From incineration to recycling – An economic and environmental assessment of circular economy of plastics in Finland

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Circular economy and waste management

- A tool for more resource-efficient and eco-friendly economy
- The value of products, materials and resources is maintained as long as possible in the economy
- The transition from linear to circular economy involves structural shifts in the economy -> need for modelling aggregate outcomes
- Wastes are inevitable part of economic processes
  - Waste recycling instead of disposal/incineration (waste hiearchy)
  - Secondary material use instead of virgin material use

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Waste management and plastic waste in Finland

- Plastic wastes in MSW and in separate waste flow
- High garbage mountain to climb!

Recycling rates	Current situtation (2018)	European Union / National goal
Municipal solid waste	42%	55% (2025); 60% (2030)
Plastic packages	31%	50% (2025); 55% (2030)

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Research questions

Main question: What are the economic and environmental impacts, if Finland reaches recycling goals of plastic waste?

1) How to model waste and secondary raw material flows and transactions in CGE model when monetary values are mostly absent?
2) What policy instruments are needed for secondary raw material manufacturing to ramp up?

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Modelling approach

- A scenario assessment of increased plastic waste recycling using environmentally-extended CGE model
- The effects of the policies as deviations from a baseline extending to 2040
- FINAGE model
  - A fairly standard, recursive, VU/MONASH-like AGE model of the Finnish economy
  - Current version of the model includes 93 industries and 144 commodities following NACE and CPA classifications

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Modelling waste management and recycling of plastic waste (1)

- Waste management is a rather large industry supplying
  - waste management services
  - district heat by incineration with energy recovery
  - recycling of wastes and manufacturing secondary materials
- Plastics in MSW and separately collected can be feedstock for
  - energy recovery
  - manufacturing secondary raw materials and supplying to market
- To ramp up secondary material manufacturing of plastics
  - Investments
  - Increased collection costs (to EPR partners and other “waste generators”)
  - Changes in intermediate use
  - Increased secondary raw material production

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Modelling waste management and recycling of plastic waste (2)

- Differentiated energy nest for waste management sector from other industries and included plastics as one energy/fuel type
  - Estimated the use via energy values and prices of alternative fuels (peat, coal)
- Modified supply (MAKE matrix) of waste management sector including secondary plastics (as plastic products)

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Environmental extensions

- Material flow accounting
  - Material-intensity coefficients (kg/€) for over 200 domestic, imported and exported products
  - Report extracted and imported material flows on basis of monetary changes in scenarios (no material-intensity changes in extraction or manufacturing assumed)
- Greenhouse gas emissions
  - Energy-based and non-energy-based GHG emission coefficients for products
  - Work in progress atm

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Scenario assumptions

	Scenario 1	Scenario 2	Scenario 3
Investments (181 M€ to WM, total)	X	X	X
Output (+97 M€ to WM, annual)	X	X	X
Intermediate use in WM (electricity and light fuel oil + 50-60%, annual)	X	X	X
Collection costs to plastic waste generators (+50 M€, annual)	X	X	X
Tax on incineration		X	X
Tax subsidy to domestic plastic products			X

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Scenario data

Variable/parameter	Amount	Unit
Collected plastic waste after CE actions	179,931	tons (annual)
Revenues from secondary plastic material after CE actions	97	M€ (annual)
Capacity investment for secondary material manufacturing	438	€ per treated waste ton
Capacity investment for MMW pretreatment	110	€ per treated waste ton
Collection and treatment costs of plastic waste (for other industries)	259	€ per ton (annual)

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Results

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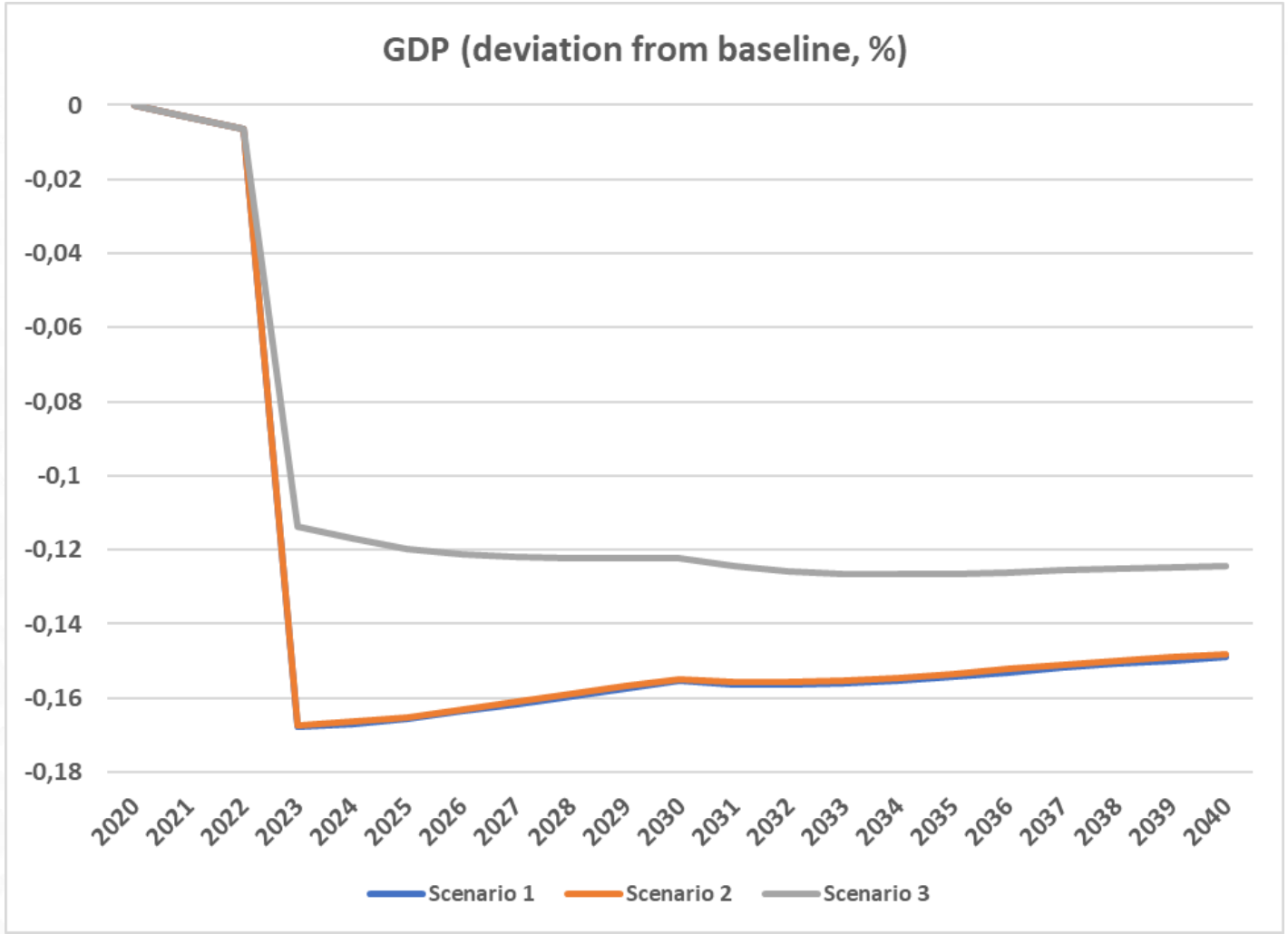
SYKE's Image Bank /
Wilma Hurskainen


GDP (deviation from baseline, %)
0
-0,02
-0,04
-0,06
-0,08
-0,1
-0,12
-0,14
-0,16
-0,18
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
Scenario 1
Scenario 2
Scenario 3

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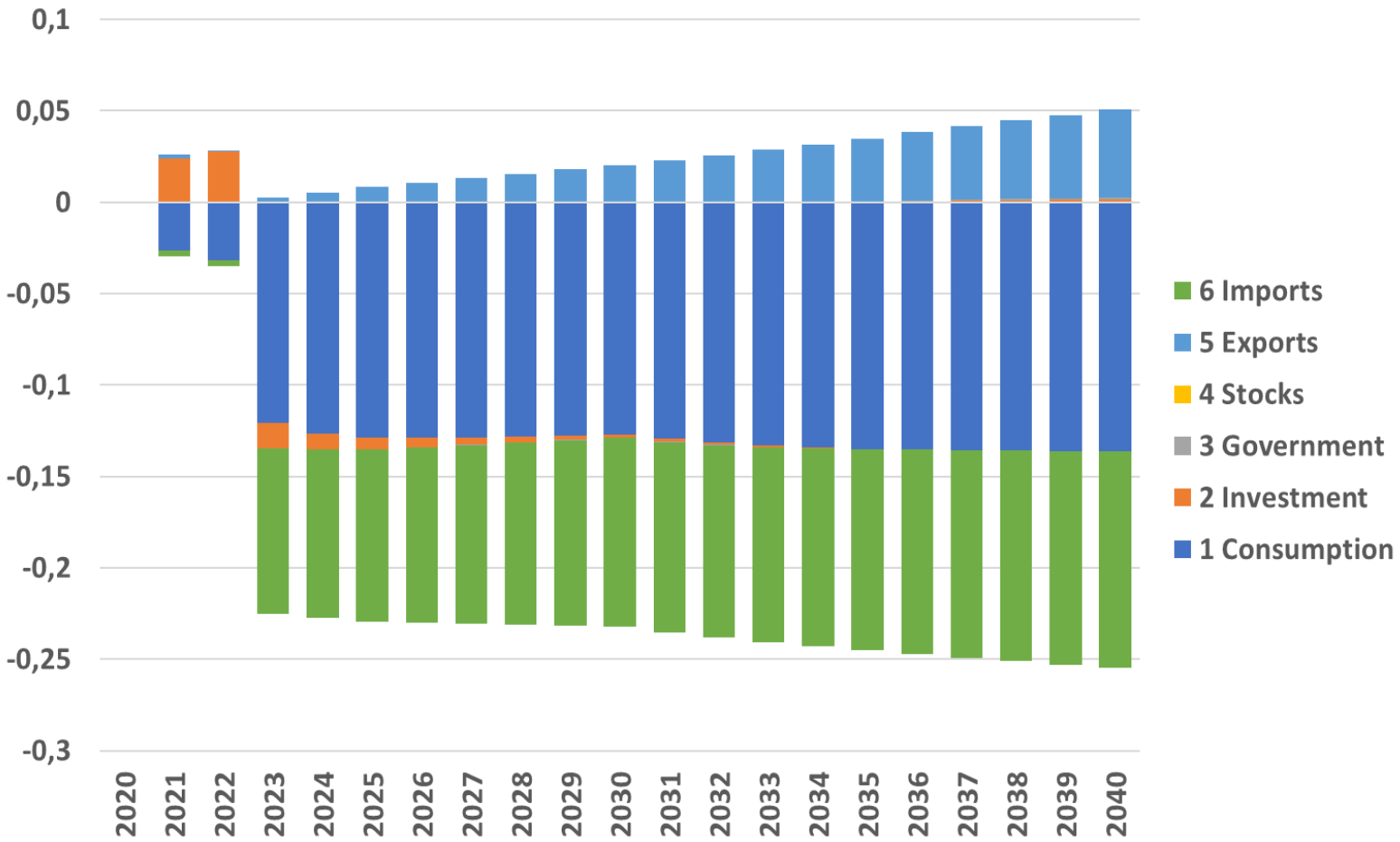
Scenario 1: Demand side decomposition (deviation from baseline, %)



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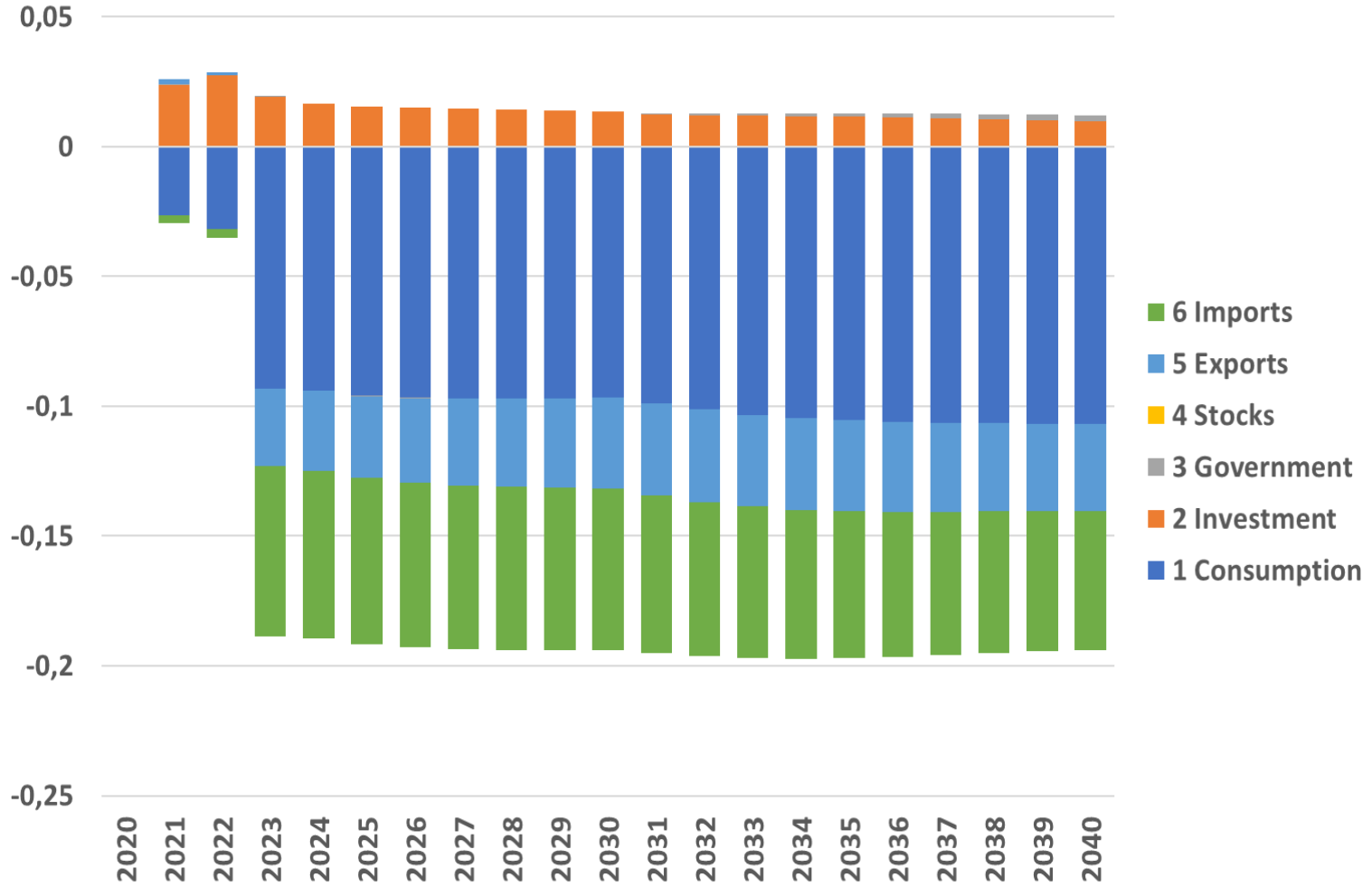
Scenario 3: Demand side decomposition (deviation from baseline, %)



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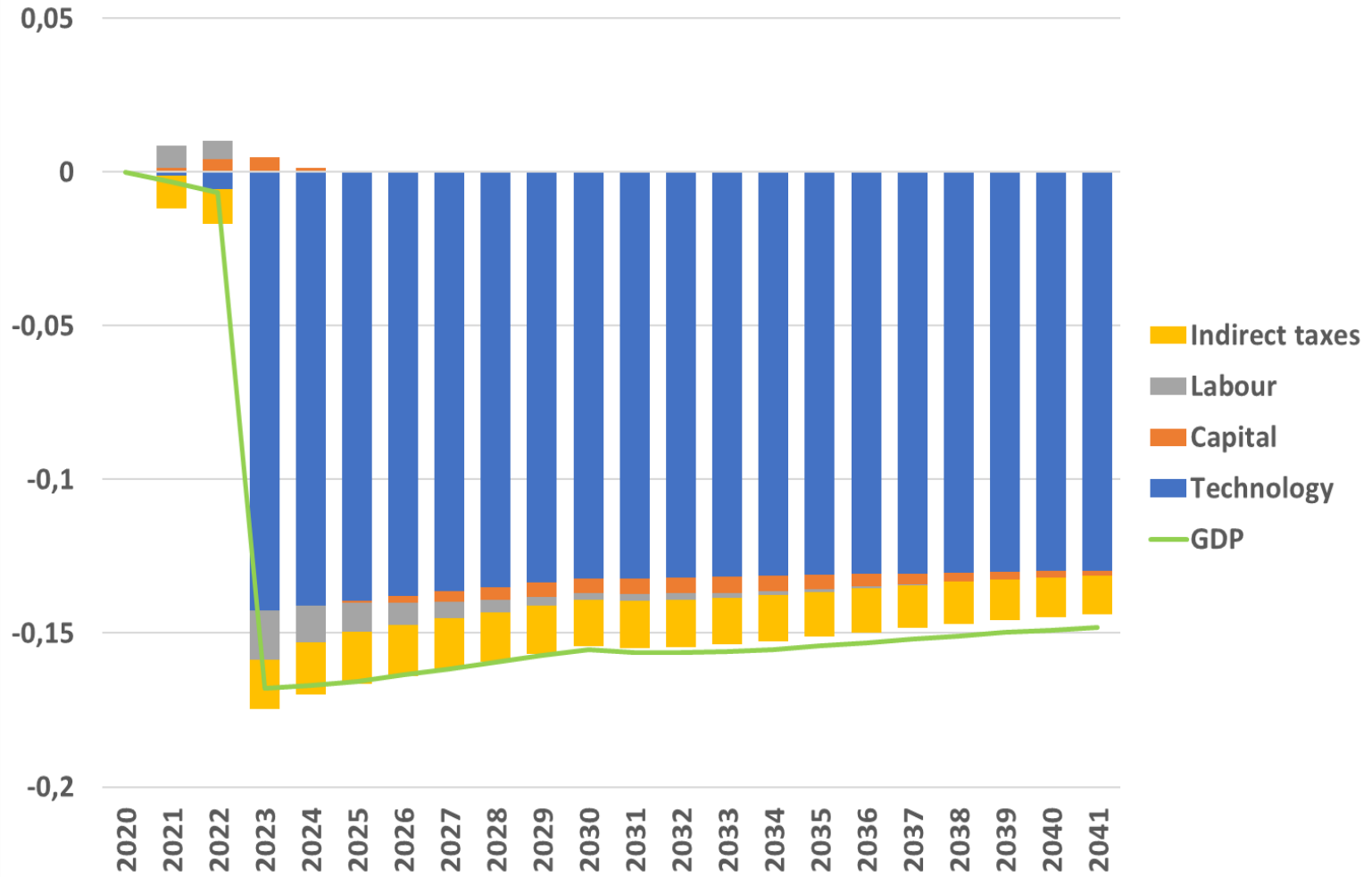
Scenario 1: Supply side decomposition (deviation from baseline, %)



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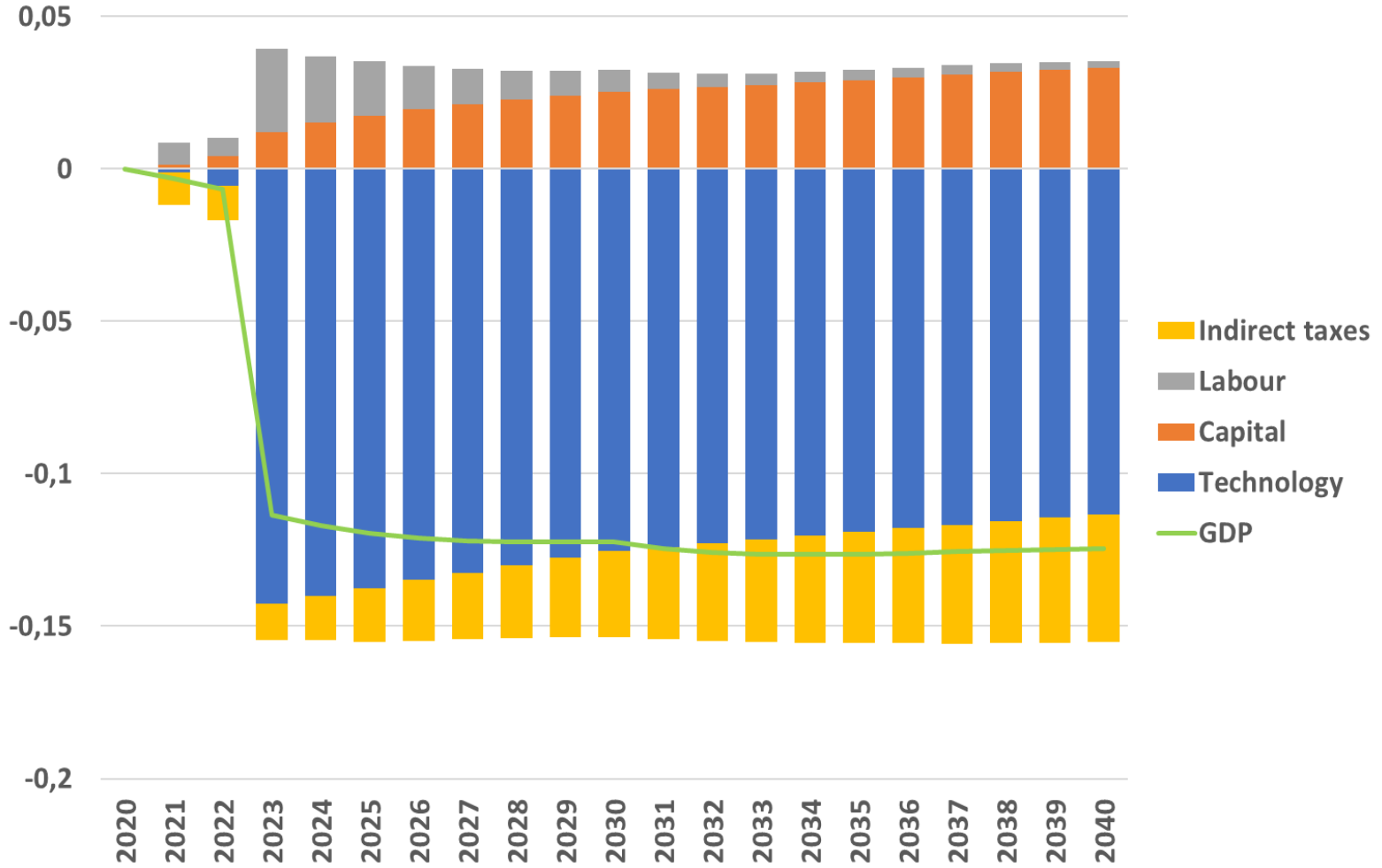
Scenario 3: Supply side decomposition (deviation from baseline, %)



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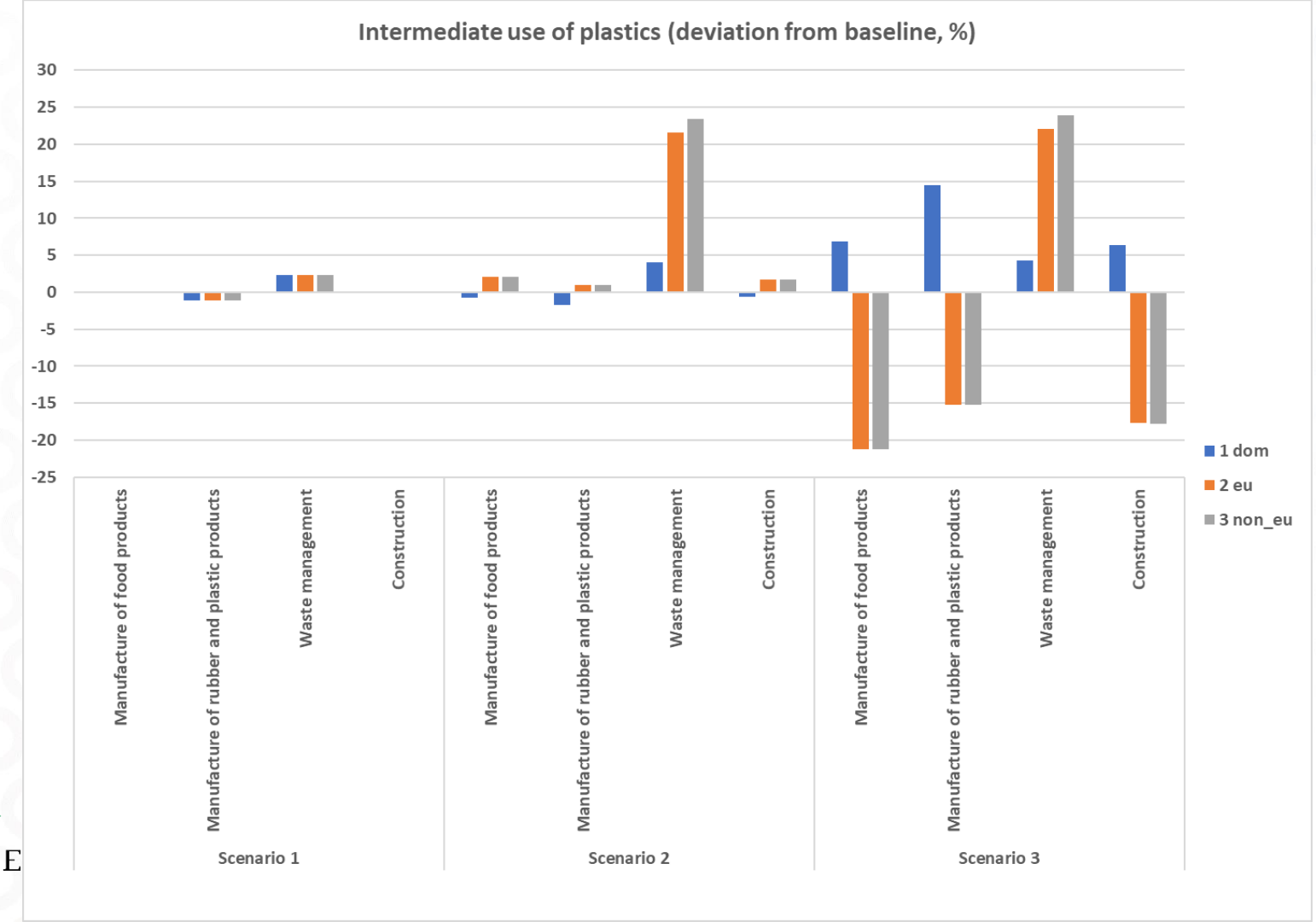
Intermediate use of plastics (deviation from baseline, %)
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
Manufacture of food products
Manufacture of rubber and plastic products
Waste management
Construction
Manufacture of food products
Manufacture of rubber and plastic products
Waste management
Construction
Manufacture of food products
Manufacture of rubber and plastic products
Waste management
Construction
Scenario 1
Scenario 2
Scenario 3
1 dom
2 eu
3 non_eu

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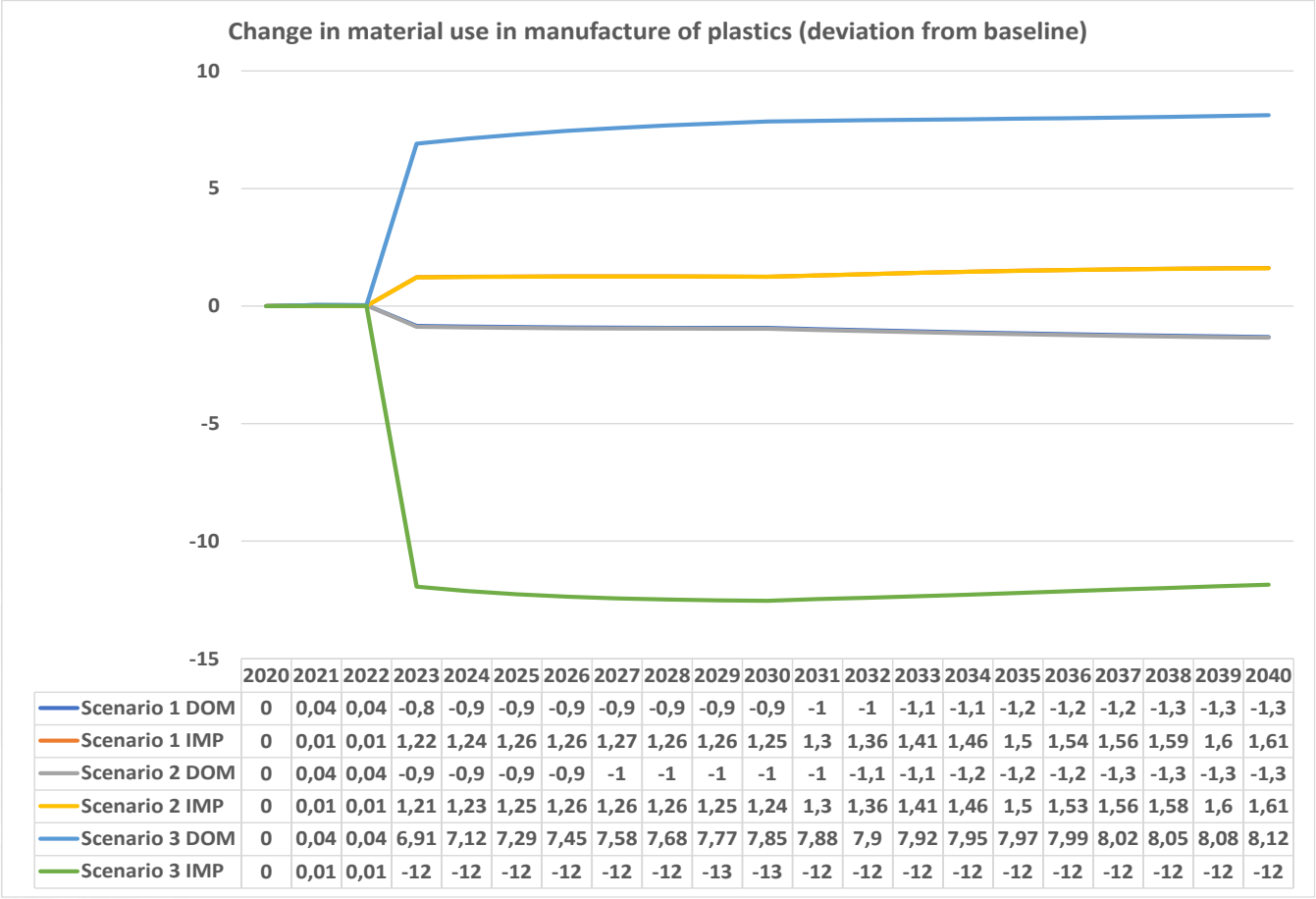
Impacts on material flows



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Scenario 1 DOM	0	0,04	0,04	-0,8	-0,9	-0,9	-0,9	-0,9	-0,9	-0,9	-0,9	-1	-1	-1,1	-1,1	-1,2	-1,2	-1,2	-1,3	-1,3	-1,3
Scenario 1 IMP	0	0,01	0,01	1,22	1,24	1,26	1,26	1,27	1,26	1,26	1,25	1,3	1,36	1,41	1,46	1,5	1,54	1,56	1,59	1,6	1,61
Scenario 2 DOM	0	0,04	0,04	-0,9	-0,9	-0,9	-0,9	-1	-1	-1	-1	-1	-1,1	-1,1	-1,2	-1,2	-1,2	-1,3	-1,3	-1,3	-1,3
Scenario 2 IMP	0	0,01	0,01	1,21	1,23	1,25	1,26	1,26	1,26	1,25	1,24	1,3	1,36	1,41	1,46	1,5	1,53	1,56	1,58	1,6	1,61
Scenario 3 DOM	0	0,04	0,04	6,91	7,12	7,29	7,45	7,58	7,68	7,77	7,85	7,88	7,9	7,92	7,95	7,97	7,99	8,02	8,05	8,08	8,12
Scenario 3 IMP	0	0,01	0,01	-12	-12	-12	-12	-12	-12	-13	-13	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12

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Discussion (1)

- Overall impacts of recycling plastic wastes
  - Effect on GDP negative (subsidies, additional costs)
  - New value chains can’t cover additional costs
  - Internalisation of environmental costs?
  - Effects on material flows positive
  - Effects on GHG emissions positive (decrease, to be modelled)

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Discussion (2)

- Limitations and uncertainties
  - Modelling CE actions requires a certain level of detailedness!
  - Input data of policy scenarios (how to “monetize” absent flows)
  - Demand and markets for secondary raw materials of plastics

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Further steps

- Sensitivity analysis of tax levels
- Identification of ”winners and losers” (industries)
- Analysis of raw material aggregates
- Completing of greenhouse gas emissions calculation
- Systematic comparison of economic and environmental effects

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Thank you!

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