

L'empreinte carbone du Luxembourg et le chemin vers la neutralité

Fondation IDEA

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THE GOVERNMENT OF THE GRAND DUCHY OF LUXEMBOURG Ministry of the Environment, Climate and Biodiversity Agenda



Carbon footprint accounting





Luxembourg in Transition





GHG EMISSIONS ACCOUNTING

1. Consumption-based

Bottom up: From household consumption surveys Top-down: From national inventories

2. Production-based

Top-down: From national inventories

GHG EMISSIONS EMBODIED IN Imports, domestic production, exports, and final consumption



Source: LIST calculations

Consumption vs production-based accounting



Due to international trade, rich countries "import" carbon emissions, while poorer countries export it

OECD Carbon dioxide emissions embodied in international trade https://www.oecd.org/sti/ind/carbondioxideemissionsembodiedininternationaltrade.htm

Consumption vs Production-based accounting (LU)

How reliable is top-down (MRIO) data?





Consumption GHGs emitted anywhere due to consumption in LU (11.7 Mt or 18.6 t/cap) Affected by daily purchase decisions Not subject to official targets 18.6 Unofficial target based on Paris Agreement 2°C: 1 to 2 t CO₂eq per capita per year by 2050 -90% Public services. 1.5 2104, 18% 2020 2050 Consumption goods 1663 14% Food, 2225,

19%

MECB calculations using data from LU's GHG Inventory, PNEC, STATEC consumption-based footprint, LIST sector shares of consumption-based footprint

Mobility,

3019, 26%

Housing,

2691, 23%

Production-based GHG Emissions

Aggregate effects of policies and measures by sector compared to 2021 GHG emissions (**kt CO₂eq**)

Reduction compared to	2030	2050
GHG emissions in 2021		
Industry (Energy and manufacturing	-44%	-82%
industries, construction)		
Transports	-53%	-93%
Residential and commercial buildings	-44%	-100%
Agriculture and forestry	-24%	-33%
Waste and wastewater treatment	-19%	-18%



PNEC

Consumption-based GHG Emissions

Decarbonization measures (t CO₂eq/capita/year)



Source: CarbonNerd, LIST

Types of measures



SLoCaT (2018). Transport and Climate Change Global Status Report 2018. Available at: http://slocat.net/tcc-gsr

Who needs to act? What kind of action?

Type of action / actor	Reduction (t CO ₂ eq /cap/year)	Share of total reduction needed
Individual/behavioral	- 7.3	57%
Public/systemic	- 8.5	67%

Shift to different mode of consumption / Improve	- 8.1	64%
Avoid/reduce consumption (sufficiency)	- 4.6	36%

01 | LUXEMBOURG IN TRANSITION

Consultation launched by the Ministry of Energy & Spatial Planning



LUXEMBOURG IN TRANSITION

Spatial visions for the low-carbon and sustainable future of the Luxembourg functional region

Inspired by other large-scale consultations that have been conducted, such as those for Greater Paris and Greater Geneva

TRANSITION

Gather strategic spatial planning proposals Produce "towards 2050" ecological transition scenarios for Luxembourg Stage 1 10/20 – 01/21 (11 teams) Transition metric Stage 2 02/21 – 05/21 (7 teams)

Cross-border functional region

Stage 3 06/21 – 11/21 (4 teams) Demonstration projects

More at https://luxembourgintransition.lu/en/teams/



DECARBONIZING REGIONS USING THE LCA METHODOLOGY Challenges

Calculate the carbon footprint of the Luxembourg Greater Region (dubbed "functional area")

Define several interventions across multiple sectors (mobility, housing, agriculture, consumption goods, public sector)

Calculate life-cycle impact on environmental metrics (GHG, local air pollutants, N, P)

Combine everything into a decarbonization path to meet the Paris 2°C target

Take into account the expected increase in population (+48% in LU, +15% in the functional area from 2020 to 2050)

Luxembourg Functional Area in darker brown (Numbers represent crossborder workers)



Source: Geographical Information System of the Greater Region (sig-gr.eu, 2019)



METHODOLOGY

Mix and match data sources across sectors

Process

- Start with the sector's contribution to the 2020 carbon footprint (populationweighted average to get FA)
- 2. Draw up a suite of interventions that are technologically feasible (realistic?)
- 3. Calculate the combined impact of these interventions on GHG (and N, P, PM) emissions using life-cycle emission factors
- 4. Dial up interventions as necessary to
 ¹⁵ meet the target

Data

- Mobility, housing, carbon sequestration from the national inventories and JRC's EU REF scenarios (EUCALC http://tool.european-calculator.eu/)
- Food from an input-output LCI (EXIOBASE v.3.8, Behrens et al. 2017)
- Consumption goods and public services from bottom-up consumption-based footprint (LIST calculations)



DECARBONIZATION TARGET TO MEET THE PARIS AGREEMENT 2°C SCENARIO

Carbon footprint of the functional area in 2020 and target in 2050 (t CO2eq / cap / yr)

2020	10% Mobility (fuel tourism)	19% Mobility (domestic)	6% Mobility (aviation)	21% Housing	19% Consumption goods	12% Food	12% Public services	15.5
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Paris Agreement Target for 2050



POPULATION GROWTH, HOUSING, AND MOBILITY STRATEGY

Urban Densification: Spatial planning as an enabler of low-carbon lifestyles



No new net land take

Reduce living space per person



Expand the tram network

Densify and overbuild to prevent sprawl and make future public transportation systems more efficient



O2 | **DECARBONIZATION**



Building energy in Luxembourg and functional area (FA), in TWh



50 Mobility in Luxembourg and functional area (FA), in Gpkm



🥢 Walk FA

FOOD AND AGRICULTURE

Shift diet and production away from meat

Only a 13% of land is used directly for food production and 87% of our land is used for livestock production.

Strategy: Maintain permanent grassland but reduce feed production by shifting to pasture-raised cattle

Free up land for a more diversified crop mix in 2050

Shift to agro-ecological / organic production methods

Shift to flexitarian diet (omnivore 1 day/week, vegetarian 6 days/week) to reduce food-related emissions by 40%

GHG emissions embodied in diets (kg CO₂eq per capita per year)



O3 CARBON UPTAKE

Land use change, nature-based solutions



CARBON SEQUESTRATION ESTIMATES OF OUR STRATEGIES

kt CO2eq/year

	2030	2040	2050	Notes
Green roofs	11	22	34	43.7 million m^2 of green roof determined by excluding good PV roofs, 770g CO2/m ² /year (Penman et al. 2003).
Grassland	63	126	189	Gradual shift to sustainable grassland management. In 2050, 15.5 kg C/ha/year for grassland (Othoniel et al. 2019), 333 thousand ha grassland in the FA.
Arable land	120	239	359	Gradual shift to sustainable/organic production on arable land. In 2050, 250 kg C/ha/year for arable land under organic production (Sanders and Hess 2019), 392 thousand ha arable land in the FA.
Trees in meadows (silvopasture)	65	130	195	Carbon sequestration of 0.16-0.48 t C/ha/yr (Kay et al. 2019, for silvopasture in France). We use the average of 0.32 t C/ha/yr on 333 thousand ha grassland in the FA and assume that 50% of the grassland do silvopasture.
Hedges and trees on field edges	147	294	441	Field edge assumption: Width of 4m (2m on each side of a field edge), for all field edges in cropland, excluding field edges that border streets or forest, resulting in 245 million m ² land in hedgerows. 4.9 t C/ha/year for part managed and part unmanaged hedgerows (Organic Research Centre 2015).
Riparian buffers	456	913	1,369	Riparian buffer area of 762 km ² in the FA, conservatively assume the same CO2 uptake as hedgerows.



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Path, timeline, and actors



Summary of interventions (1/3)

"Mobility combined measures" includes our strategies to reduce demand for transportation, halve the national car fleet, increase car-sharing from 1.2 to 1.6 passengers/vehicle, shift to public transportation and soft mobility, as well as a decarbonisation of these modes of transport over time through increased electromobility. "Mobility no fuel tourism incentive" means that Luxembourg's fuel taxes are aligned with those of its neighbours.

"Mobility aviation -90%" involves consumers taking the train instead of flying when a less than 5 hour train alternative exists, and limiting flying to only one flight every two years.



Summary of interventions (2/3)

"Housing combined measures" includes a reduction in living space from 53 to 35 m2 per person, increasing efficiency to 110 kWh/m2 and phasing out fuel oil and natural gas.

"Food diet shift" includes shifting diets to a flexitarian diet that is vegetarian for 6 days per week and omnivore for 1 day per week, while **"food waste 25% to 5%**" reduces the share of food waste from 25% to 5%.

"**Consumption goods -88%**" includes extending new product lifetimes by a factor of 2, increasing the sharing economy to get double the service per product, and created a large-scale second-hand market for a second product life.

"Public services decarbonisation" involves decarbonising the public service sector by 50%.



Summary of interventions (3/3)

"Electricity decarbonisation" includes decarbonisation of electricity produced in the functional area and imported from neighbouring countries, but excludes the increase in electrification already accounted for in "mobility combined measures" and "housing combined measures." Finally, the "**rest of measures**" includes decarbonisation of freight and refrigeration.



Overall impact of decarbonization measures 2020-2050 in the FA (t CO₂ eq./cap)



Decarbonisation path, in t CO_2 eq capita⁻¹ year⁻¹ (Mt year⁻¹) 18 Remaining measures 16 15 t (32 Mt) Mobility combined 14 measures Mobility aviation -90% 12 12 t (26 Mt) Mobility no fuel tourism incentive 10 Housing combined measures 8 Food diet shift 6 t (15 Mt) 6 Food waste 25% to 5% 1.6 t (3.8 Mt) Consumption goods -4 90% 2 Public services decarbonisation 0 Electricity 2030 2040 2020 2050 decarbonisation Carbon sequestration -2 -1.6 t

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Merci

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