

An aerial photograph of a city, likely Milan, showing a dense urban landscape with various buildings and a clear sky. A large, semi-transparent blue trapezoidal shape is overlaid on the right side of the image, containing the title text.

QUANTIFIED ENVIRONMENTAL ASPECTS

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OUTLINE



01

Introduction

02

Focus on GHG emissions

03

Focus on ecosystem service loss

04

Conclusions

SOURCES OF ENVIRONMENTAL IMPACT THROUGHOUT THE PROJECT LIFECYCLE

Construction
(2032-2047)

Operation
(2047-2062)

Decommissioning
(2063-2064)

NEGATIVE IMPACT

- Energy use
- Changes in land use
- Material use
- Transport of material
- Construction noise

- (renewable) Energy use
- Collisions of particle beams with matter

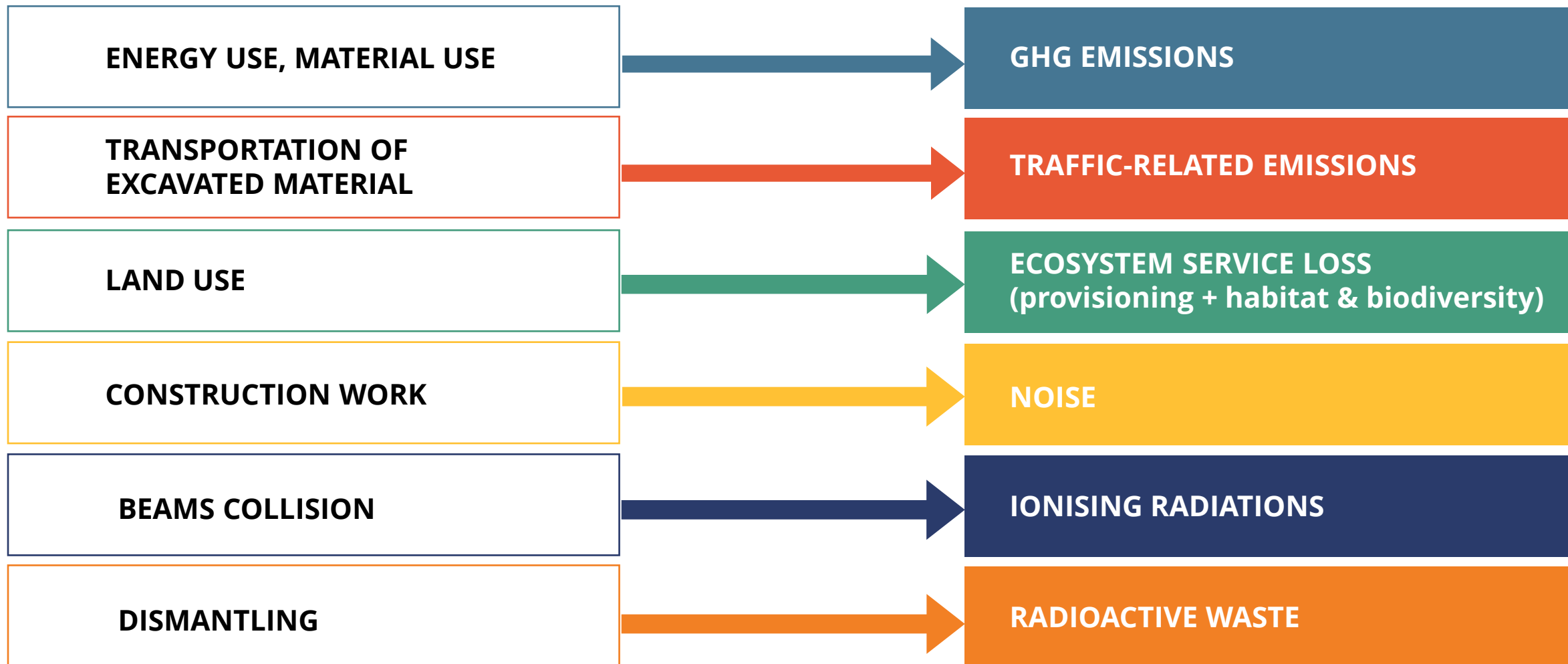
- Dismantling of radioactive facilities

POSITIVE IMPACT

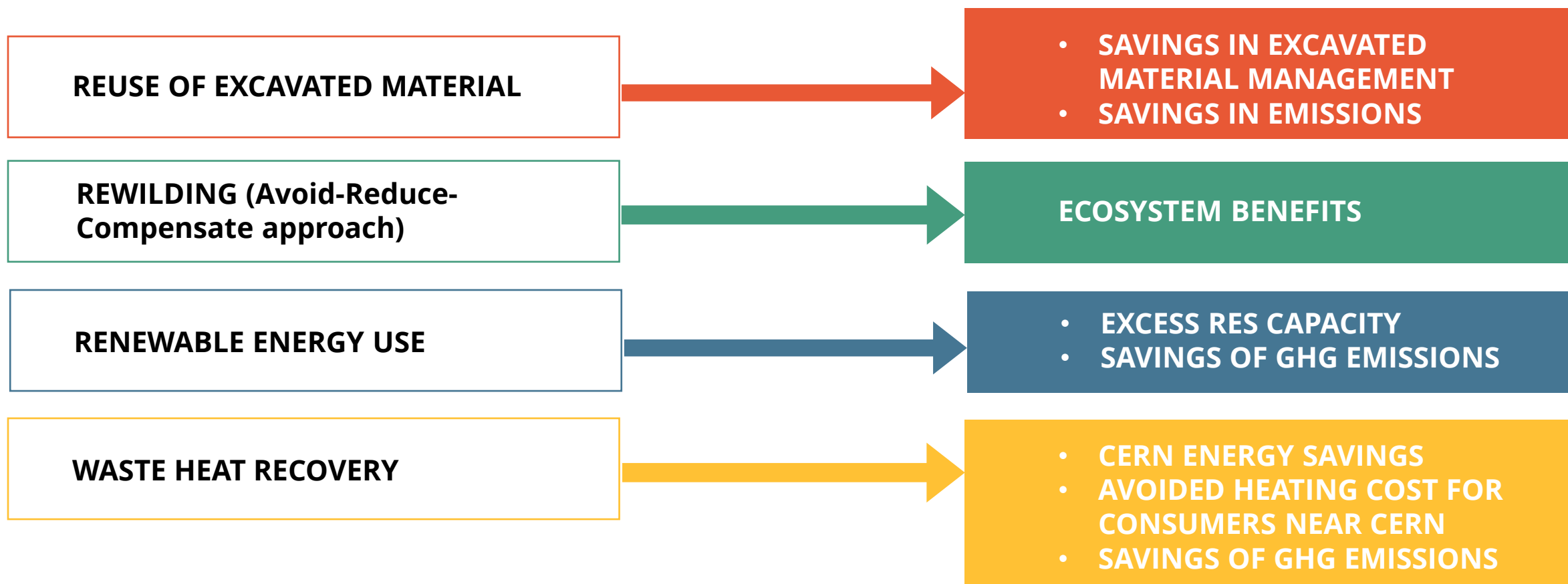
- Reuse of excavated material
- Rewilding

- PPAs for renewable energy
- Waste heat recovery

NEGATIVE IMPACTS

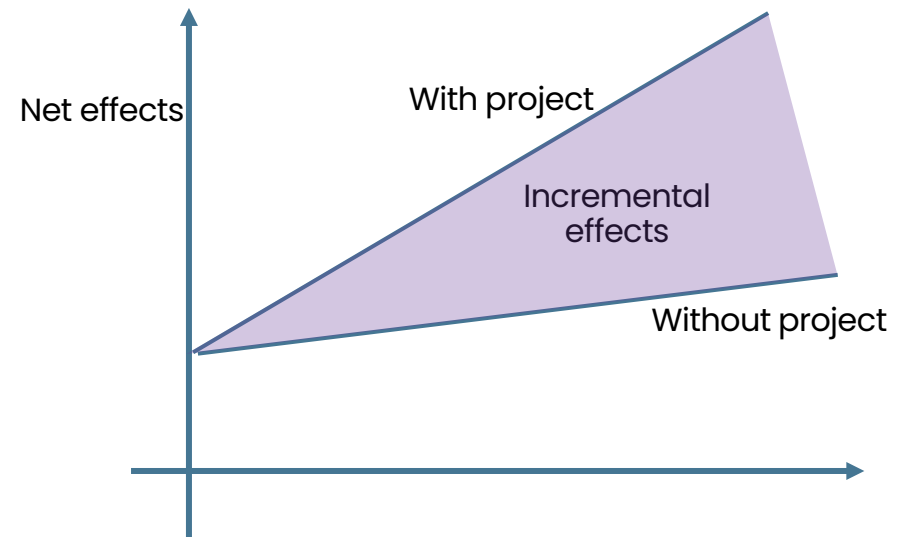


POSITIVE IMPACTS

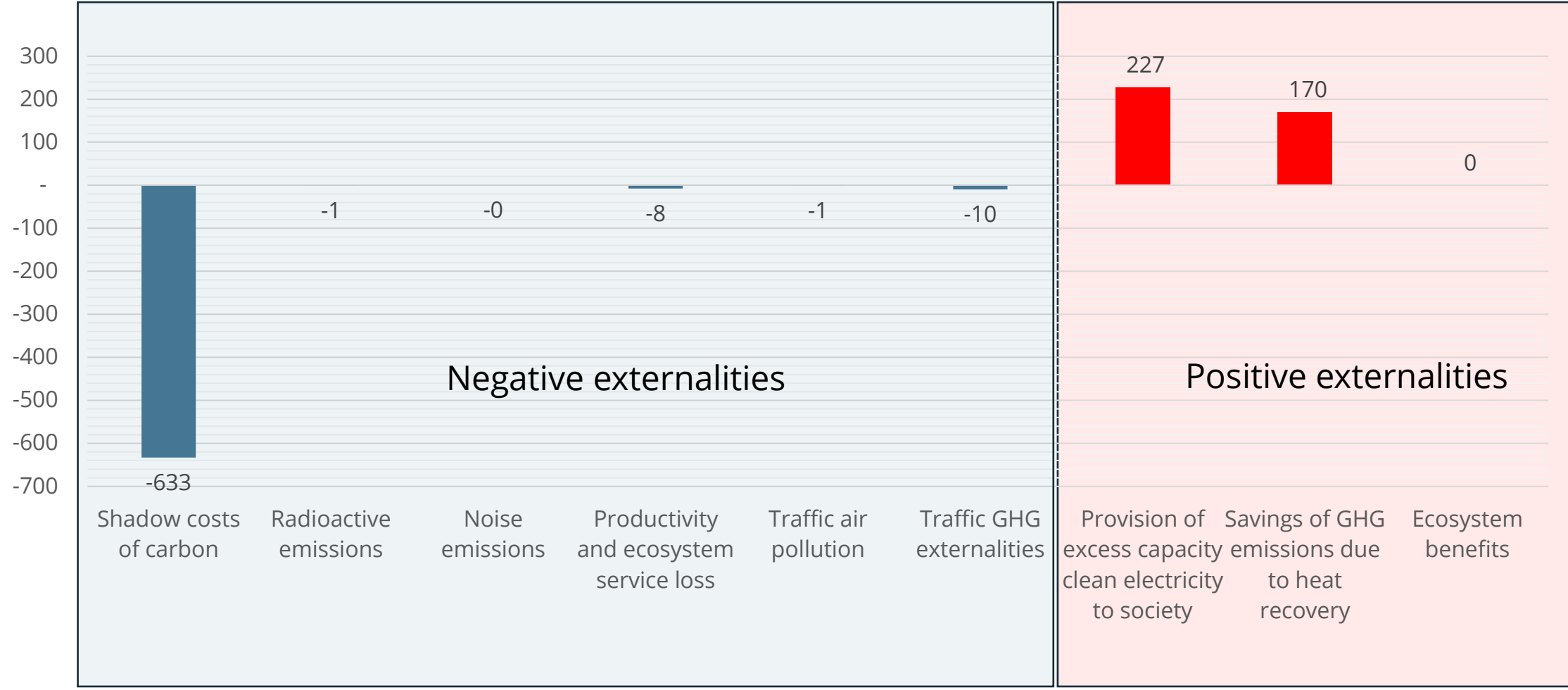


NET ENVIRONMENTAL EFFECTS

- Determining a positive or negative environmental effect depends on the **counterfactual** against which the project is assessed
- **Net effect = Difference between the «with-the-project scenario» and the «without-the-project scenario»**
- «With-the-project scenario» → **FCC-ee**
- «Without-the-project scenario» → **Absence of FCC-ee**. The LHC would continue its operation until its anticipated end of life, and no new particle-collider would be constructed at CERN



Monetised environmental externalities (undiscounted)



Monetised environmental externalities (discounted)



GHG EMISSIONS

STEP 1 -
Quantification

STEP 2 -
Monetisation

STEP 3 - Results

CONSTRUCTION

- **t/CO2 equivalent** generated during construction of the tunnel and the 8 surface sites of FCC-ee were estimated in an **LCA study conducted by WSP**.
- The study was limited to the construction (A1-A5) phase.
- The estimated total emissions were distributed over the construction period according to the workflow

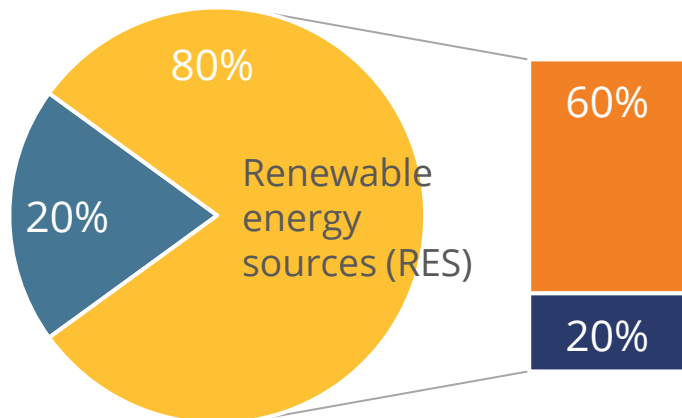


GHG EMISSIONS



OPERATION

- The FCC-ee would require **22.65 TWh during operation**, of which:



■ French electricity grid ■ Wind ■ Solar PV

- In the best-case scenario, the % of electricity from RES would increase to 95%,
- In the worst-case scenario, it would decrease to 60%.

CO₂eq INTENSITY OF FCC-ee ELECTRICITY

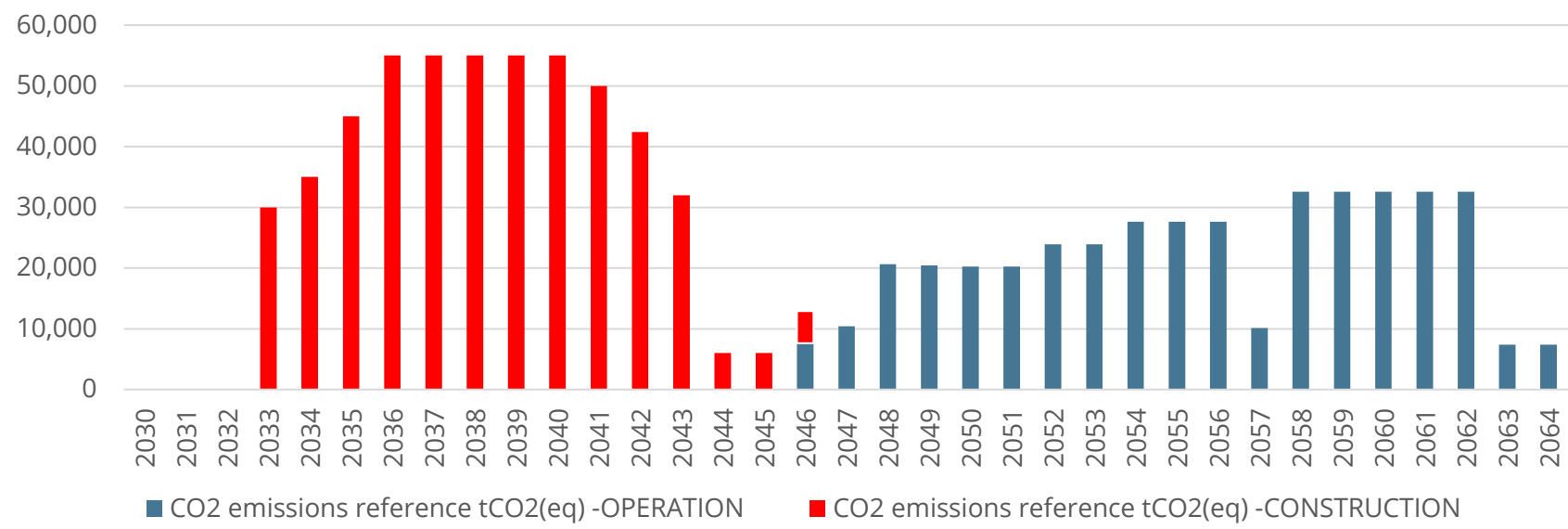
	Share	gCO ₂ eq/KWH (2024)	gCO ₂ eq/KWH (2046)	gCO ₂ eq/KWH (2050)
Baseline scenario				
Off-shore wind	60%	15.60	15.60	15.60
Photovoltaic	20%	25.20	25.20	25.20
Grid mix	20%	58.00	23.68	20.07
Combined factor	100%	26.00	19.10	18.41
Best-case scenario				
Off-shore wind	75%	15.60	15.60	15.60
Photovoltaic	20%	25.20	25.20	25.20
Grid mix	5%	58.00	18.76	15.28
Combined factor	100%	19.64	17.68	17.50
Worst-case scenario				
Off-shore wind	40%	15.60	15.60	15.60
Photovoltaic	20%	25.20	25.20	25.20
Grid mix	40%	58.00	29.68	26.27
Combined factor	100%	34.48	23.15	21.79

Source: ADEME Base Carbone for emission factors of off-shore wind, photovoltaic and FR consumption mix in 2024.

GHG EMISSIONS



Total GHG emissions (tCO2 eq)



Note: The graph refers to the baseline scenario, non-optimised, in tCO2eq, 2030-2064

UNIT: tCO2(eq)	Baseline	Best-case scenario	Worst-case scenario
Emissions for tunnel and surface structures construction	526,671	526,671	526,671
Scope 2 emissions related to operation	418,195	396,745	495,698
TOTAL	944,866	923,416	1,022,369
TOTAL OPTIMISED	850,693	833,534	912,696

GHG EMISSIONS



- Reference used for the value of one unit CO₂eq: **European Commission (2021) Vademecum for the economic appraisal.**

Table 4. Recommended shadow cost of carbon for 2020–2050 ()*

Year	EUR / t CO ₂ e	Year	EUR / t CO ₂ e	Year	EUR / t CO ₂ e	Year	EUR / t CO ₂ e
2020	80	2030	250	2040	525	2050	800
2021	97	2031	278	2041	552		
2022	114	2032	306	2042	579		
2023	131	2033	334	2043	606		
2024	148	2034	362	2044	633		
2025	165	2035	390	2045	660		
2026	182	2036	417	2046	688		
2027	199	2037	444	2047	716		
2028	216	2038	471	2048	744		
2029	233	2039	498	2049	772		

(*) Prices in Euro 2016

Source: DG CLIMA (2021)

- 2024: 1 t/CO₂eq = 148 EUR** (in 2016 prices), equivalent to 144 CHF.
- The value increases over time to reflect the rising marginal cost to society of producing an additional unit of emissions.
- 2050: 1 t/CO₂eq = 800 EUR** (in 2016 prices), equivalent to 777 CHF/ton.
- Adjustment of the 2016 prices with the **GDP deflator**

GHG EMISSIONS



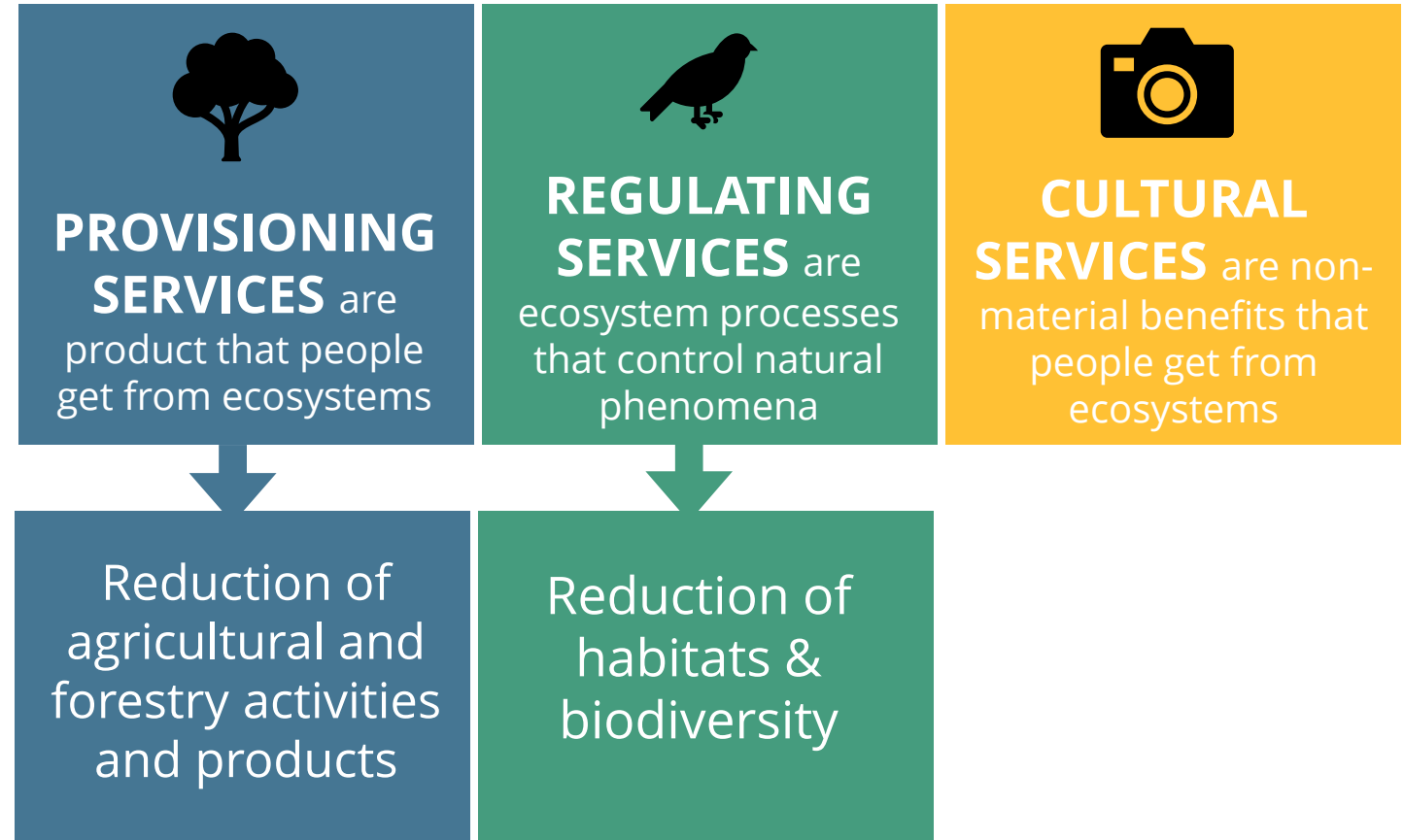
Total estimation - under different scenarios (CHF)

Scenario	Not discounted	Discounted
Baseline	633,079,473	341,308,153
Worst-case scenario	693,661,167	366,863,543
Best-case scenario	616,349,004	334,208,664

ECOSYSTEM SERVICES (ES)

- Integration of ES analysis into CBA is still **limited in practice**
- **Growing importance** both in France and at international level

Classification based on TEEB – The Economics of Ecosystems and Biodiversity – Initiative



ECOSYSTEM SERVICES (ES)

- Total land area studied: **76.2 ha**, 92% in France and 8% in Switzerland.
- France's Legal Framework:
 - For forest clearance and for agricultural economy losses of a territory mandates **compulsory measures to compensate**.
 - For biodiversity, the Environmental Code mandates the "**Avoid-Reduce-Compensate**" (ERC) approach → Projects must ensure **biodiversity gains \geq biodiversity losses** → based on the initial state analysis, the residual impact on biodiversity is expected to be low.

ECOSYSTEM SERVICES (ES) IMPACT



Reserved area:

Site	Total Area (ha)	... of which in France	... of which in Switzerland	...of which agricultural land	Cultivated	Non cultivated	... of which forest land
PA	13.9	13.9		13.9	13.9	0	
PB	5.9		5.9	5.9	5.9	0	
PD	11.5	11.5		11.5		11.5	
PF	8.3	8.3		8.3		8.3	
PG	10.8	10.8		8.4	4.3	4.1	2.4
PH	11.3	11.3		0.8		0.8	10.5
PJ	8.9	8.9		8.9	8.9		
PL	5.6	5.6		4.9	4.9		0.7
Total	76.2	70.3	5.9	62.6 (82%)	37.9	24.7	13.6 (18%)

Impacted area:

61.0 hectares considered (55.6 ha optimized). The difference between the reserved and the impacted area is made by the sum of portions of cadastral plots reserved for the project but not covered by interventions

ECOSYSTEM SERVICES (ES) IMPACT



Land use/destination change	Hectares affected by land use/destination change		Relevant loss by type of ecosystem's services and land changes	
	Baseline scenario	Optimized scenario	Provisioning services	Regulating and habitat services
Forest land → Constructed area	8.2	5.1	✓	✓
Agricultural land → Constructed area	31.7	20.8	✓	✓
Agricultural land cultivated → Meadow	5.1	10.1	✓	-
Agricultural land → Tree plantation	7.7	15.2	✓	(benefit)
Agricultural land → Wetland	7.8	7.8	✓	(benefit)

ECOSYSTEM SERVICES (ES) IMPACT



PROVISIONING SERVICES → market-based approach

- **Forest** → average value of **294 EUR/ha/year** based on a forest study by external experts (sampling + field visits). Includes soil value and actualized harvesting potential.
- **Agriculture** → average loss value of **3,649 EUR/ha/year** based on a direct investigation of the farming activities in the area reserved for the project. Accounts for direct and indirect (supply chain) loss of agricultural production, including cereal production and other cultivations, forage, etc.

REGULATING & HABITAT SERVICES → value transfer approach → ESVD database, → biome = temperate forest, intensive land use/cropland, wetlands; and geographical area = Europe.

- **Forest: 533 EUR/ha/year** (min 20 EUR/ha/year, max 6,625 EUR/ha/year).
- **Agricultural: 574 EUR/ha/year** (min 8 EUR/ha/year, max 4,854 EUR/ha/year).

ECOSYSTEM SERVICES (ES) IMPACT



- Estimated by applying **per-hectare values** (provisioning + regulating/habitat services) to the **impacted land area**, starting **one year before construction** and continuing through the full analysis period
- In the best- and worst-case scenarios, the lower and higher bound values retrieved for monetization were adopted.

Total estimation - under different scenarios (CHF)

Scenario	Not discounted	Discounted
Baseline	7,638,426	4,144,449
Optimistic	2,733,810	1,509,507
Pessimistic	25,691,824	13,486,313

CONCLUSIONS

- **Negative environmental externalities represent a small share (1.7%) of the total costs** associated with the FCC-ee
- The analysis conducted so far has identified a range of costs and benefits likely to arise from the implementation of the FCC-ee as currently designed.
- However, due to uncertainties at this stage, environmental benefits are not included in the core calculations of the net present value and benefit/cost ratio.
- As the FCC project evolves, the assessment of environmental effects will need to be updated to reflect new developments

CONCLUSIONS

	Share of the total	Not discounted	Discounted
TOTAL COSTS (MCHF)	100%	38,308	20,020
INVESTMENTS (CAPEX)	50.8%	16,215	10,171
OPERATION COSTS (OPEX)	47.1%	21,212	9,423
NEGATIVE EXTERNALITIES	1.7%	653	354
SHADOW COST OF CARBON*		633	341
SOCIAL COST OF IONISING RADIATION		1.3	0.6
SOCIAL COST OF PROJECT-RELATED INDUCED NOISE		0.02	0.02
LOSS OF AGRICULTURAL INCOME, BIODIVERSITY & HABITAT		8	4
SOCIAL COST OF PROJECT-RELATED TRAFFIC-INDUCED AIR POLLUTION		1	1
SOCIAL COST OF PROJECT-RELATED TRAFFIC-INDUCED GHG EXTERNALITIES		10	7
DECOMMISSIONING COSTS**	0.4%	228	72
TOTAL CORE BENEFITS (MCHF)	100%	57,244	24,092
SCIENTIFIC PRODUCTION	11.7%	6,515	2,817
EARLY CAREER RESEARCHER TRAINING	20.7%	20,687	4,986
INDUSTRIAL BENEFITS FOR SUPPLIERS	39.7%	17,577	9,569
OPEN SOFTWARE (EXPERIMENTS AND DETECTORS)	18.2%	7,428	4,375
CULTURAL BENEFITS	9.7%	5,037	2,344
NET PRESENT VALUE (MCHF)			4,071
BENEFIT / COST RATIO			1.20

Notes: Discounted values at 0.028 Social Discount Rate. *Construction of the tunnel and surface sites and the operation phase. GHG emissions associated with the construction of the accelerators are not included. **Since no complete estimation of these costs is available, they were approximated using the dismantling costs estimated at CERN, although being aware that decommissioning costs are generally higher than dismantling costs

An aerial photograph of the Milan cityscape, showing a dense urban area with various buildings, including a prominent brick building in the foreground. A semi-transparent dark blue triangle is overlaid on the right side of the image, containing the text 'THANK YOU'.

THANK YOU