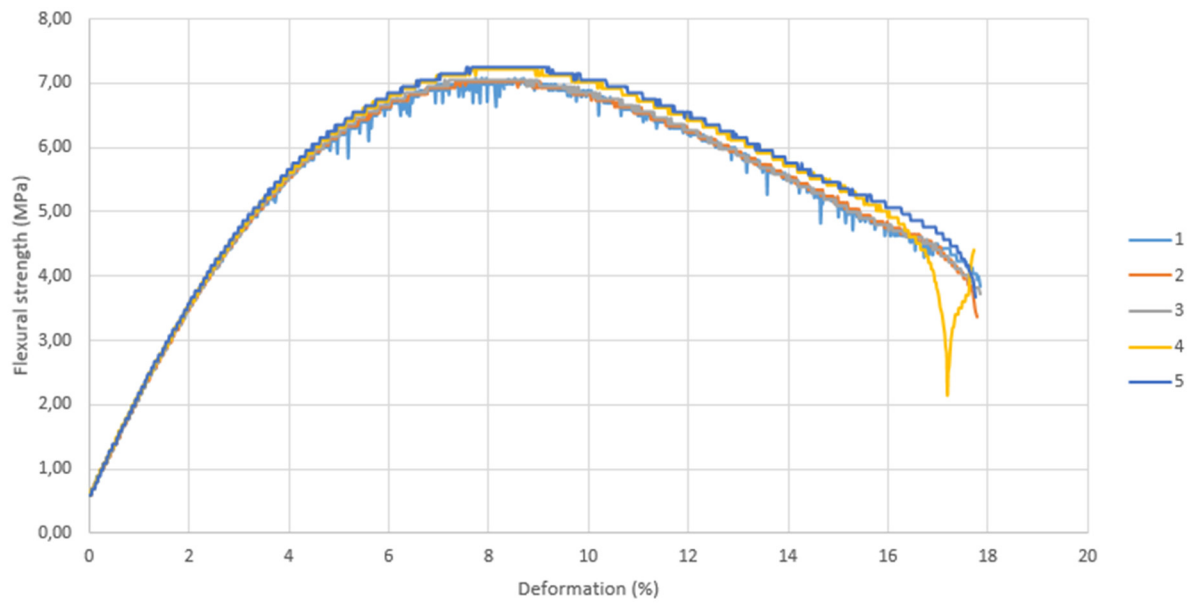
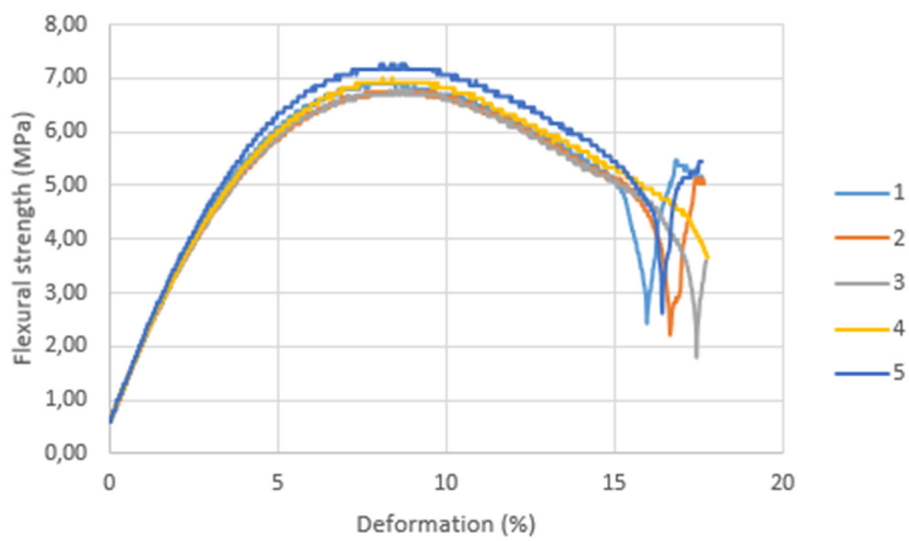


## Supplementary Material

### File S1: Tensile test results



### Flexural test of LDPE\_Blend grade



### Flexural test of LDPE\_Pure grade

## **File S2: Method of the LCA performed**

### Goal:

- Compare the environmental footprint of mechanical recycling VS incineration VS chemical recycling
- Engage discussion regarding the environmental footprint of the different plastic treatment options

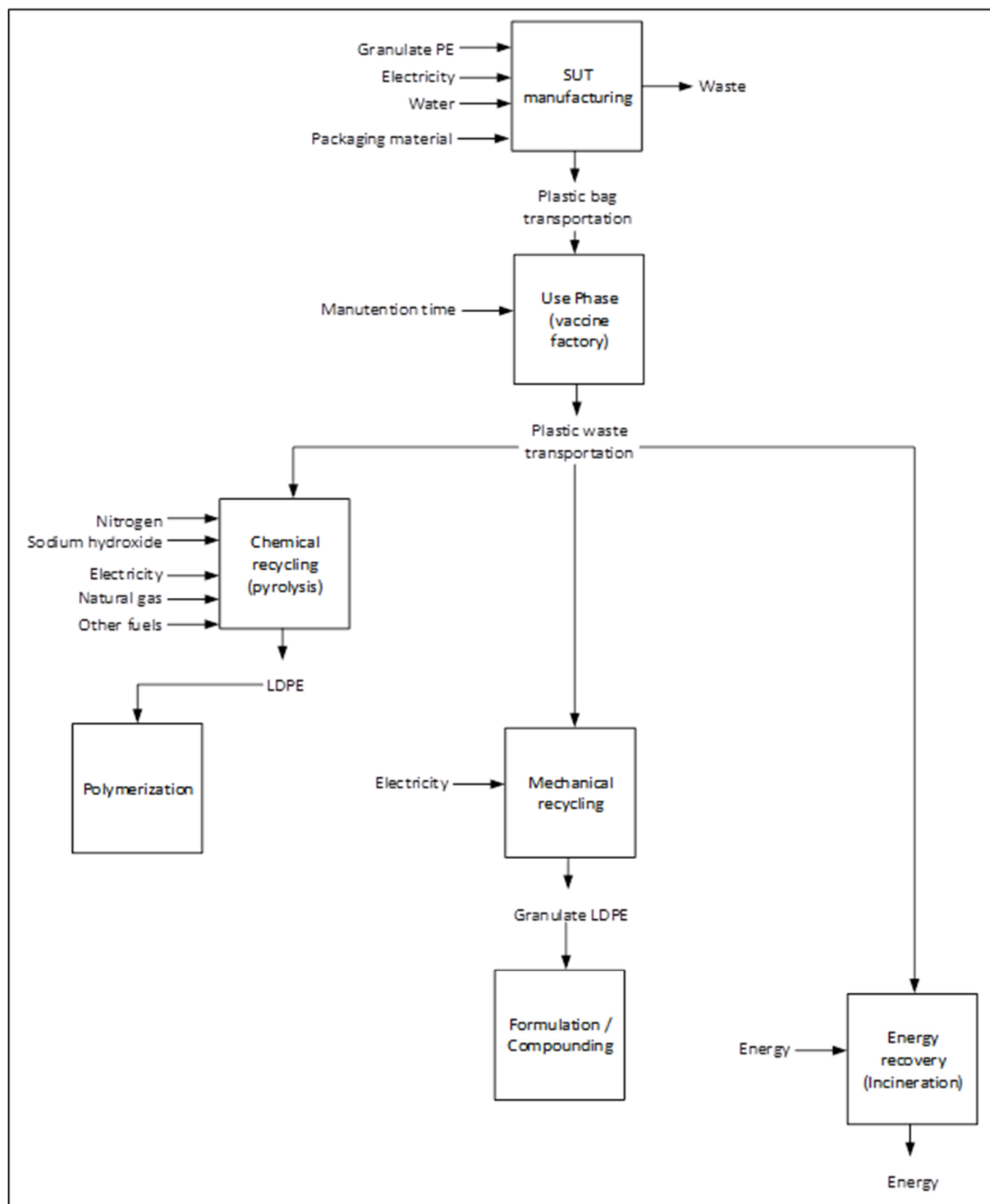
### Inventory approach:

- Mainly based on “Jeswani, H.; Krüger, C.; Russ, M.; Horlacher, M.; Antony, F.; Hann, S.; Azapagic, A. Life Cycle Environmental Impacts of Chemical Recycling via Pyrolysis of Mixed Plastic Waste in Comparison with Mechanical Recycling and Energy Recovery. *Science of The Total Environment* **2021**, 769, 144483, doi:10.1016/j.scitotenv.2020.144483” & “Gu, W.; Wang, K.; Huang, Y.; Zhang, B.; Chen, Q.; Hui, C.-W. Energy Optimization for a Multistage Crude Oil Distillation Process. *Chemical Engineering & Technology* **2015**, 38, 1243–1253, doi:10.1002/ceat.201400130.”
- Data from Sartorius annual report used with allocation rules to be closer to its activity
  - Allocation based on the activity turnover linked to single use technology

### Impact assessment:

IMPACT World+ Midpoint V1,01

## **File S3: Overall scope of the comparative LCA**



## File S4: Main assumptions & life cycle inventory

### Main assumptions

| Description                           | Value     | Unit     | Reference   | Comment                   |
|---------------------------------------|-----------|----------|---|---------------------------|
| Total energy (company wild)           | 162340,00 | MWh      | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Total water withdrawal (company wild) | 692,67    | ML       | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Waste                                 |           |          |   |                           |
| Non hazardous - recycled              | 4 464     | t        | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Hazardous - recycled                  | 527       | t        | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Non hazardous - incineration          | 3 596     | t        | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Hazardous - incineration              | 2 708     | t        | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Turnover Bioprocess Solutions         | 79%       |          | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Turnover single use product           | 75%       |          | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Production sites                      | 60        |          | <a href="https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf">https://www.sartorius.com/download/1138870/sag-annual-report-2021-en-data.pdf</a> | Used for allocation rules |
| Production volume                     | 27000,00  | t / year | Factory based on ecoinvent: Plastic processing factory {GLO}   market for   Cut-off, U  | Used for allocation rules |
| Transport                             | 500,00    | km       | By default data, based on Scope 3 methodology of Sanofi   | Used for allocation rules |
| LDPE film, loss ratio                 | 2,5%      |          | Based on Ecoinvent with conservative approach Extrusion, plastic film {RER}   production   Cut-off, U ==> 2,4%  | Used for allocation rules |
| Bag manufacturing, loss ratio         | 2,5%      |          | Based on Ecoinvent with conservative approach Extrusion, plastic film {RER}   production   Cut-off, U ==> 2,4%  | Used for allocation rules |
| Single use assembly mass repartition  |           |          |   |                           |
| Bag chamber                           | 43,7      | % (mass) | Sartorius, measured data  | Used for allocation rules |
| Plastic packaging                     | 14,1      | % (mass) | Sartorius, measured data  | Used for allocation rules |
| Carton packaging                      | 31,9      | % (mass) | Sartorius, measured data  | Used for allocation rules |
| Connectors and tubes                  | 10,3      | % (mass) | Sartorius, measured data  | Used for allocation rules |

|                                   |     |    |  |  |
|-----------------------------------|-----|----|--|--|
| Distance                          |     |    |  |  |
| Vaccine site / incineration plant | 30  | km | Waste considered as municipal waste, energy recovery |  |
| Generic assumption if no data     | 500 | km | /  |  |

### *Life cycle inventory*

| Incineration  |            |      |   |                        |
|---|------------|------|---|------------------------|
| Bag manufacturing   |            |      |   |                        |
| EF  | Value      | Unit | Description   | Comment                |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U   | 1,050625   | kg   | Bag chamber+port flange   |                        |
| Packaging film, low density polyethylene {RER}  production   Cut-off, U   | 0,3238512  | kg   | Plastic packaging   |                        |
| Folding boxboard carton {RER}  market for folding boxboard carton   Cut-off, U  | 0,72921225 | kg   | Carton packaging  |                        |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U   | 0,23468271 | kg   | Connectors and tubes  |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,05937435 | kWh  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Tap water {RER}  market group for   Cut-off, U  | 0,25       | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U        | 0,00163267 | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U        | 0,00019275 | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Municipal solid waste {FR}  treatment of, incineration   Cut-off, U   | 0,0013152  | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Hazardous waste, for incineration {Europe without Switzerland}  treatment of hazardous waste, hazardous waste incineration, with energy recovery   Cut-off, U | 0,00099043 | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Vaccine site  |            |      |   |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,06945    | kWh  | Sorting   | (Jeswani et al., 2021) |

|   |            |     |                                    |                        |
|---|------------|-----|------------------------------------|------------------------|
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,0161124  | kWh | Additional sorting                 | (Jeswani et al., 2021) |
| Incineration  |            |     |                                    |                        |
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 1          | kg  |                                    |                        |
| Transport   |            |     |                                    |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U | 1,16918559 | tkm | Raw material to bag manufacturing  |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U | 1,05465099 | tkm | Bag manufacturing to vaccine site  |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U | 0,03       | tkm | Vaccine site to incineration plant |                        |

| Mechanical treatment with sorting 55%  |            |      |   |         |
|--|------------|------|---|---------|
| Bag manufacturing  |            |      |   |         |
| EF   | Value      | Unit | Description   | Comment |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U  | 1,70989219 | kg   | Bag chamber+port flange   |         |
| Packaging film, low density polyethylene {RER}  production   Cut-off, U  | 0,52706783 | kg   | Plastic packaging   |         |
| Folding boxboard carton {RER}  market for folding boxboard carton   Cut-off, U   | 1,18679294 | kg   | Carton packaging  |         |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U  | 0,38194612 | kg   | Connectors and tubes  |         |
| Electricity, medium voltage {FR}  market for   Cut-off, U  | 0,09663176 | kWh  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |         |
| Tap water {RER}  market group for   Cut-off, U   | 0,406875   | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |         |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U | 0,00265717 | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |         |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U | 0,00031369 | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |         |
| Municipal solid waste {FR}  treatment of, incineration   Cut-off, U  | 0,00214049 | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |         |
| Hazardous waste, for incineration {Europe without Switzerland}  treatment of hazardous waste,  | 0,00161192 | kg   | Allocation based on Sartorius Annual report   |         |

|   |            |     |   |                        |
|---|------------|-----|---|------------------------|
| hazardous waste incineration, with energy recovery   Cut-off, U   |            |     | 2022 and number of production site (60) |                        |
| Vaccine site  |            |     |   |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,0729225  | kWh | Sorting                                 | (Jeswani et al., 2021) |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,01691802 | kWh | Additional sorting                      | (Jeswani et al., 2021) |
| Mechanical recycling  |            |     |   |                        |
| Thermoforming, with calendering {RER}  thermoforming, with calendering   Cut-off, U                                   | 1,05       | kg  | Loss ratio 5% based on expert           | (Jeswani et al., 2021) |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,525042   | kWh |   | (Jeswani et al., 2021) |
| Waste polyethylene {Europe without Switzerland}  treatment of waste polyethylene, municipal incineration   Cut-off, U | 0,05       | kg  |   | (Jeswani et al., 2021) |
| Transport   |            |     |   |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 1,16918559 | tkm | Raw material to bag manufacturing       |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 1,63470903 | tkm | Bag manufacturing to vaccine site       |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,5082525  | tkm | Vaccine site to mechanical plant        | (Jeswani et al., 2021) |

| Mechanical treatment with sorting 100%   |            |      |   |         |
|--|------------|------|---|---------|
| Bag manufacturing  |            |      |   |         |
| EF   | Value      | Unit | Description   | Comment |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U            | 1,10315625 | kg   | Bag chamber+port flange   |         |
| Packaging film, low density polyethylene {RER}  production   Cut-off, U        | 0,34004376 | kg   | Plastic packaging   |         |
| Folding boxboard carton {RER}  market for folding boxboard carton   Cut-off, U | 0,76567287 | kg   | Carton packaging  |         |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U            | 0,24641685 | kg   | Connectors and tubes  |         |
| Electricity, medium voltage {FR}  market for   Cut-off, U                      | 0,06234307 | kWh  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |         |
| Tap water {RER}  market group for   Cut-off, U                                 | 0,2625     | kg   | Allocation based on Sartorius Annual report 2022 and number of production site (60) |         |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}         | 0,0017143  | kg   | Allocation based on Sartorius Annual report   |         |

|   |            |     |   |                        |
|---|------------|-----|---|------------------------|
| treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U  |            |     | 2022 and number of production site (60)   |                        |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U        | 0,00020238 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Municipal solid waste {FR}  treatment of, incineration   Cut-off, U   | 0,00138096 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Hazardous waste, for incineration {Europe without Switzerland}  treatment of hazardous waste, hazardous waste incineration, with energy recovery   Cut-off, U | 0,00103995 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Vaccine site  |            |     |   |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,0729225  | kWh | Sorting   | (Jeswani et al., 2021) |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,01691802 | kWh | Additional sorting  | (Jeswani et al., 2021) |
| Mechanical recycling  |            |     |   |                        |
| Thermoforming, with calendering {RER}  thermoforming, with calendering   Cut-off, U   | 1,05       | kg  | Loss ratio 5% based on expert   | (Jeswani et al., 2021) |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,525042   | kWh |   | (Jeswani et al., 2021) |
| Waste polyethylene {Europe without Switzerland}  treatment of waste polyethylene, municipal incineration   Cut-off, U   | 0,05       | kg  |   | (Jeswani et al., 2021) |
| Transport   |            |     |   |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 1,16918559 | tkm | Raw material to bag manufacturing   |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 1,10738353 | tkm | Bag manufacturing to vaccine site   |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,5082525  | tkm | Vaccine site to mechanical plant  | (Jeswani et al., 2021) |

| Chemical treatment with sorting 55%                                     |            |      |                         |         |
|---|------------|------|-------------------------|---------|
| Bag manufacturing   |            |      |                         |         |
| EF  | Value      | Unit | Description             | Comment |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U     | 2,315479   | kg   | Bag chamber+port flange |         |
| Packaging film, low density polyethylene {RER}  production   Cut-off, U | 0,71373769 | kg   | Plastic packaging       |         |



|   |            |     |   |                        |
|---|------------|-----|---|------------------------|
| Folding boxboard carton {RER}  market for folding boxboard carton   Cut-off, U  | 1,60711544 | kg  | Carton packaging  |                        |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U   | 0,5172187  | kg  | Connectors and tubes  |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,13085551 | kWh | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Tap water {RER}  market group for   Cut-off, U  | 0,55097656 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U        | 0,00359825 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U        | 0,00042479 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Municipal solid waste {FR}  treatment of, incineration   Cut-off, U   | 0,00289859 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Hazardous waste, for incineration {Europe without Switzerland}  treatment of hazardous waste, hazardous waste incineration, with energy recovery   Cut-off, U | 0,00218281 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Vaccine site  |            |     |   |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,09874922 | kWh | Sorting   | (Jeswani et al., 2021) |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,02290982 | kWh | Additional sorting  | (Jeswani et al., 2021) |
| Pyrolysis oil   |            |     |   |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,9321903  | kWh |   | (Jeswani et al., 2021) |
| Heat, district or industrial, natural gas {RER}  market group for   Cut-off, U  | 0,13998852 | kWh |   | (Jeswani et al., 2021) |
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 0,43062201 | kg  |   | (Jeswani et al., 2021) |
| Purification  |            |     |   |                        |
| Electricity, high voltage {FR}  electricity production, oil   Cut-off, U  | 0,1072406  | kWh |   | (Gu et al., 2015)      |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,02151643 | kWh |   | (Gu et al., 2015)      |
| Heat, from steam, in chemical industry {RER}  market for heat, from steam, in chemical industry   Cut-off, U  | 0,0201503  | kWh |   | (Gu et al., 2015)      |

|   |            |     |                                   |                        |
|---|------------|-----|-----------------------------------|------------------------|
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 0,0254902  | kg  |                                   | (Gu et al., 2015)      |
| Cracker   |            |     |                                   |                        |
| Nitrogen, liquid {RER}  market for   Cut-off, U   | 0,05179122 | kg  |                                   | (Jeswani et al., 2021) |
| Sodium hydroxide, without water, in 50% solution state {GLO}  market for   Cut-off, U   | 0,00090737 | kg  |                                   | (Jeswani et al., 2021) |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,1161204  | kWh |                                   | (Jeswani et al., 2021) |
| Electricity, for reuse in municipal waste incineration only {CH}  treatment of waste cement-fibre slab, dismantled, municipal incineration with fly ash extraction   Cut-off, U | 0,31437474 | kWh |                                   | (Jeswani et al., 2021) |
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 0,234      | kg  |                                   | (Jeswani et al., 2021) |
| Polymerisation  |            |     |                                   |                        |
| Thermoforming, with calendering {RER}  thermoforming, with calendering   Cut-off, U   | 1,02       | kg  |                                   | (Jeswani et al., 2021) |
| Polyethylene, low density, granulate {RER}  polymerisation wo PE   Cut-off, U   | 1,02       | kg  |                                   | (Jeswani et al., 2021) |
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 0,02       | kg  |                                   | (Jeswani et al., 2021) |
| Transport   |            |     |                                   |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 1,16918559 | tkm | Raw material to bag manufacturing |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 1,63470903 | tkm | Bag manufacturing to vaccine site |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,51036683 | tkm | Vaccine site to Pyrolysis         | (Jeswani et al., 2021) |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,06147059 | tkm | Pyrolysis to purification         | (Jeswani et al., 2021) |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,051      | tkm | Purification to Cracker           | (Jeswani et al., 2021) |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,051      | tkm | Cracker to Polymerisation         | (Jeswani et al., 2021) |

| Chemical treatment with sorting 100% |       |      |             |         |
|--------------------------------------|-------|------|-------------|---------|
| Bag manufacturing                    |       |      |             |         |
| EF                                   | Value | Unit | Description | Comment |

|   |            |     |   |                        |
|---|------------|-----|---|------------------------|
| Polyethylene, low density, granulate {RER}  production   Cut-off, U   | 1,49385742 | kg  | Bag chamber+port flange   |                        |
| Packaging film, low density polyethylene {RER}  production   Cut-off, U   | 0,46047593 | kg  | Plastic packaging   |                        |
| Folding boxboard carton {RER}  market for folding boxboard carton   Cut-off, U  | 1,03684867 | kg  | Carton packaging  |                        |
| Polyethylene, low density, granulate {RER}  production   Cut-off, U   | 0,33368948 | kg  | Connectors and tubes  |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,08442291 | kWh | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Tap water {RER}  market group for   Cut-off, U  | 0,35546875 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U        | 0,00232145 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Waste polyethylene, for recycling, sorted {Europe without Switzerland}  treatment of waste polyethylene, for recycling, unsorted, sorting   Cut-off, U        | 0,00027406 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Municipal solid waste {FR}  treatment of, incineration   Cut-off, U   | 0,00187006 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Hazardous waste, for incineration {Europe without Switzerland}  treatment of hazardous waste, hazardous waste incineration, with energy recovery   Cut-off, U | 0,00140826 | kg  | Allocation based on Sartorius Annual report 2022 and number of production site (60) |                        |
| Vaccine site  |            |     |   |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,09874922 | kWh | Sorting   | (Jeswani et al., 2021) |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,02290982 | kWh | Additional sorting  | (Jeswani et al., 2021) |
| Pyrolysis oil   |            |     |   |                        |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,9321903  | kWh |   | (Jeswani et al., 2021) |
| Heat, district or industrial, natural gas {RER}  market group for   Cut-off, U  | 0,16860768 | kWh |   | (Jeswani et al., 2021) |
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 0,4303125  | kg  |   | (Jeswani et al., 2021) |
| Purification  |            |     |   |                        |
| Electricity, high voltage {FR}  electricity production, oil   Cut-off, U  | 0,1072406  | kWh |   | (Gu et al., 2015)      |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,02151643 | kWh |   | (Gu et al., 2015)      |

|   |            |     |                                   |                        |
|---|------------|-----|-----------------------------------|------------------------|
| Heat, from steam, in chemical industry {RER}  market for heat, from steam, in chemical industry   Cut-off, U  | 0,0201503  | kWh |                                   | (Gu et al., 2015)      |
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 0,0254902  | kg  |                                   | (Gu et al., 2015)      |
| Cracker   |            |     |                                   |                        |
| Nitrogen, liquid {RER}  market for   Cut-off, U   | 0,05179122 | kg  |                                   | (Jeswani et al., 2021) |
| Sodium hydroxide, without water, in 50% solution state {GLO}  market for   Cut-off, U   | 0,00090737 | kg  |                                   | (Jeswani et al., 2021) |
| Electricity, medium voltage {FR}  market for   Cut-off, U   | 0,1161204  | kWh |                                   | (Jeswani et al., 2021) |
| Electricity, for reuse in municipal waste incineration only {CH}  treatment of waste cement-fibre slab, dismantled, municipal incineration with fly ash extraction   Cut-off, U | 0,31437474 | kWh |                                   | (Jeswani et al., 2021) |
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 0,234      | kg  |                                   | (Jeswani et al., 2021) |
| Polymerisation  |            |     |                                   |                        |
| Thermoforming, with calendering {RER}  thermoforming, with calendering   Cut-off, U   | 1,02       | kg  |                                   | (Jeswani et al., 2021) |
| Polyethylene, low density, granulate {RER}  polymerisation wo PE   Cut-off, U   | 1,02       | kg  |                                   | (Jeswani et al., 2021) |
| Municipal solid waste {FR}  market for municipal solid waste   Cut-off, U   | 0,02       | kg  |                                   | (Jeswani et al., 2021) |
| Transport   |            |     |                                   |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 1,16918559 | tkm | Raw material to bag manufacturing |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 1,05465099 | tkm | Bag manufacturing to vaccine site |                        |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,51036683 | tkm | Vaccine site to Pyrolysis         | (Jeswani et al., 2021) |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,06147059 | tkm | Pyrolysis to purification         | (Jeswani et al., 2021) |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,051      | tkm | Purification to Cracker           | (Jeswani et al., 2021) |
| Transport, freight, lorry >32 metric ton, EURO5 {RER}  transport, freight, lorry >32 metric ton, EURO5   Cut-off, U   | 0,051      | tkm | Cracker to Polymerisation         | (Jeswani et al., 2021) |

Jeswani, H.; Krüger, C.; Russ, M.; Horlacher, M.; Antony, F.; Hann, S.; Azapagic, A. Life Cycle Environmental Impacts of Chemical Recycling via Pyrolysis of Mixed Plastic Waste in Comparison

with Mechanical Recycling and Energy Recovery. *Science of The Total Environment* **2021**, 769, 144483, doi:10.1016/j.scitotenv.2020.144483.

Gu, W.; Wang, K.; Huang, Y.; Zhang, B.; Chen, Q.; Hui, C.-W. Energy Optimization for a Multistage Crude Oil Distillation Process. *Chemical Engineering & Technology* **2015**, 38, 1243–1253, doi:10.1002/ceat.201400130.

## File S5: LCA results

### *Results for 1 kg of Bag chamber+port flange treated*

IMPACT World+ Midpoint V1,01

| Impact category                   | Unit         | Incineration with energy recovery | Mechanical recycling LDPE Blend | Chemical recycling LDPE Blend |
|-----------------------------------|--------------|-----------------------------------|---------------------------------|-------------------------------|
| Climate change, short term        | kg CO2 eq    | 100%                              | 98%                             | 194%                          |
| Climate change, long term         | kg CO2 eq    | 100%                              | 104%                            | 198%                          |
| Fossil and nuclear energy use     | MJ deprived  | 100%                              | -39%                            | 70%                           |
| Mineral resources use             | kg deprived  | 100%                              | 46%                             | 178%                          |
| Photochemical oxidant formation   | kg NMVOC eq  | 100%                              | 31%                             | 142%                          |
| Ozone layer depletion             | kg CFC-11 eq | 100%                              | 180%                            | 246%                          |
| Freshwater ecotoxicity            | CTUe         | 100%                              | 63%                             | 263%                          |
| Human toxicity cancer             | CTUh         | 100%                              | 77%                             | 194%                          |
| Human toxicity non-cancer         | CTUh         | 100%                              | 123%                            | 230%                          |
| Freshwater acidification          | kg SO2 eq    | 100%                              | 53%                             | 153%                          |
| Terrestrial acidification         | kg SO2 eq    | 100%                              | 54%                             | 153%                          |
| Freshwater eutrophication         | kg PO4 eq    | 100%                              | 127%                            | 239%                          |
| Marine eutrophication             | kg N eq      | 100%                              | 53%                             | 252%                          |
| Particulate matter formation      | kg PM2,5 eq  | 100%                              | 63%                             | 154%                          |
| Ionizing radiation                | Bq C-14 eq   | 100%                              | 106%                            | 157%                          |
| Land transformation, biodiversity | m2yr arable  | 100%                              | 60%                             | 156%                          |
| Land occupation, biodiversity     | m2yr arable  | 100%                              | 340%                            | 337%                          |
| Water scarcity                    | m3 world eq  | 100%                              | 71%                             | 211%                          |

*Results for 1 of LDPE recycled (in output)*

IMPACT World+ Midpoint V1,01

|                                   |              | Mechanical<br>treatment,<br>55% | Mechanical<br>treatment,<br>100% | Chemical<br>treatment,<br>55% | Chemical<br>treatment,100% |
|-----------------------------------|--------------|---------------------------------|----------------------------------|-------------------------------|----------------------------|
| Impact category                   | Unit         | 146%                            | 100%                             | 208%                          | 145%                       |
| Climate change, short term        | kg CO2 eq    | 146%                            | 100%                             | 205%                          | 144%                       |
| Climate change, long term         | kg CO2 eq    | 148%                            | 100%                             | 207%                          | 142%                       |
| Fossil and nuclear energy use     | MJ deprived  | 147%                            | 100%                             | 224%                          | 161%                       |
| Mineral resources use             | kg deprived  | 149%                            | 100%                             | 219%                          | 153%                       |
| Photochemical oxidant formation   | kg NMVOC eq  | 140%                            | 100%                             | 200%                          | 148%                       |
| Ozone layer depletion             | kg CFC-11 eq | 147%                            | 100%                             | 296%                          | 232%                       |
| Freshwater ecotoxicity            | CTUe         | 144%                            | 100%                             | 218%                          | 159%                       |
| Human toxicity cancer             | CTUh         | 143%                            | 100%                             | 222%                          | 164%                       |
| Human toxicity non-cancer         | CTUh         | 147%                            | 100%                             | 211%                          | 148%                       |
| Freshwater acidification          | kg SO2 eq    | 147%                            | 100%                             | 210%                          | 147%                       |
| Terrestrial acidification         | kg SO2 eq    | 150%                            | 100%                             | 210%                          | 142%                       |
| Freshwater eutrophication         | kg PO4 eq    | 149%                            | 100%                             | 260%                          | 194%                       |
| Marine eutrophication             | kg N eq      | 149%                            | 100%                             | 208%                          | 142%                       |
| Particulate matter formation      | kg PM2,5 eq  | 131%                            | 100%                             | 202%                          | 161%                       |
| Ionizing radiation                | Bq C-14 eq   | 142%                            | 100%                             | 200%                          | 144%                       |
| Land transformation, biodiversity | m2yr arable  | 149%                            | 100%                             | 200%                          | 133%                       |
| Land occupation, biodiversity     | m2yr arable  | 139%                            | 100%                             | 206%                          | 153%                       |