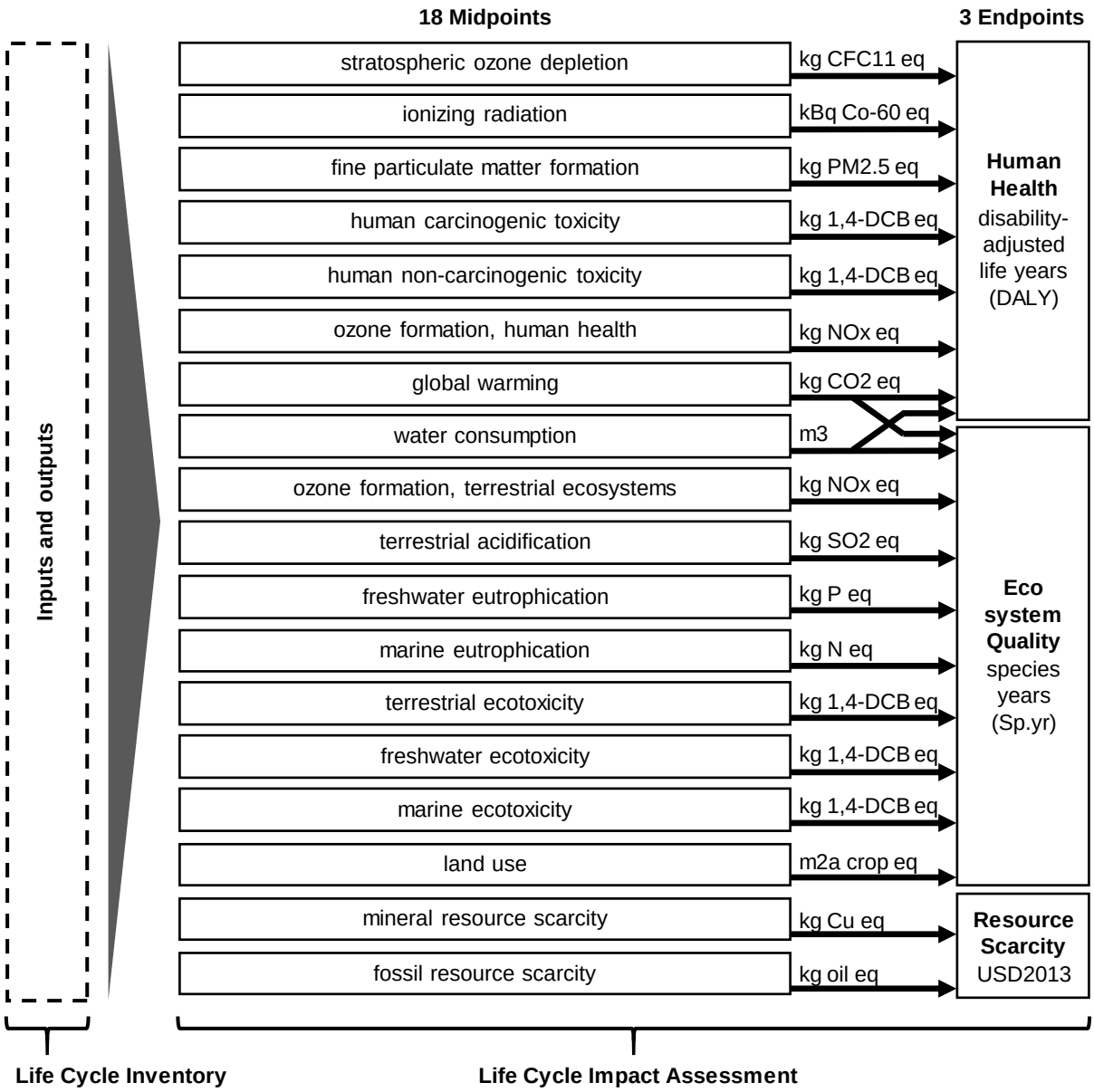
Economic and Environmental Benefits of Recovery Networks for WEEE in Europe

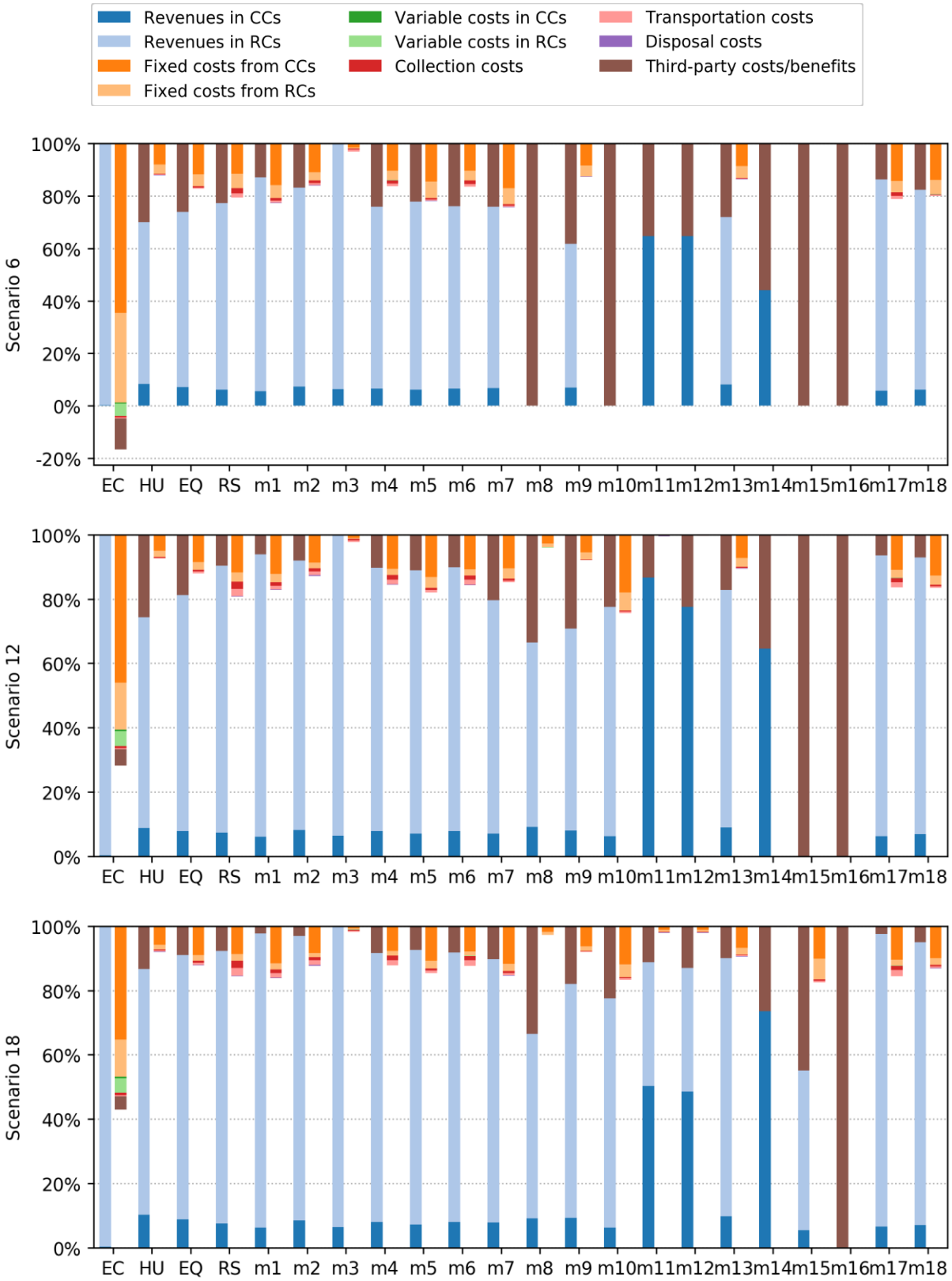
Lukas Messmann, Christoph Helbig, Andrea Thorenz, Axel Tuma

--- Supplementary figures ---

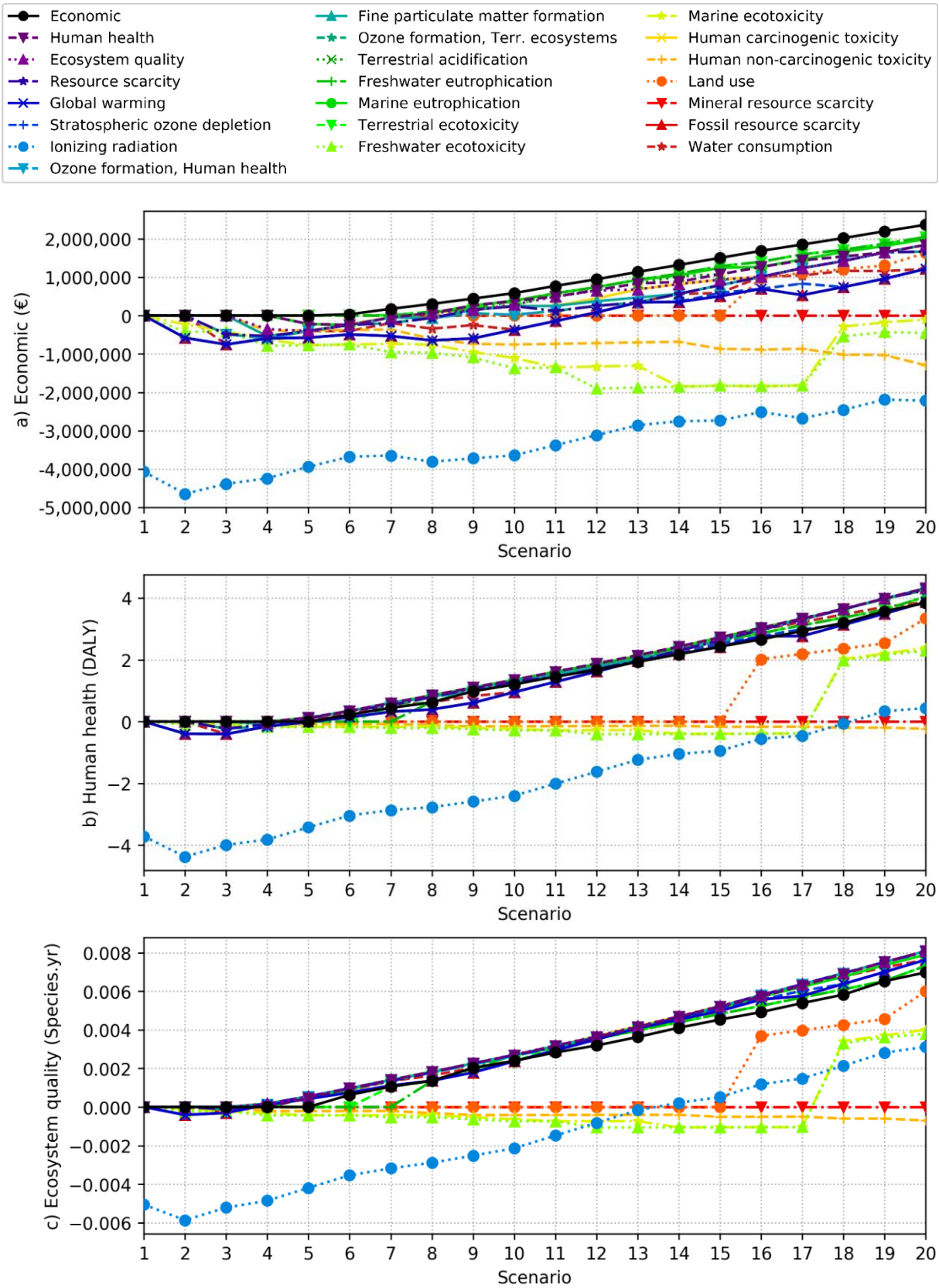
Supplementary figure S1. Composition of environmental objectives within the LCIA as defined by Huijbregts et al. (2017)

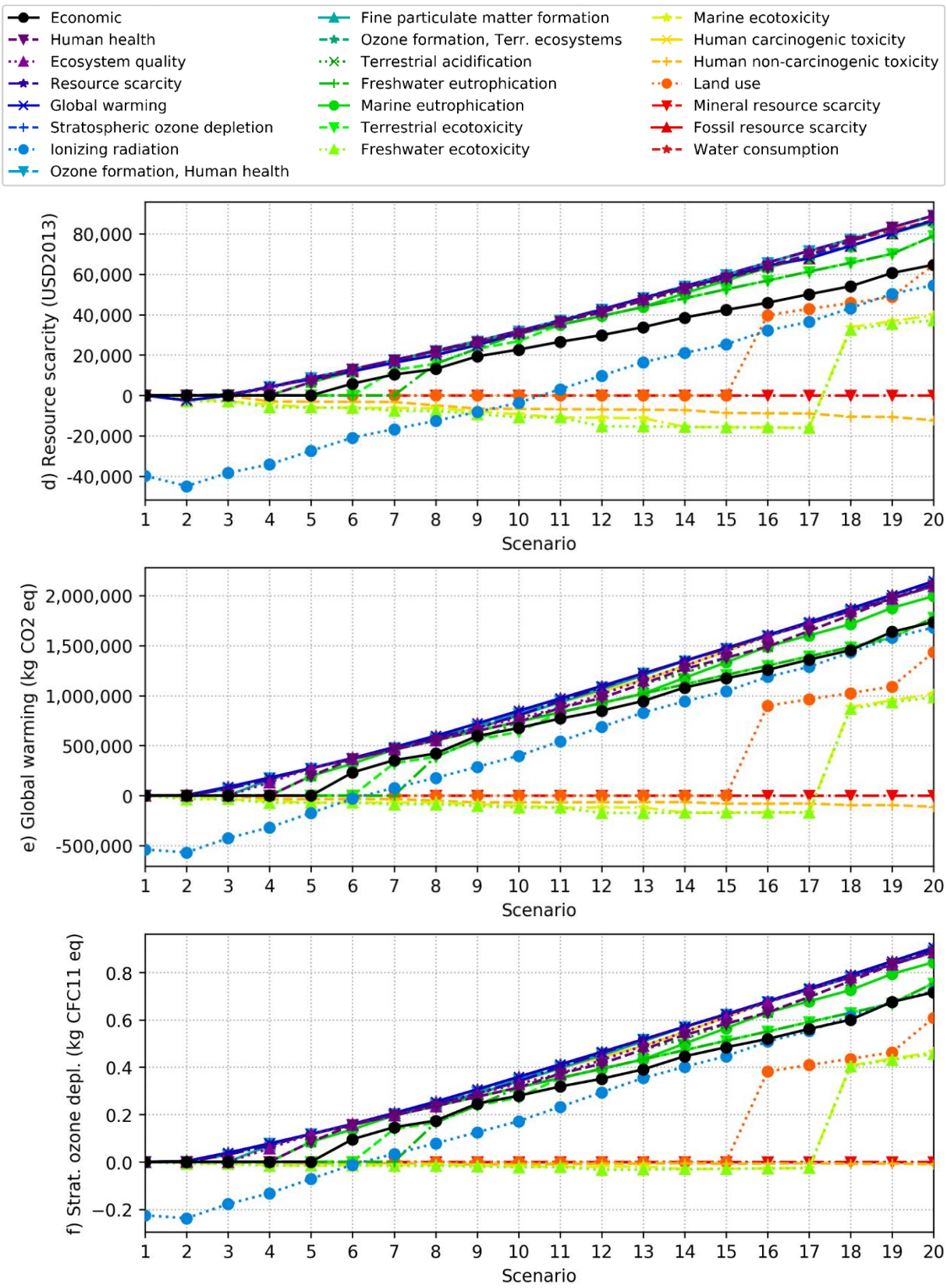


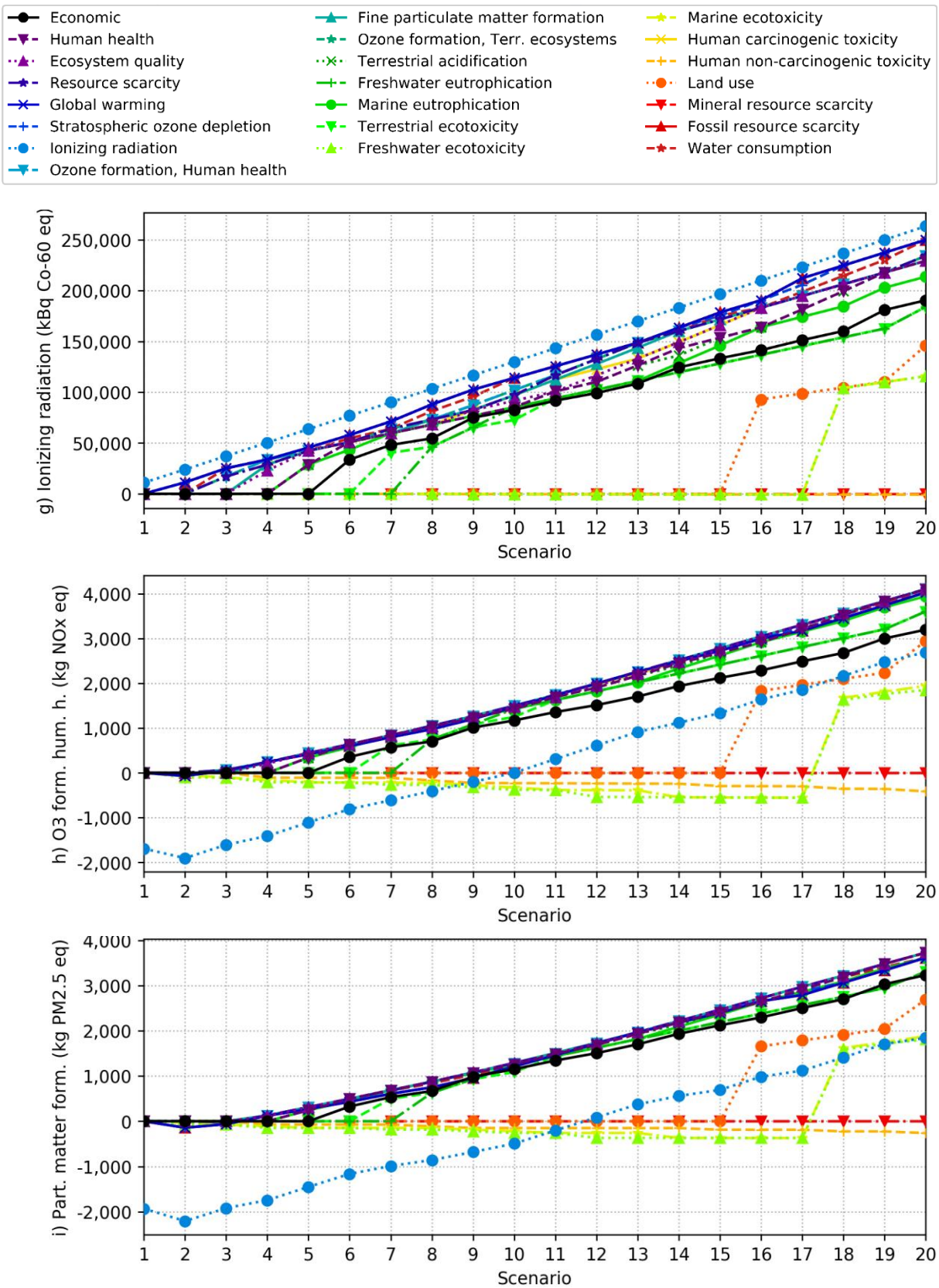
Supplementary figure S2 a–c. Relative composition of objective values for each dimension in scenarios 6, 12, and 18



Supplementary figure S3 a–v. Effects of different objective functions (legend) on each dimension (ordinates)




Economic
Human health
Ecosystem quality
Resource scarcity
Global warming
Stratospheric ozone depletion
Ionizing radiation
Ozone formation, Human health
Fine particulate matter formation
Ozone formation, Terr. ecosystems
Terrestrial acidification
Freshwater eutrophication
Marine eutrophication
Terrestrial ecotoxicity
Freshwater ecotoxicity
Marine ecotoxicity
Human carcinogenic toxicity
Human non-carcinogenic toxicity
Land use
Mineral resource scarcity
Fossil resource scarcity
Water consumption
d) Resource scarcity (USD2013)
80,000
60,000
40,000
20,000
0
-20,000
-40,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Scenario
e) Global warming (kg CO2 eq)
2,000,000
1,500,000
1,000,000
500,000
0
-500,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Scenario
f) Strat. ozone depl. (kg CFC11 eq)
0.8
0.6
0.4
0.2
0.0
−0.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Scenario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Human health
Ecosystem quality
Resource scarcity
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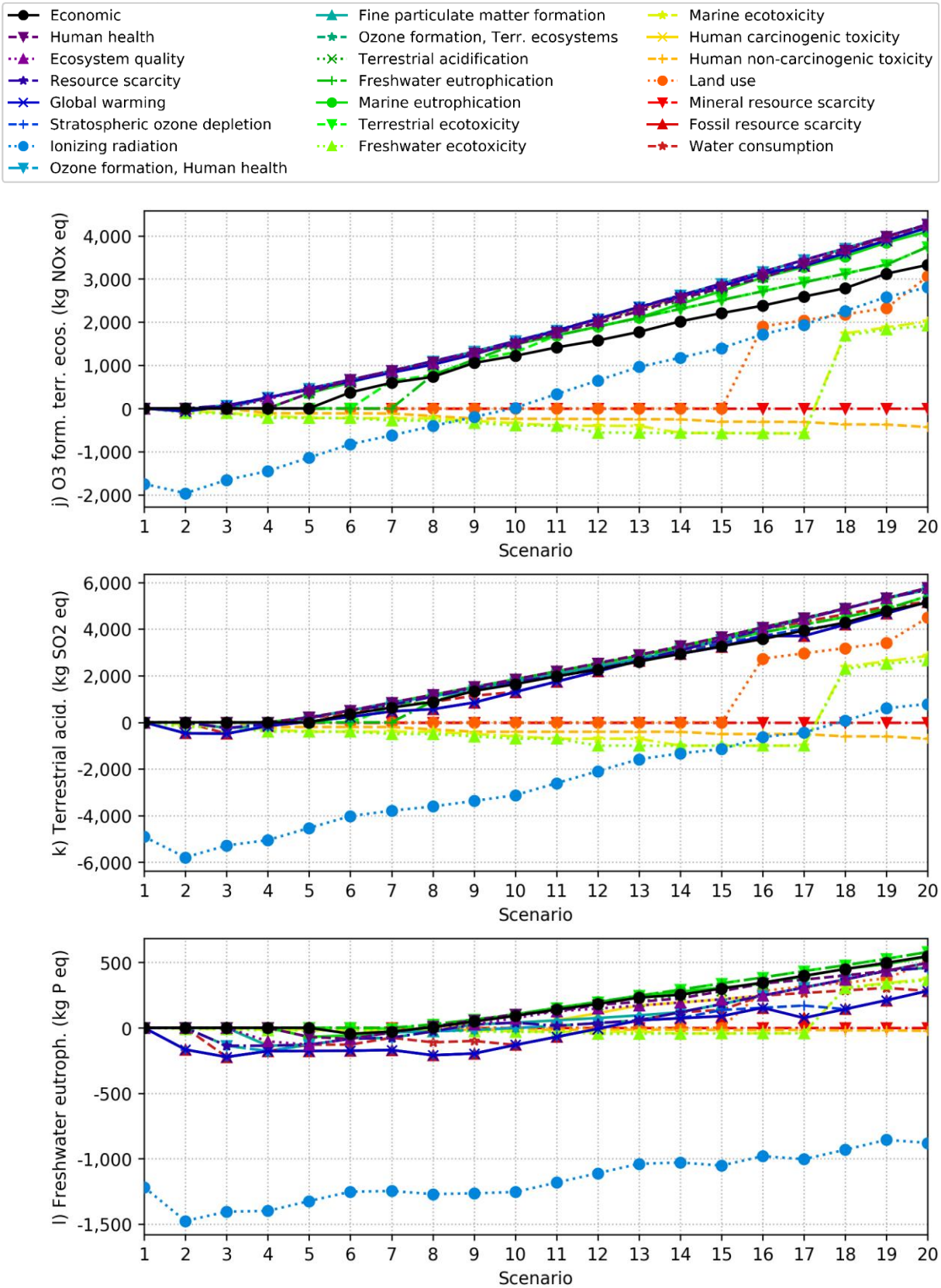
Terrestrial ecotoxicity
Freshwater ecotoxicity
Marine ecotoxicity
Human carcinogenic toxicity
Human non-carcinogenic toxicity
Land use
Mineral resource scarcity
Fossil resource scarcity
Water consumption
g) Ionizing radiation (kBq Co-60 eq)
h) O3 form. hum. h. (kg NOx eq)
i) Part. matter form. (kg PM2.5 eq)
Scenario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Resource scarcity
Global warming
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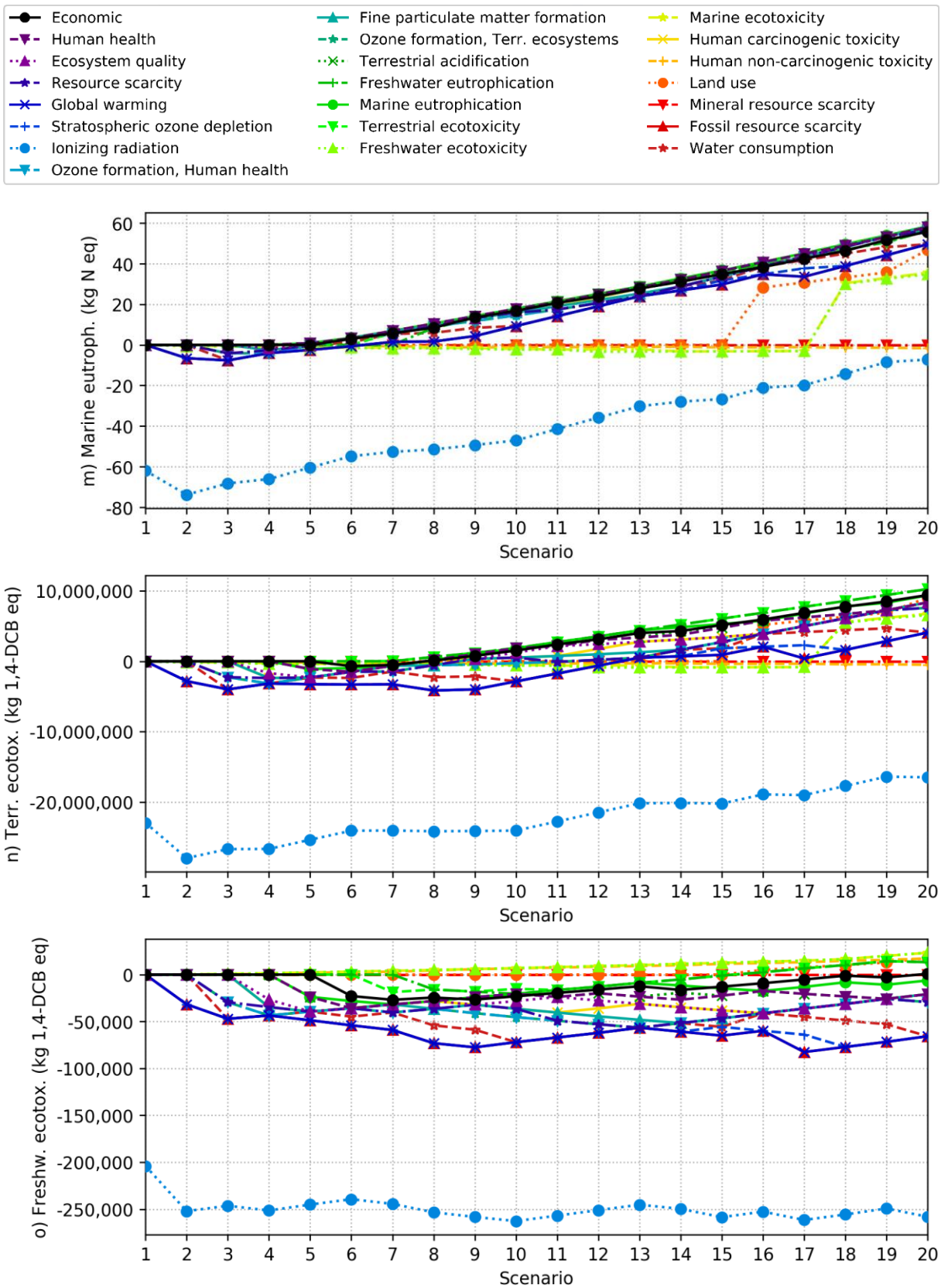
Freshwater ecotoxicity
Marine ecotoxicity
Human carcinogenic toxicity
Human non-carcinogenic toxicity
Land use
Mineral resource scarcity
Fossil resource scarcity
Water consumption
j) O3 form. terr. ecos. (kg NOx eq)
k) Terrestrial acid. (kg SO2 eq)
l) Freshwater eutroph. (kg P eq)
Scenario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Resource scarcity
Global warming
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Ozone formation, Human health
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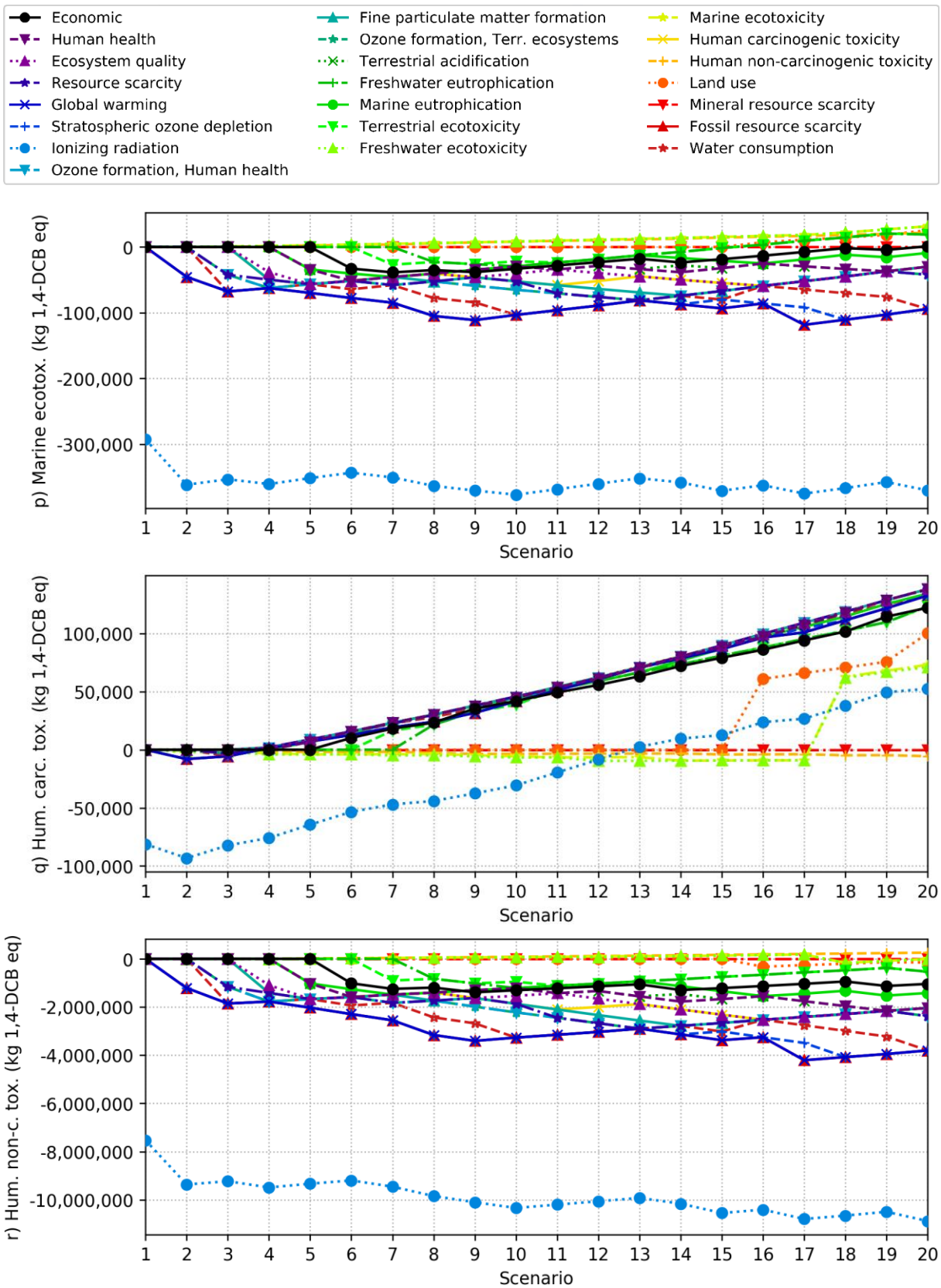
Marine eutrophication
Terrestrial ecotoxicity
Freshwater ecotoxicity
Marine ecotoxicity
Human carcinogenic toxicity
Human non-carcinogenic toxicity
Land use
Mineral resource scarcity
Fossil resource scarcity
Water consumption
m) Marine eutroph. (kg N eq)
n) Terr. ecotox. (kg 1,4-DCB eq)
o) Freshw. ecotox. (kg 1,4-DCB eq)
Scenario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Global warming
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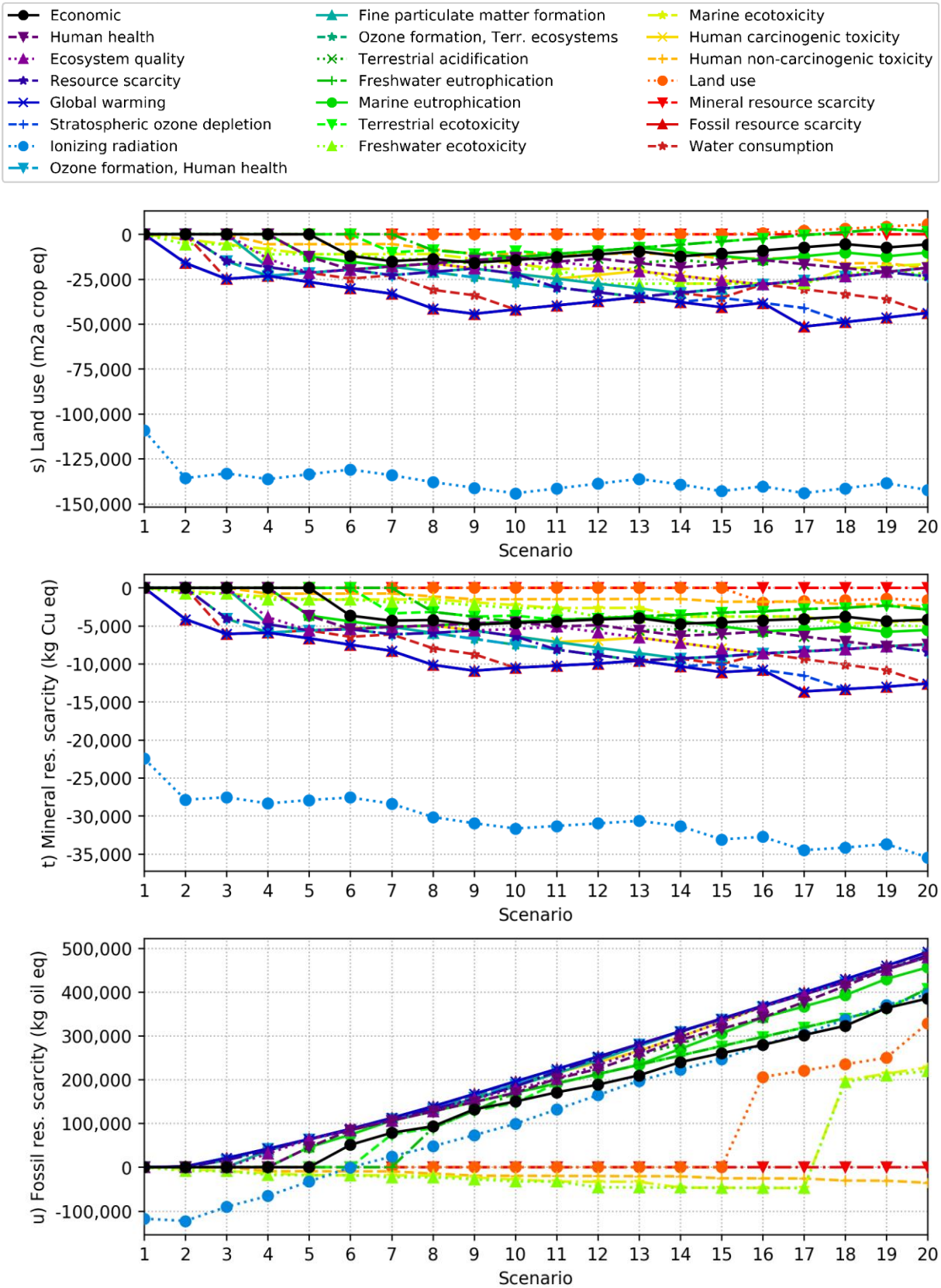
Ionizing radiation
Ozone formation, Human health
Fine particulate matter formation
Ozone formation, Terr. ecosystems
Terrestrial acidification
Freshwater eutrophication
Marine eutrophication
Terrestrial ecotoxicity
Freshwater ecotoxicity
Marine ecotoxicity
Human carcinogenic toxicity
Human non-carcinogenic toxicity
Land use
Mineral resource scarcity
Fossil resource scarcity
Water consumption
p) Marine ecotox. (kg 1,4-DCB eq)
0
-100,000
-200,000
-300,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Scenario
q) Hum. carc. tox. (kg 1,4-DCB eq)
100,000
50,000
0
-50,000
-100,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Scenario
r) Hum. non-c. tox. (kg 1,4-DCB eq)
0
-2,000,000
-4,000,000
-6,000,000
-8,000,000
-10,000,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Scenario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Resource scarcity
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Fine particulate matter formation
Ozone formation, Terr. ecosystems
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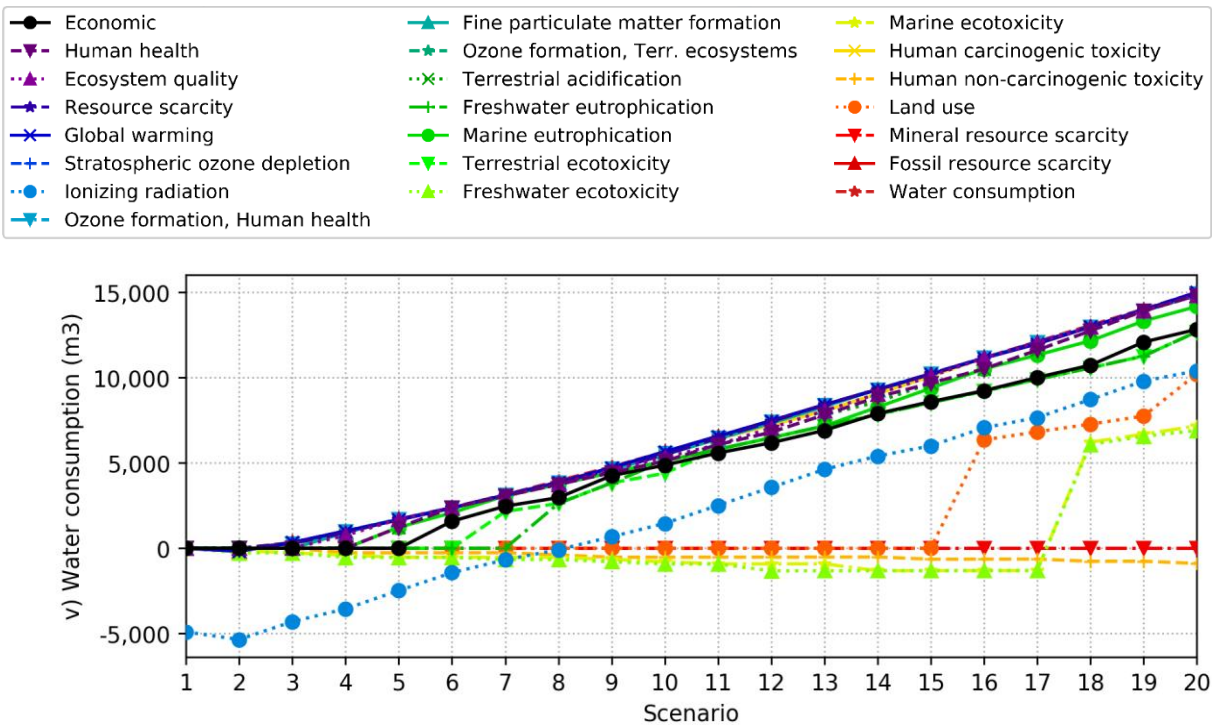
Freshwater eutrophication
Marine eutrophication
Terrestrial ecotoxicity
Freshwater ecotoxicity
Marine ecotoxicity
Human carcinogenic toxicity
Human non-carcinogenic toxicity
Land use
Mineral resource scarcity
Fossil resource scarcity
Water consumption
s) Land use (m2a crop eq)
t) Mineral res. scarcity (kg Cu eq)
u) Fossil res. scarcity (kg oil eq)
Scenario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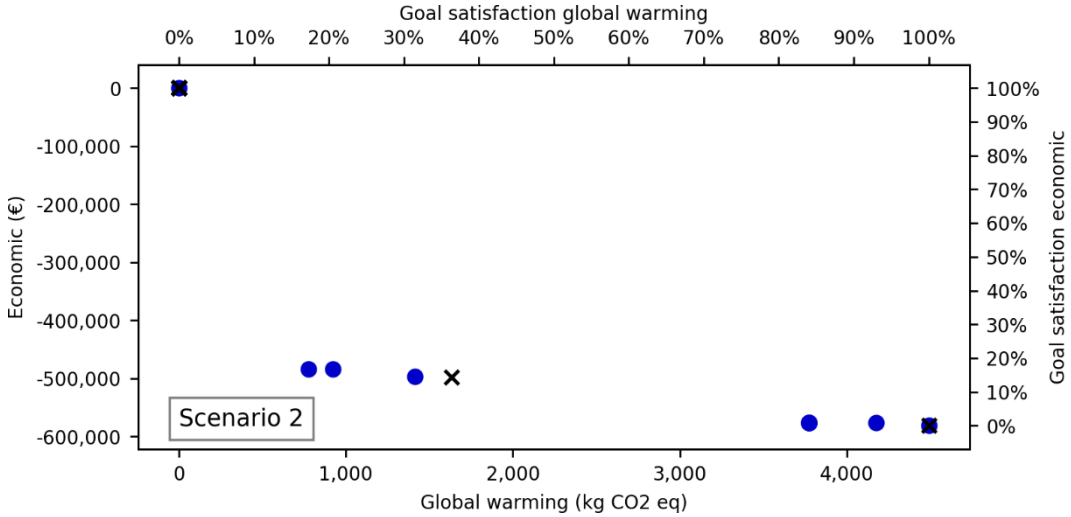
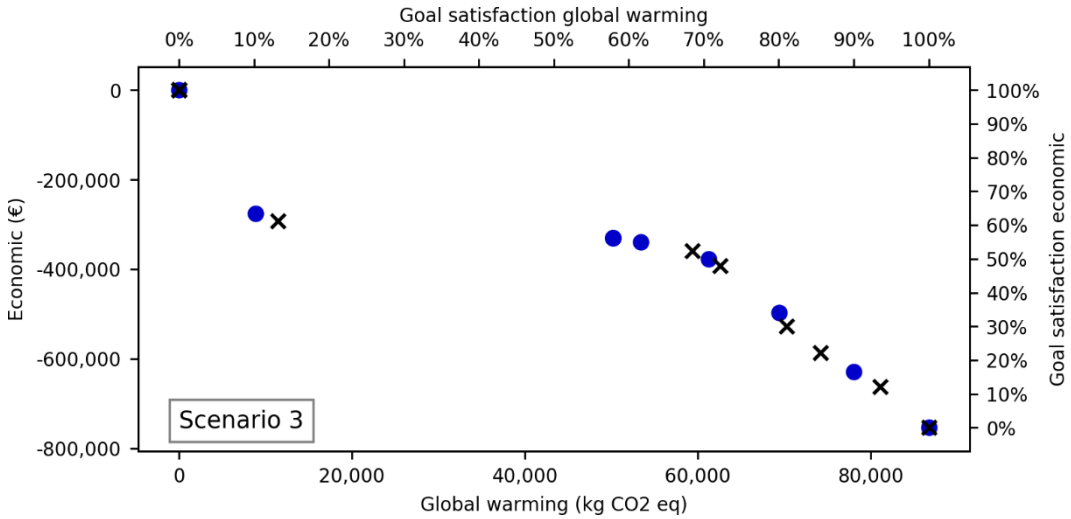
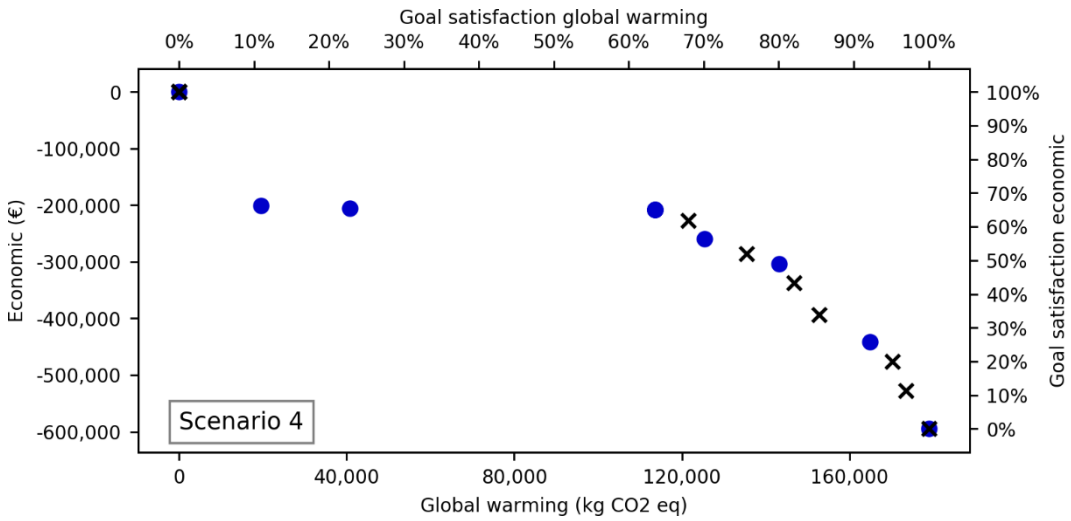
Ecosystem quality
Resource scarcity
Global warming
Stratospheric ozone depletion
Ionizing radiation
Ozone formation, Human health
Fine particulate matter formation
Ozone formation, Terr. ecosystems
Terrestrial acidification
Freshwater eutrophication
Marine eutrophication
Terrestrial ecotoxicity
Freshwater ecotoxicity
Marine ecotoxicity
Human carcinogenic toxicity
Human non-carcinogenic toxicity
Land use
Mineral resource scarcity
Fossil resource scarcity
Water consumption
v) Water consumption (m3)
15,000
10,000
5,000
0
-5,000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Scenario

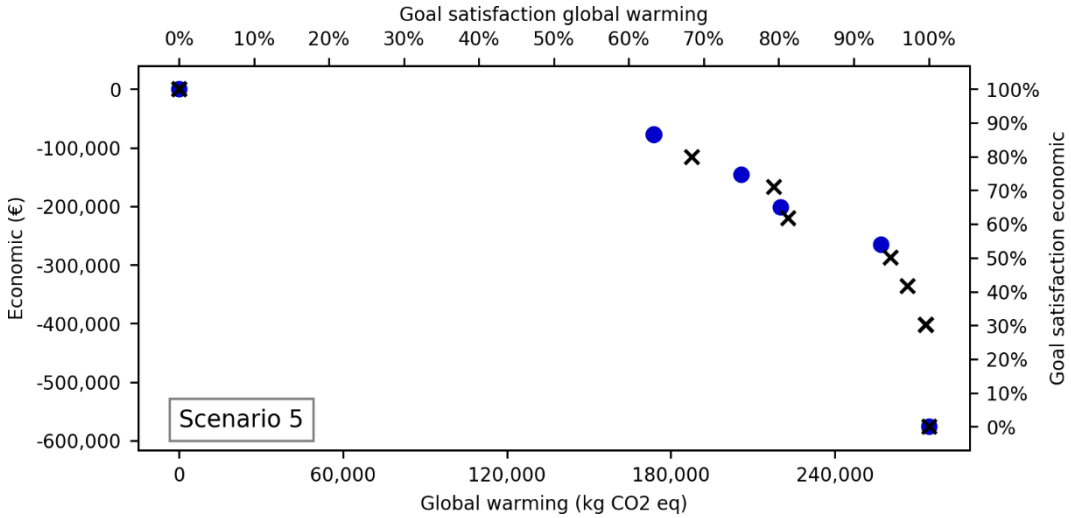
Supplementary figure S4 a–s. Pareto-optimal frontier for economic optimization with global warming constraint (circles), and global warming optimization with economic constraint (crosses) for scenarios 2 to 20

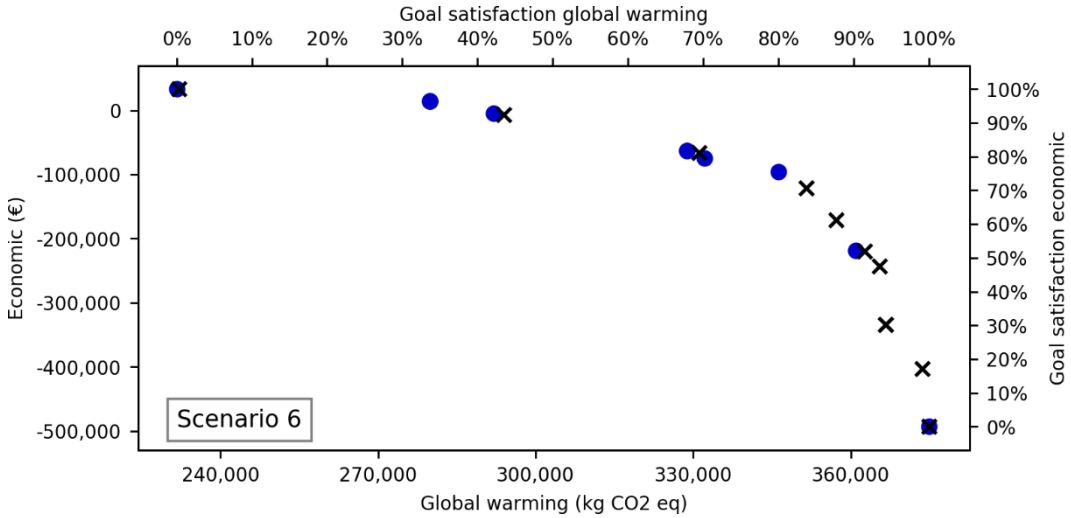
Scenario 1 is omitted. No frontier exists, since all solutions are equal (0).

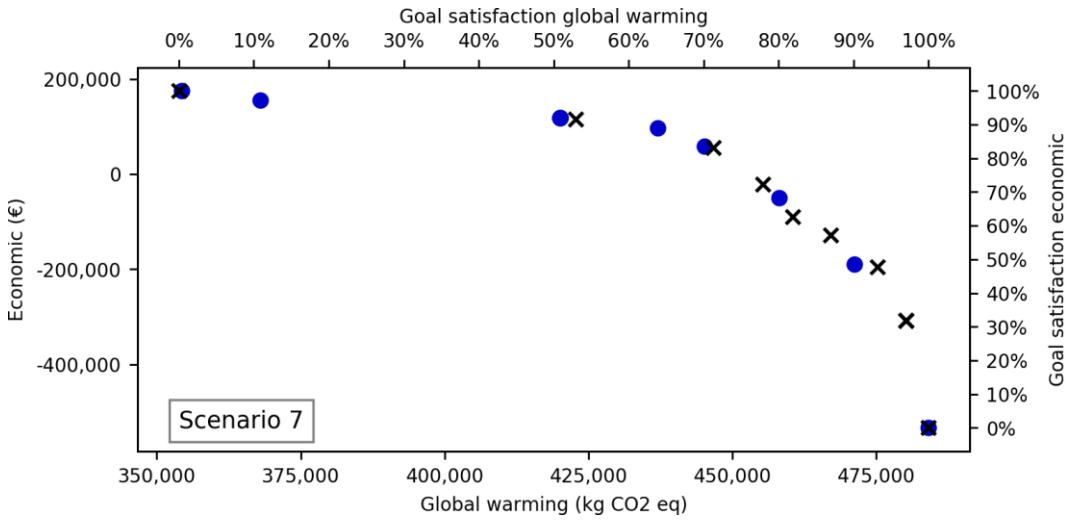


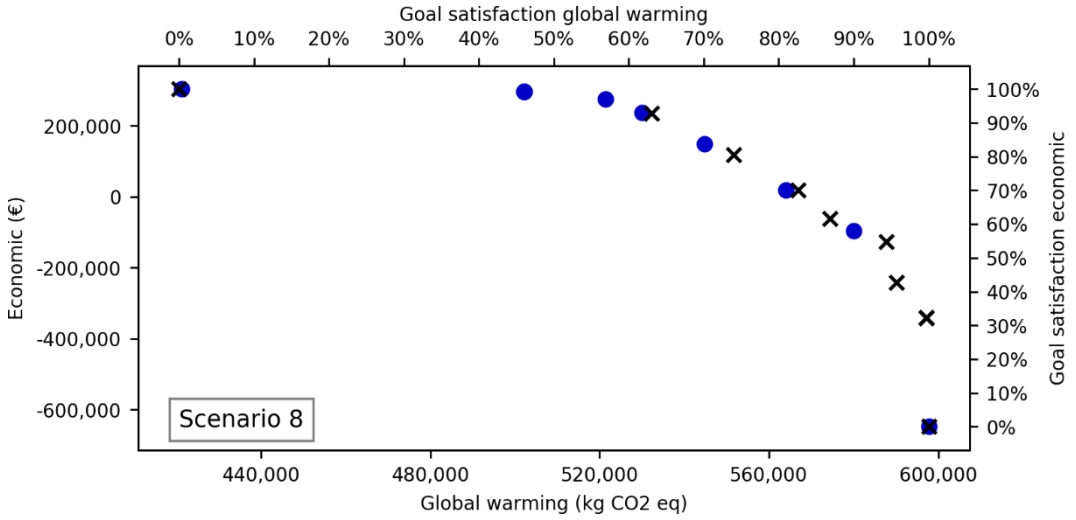


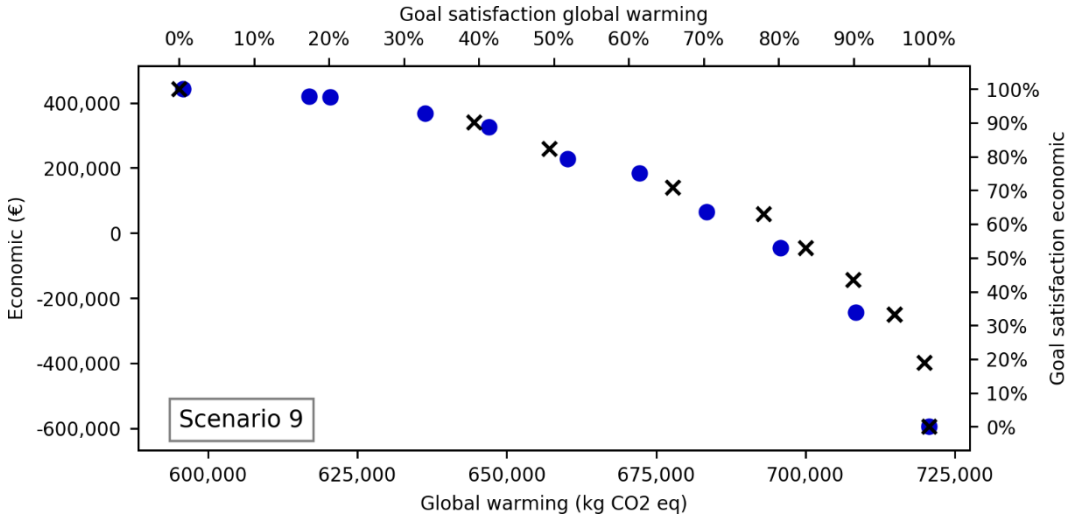


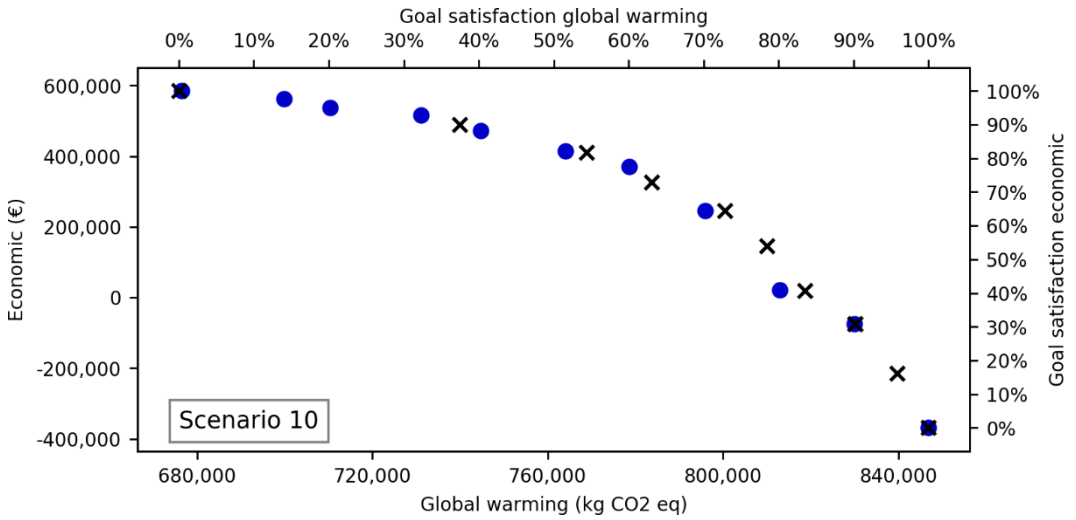

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
0
-100,000
-200,000
-300,000
-400,000
-500,000
-600,000
Goal satisfaction economic
Scenario 5
0
60,000
120,000
180,000
240,000
Global warming (kg CO2 eq)

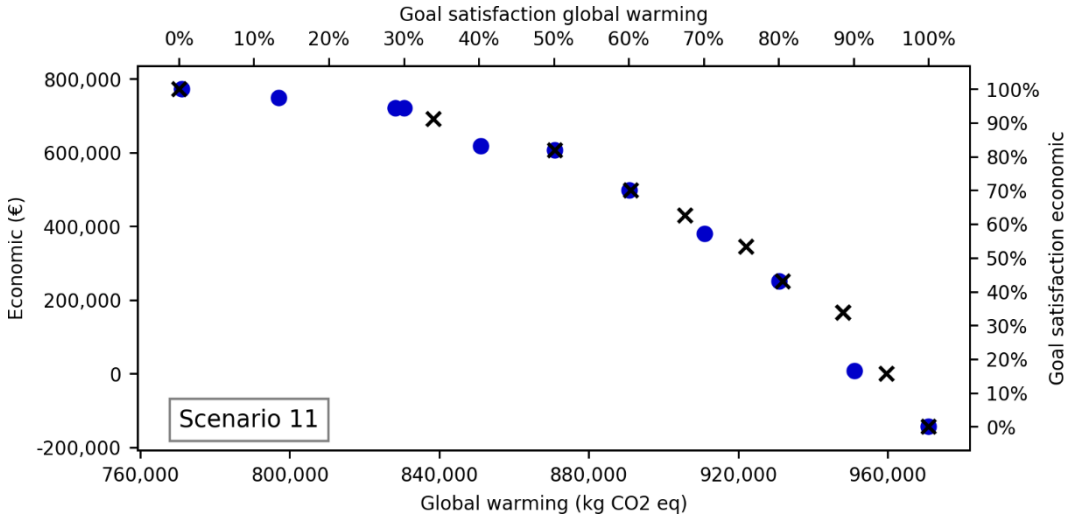

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
0
-100,000
-200,000
-300,000
-400,000
-500,000
Goal satisfaction economic
Scenario 6
240,000
270,000
300,000
330,000
360,000
Global warming (kg CO2 eq)

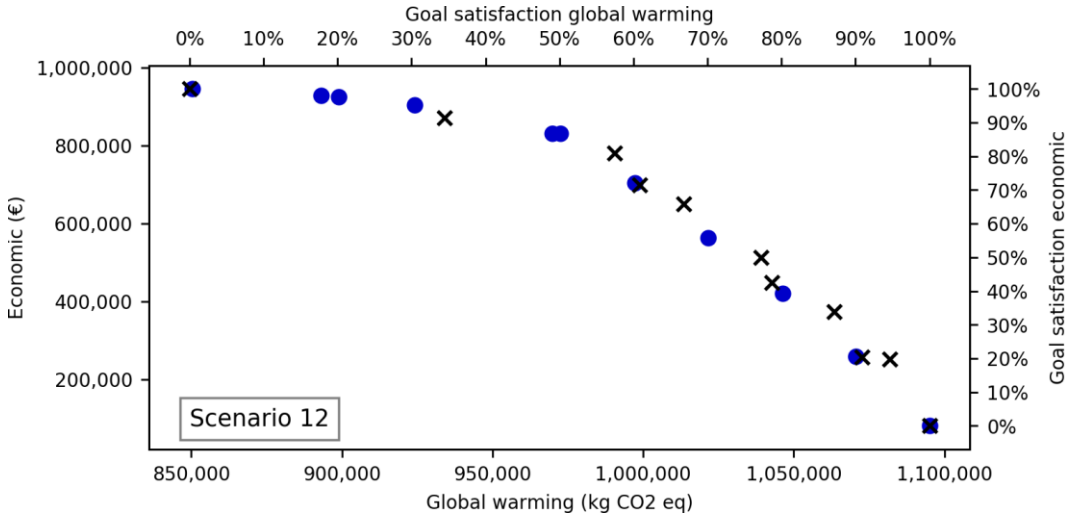

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
200,000
0
-200,000
-400,000
Goal satisfaction economic
Scenario 7
350,000
375,000
400,000
425,000
450,000
475,000
Global warming (kg CO2 eq)

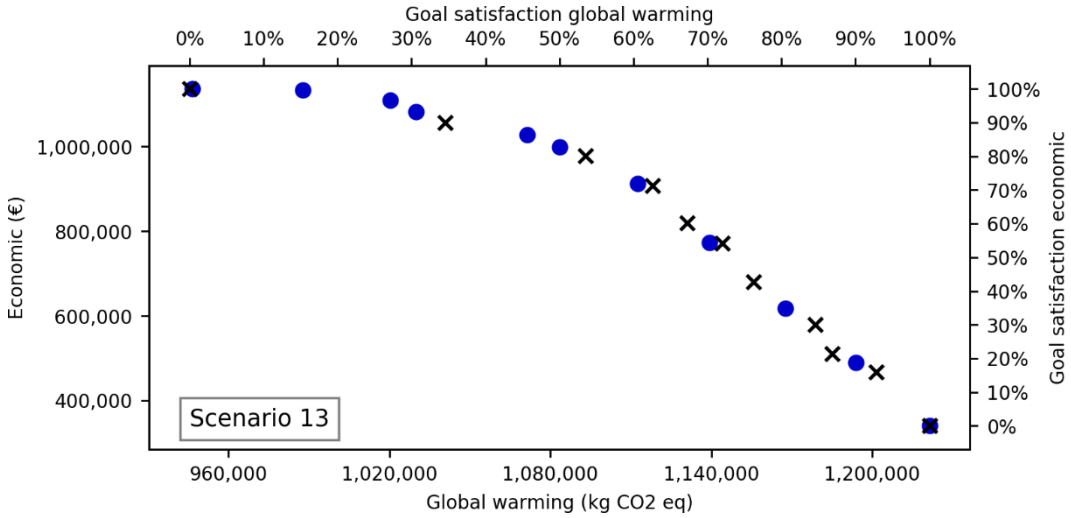

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
200,000
0
-200,000
-400,000
-600,000
Goal satisfaction economic
Scenario 8
440,000
480,000
520,000
560,000
600,000
Global warming (kg CO2 eq)

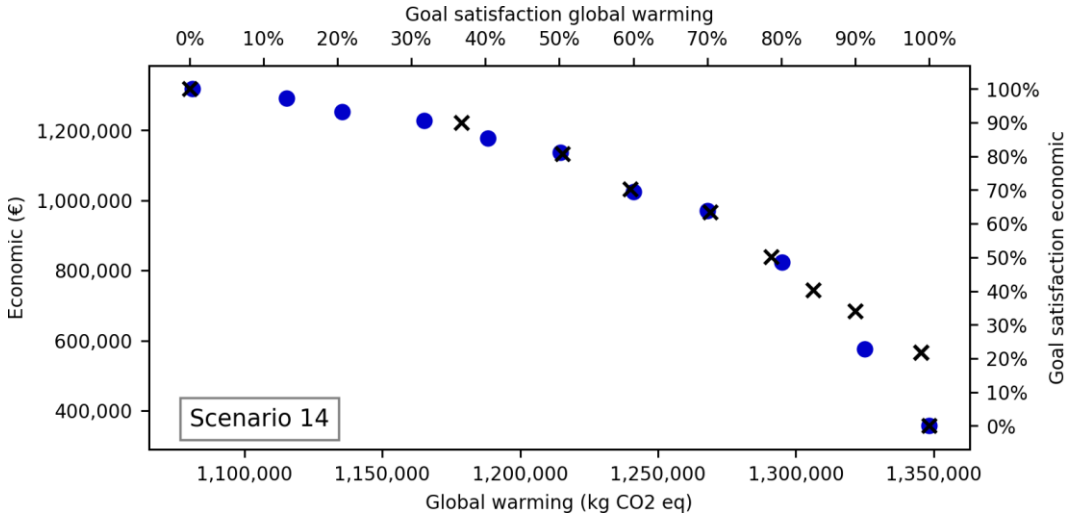

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
400,000
200,000
0
-200,000
-400,000
-600,000
Goal satisfaction economic
Scenario 9
600,000
625,000
650,000
675,000
700,000
725,000
Global warming (kg CO2 eq)

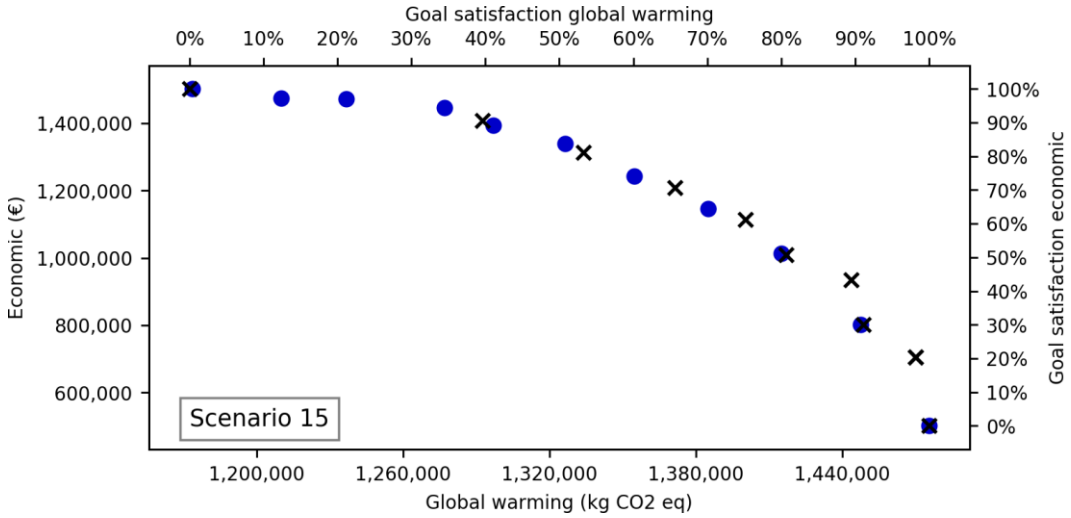

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
600,000
400,000
200,000
0
-200,000
-400,000
Goal satisfaction economic
Scenario 10
680,000
720,000
760,000
800,000
840,000
Global warming (kg CO2 eq)

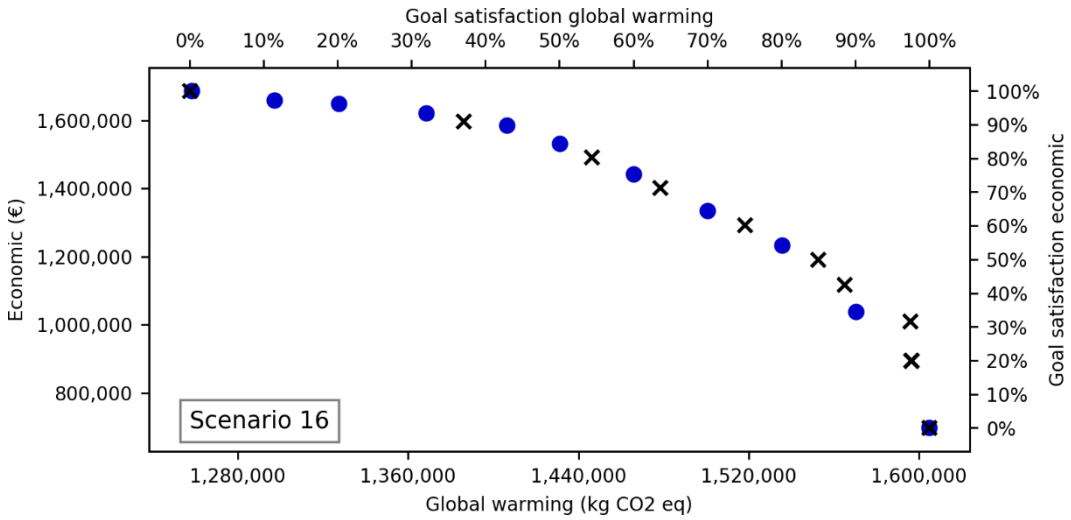

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
800,000
600,000
400,000
200,000
0
-200,000
Economic (€)
Scenario 11
760,000
800,000
840,000
880,000
920,000
960,000
Global warming (kg CO2 eq)
Goal satisfaction economic

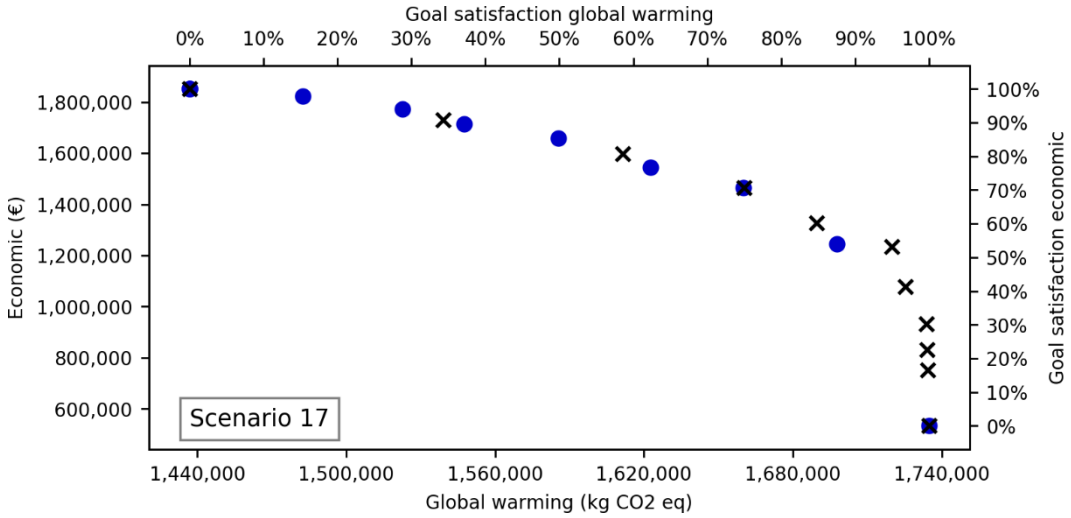

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1,000,000
800,000
600,000
400,000
200,000
Economic (€)
Scenario 12
850,000
900,000
950,000
1,000,000
1,050,000
1,100,000
Global warming (kg CO2 eq)
Goal satisfaction economic

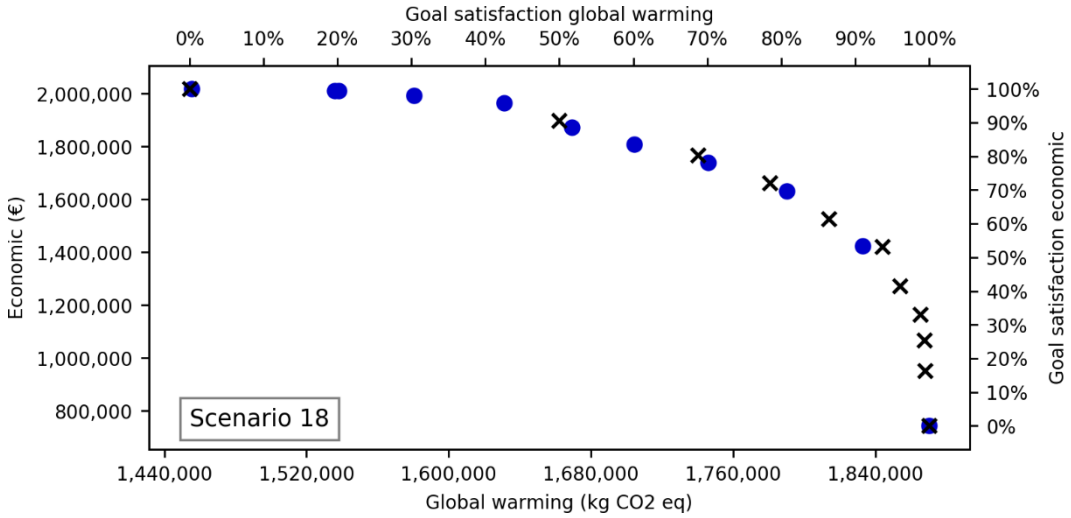

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1,000,000
800,000
600,000
400,000
Economic (€)
Scenario 13
960,000
1,020,000
1,080,000
1,140,000
1,200,000
Global warming (kg CO2 eq)
Goal satisfaction economic

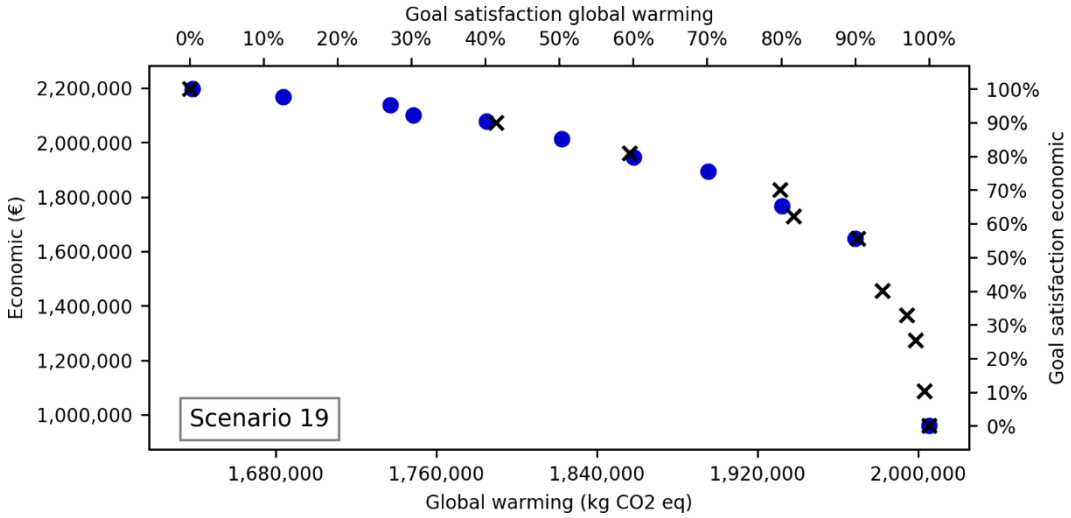

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,200,000
1,000,000
800,000
600,000
400,000
Scenario 14
1,100,000
1,150,000
1,200,000
1,250,000
1,300,000
1,350,000
Global warming (kg CO2 eq)
Goal satisfaction economic

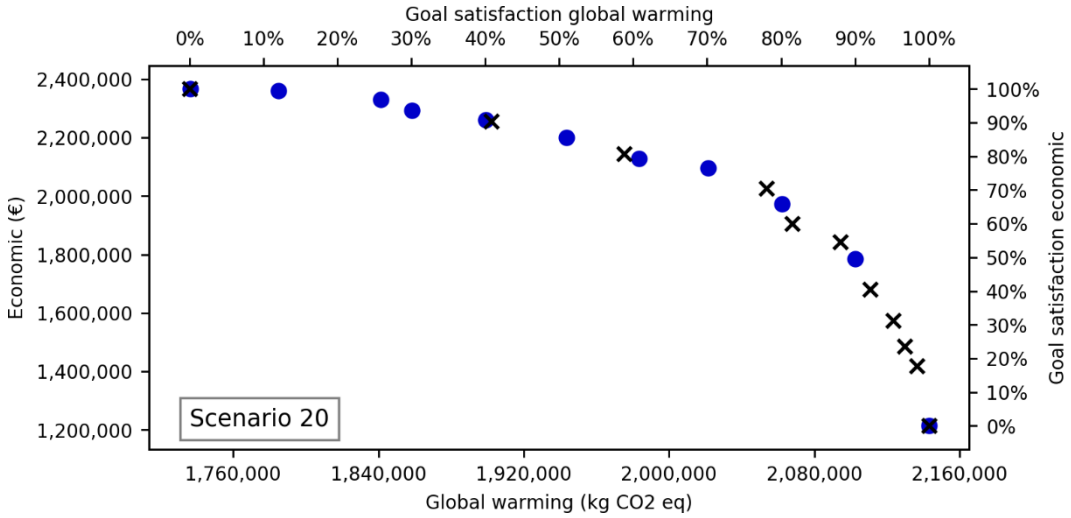

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,400,000
1,200,000
1,000,000
800,000
600,000
Scenario 15
1,200,000
1,260,000
1,320,000
1,380,000
1,440,000
Global warming (kg CO2 eq)
Goal satisfaction economic


Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,600,000
1,400,000
1,200,000
1,000,000
800,000
Scenario 16
1,280,000
1,360,000
1,440,000
1,520,000
1,600,000
Global warming (kg CO2 eq)
Goal satisfaction economic


Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
Scenario 17
1,440,000
1,500,000
1,560,000
1,620,000
1,680,000
1,740,000
Global warming (kg CO2 eq)
Goal satisfaction economic

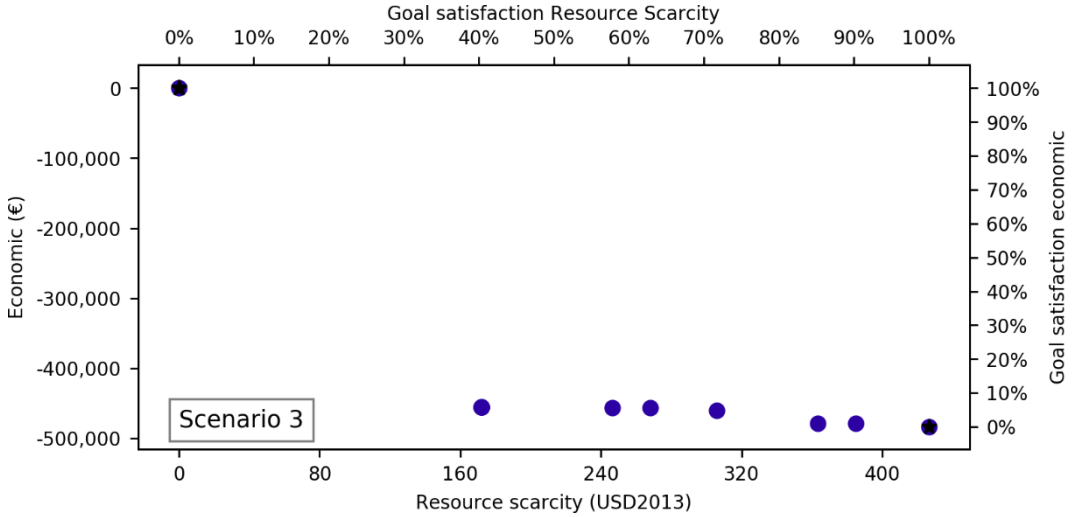

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
Scenario 18
1,440,000
1,520,000
1,600,000
1,680,000
1,760,000
1,840,000
Global warming (kg CO2 eq)
Goal satisfaction economic

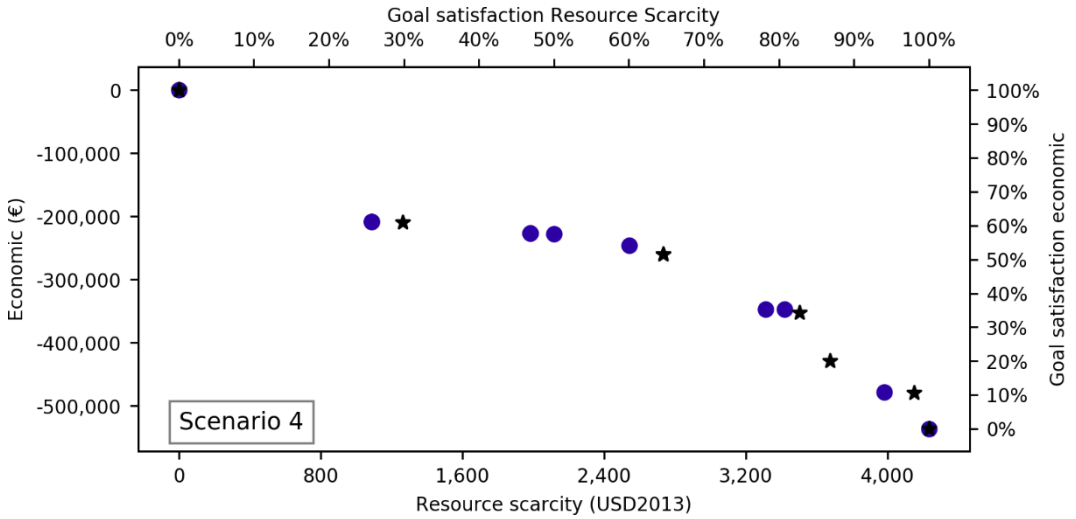

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
2,200,000
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
Scenario 19
1,680,000
1,760,000
1,840,000
1,920,000
2,000,000
Global warming (kg CO2 eq)
Goal satisfaction economic

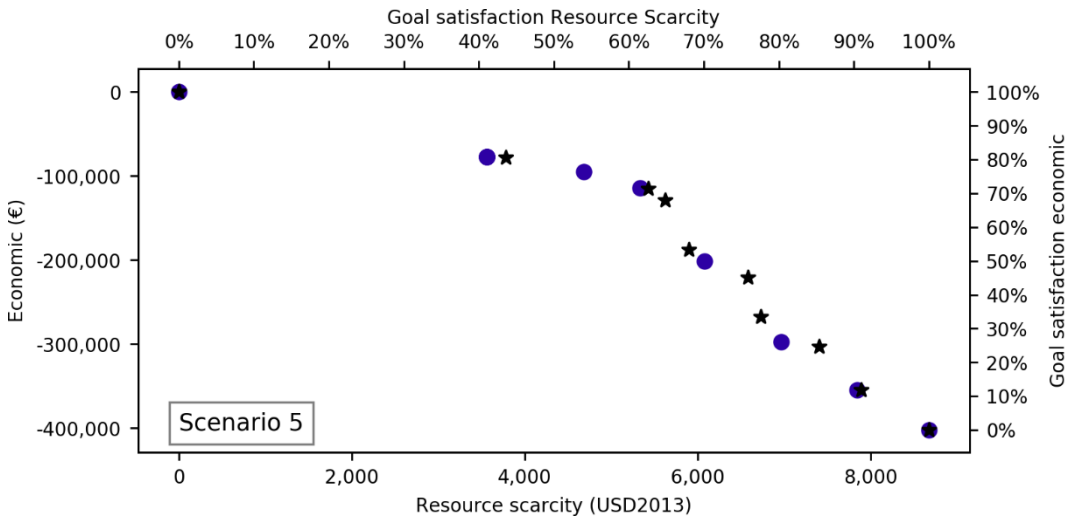

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2,400,000
2,200,000
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
Economic (€)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal satisfaction economic
Scenario 20
1,760,000
1,840,000
1,920,000
2,000,000
2,080,000
2,160,000
Global warming (kg CO2 eq)

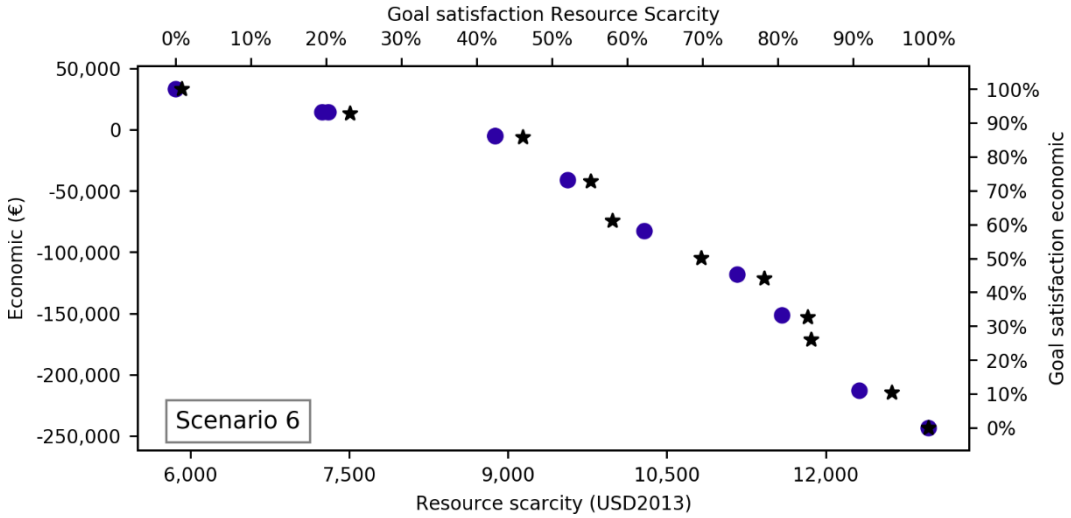
Supplementary figure S5 a–r. Pareto-optimal frontier for economic optimization with resource scarcity constraint (circles), and resource scarcity optimization with economic constraint (stars) for scenarios 3 to 20

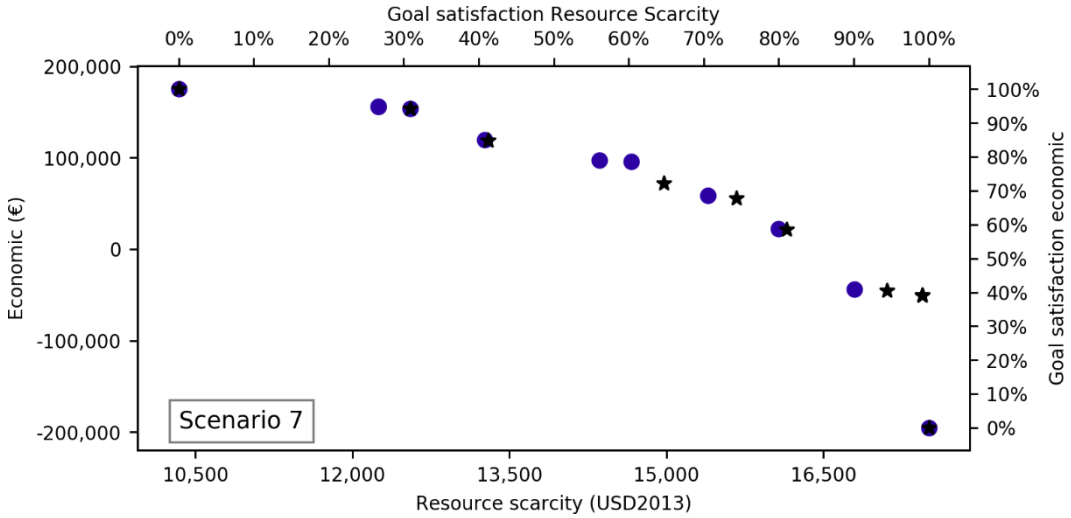
Scenarios 1 and 2 are omitted. No frontier exists, since all solutions are equal (0).

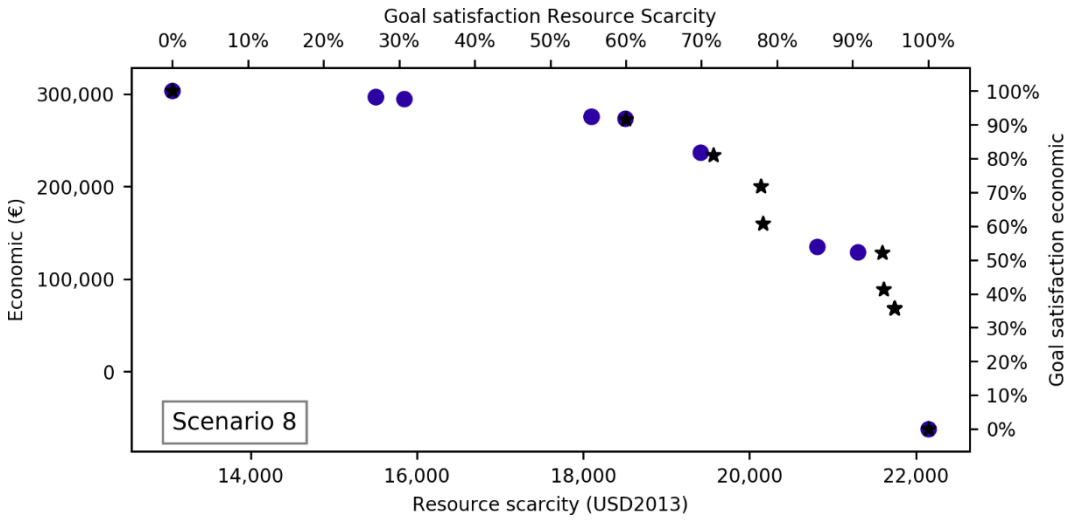


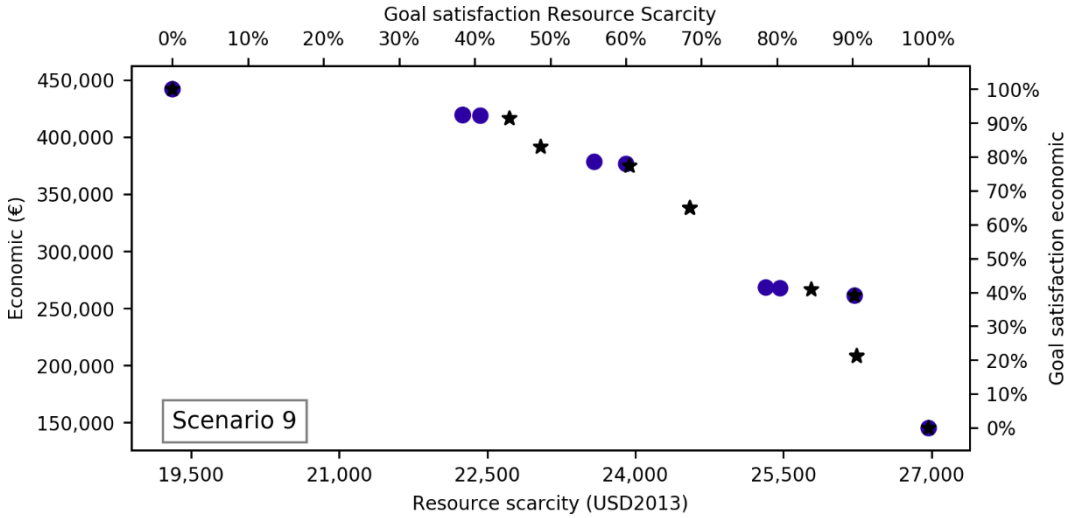


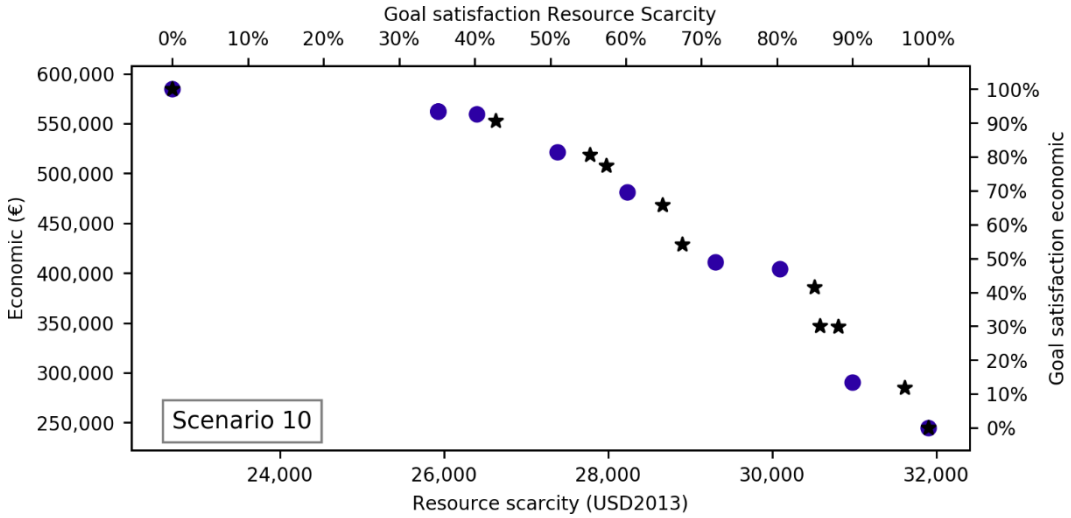


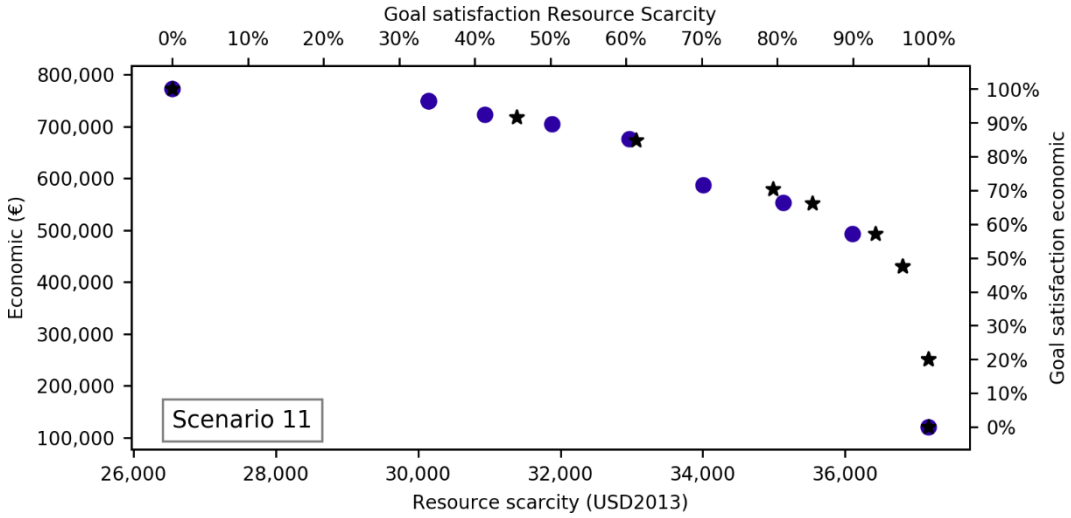

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
50,000
0
-50,000
-100,000
-150,000
-200,000
-250,000
Economic (€)
Goal satisfaction economic
Scenario 6
6,000
7,500
9,000
10,500
12,000
Resource scarcity (USD2013)

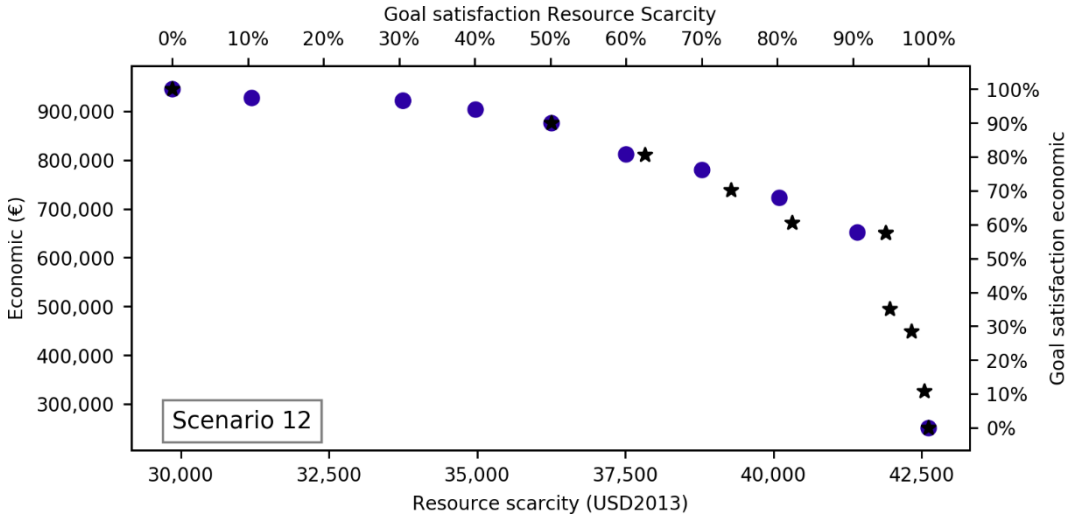

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
200,000
100,000
0
-100,000
-200,000
Economic (€)
Goal satisfaction economic
Scenario 7
10,500
12,000
13,500
15,000
16,500
Resource scarcity (USD2013)

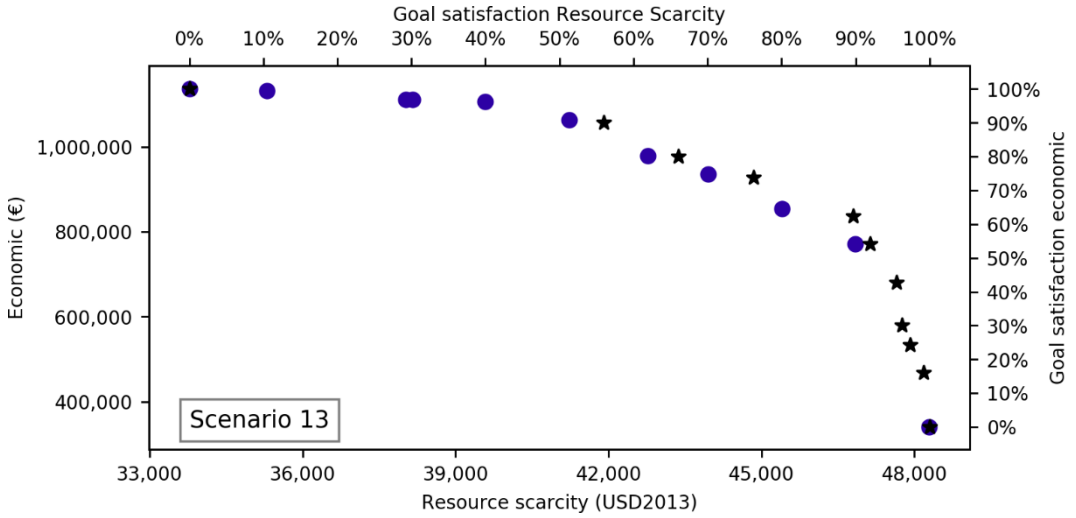

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
300,000
200,000
100,000
0
Economic (€)
Goal satisfaction economic
Scenario 8
14,000
16,000
18,000
20,000
22,000
Resource scarcity (USD2013)

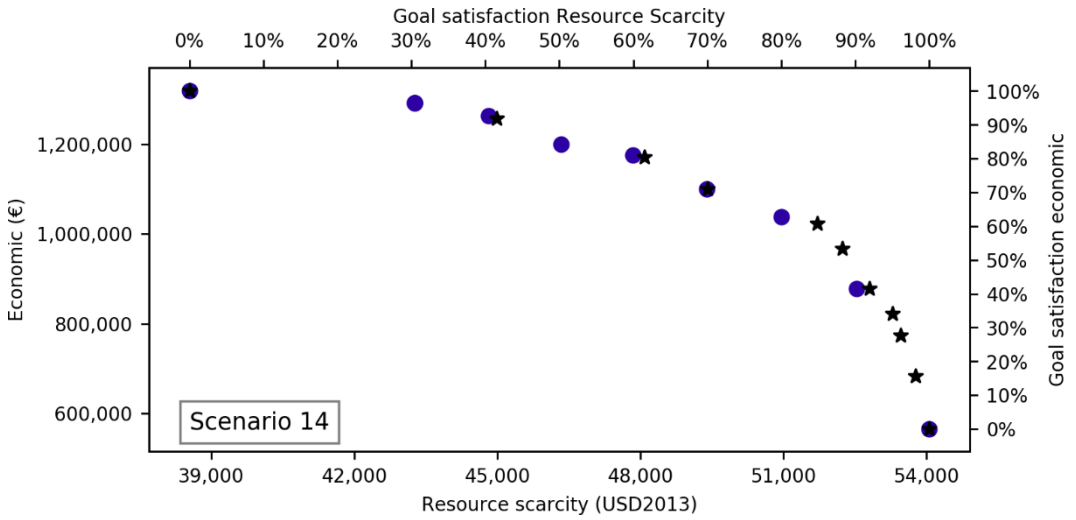

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
Goal satisfaction economic
Scenario 9
19,500
21,000
22,500
24,000
25,500
27,000
Resource scarcity (USD2013)

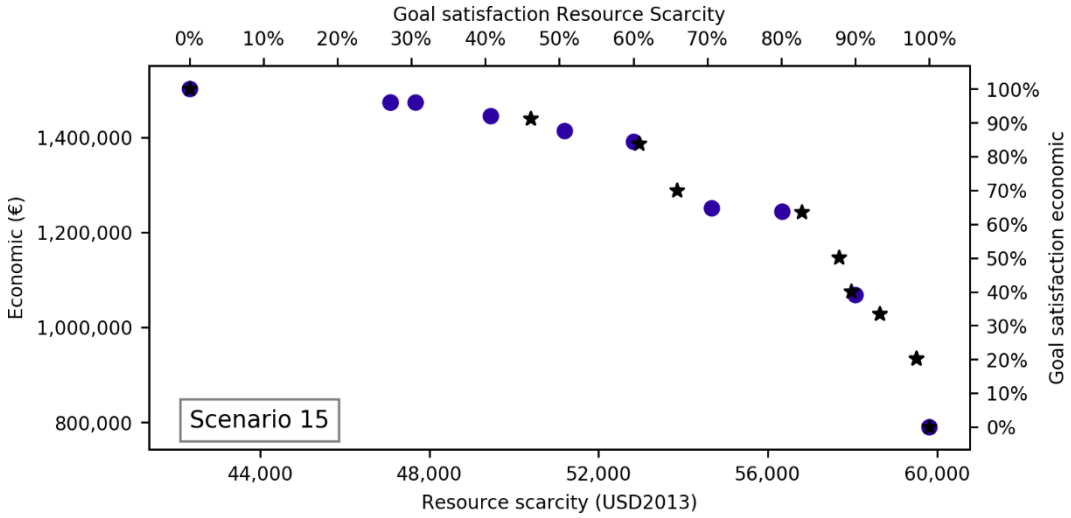

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
Goal satisfaction economic
Scenario 10
24,000
26,000
28,000
30,000
32,000
Resource scarcity (USD2013)

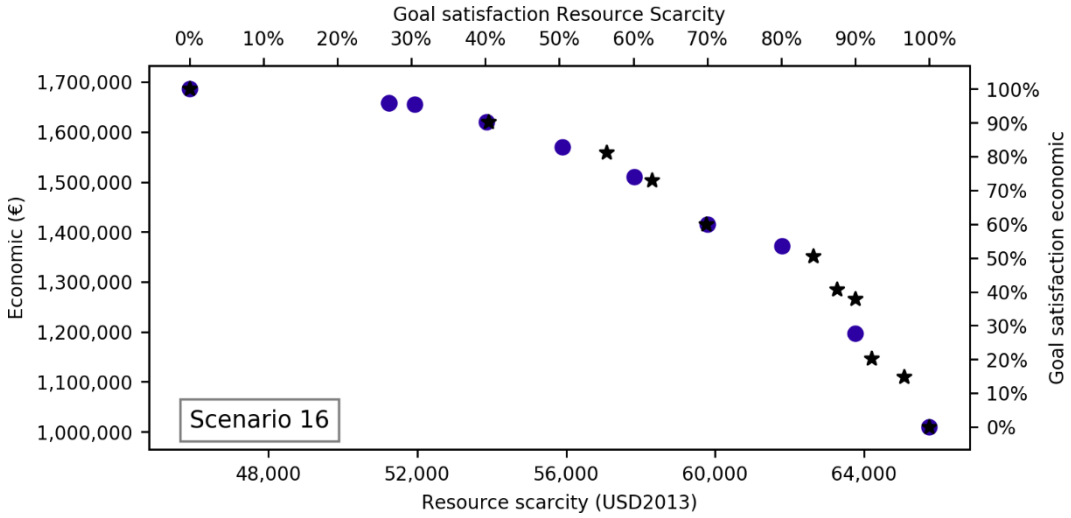

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
Goal satisfaction economic
Scenario 11
26,000
28,000
30,000
32,000
34,000
36,000
Resource scarcity (USD2013)

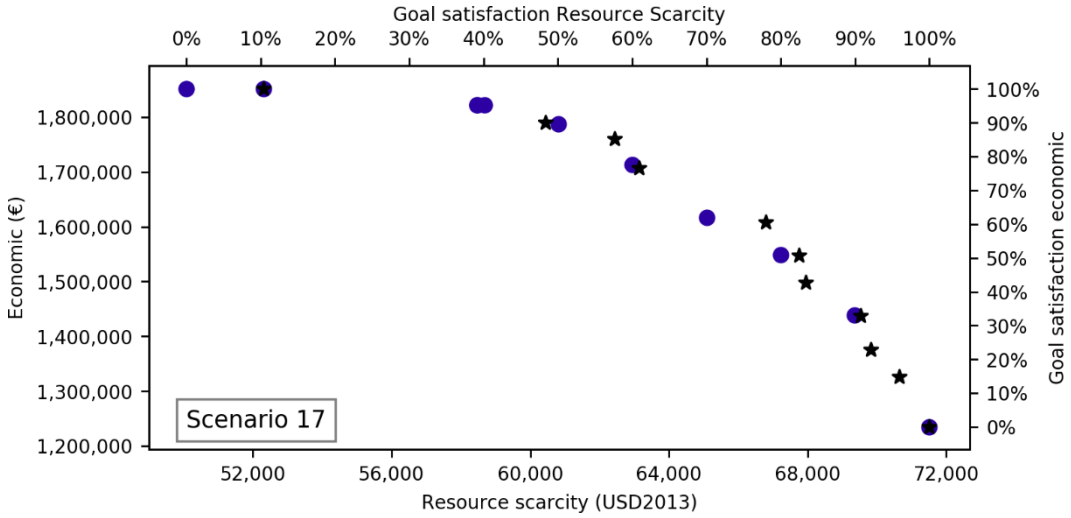

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
900,000
800,000
700,000
600,000
500,000
400,000
300,000
Goal satisfaction economic
Scenario 12
30,000
32,500
35,000
37,500
40,000
42,500
Resource scarcity (USD2013)

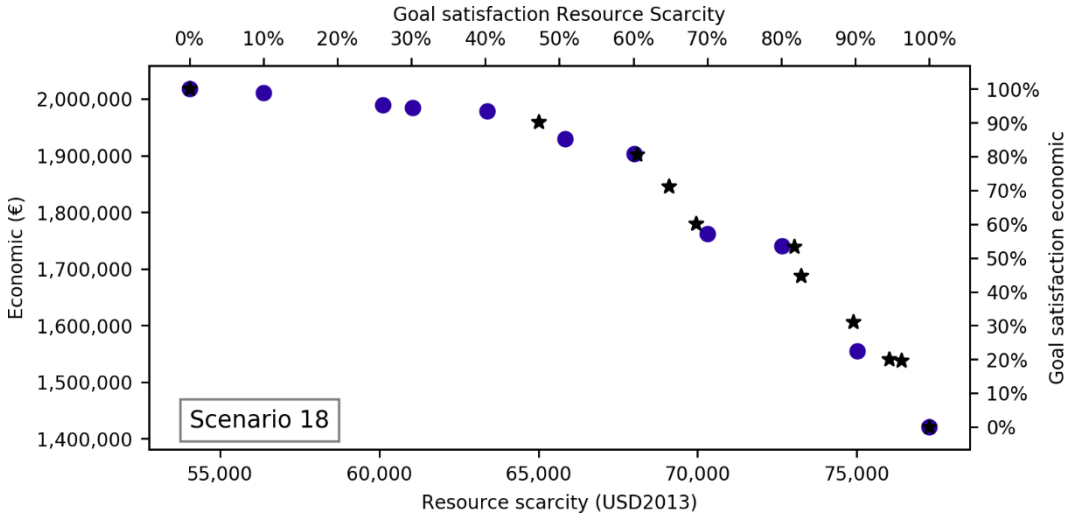

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,000,000
800,000
600,000
400,000
Goal satisfaction economic
Scenario 13
33,000
36,000
39,000
42,000
45,000
48,000
Resource scarcity (USD2013)

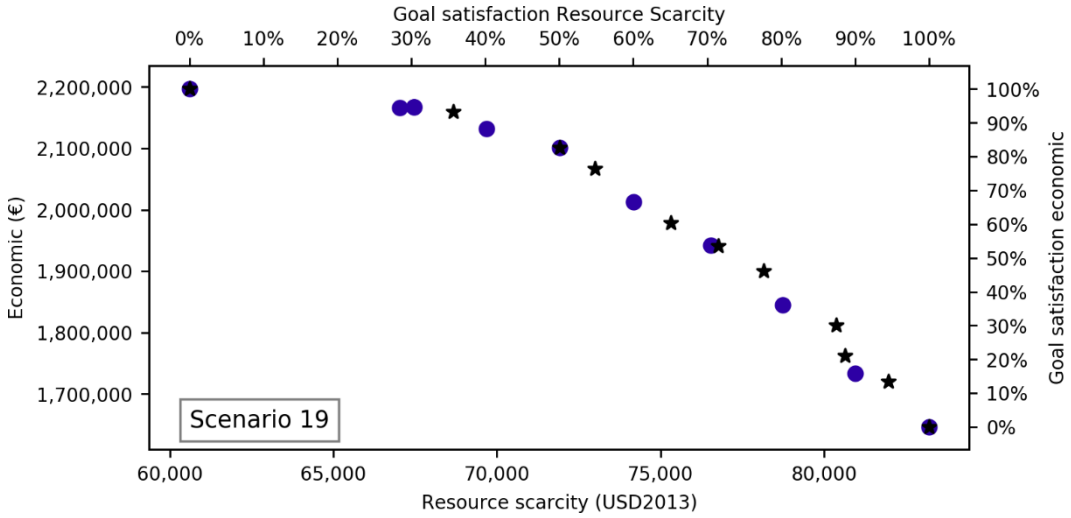

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,200,000
1,000,000
800,000
600,000
Goal satisfaction economic
Scenario 14
39,000
42,000
45,000
48,000
51,000
54,000
Resource scarcity (USD2013)

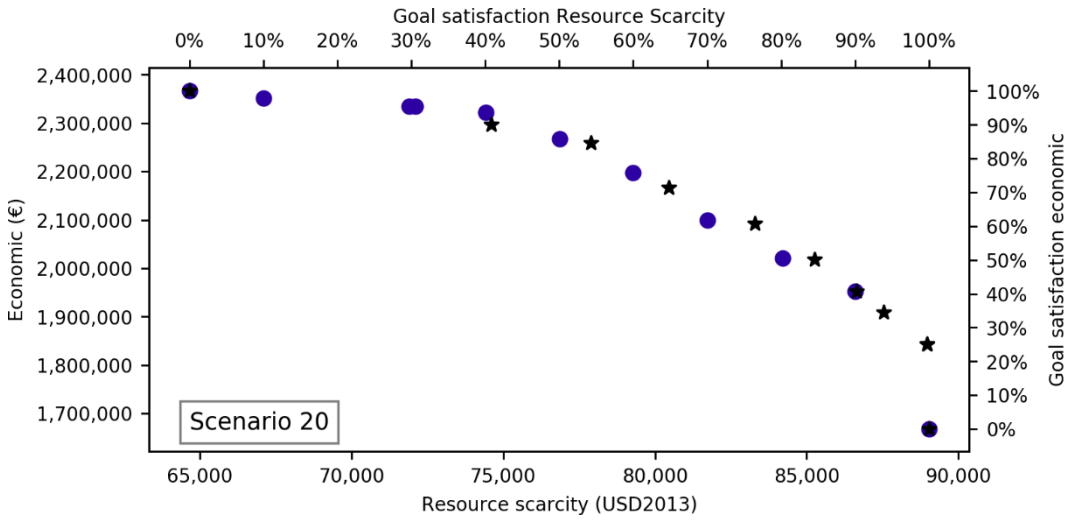

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,400,000
1,200,000
1,000,000
800,000
Scenario 15
44,000
48,000
52,000
56,000
60,000
Resource scarcity (USD2013)
Goal satisfaction economic


Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
Scenario 16
48,000
52,000
56,000
60,000
64,000
Resource scarcity (USD2013)
Goal satisfaction economic


Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
Scenario 17
52,000
56,000
60,000
64,000
68,000
72,000
Resource scarcity (USD2013)
Goal satisfaction economic

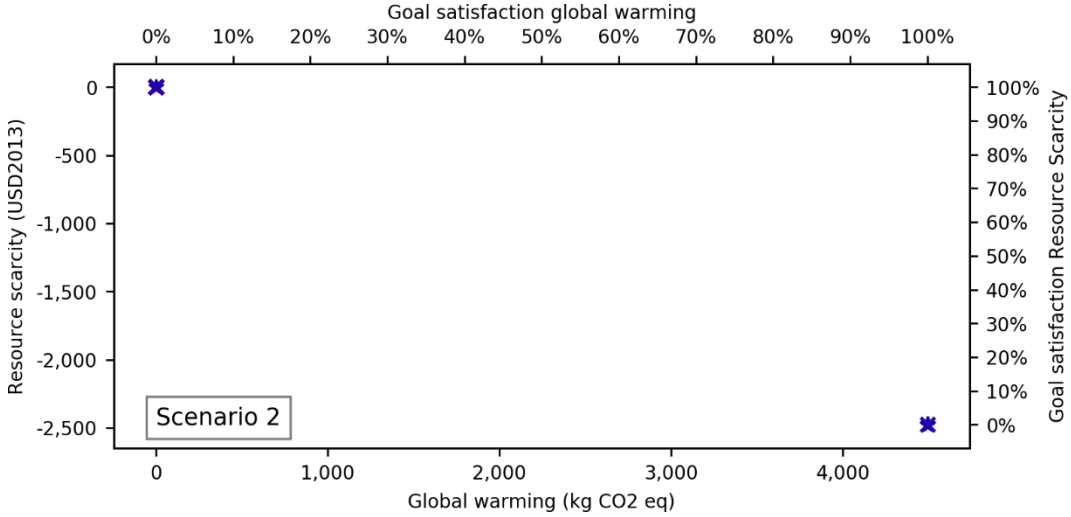

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
Goal satisfaction economic
Scenario 18
55,000
60,000
65,000
70,000
75,000
Resource scarcity (USD2013)

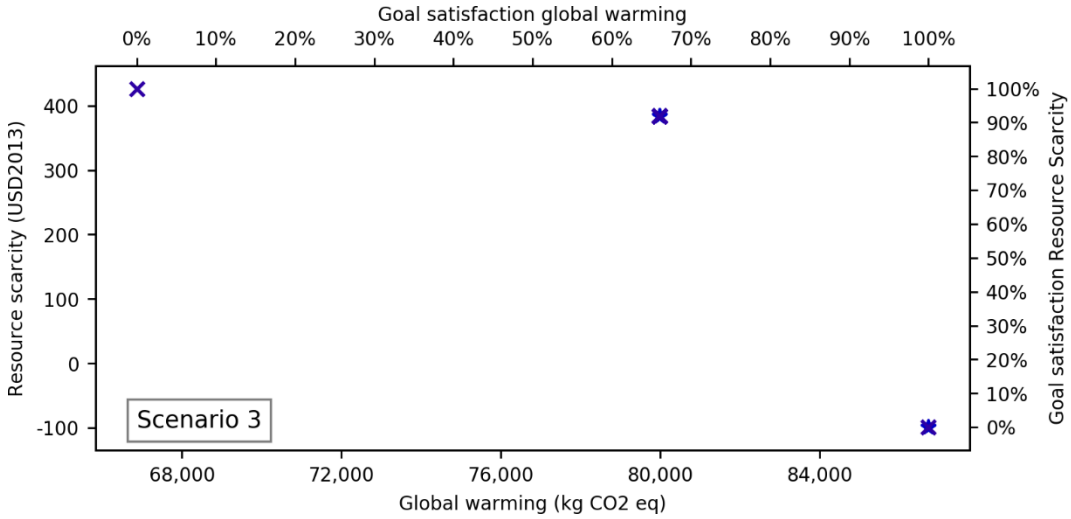

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
2,200,000
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
Goal satisfaction economic
Scenario 19
60,000
65,000
70,000
75,000
80,000
Resource scarcity (USD2013)

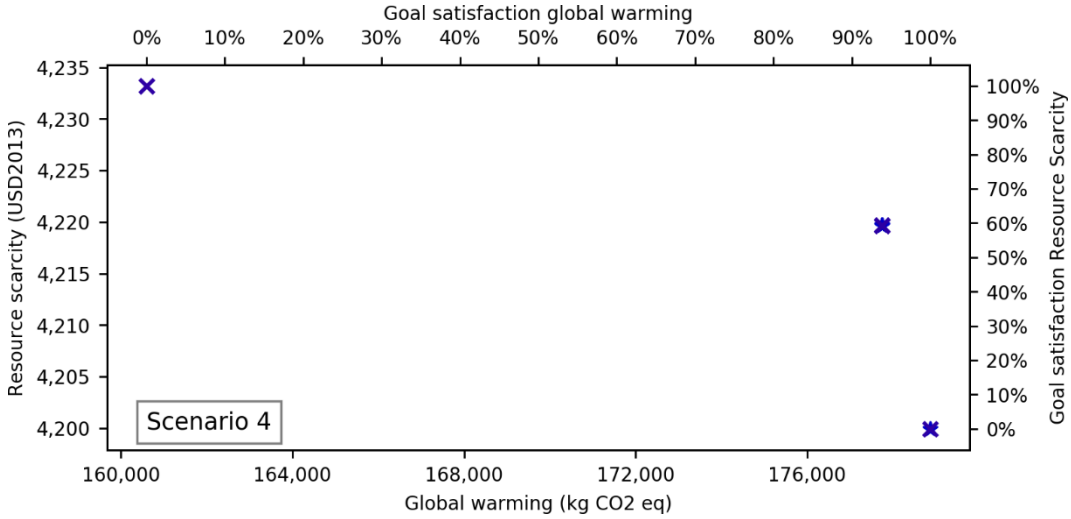

Goal satisfaction Resource Scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
2,400,000
2,300,000
2,200,000
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
Goal satisfaction economic
Scenario 20
65,000
70,000
75,000
80,000
85,000
90,000
Resource scarcity (USD2013)

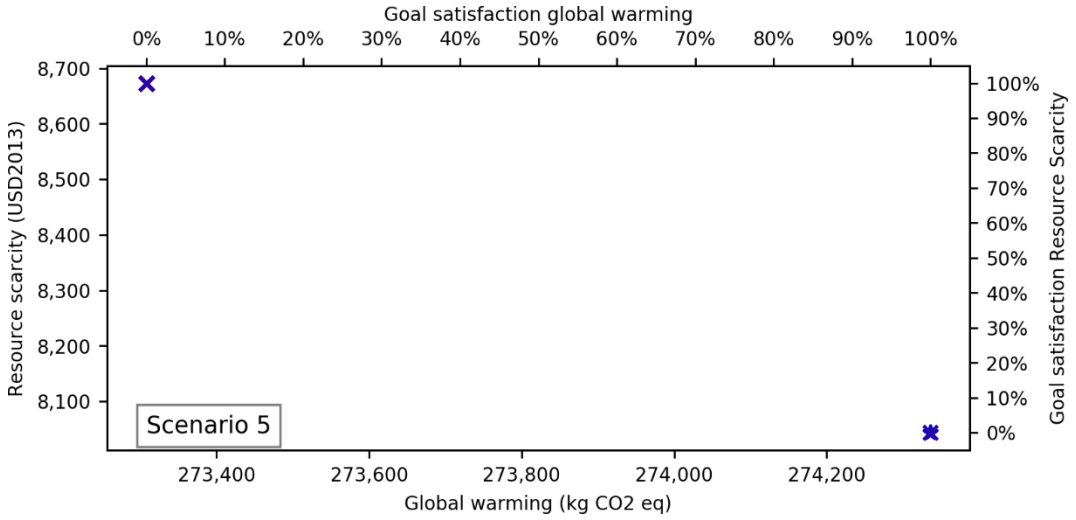
Supplementary figure S6 a–r. Pareto-optimal frontier for resource scarcity optimization with global warming constraint (stars), and global warming optimization with resource scarcity constraint (crosses) for scenarios 2 to 12 and 14 to 20

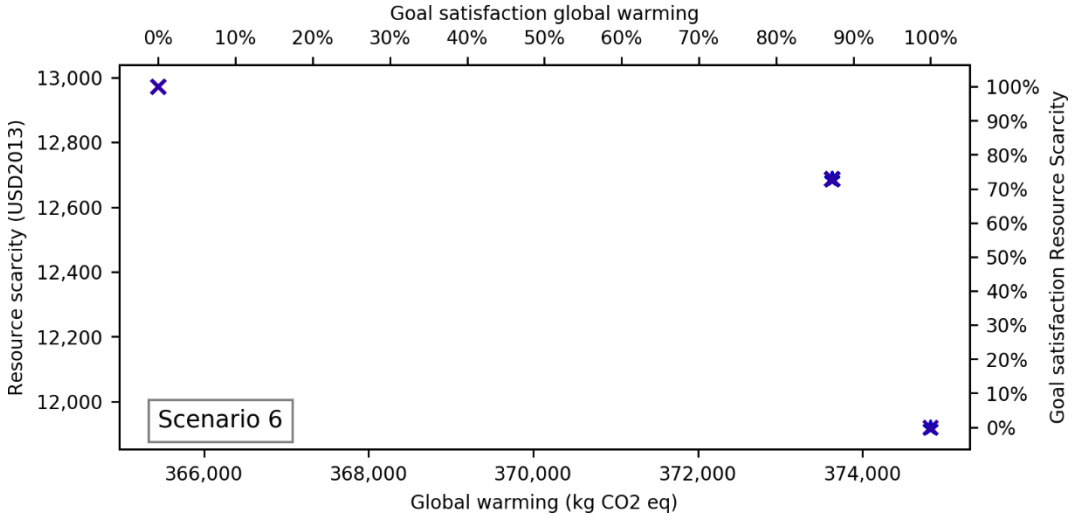
Scenarios 1 and 13 are omitted. No frontier exists, since all solutions are equal.

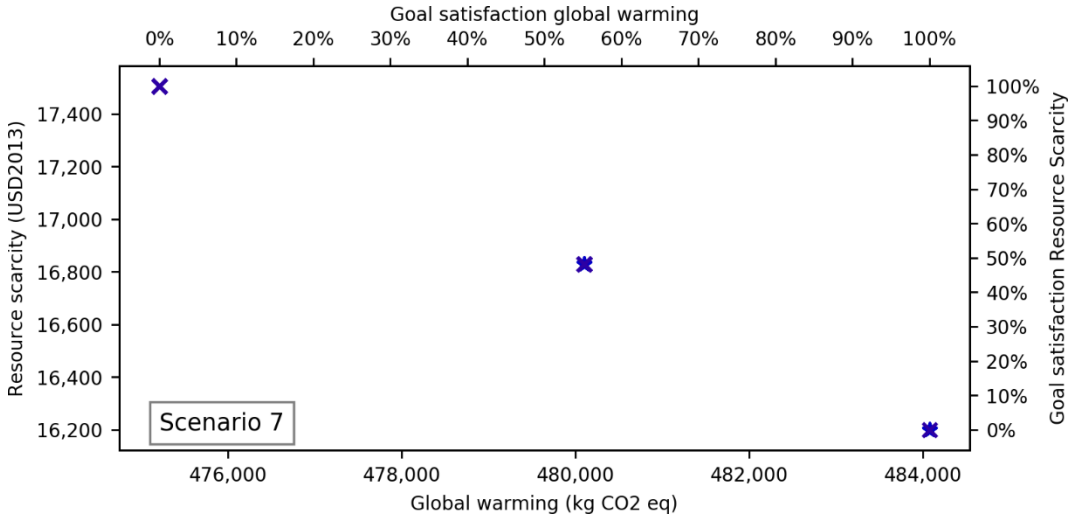


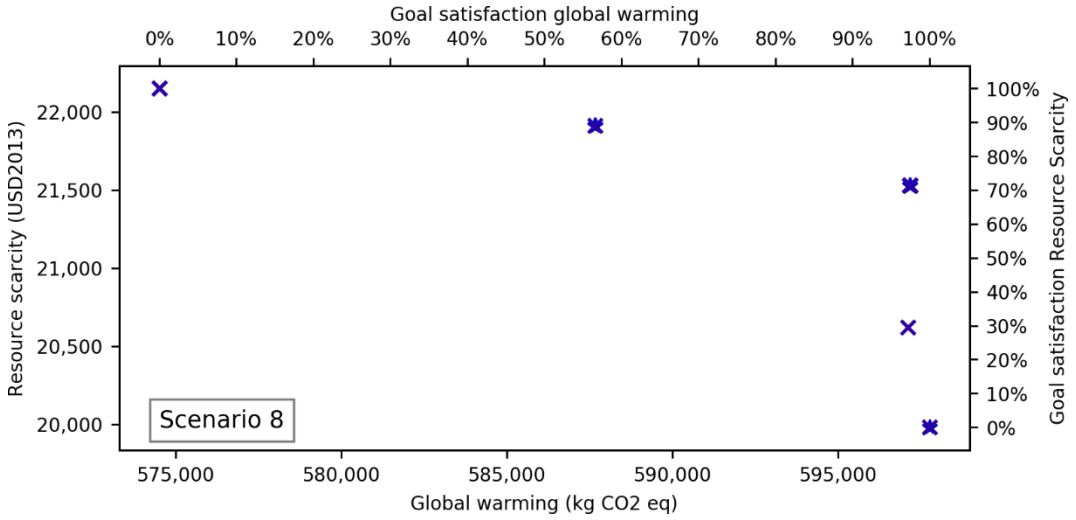


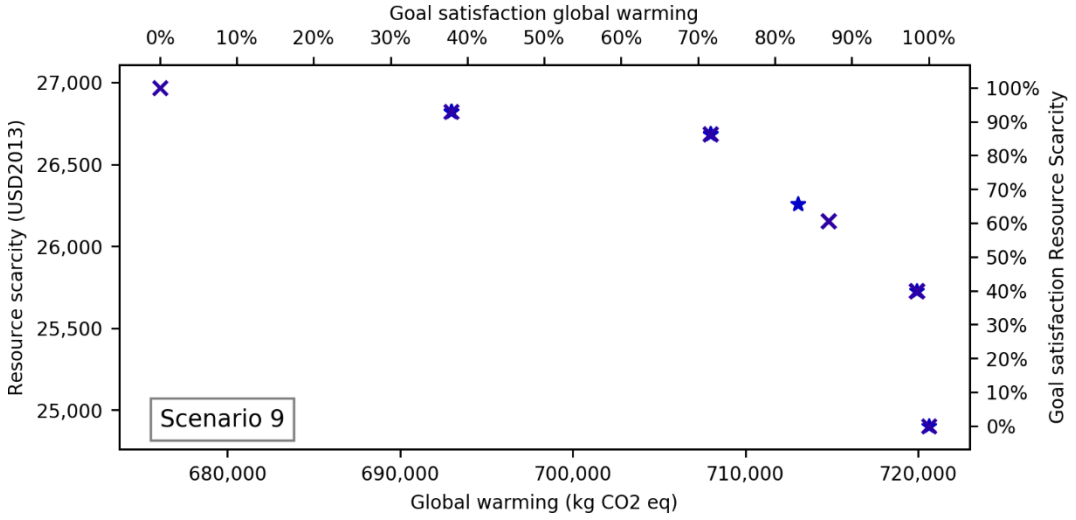


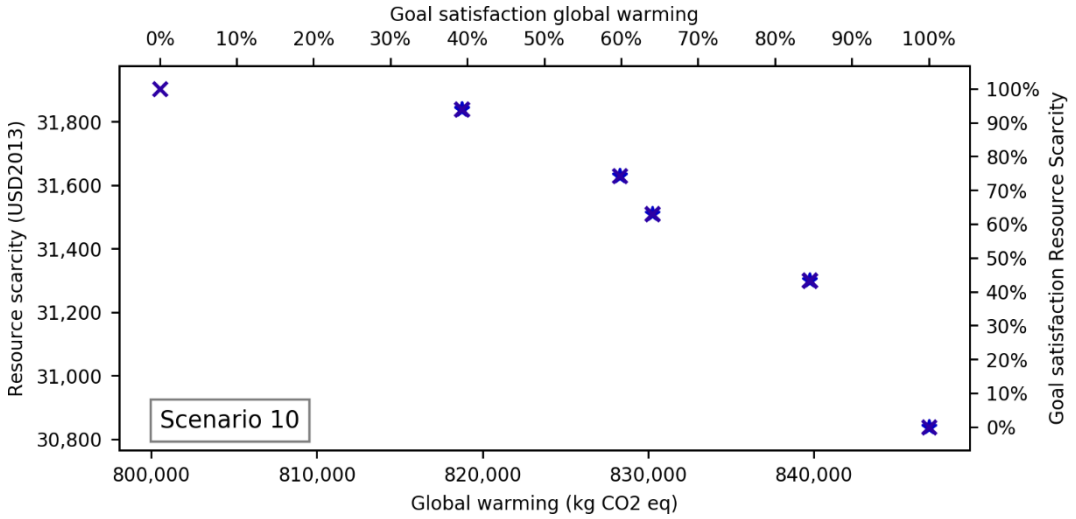

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
8,700
8,600
8,500
8,400
8,300
8,200
8,100
Scenario 5
273,400
273,600
273,800
274,000
274,200
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity

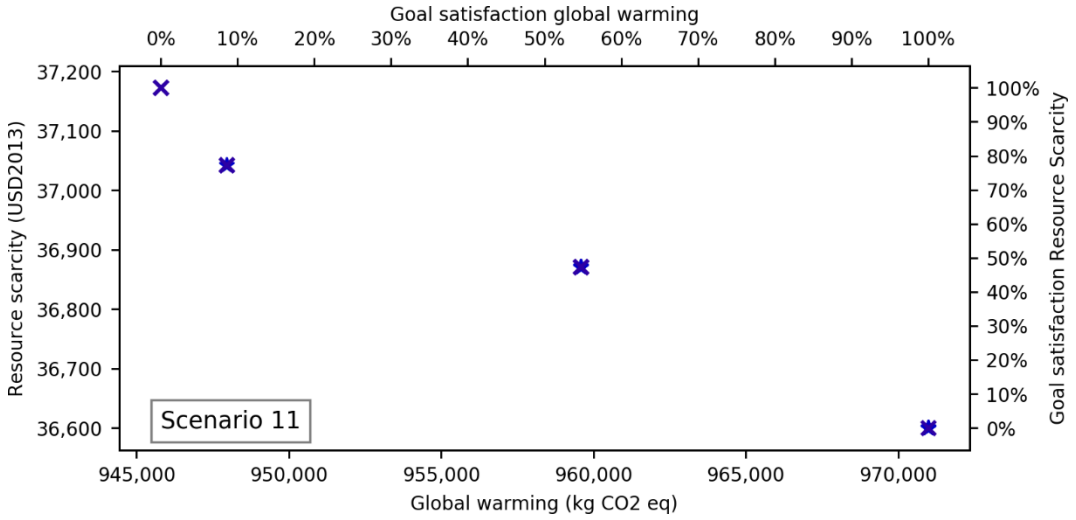

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
13,000
12,800
12,600
12,400
12,200
12,000
Scenario 6
366,000
368,000
370,000
372,000
374,000
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity

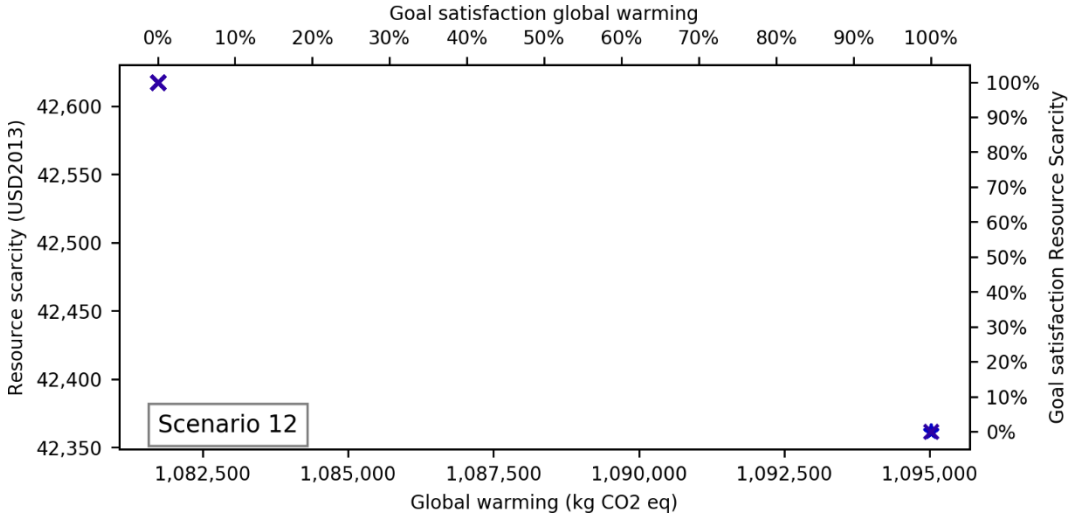

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
17,400
17,200
17,000
16,800
16,600
16,400
16,200
Scenario 7
476,000
478,000
480,000
482,000
484,000
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity

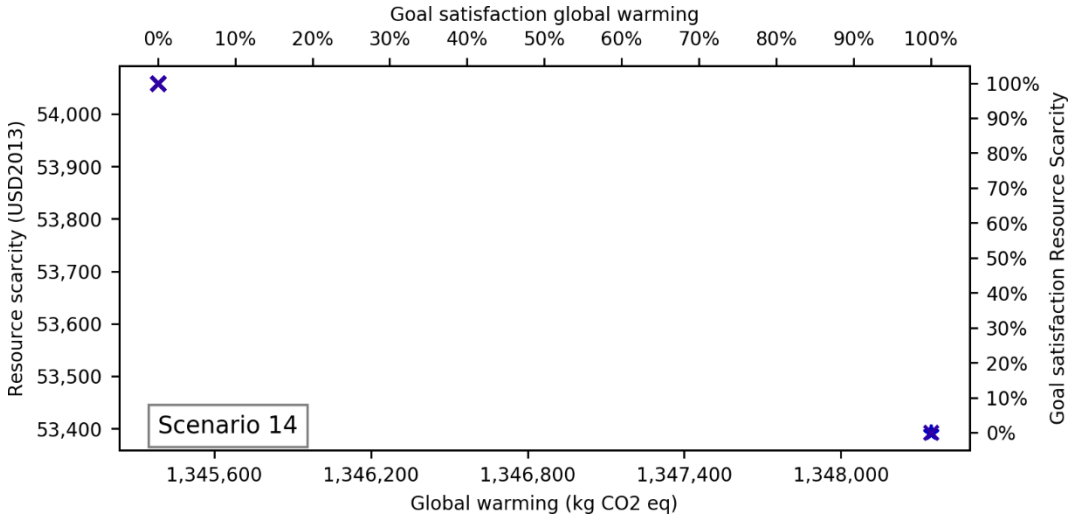

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
22,000
21,500
21,000
20,500
20,000
Scenario 8
575,000
580,000
585,000
590,000
595,000
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity

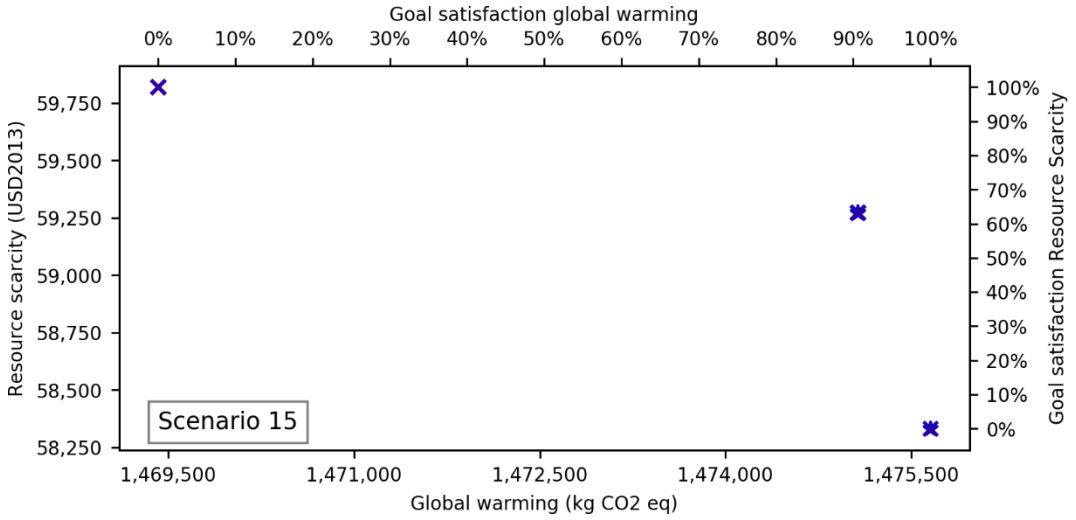

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
27,000
26,500
26,000
25,500
25,000
Scenario 9
680,000
690,000
700,000
710,000
720,000
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity

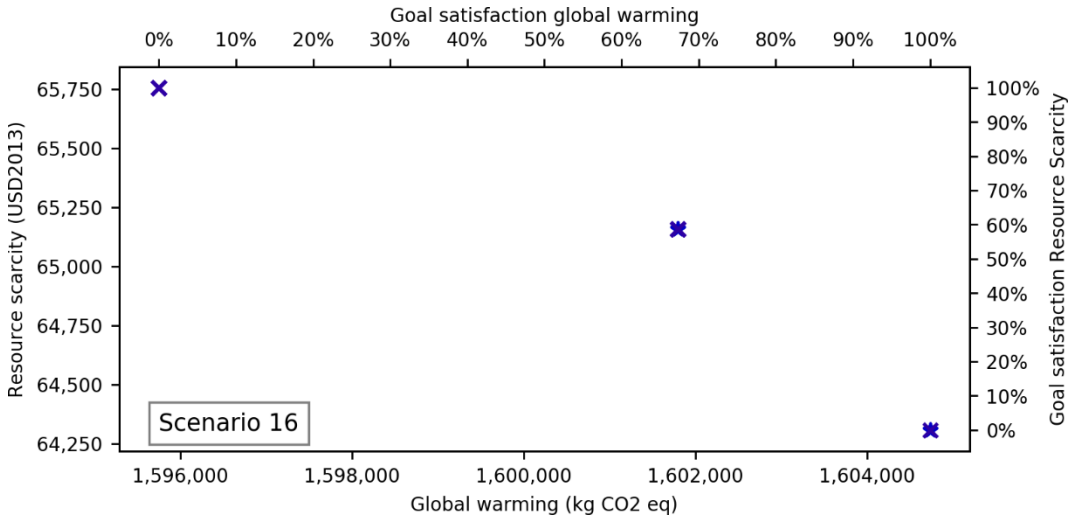

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
31,800
31,600
31,400
31,200
31,000
30,800
Scenario 10
800,000
810,000
820,000
830,000
840,000
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity

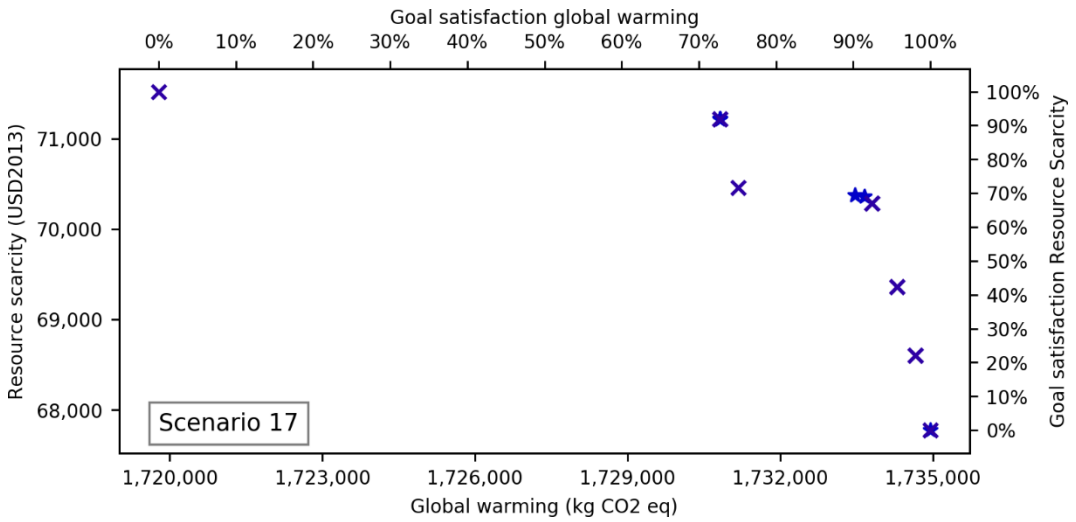

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
37,200
37,100
37,000
36,900
36,800
36,700
36,600
Goal satisfaction Resource Scarcity
Scenario 11
945,000
950,000
955,000
960,000
965,000
970,000
Global warming (kg CO2 eq)

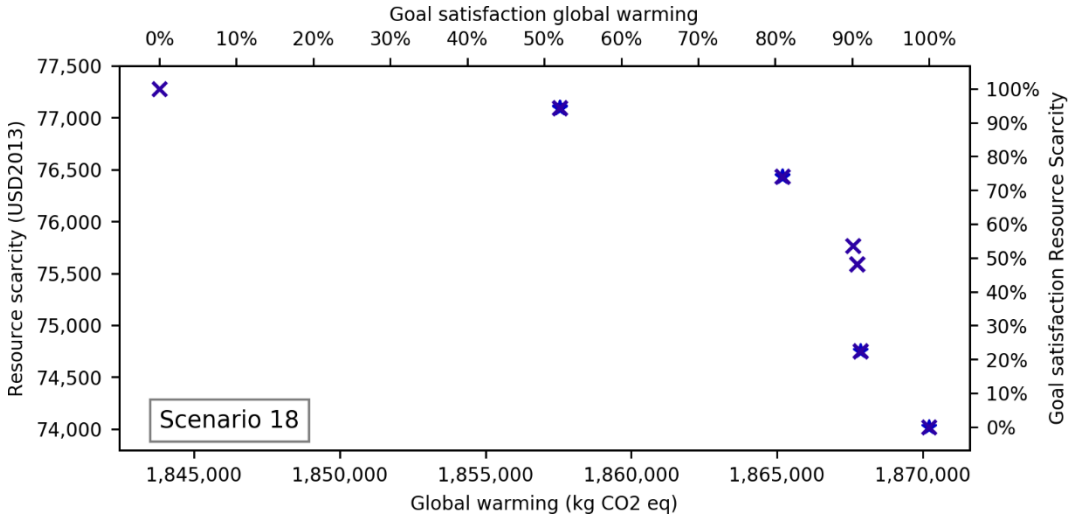

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
42,600
42,550
42,500
42,450
42,400
42,350
Goal satisfaction Resource Scarcity
Scenario 12
1,082,500
1,085,000
1,087,500
1,090,000
1,092,500
1,095,000
Global warming (kg CO2 eq)

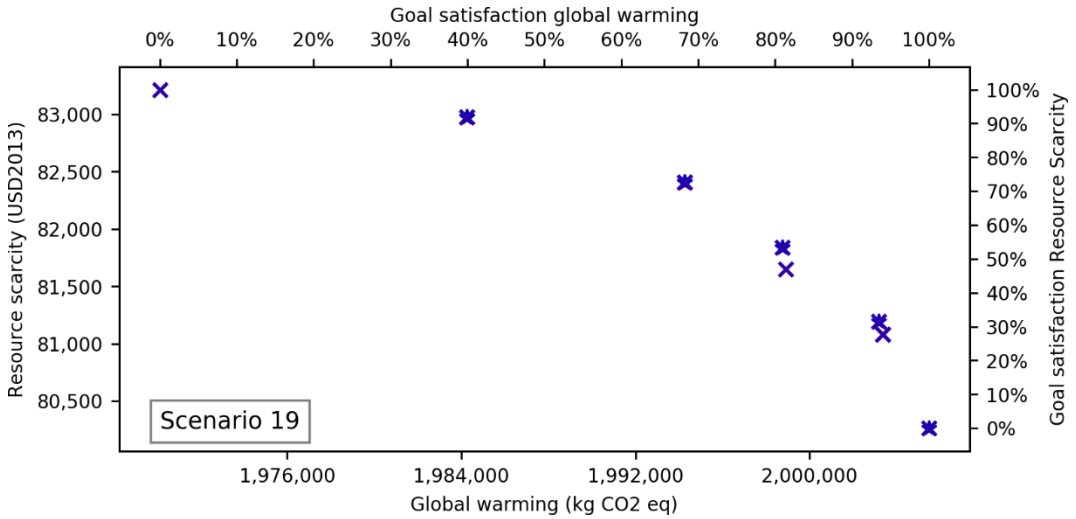

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
54,000
53,900
53,800
53,700
53,600
53,500
53,400
Goal satisfaction Resource Scarcity
Scenario 14
1,345,600
1,346,200
1,346,800
1,347,400
1,348,000
Global warming (kg CO2 eq)

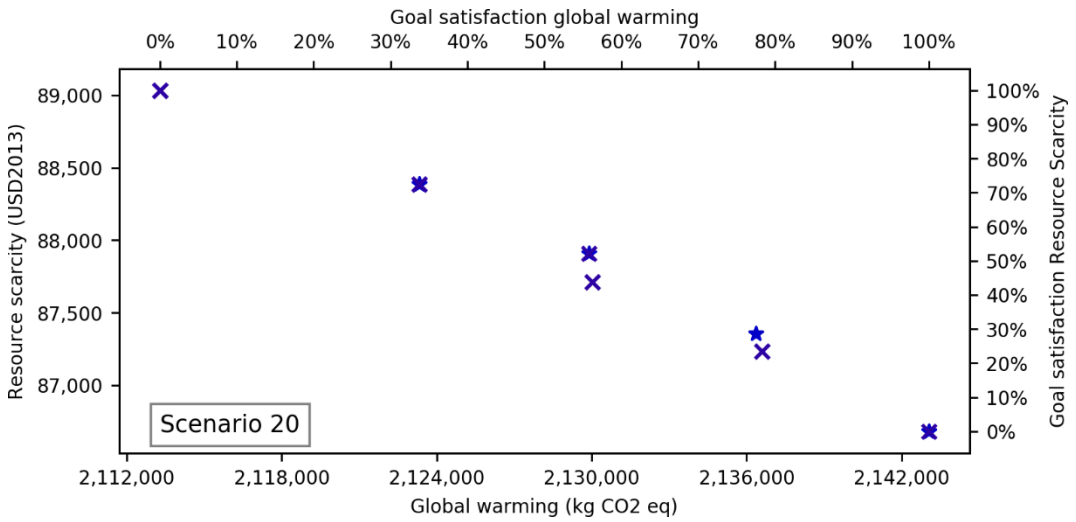

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
59,750
59,500
59,250
59,000
58,750
58,500
58,250
Scenario 15
1,469,500
1,471,000
1,472,500
1,474,000
1,475,500
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity


Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
65,750
65,500
65,250
65,000
64,750
64,500
64,250
Scenario 16
1,596,000
1,598,000
1,600,000
1,602,000
1,604,000
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity


Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
71,000
70,000
69,000
68,000
Scenario 17
1,720,000
1,723,000
1,726,000
1,729,000
1,732,000
1,735,000
Global warming (kg CO2 eq)
Goal satisfaction Resource Scarcity

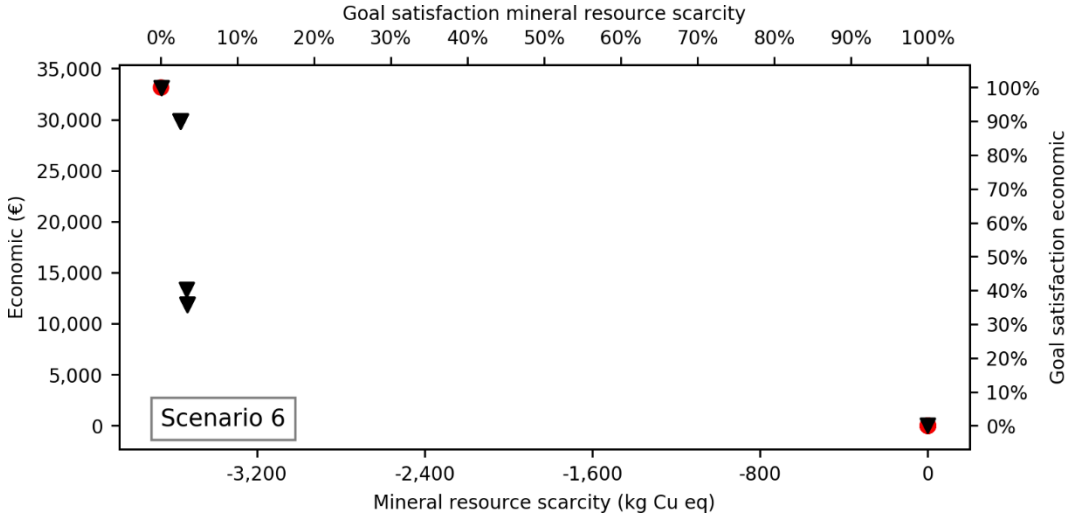

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
77,500
77,000
76,500
76,000
75,500
75,000
74,500
74,000
Goal satisfaction Resource Scarcity
Scenario 18
1,845,000
1,850,000
1,855,000
1,860,000
1,865,000
1,870,000
Global warming (kg CO2 eq)

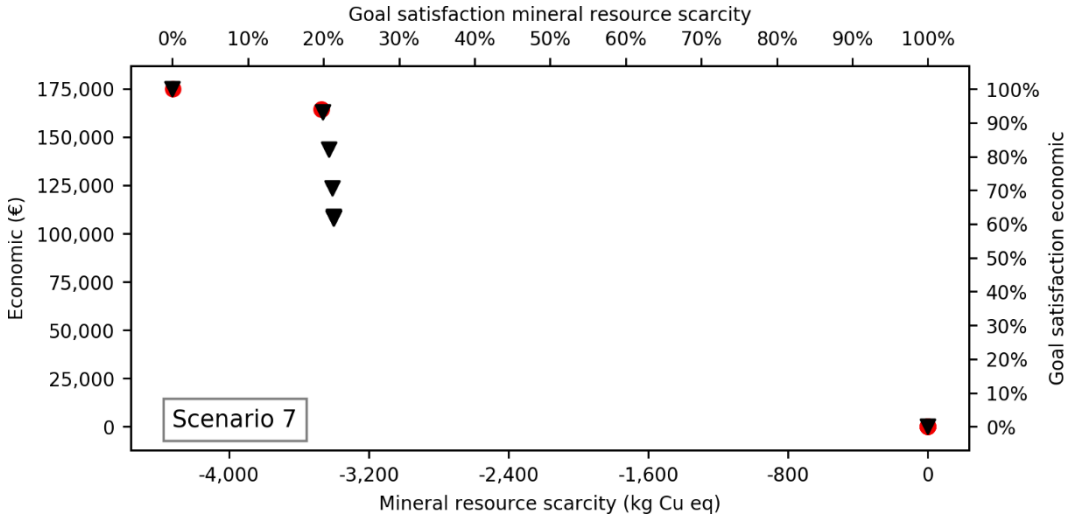

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
83,000
82,500
82,000
81,500
81,000
80,500
Goal satisfaction Resource Scarcity
Scenario 19
1,976,000
1,984,000
1,992,000
2,000,000
Global warming (kg CO2 eq)

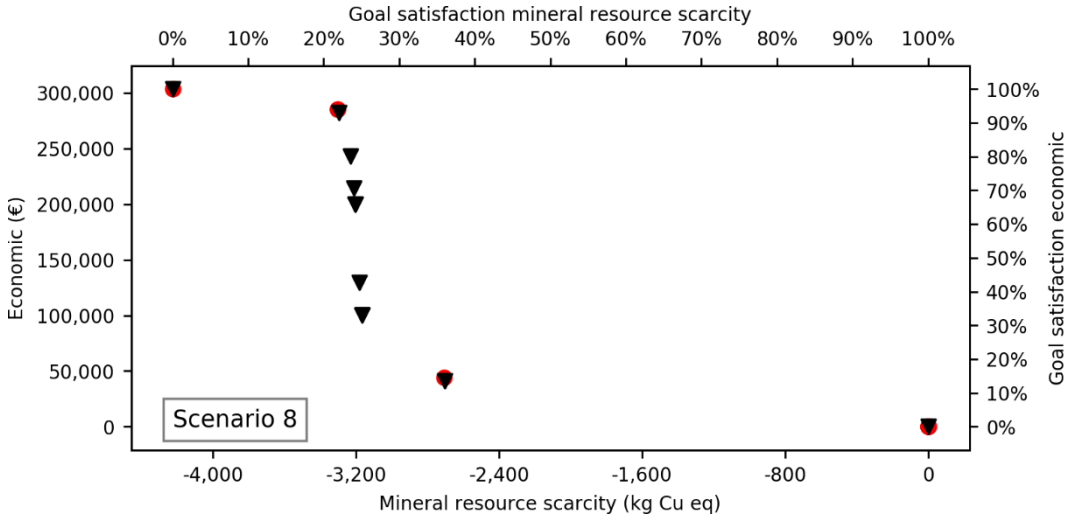

Goal satisfaction global warming
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Resource scarcity (USD2013)
89,000
88,500
88,000
87,500
87,000
Goal satisfaction Resource Scarcity
Scenario 20
2,112,000
2,118,000
2,124,000
2,130,000
2,136,000
2,142,000
Global warming (kg CO2 eq)

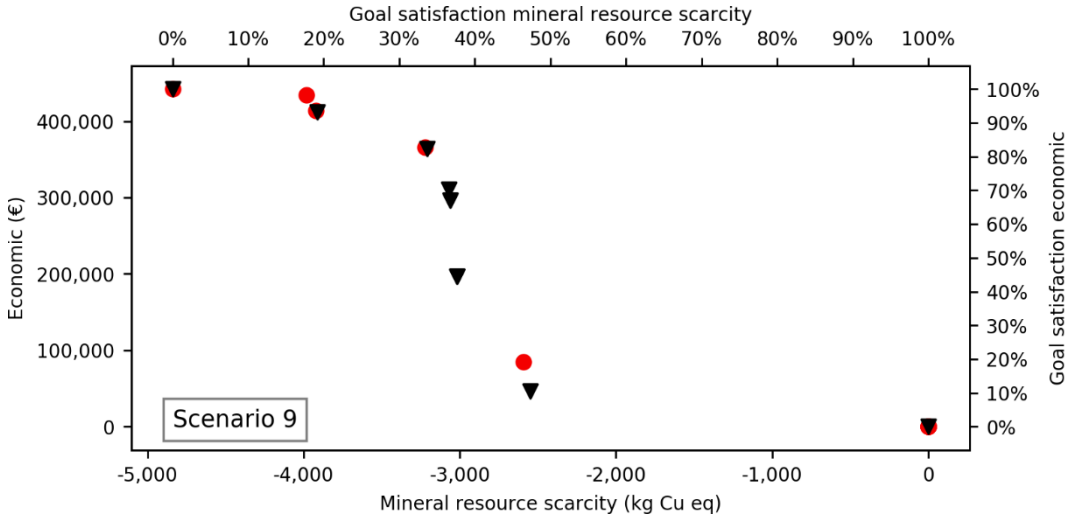
Supplementary figure S7 a–o. Pareto-optimal frontier for economic optimization with mineral resource scarcity constraint (circles), and mineral resource scarcity optimization with economic constraint (triangles) for scenarios 6 to 20

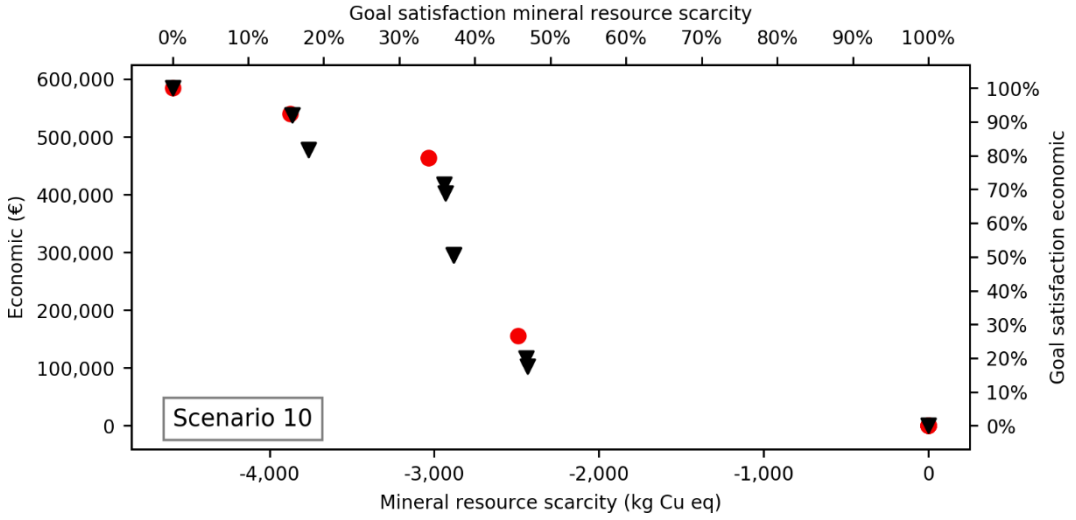
Scenarios 1 to 5 are omitted. No frontier exists, since all solutions are equal (0).

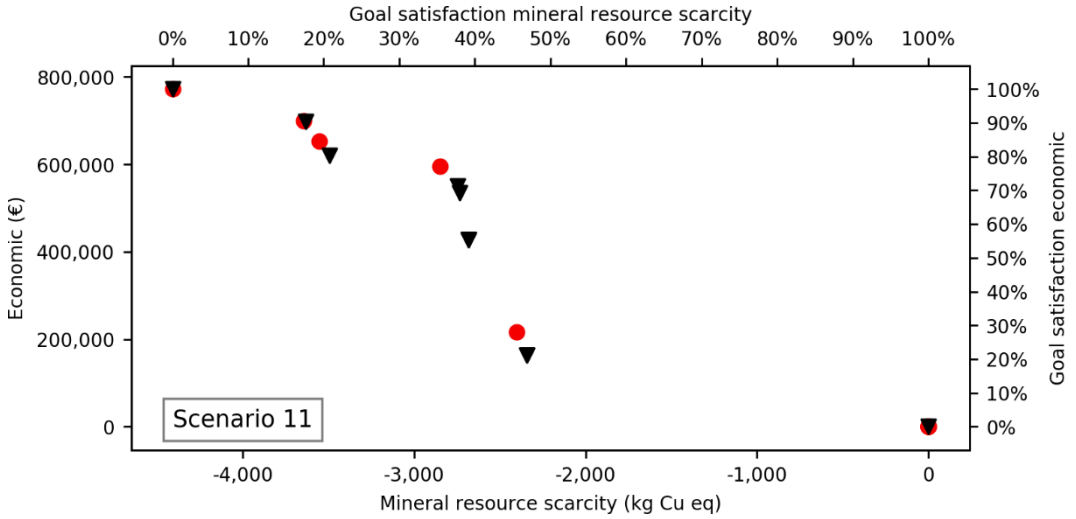


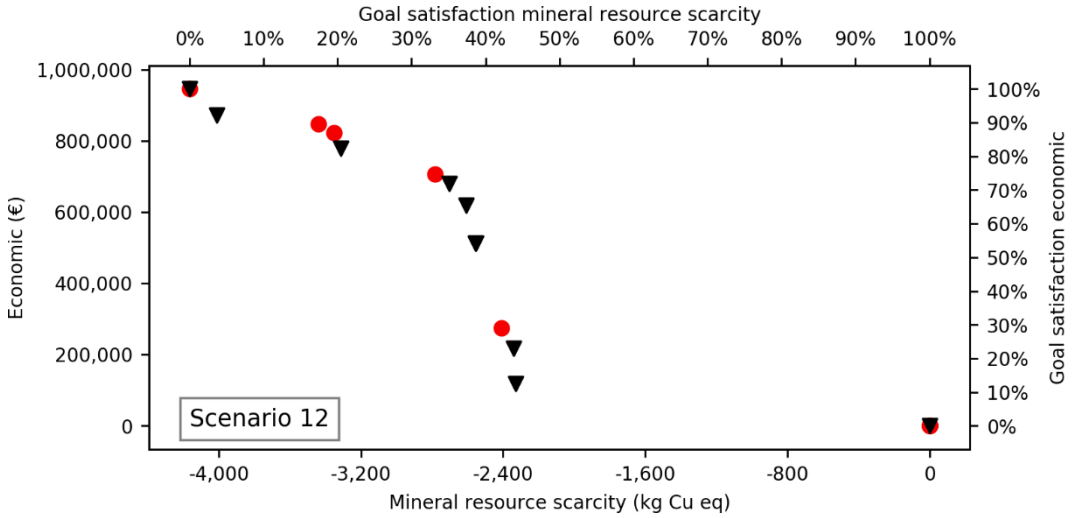


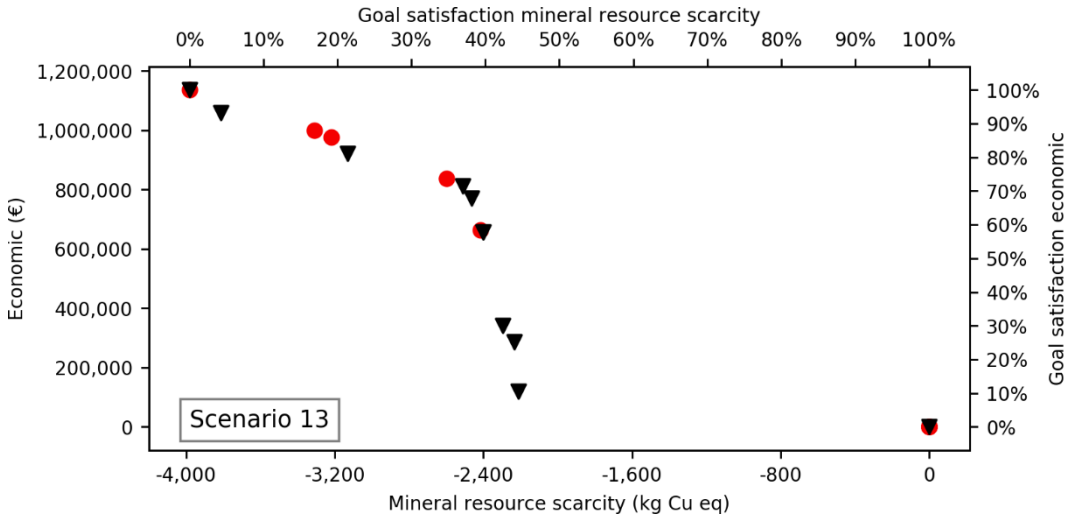


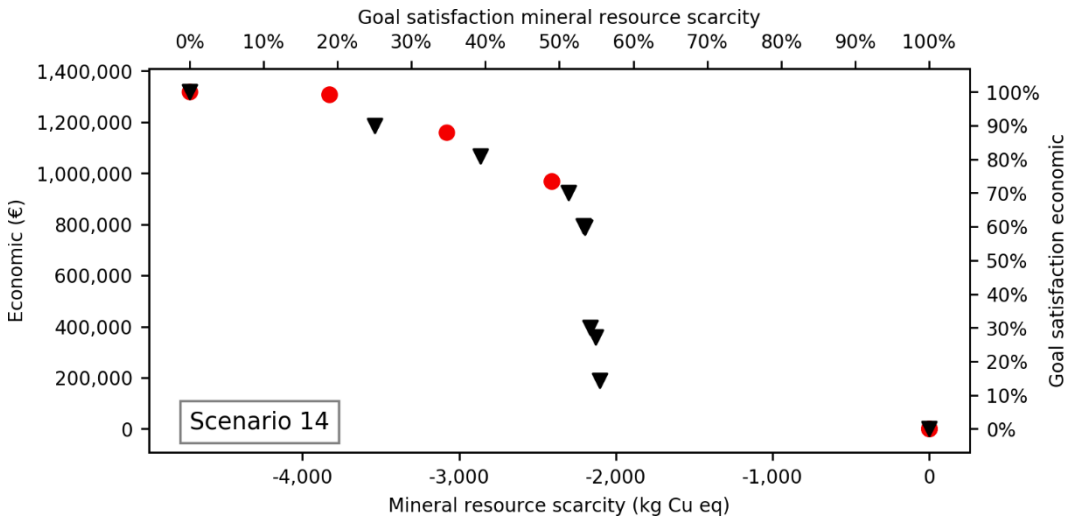

Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
400,000
300,000
200,000
100,000
0
Goal satisfaction economic
Scenario 9
-5,000
-4,000
-3,000
-2,000
-1,000
0
Mineral resource scarcity (kg Cu eq)

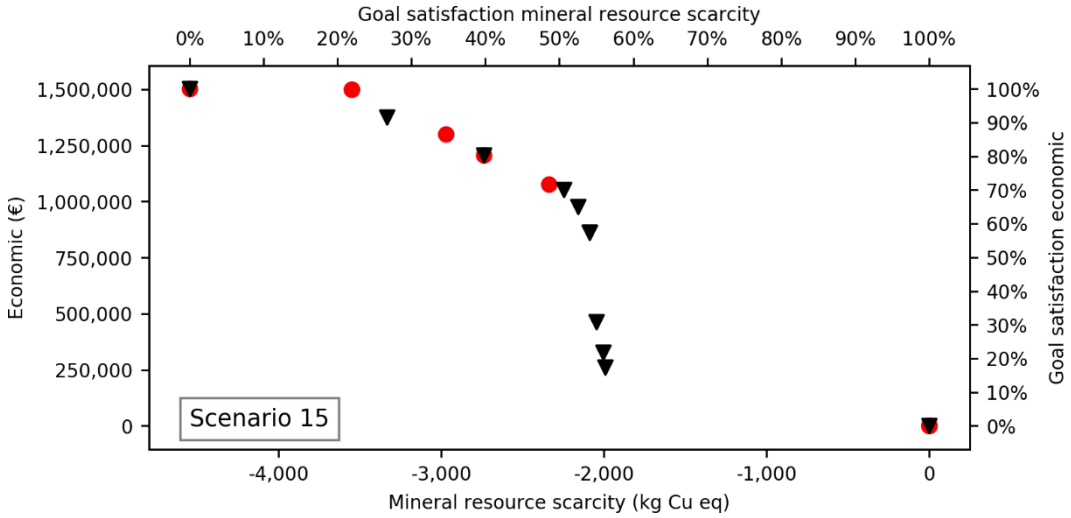

Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
600,000
500,000
400,000
300,000
200,000
100,000
0
Goal satisfaction economic
Scenario 10
-4,000
-3,000
-2,000
-1,000
0
Mineral resource scarcity (kg Cu eq)

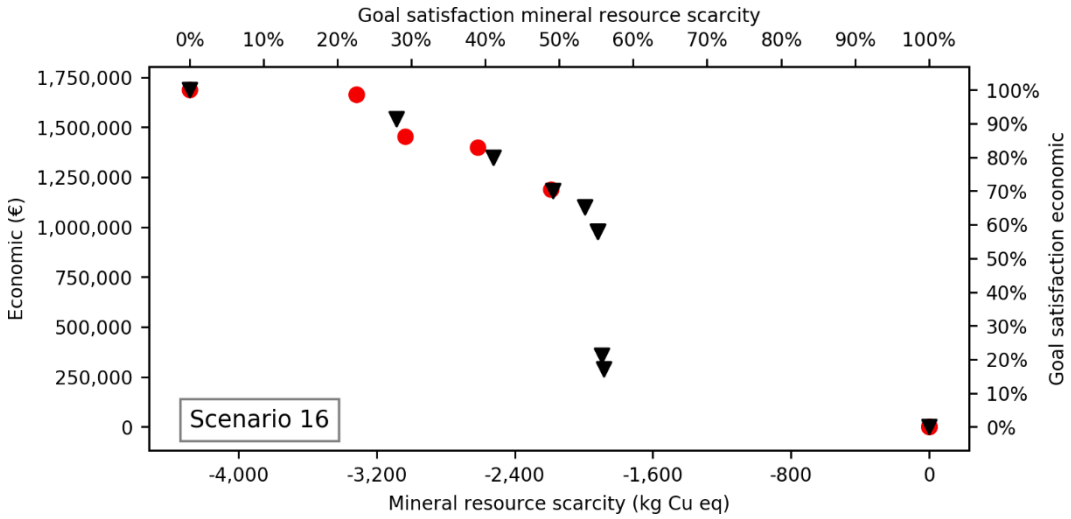

Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
800,000
600,000
400,000
200,000
0
Goal satisfaction economic
Scenario 11
-4,000
-3,000
-2,000
-1,000
0
Mineral resource scarcity (kg Cu eq)

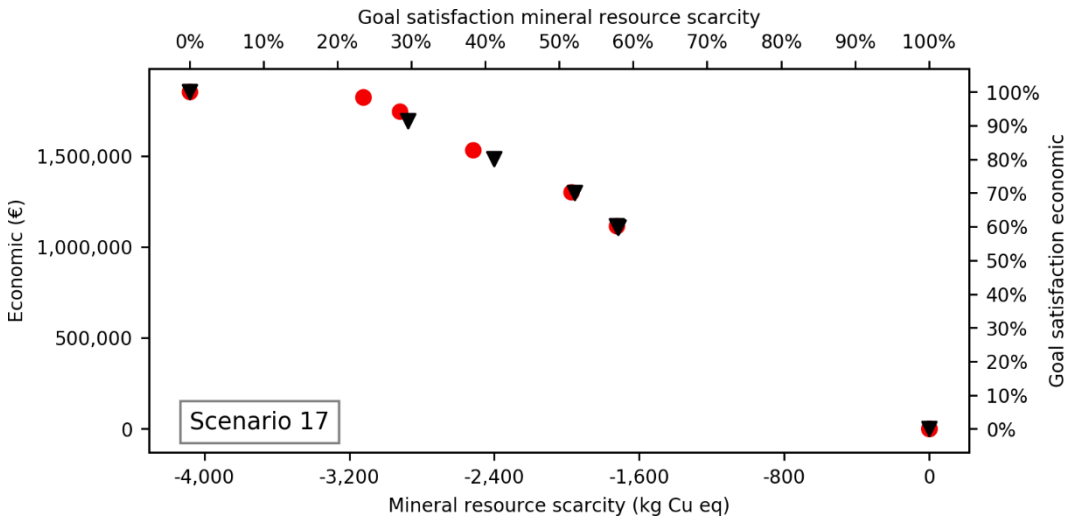

Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1,000,000
800,000
600,000
400,000
200,000
0
Economic (€)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal satisfaction economic
Scenario 12
-4,000
-3,200
-2,400
-1,600
-800
0
Mineral resource scarcity (kg Cu eq)

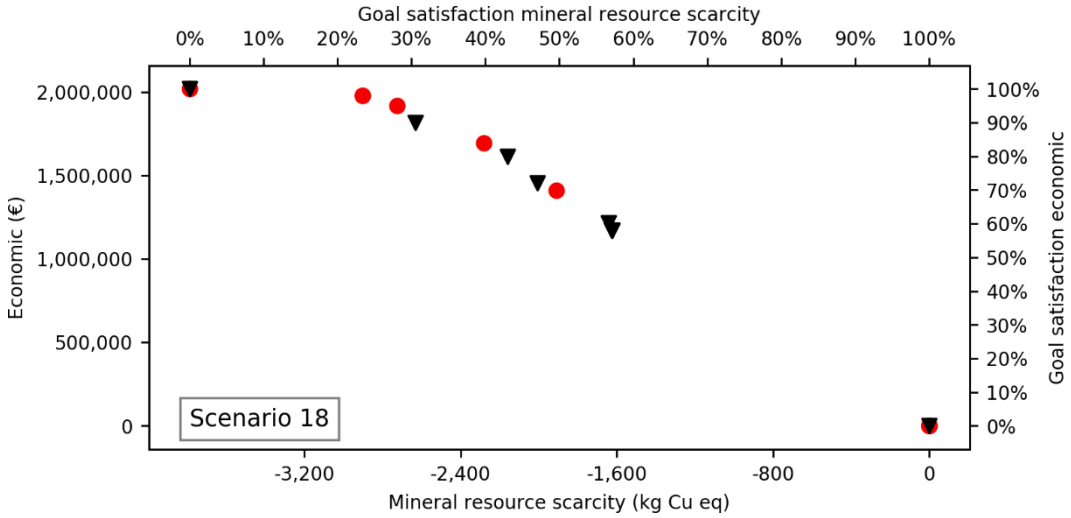

Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Economic (€)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal satisfaction economic
Scenario 13
-4,000
-3,200
-2,400
-1,600
-800
0
Mineral resource scarcity (kg Cu eq)

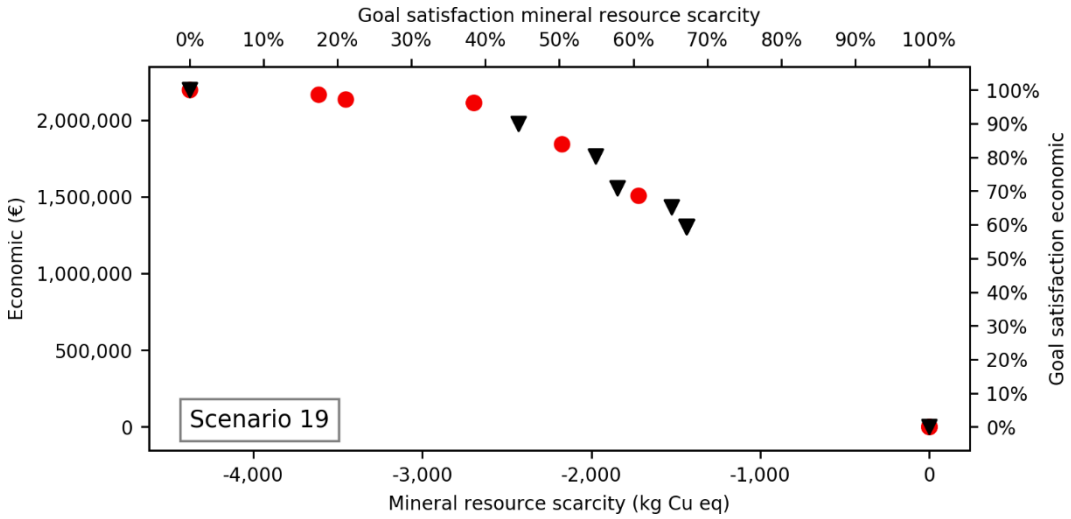

Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Economic (€)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Goal satisfaction economic
Scenario 14
-4,000
-3,000
-2,000
-1,000
0
Mineral resource scarcity (kg Cu eq)

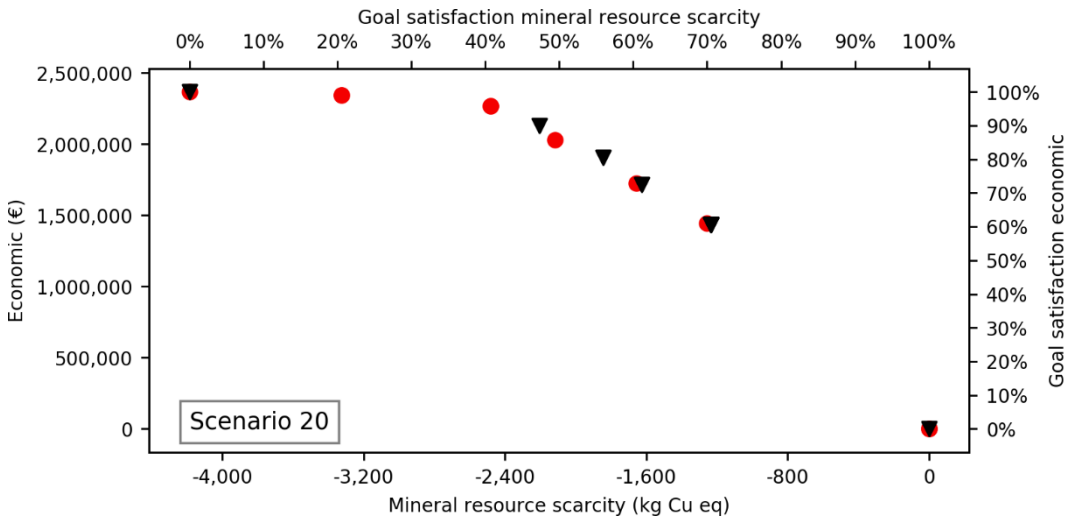

Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1,500,000
1,250,000
1,000,000
750,000
500,000
250,000
0
Economic (€)
Scenario 15
-4,000
-3,000
-2,000
-1,000
0
Mineral resource scarcity (kg Cu eq)
Goal satisfaction economic


Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1,750,000
1,500,000
1,250,000
1,000,000
750,000
500,000
250,000
0
Economic (€)
Scenario 16
-4,000
-3,200
-2,400
-1,600
-800
0
Mineral resource scarcity (kg Cu eq)
Goal satisfaction economic


Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1,500,000
1,000,000
500,000
0
Economic (€)
Scenario 17
-4,000
-3,200
-2,400
-1,600
-800
0
Mineral resource scarcity (kg Cu eq)
Goal satisfaction economic


Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
2,000,000
1,500,000
1,000,000
500,000
0
Goal satisfaction economic
Scenario 18
-3,200
-2,400
-1,600
-800
0
Mineral resource scarcity (kg Cu eq)


Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
2,000,000
1,500,000
1,000,000
500,000
0
Goal satisfaction economic
Scenario 19
-4,000
-3,000
-2,000
-1,000
0
Mineral resource scarcity (kg Cu eq)


Goal satisfaction mineral resource scarcity
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Economic (€)
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Goal satisfaction economic
Scenario 20
-4,000
-3,200
-2,400
-1,600
-800
0
Mineral resource scarcity (kg Cu eq)