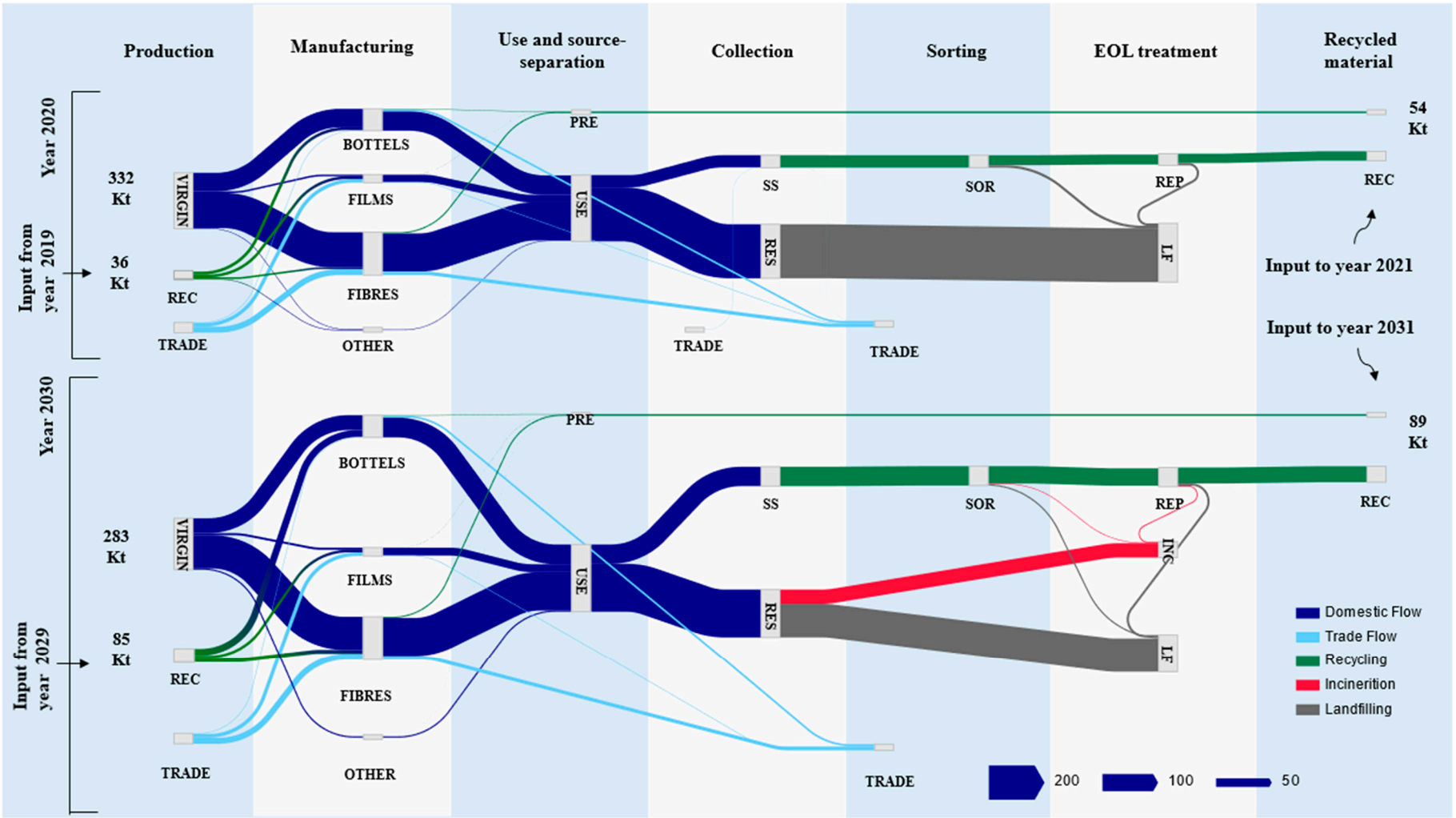


Figure S1.96 Sankey diagram for S11 in year 1 and year 30 in South Africa.

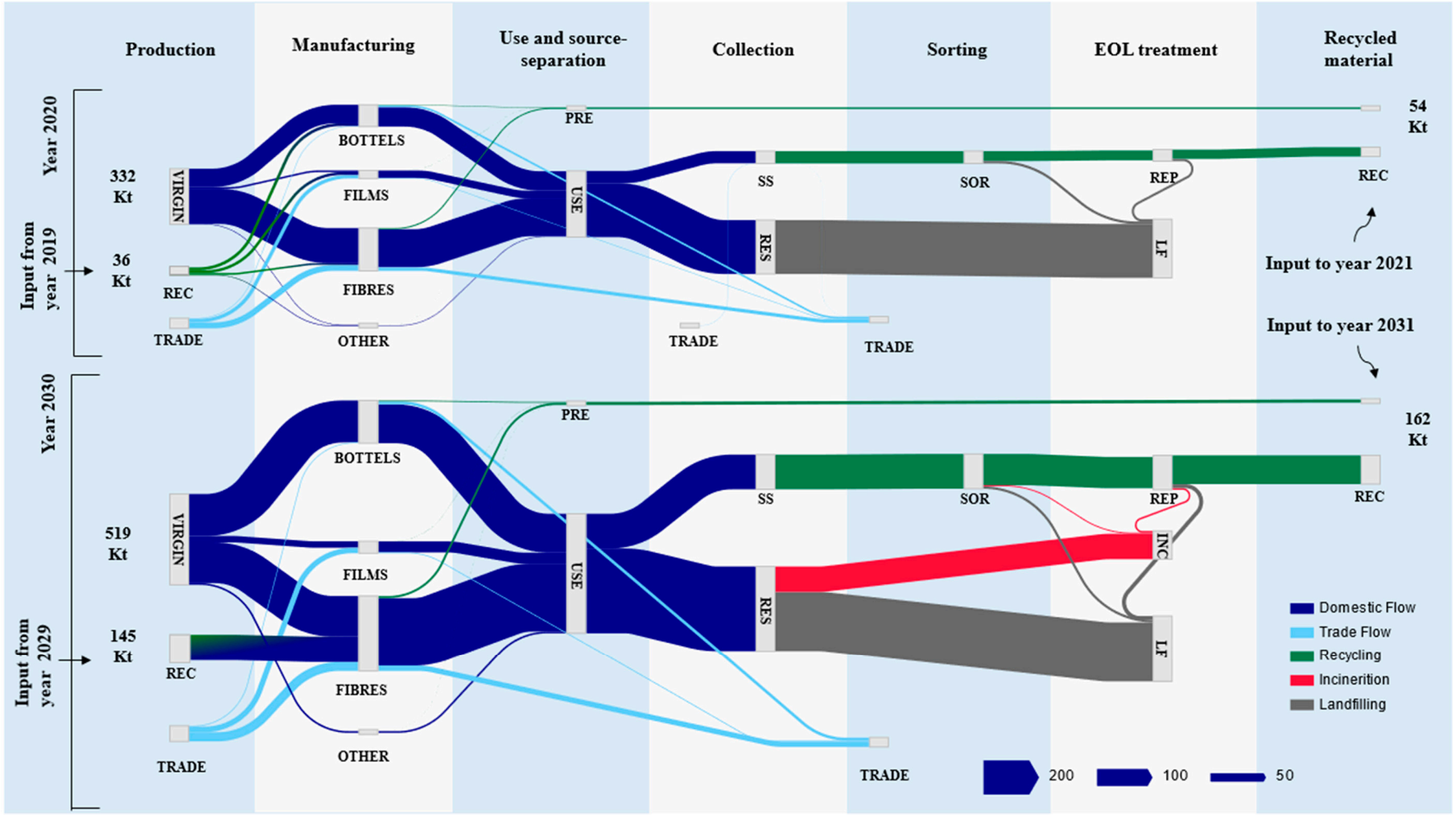


Figure S1.97 Sankey diagram for S12 in year 1 and year 30 in South Africa.

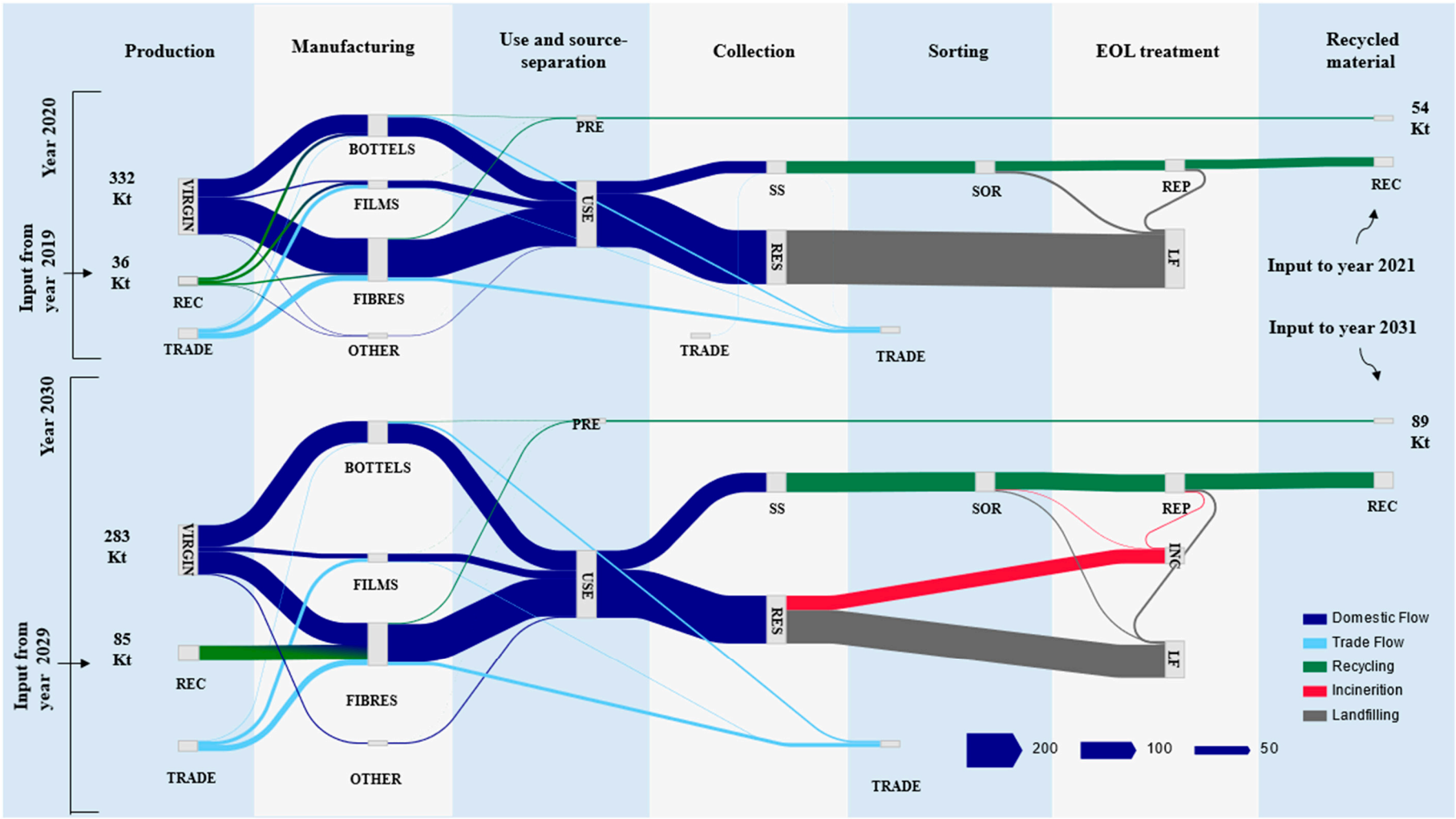


Figure S1.98 Sankey diagram for S13 in year 1 and year 30 in South Africa.

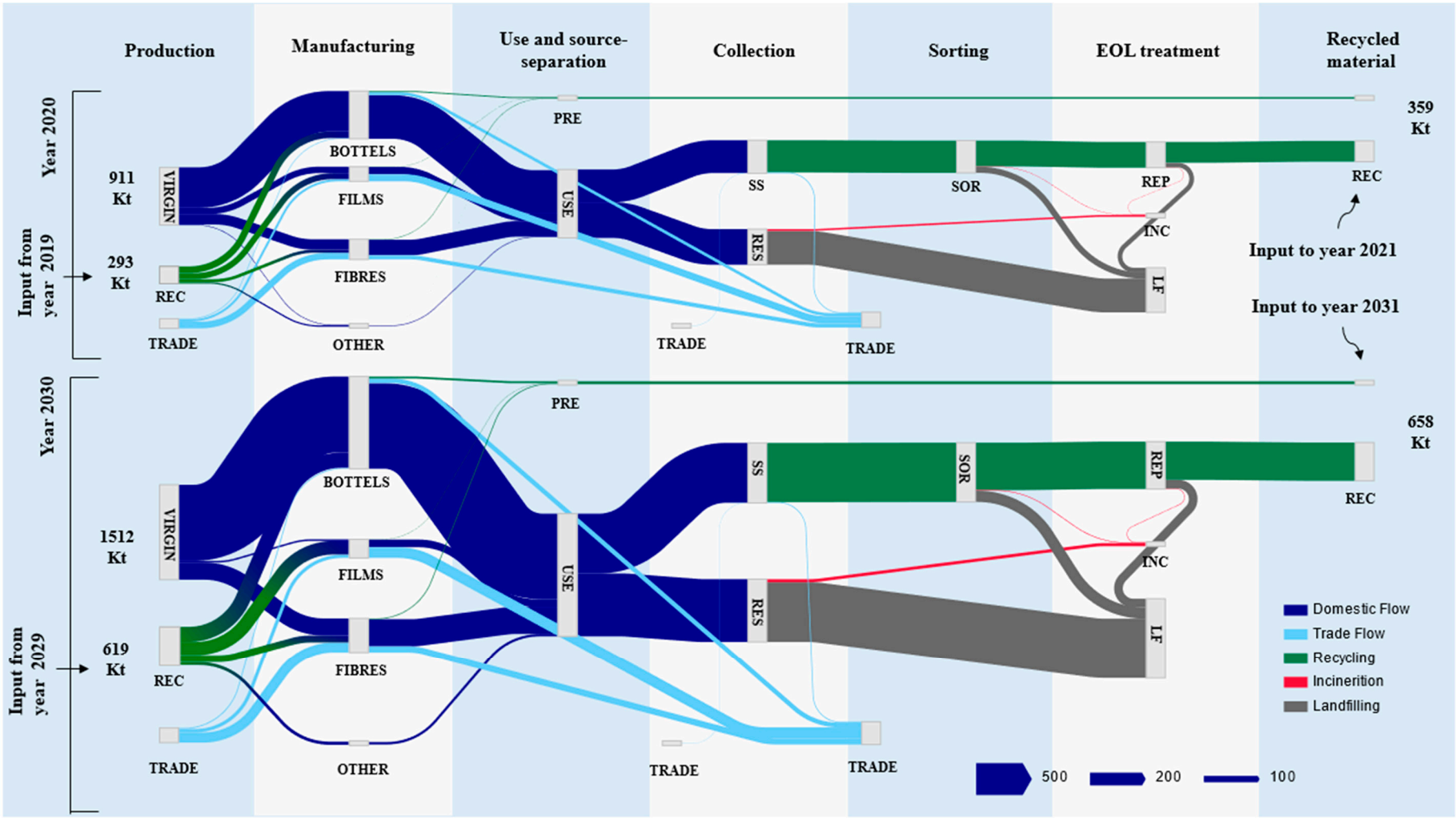


Figure S1.99 Sankey diagram for S0 in year 1 and year 30 in Mexico.

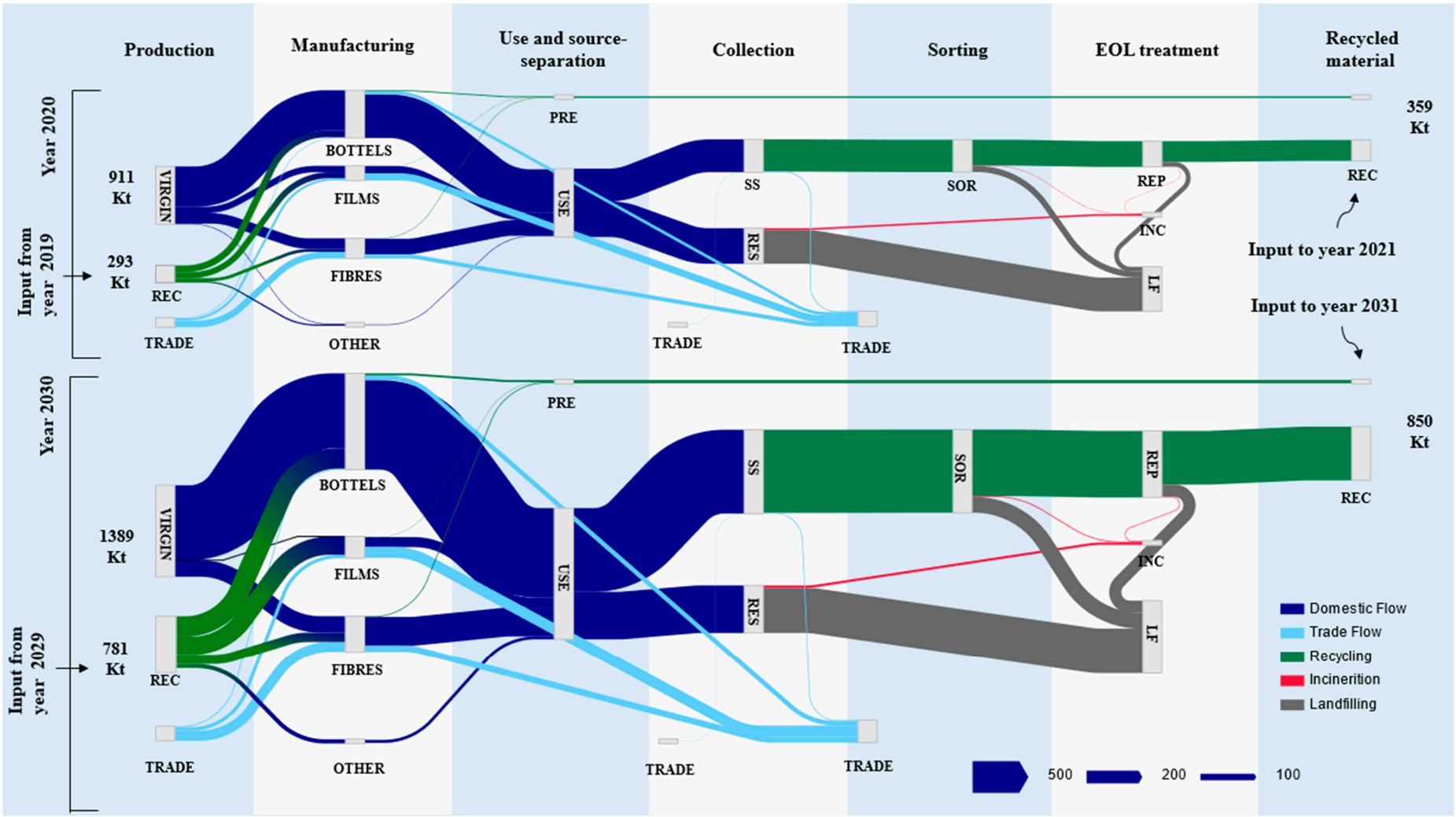


Figure S1.100 Sankey diagram for S1 in year 1 and year 30 in Mexico.

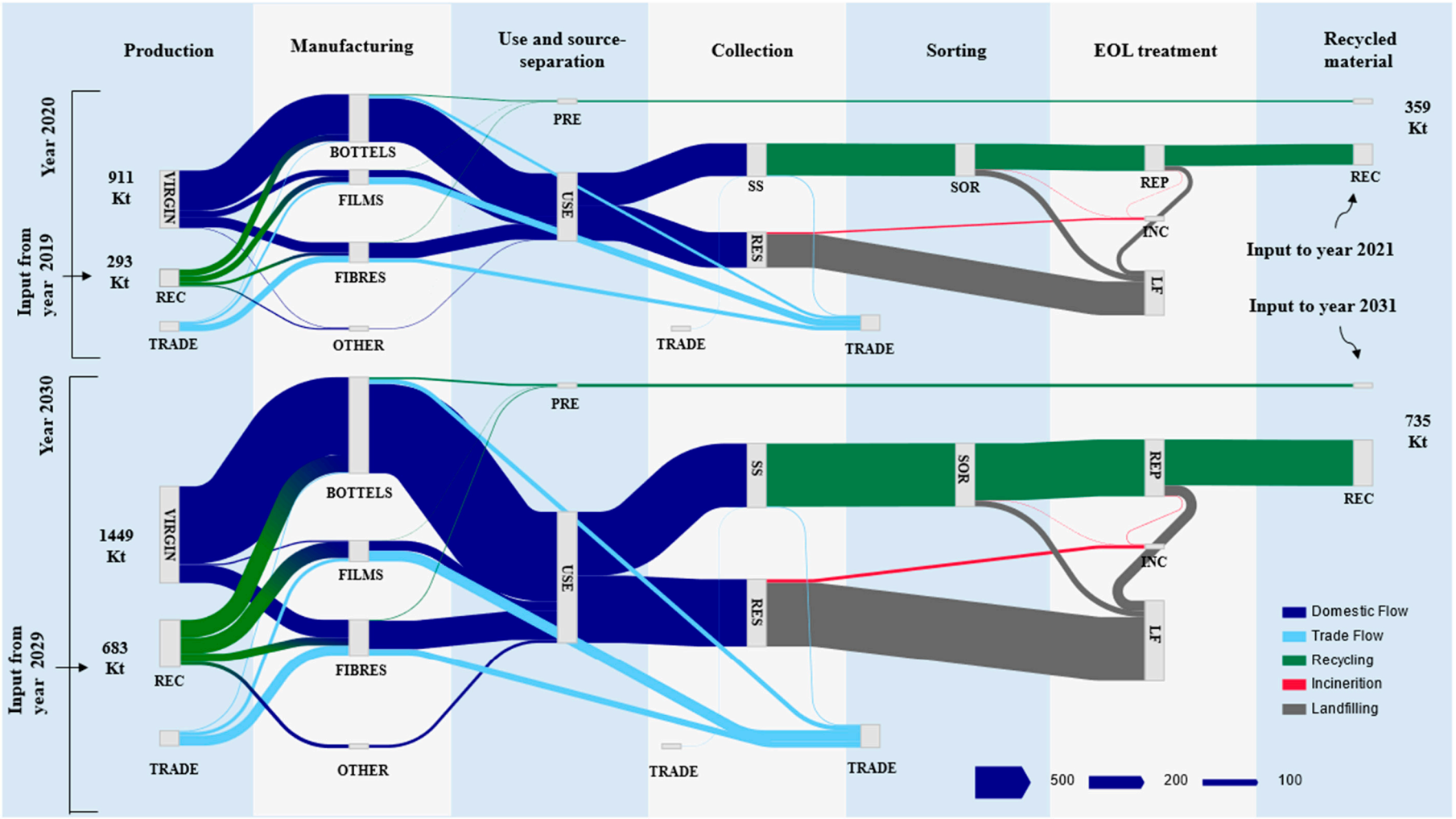


Figure S1.101 Sankey diagram for S2 in year 1 and year 30 in Mexico.

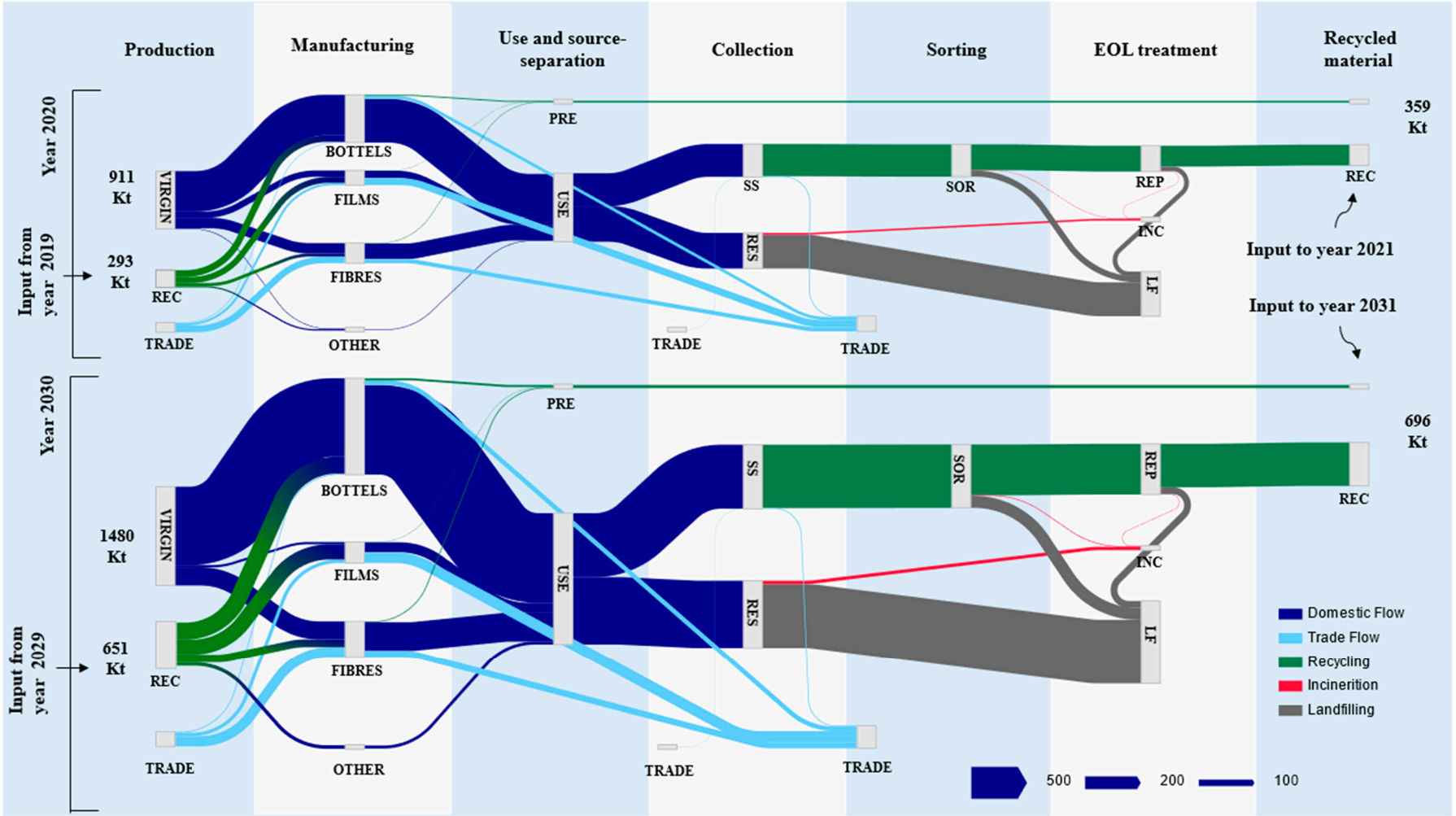


Figure S1.102 Sankey diagram for S3 in year 1 and year 30 in Mexico.

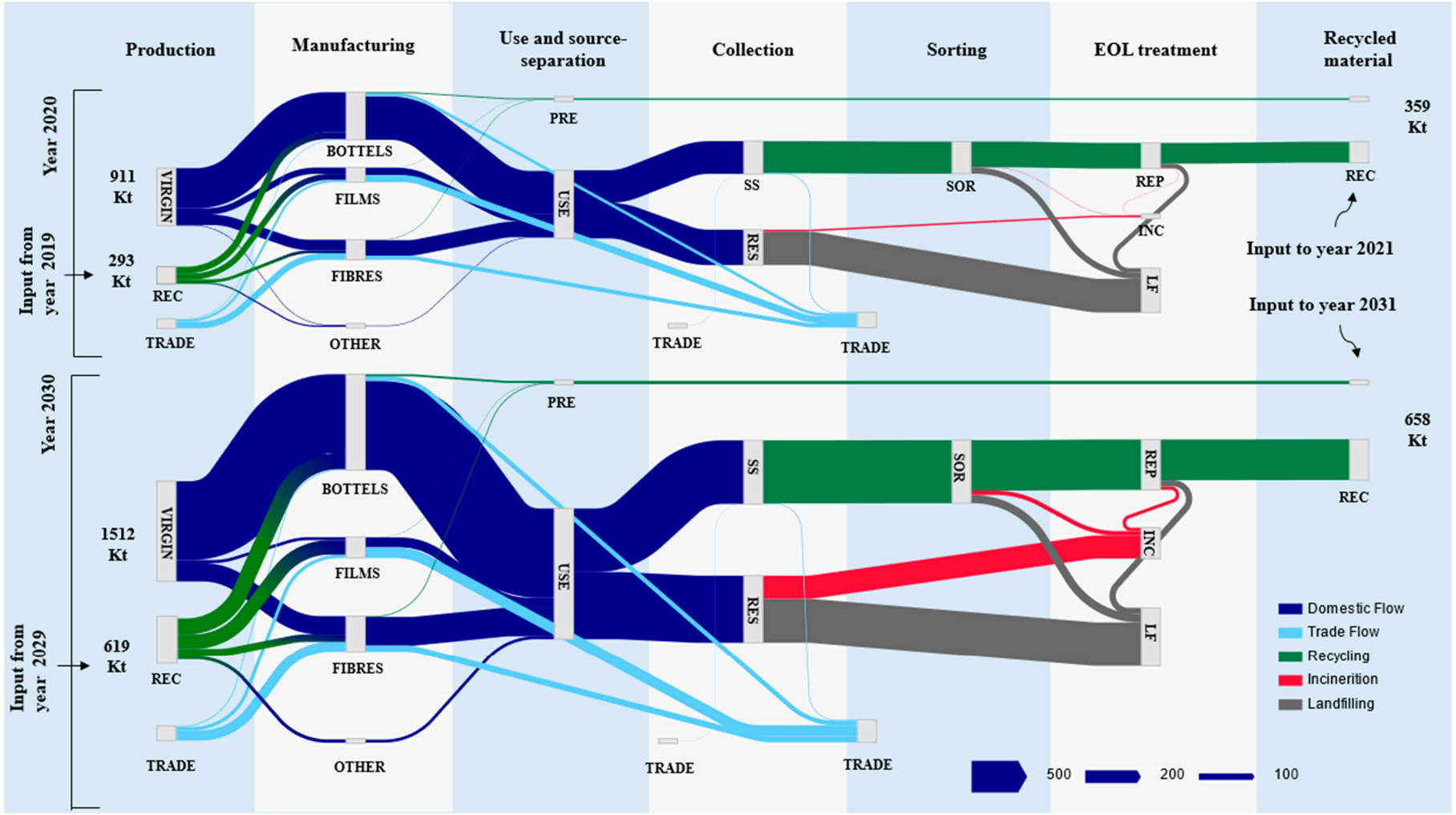


Figure S1.103 Sankey diagram for S4 in year 1 and year 30 in Mexico.

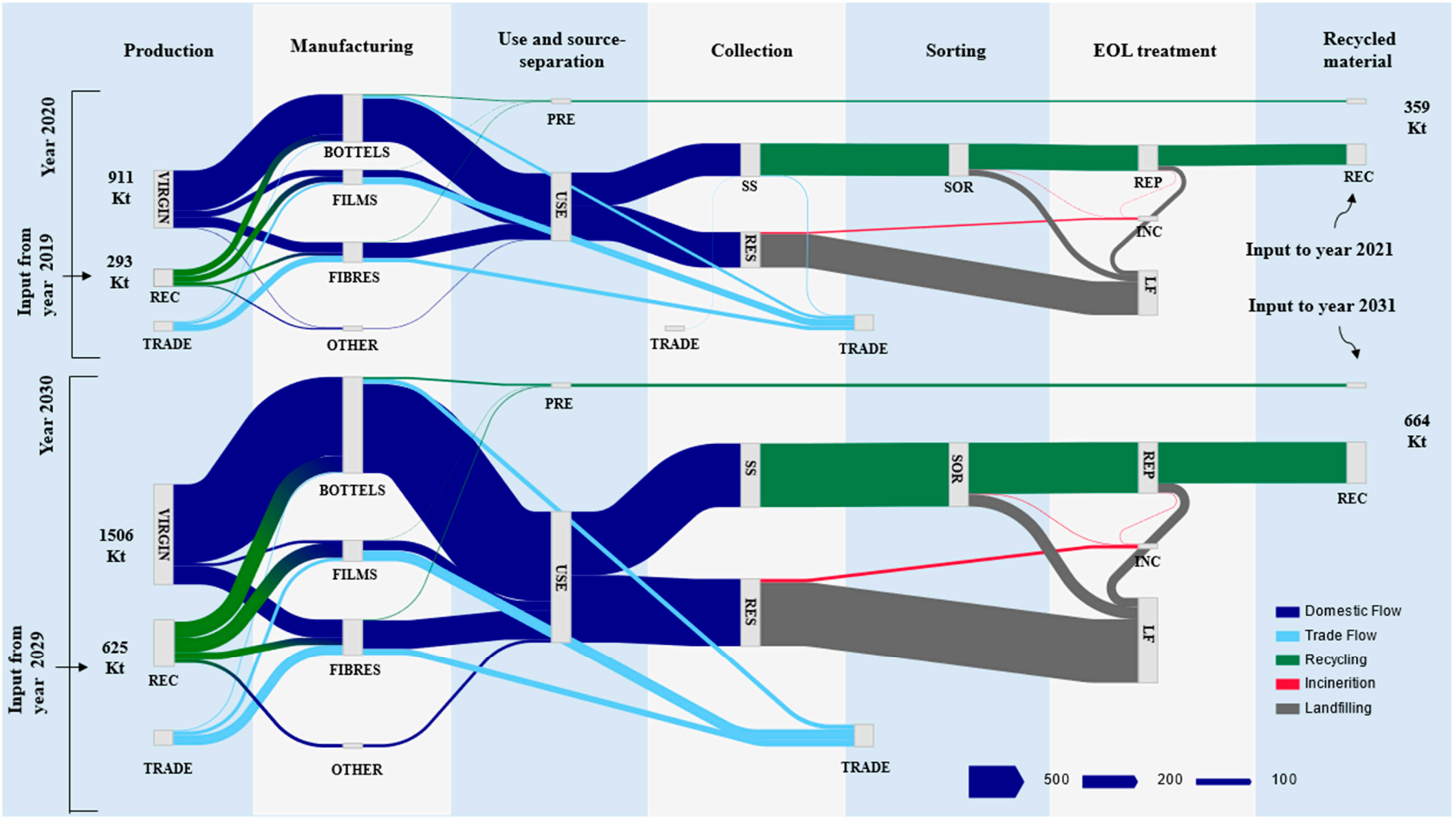


Figure S1.104 Sankey diagram for S5 in year 1 and year 30 in Mexico.

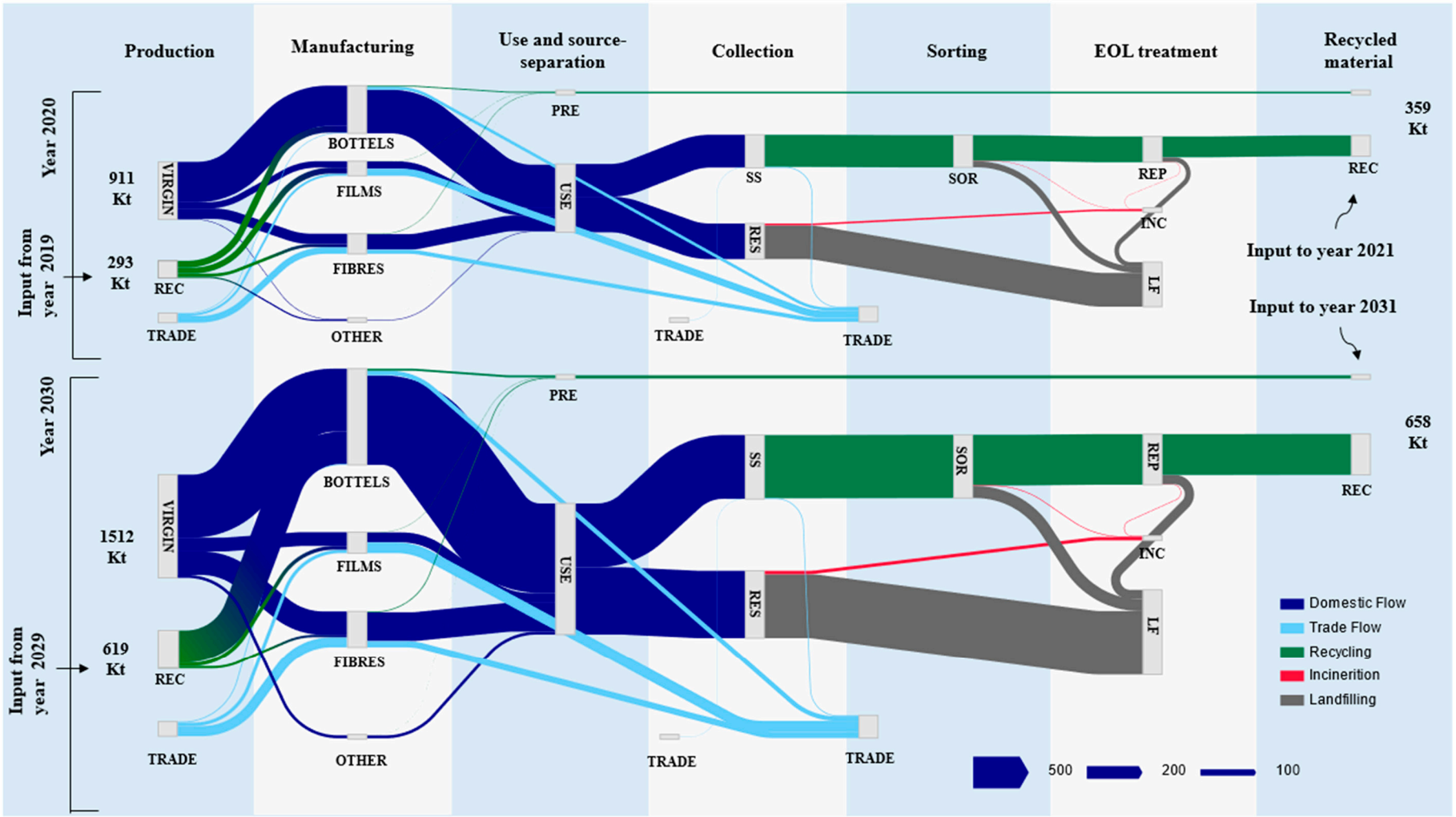


Figure S1.105 Sankey diagram for S6 in year 1 and year 30 in Mexico.

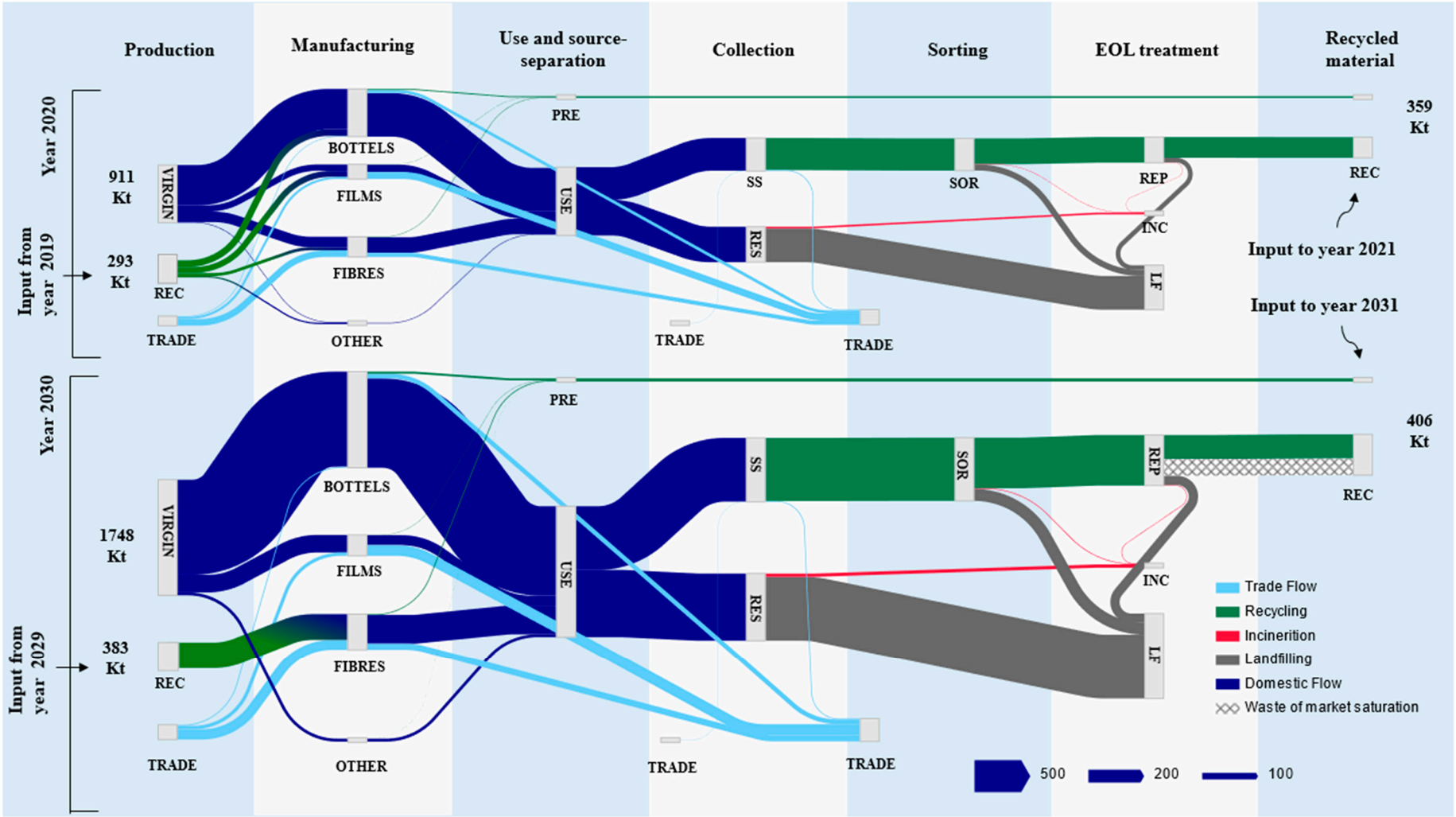


Figure S1.106 Sankey diagram for S7 in year 1 and year 30 in Mexico.

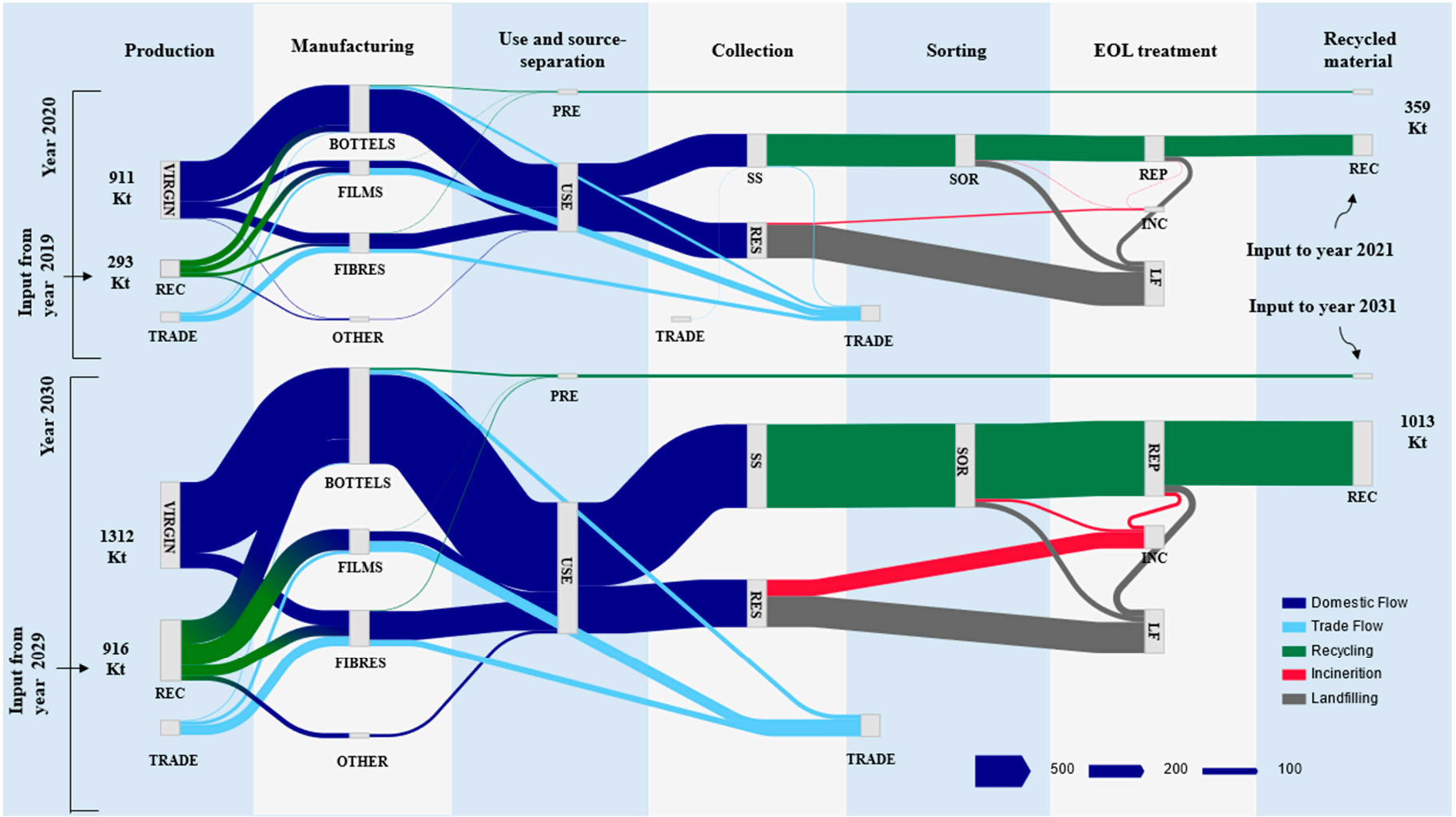


Figure S1.107 Sankey diagram for S8 in year 1 and year 30 in Mexico.

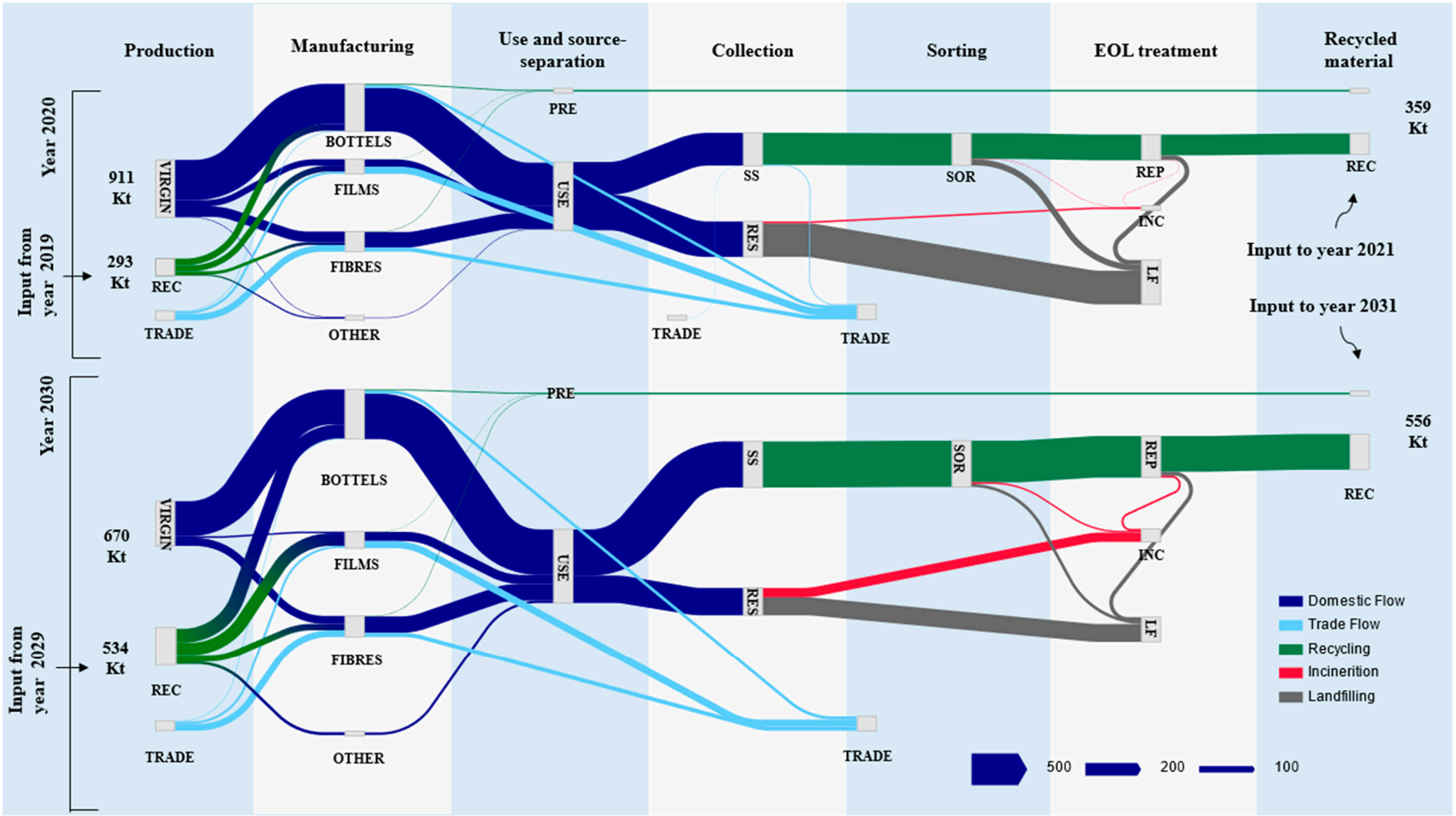


Figure S1.108 Sankey diagram for S9 in year 1 and year 30 in Mexico.

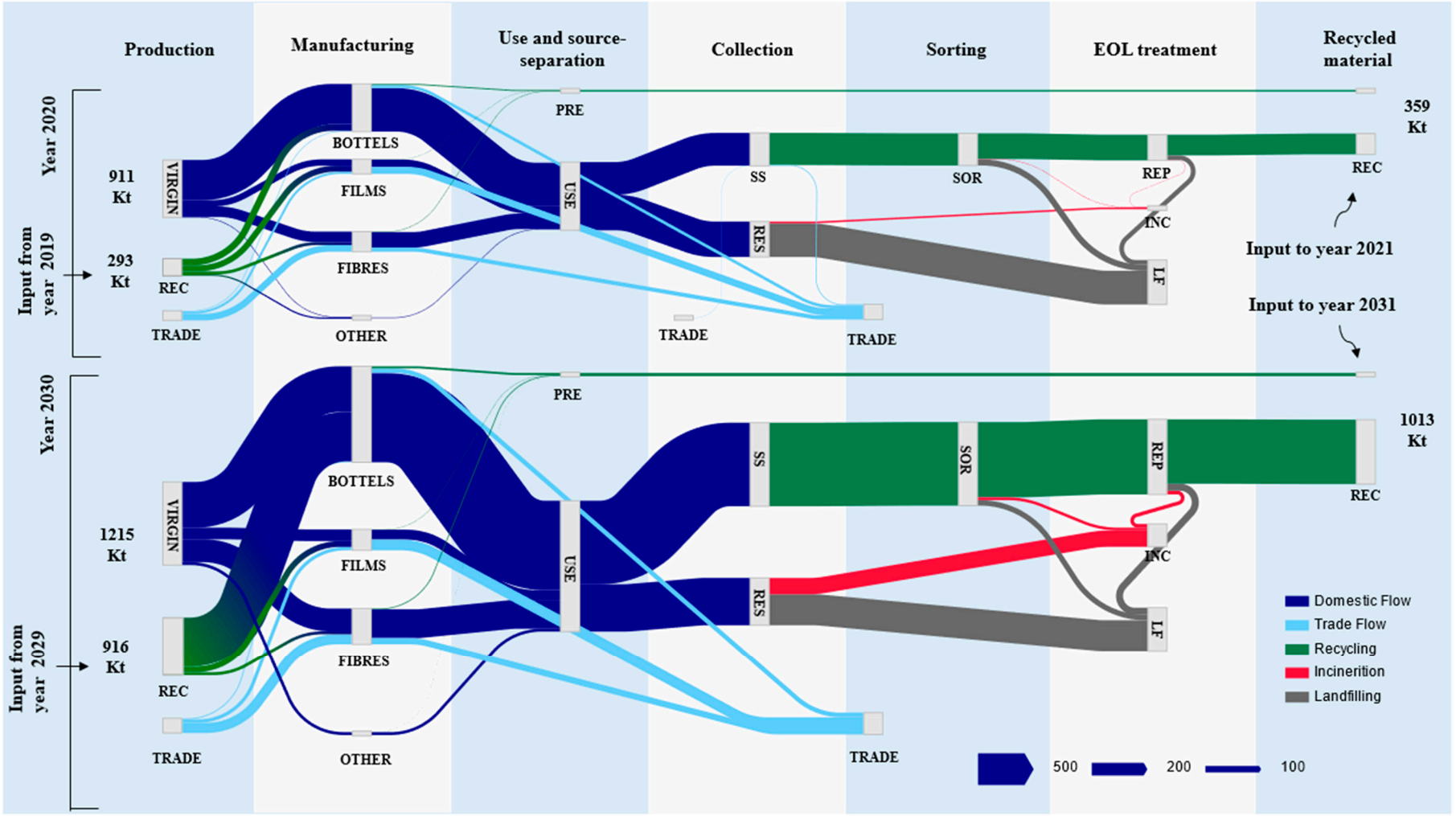


Figure S1.109 Sankey diagram for S10 in year 1 and year 30 in Mexico.

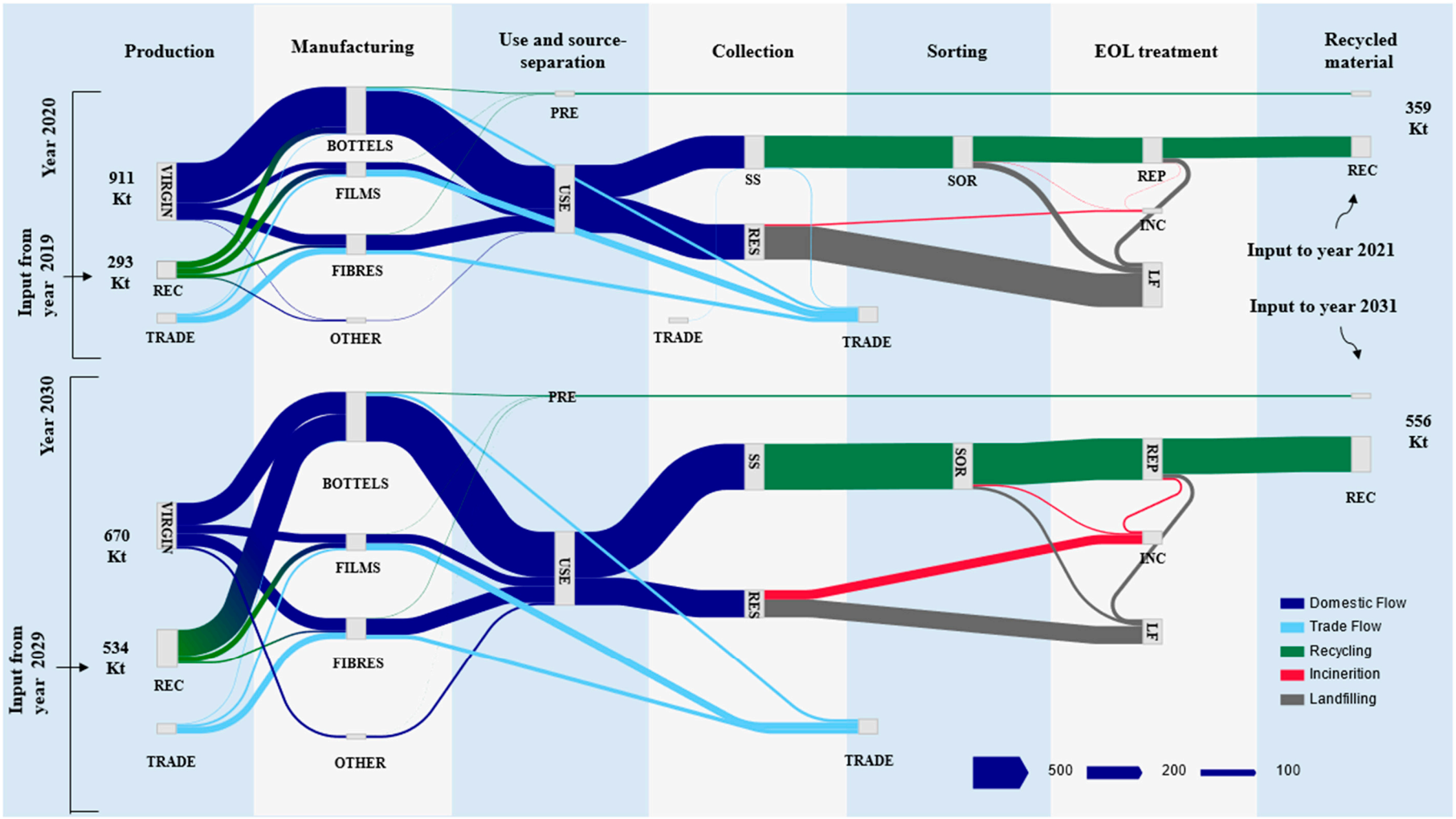


Figure S1.110 Sankey diagram for S11 in year 1 and year 30 in Mexico.

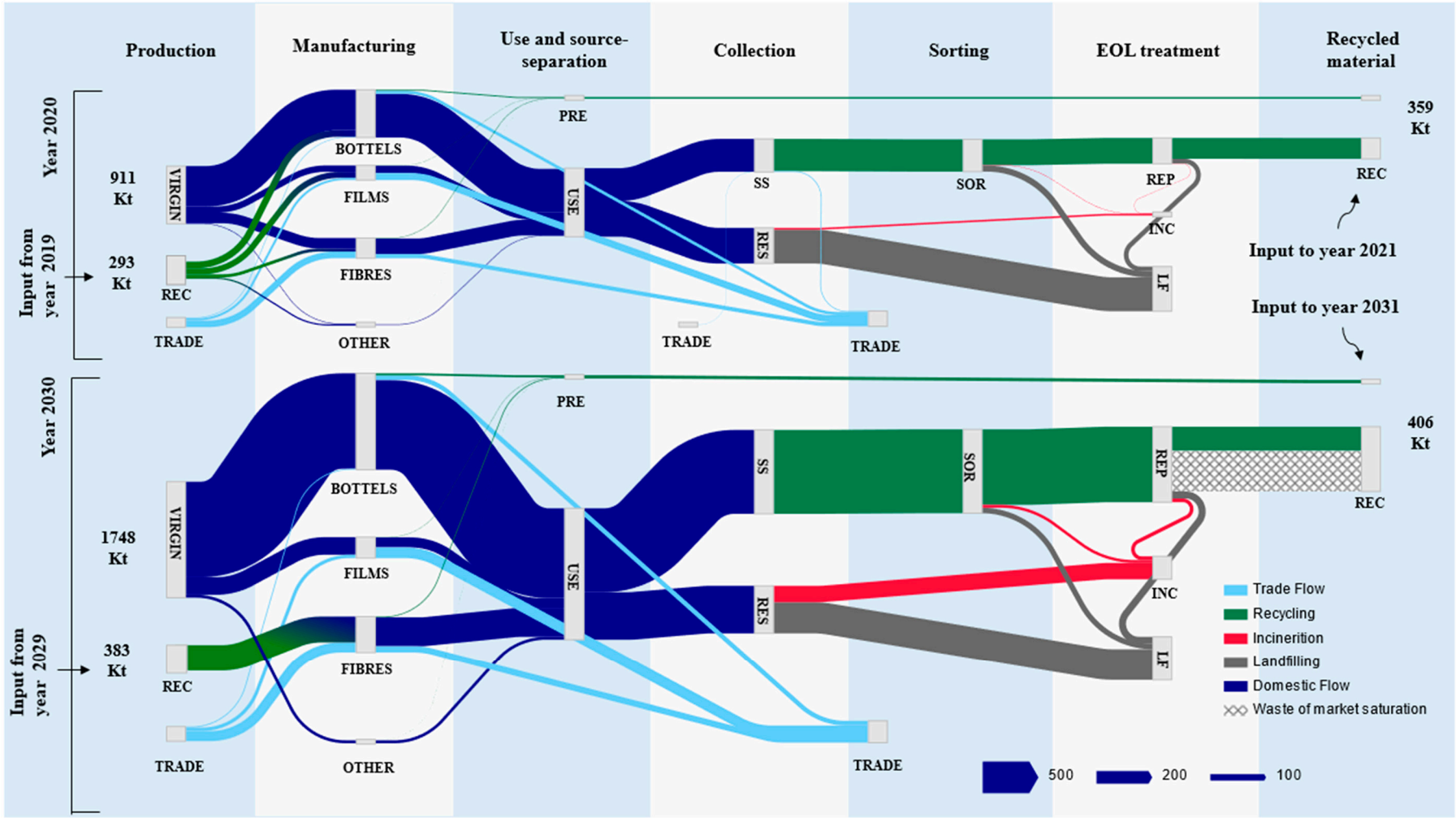


Figure S1.111 Sankey diagram for S12 in year 1 and year 30 in Mexico.

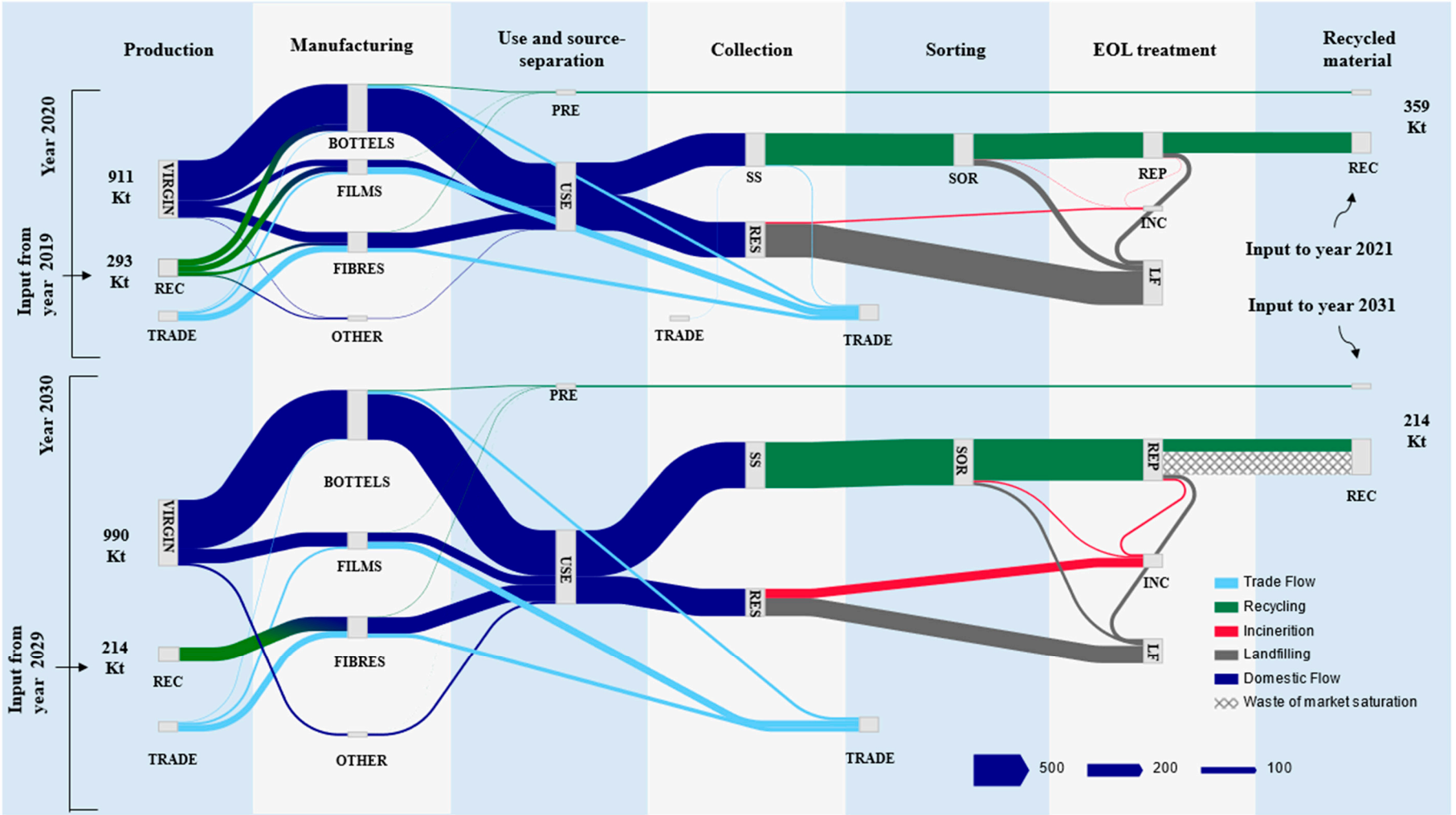


Figure S1.112 Sankey diagram for S13 in year 1 and year 30 in Mexico.

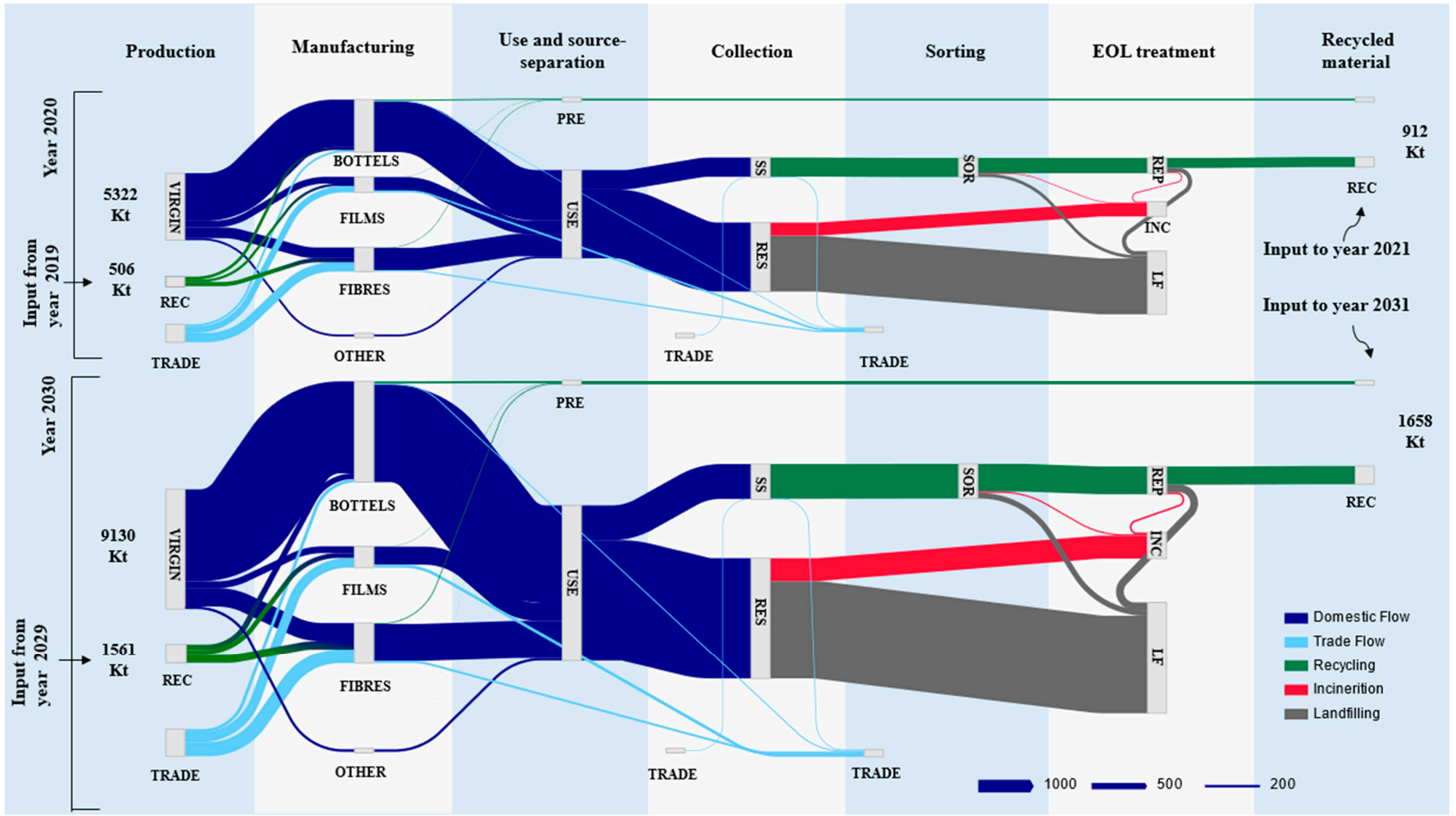


Figure S1.113 Sankey diagram for S0 in year 1 and year 30 in America.

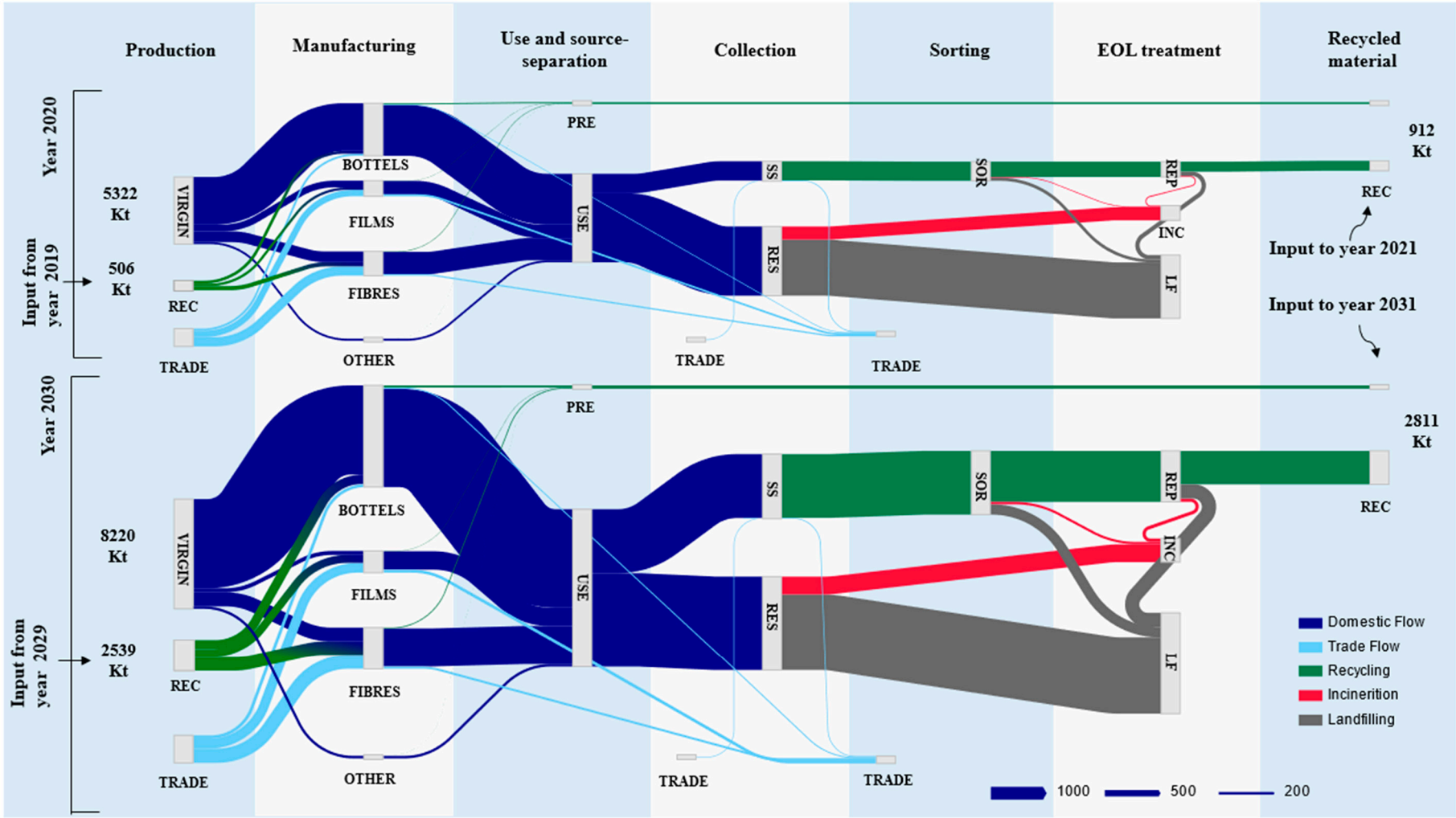


Figure S1.114 Sankey diagram for S1 in year 1 and year 30 in America.

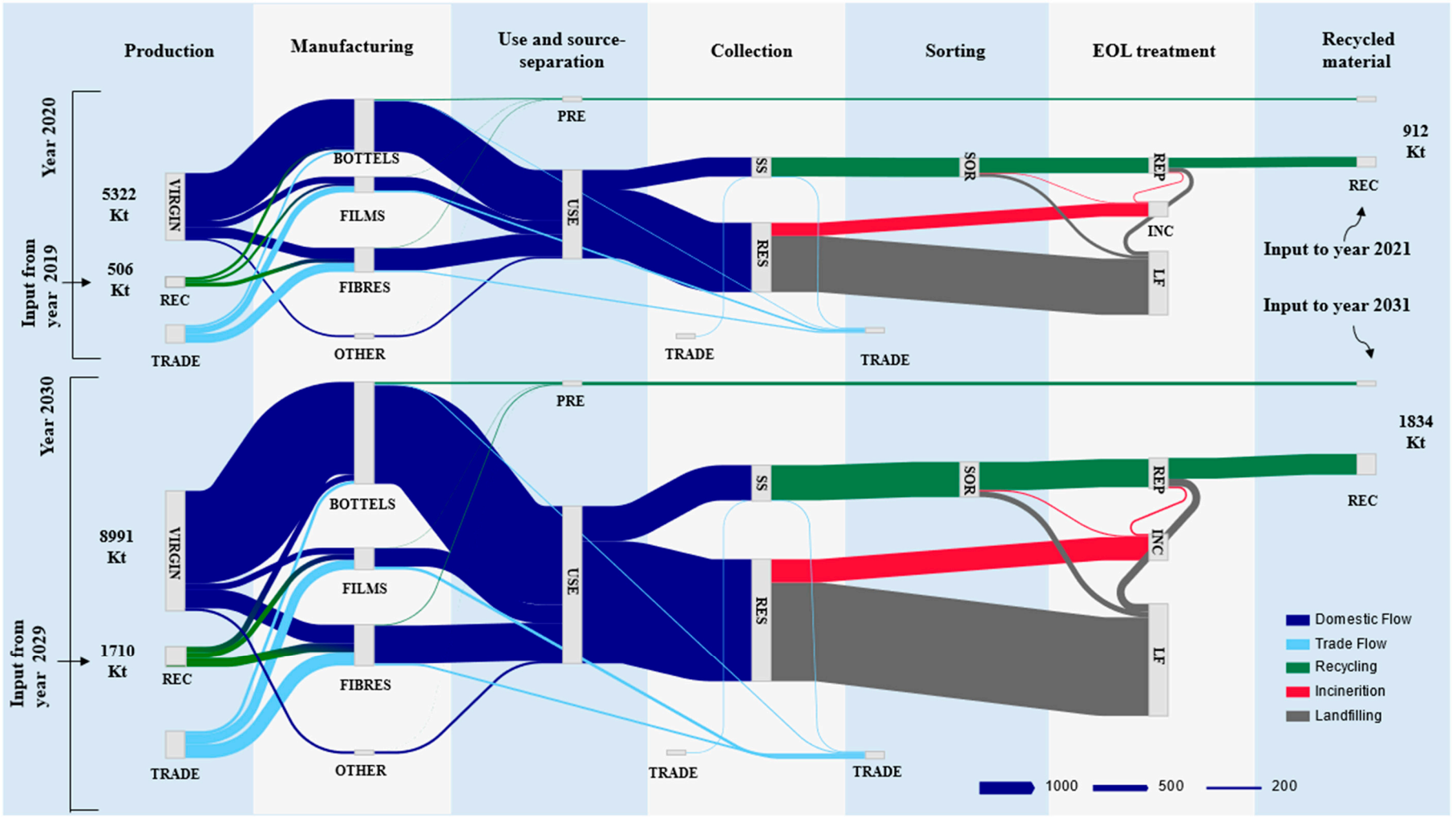


Figure S1.115 Sankey diagram for S2 in year 1 and year 30 in America.

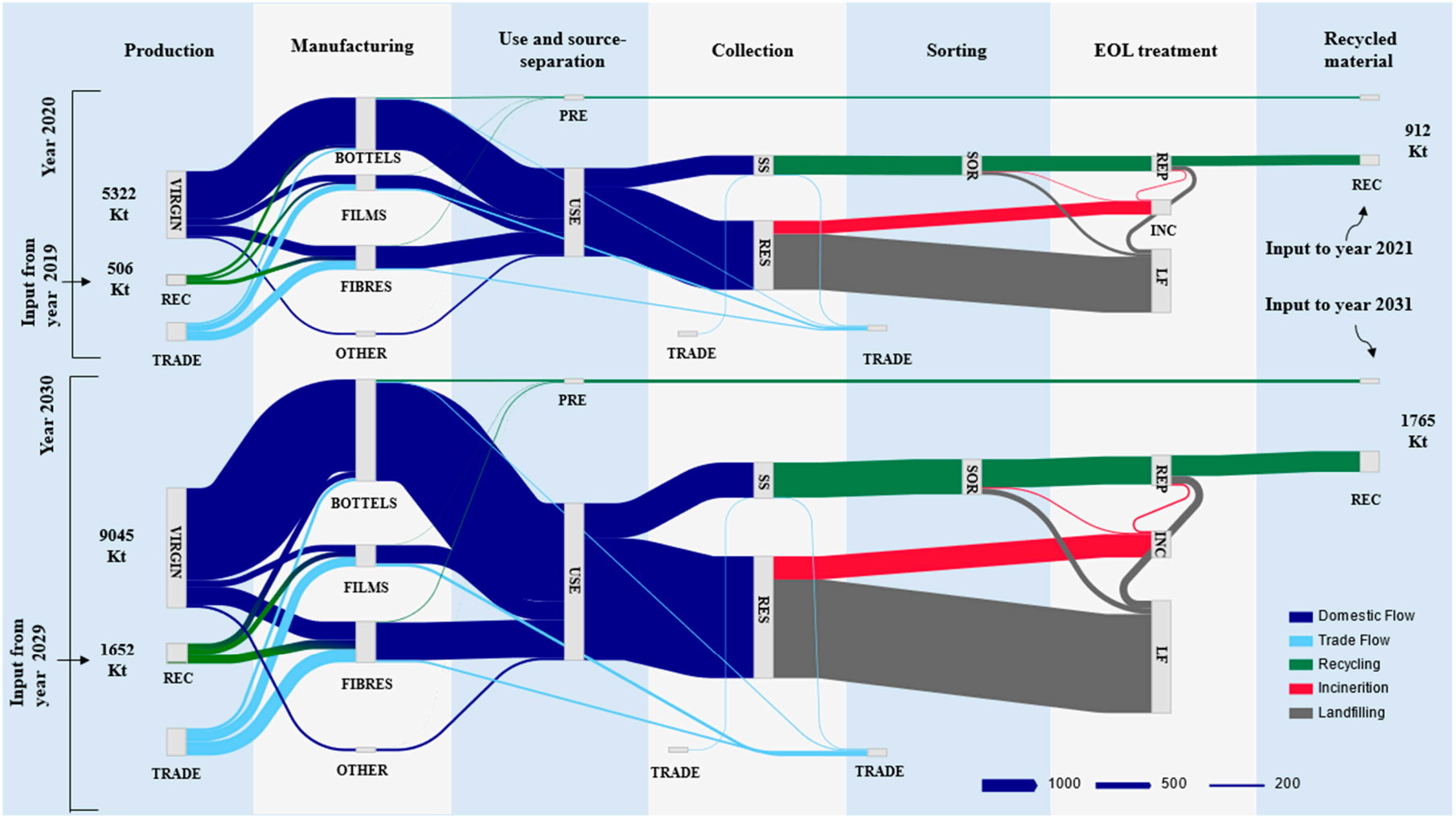


Figure S1.116 Sankey diagram for S3 in year 1 and year 30 in America.

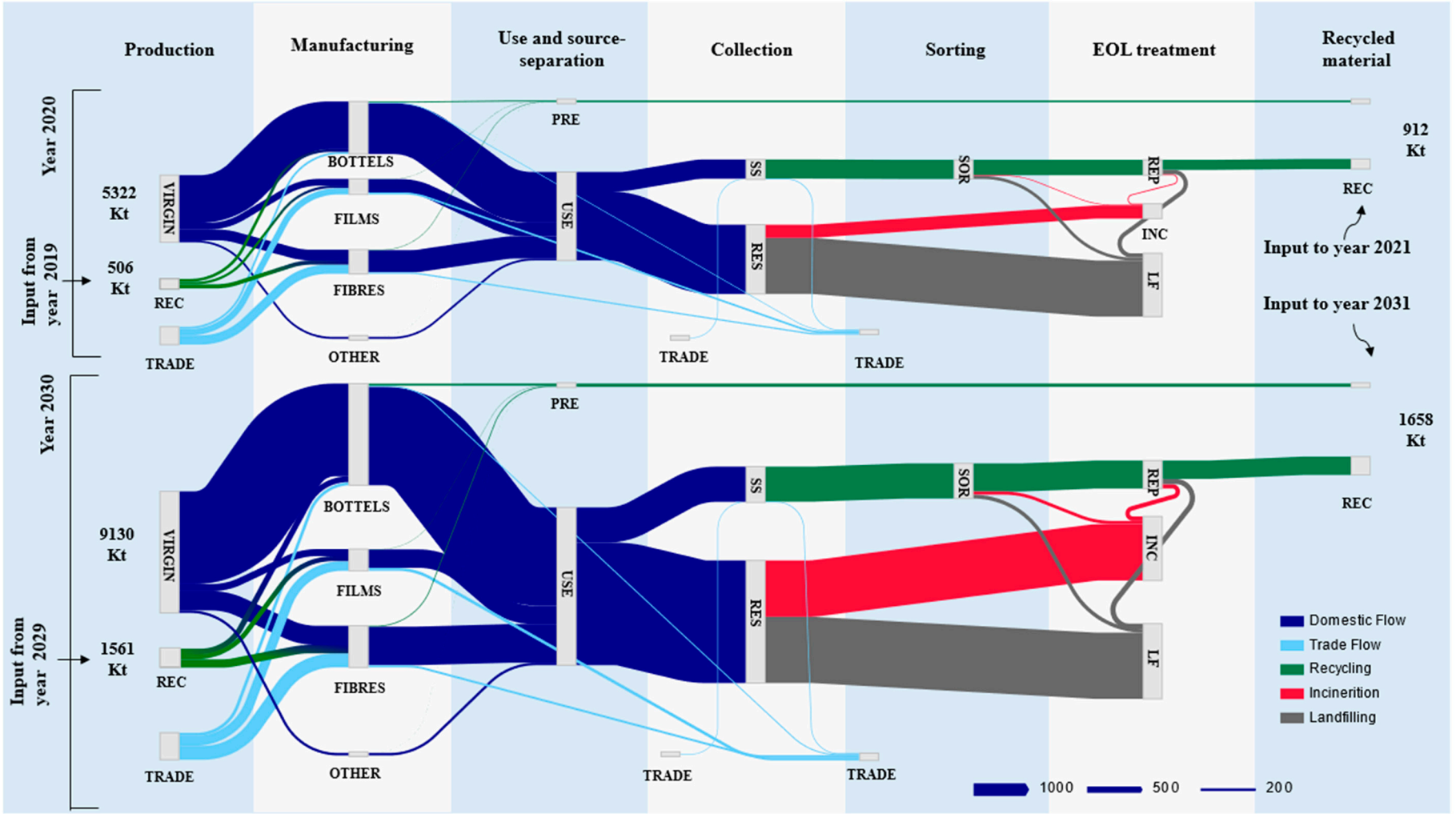


Figure S1.117 Sankey diagram for S4 in year 1 and year 30 in America.

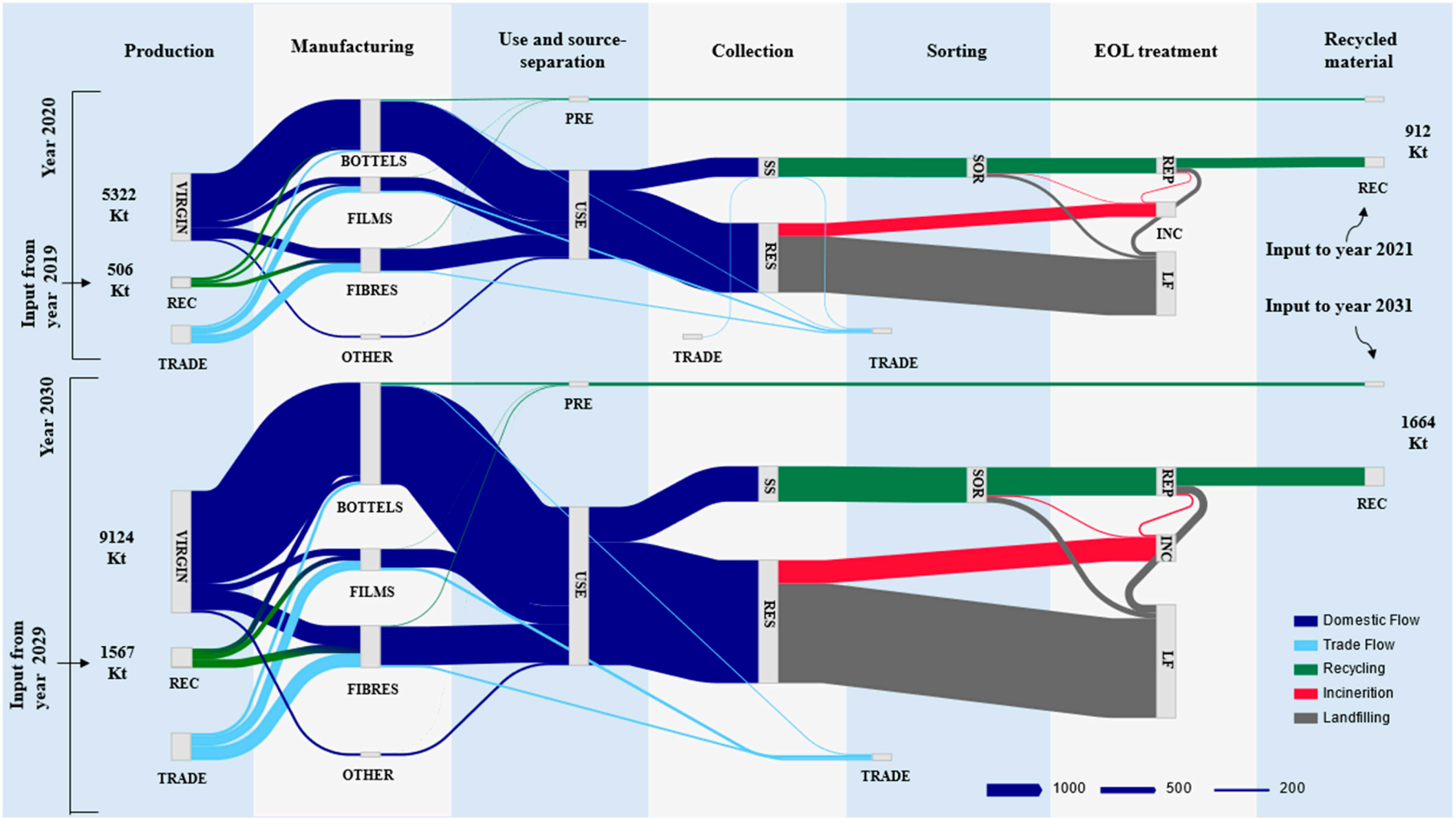


Figure S1.118 Sankey diagram for S5 in year 1 and year 30 in America.

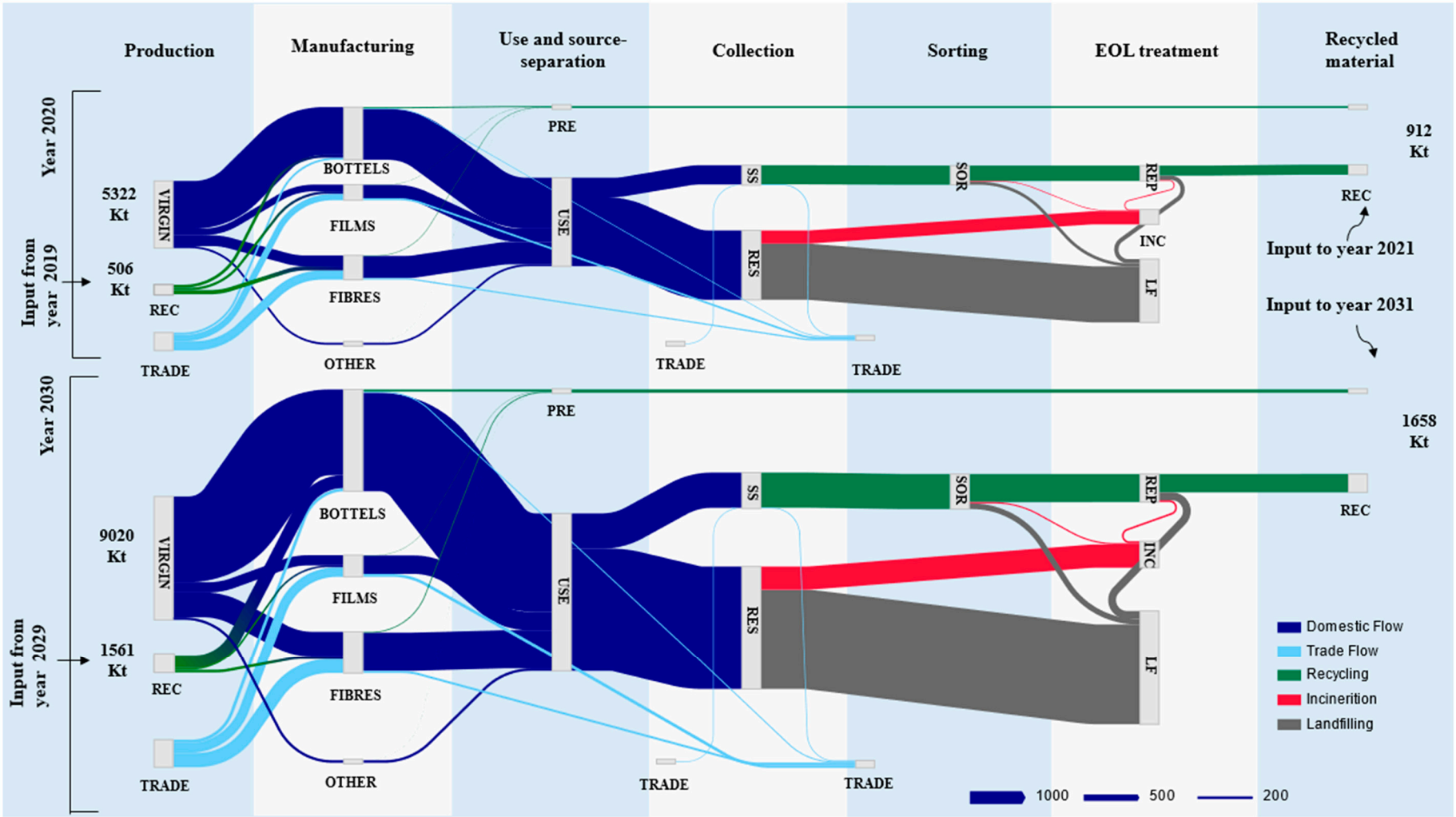


Figure S1.119 Sankey diagram for S6 in year 1 and year 30 in America.

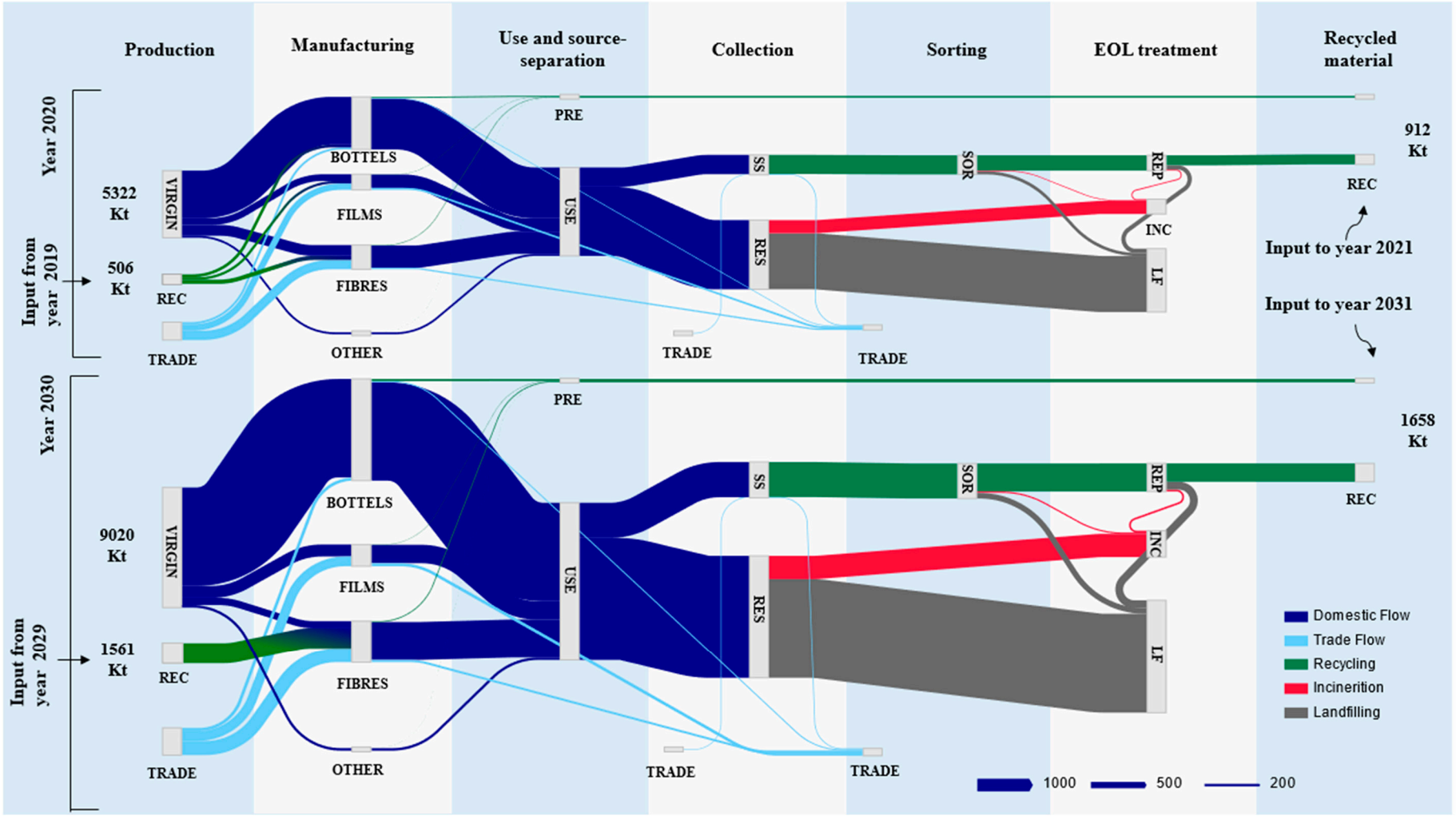


Figure S1.120 Sankey diagram for S7 in year 1 and year 30 in America.

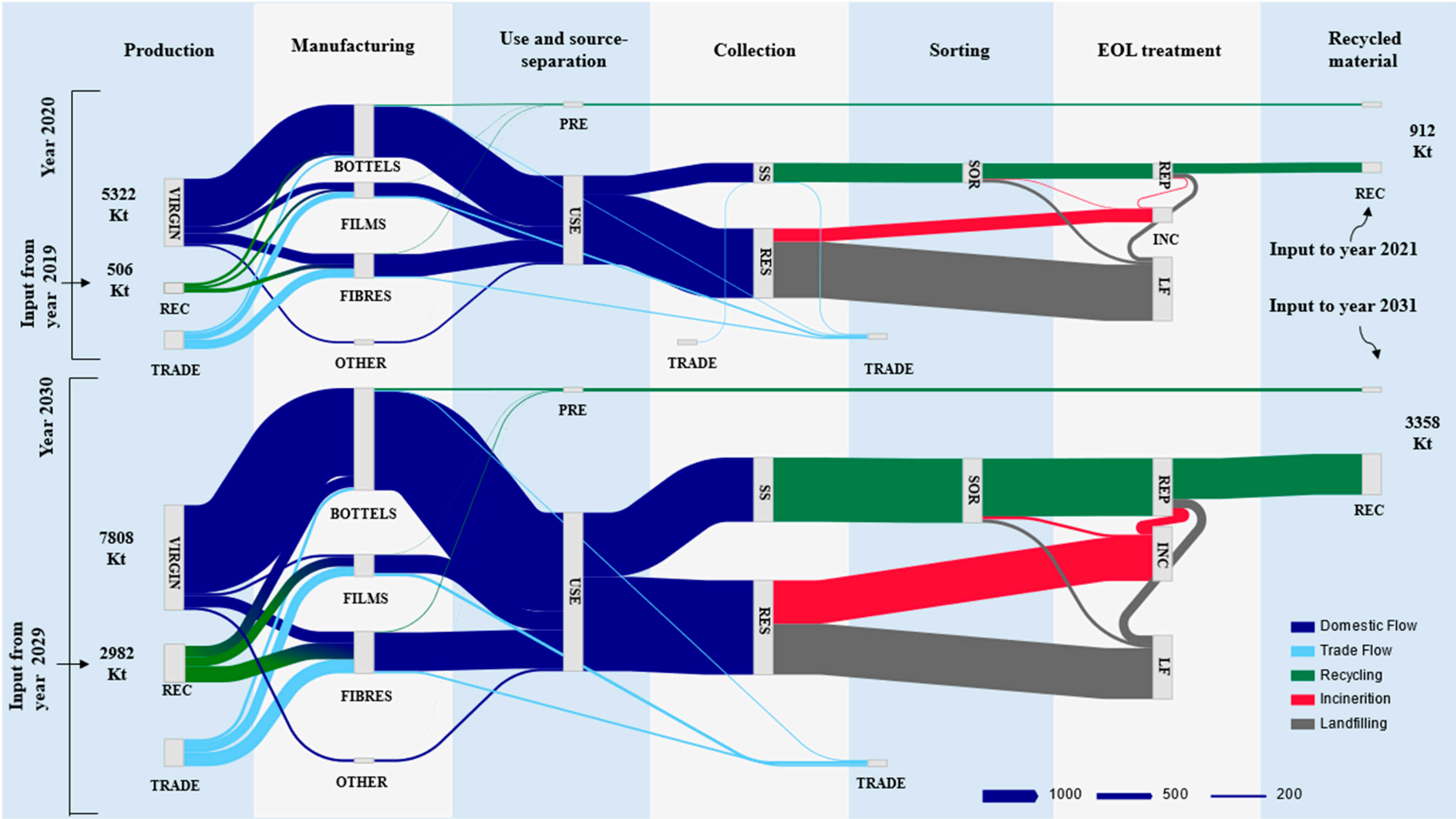


Figure S1.121 Sankey diagram for S8 in year 1 and year 30 in America.

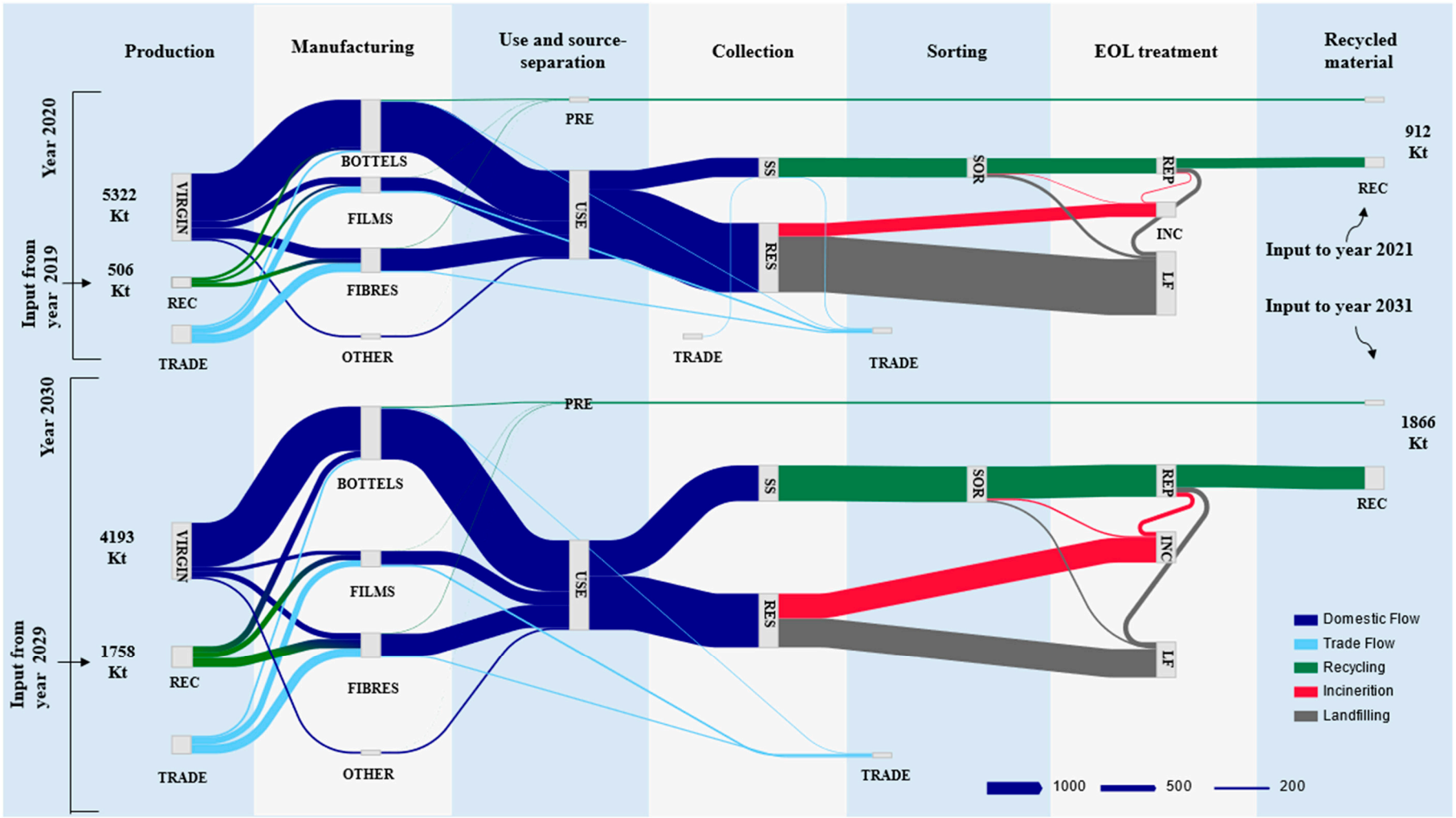


Figure S1.122 Sankey diagram for S9 in year 1 and year 30 in America.

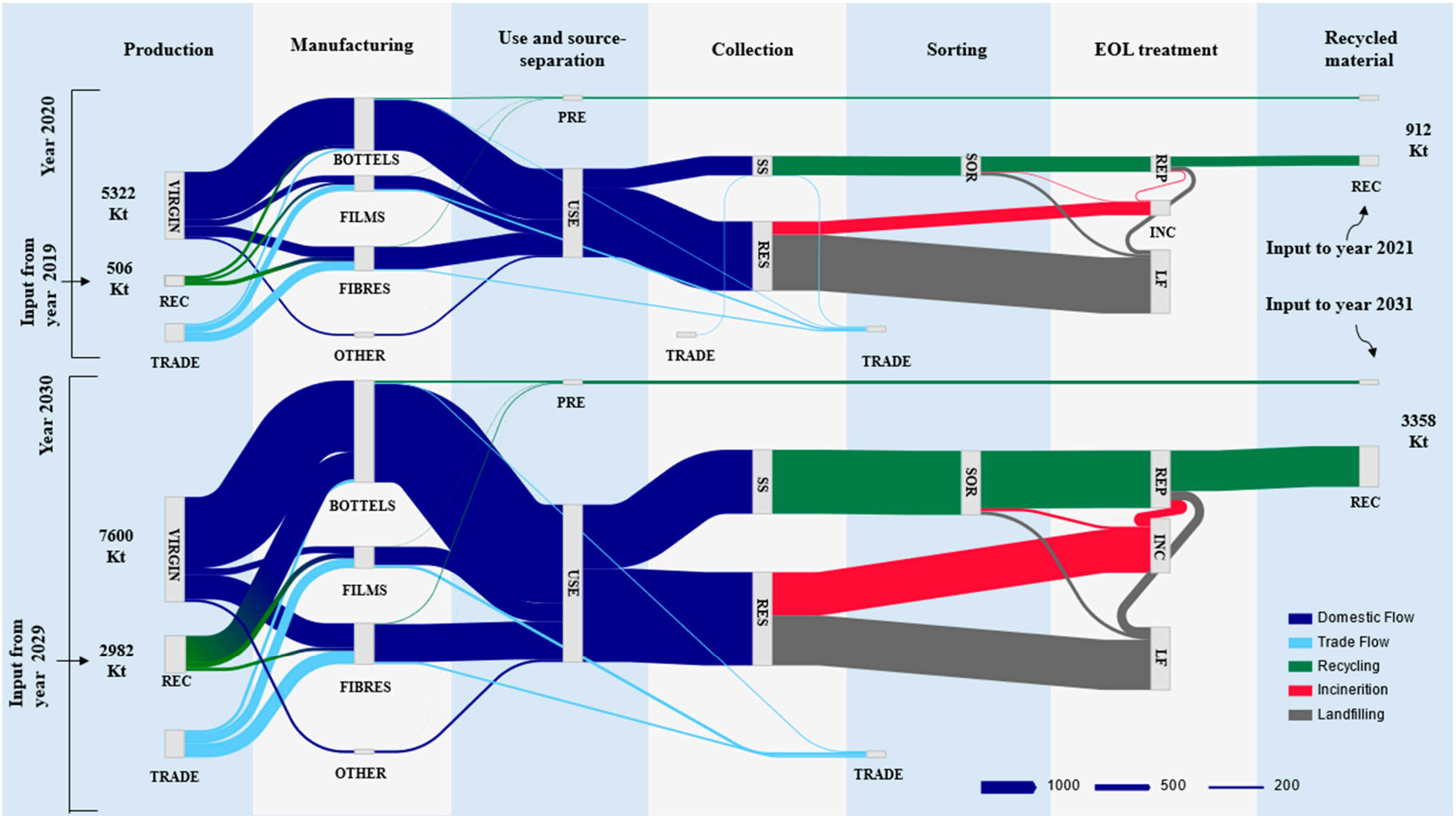


Figure S1.123 Sankey diagram for S10 in year 1 and year 30 in America.

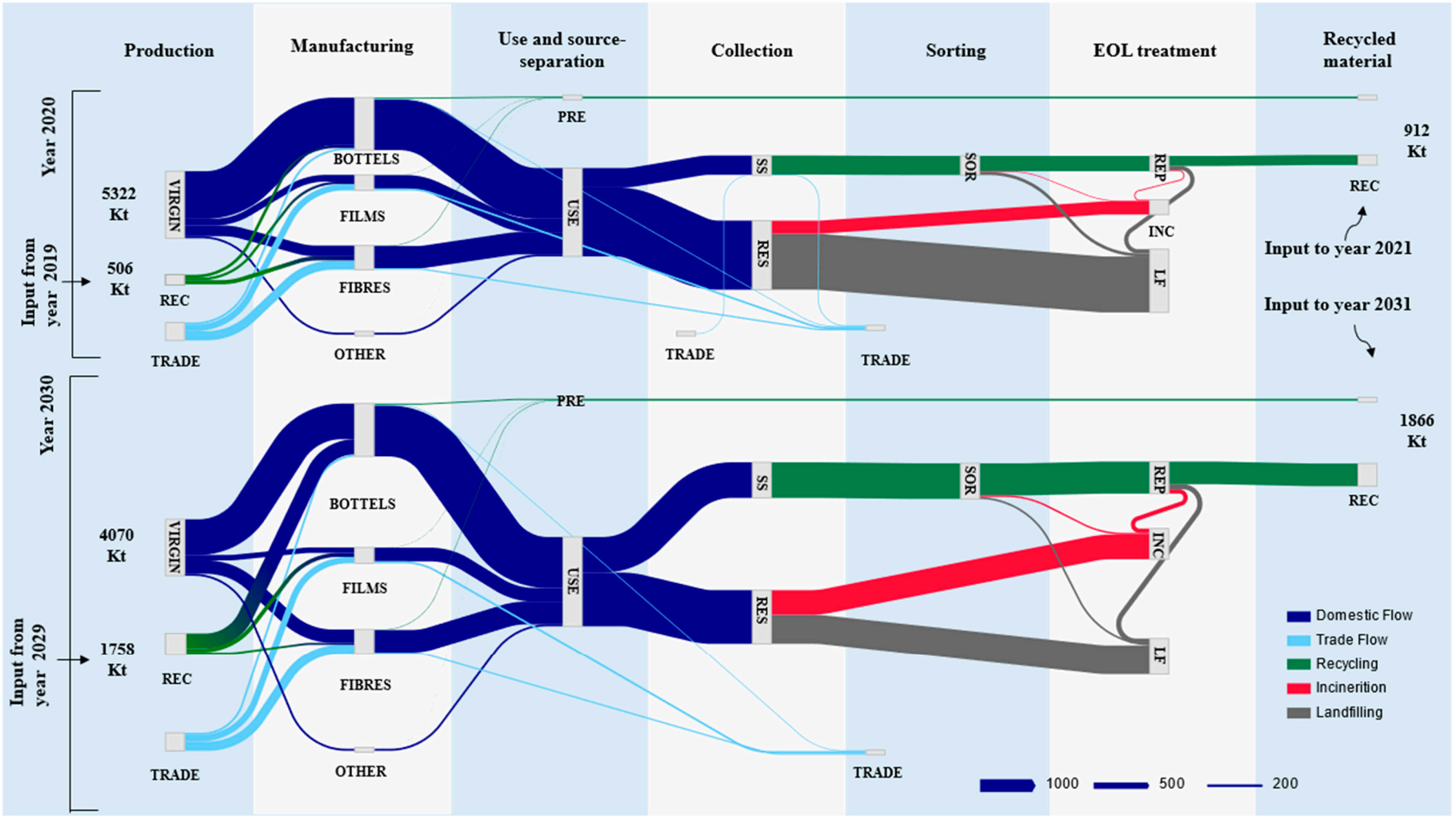


Figure S1.124 Sankey diagram for S11 in year 1 and year 30 in America.

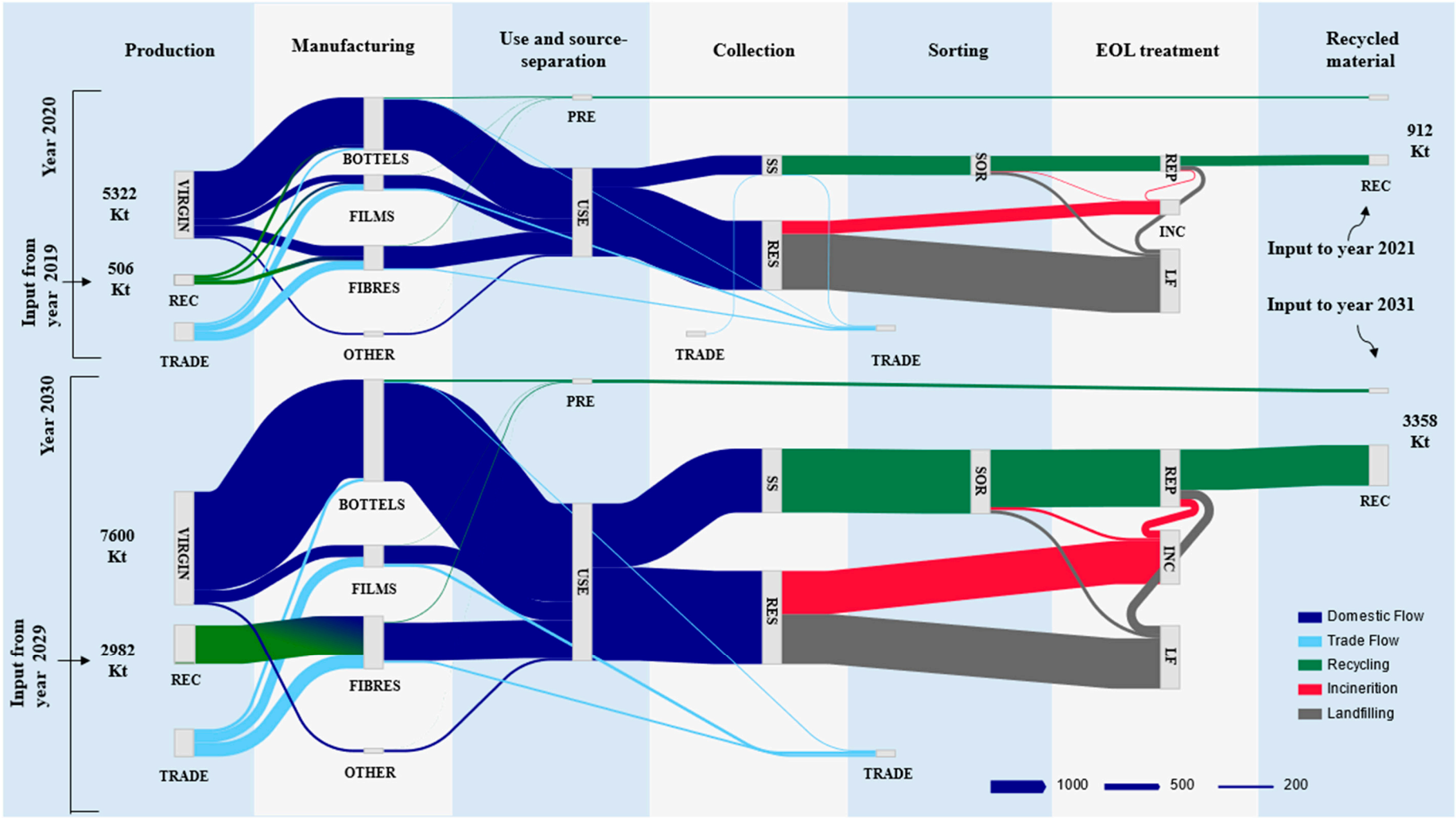


Figure S1.125 Sankey diagram for S12 in year 1 and year 30 in America.

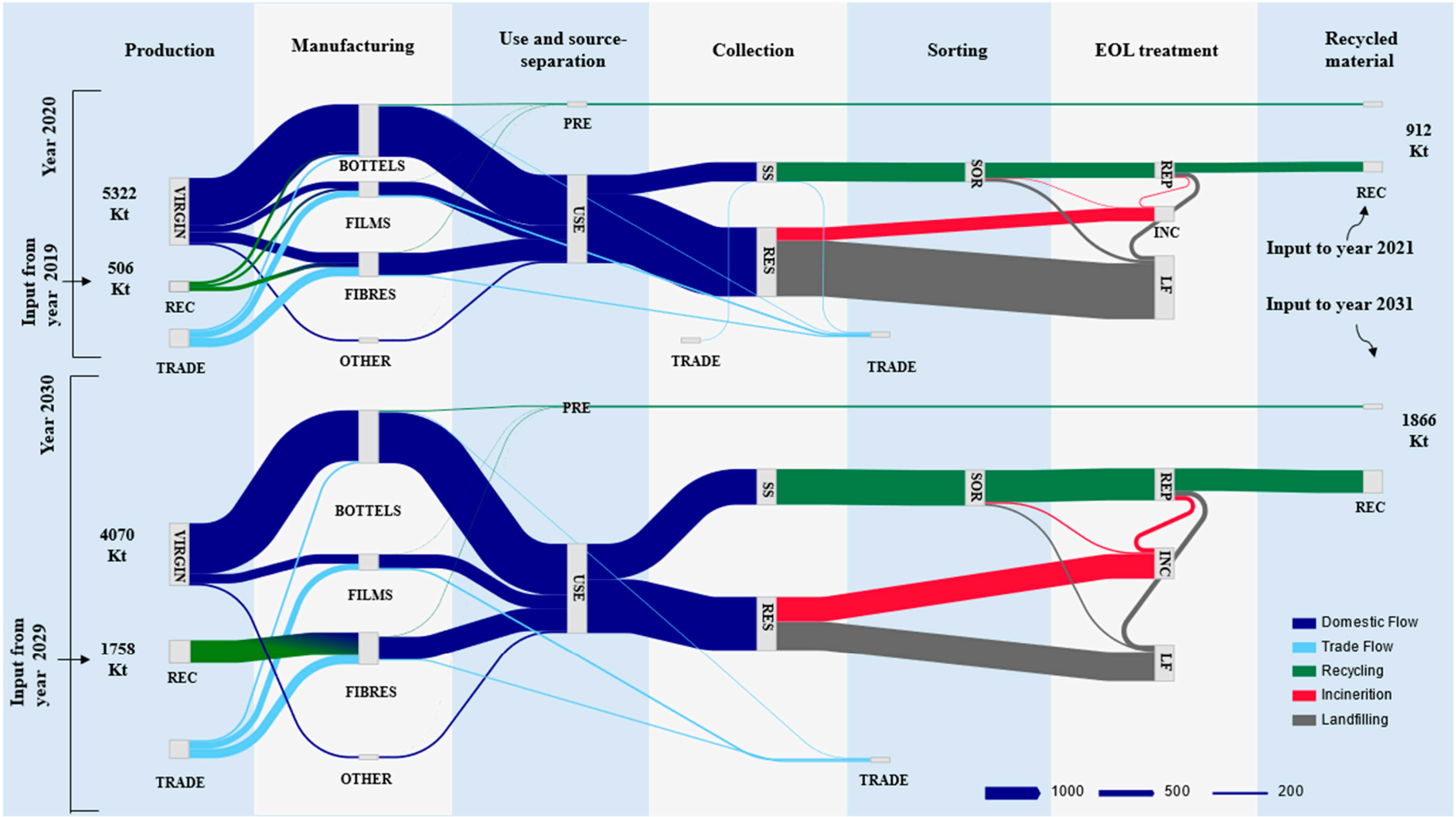


Figure S1.126 Sankey diagram for S13 in year 1 and year 30 in America.

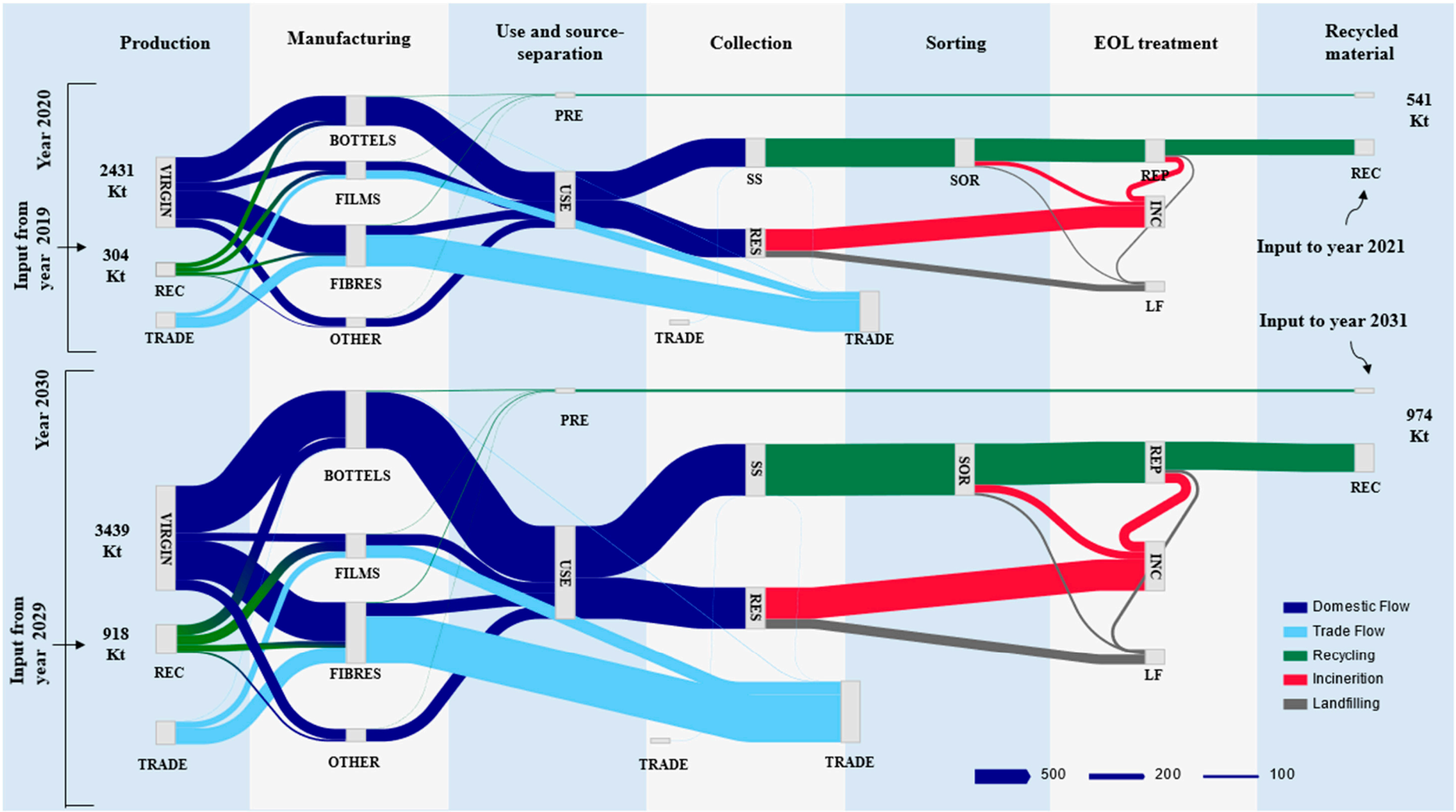


Figure S1.127 Sankey diagram for S0 in year 1 and year 30 in Korea.

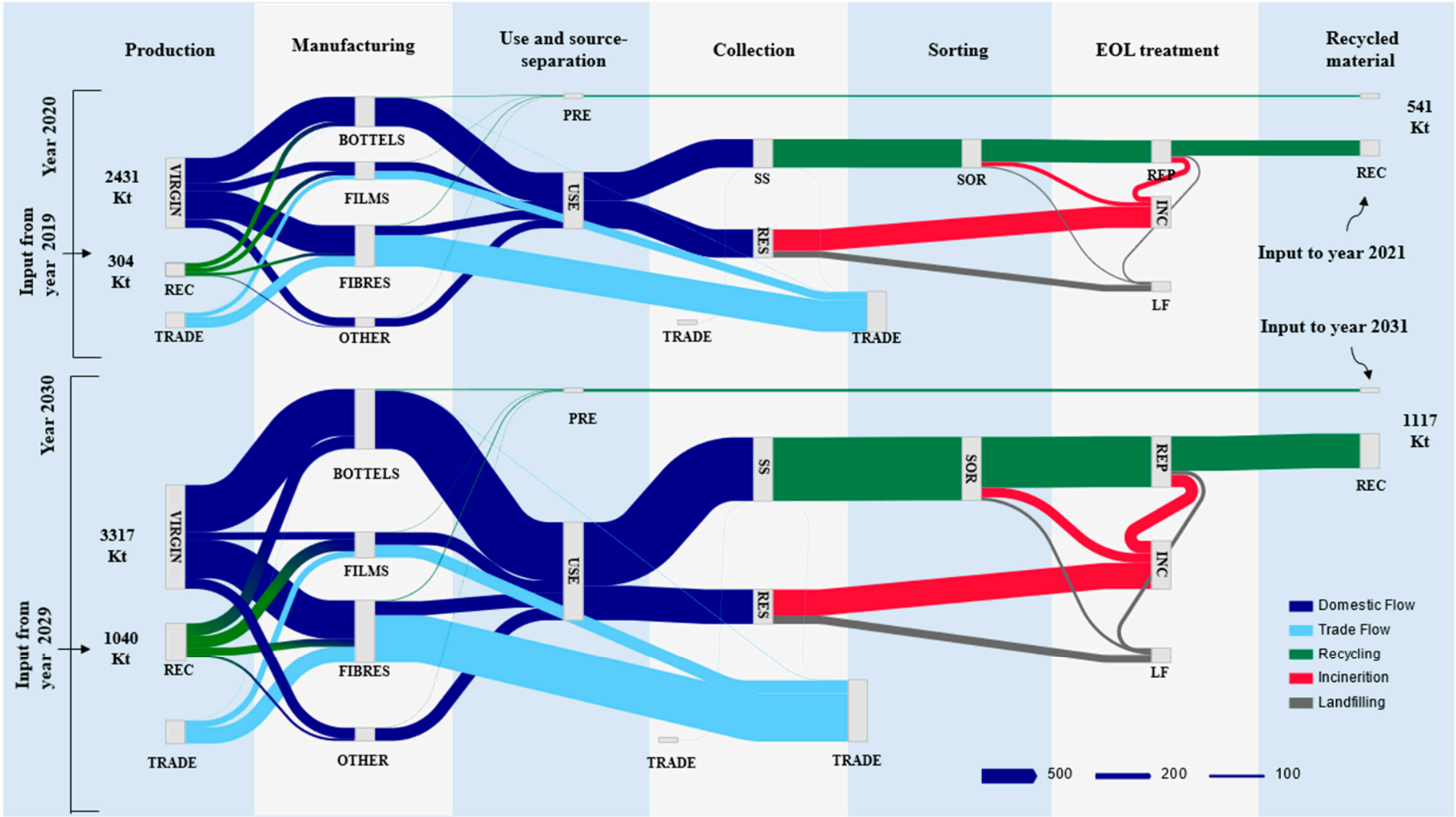


Figure S1.128 Sankey diagram for S1 in year 1 and year 30 in Korea.

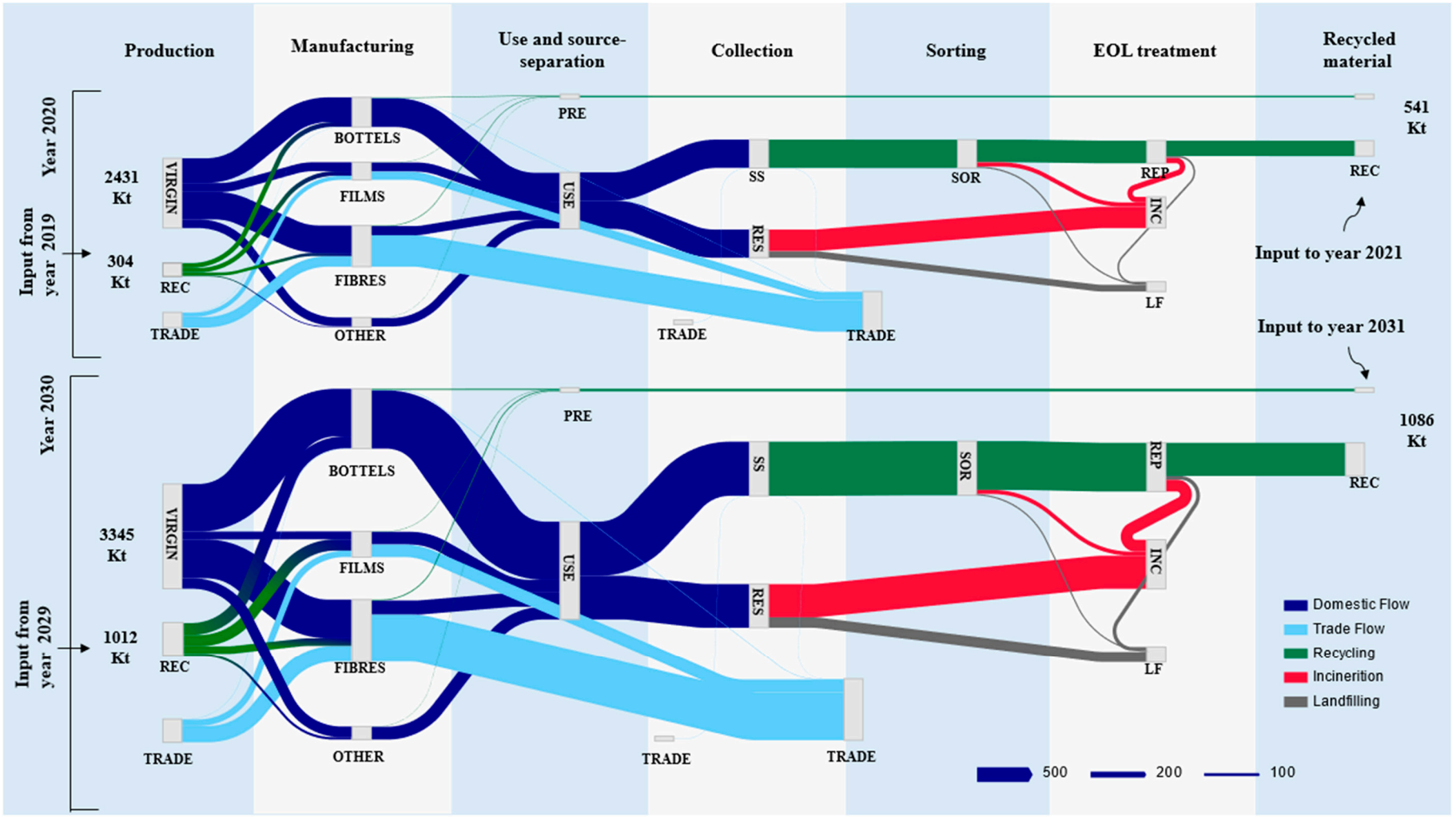


Figure S1.129 Sankey diagram for S2 in year 1 and year 30 in Korea.

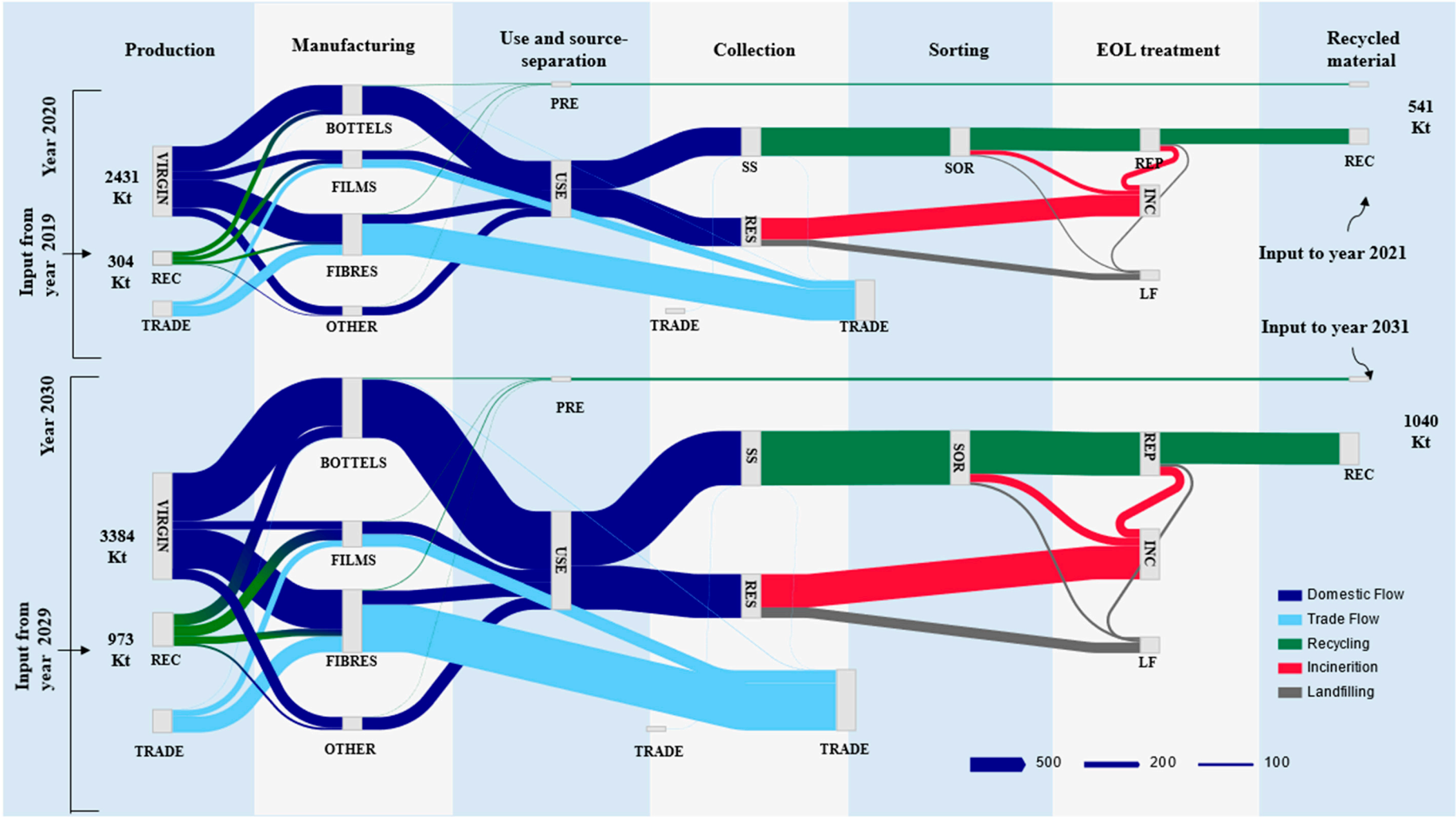


Figure S1.130 Sankey diagram for S3 in year 1 and year 30 in Korea.

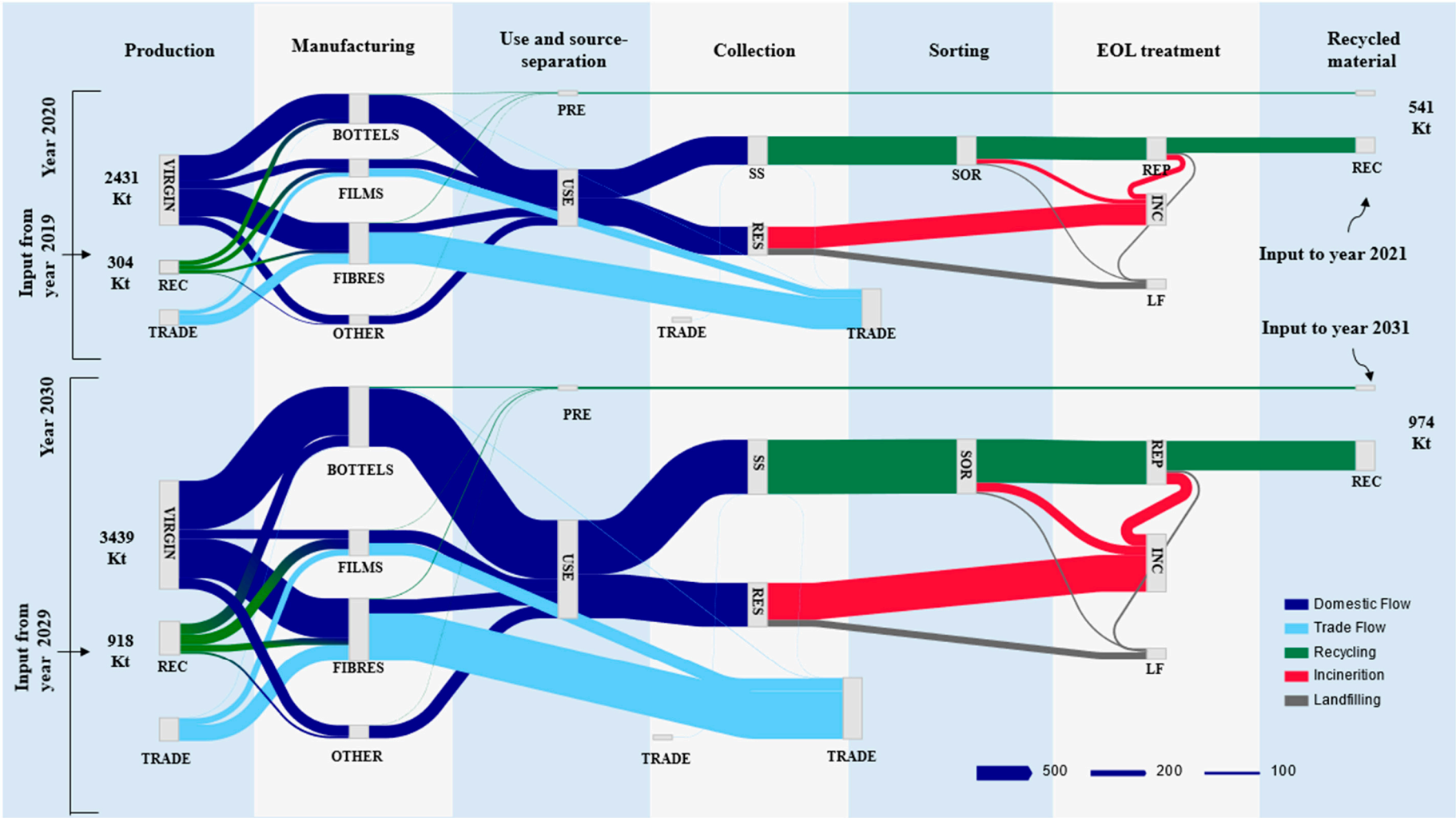


Figure S1.131 Sankey diagram for S4 in year 1 and year 30 in Korea.

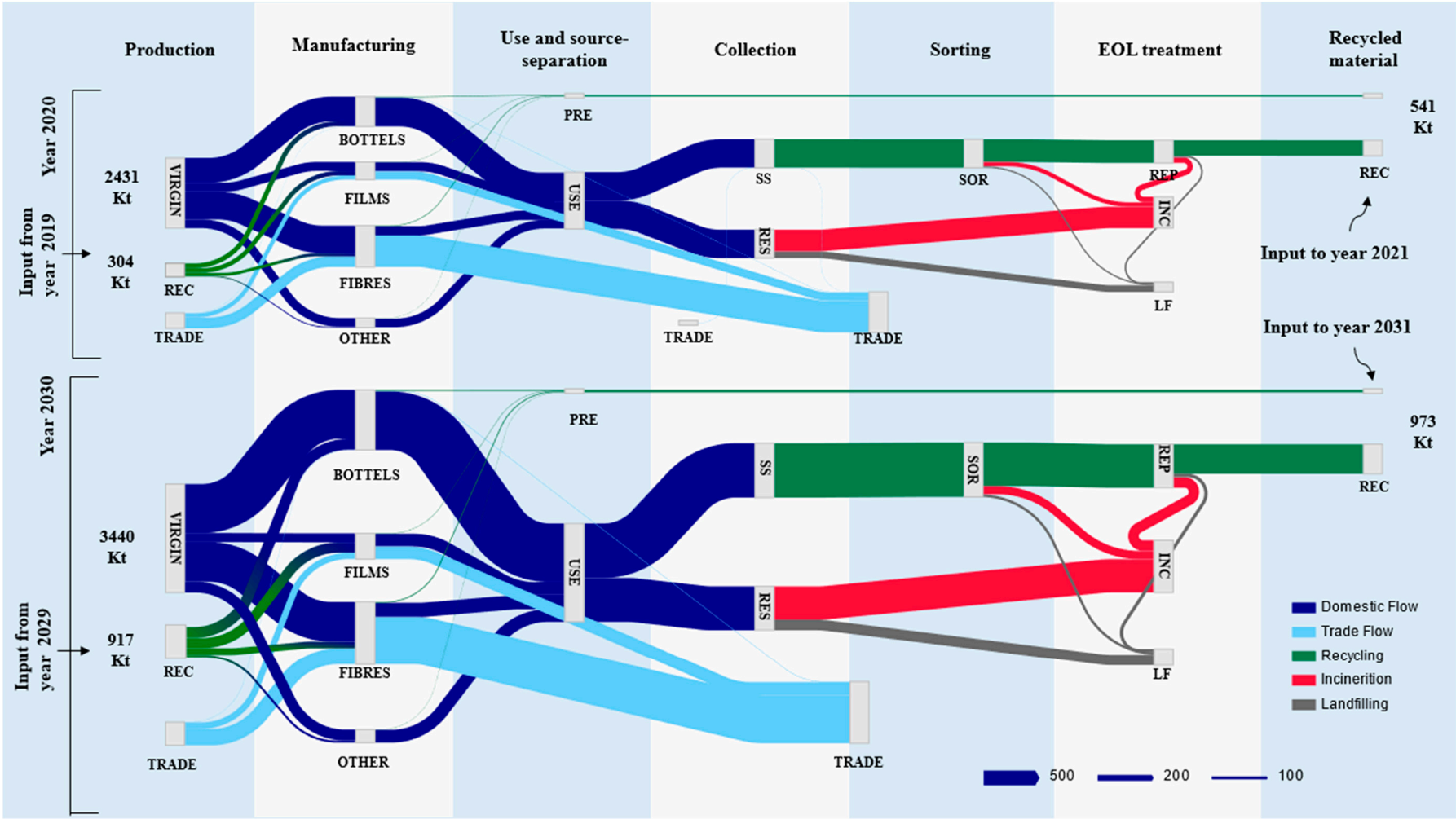


Figure S1.132 Sankey diagram for S5 in year 1 and year 30 in Korea.

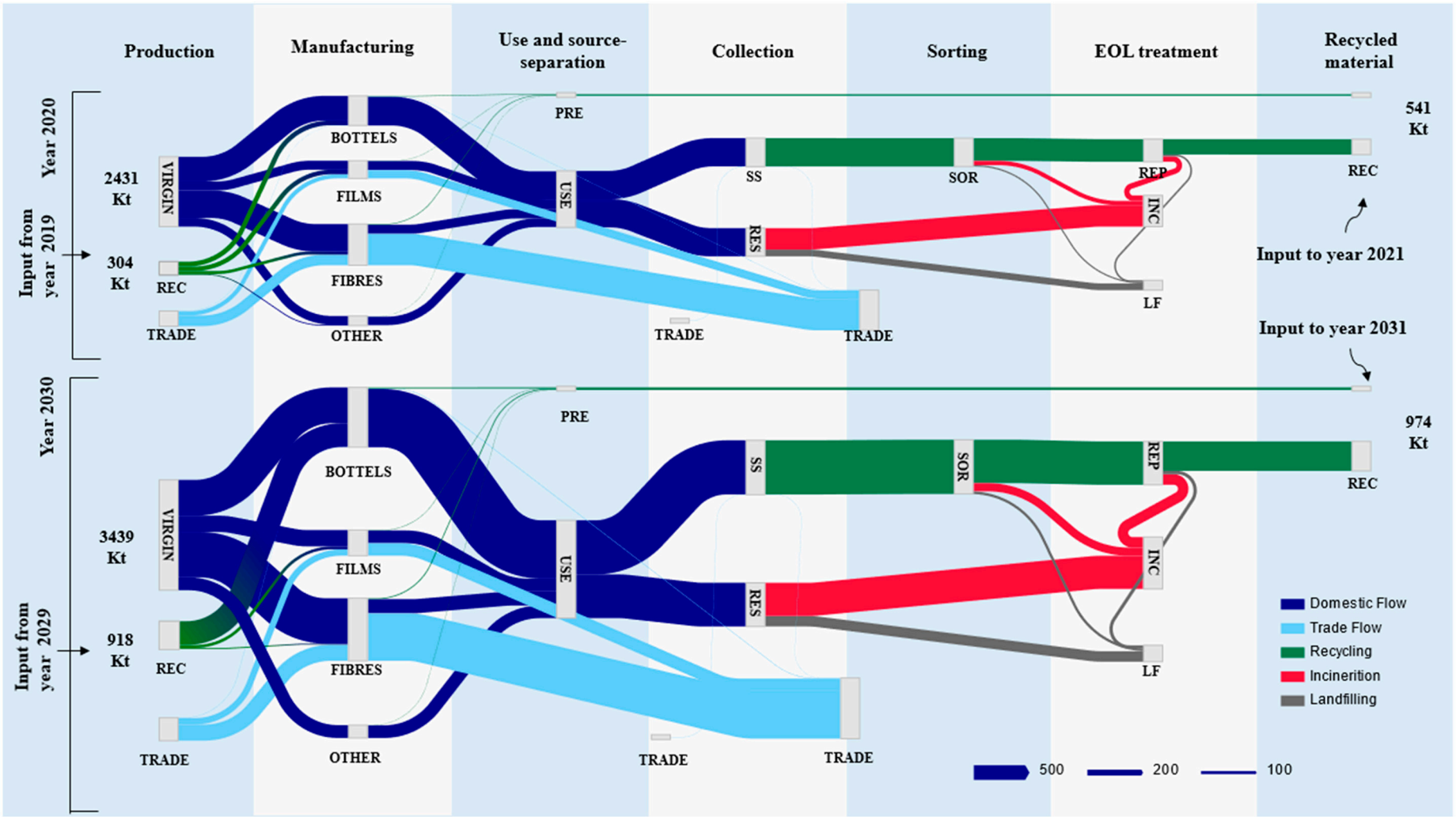


Figure S1.133 Sankey diagram for S6 in year 1 and year 30 in Korea.

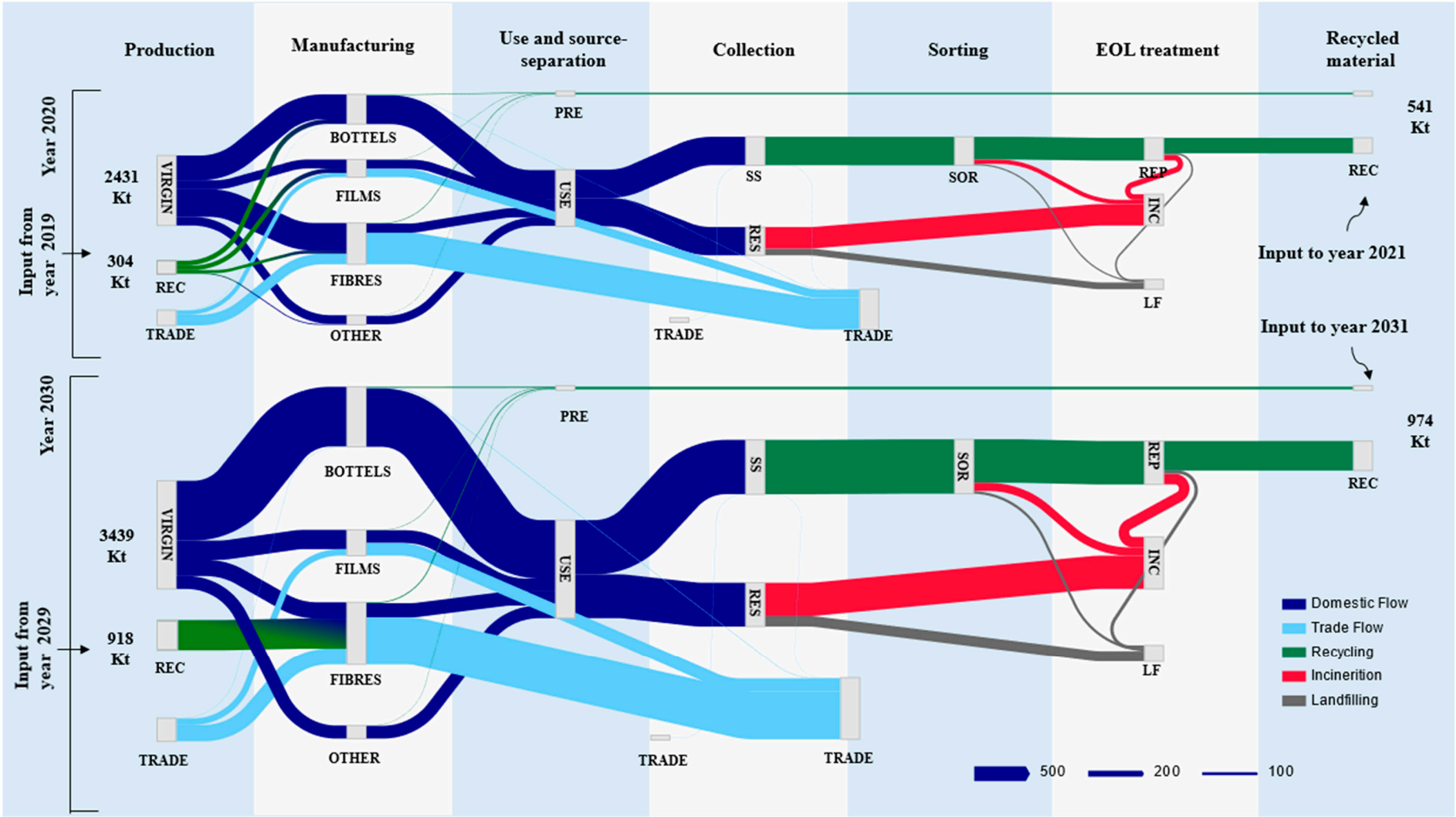


Figure S1.134 Sankey diagram for S7 in year 1 and year 30 in Korea.

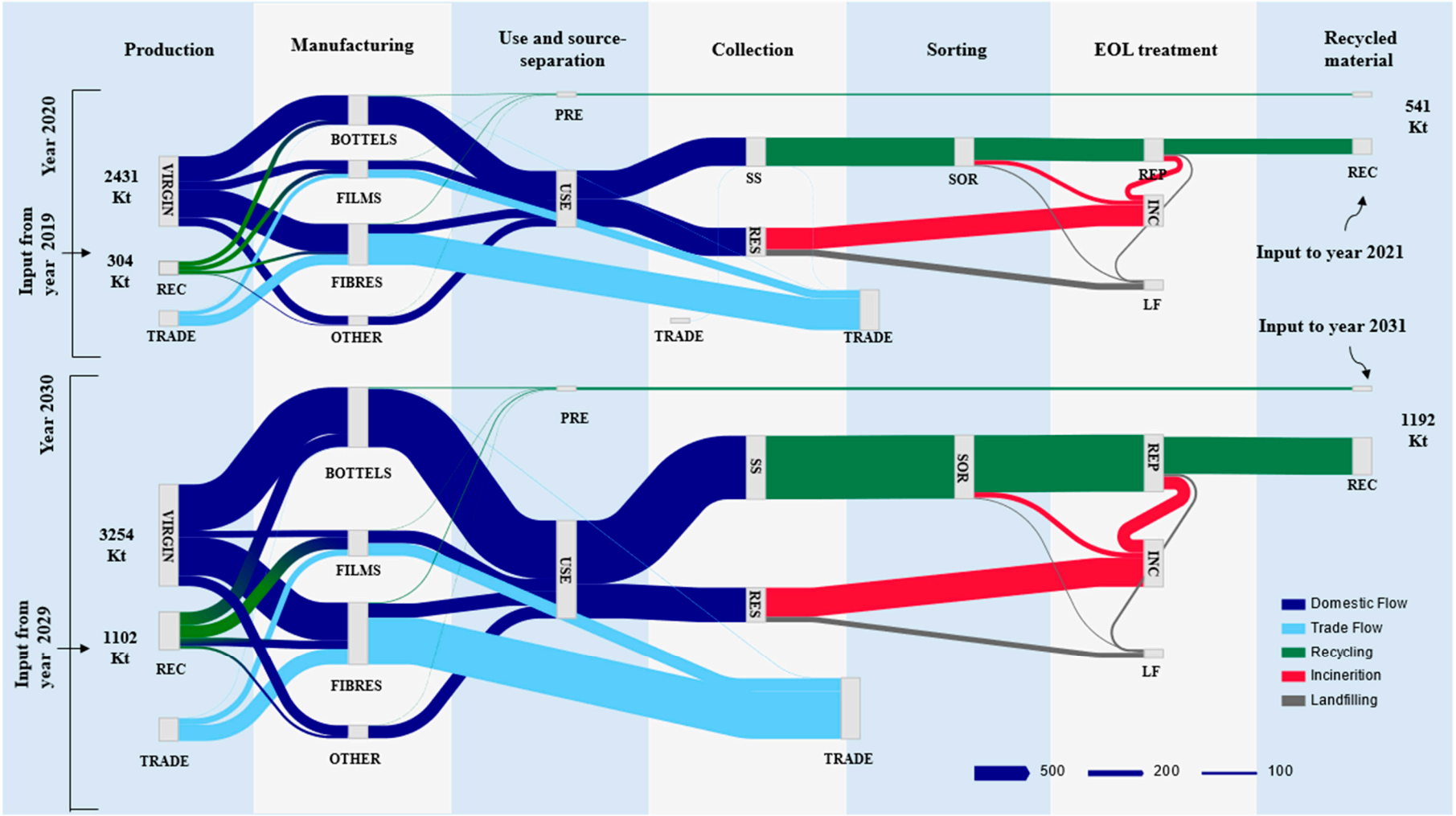


Figure S1.135 Sankey diagram for S8 in year 1 and year 30 in Korea.

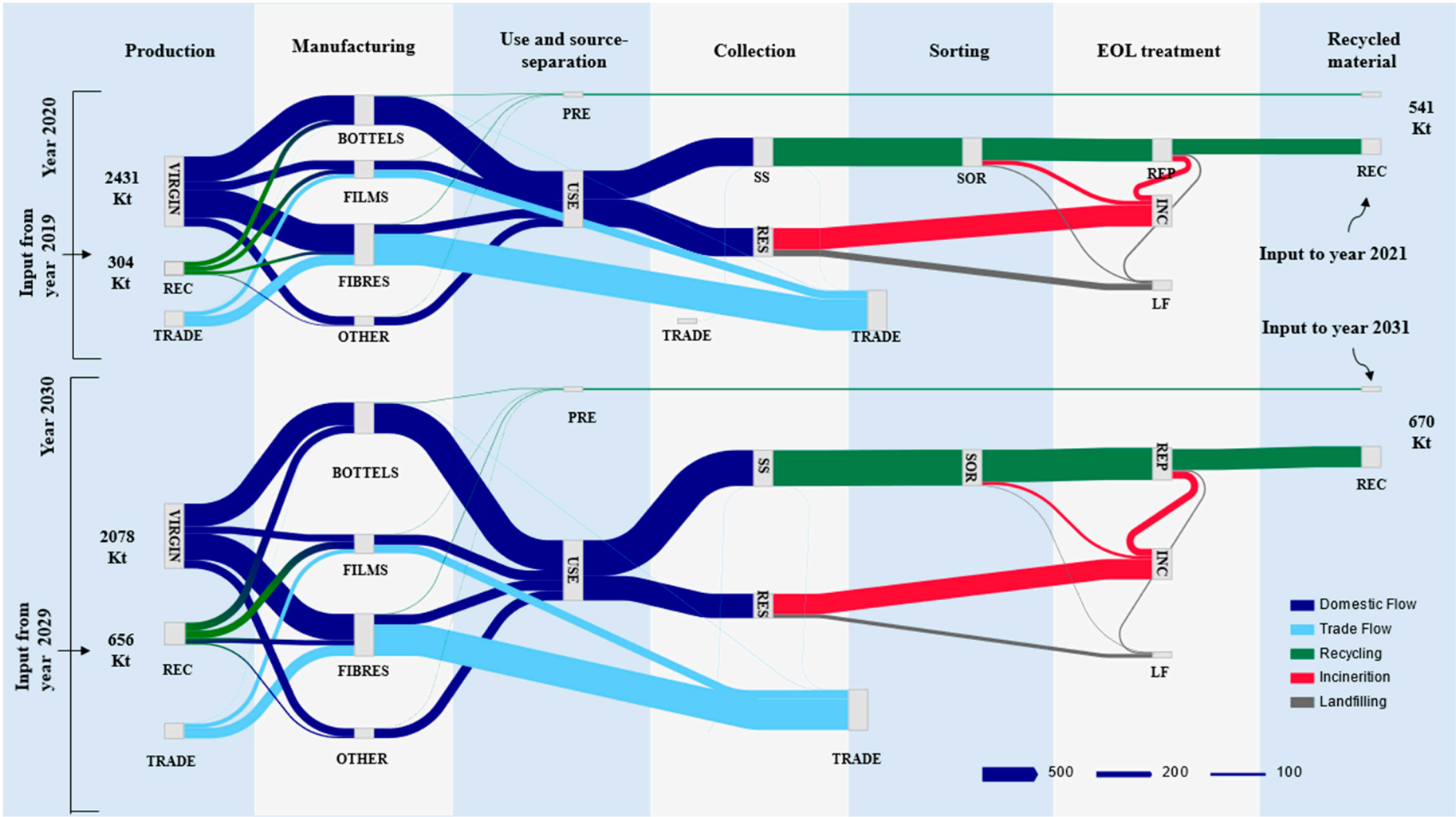


Figure S1.136 Sankey diagram for S9 in year 1 and year 30 in Korea.

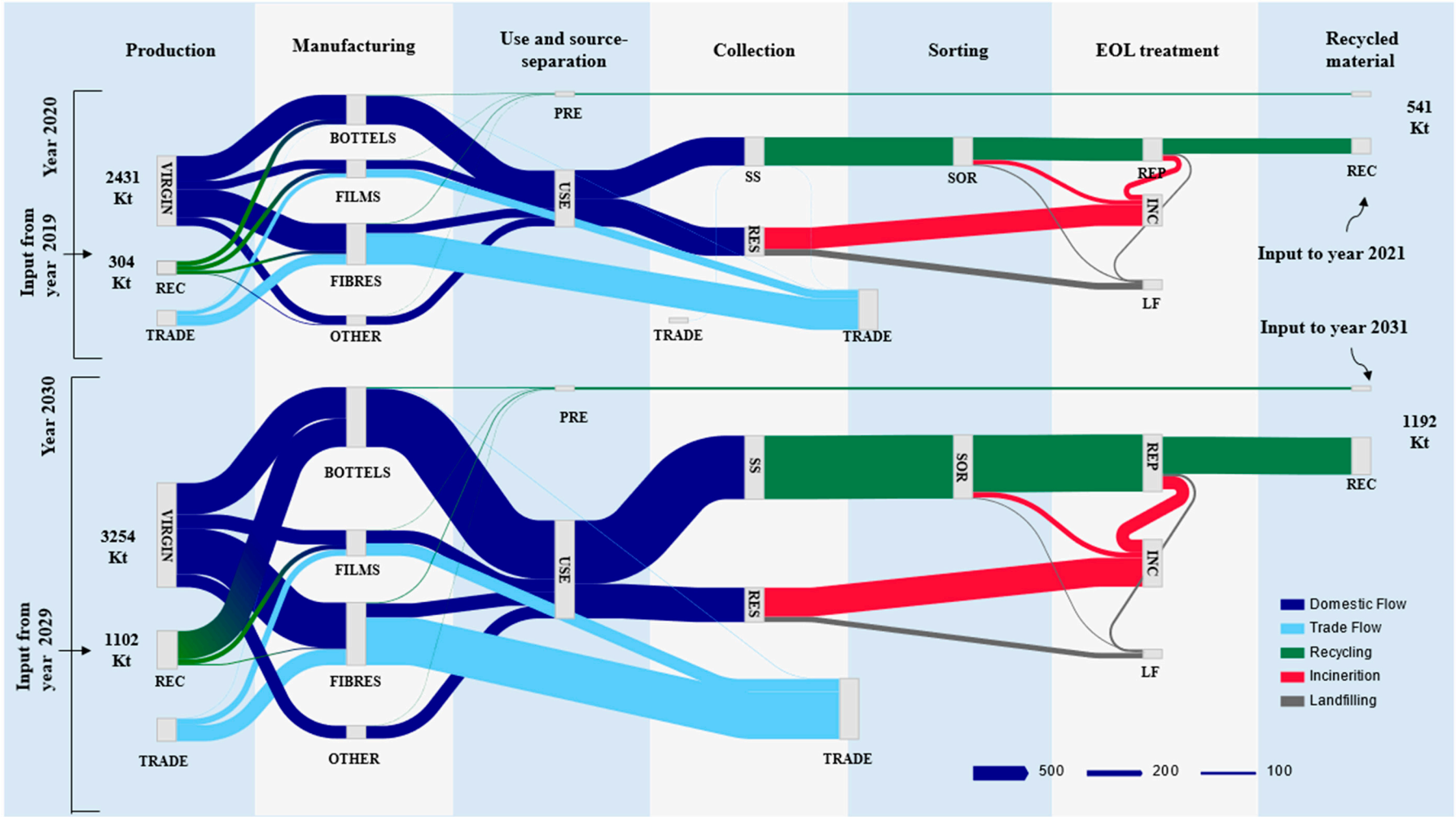


Figure S1.137 Sankey diagram for S10 in year 1 and year 30 in Korea.

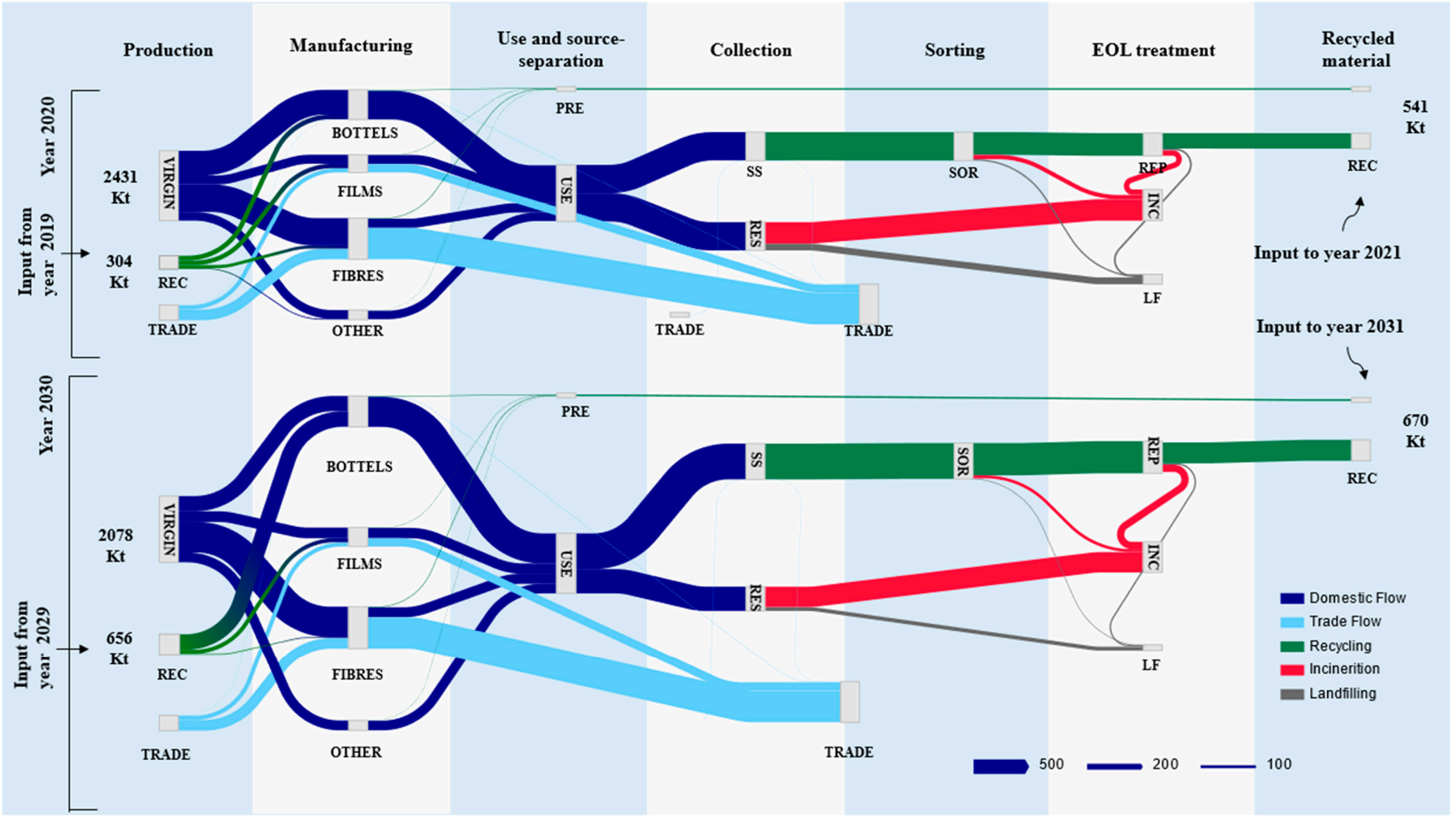


Figure S1.138 Sankey diagram for S11 in year 1 and year 30 in Korea.

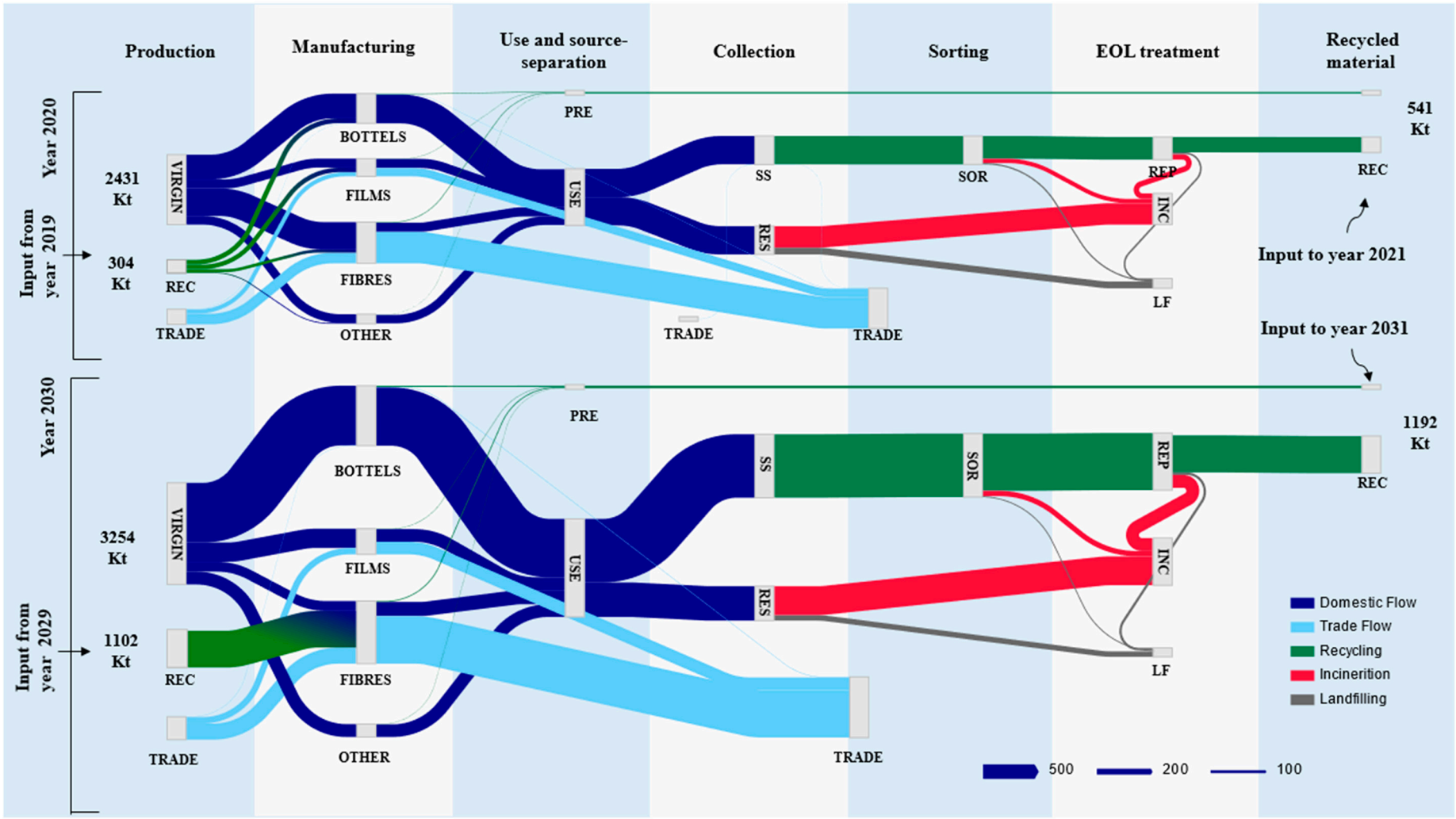


Figure S1.139 Sankey diagram for S12 in year 1 and year 30 in Korea.

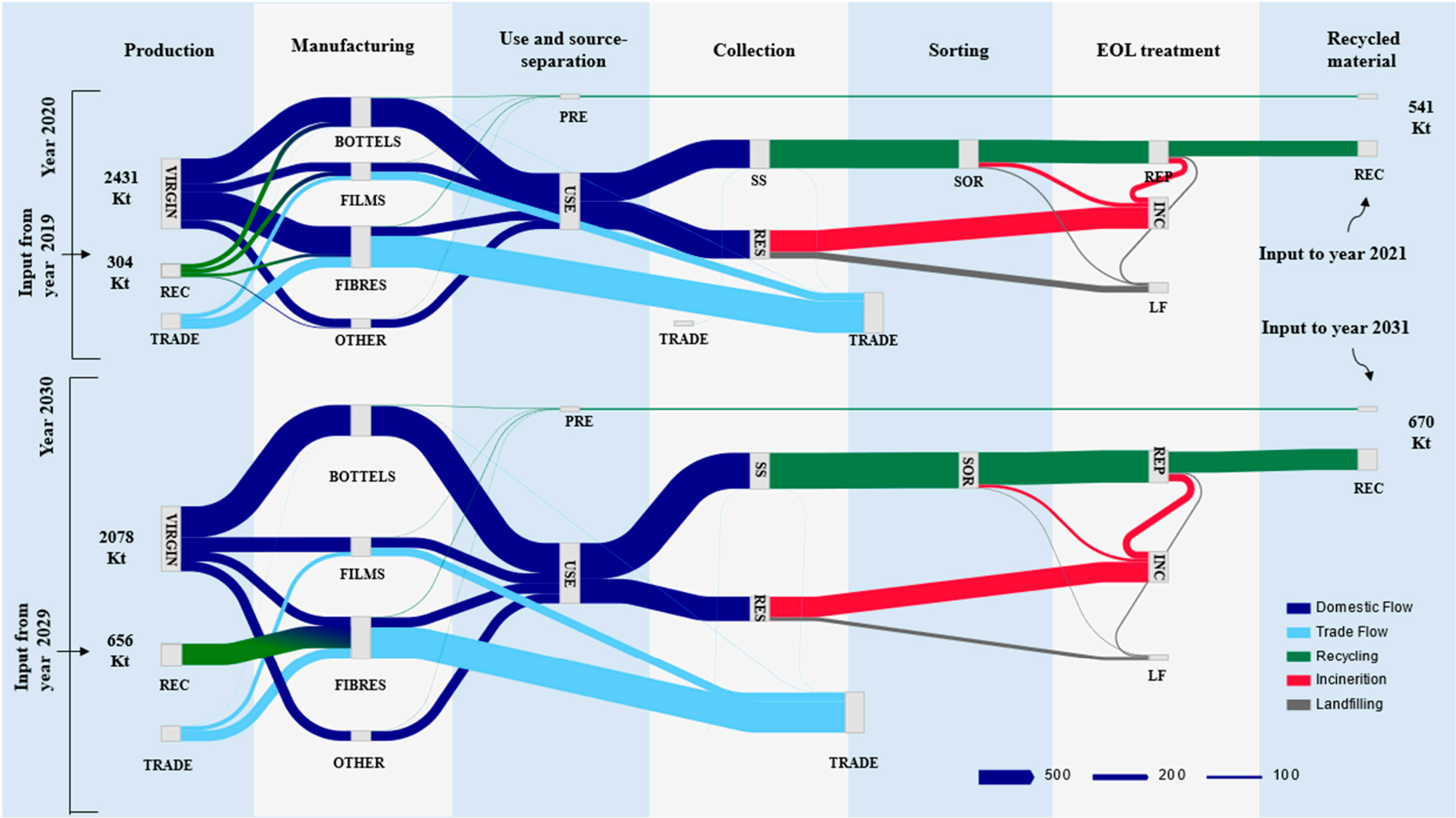


Figure S1.140 Sankey diagram for S13 in year 1 and year 30 in Korea.

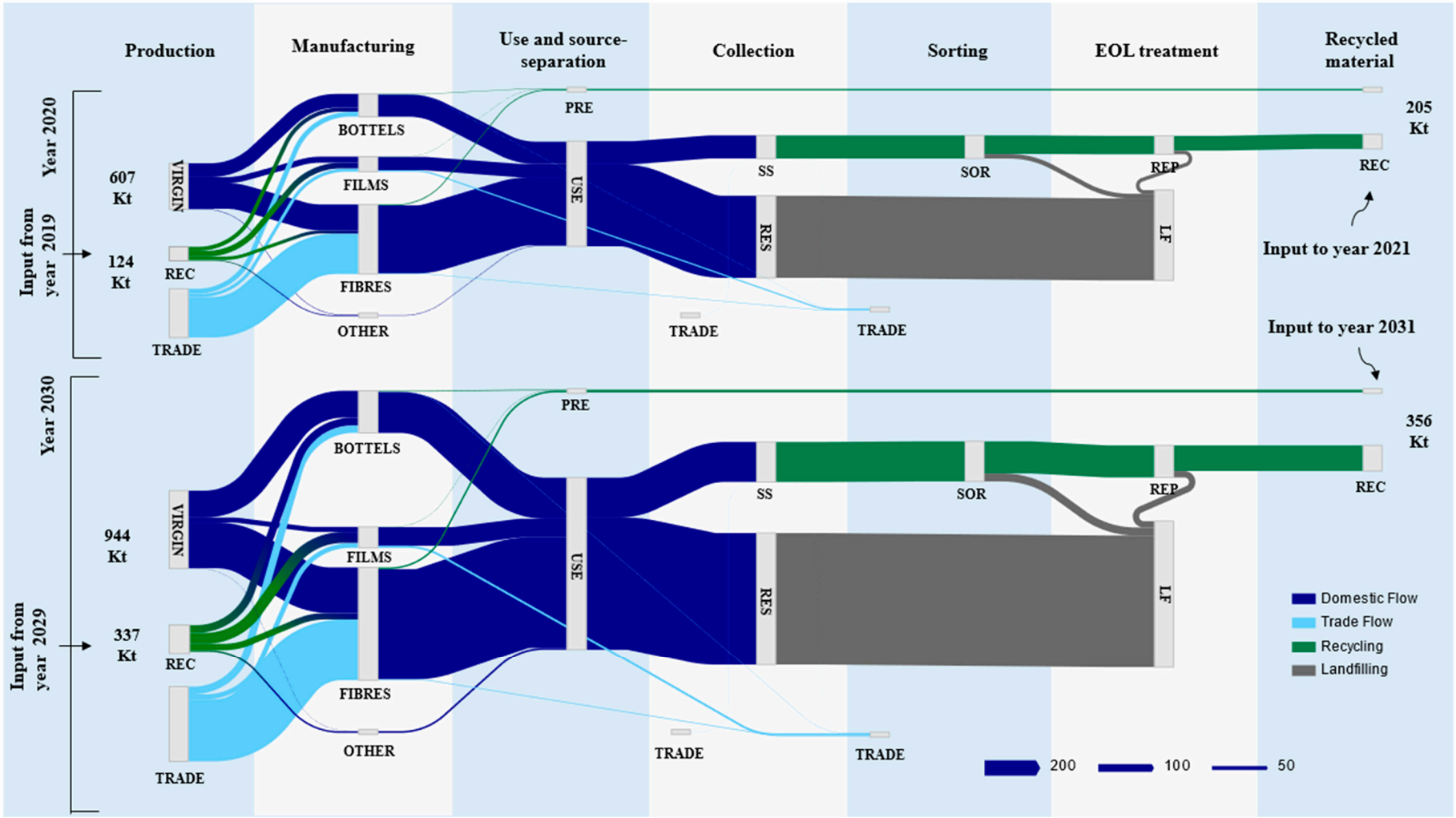


Figure S1.141 Sankey diagram for S0 in year 1 and year 30 in Brazil.

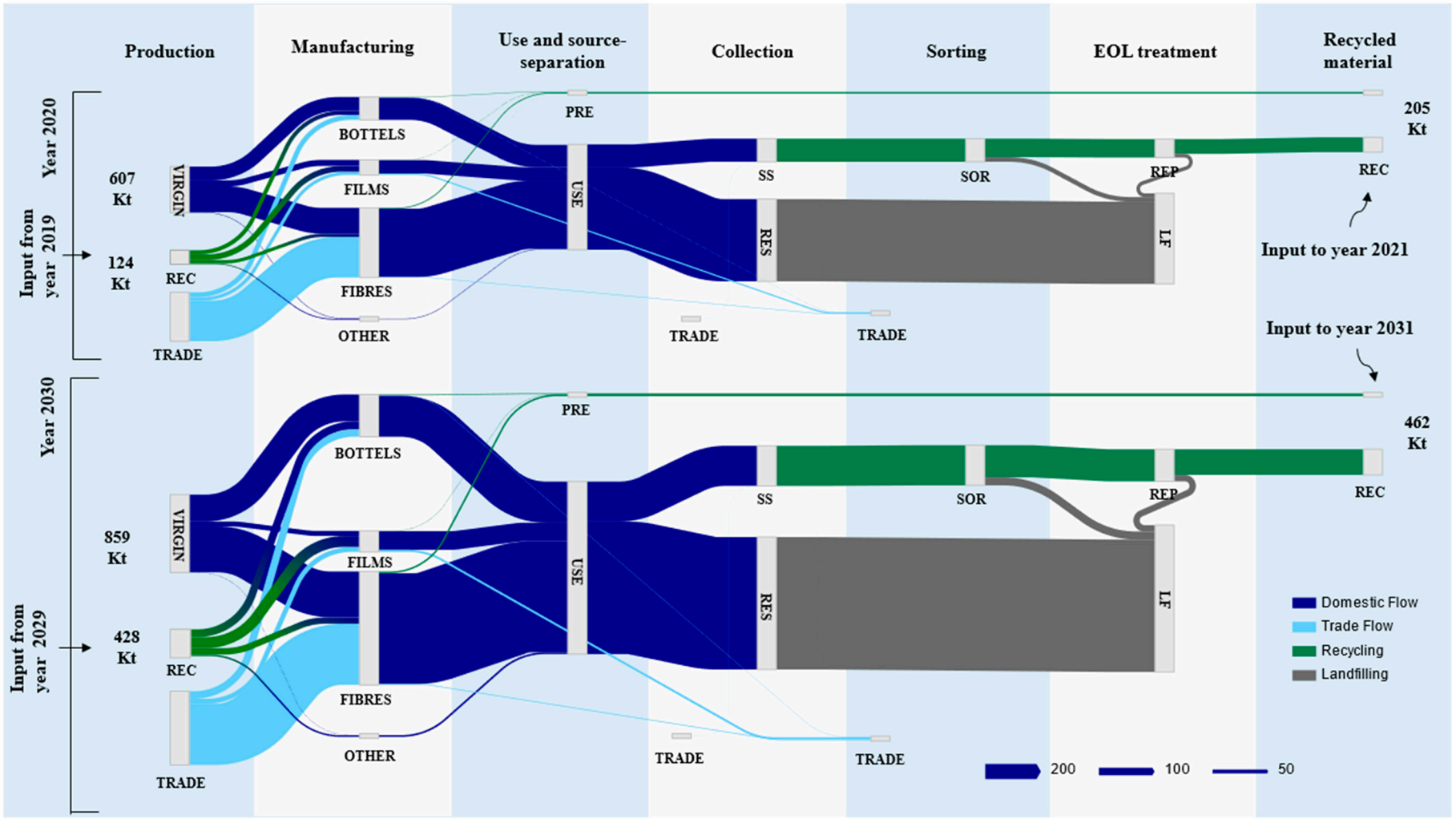


Figure S1.142 Sankey diagram for S1 in year 1 and year 30 in Brazil.

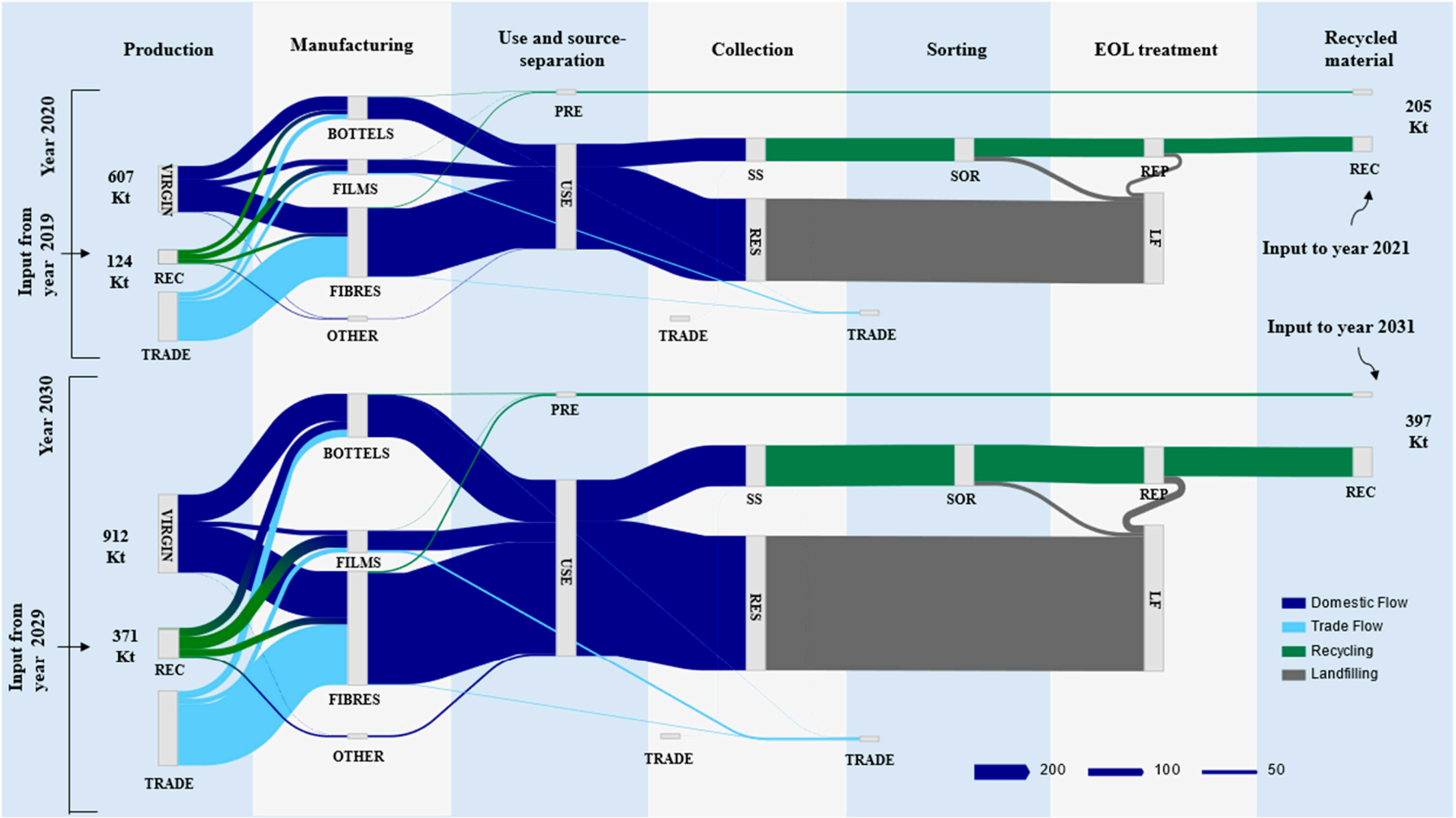


Figure S1.143 Sankey diagram for S2 in year 1 and year 30 in Brazil.

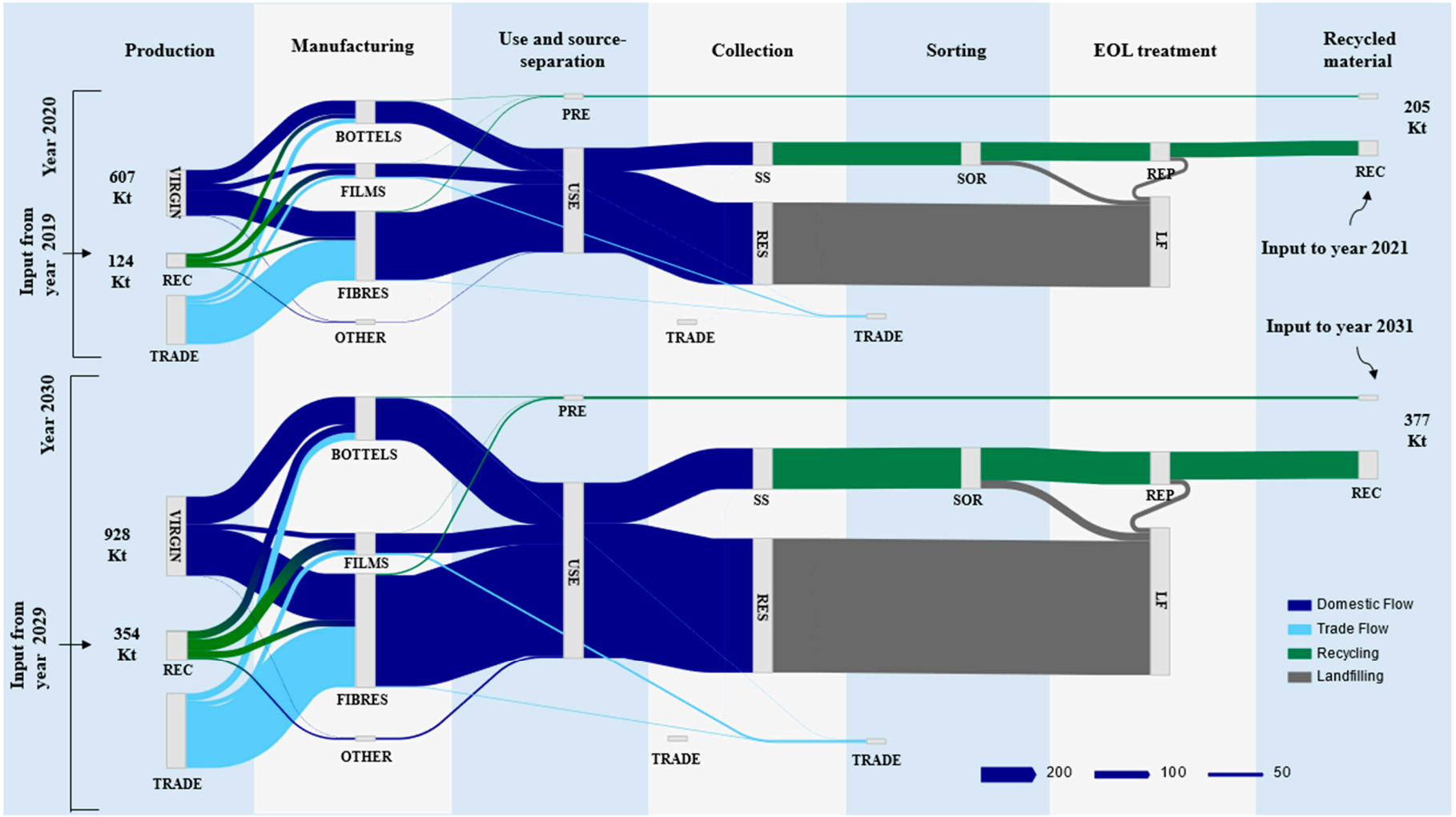


Figure S1.144 Sankey diagram for S3 in year 1 and year 30 in Brazil.

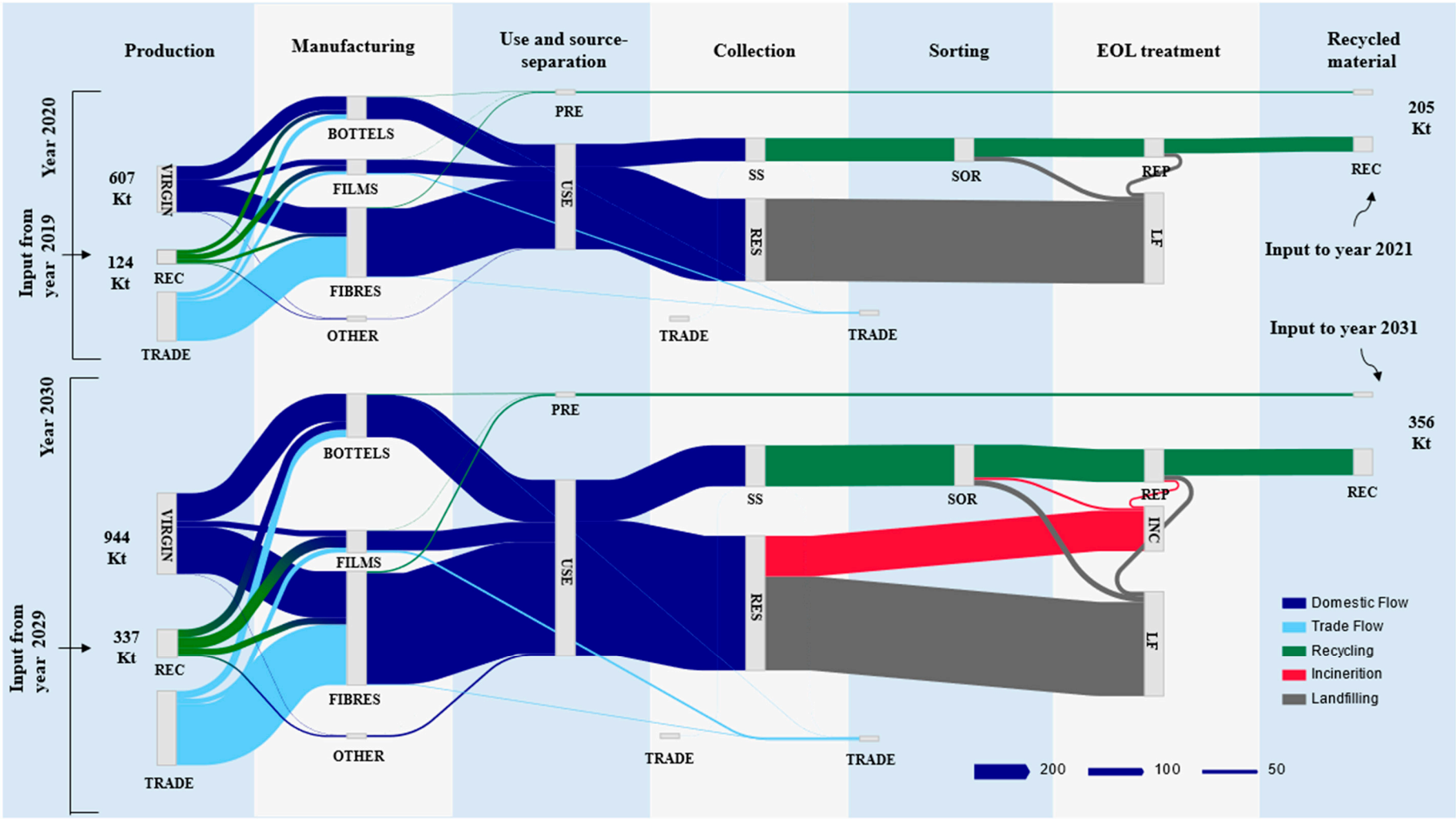


Figure S1.145 Sankey diagram for S4 in year 1 and year 30 in Brazil.

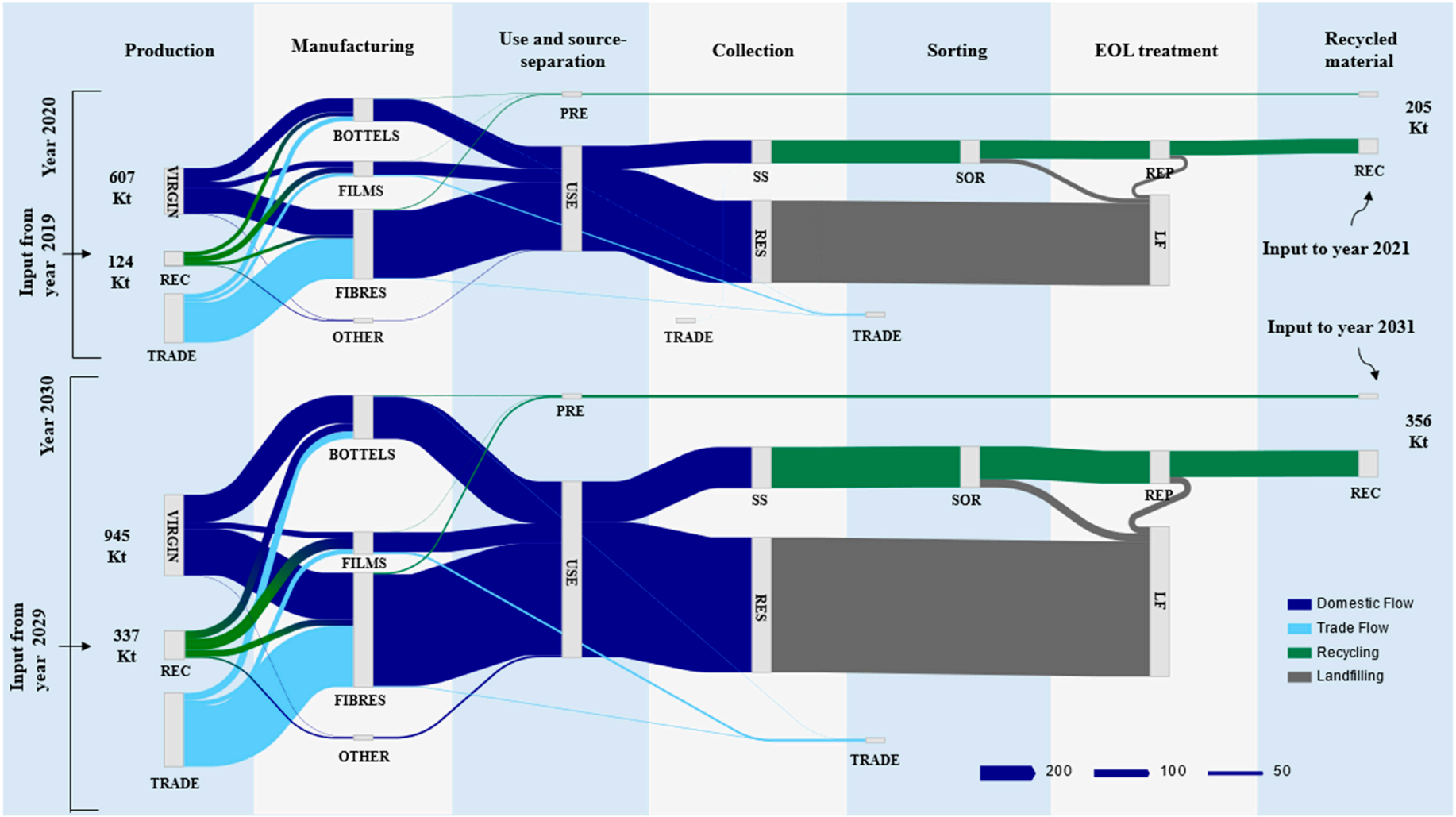


Figure S1.146 Sankey diagram for S5 in year 1 and year 30 in Brazil.

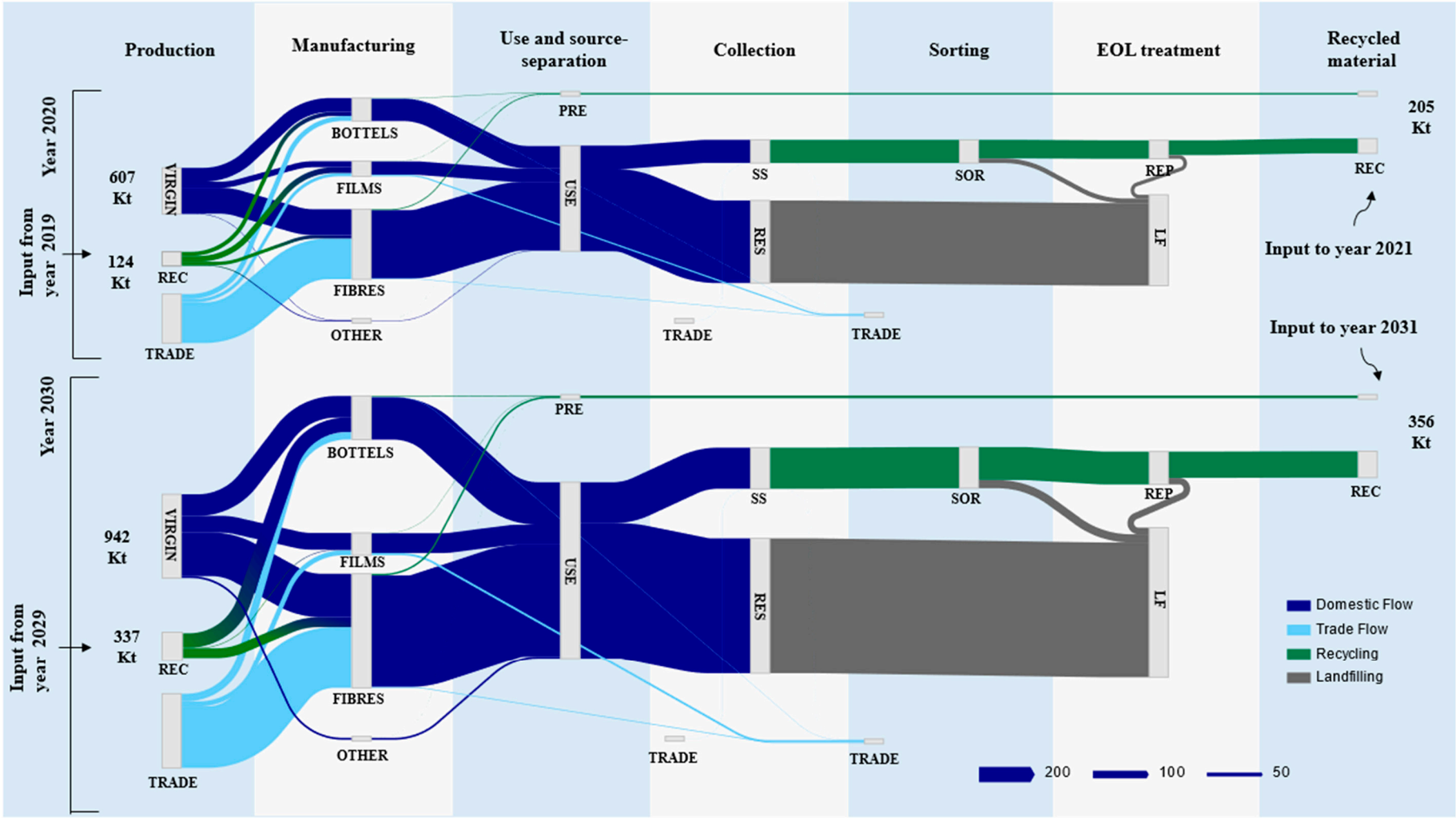


Figure S1.147 Sankey diagram for S6 in year 1 and year 30 in Brazil.

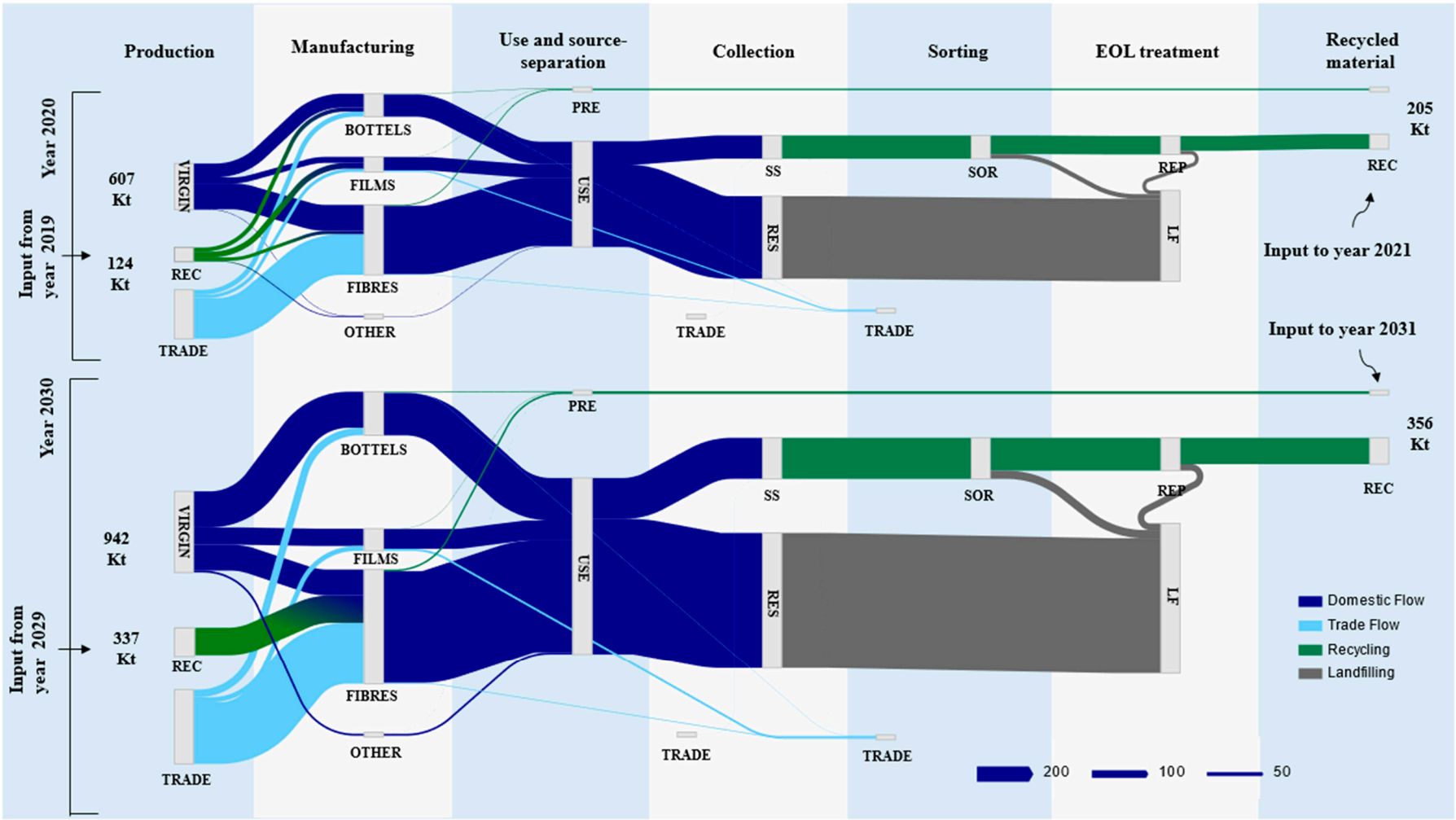


Figure S1.148 Sankey diagram for S7 in year 1 and year 30 in Brazil.

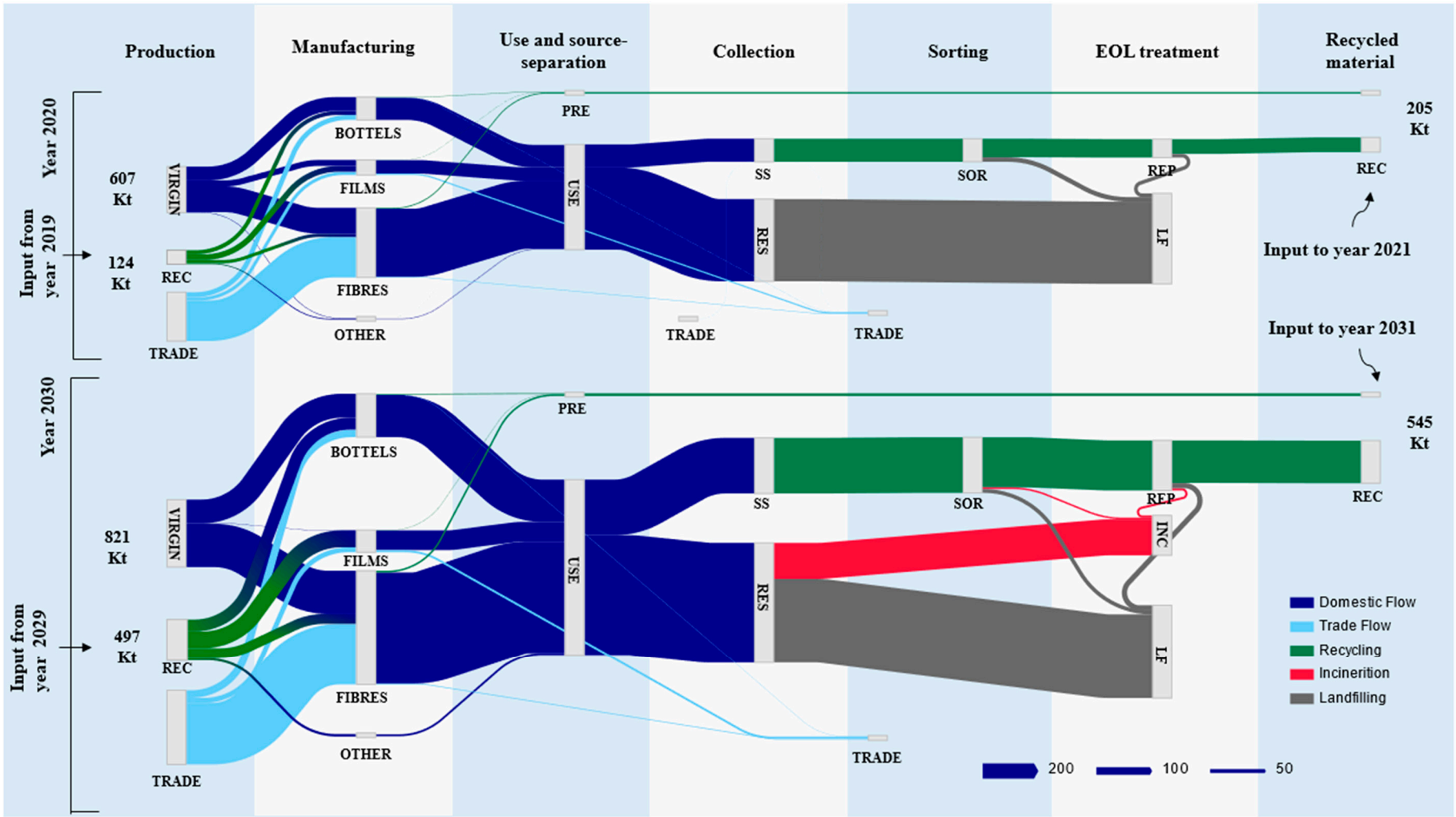


Figure S1.149 Sankey diagram for S8 in year 1 and year 30 in Brazil.

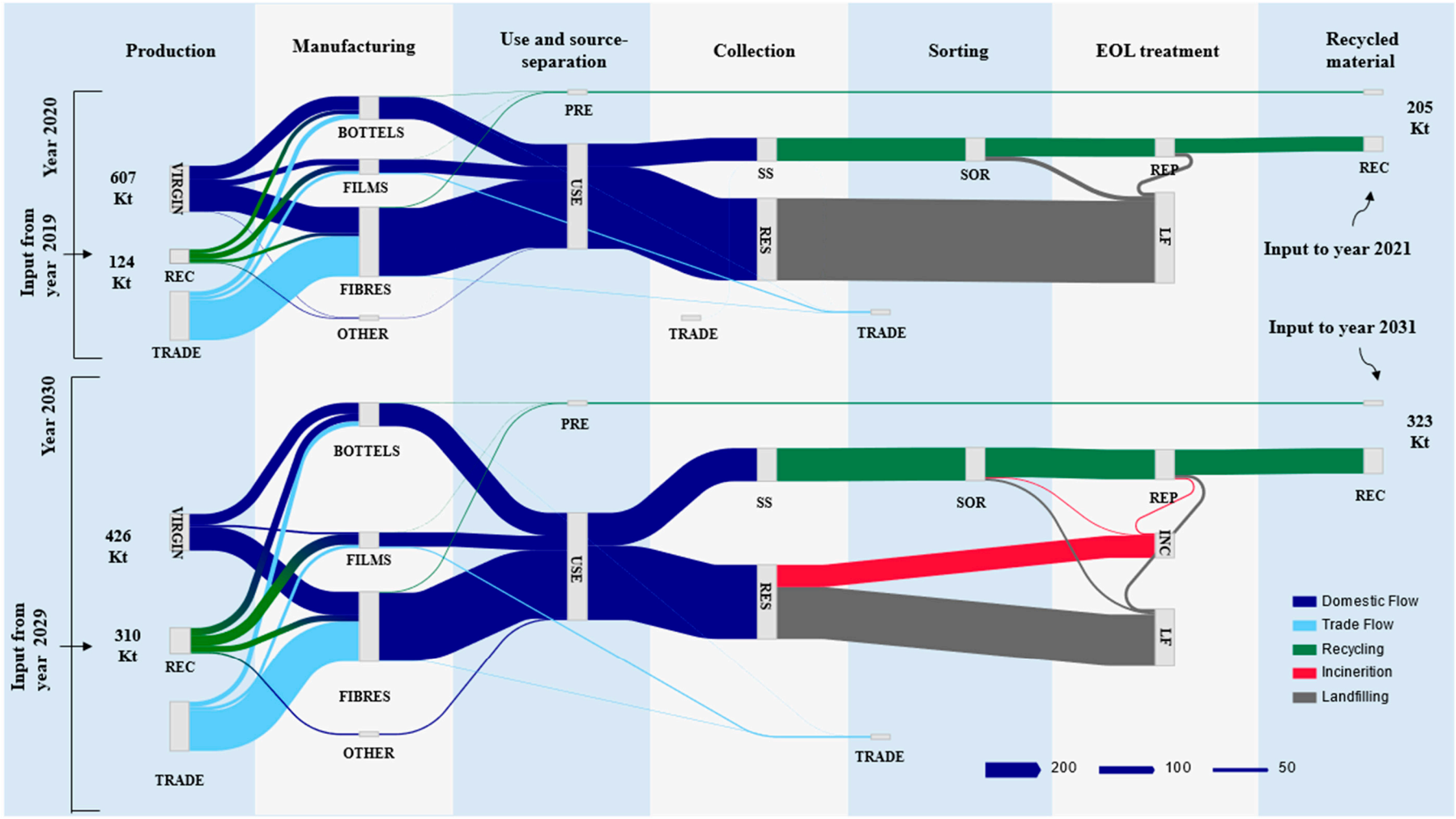


Figure S1.150 Sankey diagram for S9 in year 1 and year 30 in Brazil.

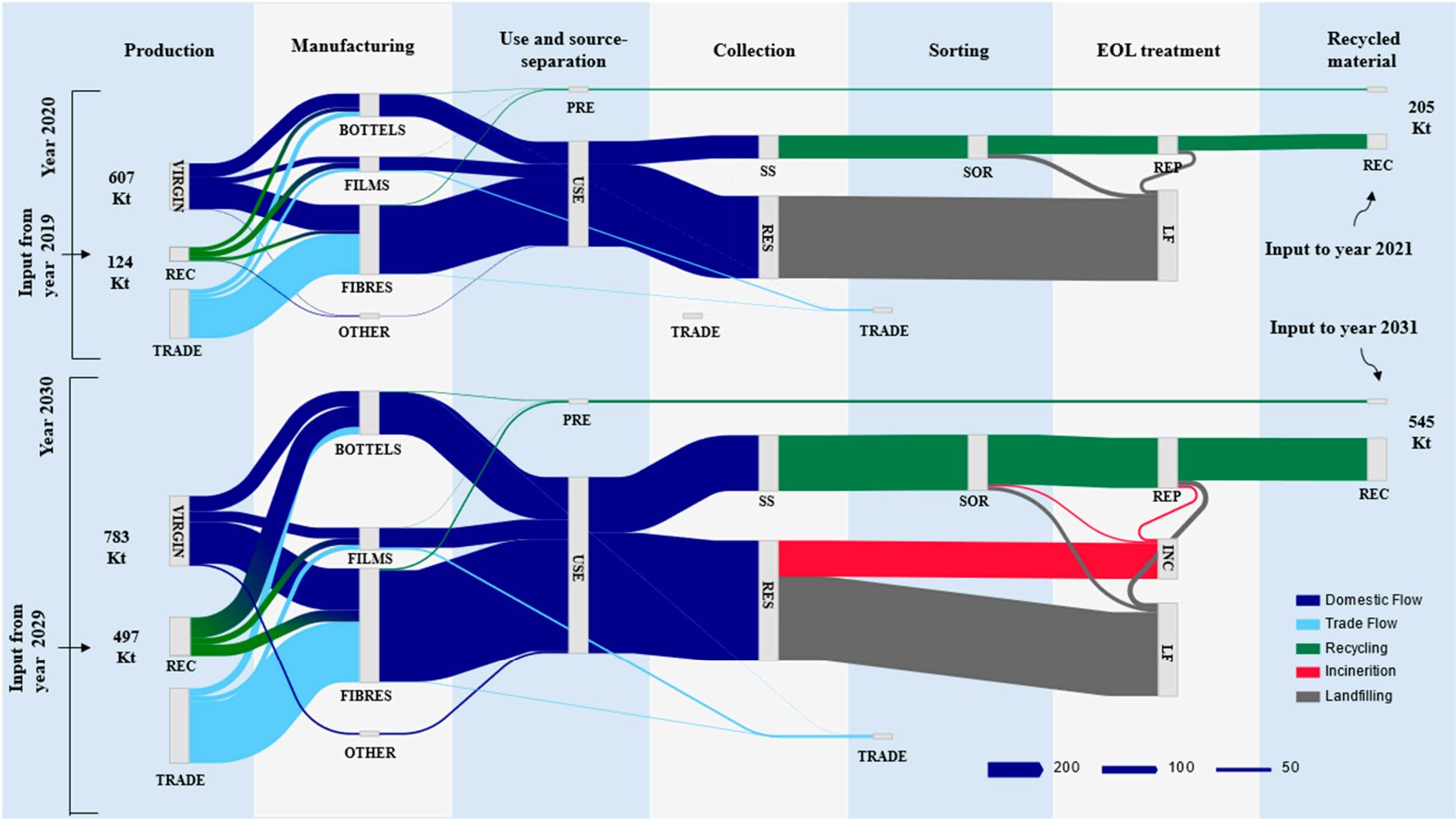


Figure S1.151 Sankey diagram for S10 in year 1 and year 30 in Brazil.

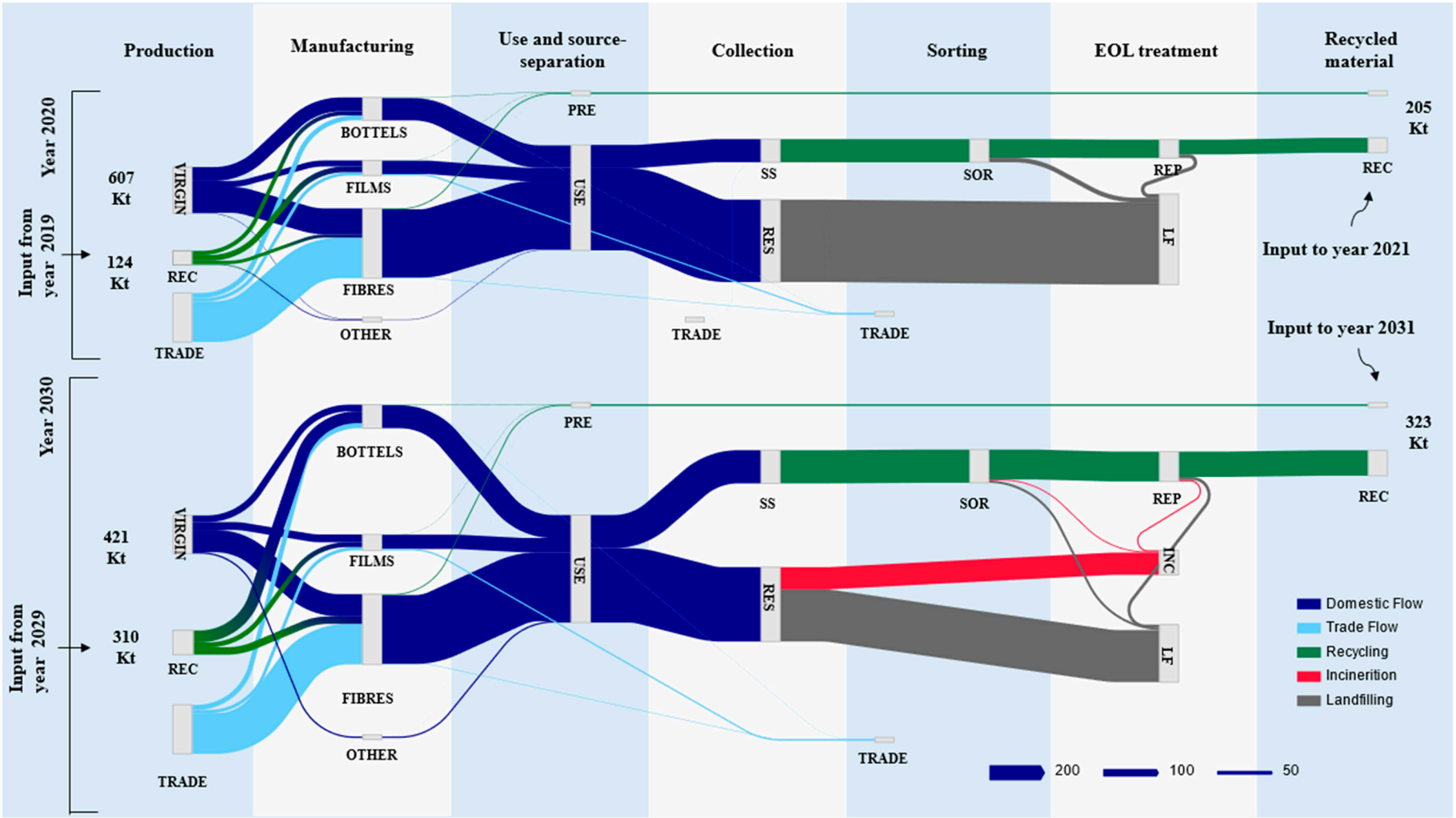


Figure S1.152 Sankey diagram for S11 in year 1 and year 30 in Brazil.

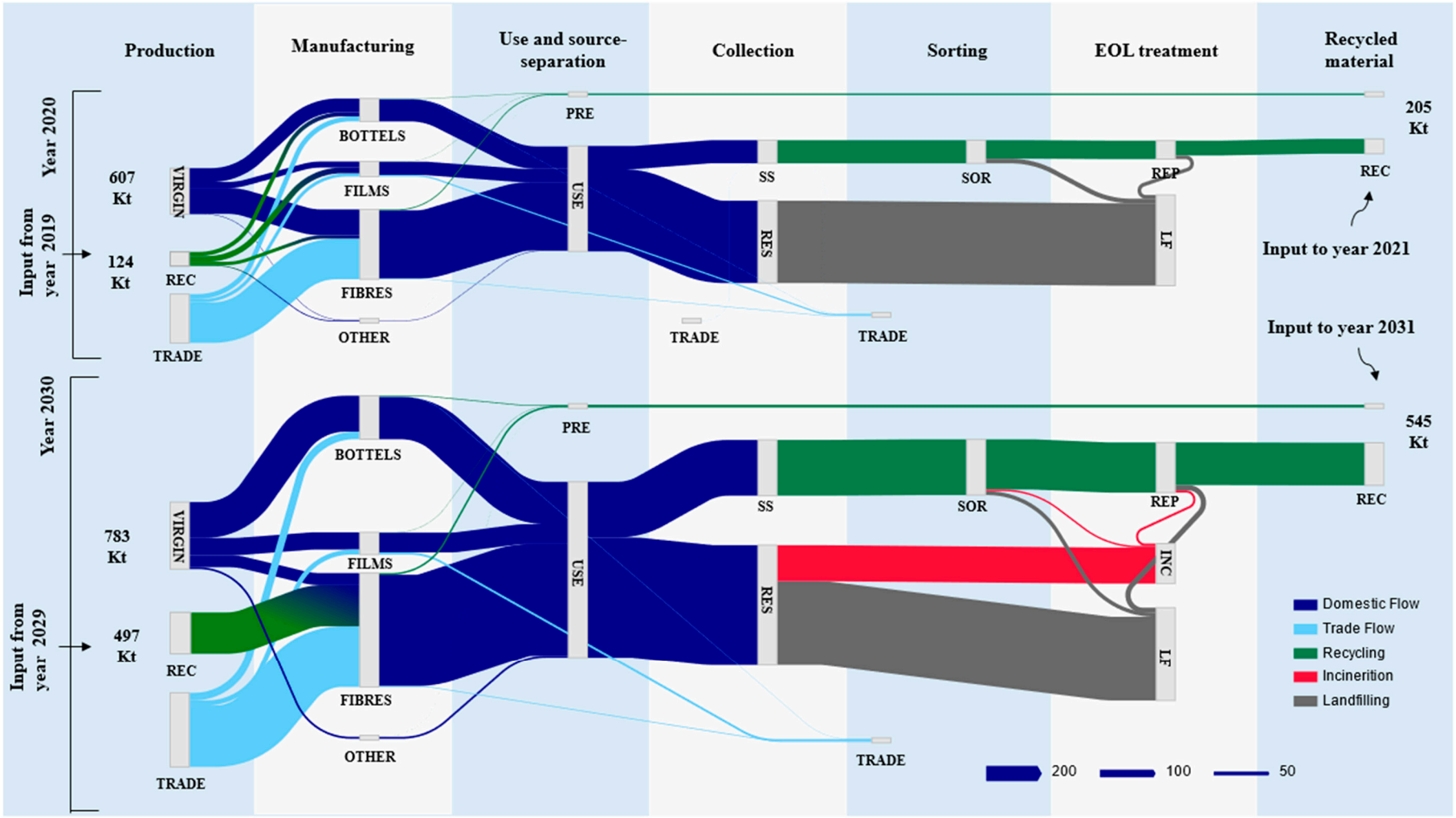


Figure S1.153 Sankey diagram for S12 in year 1 and year 30 in Brazil.

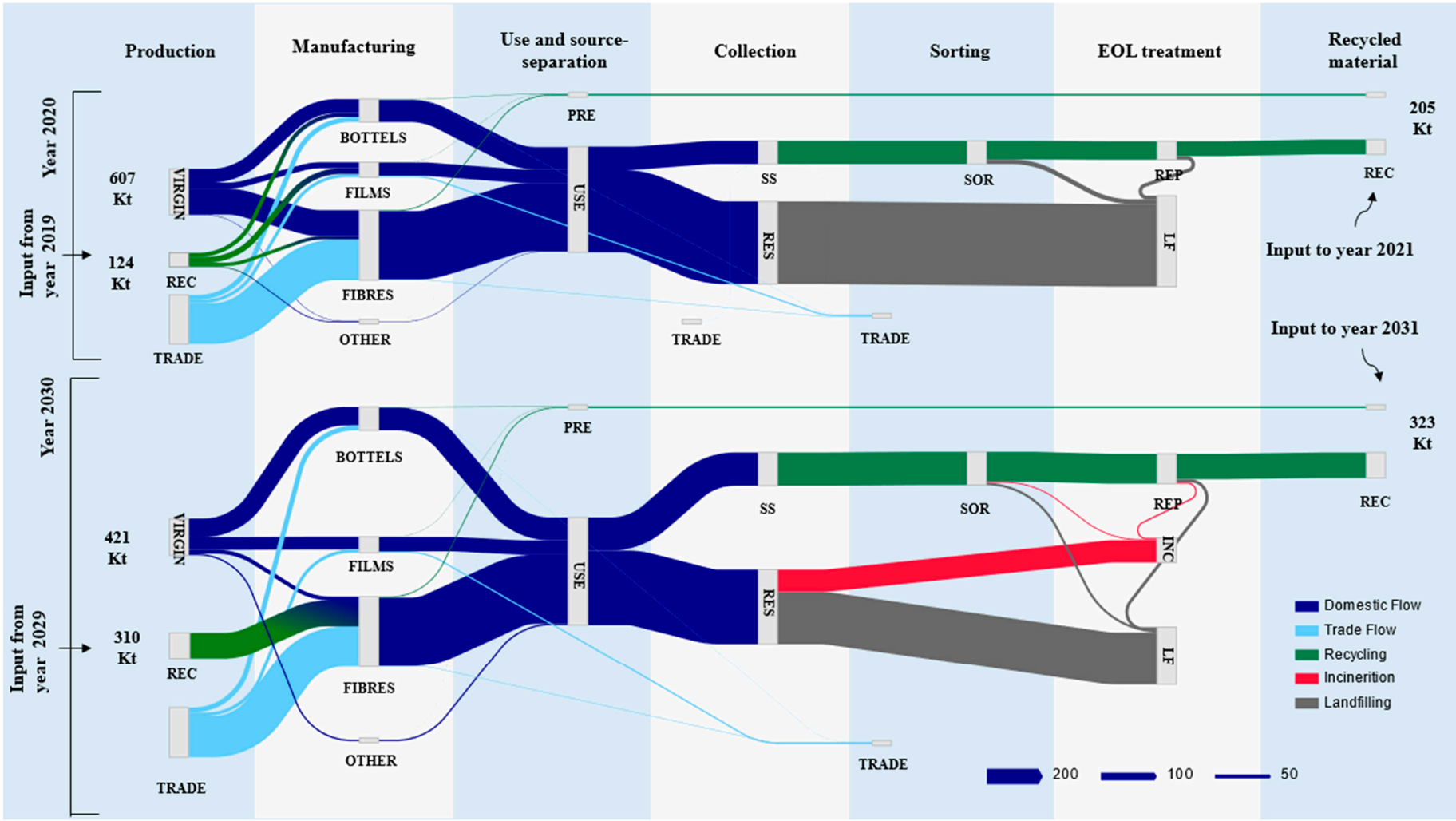


Figure S1.154 Sankey diagram for S13 in year 1 and year 30 in Brazil.

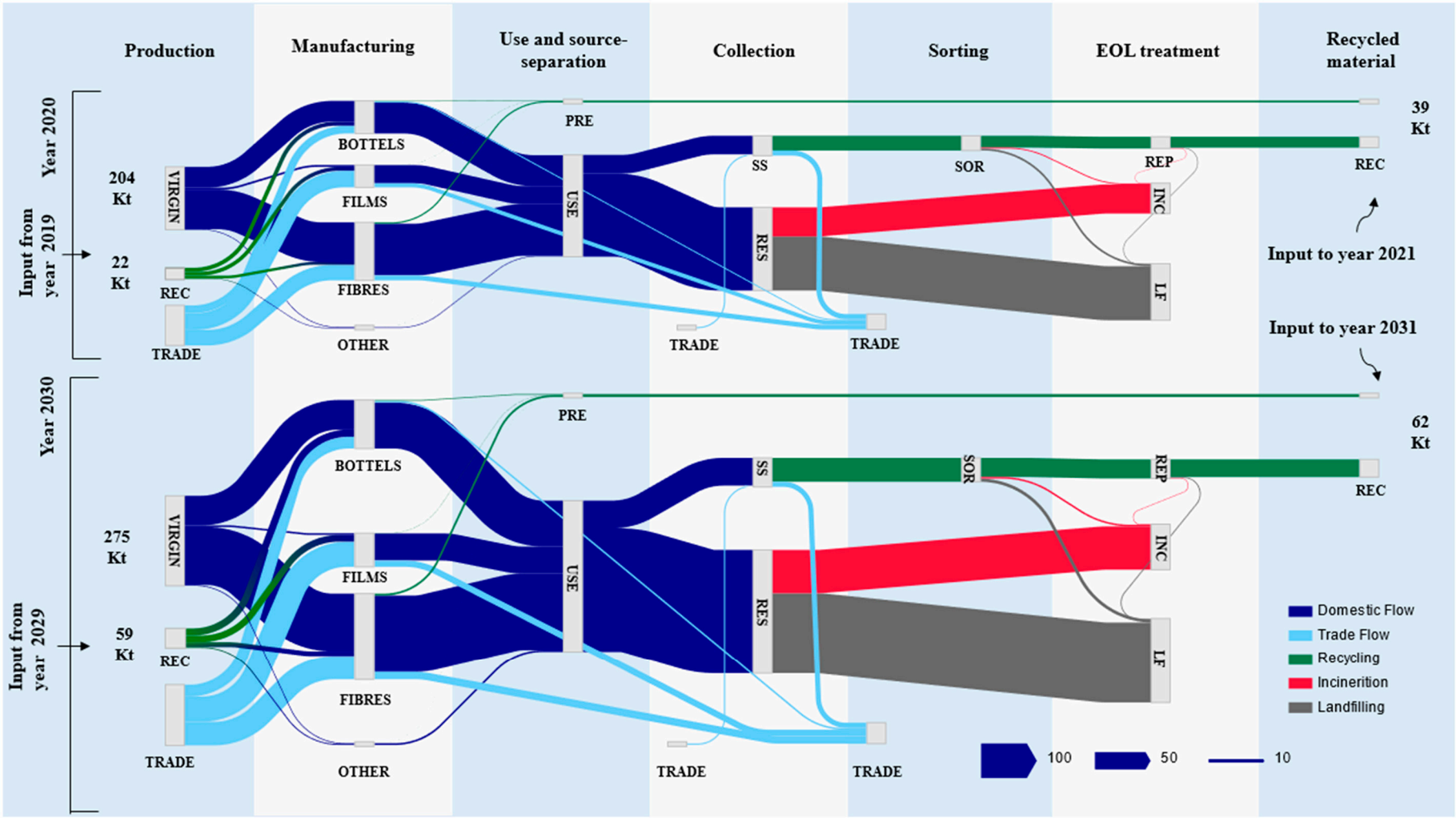


Figure S1.155 Sankey diagram for S0 in year 1 and year 30 in Australia.

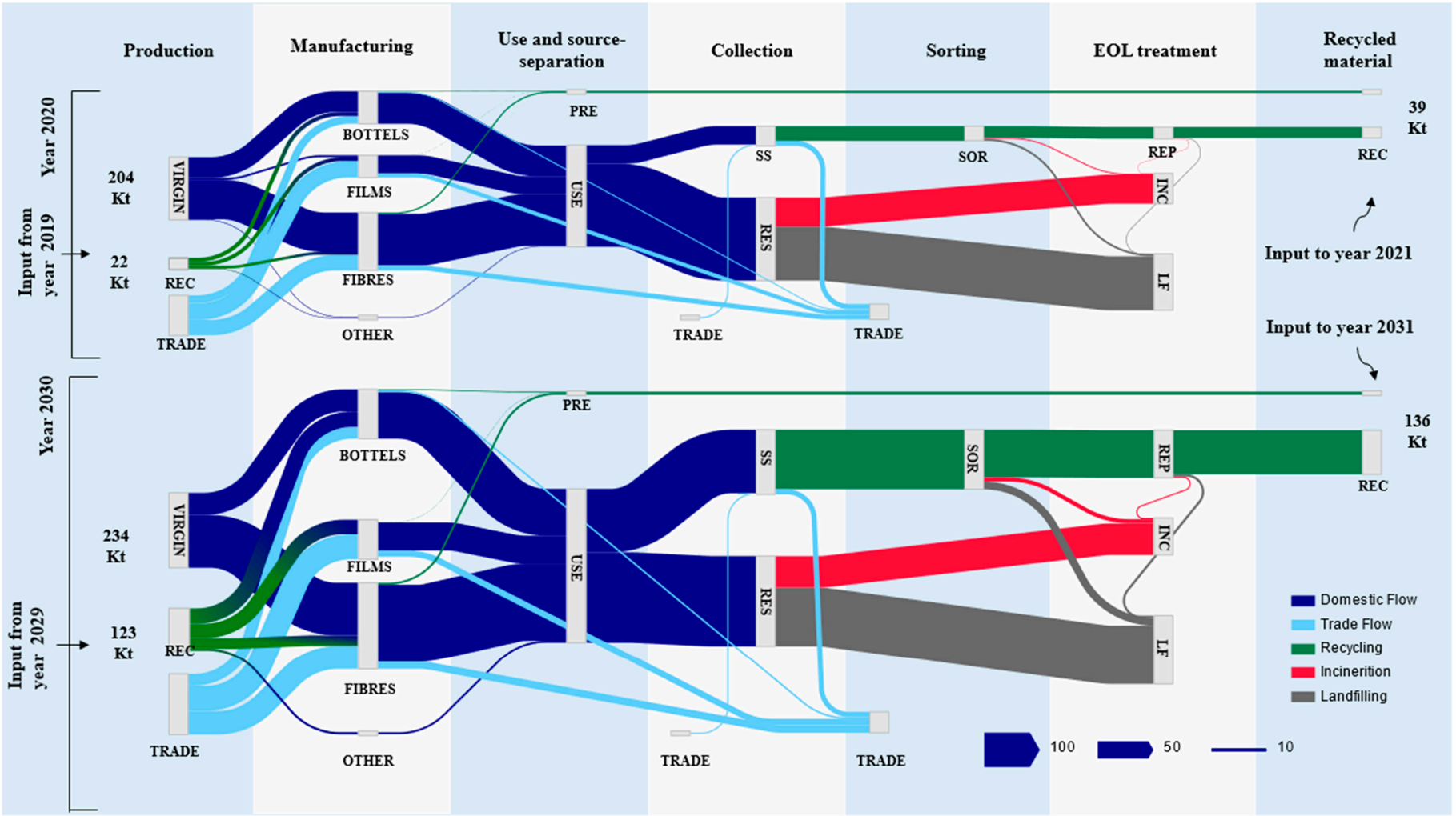


Figure S1.156 Sankey diagram for S1 in year 1 and year 30 in Australia.

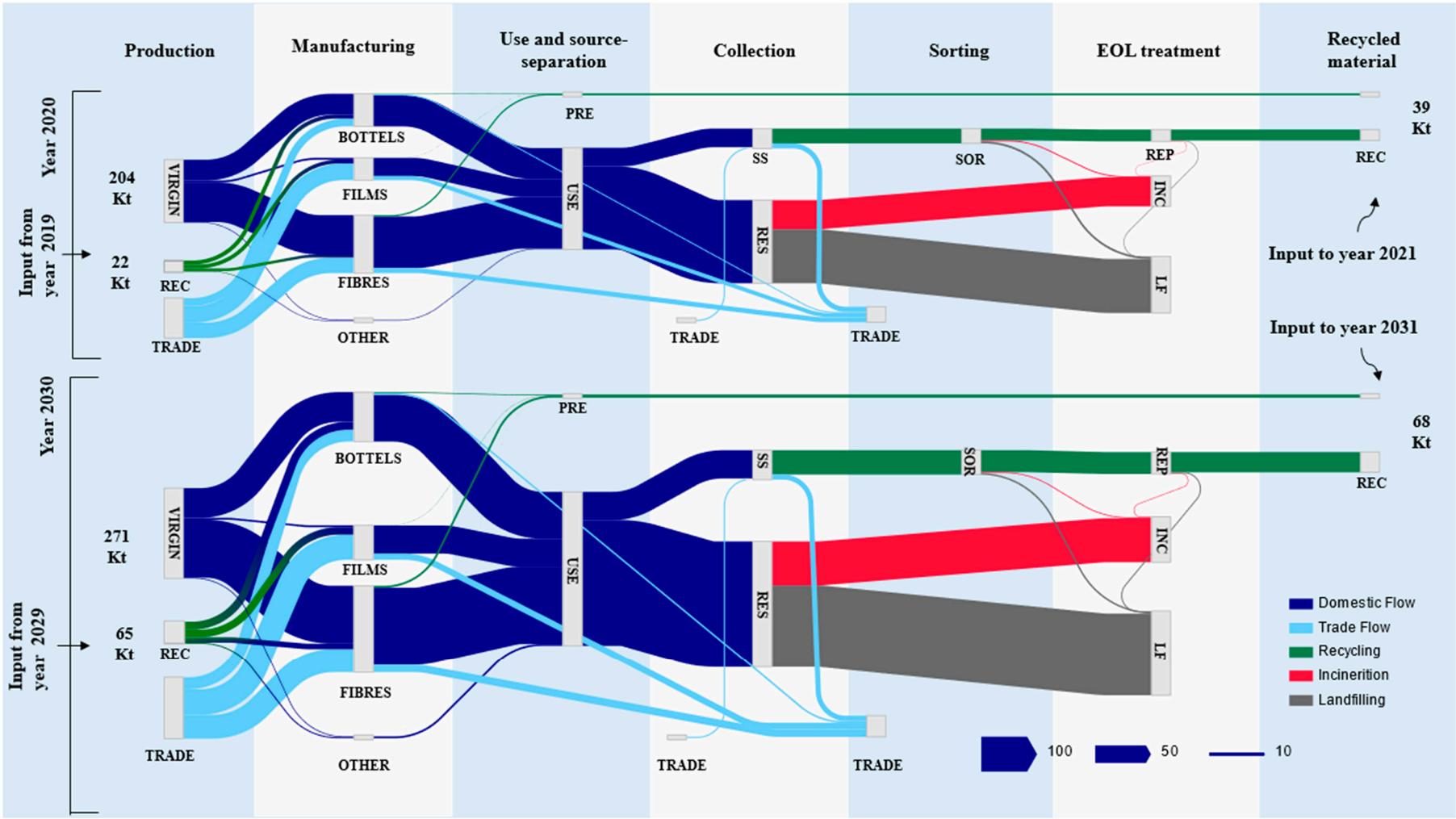


Figure S1.157 Sankey diagram for S2 in year 1 and year 30 in Australia.

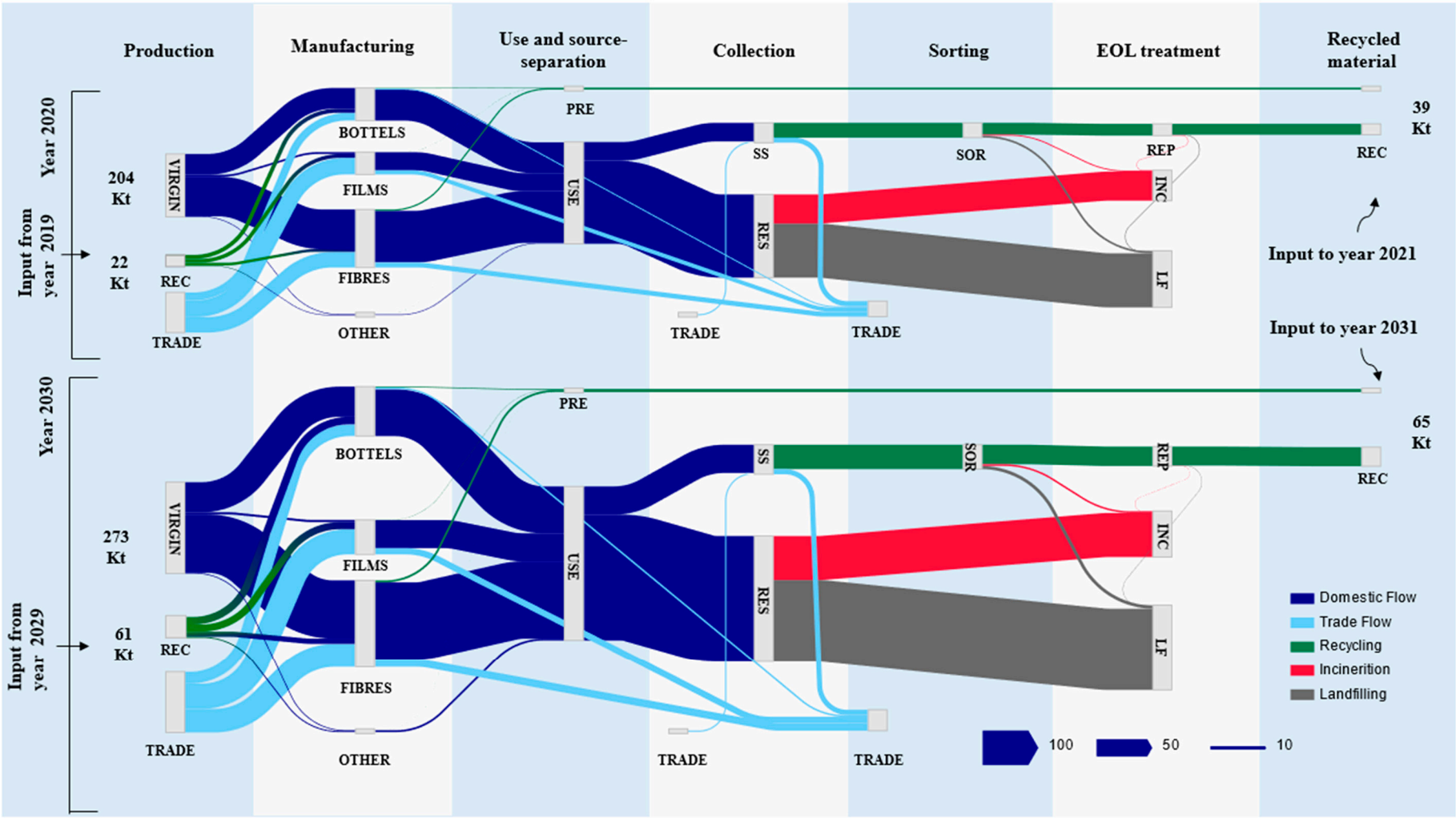


Figure S1.158 Sankey diagram for S3 in year 1 and year 30 in Australia.

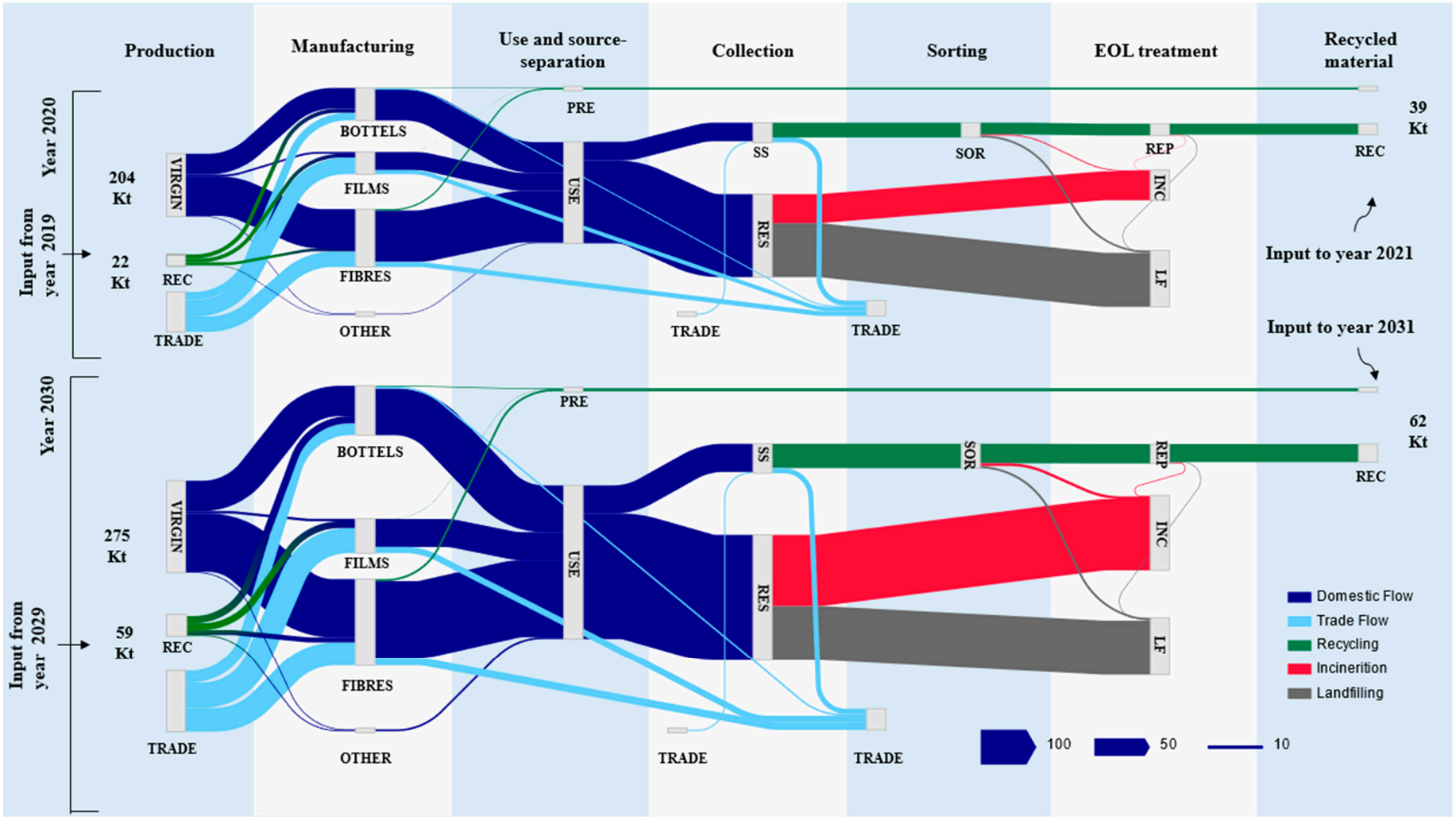


Figure S1.159 Sankey diagram for S4 in year 1 and year 30 in Australia.

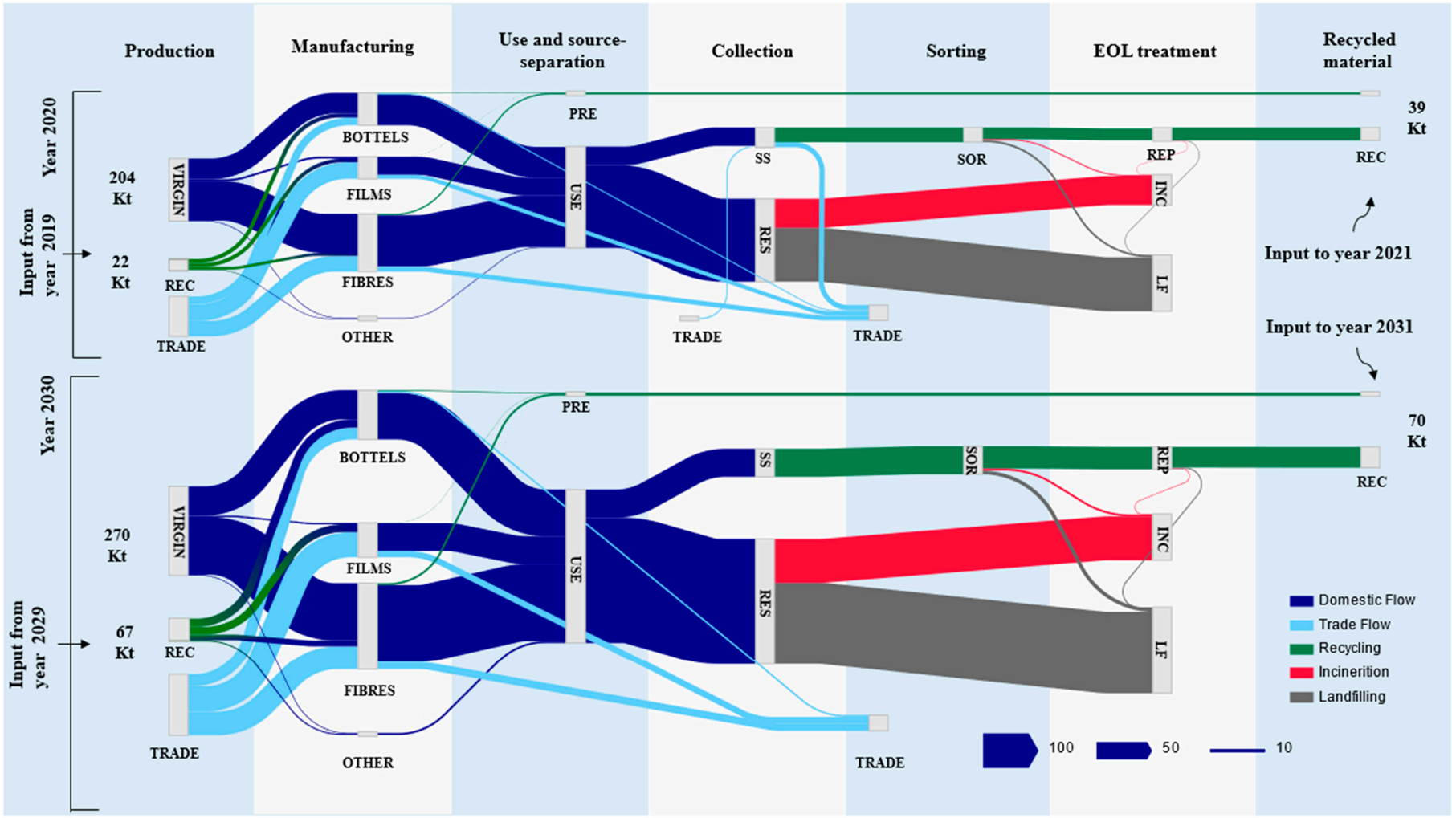


Figure S1.160 Sankey diagram for S5 in year 1 and year 30 in Australia.

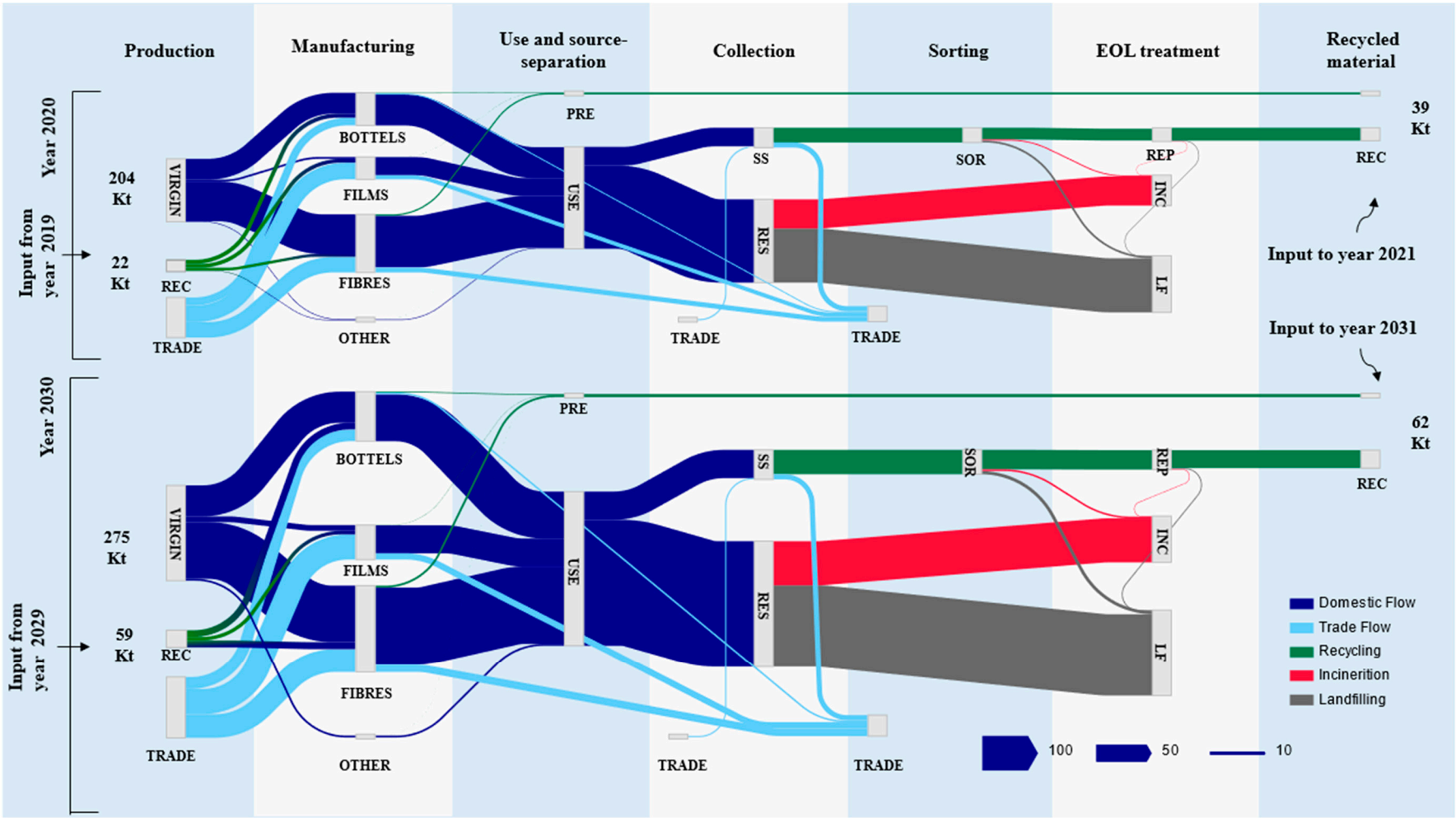


Figure S1.161 Sankey diagram for S6 in year 1 and year 30 in Australia.

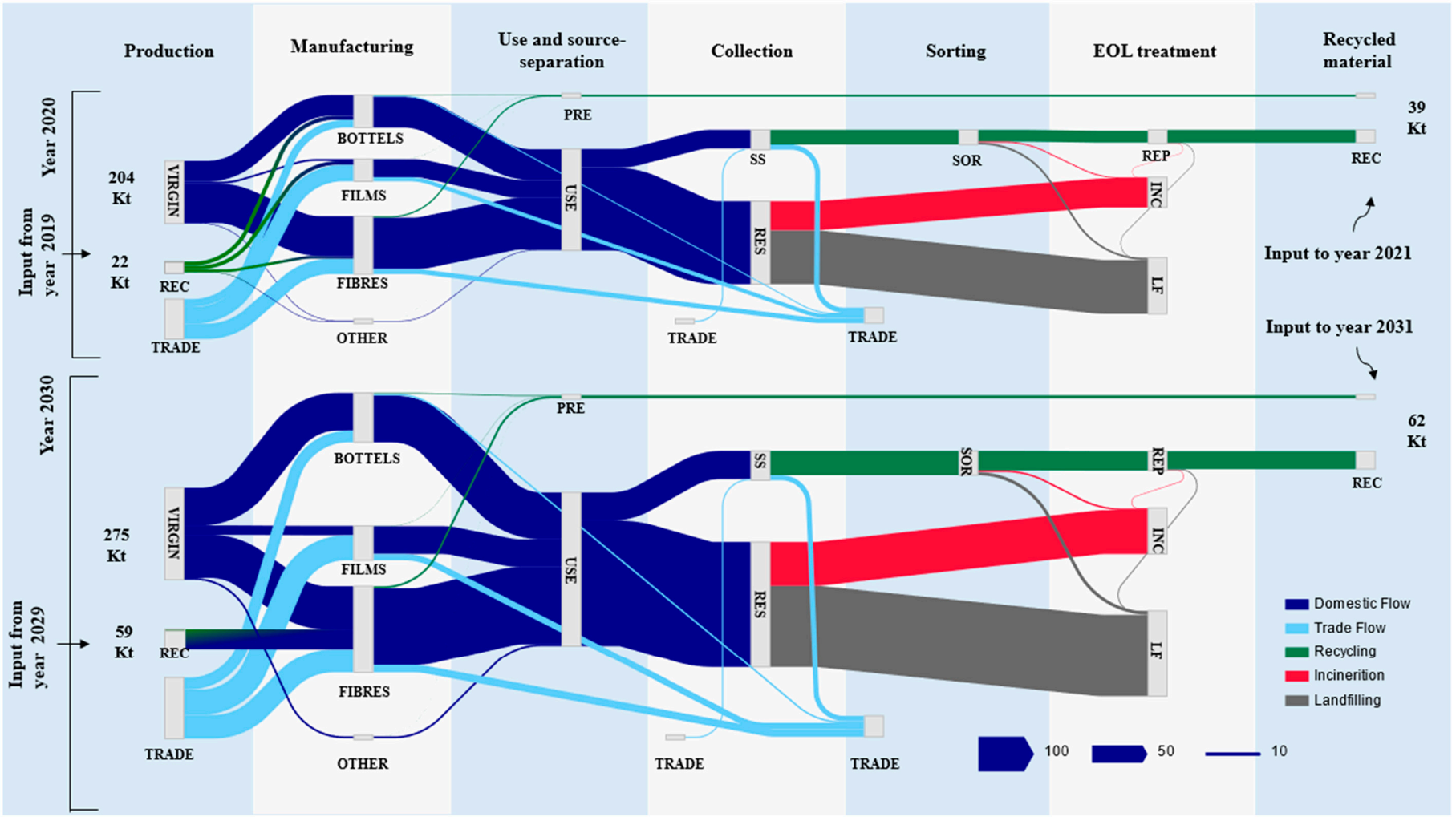


Figure S1.162 Sankey diagram for S7 in year 1 and year 30 in Australia.

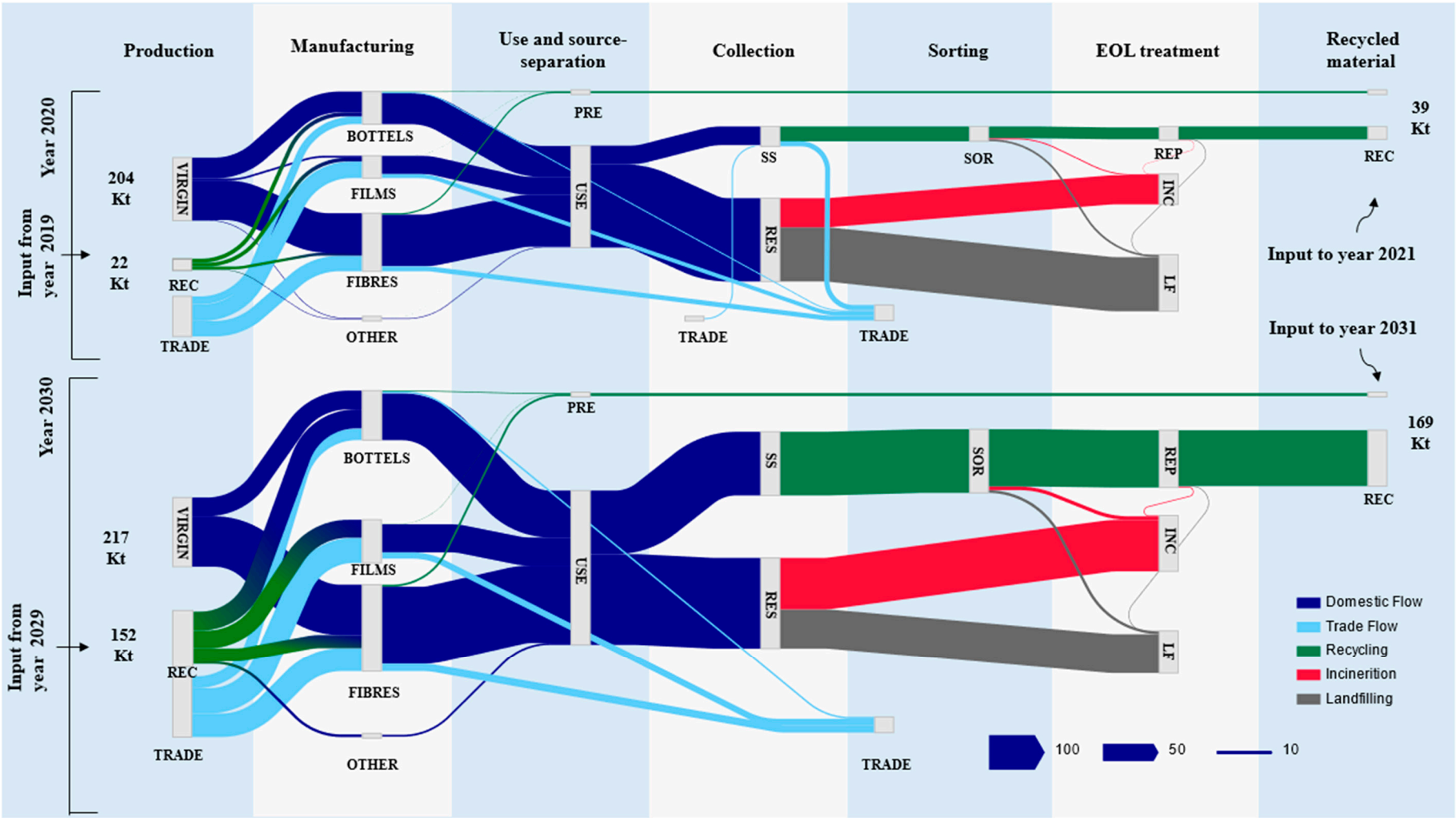


Figure S1.163 Sankey diagram for S8 in year 1 and year 30 in Australia.

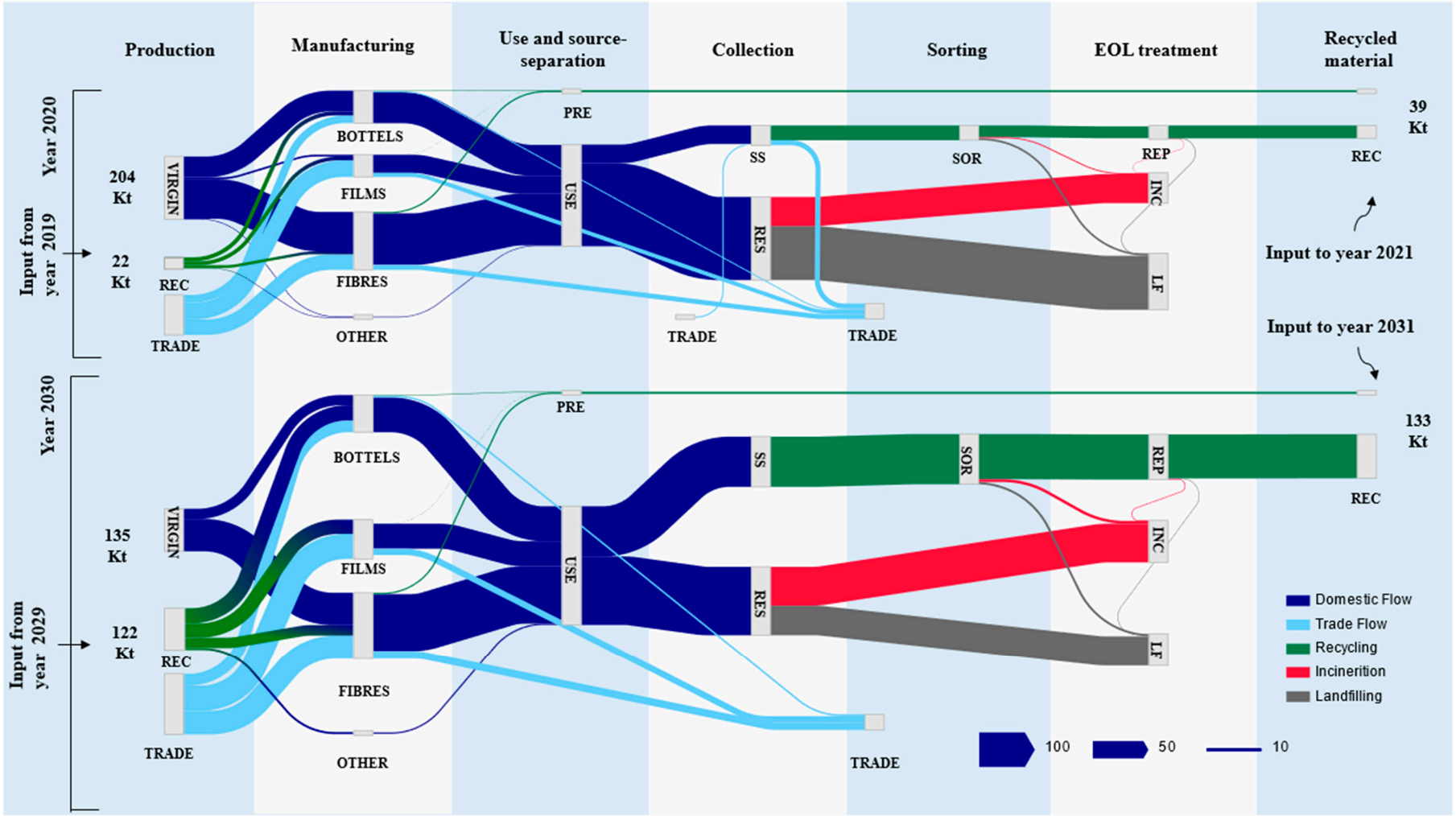


Figure S1.164 Sankey diagram for S9 in year 1 and year 30 in Australia.

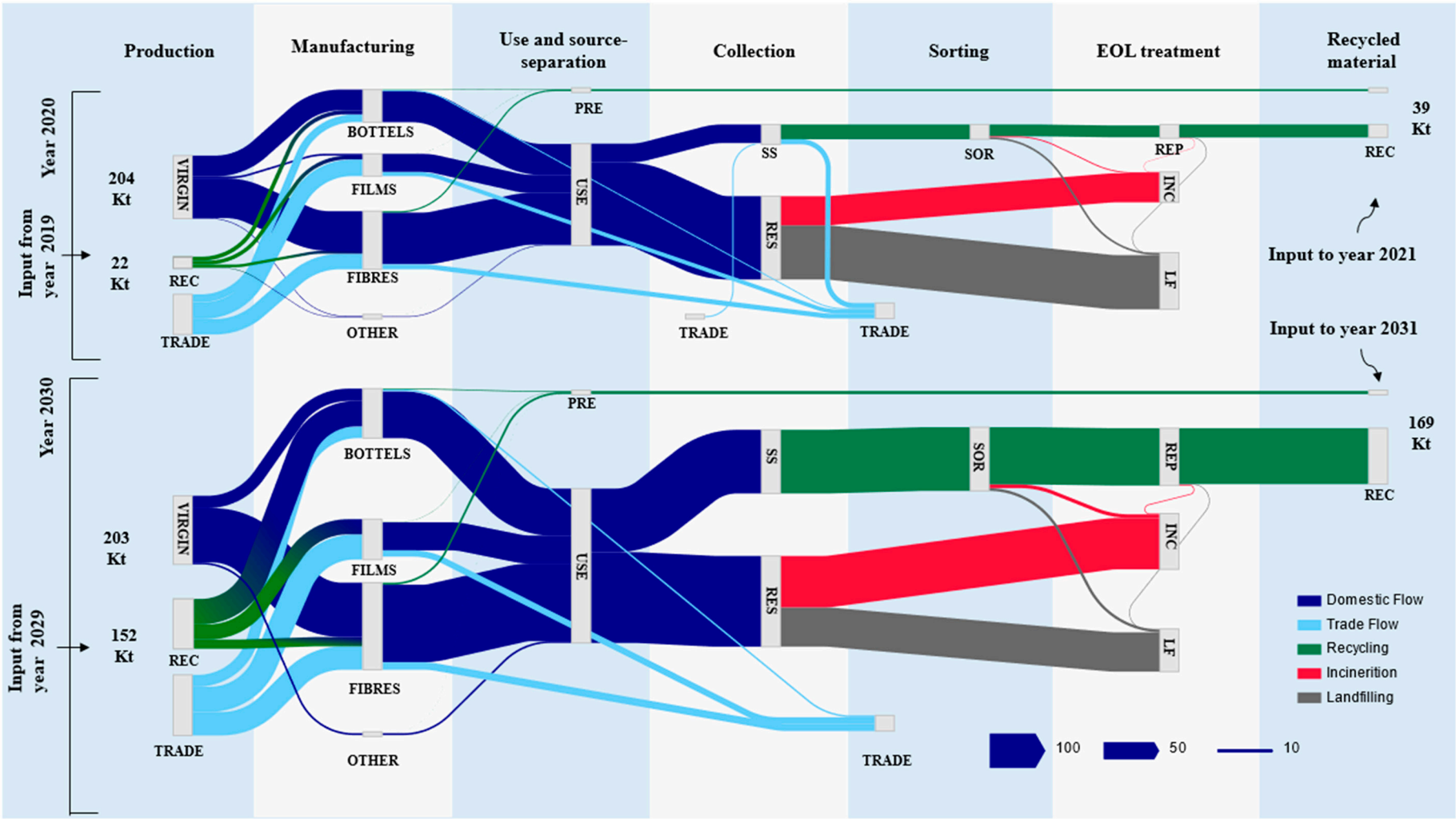


Figure S1.165 Sankey diagram for S10 in year 1 and year 30 in Australia.

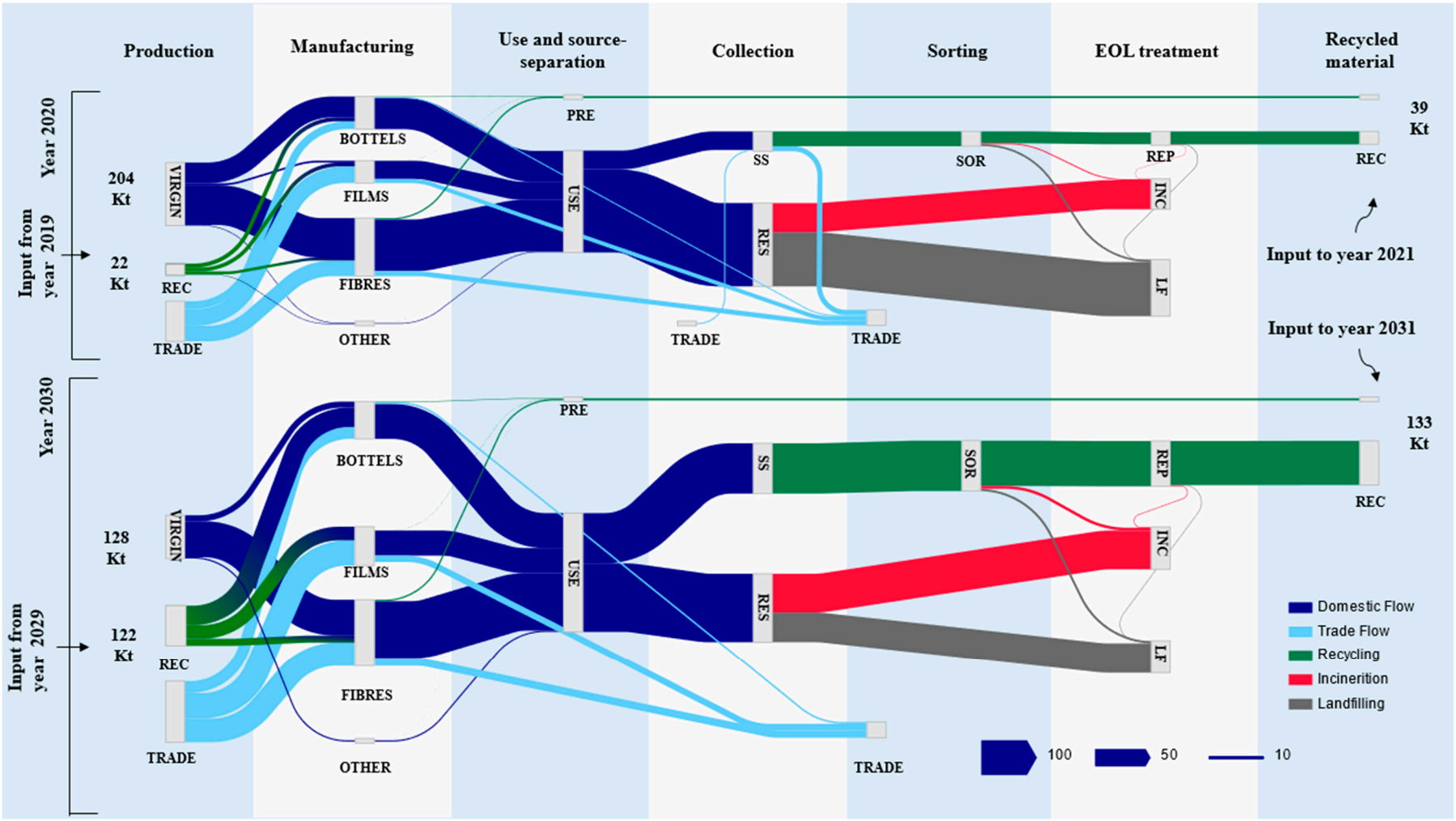


Figure S1.166 Sankey diagram for S11 in year 1 and year 30 in Australia.

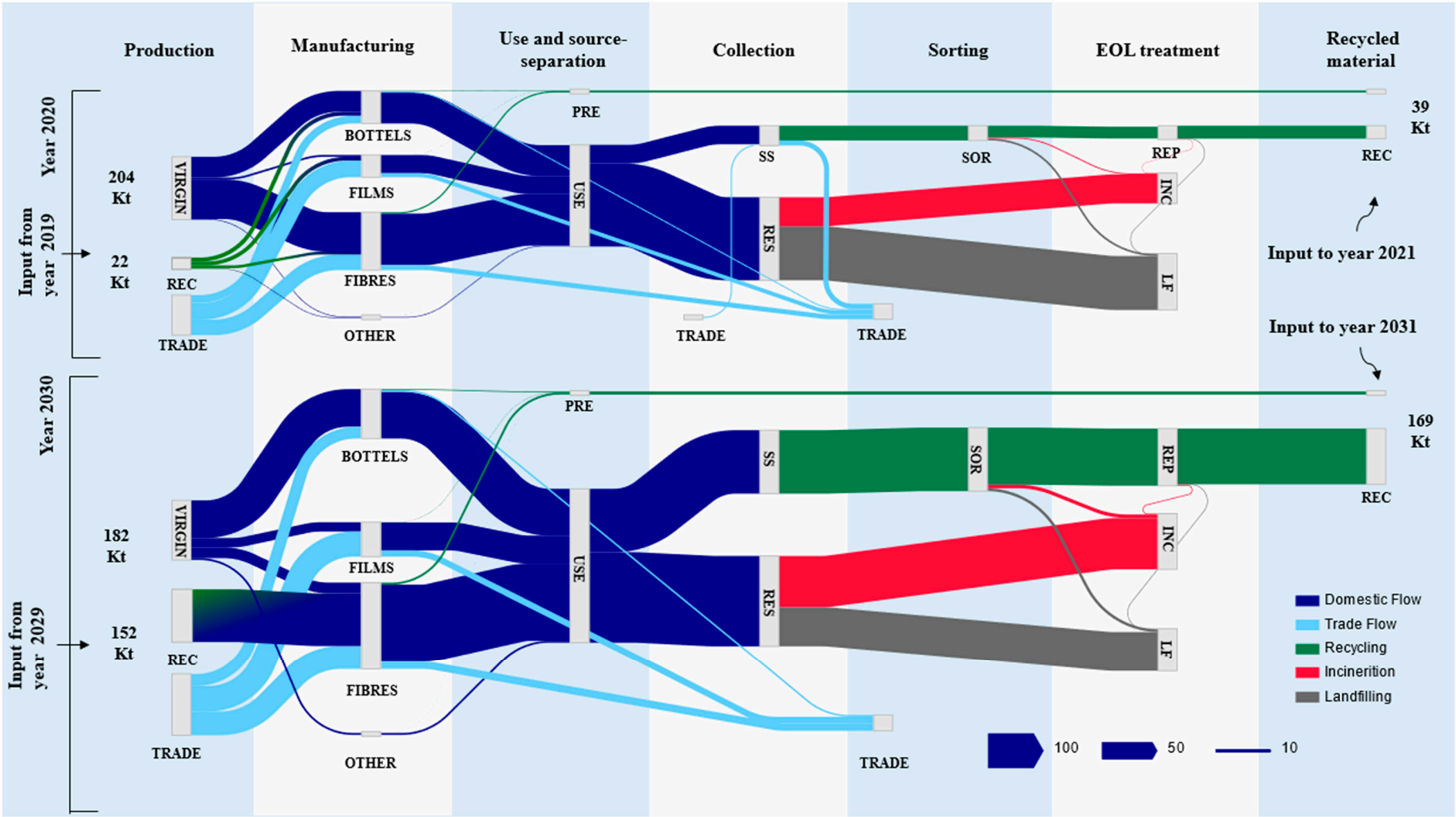


Figure S1.167 Sankey diagram for S12 in year 1 and year 30 in Australia.

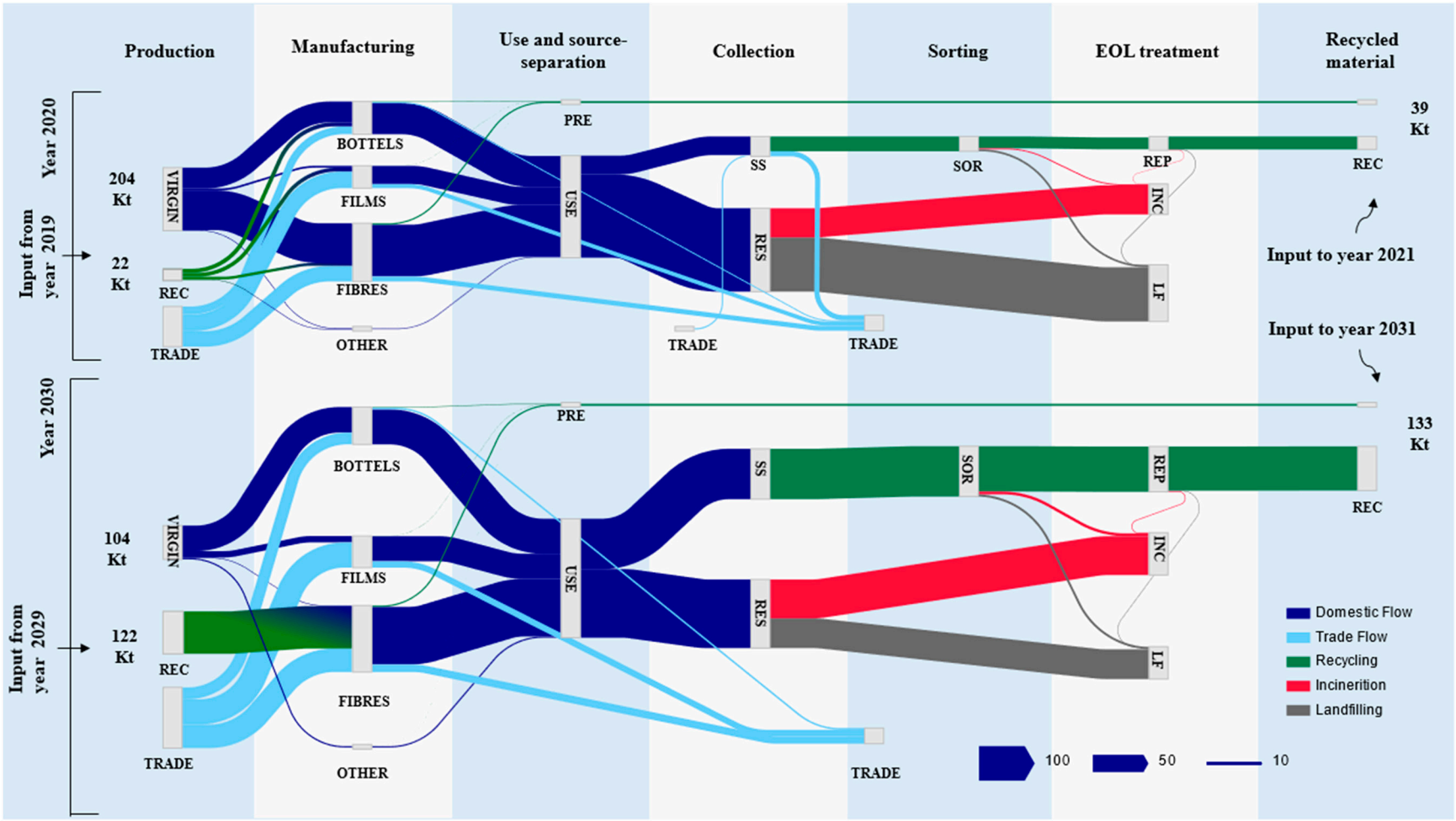


Figure S1.168 Sankey diagram for S13 in year 1 and year 30 in Australia.

S6.2 Results for LCA

For each country, under scenarios S0-S13, the cumulative greenhouse gas emissions from various lifecycle stages for 2020-2030 were calculated relative to the business as usual (BAU) scenario (represented by the baseline), with a 95% confidence interval. The green area indicates a reduction in greenhouse gas emissions compared to BAU, while the red area indicates an increase compared to BAU, with (•) representing the total.

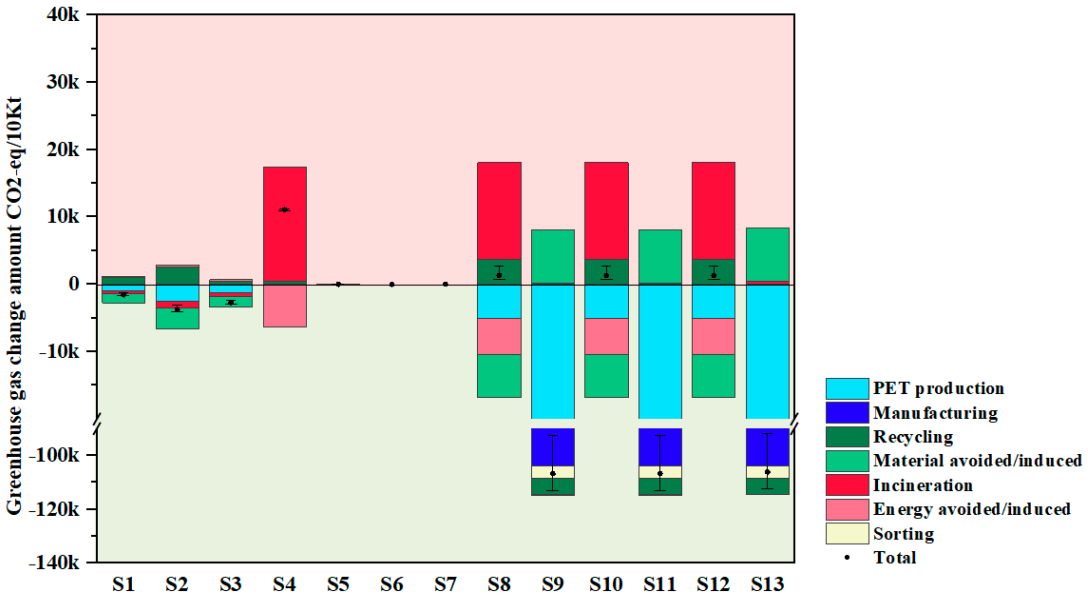


Figure S1.169 China

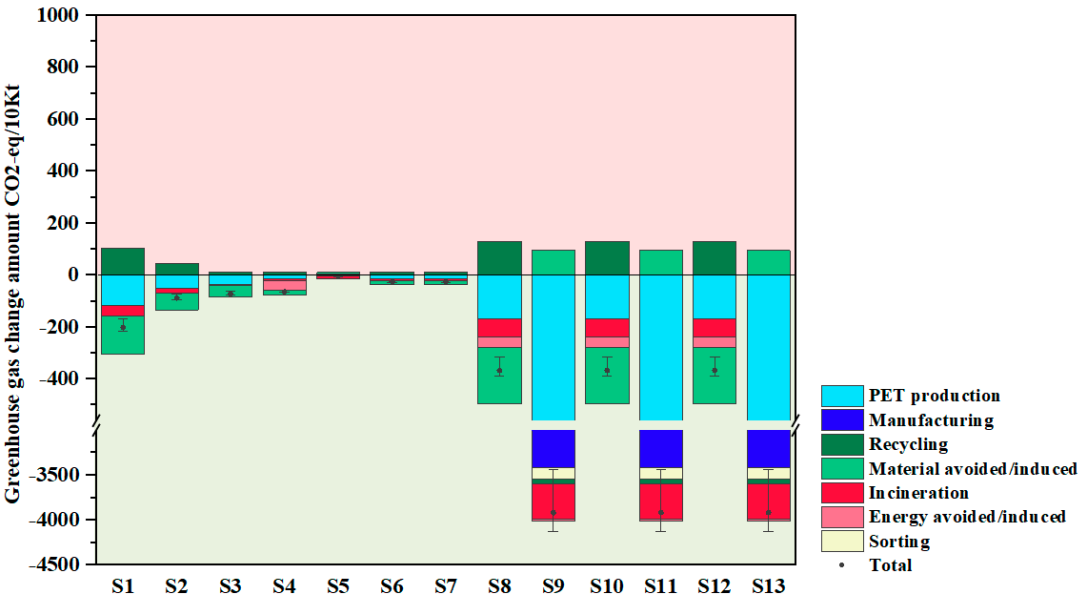


Figure S1.170 Indonesia

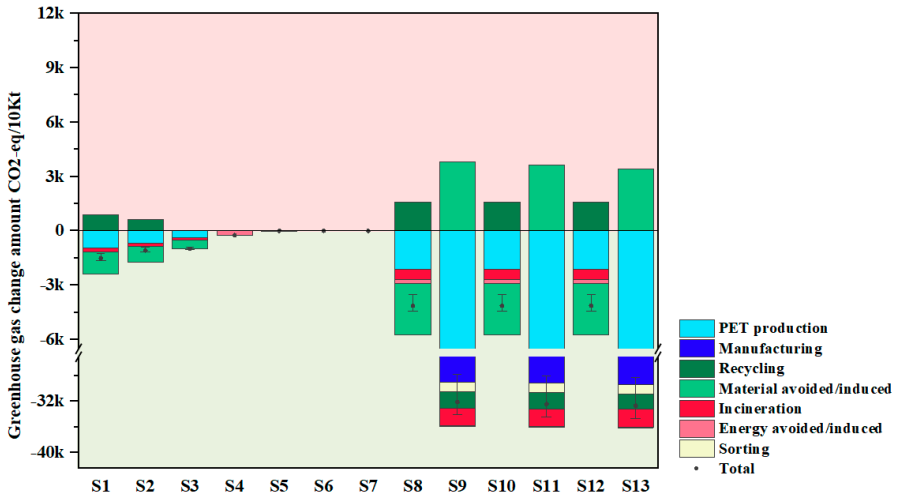


Figure S1.171 India

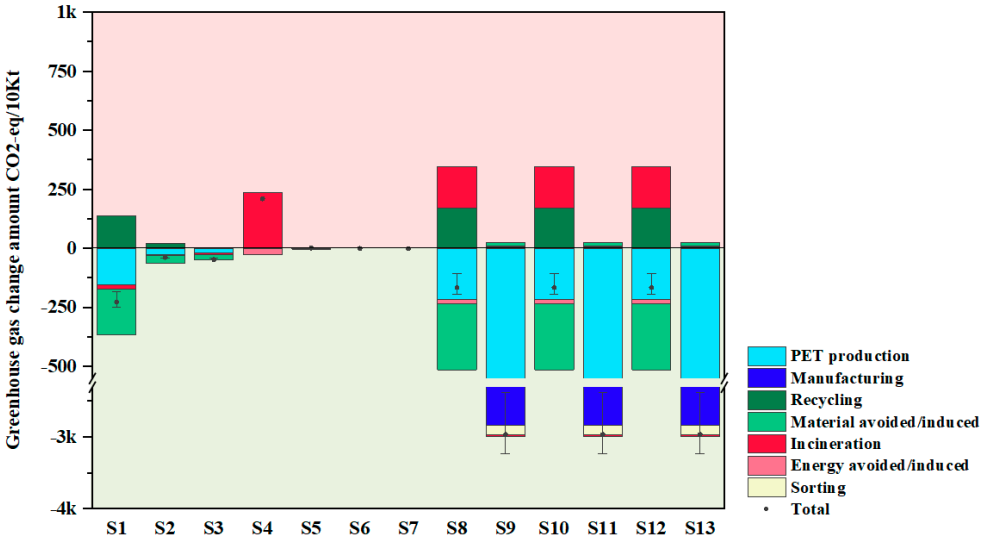


Figure 1.172 Thailand

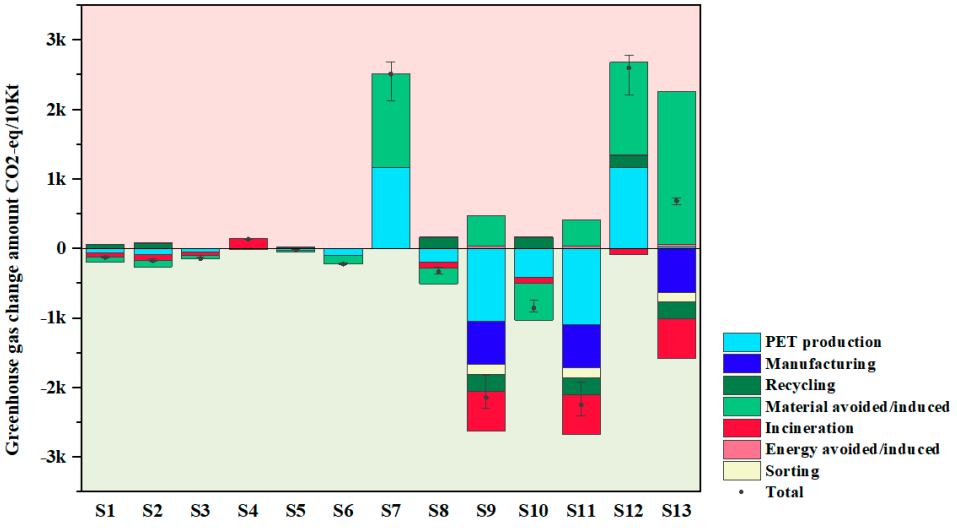


Figure 1.173 Japan

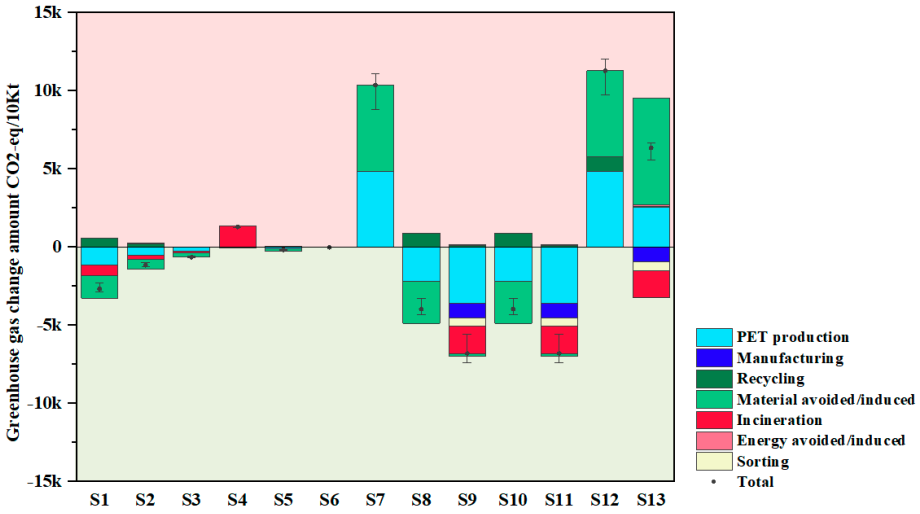


Figure 1.174 Europe

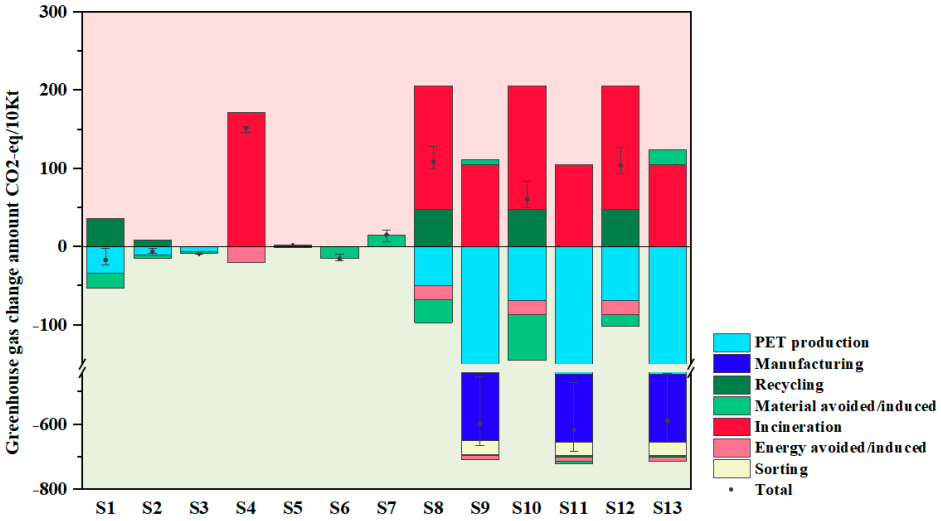


Figure 1.175 South Africa

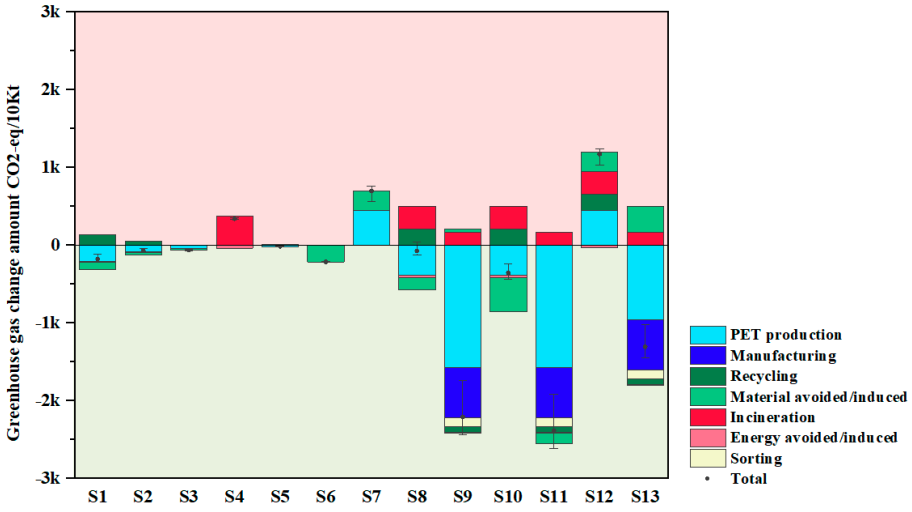


Figure 1.176 Mexico

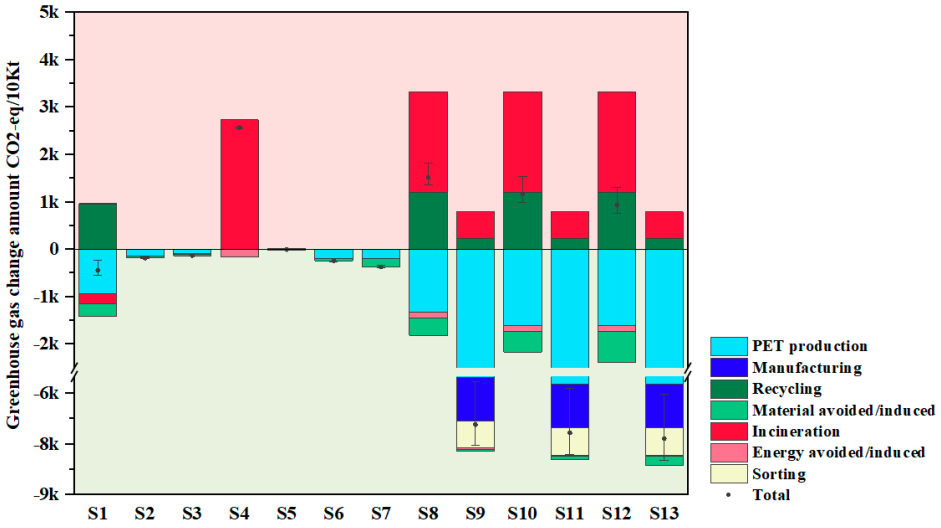


Figure 1.177 America

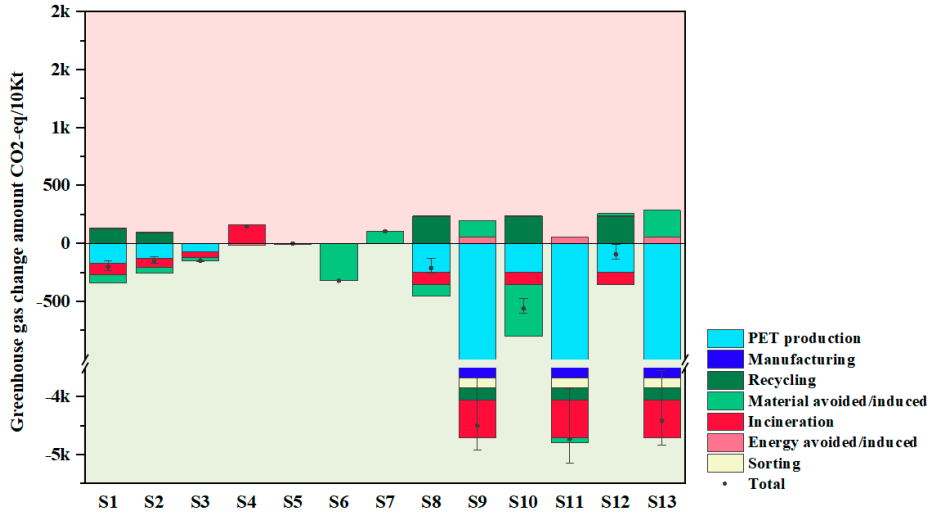


Figure 1.178 Korea

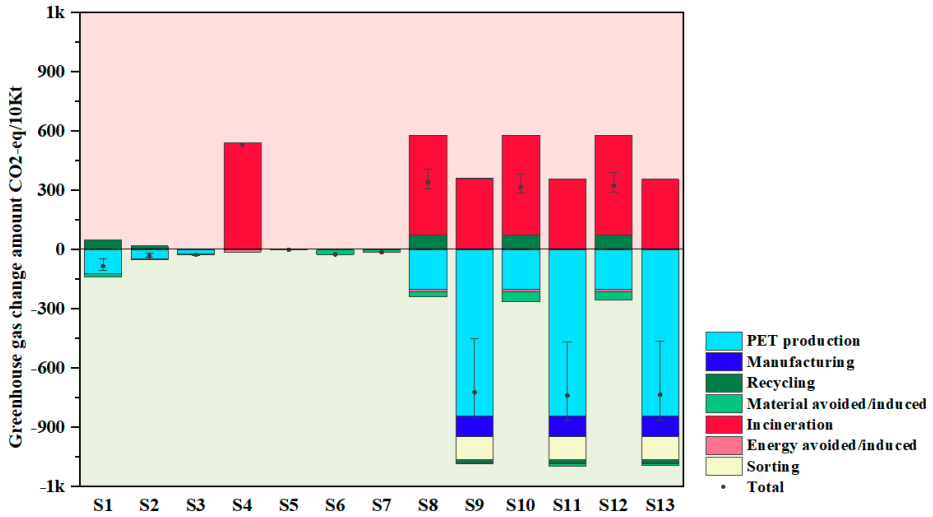


Figure 1.179 Brazil

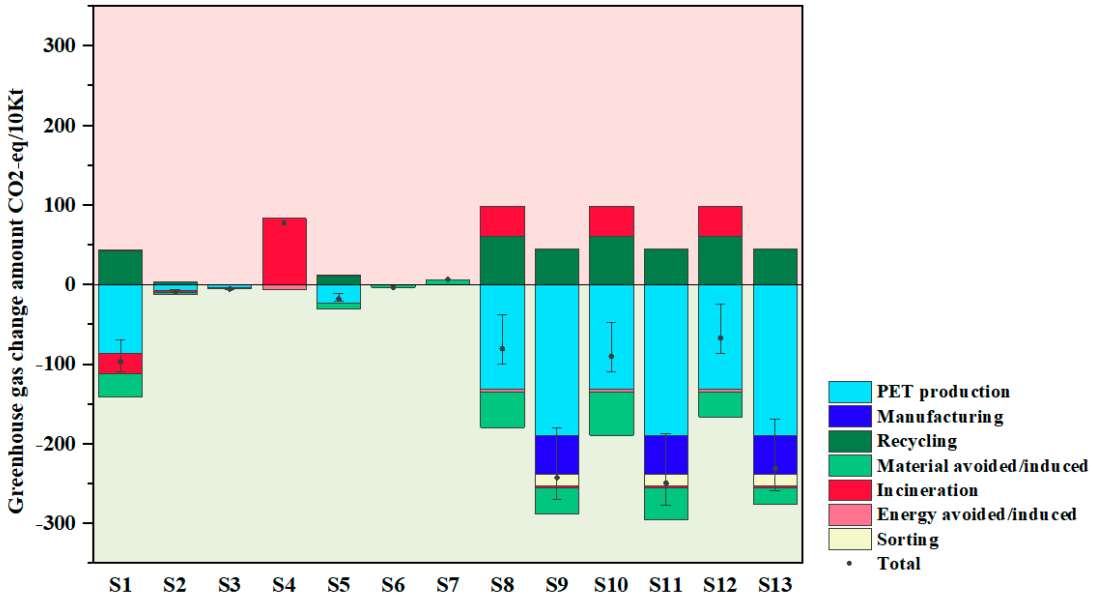


Figure 1.180 Australia

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