
Beyond
Lux(e)!

Luxembourg in Transition: A Roadmap to 2050

With one of the largest ecological footprints in the world, Luxembourg and its surrounding regions have both an obligation and an opportunity to set a precedent through structural transition that leverages the commitment and ingenuity of its people to improve equity and quality of life for all Luxembourgers. Technology alone is not the solution. The calculations of all Luxembourg in Transition teams demonstrate that only an integrated response from government, communities, industry, and individuals can catalyze the 90% reduction of greenhouse gases necessary to achieve the net-zero carbon goal. Interventions for decarbonisation and resilience in Luxembourg by 2050 will affect all aspects of society, but this transition map illustrates how these changes can set the course for a transition that aspires beyond economic growth and environmental resilience to achieve spatial, social, and environmental justice.

Over the course of the last century, Luxembourg has transformed its agrarian economy to an industrial powerhouse, and finally to a service nation. It has an inherent capacity to implement profound change in only a few decades. Harnessing this strength is the departure point for the net zero transition journey. Given the current state of affairs, there is but one choice: act. Act now. A zero-carbon Luxembourg in 2050 begins today. The following seven principles create a framework for the journey to 2050.

1. Take no more land
- + Build only on land that is already sealed and densify.
- + Build less, transform more, prioritize renovation and adaptive re-use.
- + Expand the public transportation system and optimize existing roads and soft mobility networks.

2. Work with water resources
- + Make water a central topic of spatial planning and design.
- + Make river water potable.
- + Integrate flood management for territorial spatial planning.

3.Mix functions on all levels
- + Transform mono-functional activity zones to multi-functional spaces.
- + Encourage citizens to work where they live, and live where they work, enhancing the affordable housing stock in mixed-use areas.
- + Mix modes of transport and reduce the volume of mobility through an urbanism of proximity.
- + Multiply rural land use to combine agriculture, forestry, recreation, biodiversity, and water management.
- + Cultivate productive green areas within cities.

4.Adapt agricultural practices and change diet
- + Promote zero carbon farming: a productive agriculture considering sequestration.
- + Develop agroforestry, silviculture, and its value-chains.
- + Develop new crops, research and develop meat alternatives to foster dietary change.
- + Reduce meat and dairy production.

5.Develop a land and housing policy for the common good
- + Consider the bio-functional region as territory of shared resources.
- + Support affordable housing solutions for all members of society, as well as community-based, decentralized housing distribution management.
- + Implement measures that prevent speculation of land for private profits.

6.Challenge the mobility hierarchy
- + Make public transport more convenient than individual vehicular transport, and train travel more convenient than air travel.
- + Transform the car-centric city into the pedestrian- and bike-friendly city.
- + Support investments in clean and soft mobility options.

7.Boost alternative ecological economies and initiatives
- + Champion sustainable practices, renewable energy and storage infrastructure.
- + Scale-up civil initiatives in the sectors of energy production, repair and food, housing and living environment.
- + Federate alliances of existing civic best practices through a ‘Chamber of Commons’.

The 4 teams that were invited by the Minister of Energy and Environmental Planning -
2001 / LOLA / 51NE4 with Endeavour, YellowBall, TUK, ETHZ, Transsolar, Systematica, OFC and Gregor Waltersdorfer
AREP / TAKTYK with Quattrolibri, SU-ITE, Mobil’Homme
MVRDV / DRIFT / H+N+S with Deltares, Goudappel, Transsolar, UTwente
University of Luxembourg + LIST + CELL + IBLA + OLM

Beyond Lux(e)!

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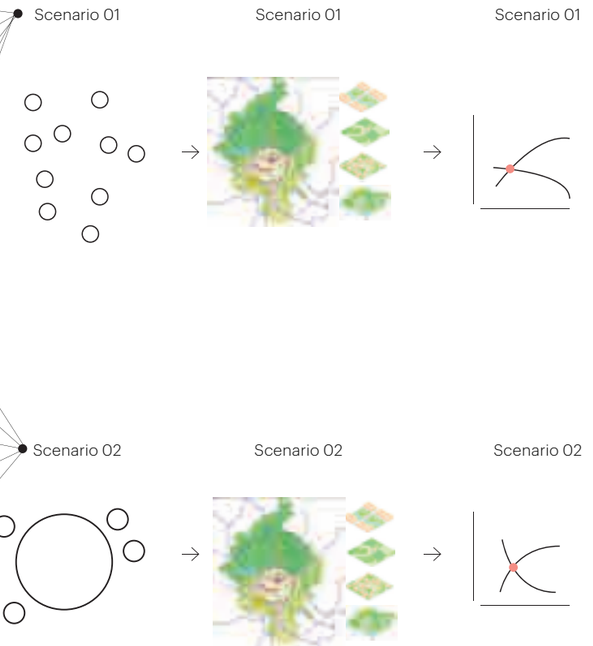

Forecasting

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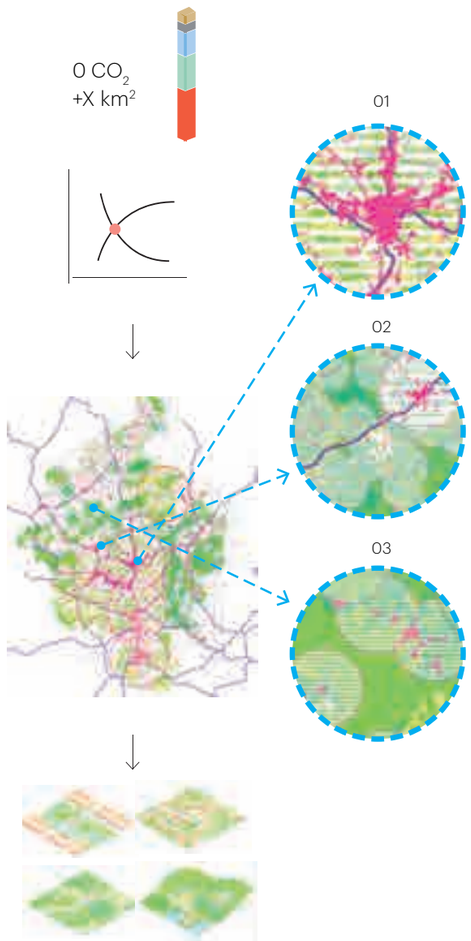


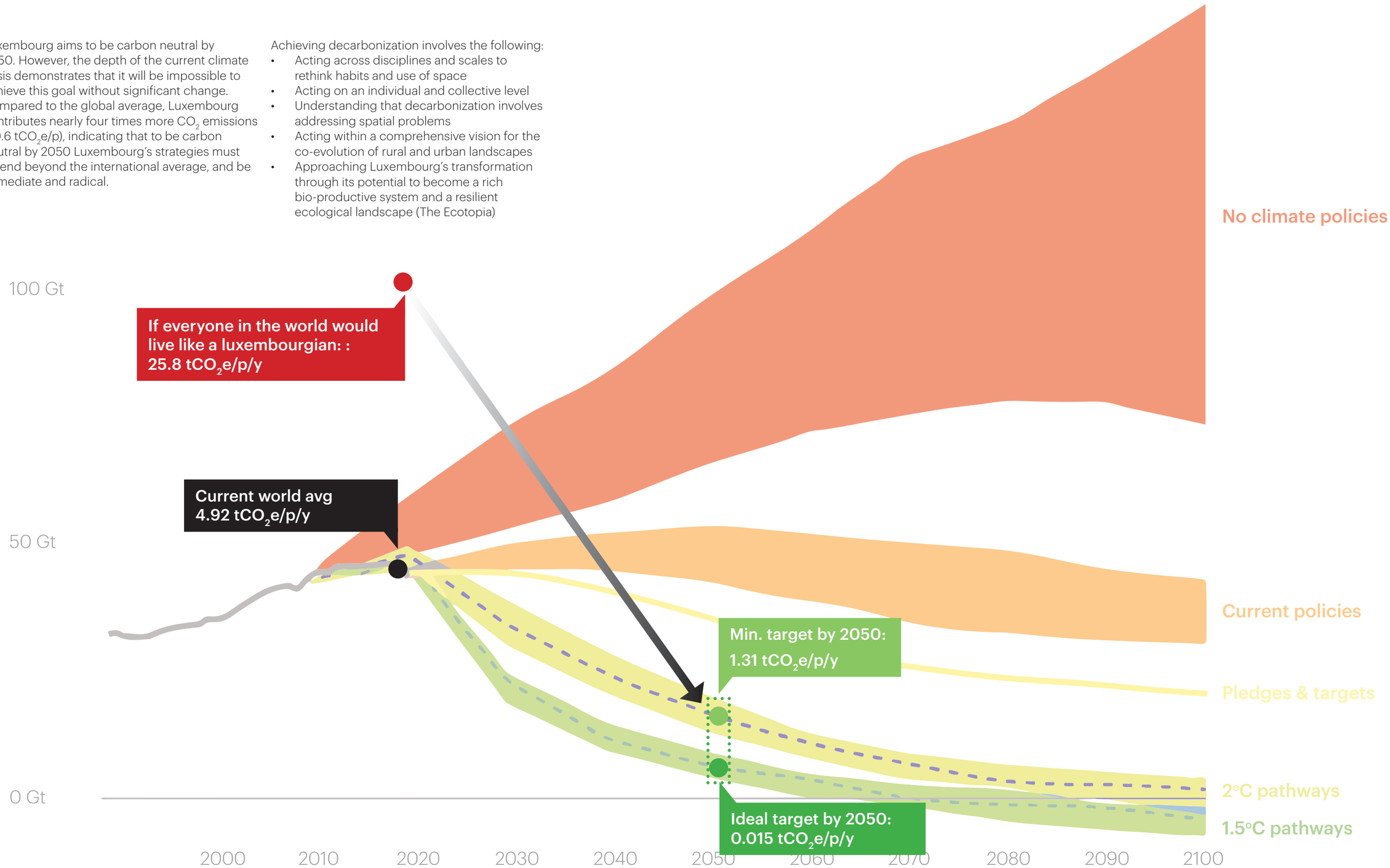
Tasks & Ambitions

What is Lux's decarbonization goal?

Luxembourg aims to be carbon neutral by 2050. However, the depth of the current climate crisis demonstrates that it will be impossible to achieve this goal without significant change. Compared to the global average, Luxembourg contributes nearly four times more CO_2 emissions (20.6 tCO_2e/p), indicating that to be carbon neutral by 2050 Luxembourg's strategies must extend beyond the international average, and be immediate and radical.

Achieving decarbonization involves the following:

- Acting across disciplines and scales to rethink habits and use of space
- Acting on an individual and collective level
- Understanding that decarbonization involves addressing spatial problems
- Acting within a comprehensive vision for the co-evolution of rural and urban landscapes
- Approaching Luxembourg's transformation through its potential to become a rich bio-productive system and a resilient ecological landscape (The Ecotopia)



https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

How does Luxembourg compare?

Given this size and Luxembourg's considerable dependency on neighbouring nations, comparison to other European regions is more illustrative than comparisons with entire countries. For example, Luxembourg's size and scale compares to Switzerland's Grand Geneve, and is at least four times smaller than the Netherlands' Randstad area, or France's Ile-de-France.

Despite its small size, population, and low in density, Luxembourg is an economically wealthy nation, with the highest GDP per capita in Europe, and the third highest internationally. It has twice the GDP per capita of the Netherlands.

Though Luxembourg is small, due to these critical variables, is has considerable potential to be a driving force for sustainable growth within its region of influence.

Ecotopia advances strategies that intensifies fragmented territories and cities, maximising the productive activities of the landscape, while limiting peri-urban, and suburban expansion.

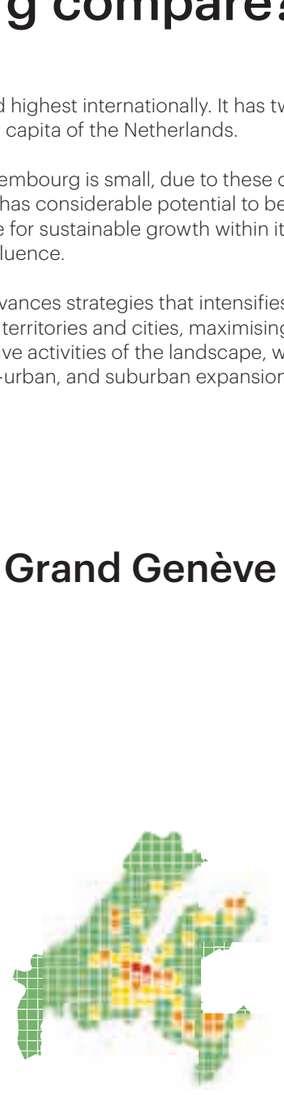
Luxembourg

242
inhabitants
/km²

GDP: €102k per capita

Land: 2,586 km²
Population: 0.63 million

Grand Genève

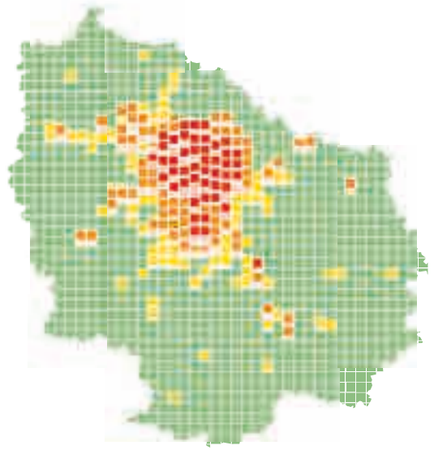


500
inhabitants
/km²

GDP: €75k per capita

Land: 2,009 km²
Population: 1.01 million

Ile-de-France

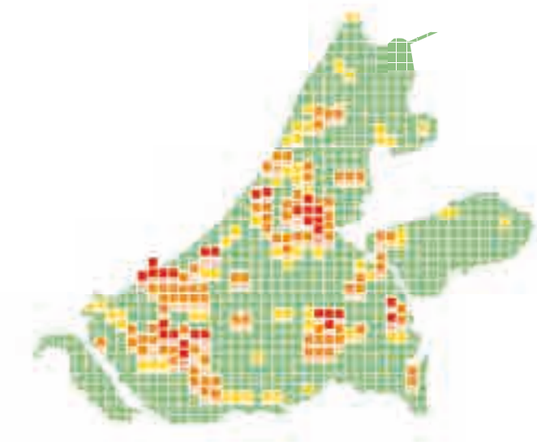


1022
inhabitants
/km²

GDP: €61k per capita

Land: 12,012 km²
Population: 12.28 million

Randstad



735
inhabitants
/km²

GDP: €51k per capita

Land: 11,372 km²
Population: 8.36 million

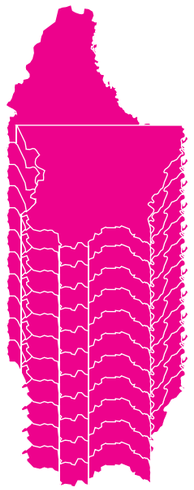
GDP source: https://ourworldindata.org/grapher/gdp-per-capita-worldbank
Density map source: https://luminocity3d.org/WorldPopDen/#3/12.00/10.00

How much is Luxembourg consuming?

To achieve its decarbonization goal, Luxembourg has some strides to make. It has the second largest ecological footprint per person in the world, and a 955% biocapacity deficit. This means the population's needs exceed the capacity of Luxembourg's area to sustain itself, requiring an area 10.5 times the country's current size. It has real spatial problems to address in its larger pursuit of decarbonization. The question is: how do Luxembourg's increasing demands "fit" into its territory?

The three other regions in this comparison (Grande Geneve, Ile-de-France, and the Ranstad), face similar challenges, so with the right strategies, Luxembourg can drive and influence changes in these regions as well, emerging as a strong precedent.

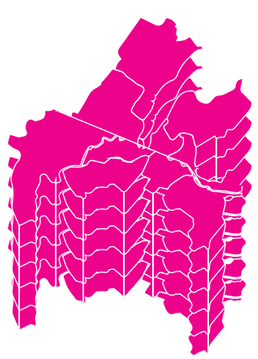
Luxembourg



10.5 x Luxembourg
(12.8 gha/p)

Land: 2,586 km²
Population: 0.63 million

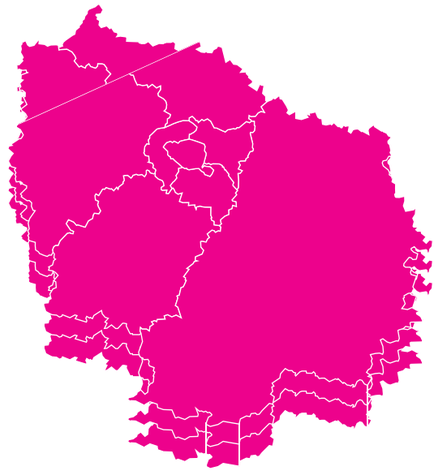
Grand Genève



4.4 x Switzerland
(4.47 gha/p)

Land: 2,009 km²
Population: 1.01 million

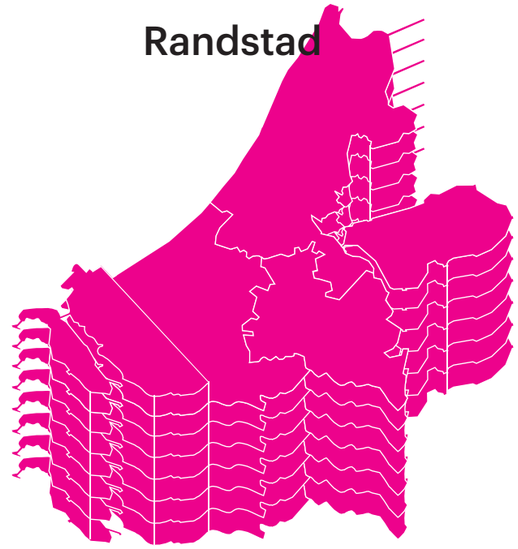
Ile-de-France



1.8 x France
(4.6 gha/p)

Land: 12,012 km²
Population: 12.28 million

Randstad

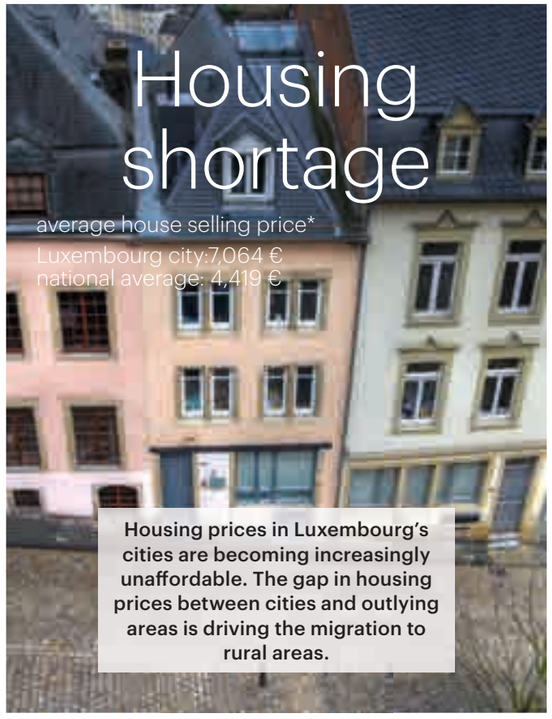


6.2 x Netherlands
(5.02 gha/p)

Land: 11,372 km²
Population: 8.36 million

* calculated based on country's average
Sources: https://data.footprintnetwork.org/#/compareCountries?type=EFCpc&cn=all&yr=2017

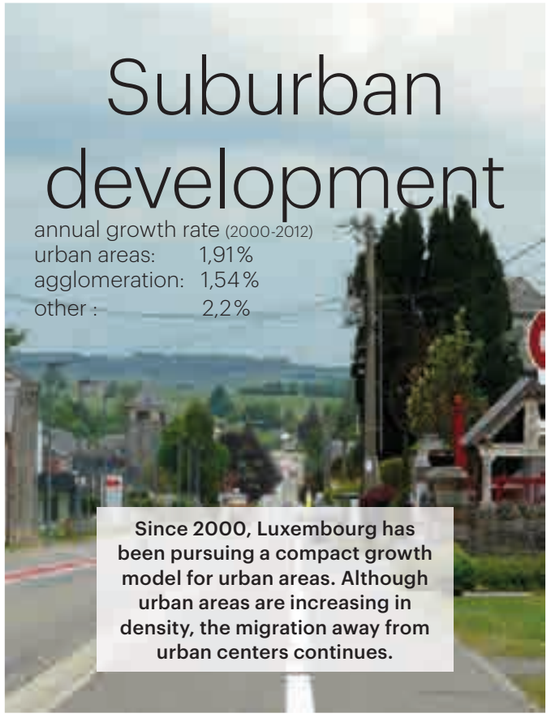
Luxembourg is unsustainable



Housing shortage

average house selling price*
Luxembourg city:7,064 €
national average: 4,419 €

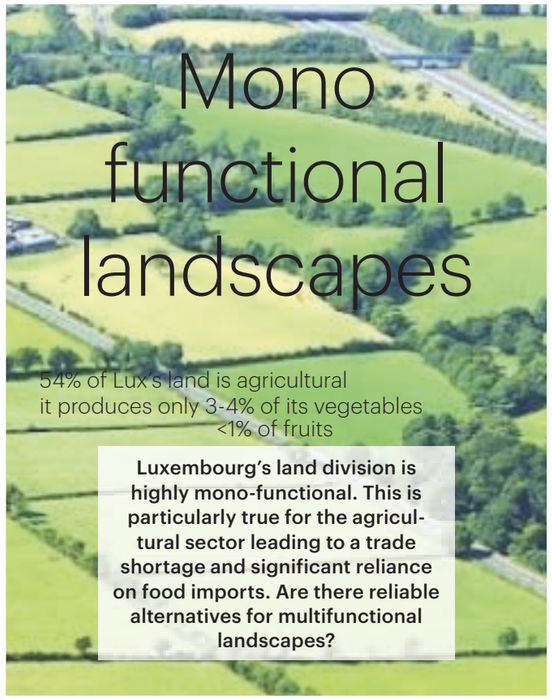
Housing prices in Luxembourg's cities are becoming increasingly unaffordable. The gap in housing prices between cities and outlying areas is driving the migration to rural areas.



Suburban development

annual growth rate (2000-2012)
urban areas: 1,91%
agglomeration: 1,54%
other : 2,2%

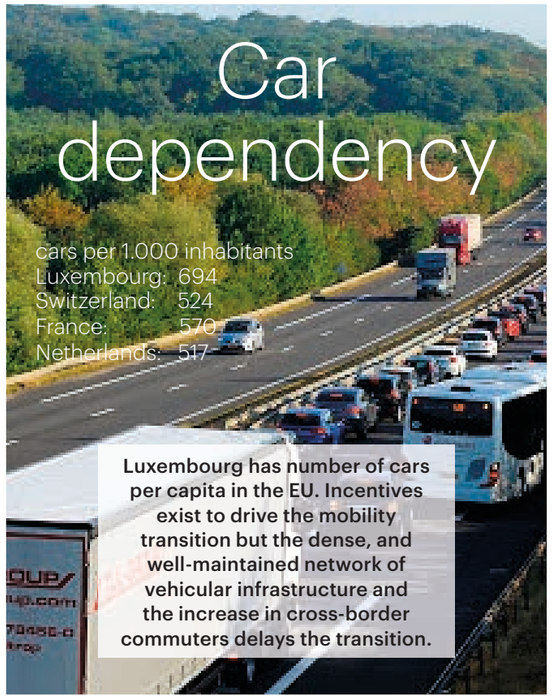
Since 2000, Luxembourg has been pursuing a compact growth model for urban areas. Although urban areas are increasing in density, the migration away from urban centers continues.



Mono functional landscapes

54% of Lux's land is agricultural
it produces only 3-4% of its vegetables
<1% of fruits

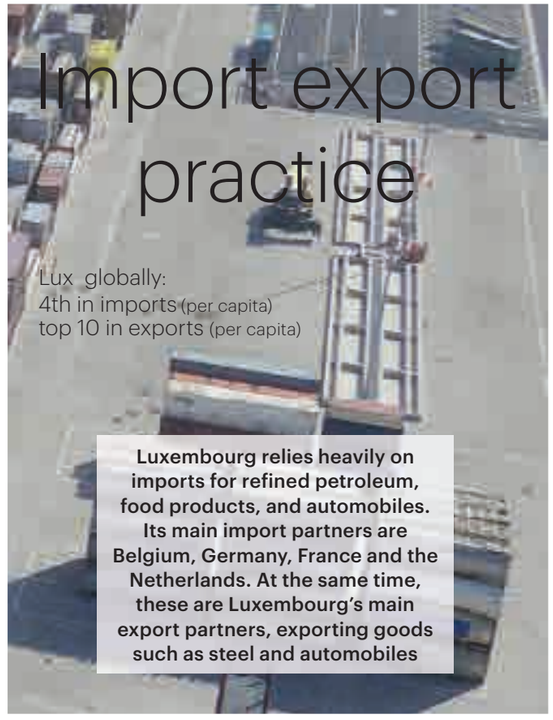
Luxembourg's land division is highly mono-functional. This is particularly true for the agricultural sector leading to a trade shortage and significant reliance on food imports. Are there reliable alternatives for multifunctional landscapes?



Car dependency

cars per 1.000 inhabitants
Luxembourg: 694
Switzerland: 524
France: 570
Netherlands: 517

Luxembourg has number of cars per capita in the EU. Incentives exist to drive the mobility transition but the dense, and well-maintained network of vehicular infrastructure and the increase in cross-border commuters delays the transition.



Import export practice

Lux globally:
4th in imports (per capita)
top 10 in exports (per capita)

Luxembourg relies heavily on imports for refined petroleum, food products, and automobiles. Its main import partners are Belgium, Germany, France and the Netherlands. At the same time, these are Luxembourg's main export partners, exporting goods such as steel and automobiles

Environmental threats

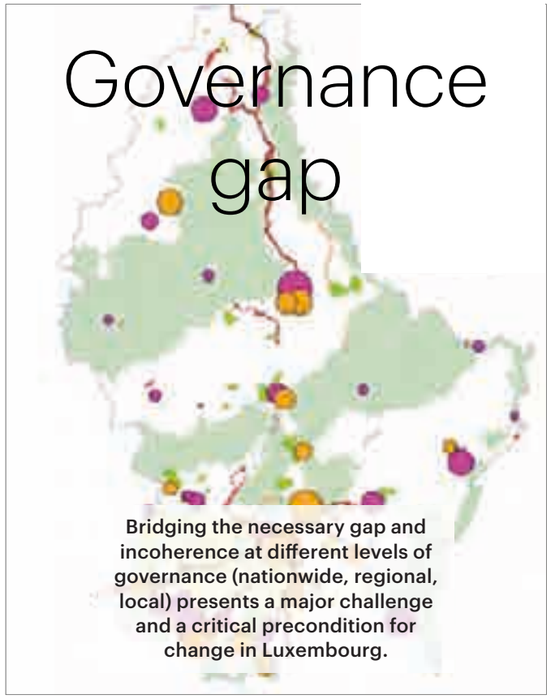
risk of river flooding: high (next 10 years)

Like many European countries, Luxembourg's environmental challenges are not self-healing. These challenges include increasing shortages of potable water, river pollution, and high flood risks all require rapid and integrated actions.

Transborder dependency

Top 5 in EU cross border worker flows
France to Luxembourg: 92.629
Germany to Luxembourg: 54.178

Luxembourg is highly dependent on its neighbouring countries both in human resources and goods. It is the fourth most import-dependent country per capita in the world, and in the top five of cross-border flow intake in the EU, especially for male construction workers.



Governance gap

Bridging the necessary gap and incoherence at different levels of governance (nationwide, regional, local) presents a major challenge and a critical precondition for change in Luxembourg.

Using Ecological Footprint as...

Ecological footprint measures and evaluates a population's demand on productive areas. It comprises the footprint of a country's imports and production, subtracting the footprint of its exports. The Ecotopia strategy uses ecological footprint as a tool to quantify Luxembourg's demands in terms of the following categories:

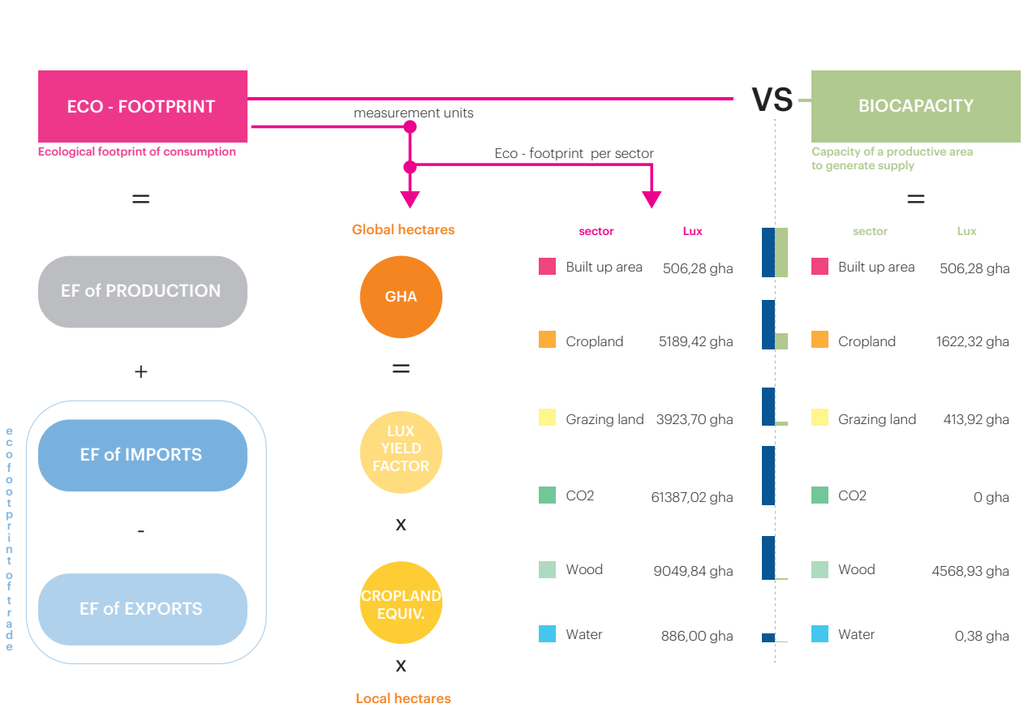
- Cropland
- Grazing land
- Built up area
- Carbon demand on land
- Wood production
- Water ways for fishing activities

The strategy estimates supply through biocapacity. This implies the biologically productive land and water of a given area, city, or state. Ecotopia measures both ecological footprint and biocapacity in global hectares, and is a standardized, globally-comparable unit which calculates with the productivity factor in terms of land use and country context.

In Beyond Lux(e) the strategy adapts this method to create the Lux Monitor. This is a tool which spatializes and allocates resources necessary for Luxembourg with the following rationale:

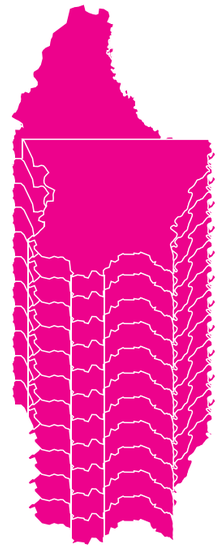
1. It allocates the Luxembourg's demand in terms of global hectares to hectares in the Luxembourg context
2. It adjusts eco-footprint categories from cropland, grazing land, built up area, carbon demand on land, wood production and water for fishing activities, into urban area, mobility, agriculture, forest, water, and energy.

Ecological Footprint method*



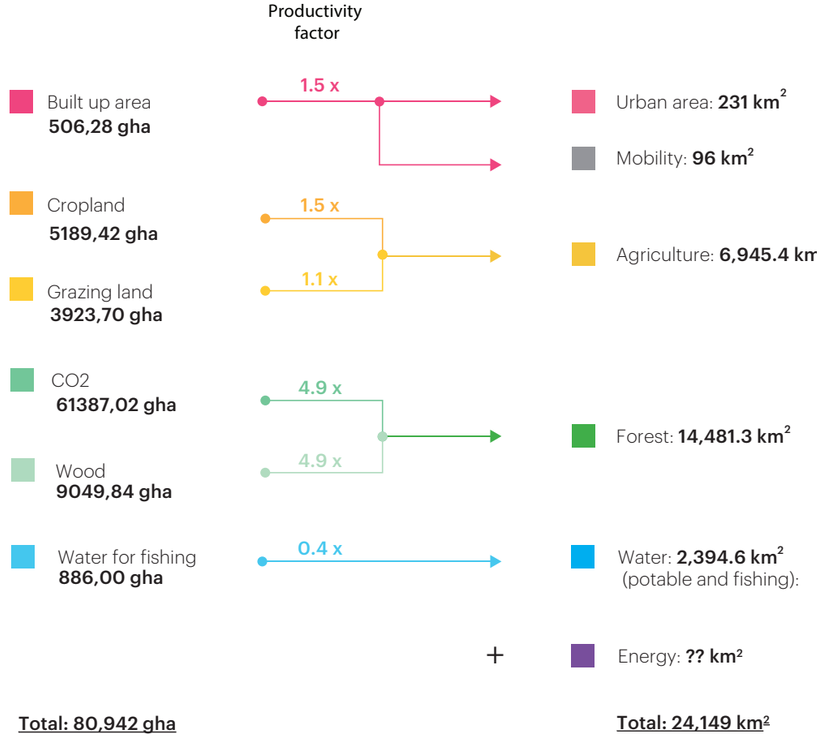
* https://www.footprintnetwork.org/resources/data/

an Ecotopia Monitor



ECO - FOOTPRINT
Ecological footprint of consumption

LUX MONITOR
Lux footprint monitor



Total: 80,942 gha

Total: 24,149 km²

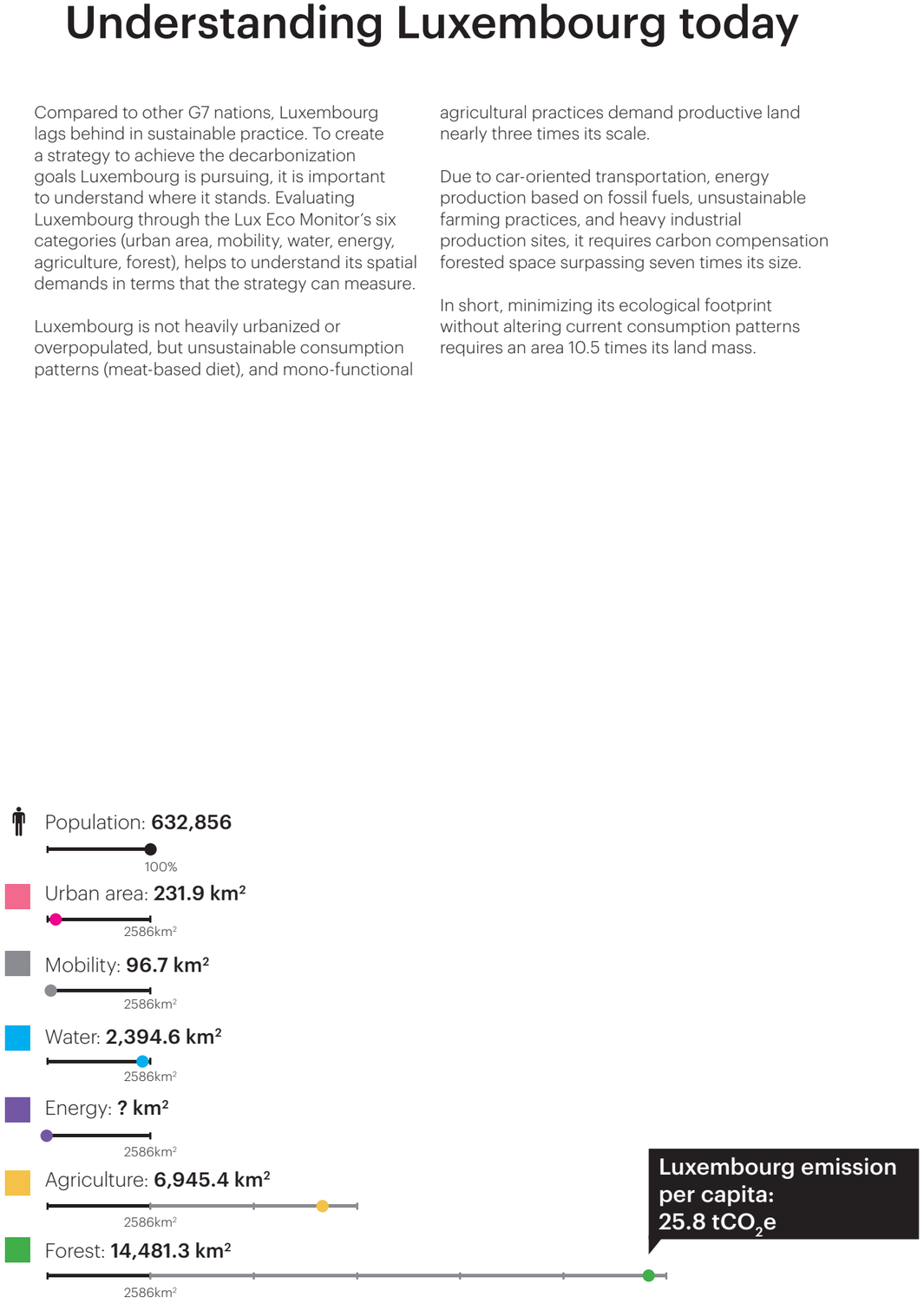
Understanding Luxembourg today

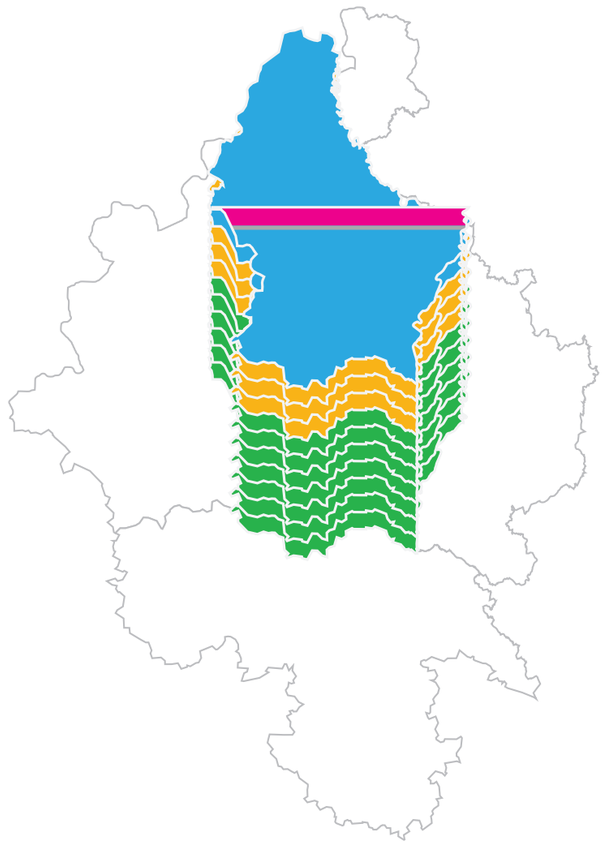
Compared to other G7 nations, Luxembourg lags behind in sustainable practice. To create a strategy to achieve the decarbonization goals Luxembourg is pursuing, it is important to understand where it stands. Evaluating Luxembourg through the Lux Eco Monitor's six categories (urban area, mobility, water, energy, agriculture, forest), helps to understand its spatial demands in terms that the strategy can measure.

Luxembourg is not heavily urbanized or overpopulated, but unsustainable consumption patterns (meat-based diet), and mono-functional agricultural practices demand productive land nearly three times its scale.

Due to car-oriented transportation, energy production based on fossil fuels, unsustainable farming practices, and heavy industrial production sites, it requires carbon compensation forested space surpassing seven times its size.

In short, minimizing its ecological footprint without altering current consumption patterns requires an area 10.5 times its land mass.





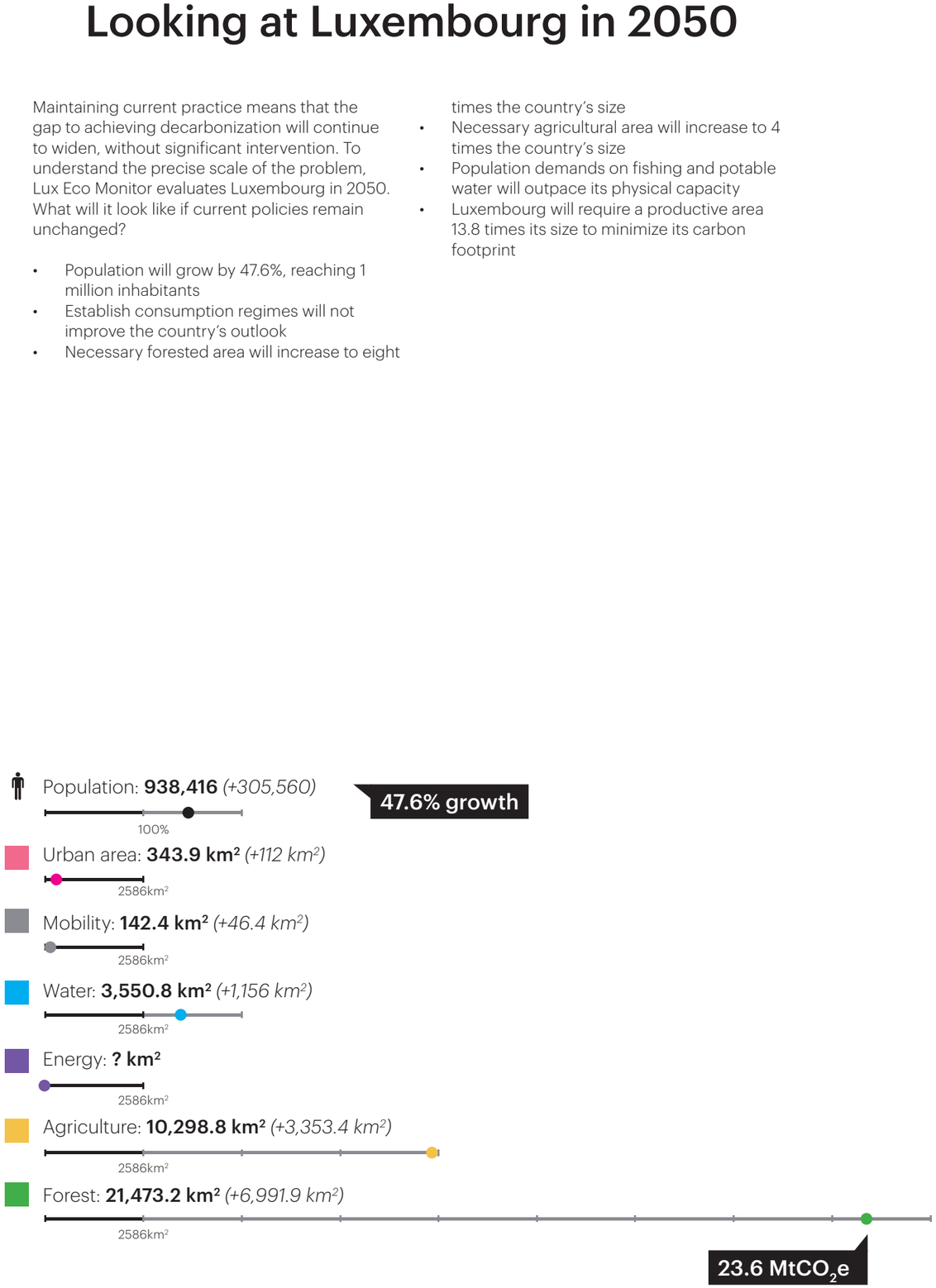
10.5x Luxembourg

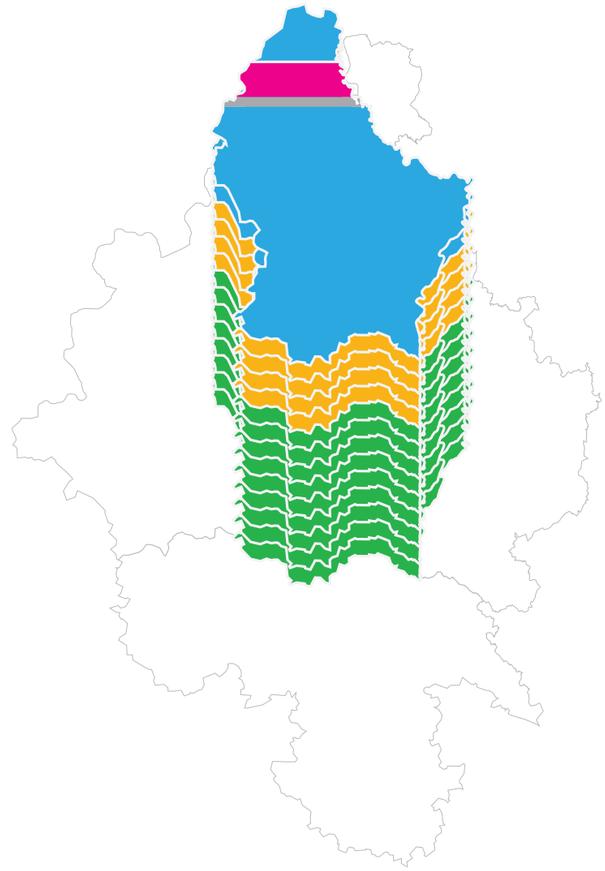
with current practices

Looking at Luxembourg in 2050

Maintaining current practice means that the gap to achieving decarbonization will continue to widen, without significant intervention. To understand the precise scale of the problem, Lux Eco Monitor evaluates Luxembourg in 2050. What will it look like if current policies remain unchanged?

- Population will grow by 47.6%, reaching 1 million inhabitants
- Establish consumption regimes will not improve the country's outlook
- Necessary forested area will increase to eight times the country's size
- Necessary agricultural area will increase to 4 times the country's size
- Population demands on fishing and potable water will outpace its physical capacity
- Luxembourg will require a productive area 13.8 times its size to minimize its carbon footprint





13.8x Luxembourg

with 2050 population

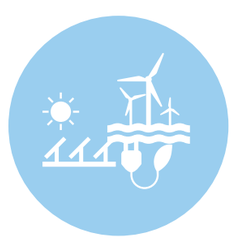
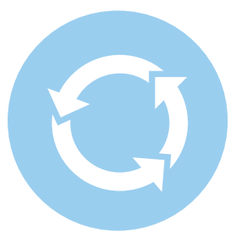
The Ecotopia Monitor

Understanding decarbonization challenges

Without changes in models of governance, planning policies, and technological advances, decarbonization is not possible, so these become integral in the framework for Ecotopia.

- Governance mechanisms stimulate lifestyle changes en mass, incentivizing sustainable consumption through tax reduction, monitoring food branding, and encouraging producers to offer healthier food
- Planning policy changes can encourage and incentivize local food production of fruits and vegetables as currently only 1% of Luxembourg's agricultural land produces local fruit, and only 2% vegetable and horticultural products
- Technology that facilitates innovation and system integration to combine different incentives through green practices (circularity, energy production, etc)

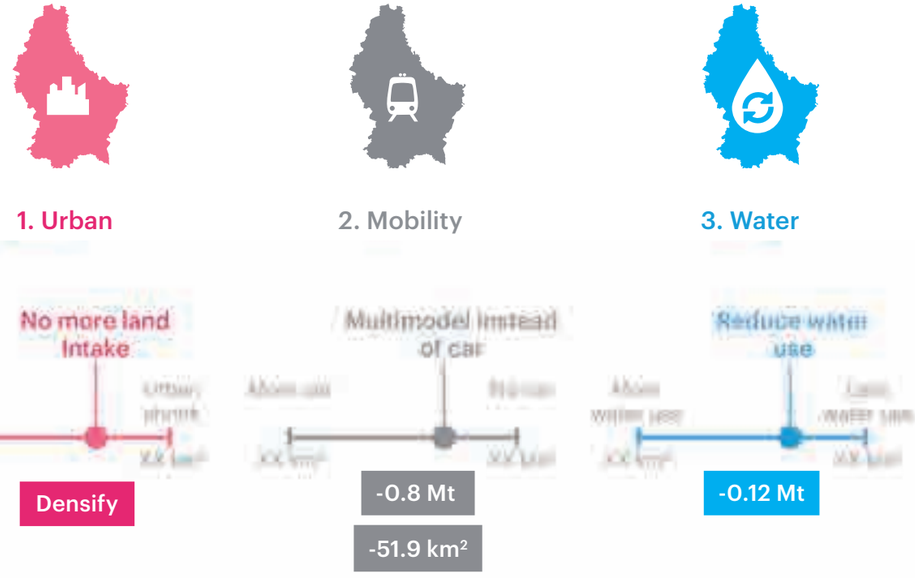
Enabling these strategies will require the revision of past practices and enabling a collaborative culture across scales and stakeholders (governmental authorities, institutions, communities, and NGOs).

Decarbonization drivers	Decarbonization tasks
 CHANGING TO SUSTAINABLE LIFESTYLE	Urban: **No more land Intake** Mobility: **Multimodel instead of car** Water: **Reduce water use** Energy: **Reduce energy use** Agriculture: **Plant-based diet**
 OPTIMIZING GREEN PRACTICES	Urban: **Building performance upgrade** Mobility: **Non-emission mobility** Water: **Retain rainwater** Energy: **Green energy** Agriculture: **Eco-farming**
 LOCALIZING CONSUMPTION AND PRODUCTION	Urban: **Mixed-use planning** Mobility: **Reduce trips and commuting** Water: **Quality local water system** Energy: Local **production and storage** Agriculture: **Short supply chain**

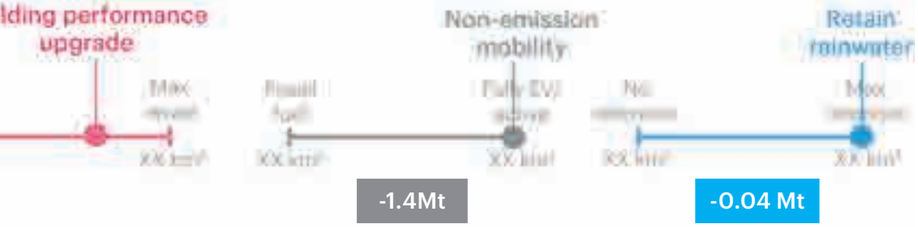
Ecotopia monitor

in Luxembourg

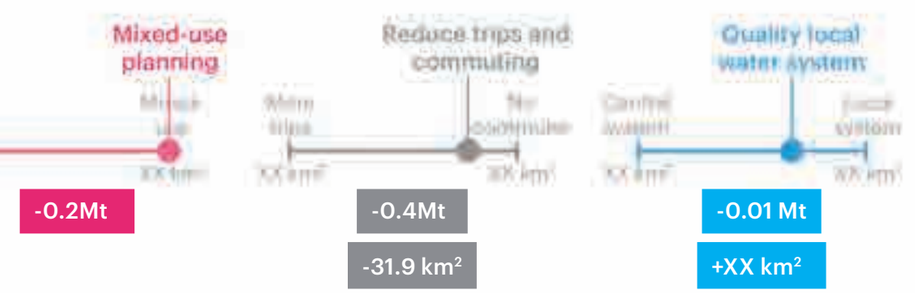
Change to sustainable lifestyle



Optimize green practices



Localizing consumption and production



Understanding Luxembourg's needs

Decarbonizing Luxembourg requires action across all of the Lux Eco Monitor's five sectors, to reduce the demands from 10.5 times its size to 3.5 times:

1. **Urbanization:** no additional land intake, building upgrade through green systems, multi-functionality, and mixed-use planning
2. **Mobility:** transition towards a multimodal, clean energy mobility pattern replacing the exclusively car-oriented lifestyle enabled multiuse areas, living, working and services will all be met within the same area so that trips and commuting will be reduced
3. **Water:** retain rainwater in the water system as long as possible for consumption and agricultural use
4. **Energy:** scale up sustainable energy production and fight intermittency with a smart network and increased storage capacity
5. **Agriculture:** mobilize a shift a meat-based diet to plant-based consumption habits, necessitating the conversion of grazing lands to hybrid agricultural areas that support eco-farming and organic, local food production offering a variety of food alternatives

Population: **938,416**

100%

Urban area: **231.9 km²**

2586km²

Mobility: **58.6 km²** *(-38.1 km²)*

2586km²

Water: **404.2 km²** *(-1,990.4 km²)*

2586km²

Energy: **440 km²** *(+440 km²)*

2586km²

Agriculture: **2,978.5 km²** *(-7,320.3 km²)*

2586km²

Forest: **4,823 km²** *(-9,658.3 km²)*

2586km²

3.5x Luxembourg

Ecotopia 2050

Looking beyond decarbonization

Climate change is just one of many global crises we're facing today. There's also a biodiversity crisis, a health crisis, a housing crisis, and a migration crisis to be solved. It seems impossible to address all these crises with one plan or strategy. However if we look at the underlying patterns and behavior, we might discover system failures that underlie these crises and that can be repaired or bent. In Beyond lux(e) we mainly focus on the exploitation of natural resources. We propose to invest in quality, abundance and resilience of natural systems like forests and streams, and to harvest them at a sustainable scale. At a first glance this seems to lower the yield, but if we then take into account all the ecosystem services that are provided by these resilient systems then we find out that these 'under-engineered' systems are actually much more efficient at providing for human needs then the current practices of take and restore.

Rather than carbon, we are therefore focusing on resilience as the most prominent layer in the shift towards a sustainable future. To build this resilience, the plan incorporates the following three target resilience strategies:

1. Event resilience: to address flooding such as that of Summer 2021, and forseeing future floods and droughts that arise as a result of climate change, managing the water system is a first means of mitigating future crises.
2. Ecological resilience and biodiversity: the region of Grand Duchy has a fragmented habitat, and by maintaining and restoring biodiversity, connecting landscapes, and ending unsustainable wood production, and improving soil and water quality, it is possible to create a rich habitat for all living things.
3. Socio-cultural resilience: encouraging shared social and community values, as well as diversity helps to establish stability and strength.

Renaturalization in water buffer zone (300m from river): **+ 396 km²**

581 km²

NOW: 32% of naturalized area in total water buffer zone

Organic and regenerative agriculture: **+ 1,230 km²**

1285 km²

NOW: 4% of organic farming in total agricultural land

Natural forest: **+642 km²**

924 km²

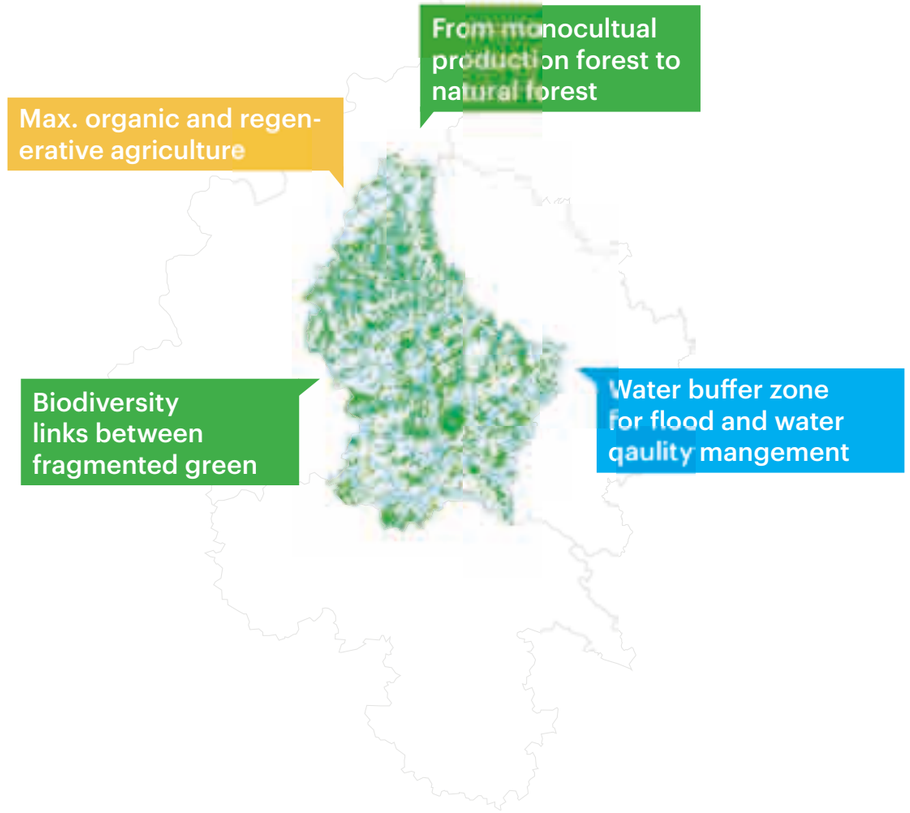
NOW: 31% of natural forest in total forest coverage(2)

Connected green: **+xxx km²**

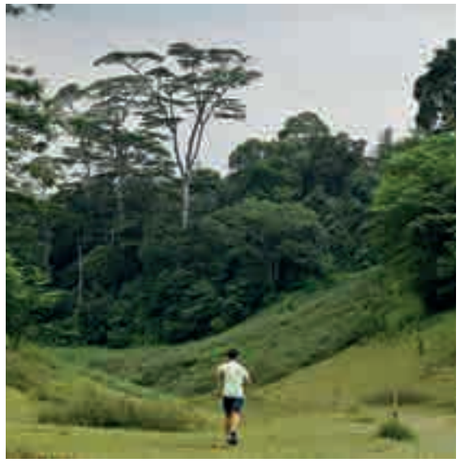
xx km²

1. Eurostat. "Agriculture: EU organic area up 25% since 2012". Accessed on 19/12/2021 from https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20190130-1
2. Global Forest Watch. "Tree cover in Luxembourg". Accessed on 19/12/2021 from www.globalforestwatch.org.

Resilience



Drinkable river system

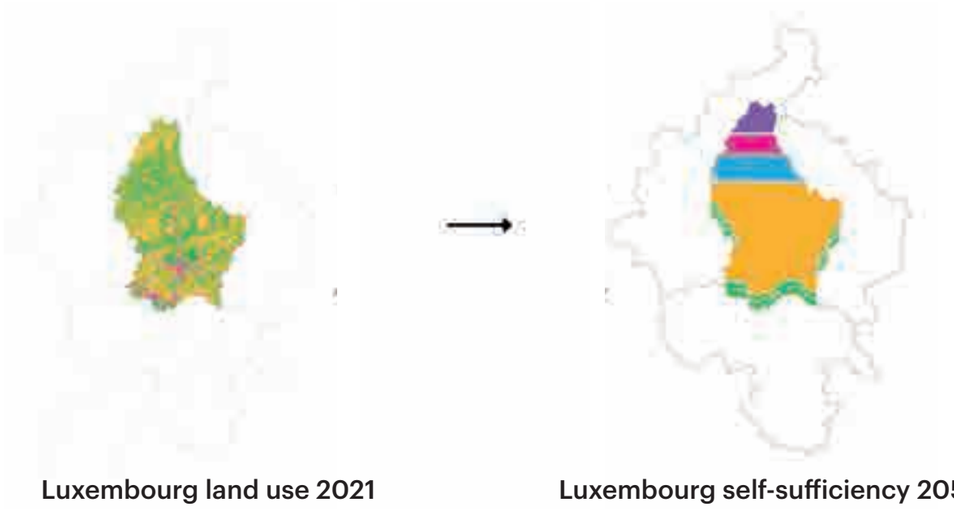


Biodiverse eco-system

Looking beyond decarbonization

So “just” decarbonizing Luxembourg should not be the end game. It is possible to generate surpluses of available resources, enhancing biocapacity, and also enriching the greater region.

It is possible for Luxembourg to increase its productive capacity to not only ensure self-sufficiency but also contribute to neighbouring regions. This strategy can be even more influential when connected to neighbouring regional systems. For example, energy produced that exceeds capacity can be stored or distributed to other regions. Similarly, if Luxembourg invests a great deal in reforestation, this can ‘compensate’ for its carbon emissions, and for that of neighbouring regions.



Luxembourg land use 2021

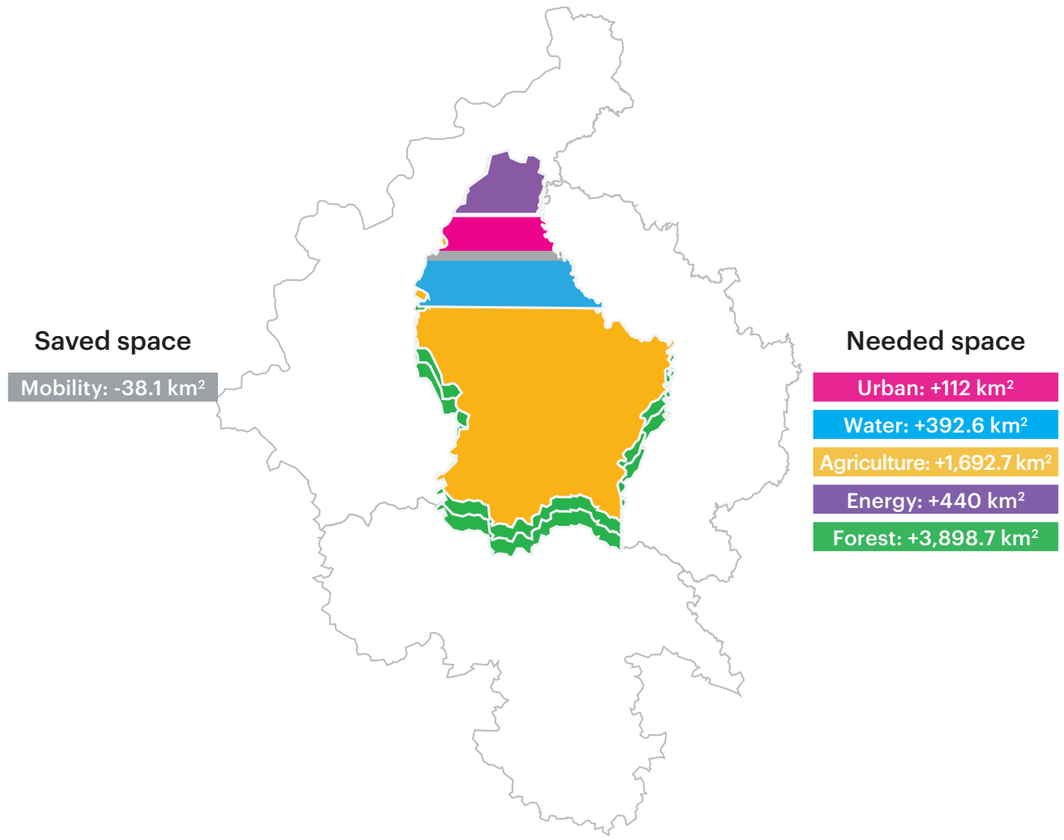
- Population: **632,856**
- Urban area: **231.9 km²** / 2586km²
- Mobility: **96.7 km²** / 2586km²
- Water: **11.6 km²** / 2586km²
- Energy: **? km²** / 2586km²
- Agriculture: **1,285.8 km²** / 2586km²
- Forest: **924.3 km²** / 2586km²

VS

Luxembourg self-sufficiency 2050

- Population: **938,416**
- Urban area: **343.9 km²** / 2586km²
- Mobility: **58.6 km²** / 2586km²
- Water: **404.2 km²** / 2586km²
- Energy: **440 km²** / 2586km²
- Agriculture: **2,978.5 km²** / 2586km²
- Forest: **4,823 km²** / 2586km²

Self-sufficiency



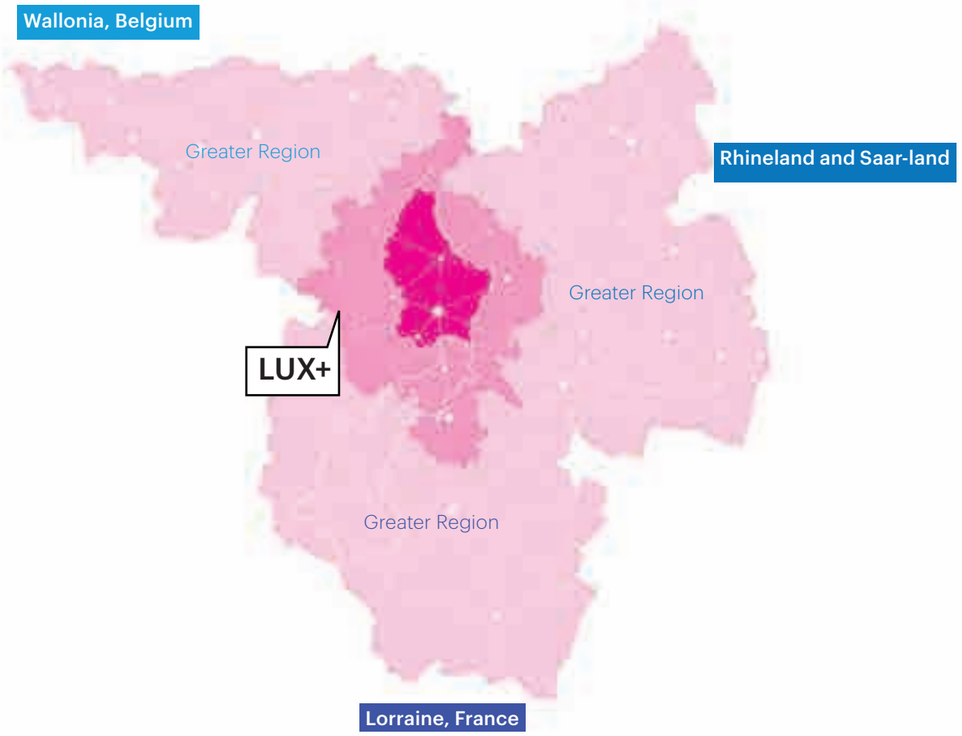
How can Luxembourg be self-sufficient or surplus by 2050?

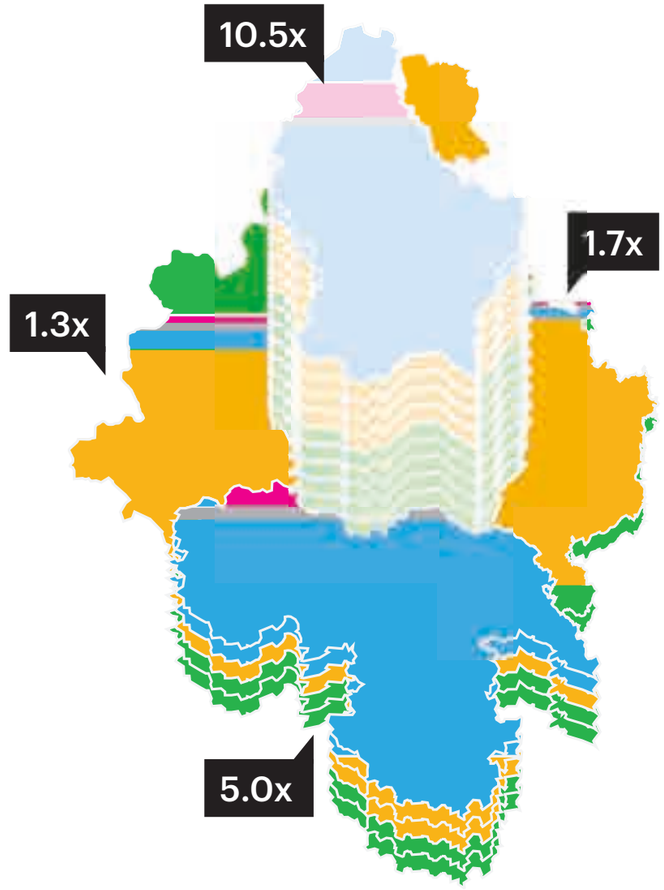
Collaborating with neighbouring regions

Luxembourg functions as the hub of a trans-border region that also includes parts of Germany, France, and Belgium. The complexity of this dependency is both in work force, and in goods. According to STATEC, nearly half of Luxembourg's workforce (44.9%) comprises cross-border workers, primarily from the neighbouring French region. In terms of goods, Luxembourg is the 4th greatest importer, and in the top 10 of exports per capita in the world. Germany, France and Belgium represent its strongest trading partners.

Deploying decarbonziation strategies in Luxembourg's relationship with its neighbours can serve as a strong precedent for smaller countries that also depend on imports, but can in exchange absorb emissions effectively in their territories.

With a critical mass of countries uniting to decarbonize, they can not only share land and resources but also technological knowledge, and discrete economic strengths to create optimal spatial design solutions without completely reinventing systems of production.





4.2x Lux+

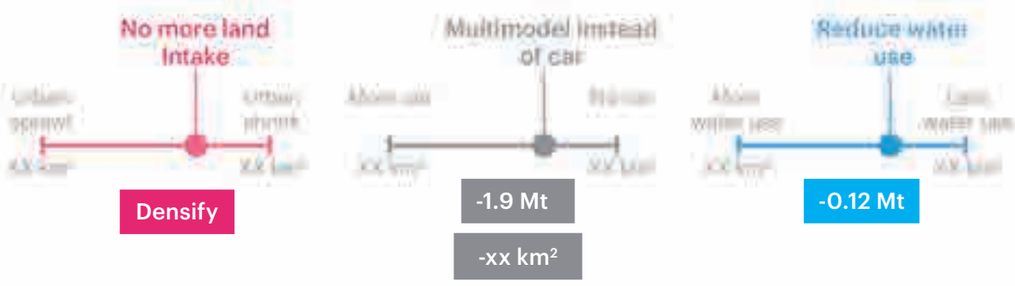
with current population

Ecotopia monitor

in Lux+

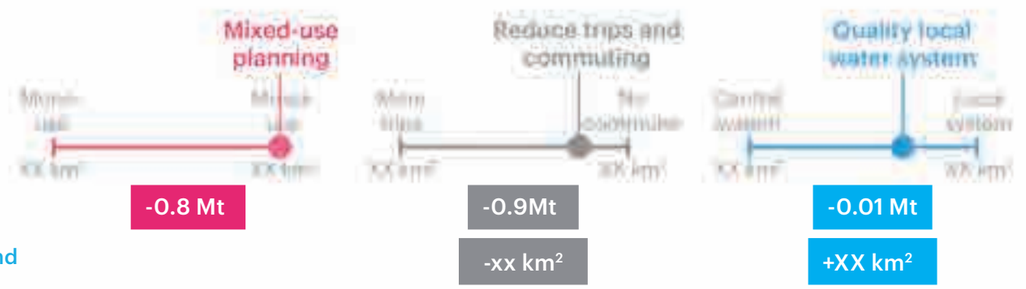
1. Urban
2. Mobility
3. Water
4. Energy
5. Agriculture
Forest

Change to sustainable lifestyle

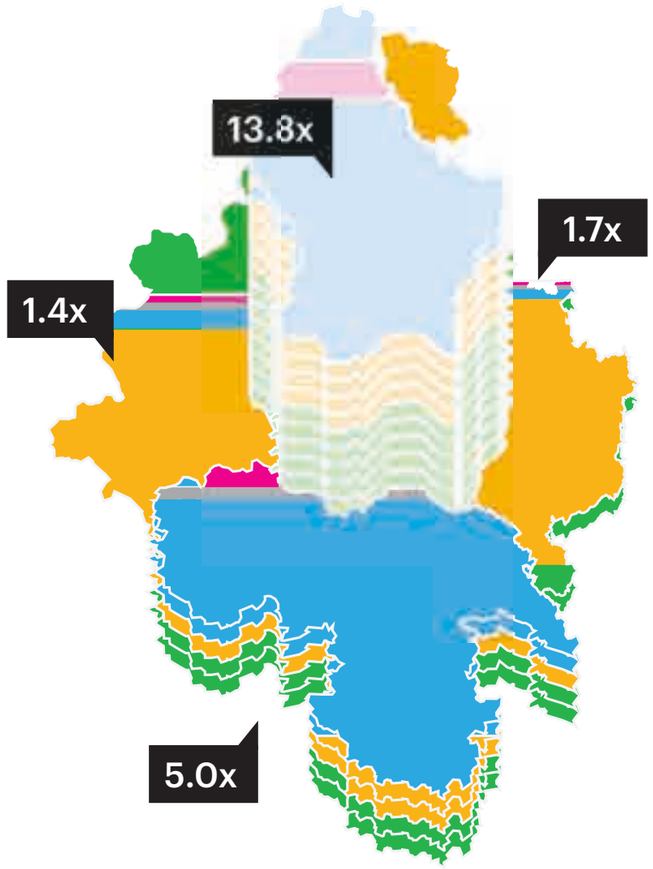


Optimize green practices

Localizing consumption and production



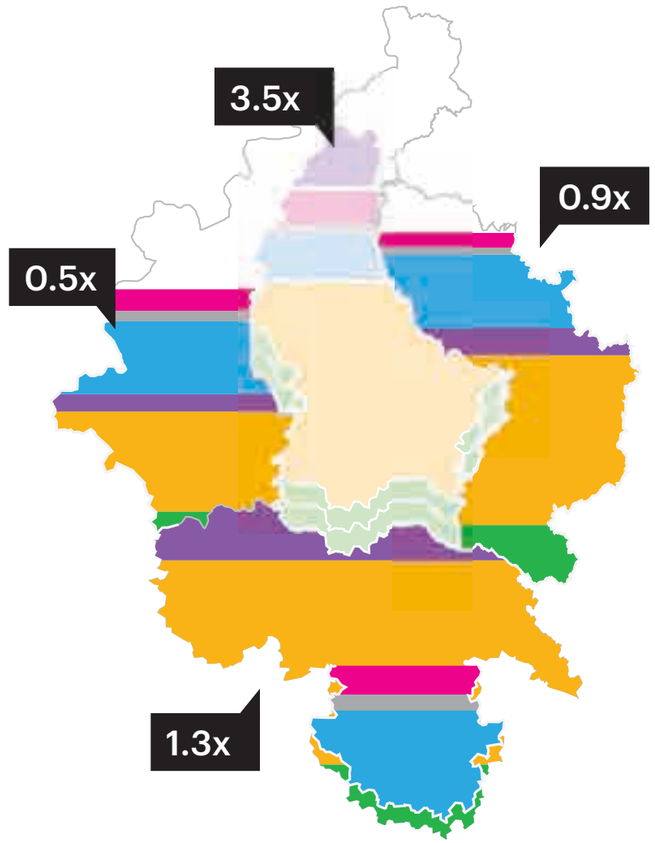
Business as usual Lux+ 2050



5.2x Lux+

with population growth

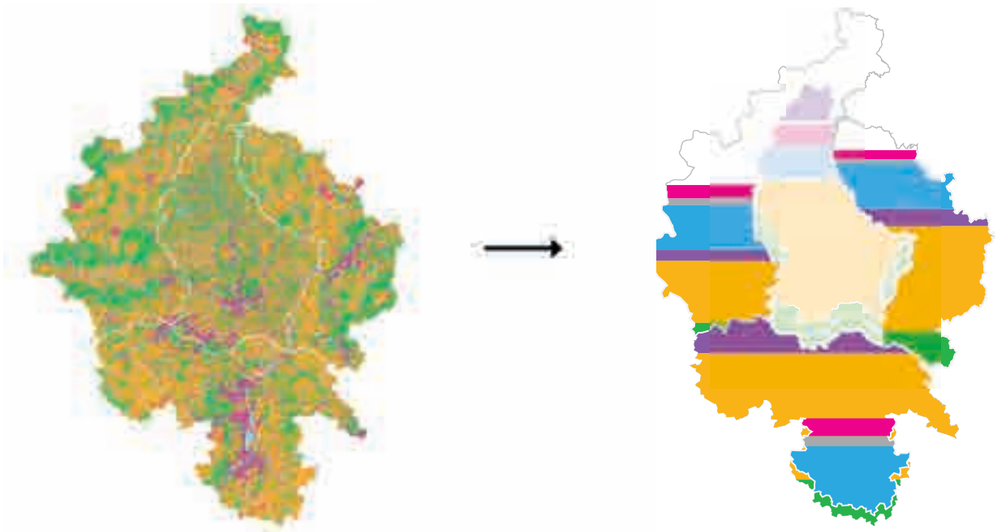
Ecotopia Lux+ 2050



1.5x Lux+

with all decarbonization tasks

From now to Ecotopia per sub-region



Land use per sub-region 2021

BE

Urban: **190.6 km²**
Mobility: **34.3 km²**
Water: **1.5 km²**
Agriculture **1521.4 km²**
Energy: **? km²**
Forest: **1428.3 km²**

LUX

Urban: **231.9 km²**
Mobility: **96.7 km²**
Water: **11.6 km²**
Agriculture: **1285.8 km²**
Energy: **? km²**
Forest: **924.3 km²**

FR

Urban: **362.7 km²**
Mobility: **117.5 km²**
Water: **38.3 km²**
Agriculture **1971.2 km²**
Energy: **? km²**
Forest: **853.7 km²**

DE

Urban: **157.7 km²**
Mobility: **53.3 km²**
Water: **15.3 km²**
Agriculture **1229.2 km²**
Energy: **? km²**
Forest: **909.6 km²**

Ecotopia footprint per sub-region 2050

BE

Urban: **202.4 km²**
Mobility: **12.4 km²**
Water: **584.6 km²**
Agriculture **780.4 km²**
Energy: **115 km²**
Forest: **42.1 km²**

LUX

Urban: **343.9 km²**
Mobility: **58.6 km²**
Water: **404.2 km²**
Agriculture: **2978.5 km²**
Energy: **440 km²**
Forest: **4823 km²**

FR

Urban: **364.8 km²**
Mobility: **48 km²**
Water: **660.6 km²**
Agriculture **2472.4 km²**
Energy: **366 km²**
Forest: **472.8 km²**

DE

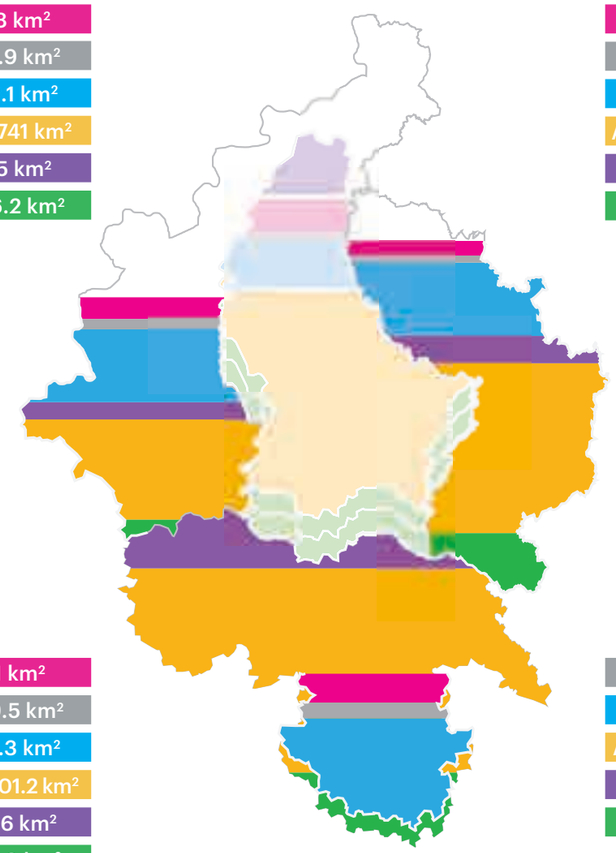
Urban: **157.7 km²**
Mobility: **23.3 km²**
Water: **496.8 km²**
Agriculture **1066.3 km²**
Energy: **158 km²**
Forest: **266.2 km²**

BE

Urban: +11.8 km²
Mobility: -21.9 km²
Water: +583.1 km²
Agriculture: -741 km²
Energy: +115 km²
Forest: -1386.2 km²

LUX

Urban: +112 km²
Mobility: -38.1 km²
Water: +395.1 km²
Agriculture: +1,692.7 km²
Energy: +440 km²
Forest: +3,898.7 km²



FR

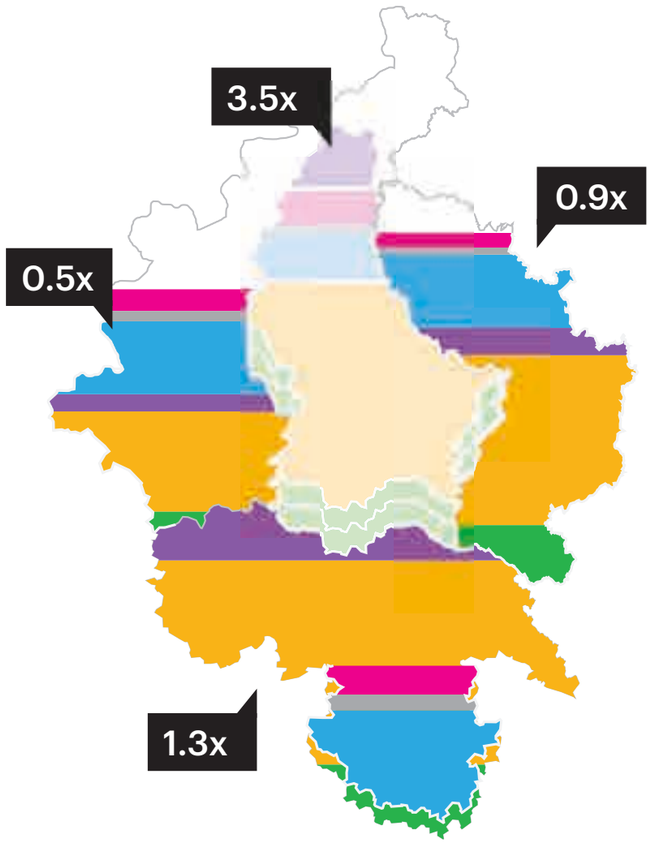
Urban: +2.1 km²
Mobility: -69.5 km²
Water: +622.3 km²
Agriculture: +501.2 km²
Energy: +366 km²
Forest: -380.9 km²

DE

Mobility: -30 km²
Water: +481.5 km²
Agriculture: -162.9 km²
Energy: +158 km²
Forest: -643.4 km²

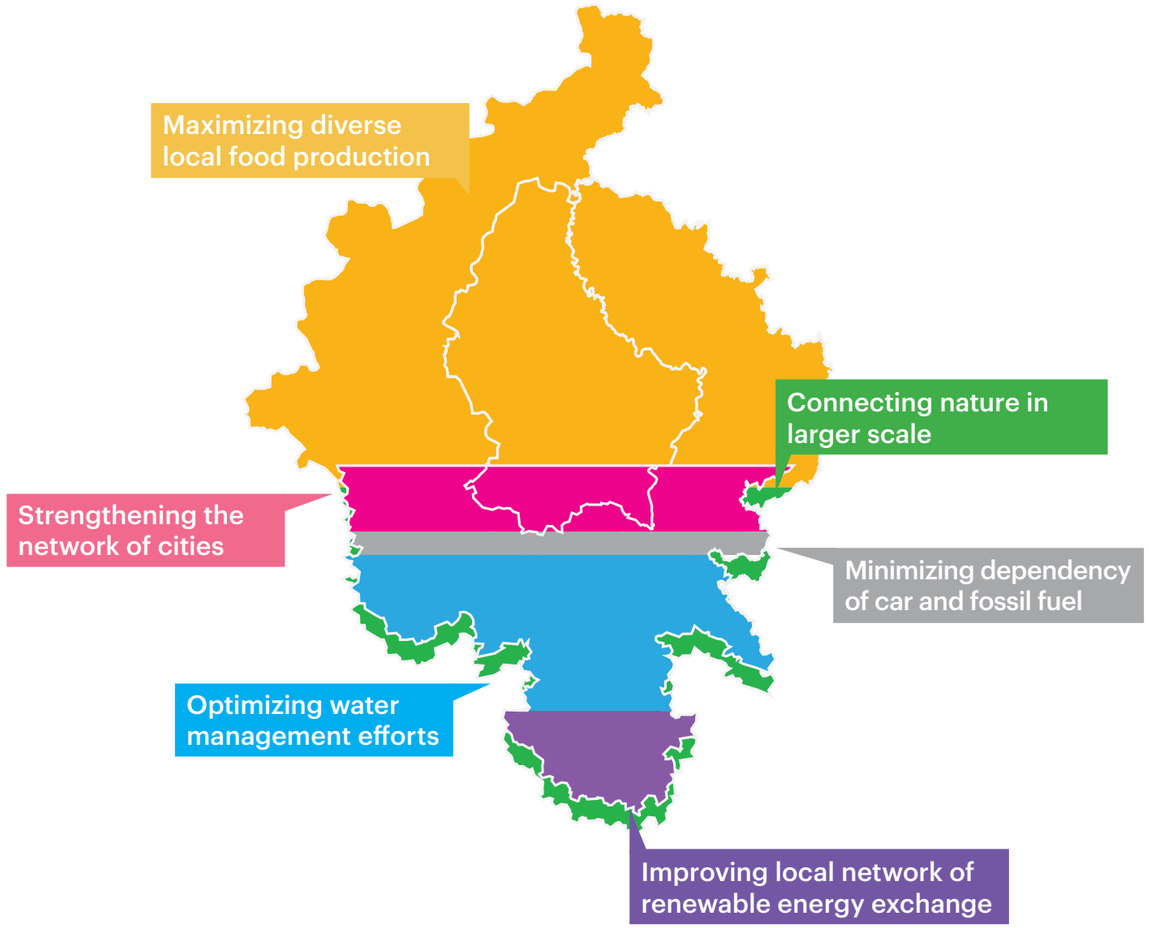
How much does the land density need to change on each sub-region to achieve Ecotopia Lux+?

Collaborative Lux+



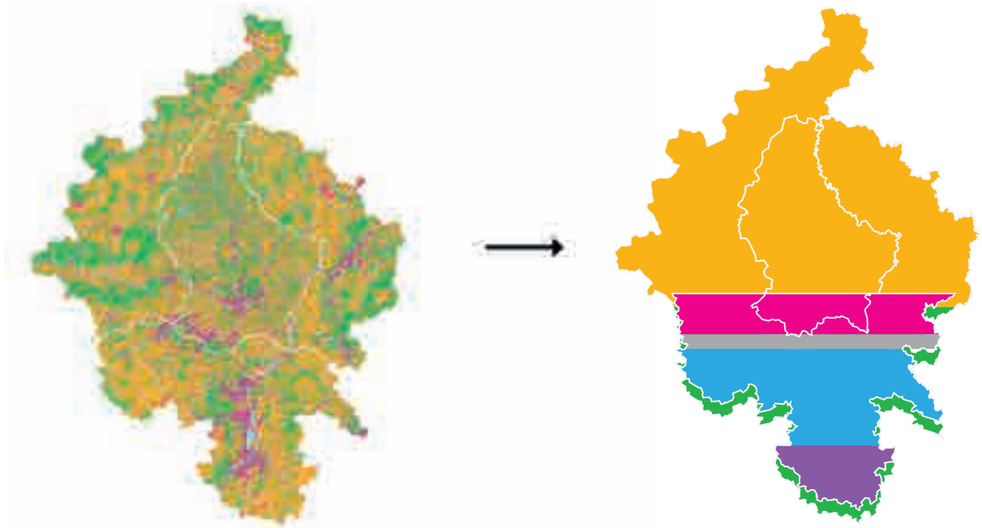
1.5x Lux+

with all decarbonization tasks



Can we generate a collaborative Lux+ as one entity?

From now to Ecotopia Lux+



Lux+ land use 2021

Population: **1,981,299**

Urban area: **937.2 km²**
11565km²

Mobility: **301.8 km²**
11565km²

Water: **66.73 km²**
11565km²

Energy: **? km²**
11565km²

Agriculture: **6007.6 km²**
11565km²

Forest: **4115.9 km²**
11565km²

Lux+ Ecotopia 2050

Population: **2,286,859**

Urban area: **1063.1 km²**
11565km²

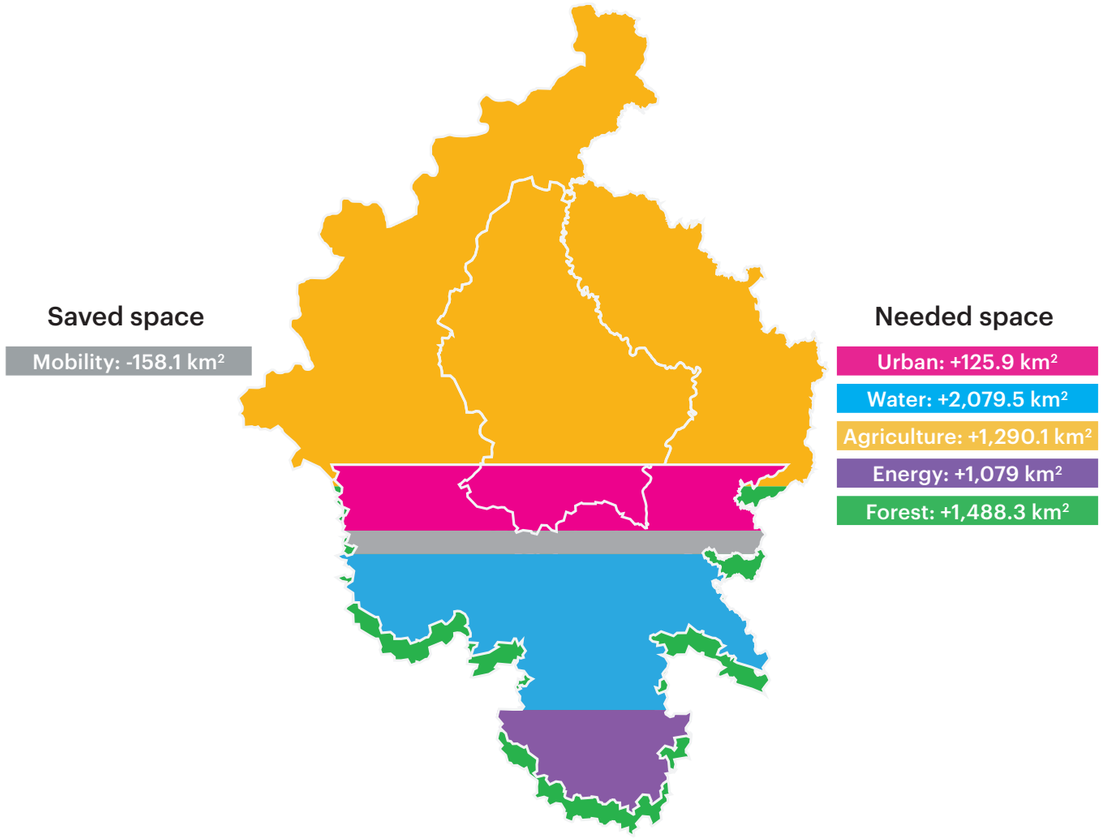
Mobility: **143.7 km²**
11565km²

Water: **2,146.2 km²**
11565km²

Energy: **1,079 km²**
11565km²

Agriculture: **7,297.7 km²**
11565km²

Forest: **5,604.2 km²**
11565km²



How much does the land density need to change on the collaborative Lux+ as one entity?

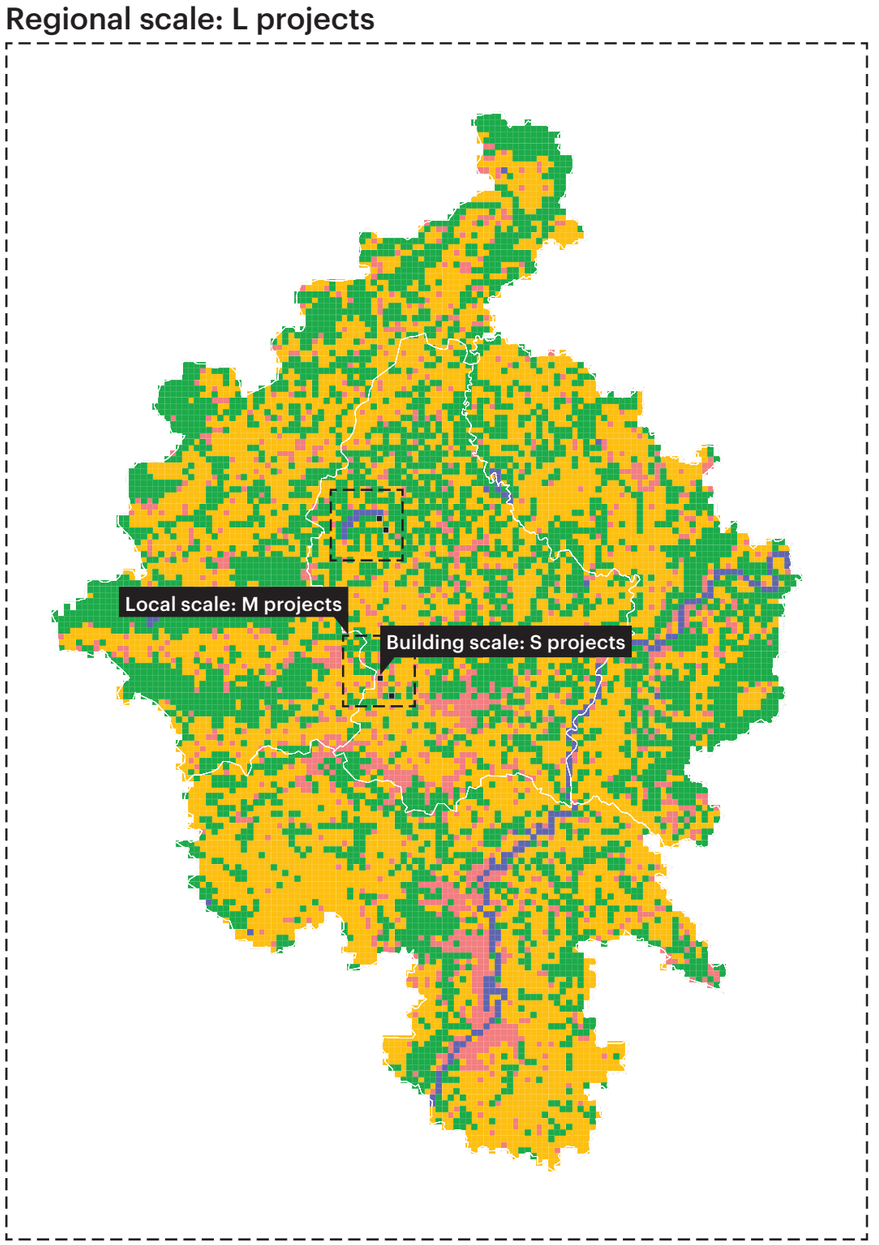
Spatial Scenarios

Ecotopia spatial scenarios

Estimating that a decarbonized Lux+ requires 1.2 times its available productive land, density is clearly a necessity. This not only means more development in layers, but also on or under land for production of food, energy, goods, water, as well as carbon absorption.

Translating decarbonization tasks into a catalogue of spatial projects illustrates how calculations are made, as well as the inherent possibilities of small scale building or district applications to medium scale local applications and finally, to large scale regional applications.

Each project demonstrates possible location and calculation in clear scenarios and this way provides a strong base for building density in layers. Such a list of possible projects can catalyze dialogue-based collaboration, which in turn fuels shared ambitions, and concrete actions to achieve the future vision.



From Ecotopia tasks

to spatial projects

Urban area

No more land Intake

Building performance upgrade

Mixed-use planning

L01.1

L

Set urban boundary

XX km² — XX km²

L01.2
Super-city(s) & Eco-villages

XX km² — XX km²

M

M01.
Mixed-use city

XX km² — XX km²

S

S01.
Existing building upgarde

XX km² — XX km²

Mobility

Multimodel instead of car

Non-emission mobility

Reduce trips and commuting

L02.1

L

Strengthen city connection

XX km² — XX km²

L02.2
Reduce mobility in rural area

XX km² — XX km²

M

M02
Local soft mobility network

XX km² — XX km²

S

S02.
Multifunctional mobility hub

XX km² — XX km²

Water

Reduce water use

Retain rainwater

Ensure quality local water system

L

L03.
Water buffer

XX km² — XX km²

M

M03.1
Flood area renaturalization

XX km² — XX km²

M03.2
Local retention landscape

XX km² — XX km²

S

S03
Building water capture and retention

XX km² — XX km²

Energy

Reduce energy use

Green energy

Local production and storage

L05.1

L

Energy landscape (Solar)

XX km² — XX km²

L05.2
Energy landscape (Wind)

XX km² — XX km²

M

M05
Energy storage

XX km² — XX km²

S

S05
Solar roofs

XX km² — XX km²

Agriculture

Plant-based diet

Eco-farming

Short supply chain

L06.1

L

Mixed-use agriculture

XX km² — XX km²

L06.2
Agroecology

XX km² — XX km²

M

M06
Urban/stack farming

XX km² — XX km²

S

S06
Local production hub

XX km² — XX km²

Forest

Sustainable forestry

Max. capture and store

Connecting nature

L

L04.
Max. reforestation & biodiversity

XX km² — XX km²

M

M04.1
Ecological forest with selective harvesting

XX km² — XX km²

M04.2
Green streets

XX km² — XX km²

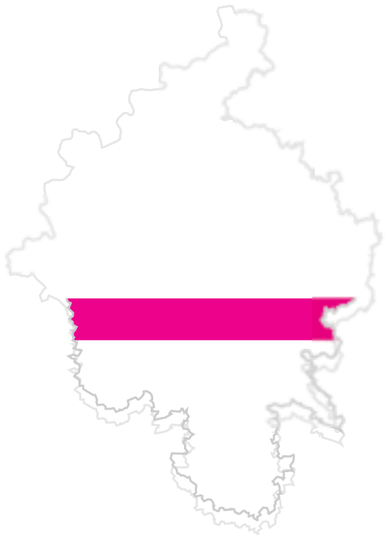
S

S04.
Green roofs & facade

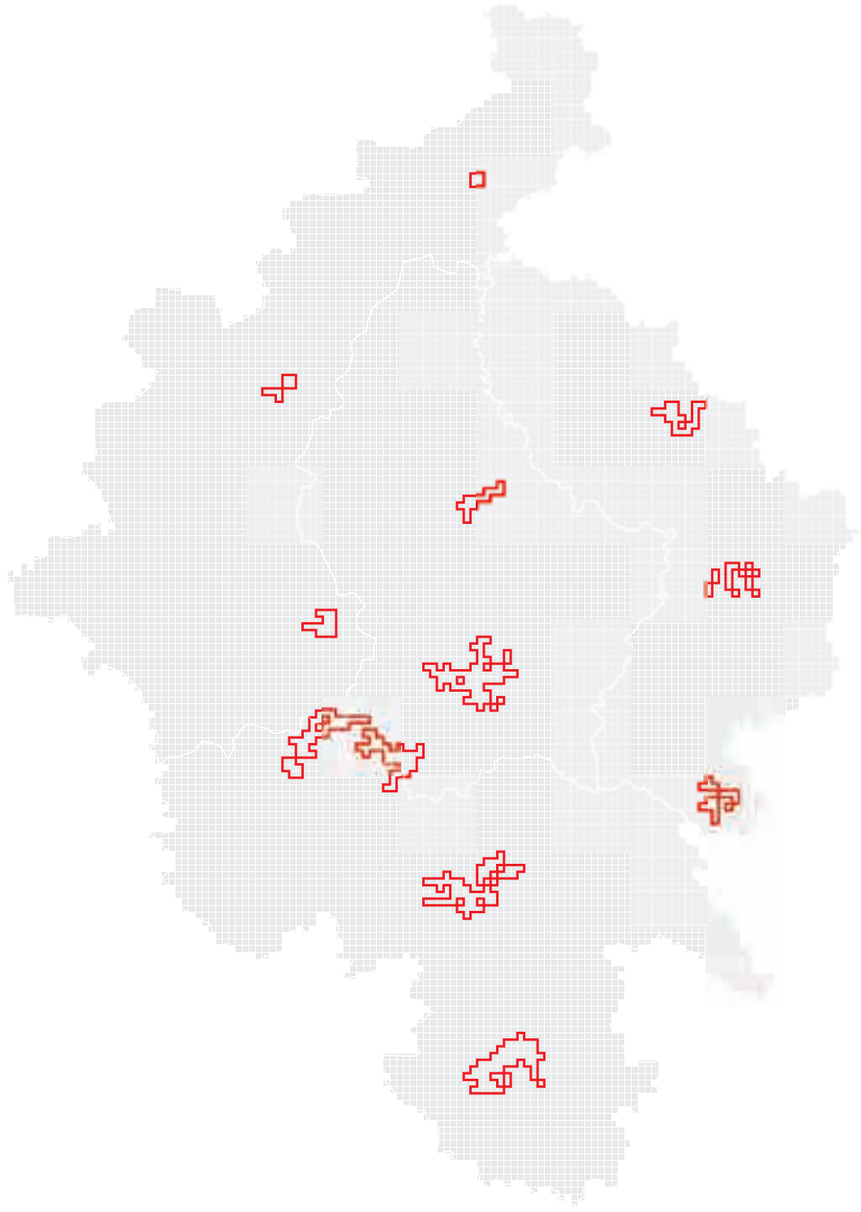
XX km² — XX km²

Scenario 1

Control cities' expansion



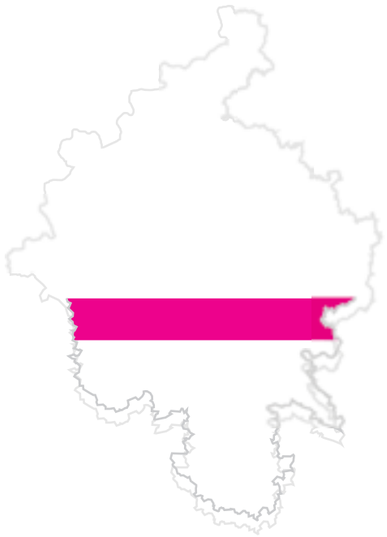
Ecotopia urban footprint = 1063.1 km^2
Existing urban surface = 937.2 km^2



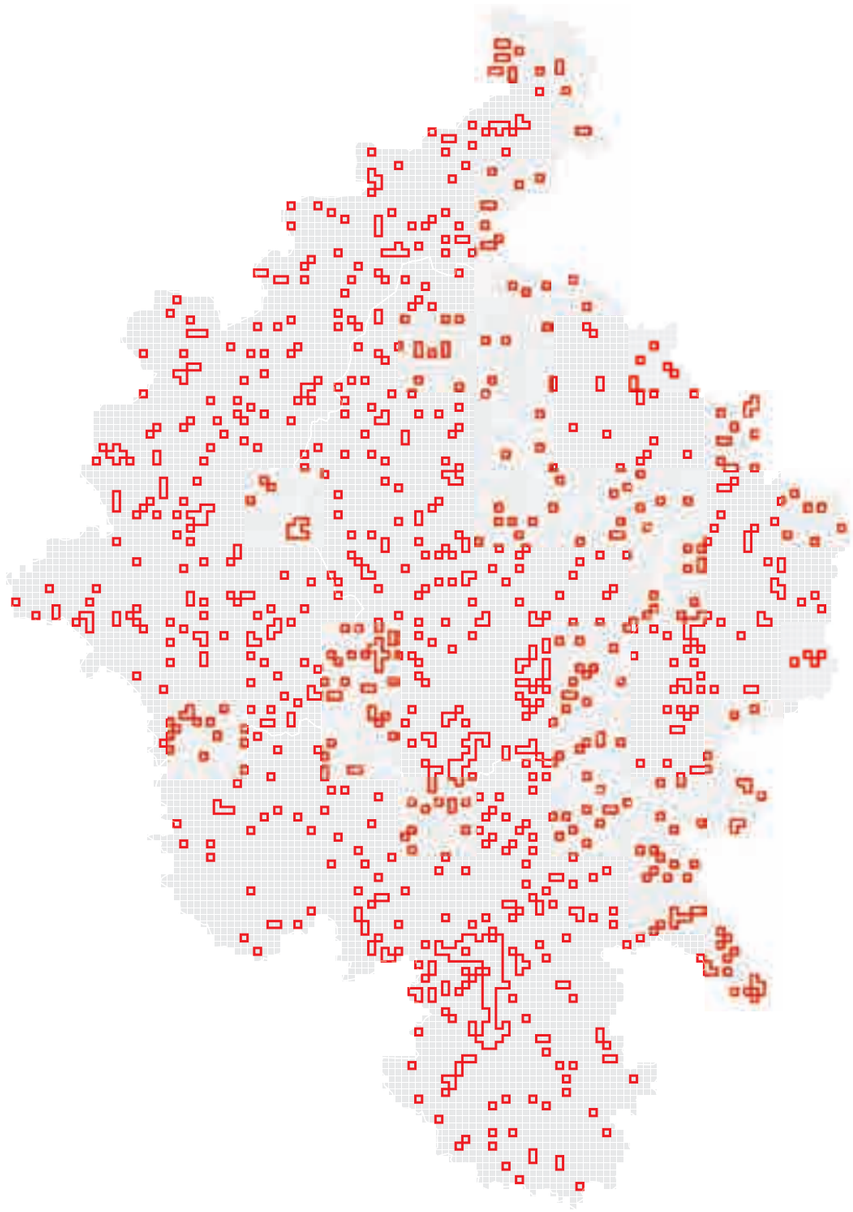
Urban boundary on cities: 223 km^2

Scenario 2

Control villages' suburbanization



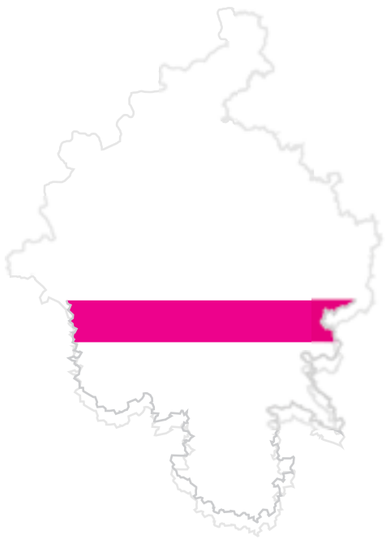
Ecotopia urban footprint = 1063.1 km^2
Existing urban surface = 937.2 km^2



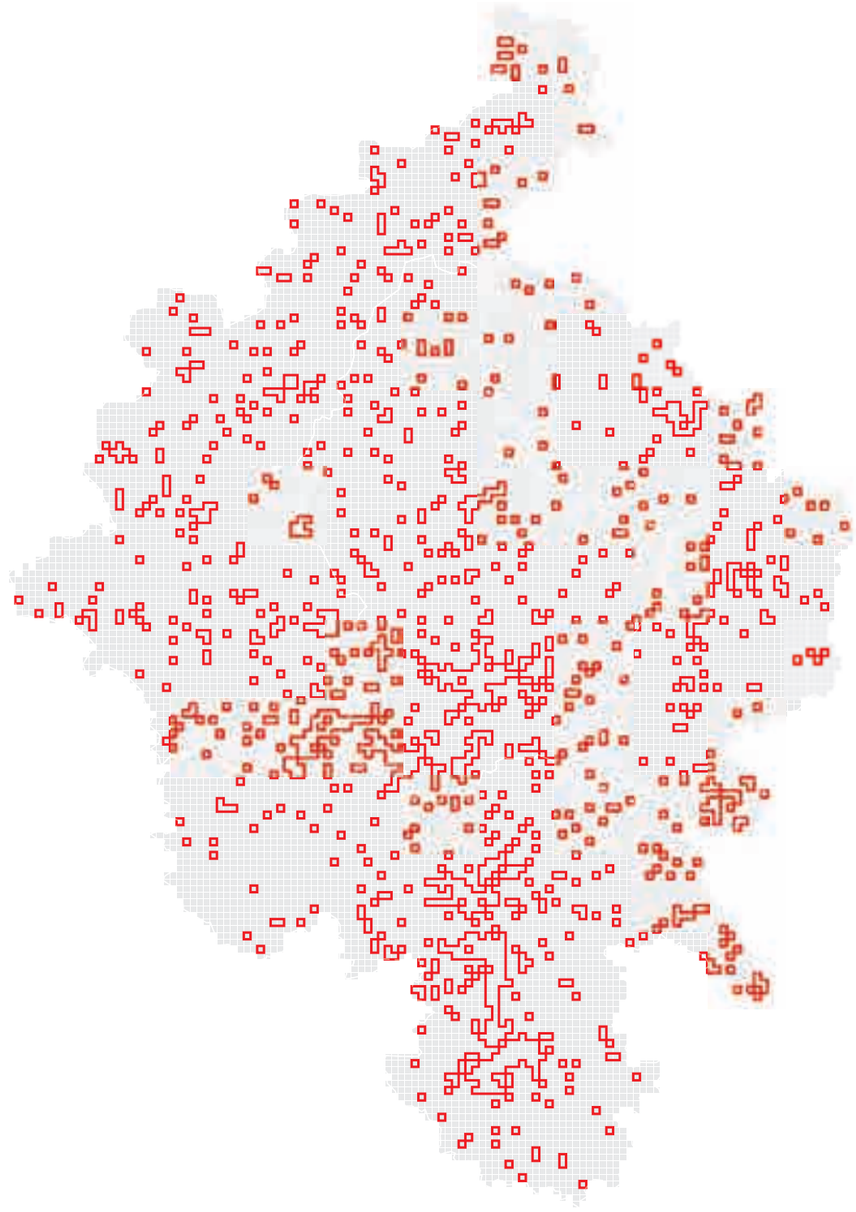
Urban boundary on villages: 720 km^2

Scenario 3

Apply urban boundaries on all settlements



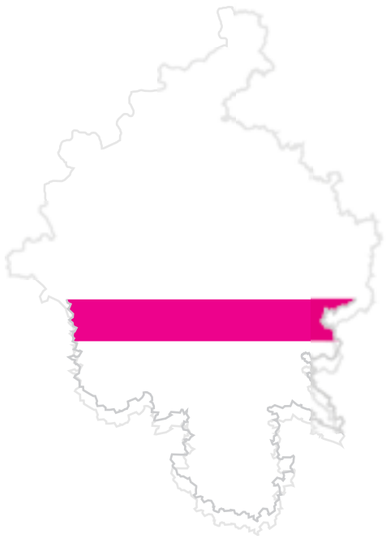
Ecotopia urban footprint = 1063.1 km^2
Existing urban surface = 937.2 km^2



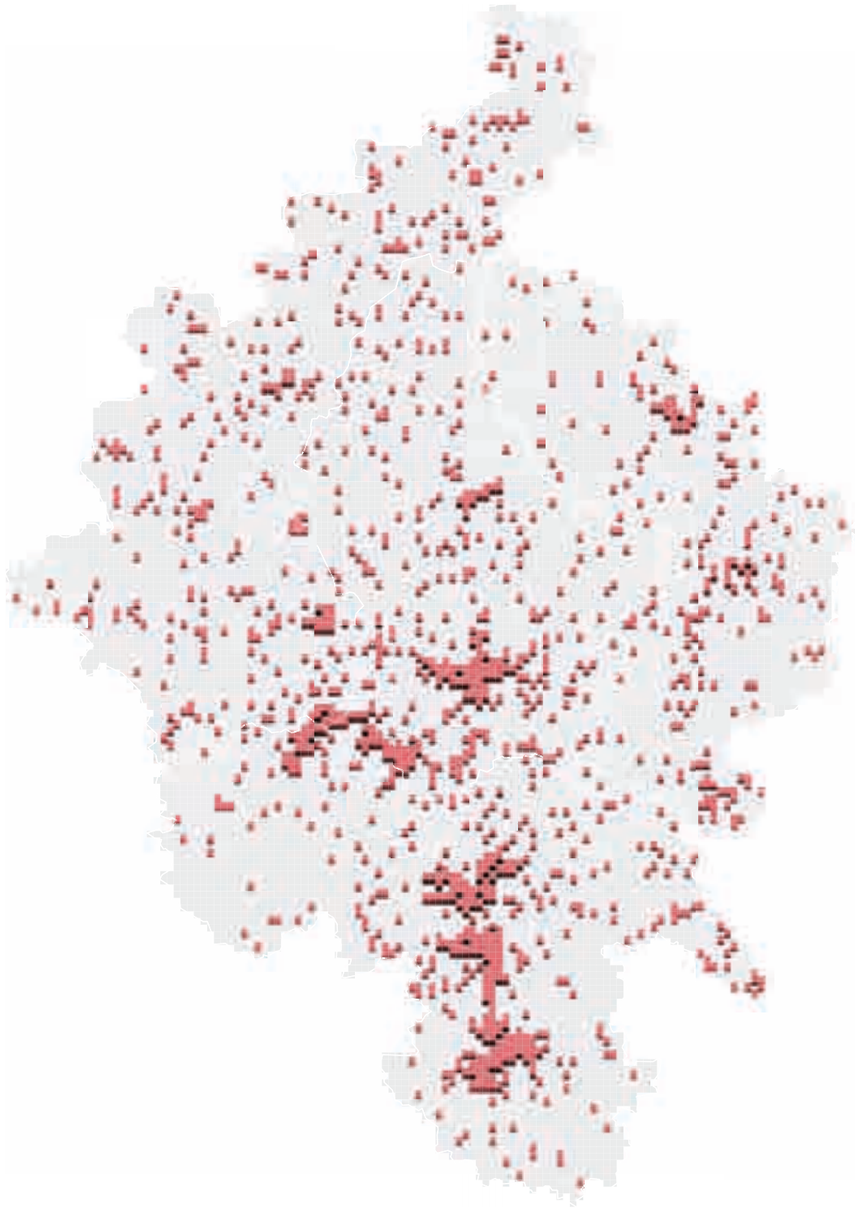
Urban boundary on all settlements: 937 km^2

Scenario 1

Densify all settlements



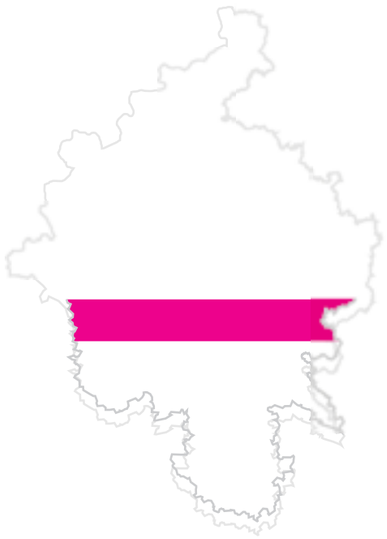
Ecotopia urban footprint = 1063.1 km^2
Urban densification by 2050 = +126.8 km^2



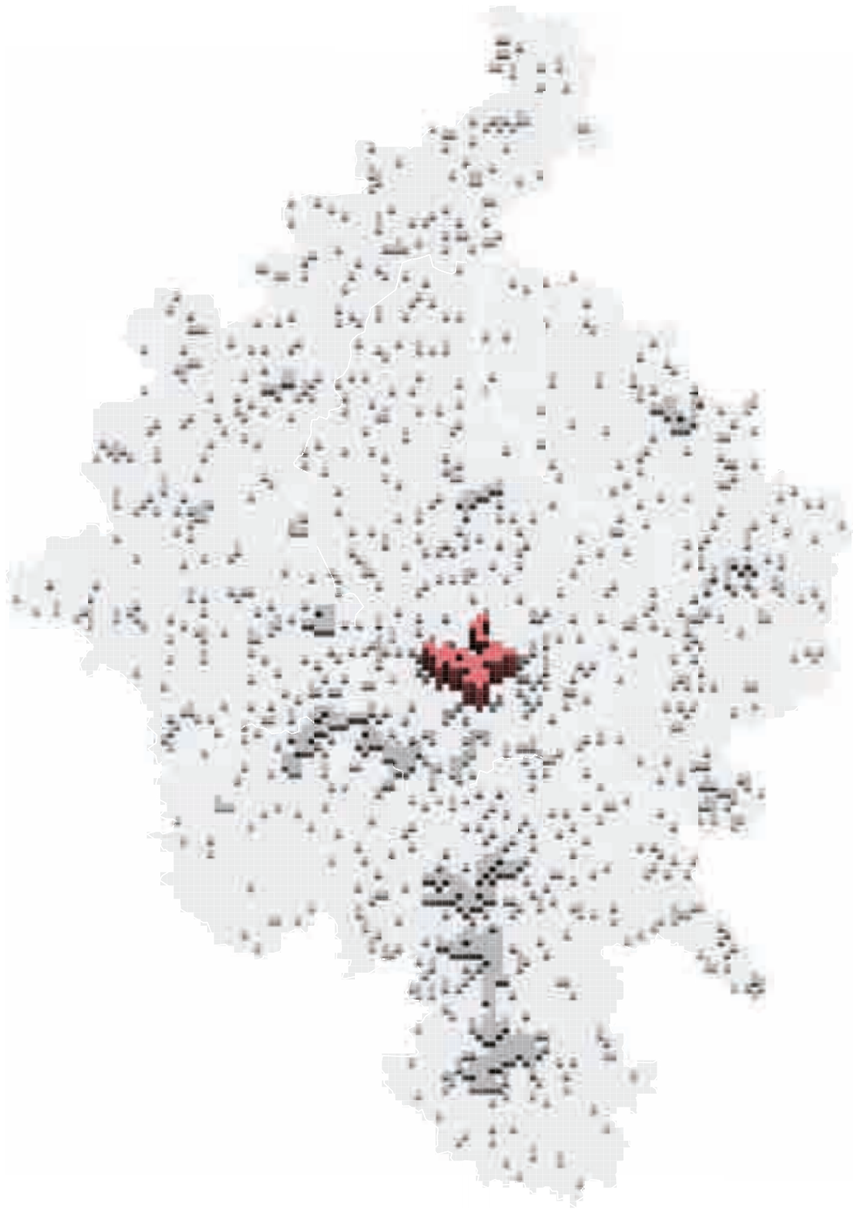
+14% on all settlements: 937 km^2

Scenario 2

A ‘Super LUX City‘



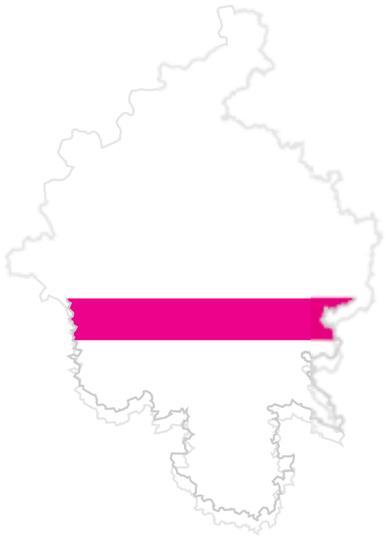
Ecotopia urban footprint = 1063.1 km^2
Urban densification by 2050 = +126.8 km^2



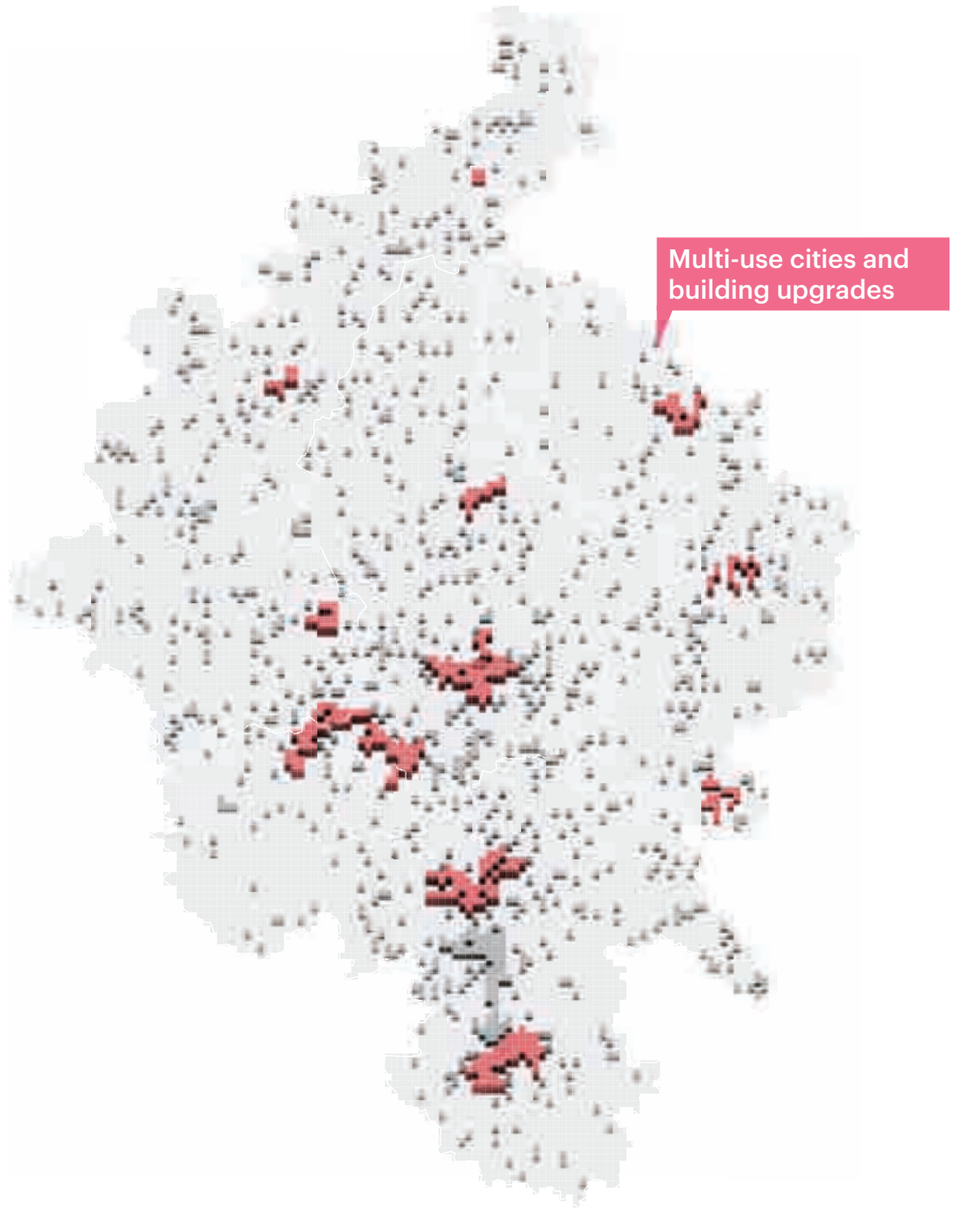
+300% on Luxembourg City: 50 km^2

Scenario 3

Densify all key (commuter) cities



Ecotopia urban footprint = 1063.1 km^2
Urban densification by 2050 = +126.8 km^2



+49.5% on key cities: 223 km^2

M01 | **Mixed-use city**

Image: Bastide Niel masterplan, France

Monofunctional districts to mixed-use districts = XXkm^2

Do not only densify, but also diversify and intensify uses to strengthen local communities

S01 | **Existing building upgrade**

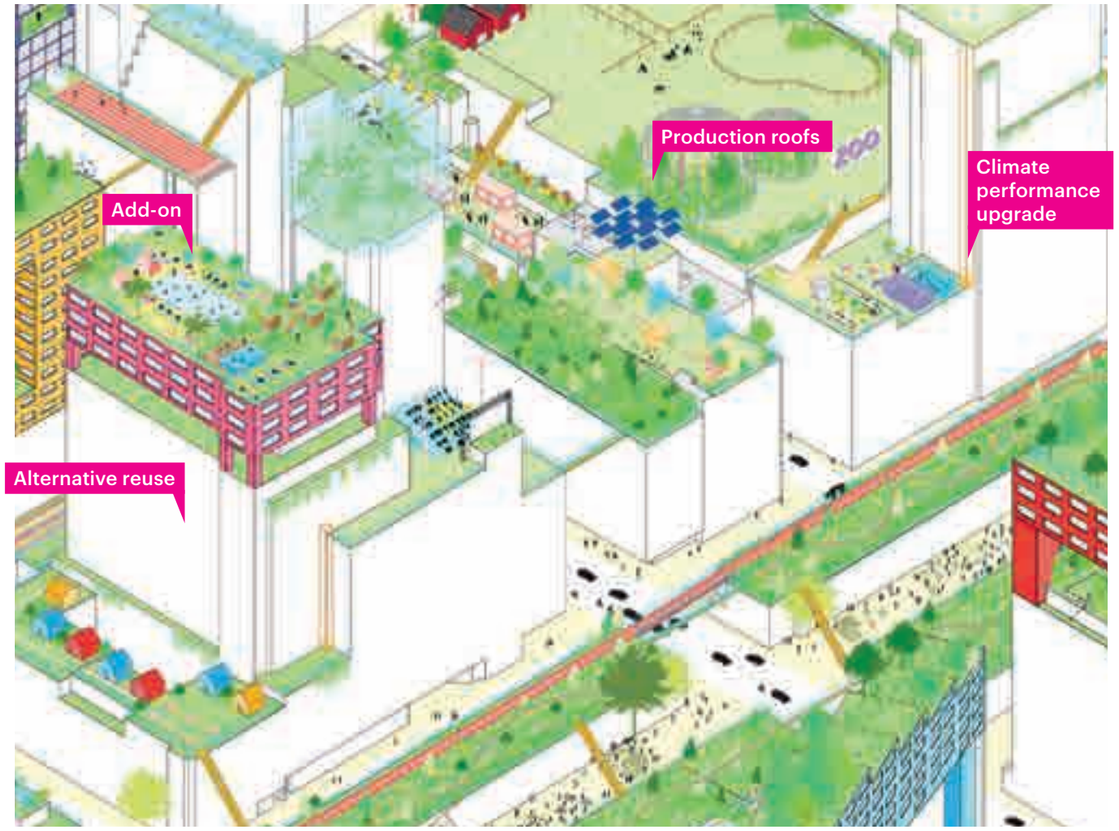


Image: Rotterdam rooftop catalogue, The Netherlands

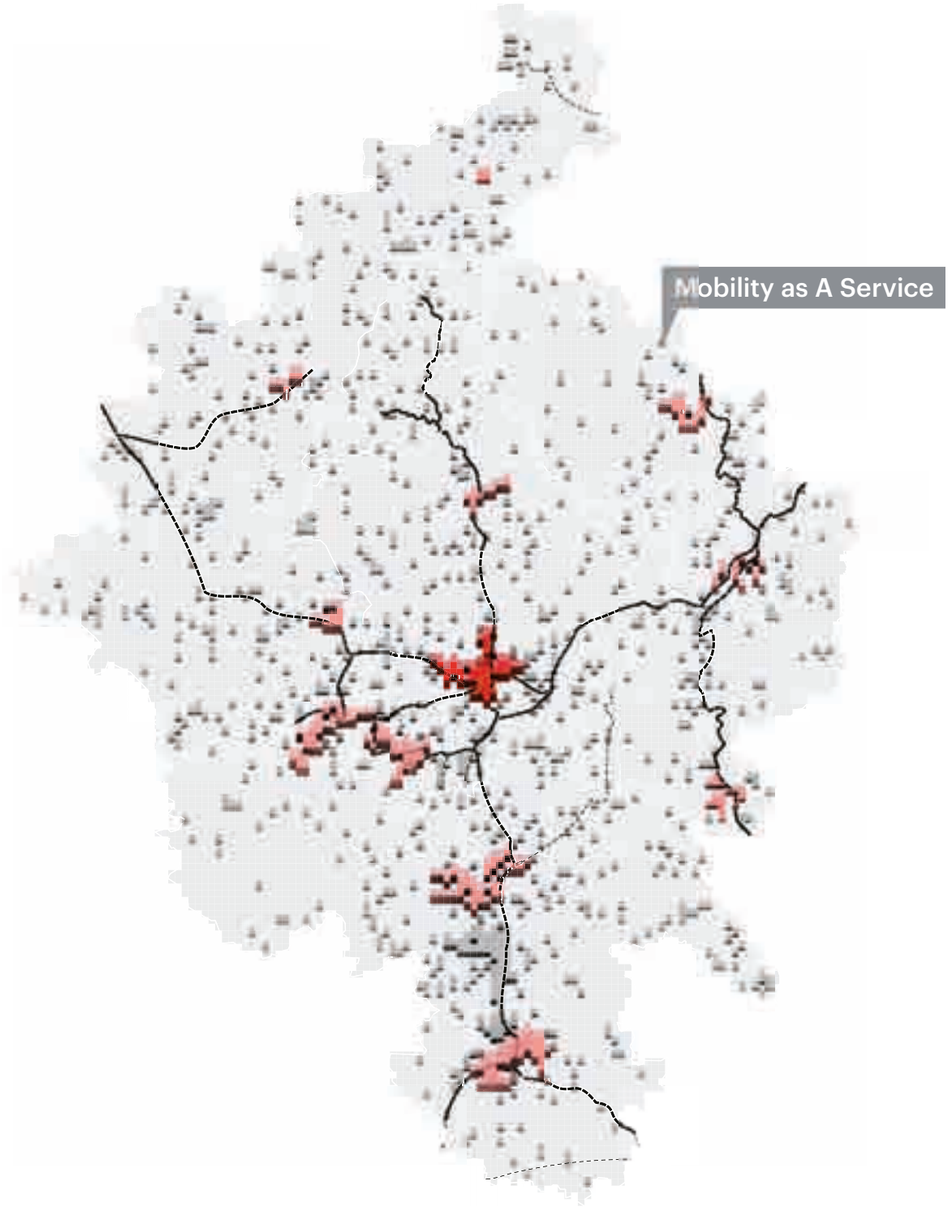
Existing building re-use and upgrade = XXkm^2

Maximize reuse and upgrade performance of existing buildings with minimal new construction

Scenario 1

Strengthen public transportation with rapid train connections between cities

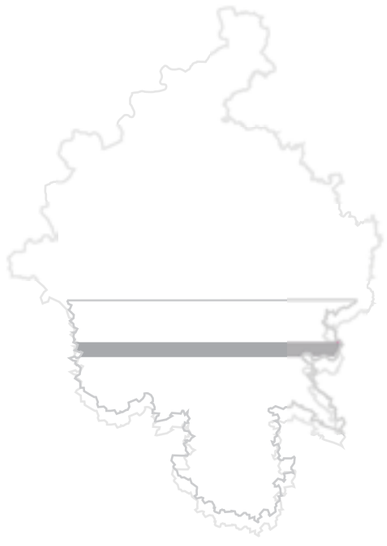
Ecotopia mobility footprint = 143.7 km^2



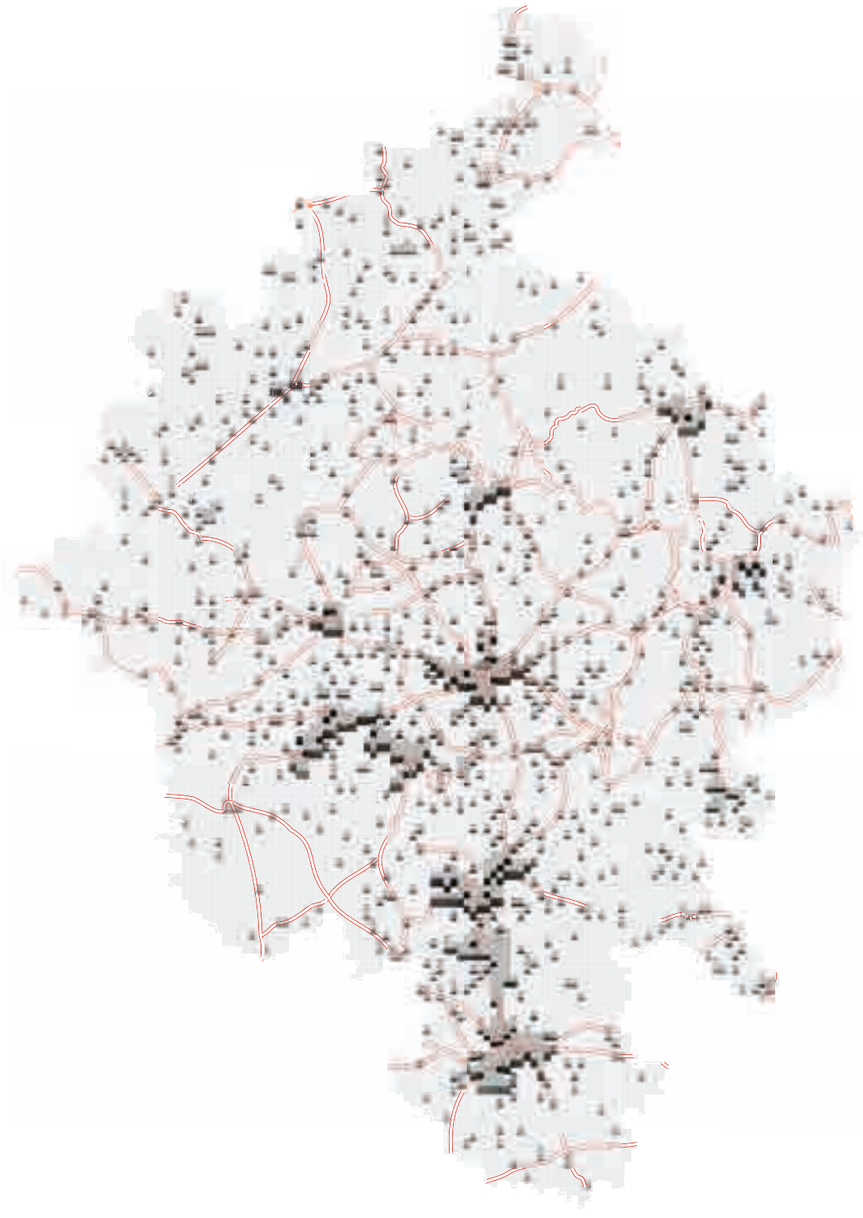
Rapid train railway: xx km^2

Scenario 2

Downgrade redundant countryside roads



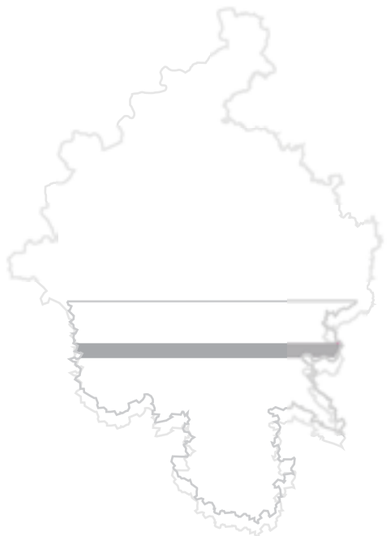
Ecotopia mobility footprint = 143.7 km²
Existing mobility surface = ca. 348.9 km²



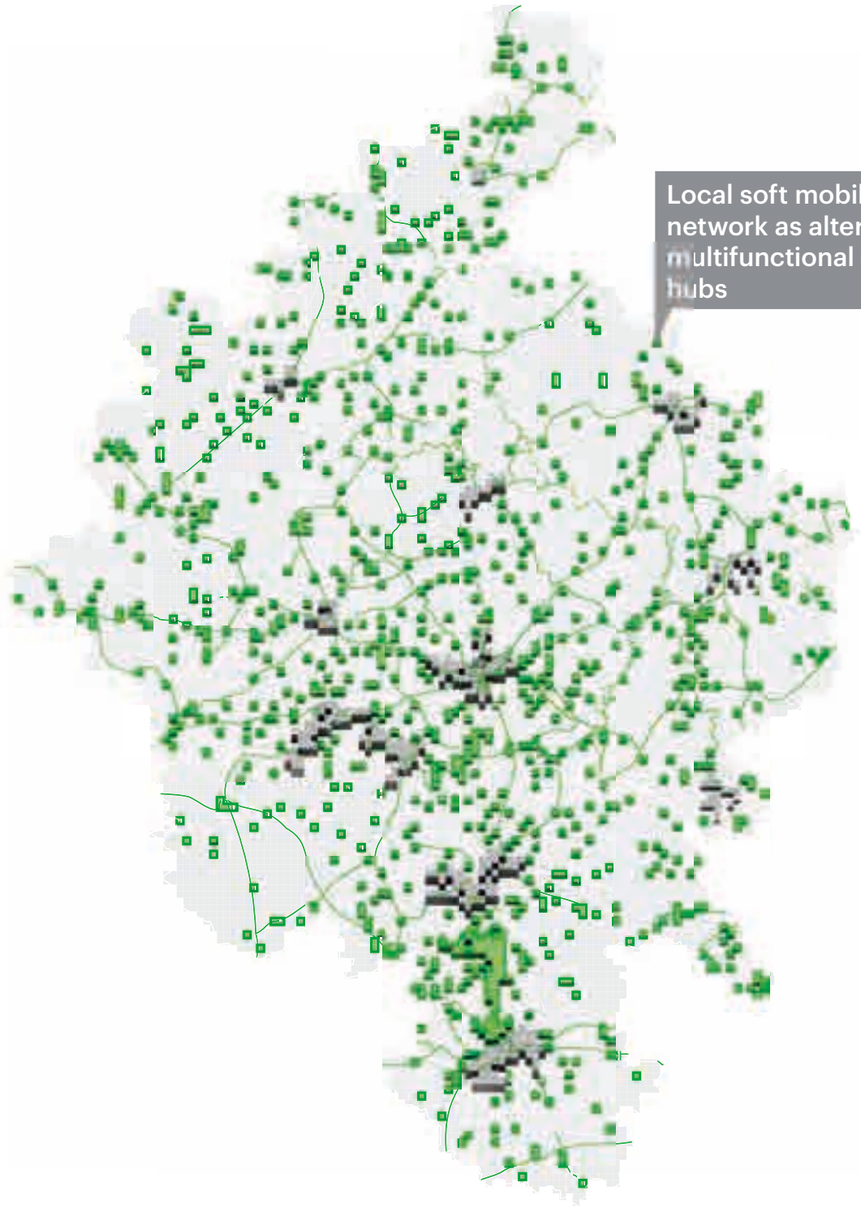
Downgraded countryside roads: xx km²

Scenario 3

Ban through traffic in villages



Ecotopia mobility footprint = 143.7 km²
Existing mobility surface = ca. 348.9 km²



Car-free village roads: xx km²

M02 | **Local soft mobility network**

Mobility as a Service. *openabt.com*

Electric scooter. *autocar.co.uk*

Cycling

Low-speed electric vehicle, Eli Zero. *Eli electric vehicles*

Provide local soft mobility as an alternative to vehicular use

S02 | **Multifunctional mobility hub**

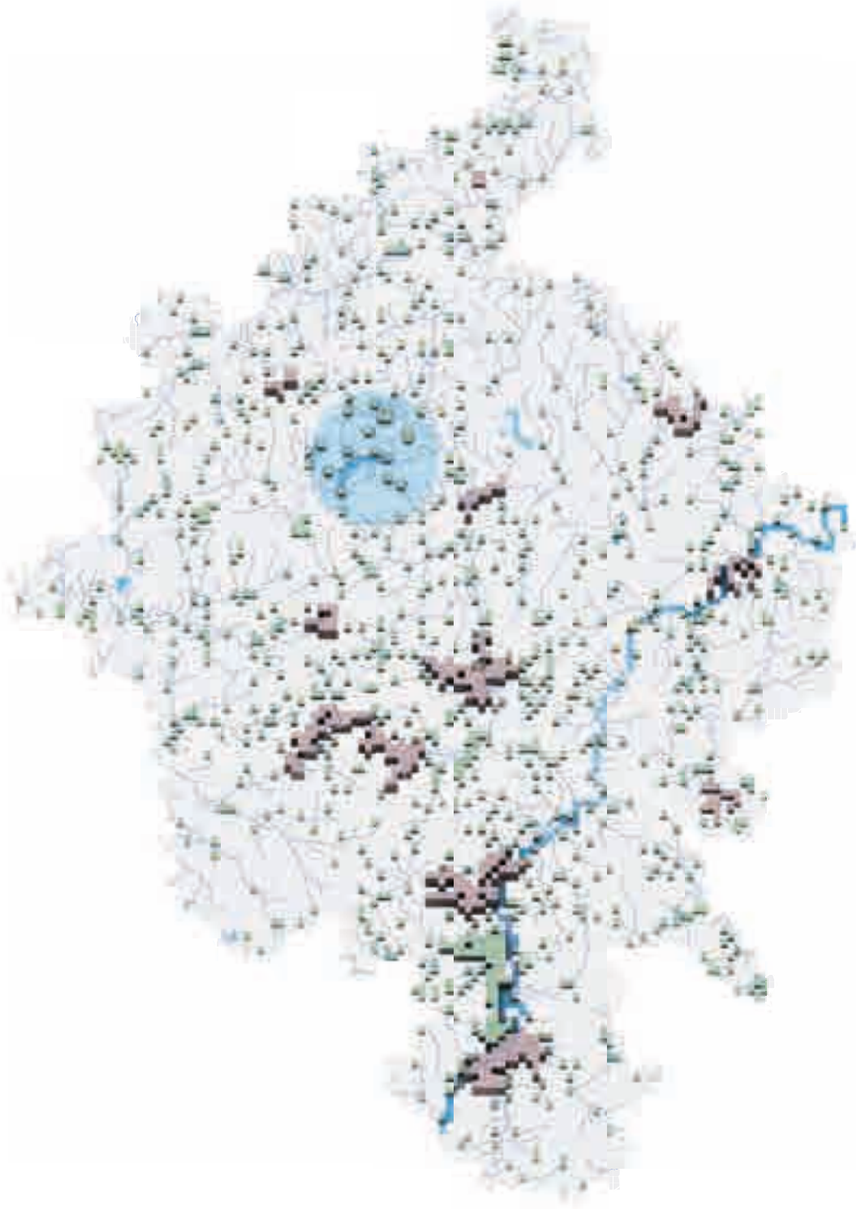
Image: Destination car park, Miami

Mobility hubs combine with community/production programs for local mixed-use

Scenario 1

Implement an ecological water buffer zone in the reservoir region to produce potable water

Ecotopia water footprint = 2416 km^2
Existing water surface = 64.2 km^2



Reservoir water buffer: ca. 70km^2

Scenario 2

300m wide buffers along main streams for flood management as well as potable river water

Ecotopia water footprint = 2416 km^2
Existing water surface = 64.2 km^2

River water buffer: 2750km^2

M03 | **Local retention landscape**

Image: Tamera water retention landscape, Portugal. Simon du Vinage

Retention basin = XXkm^2

Insert a local retention landscape at the head of catchment

S03 | **Building water capture and retention**

Image: Tainan Spring, Taiwan. *MVRDV*

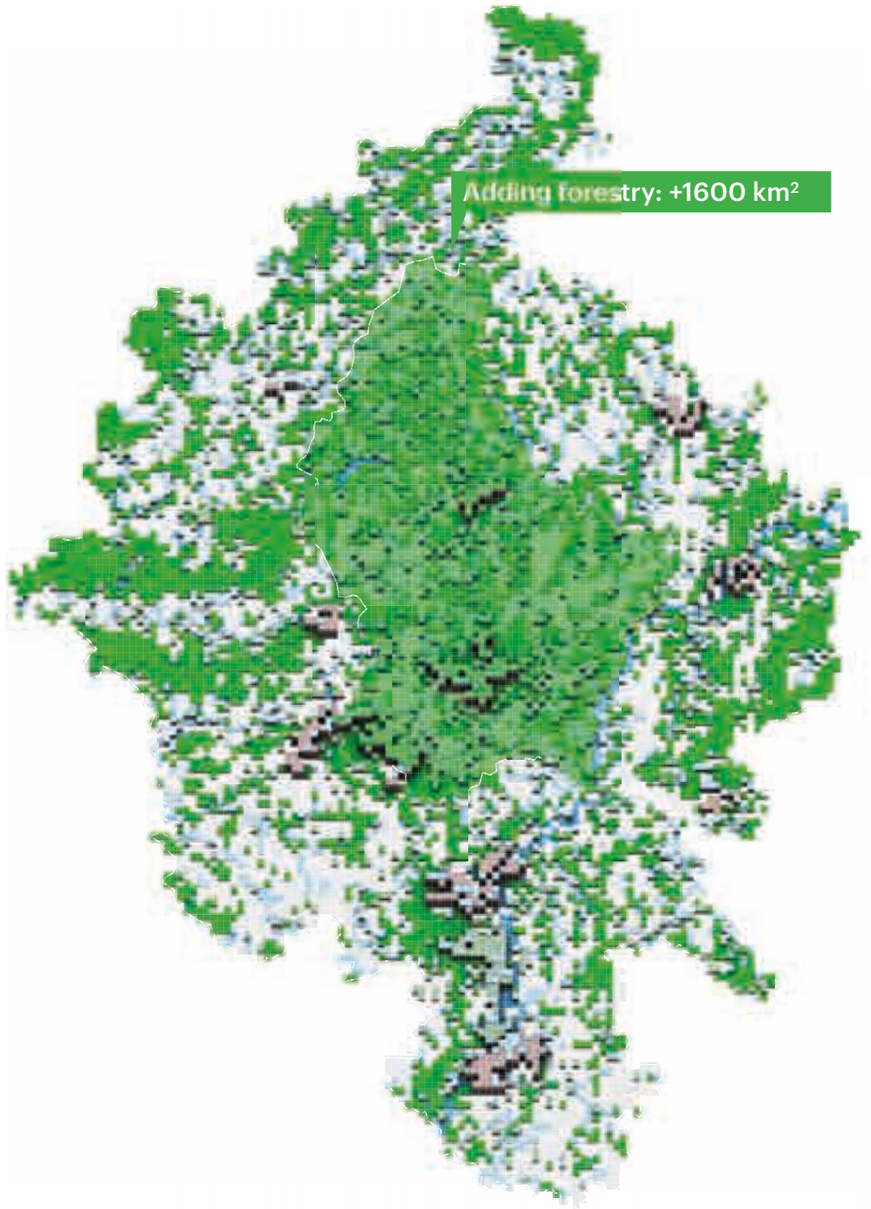
1% Urban surface with water retention = 9.6km^2

Implement storm and waste water capture for reuse in urban areas to reduce dependancy on central water reserves

Scenario 1

Create a green lung for LUX

Ecotopia nature footprint = 5604.2 km²
Existing forest =4115.9 km²

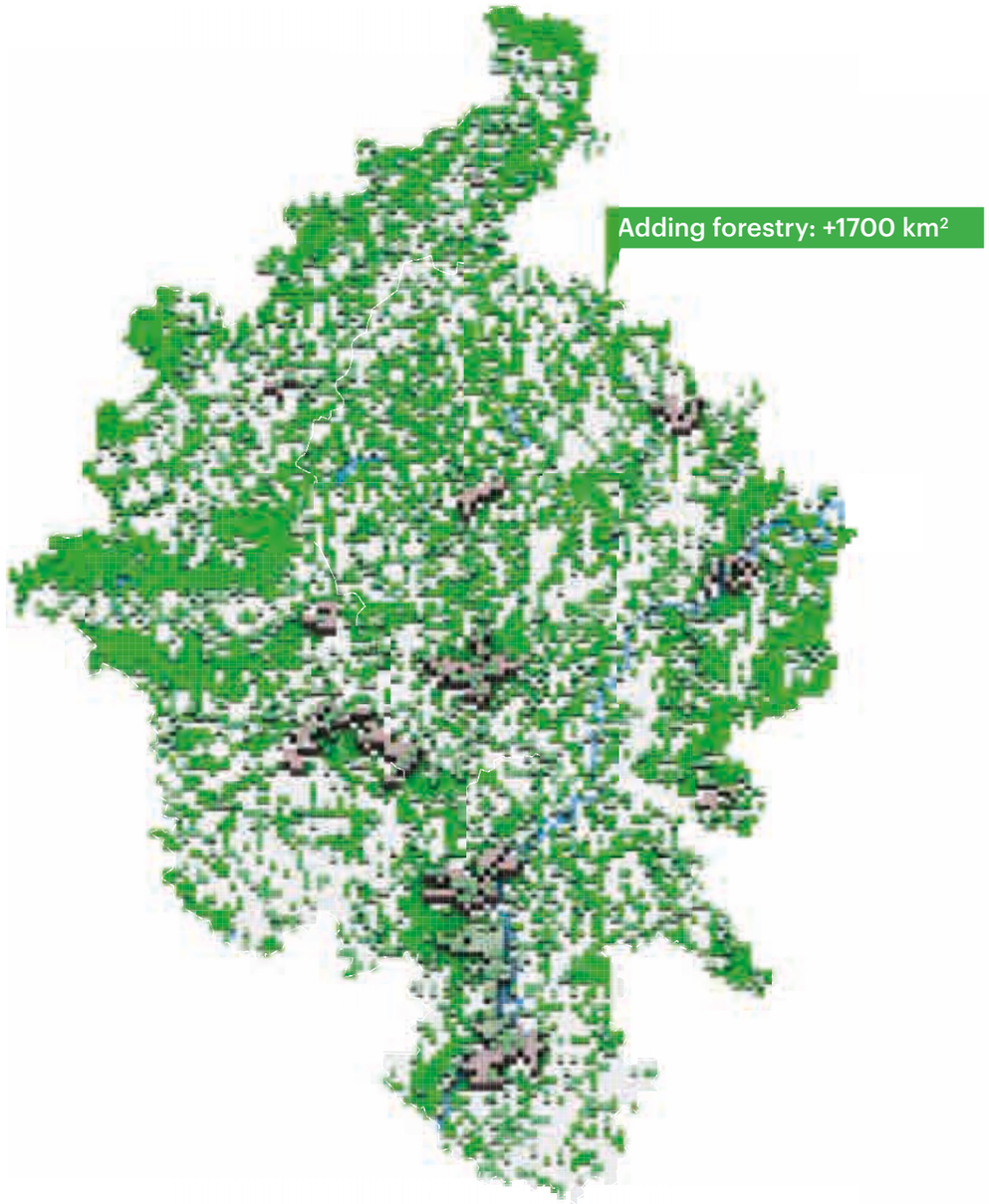


Total forest and urban green = 5536km²

Scenario 2

A biodiverse green network connecting nature through the water buffer along river streams

Ecotopia nature footprint = 5604.2 km²
Existing forest =4115.9 km²



Total connected forest = 5636km²

M04.1 | **Ecological forest with selective harvesting**

Image: Selective logging. *National Geographic*

Ecological forest = +XXkm^2

Ensure ecological forest management, placing a moratorium on clear cutting to maintain biodiversity

M04.2 | **Green streets**

Image: Eindhoven green dip, The Netherlands

Max. green streets = +XXkm^2

Reep benefits from the mobility transition; vehicular roads can transform into greenstreets and green urban corridors

S04 | **Green roofs & facade**

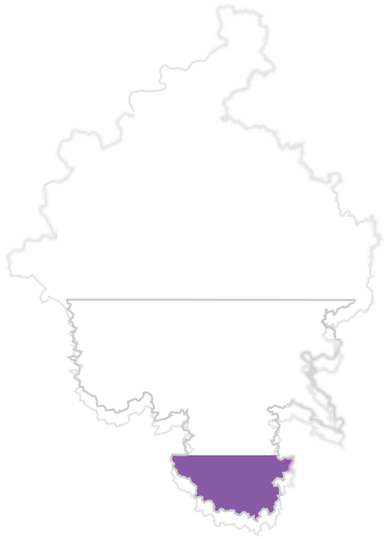
Image: Green Valley, The Netherlands

Max. green roofs and facade = +XXkm^2

Maximize urban greenery on building roofs and facades

Scenario 1

Insert agrivoltaics on all agriculture land



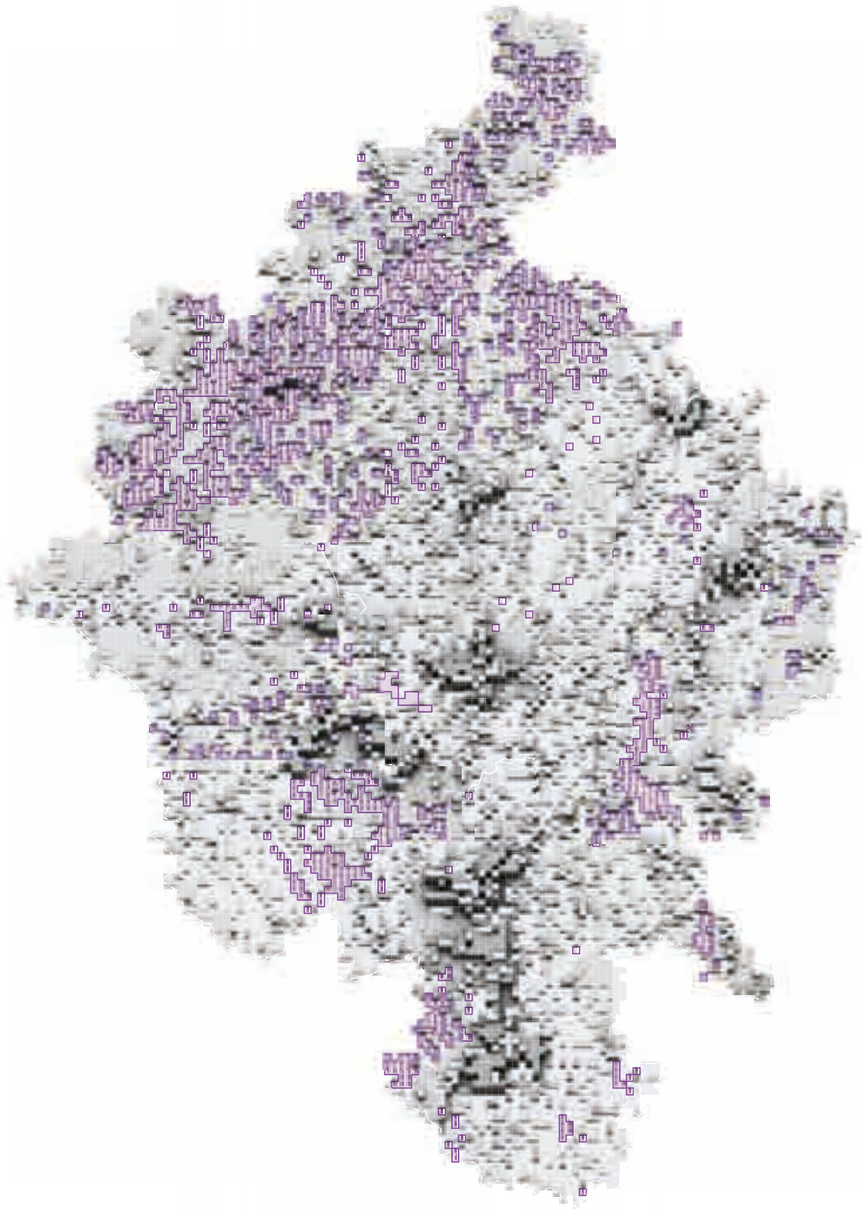
Ecotopia energy footprint = 1226 km^2
(100% solar)

30% coverage on potential solar energy
production = 1839km^2

Scenario 2

Mix solar and windmills on agriculture land (+400w/m2 area) for a more stable energy output

Ecotopia energy footprint = 1079 km^2
(70% Wind = 711 km^2, 30% Solar = 368 km^2)



Potential wind energy production = 1441km^2

M05 | **Energy storage**
(Hydrostorage, hydrogen, etc.)

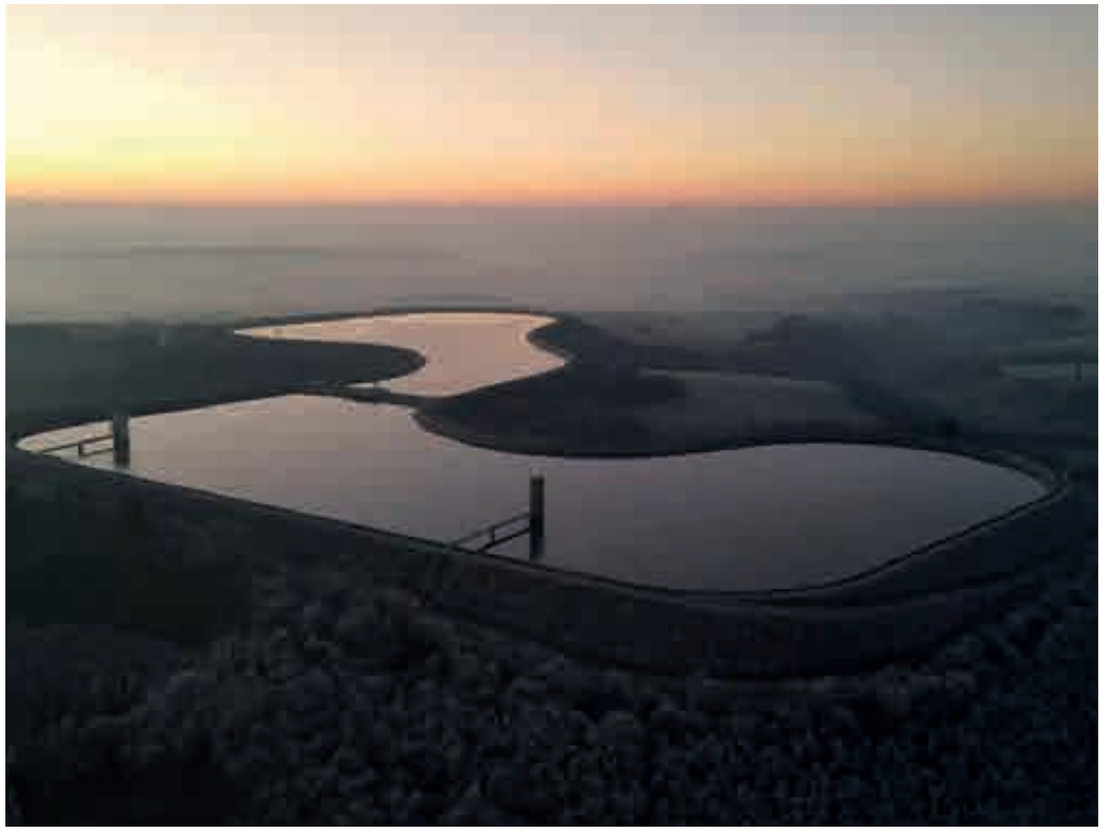


Image: Vianden hydrostorage, Luxembourg

New hydrostorages around Esch-sur-Sûre= 5.25km^2 (Estimated max. 5.6GW)

Energy storage balances the gap of production and consumption at peak difference

S05 | **Solar roofs**

Image: PV panels on roof, Luxembourg

Max. solar roofs = +XXkm^2

Enhance local energy production on building roofs

Scenario 1

Intensify agricultural land with production forests for the additional footprint

Ecotopia agriculture footprint = 7297 km²
Existing agriculture land = 6007.6 km²

Double layer production by agroforestry on water buffer = 1690km²

Scenario 2

Agro-ecology practices with agroforestry, organic and regenerative agriculture to reduce carbon and improve soil/water condition

Ecotopia agriculture footprint = 7297 km^2
Existing agriculture land = 6007.6 km^2

Agro-ecology practice = 6007km^2

M06 | **Urban/stack farming**

Image: Vertical farming, Regen Villages

Urban/stack farming = +XXkm^2

Insert food production in the urban area

S06 | **Local production hub**

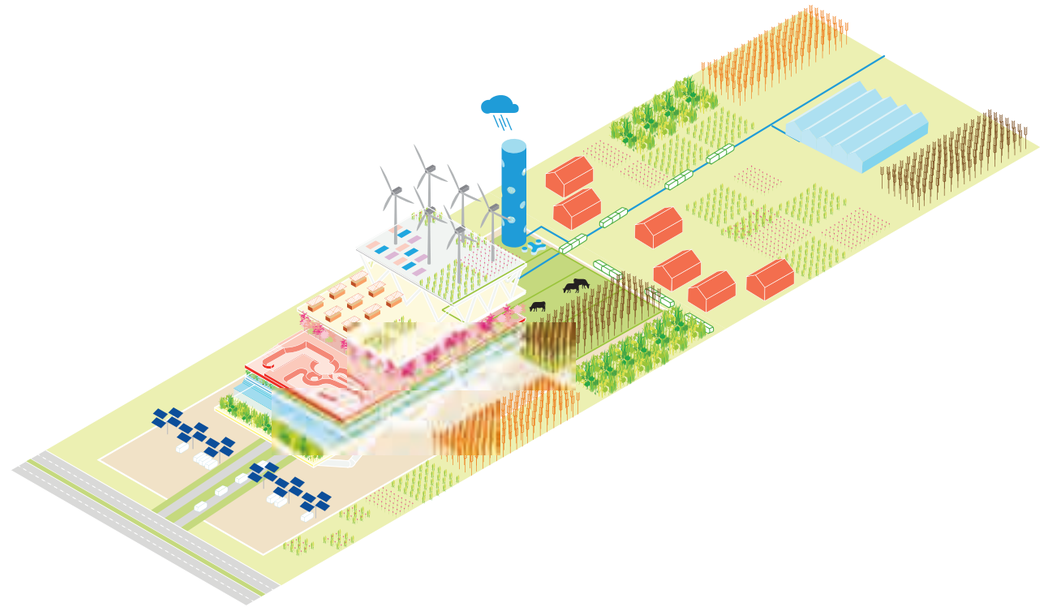


Image: Luxembourg transition production scenario. *MVRDV*

Local production hub = XXkm^2

Combine local production hubs with mobility hubs to shorten the production chain

Towards Ecotopia

Maximizing potential...

in every plot of land

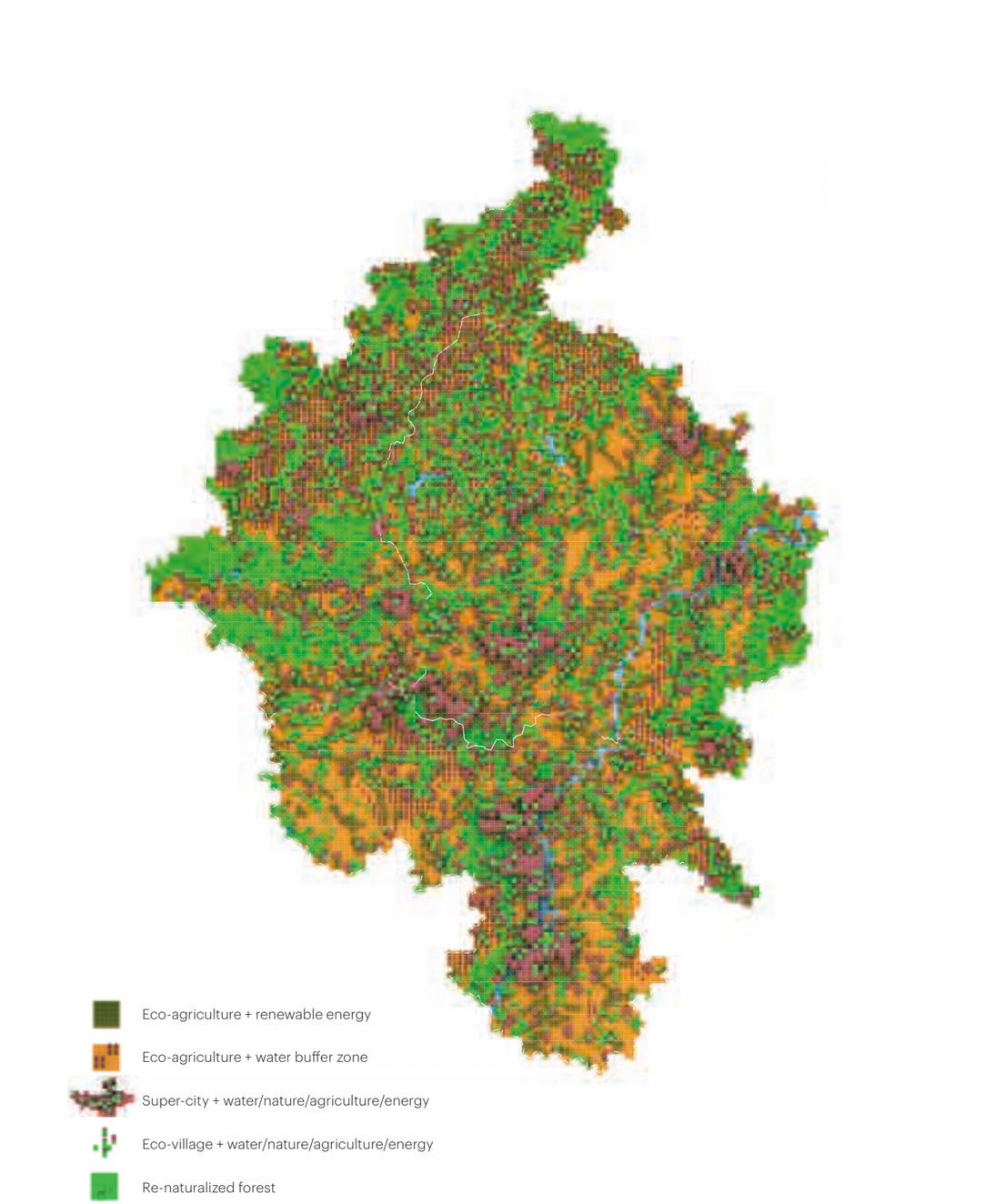
Ecotopia provides a future vision of an intensely mixed-use landscape that maximize every square meter for useful purpose. Land no longer has a singular function, either in urban or rural contexts. Instead, a mix of more than one value, function, or land-use in both contexts maximizes the capacity of the entire region to produce food, store and recycle storm water, and store carbon, ensuring long term resilience and robustness through biodiversity.

Combinations could include:

- Agriculture + renewable energy
- Agriculture + forestry
- Urban + farming/forest
- Urban + solar energy
- Argiculture + water buffer
- Rewilding forest + Flood management

Within sectors, combinations also strategically enhance productive potential through maximization, for example in forestry where monoculture and fragmentation can transform into networks of mixed, connected, and renaturalized forest.

At numerous layers, and through numerous permutations and combinations, mixed use cultivates a rich and productive density, exponentially increasing potential capacities for Luxembourg.



Ecotopia Vision Map

Shifting from the individual to the collective

Achieving mixed-use capacities on a single plot of land is a complex task. To this end, it is critical to ensure that the prospective value benefits not only one individual, but collective wishes, with global benefits. For example, an organic farmer in Eschdorf must be able to benefit from the value of their contribution to a nearby reservoir's water quality. Similarly, a home owner should be able to share the excess energy of their solar roof to the neighbourhood in exchange for other resources that benefit them individually.

It is only possible to achieve these benefits by enabling collaboration between governmental bodies, the private sector, and local initiatives.

Extending from the ground to the sky

Perceiving land value with multiple facets above and below ground, advances the concept of maximizing productive potentials. From energy production to biodiversity interdependencies, and from water retention to CO^2 offset, a whole multitude of successful practices prove the feasibility of multi-purpose land-use in both agricultural land and urban contexts.

This opens a whole new prospect of land-use which will also limits the domination of mono-functional real-estate development in the Luxembourg region.

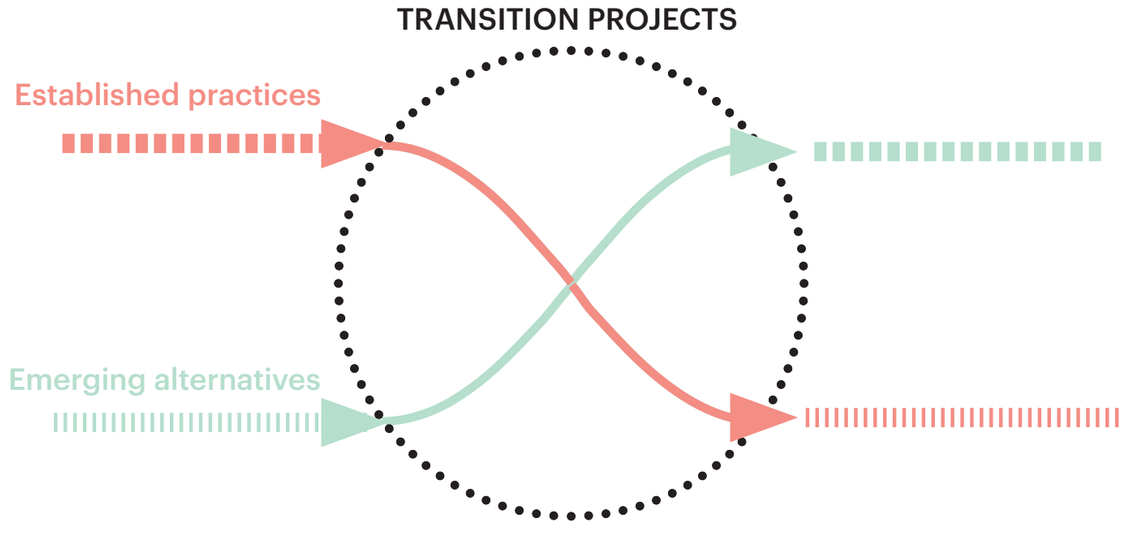
Rethinking the value of land

Shifting the perspective to encompass a multi-faceted valuation of land, requires a shift in urban planning methodologies from two-dimensional mapping to three-dimensional planning. This will help the general public understand and appreciate land's inherent multi-value, making decarbonization, resilience measures, and biodiversity tangible and concrete.

Enabling a collaborative culture

Immediate action is necessary in order to shift the trajectory and enable alternative projects that facilitate a carbon neutral future. Collaboration is critical to this in order to maximize impact and effort. This forms the basis of wide-scale transition on multiple scales and levels of governance, including:

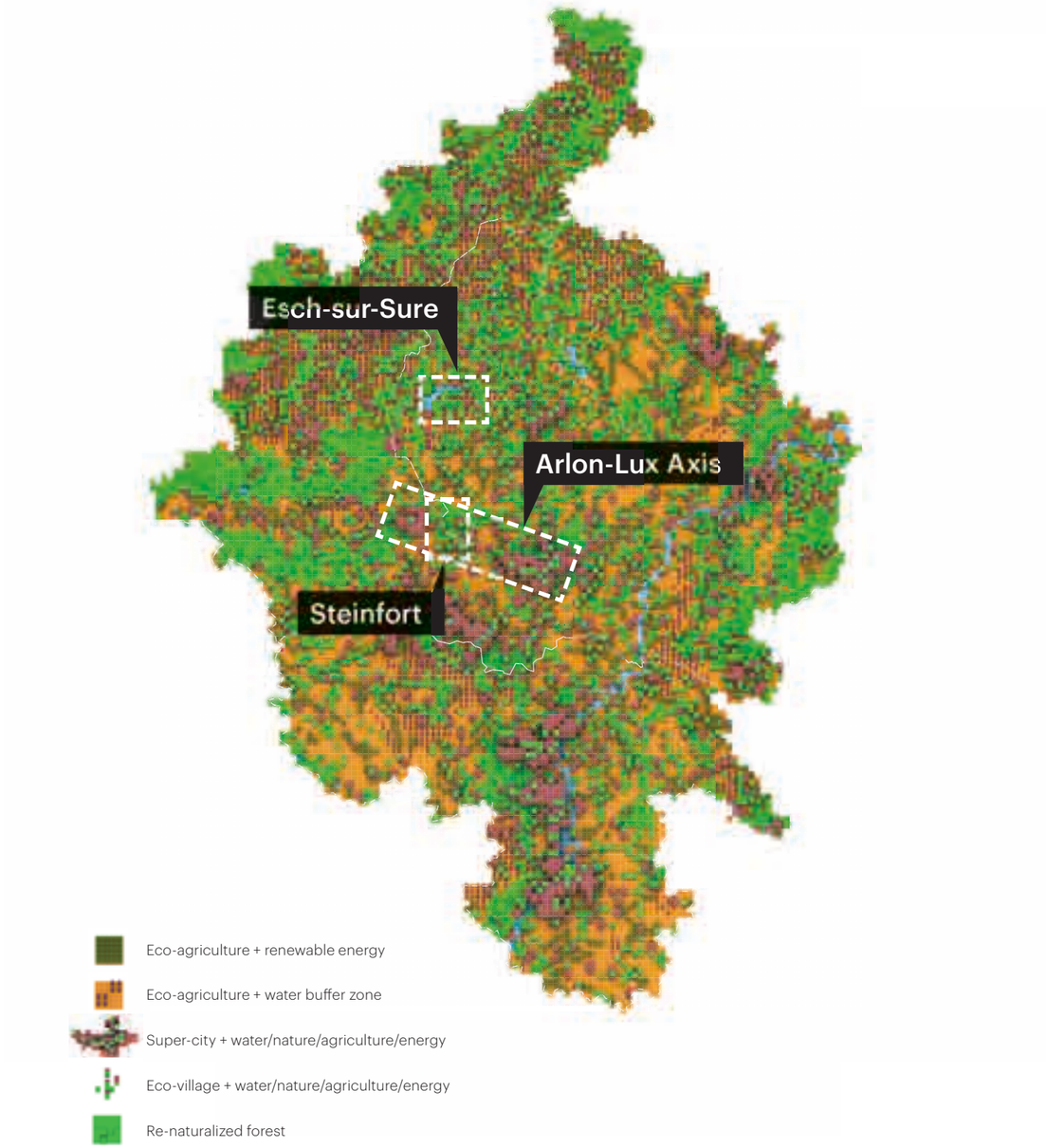
- A trans-border governance model that enables cross-border exchange and cooperation
- A mixed governance structure that facilitates cross-scale, and multidisciplinary actions
- A time & scenario based(four-dimensional) transition strategy



Illustrating implementation zooms

To showcase projects at a contextual scale, two "zooms" present examples of implementation in two critical Luxembourg regions:

1. Steinfort: A trans-border region with dispersed villages experiencing intense pressures from suburbanization, natural and water systems are currently at risk. There is great potential in the soil for intensive agriculture, and the cultivation of solar energy. The question in this "zoom" is how to limit urban sprawl, and in turn, increase this southern Luxembourg area's value in terms of natural space, resilience, and productivity.
2. Esch-sur-Sûre: A beautiful, tranquil region, comprising important natural and leisure-based Luxembourg resources, this area stands to benefit from the new by-pass construction in Nordstad, and as a result, has piqued the interest of real estate developers. The question in this "zoom" is how to prevent the overdevelopment that has plagued the northern region, adding strategic productive value to the beautiful natural landscape, while strengthening the Esch-sur-Sûre region's identity.

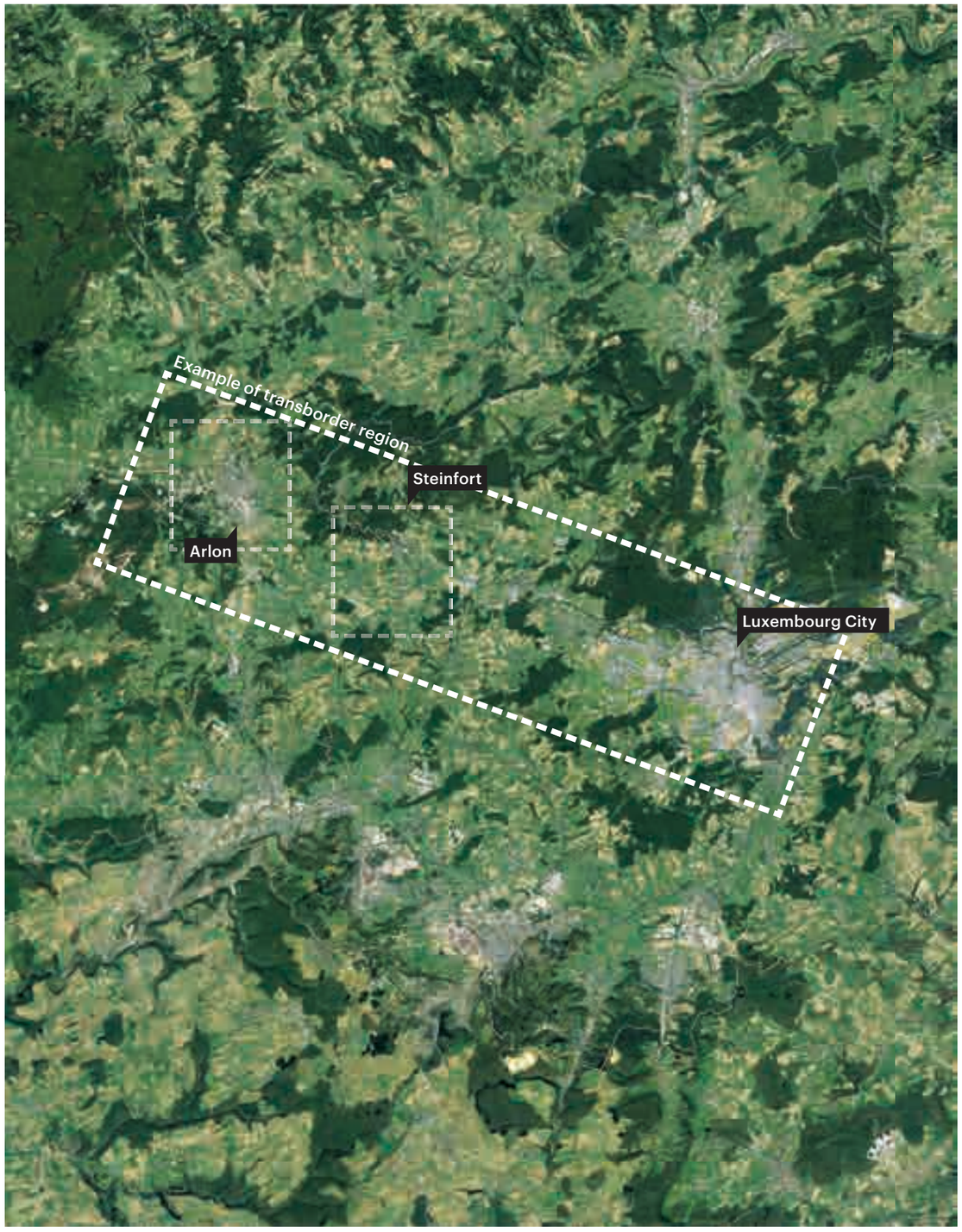


Implementation Arlon-Lux Axis, Steinfort

Arlon-Lux Axis: The Super Cities
Steinfort: The Eco-village
Steinfort in Transition

2

Regional zoom: Arlon-Lux Axis



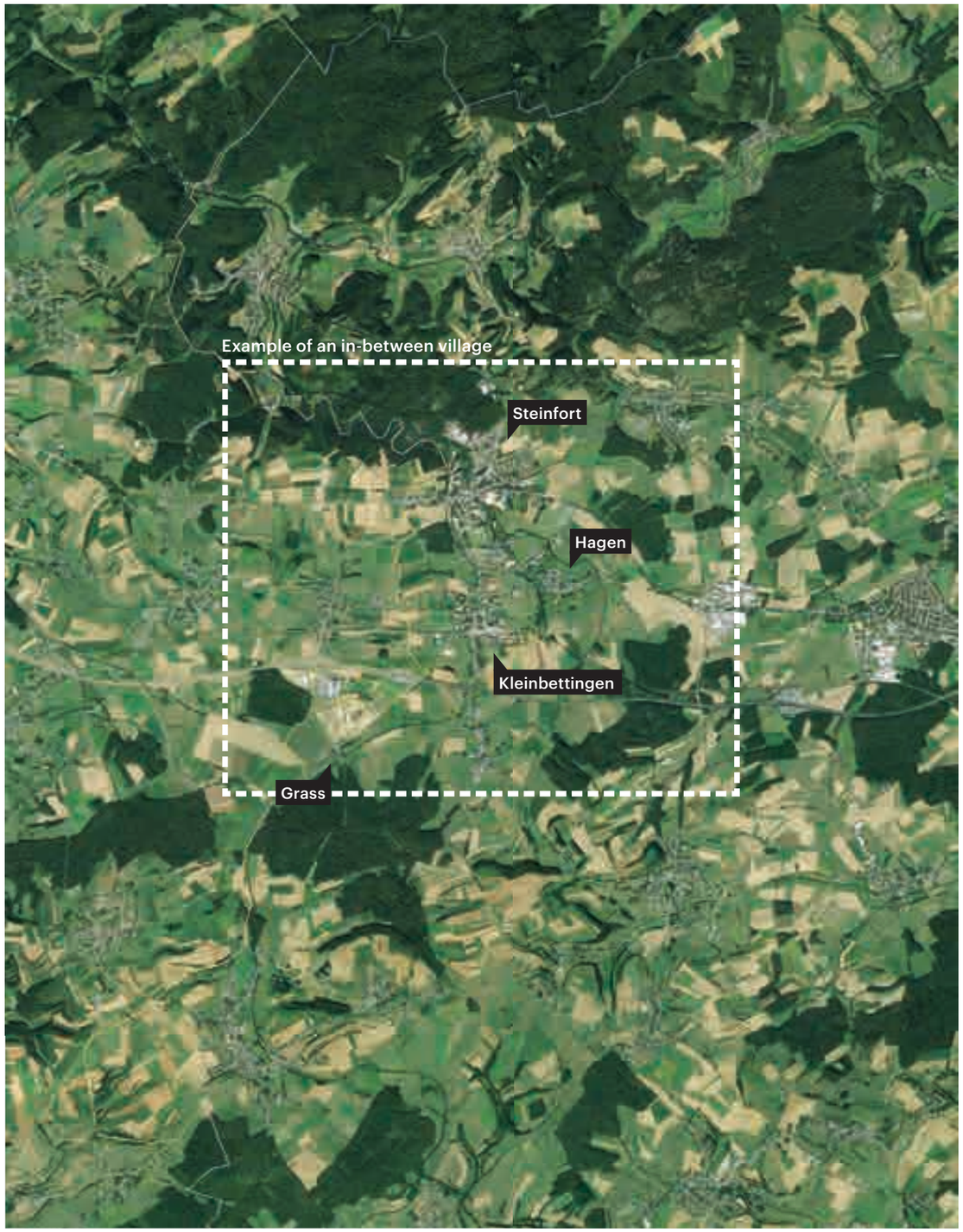
Kirchberg, Luxembourg City - Retrieved from lequotidien.lu

Arlon City Centre - Photo of AMCV

Town centre, Steinfort - Retrieved from Jornal do Luxemburgo

Commerical hub, Windhof - Retrieved from Vymaps.com

Site zoom: Steinfort



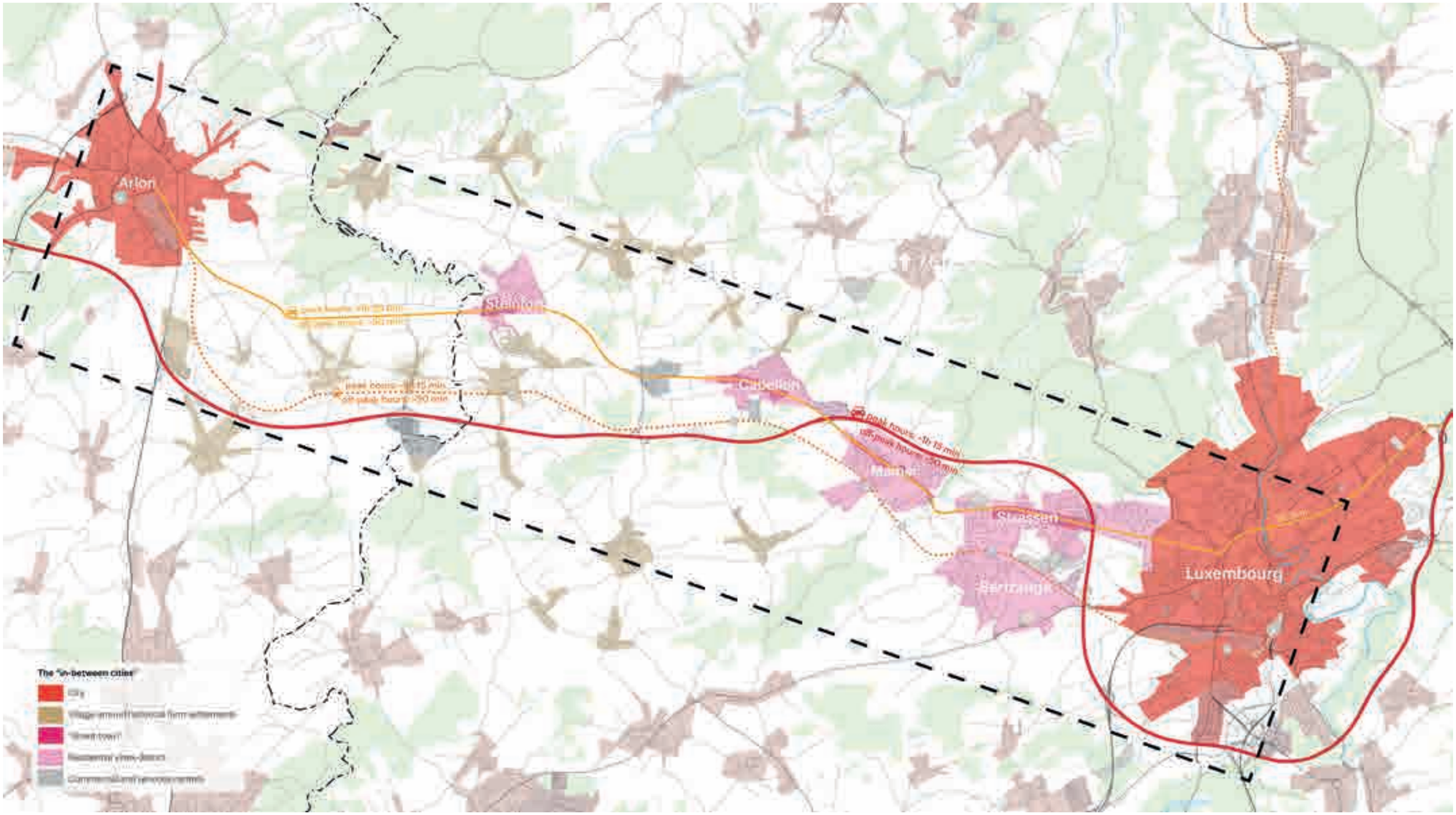

Town Center, Steinfort


Rea estate development, Grass


Agriculture land, Steinfort

Arlon-Lux Axis: The Super Cities

Arlon to Lux Axis



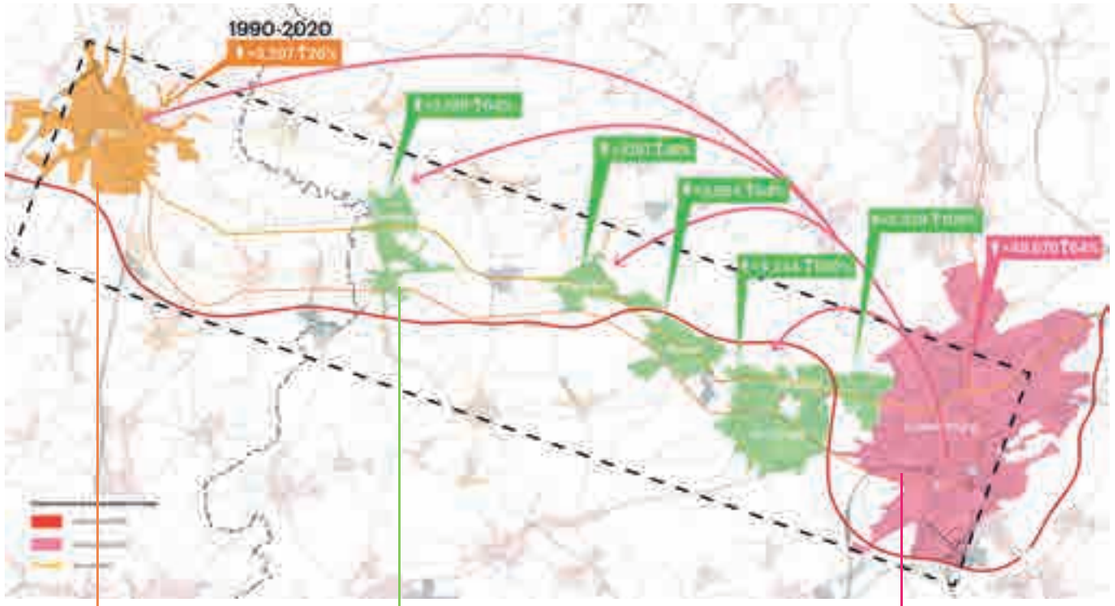
Arlon + in-between villages population (2021)= 49,970
Luxembourg City population (2021)= 124,509

Suburban expansion

A strong example of a typical trans-border Luxembourg region, the axis of Arlon and Luxembourg City concentrates considerable economic activity. Here, housing prices are rapidly increasing, whilst quality of life stagnates. Much of the Luxembourg workforce opt to live outside the city in the bedroom communities of small villages and neighbouring cities. Because of this, the Belgian border city, Arlon (with 60% of its population commuting to Luxembourg daily) and villages in-between suffer from an unchecked real-estate boom, and rapid suburbanization over the last few decades.

In Luxembourg's border town of Steinfort, 80% of its working population commutes, while 80% of its workforce comes into town at the same time.

These conditions generate both urban sprawl, and contribute to the region's carbon emissions, with vehicular transport being the primary mobility.



Housing price:
avg. €2500 / m2

Housing price:
avg. €7500 / m2

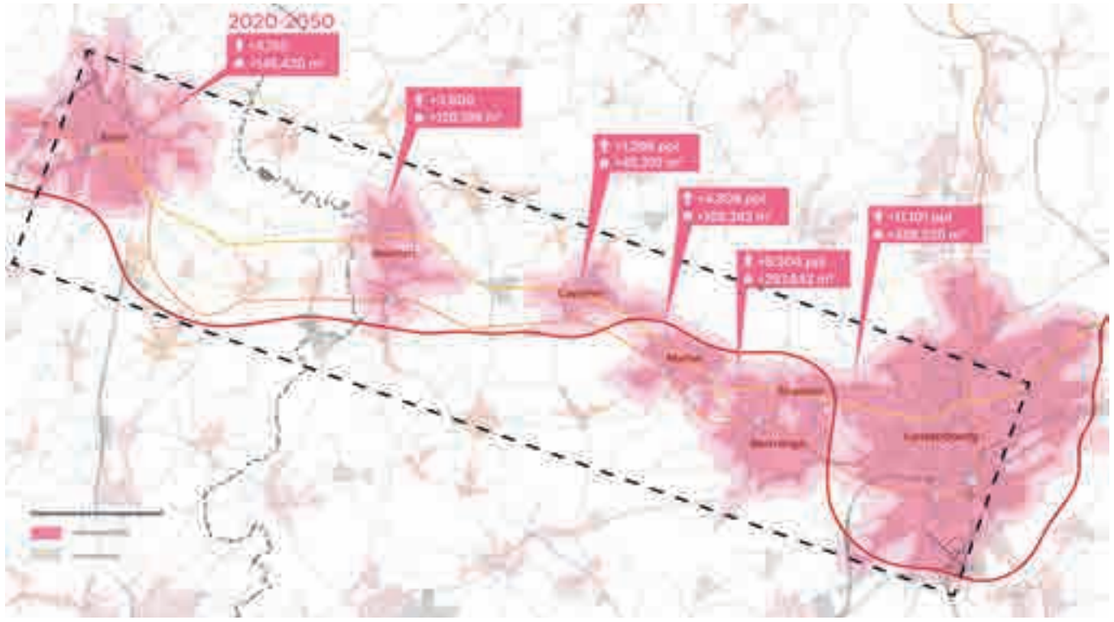
Housing price:
avg. €11,000 / m2

On course to 2050

If the trend continues uninterrupted to 2050, the region will see a population increase of 33,000, which means a population growth of over 65%. Even if average housing sizes for a single person decrease from 35m2 to 52m2, this population growth will still require 1.1 million square meters in new residential development.

What implications does this growth have on an urban scale? Will it continue to consume agricultural land and expanses of natural landscapes?

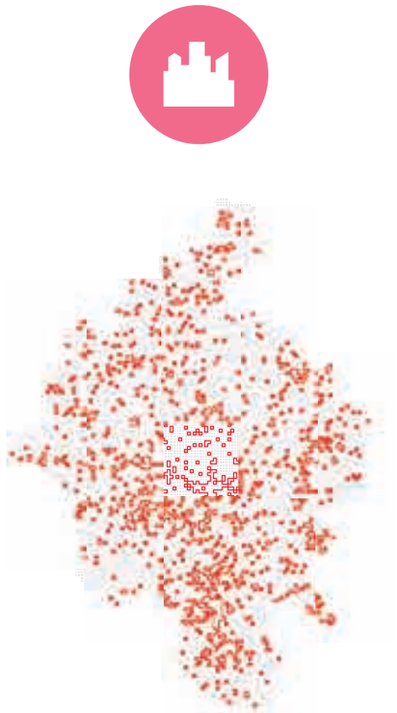
Is it possible to retreat from this advance, and pivot towards intelligent growth that can support Steinfort in the long term?



Extreme population growth till 2050 in the commuter city/villages= approx. 33k
Total new appartment area (35m2 per person) till 2050= approx. 1.1 million m²

Applied scenarios on the Arlon-Lux Axis

Arlon-Lux Axis demonstrates potential combinations of these scenarios for transborder regions.



Urban boundary on all settlements
= 937.2 km²

+

Densifying, diversify, greenify the cities
= 223 km²

+

Rapid train connection + no more road investment
= xx km²

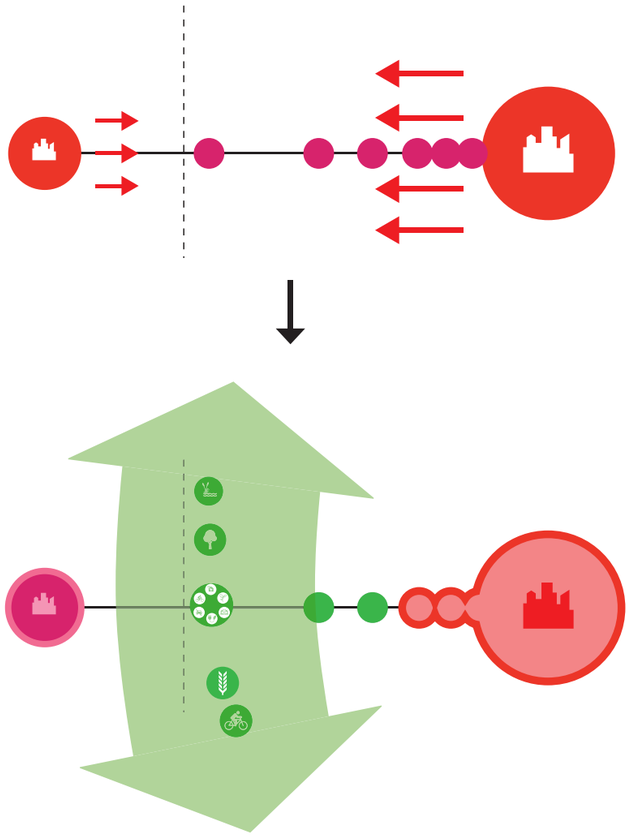
Ecotopia driving intelligent growth

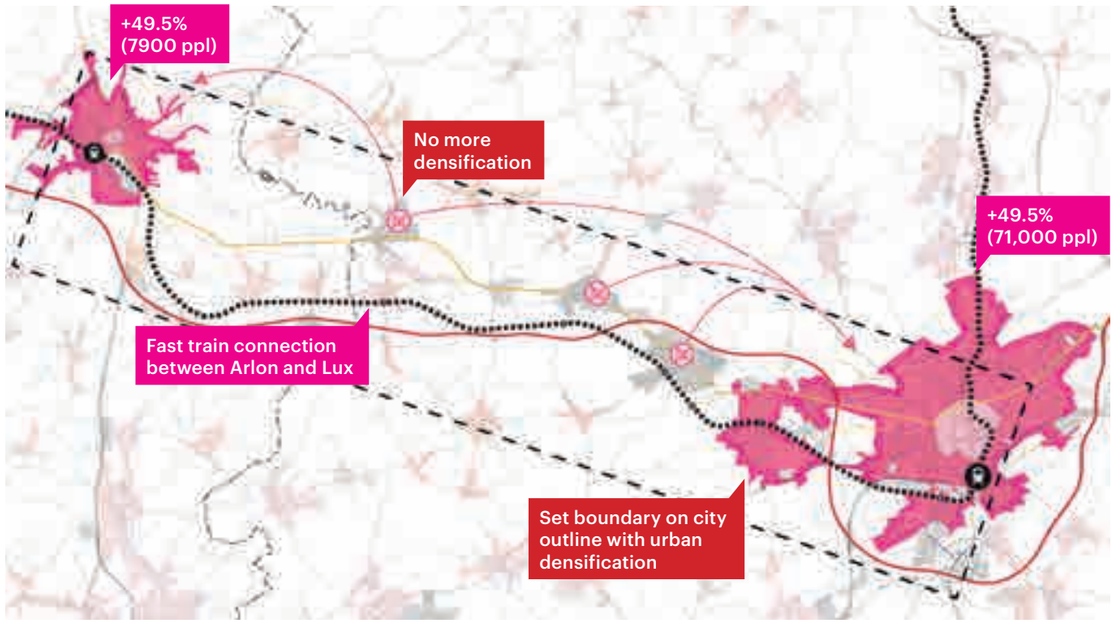
To stem the current tide of the suburbanization of the cross-border region, it is necessary to impose clear boundaries. Most importantly, a fundamental task is drawing a hard line on additional land intake as a means of accommodating growth.

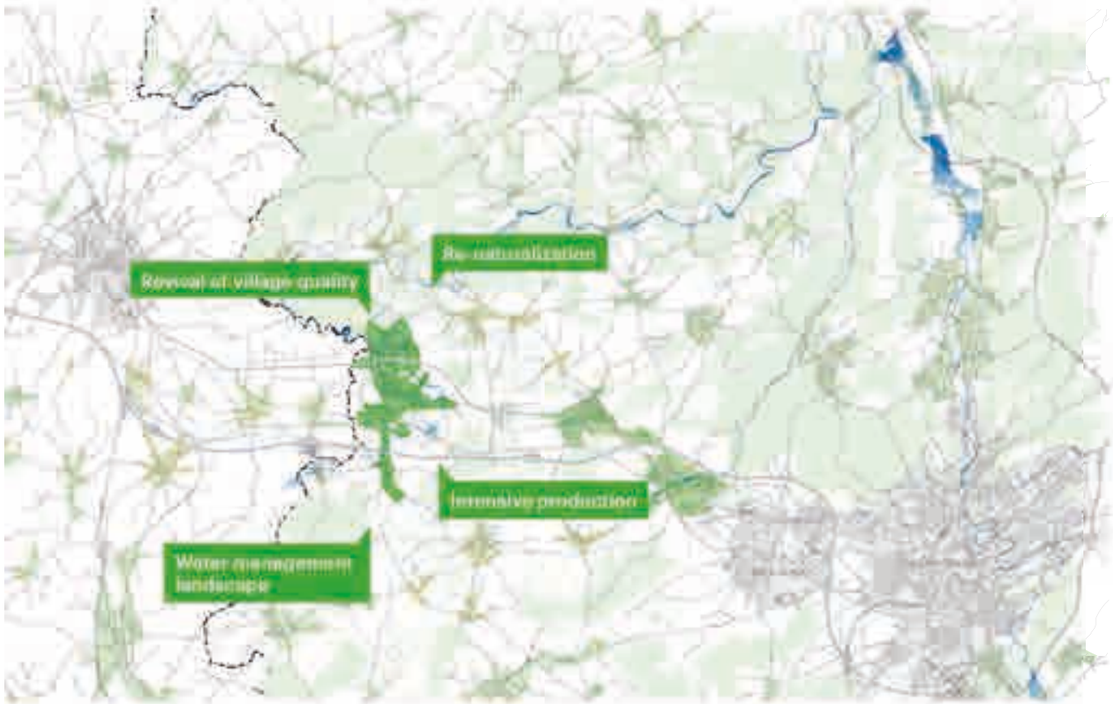
Encouraging smart growth means cultivating affordable housing, densifying cities, and using mixed-use urban planning strategies to offer high quality living and working environments, with effective and efficient public transport connections between cities.

Providing strong alternatives to the convenience of single car transport to rural areas can drive population growth away from agricultural areas, protecting the historic identity of traditional villages from encroaching suburbanization.

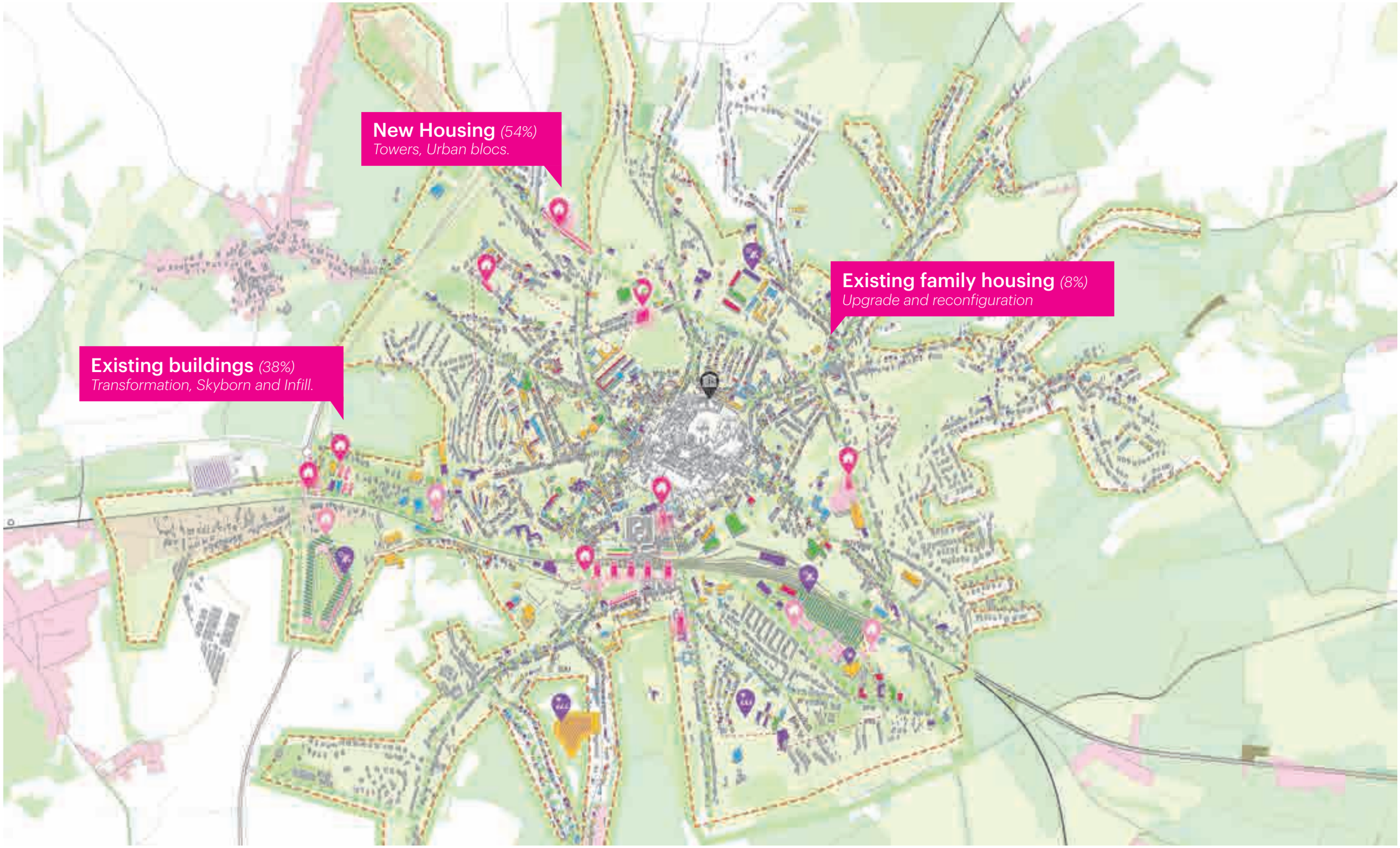
Cultivating natural landscapes between villages, these liminal landscapes become havens of biodiversity and resilience, intensifying water management, as well as food and energy production. This reorients villages and landscapes to enhancing natural ecologies, rather than displacing them with growth.





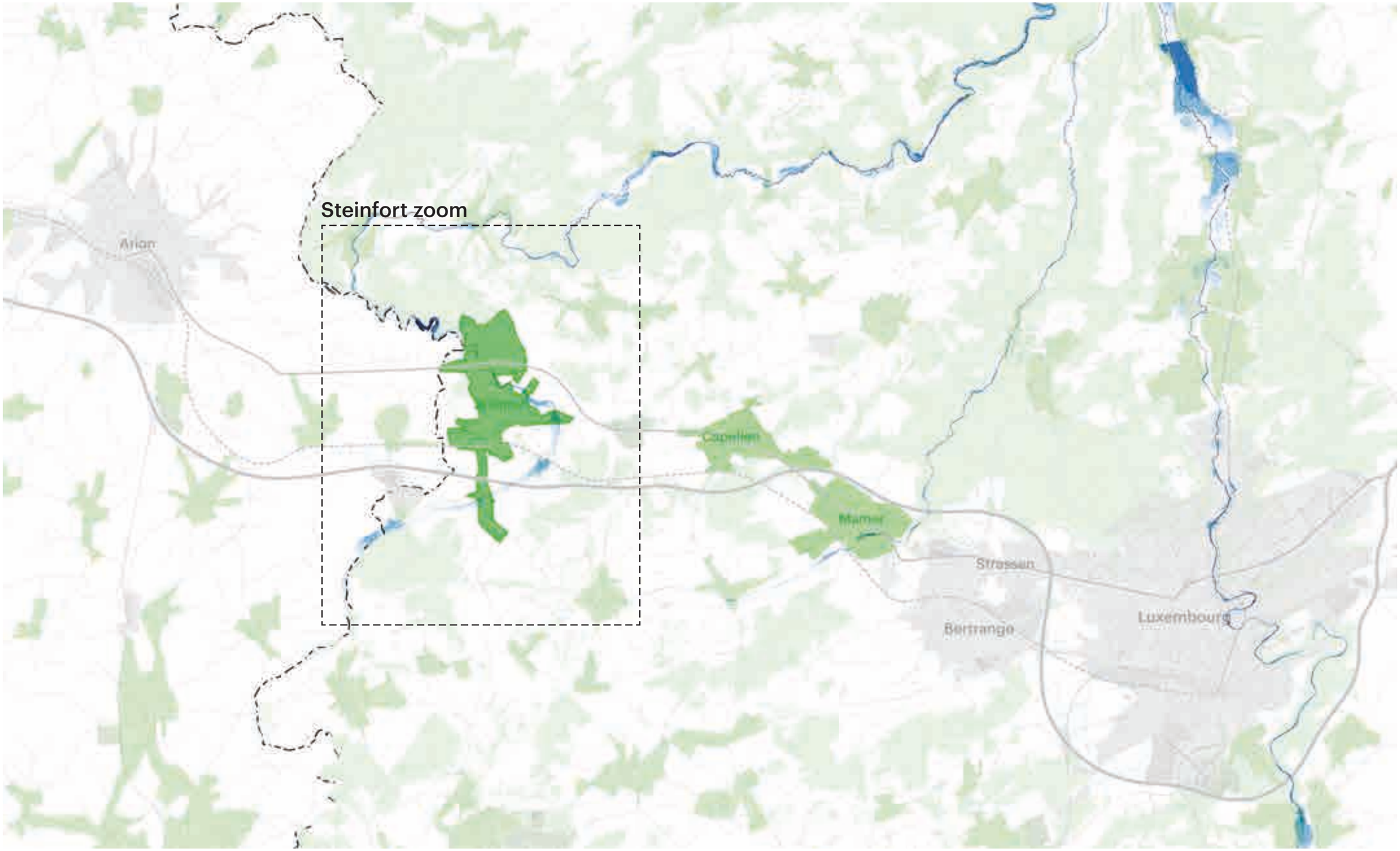


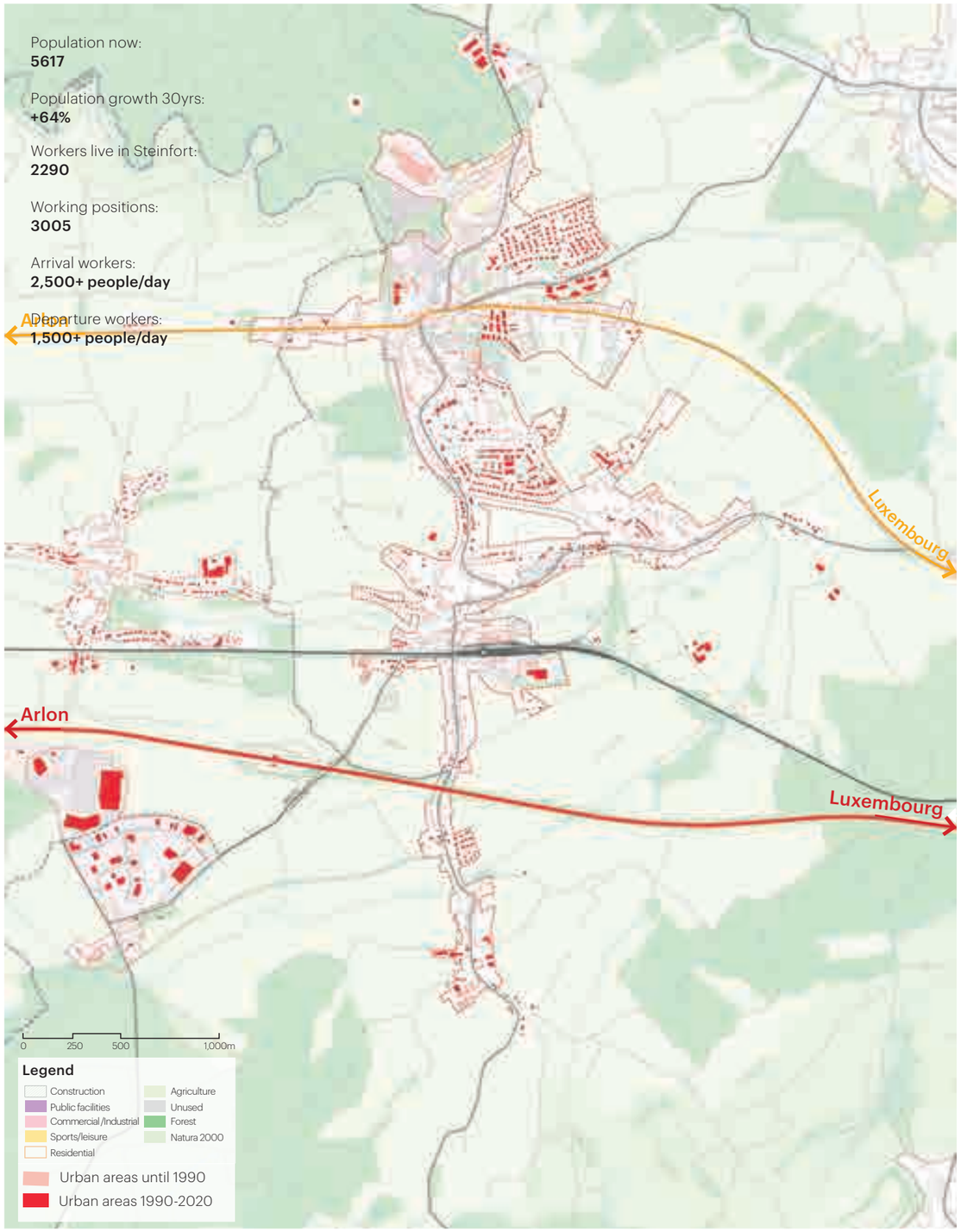
Super-city example: Arlon

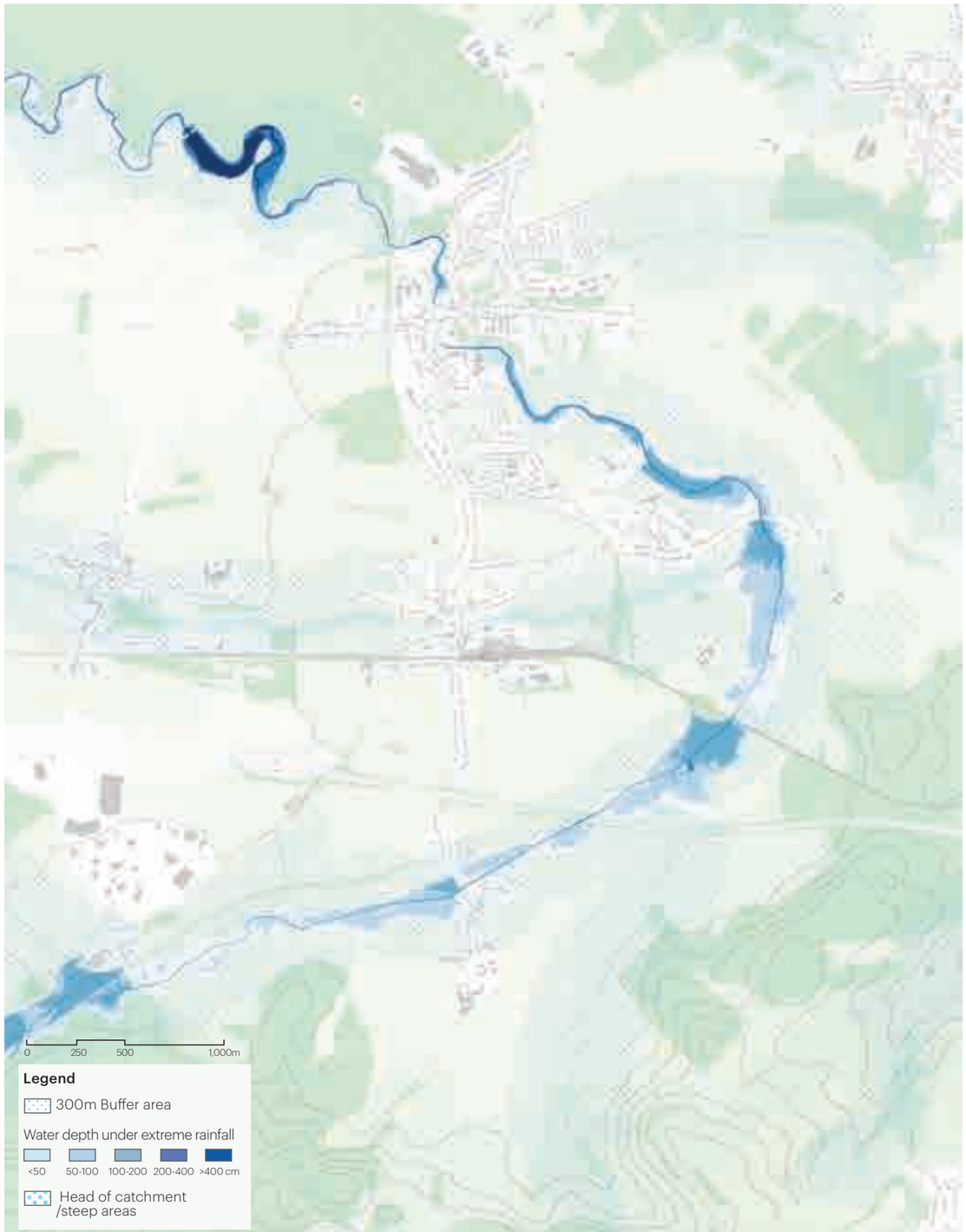


Steinfort:
The Eco-village

Steinfort

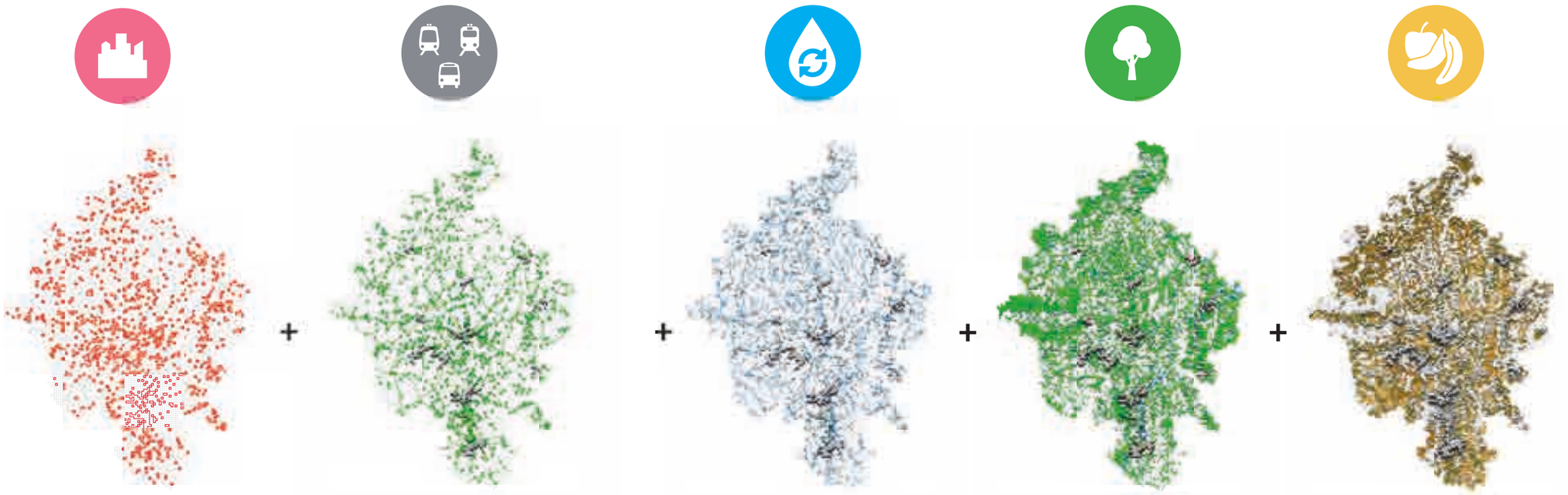

Steinfort zoom
Arlon
Capellen
Mamer
Strassen
Bertrange
Luxembourg


Population now:
5617
Population growth 30yrs:
+64%
Workers live in Steinfort:
2290
Working positions:
3005
Arrival workers:
2,500+ people/day
Departure workers:
1,500+ people/day
Arlon
Luxembourg
Arlon
Luxembourg
0
250
500
1,000m
Legend
Construction
Public facilities
Commercial/Industrial
Sports/leisure
Residential
Agriculture
Unused
Forest
Natura 2000
Urban areas until 1990
Urban areas 1990-2020


0
250
500
1,000m
Legend
300m Buffer area
Water depth under extreme rainfall
<50
50-100
100-200
200-400
>400 cm
Head of catchment
/steep areas

Applied scenarios in Steinfort

Steinfort demonstrates potential combinations of these scenarios for the “in-between” villages



Urban boundary on all settlements
= 937.2 km²

Reduce mobility and ban through traffic
= xx km²

Water buffer of rivers
= 2750 km²

Connecting nature along water buffer
= 1600 km²

Mixed-use and eco-agriculture
= 6007 km²
(Agroforestry = 1600 km²)

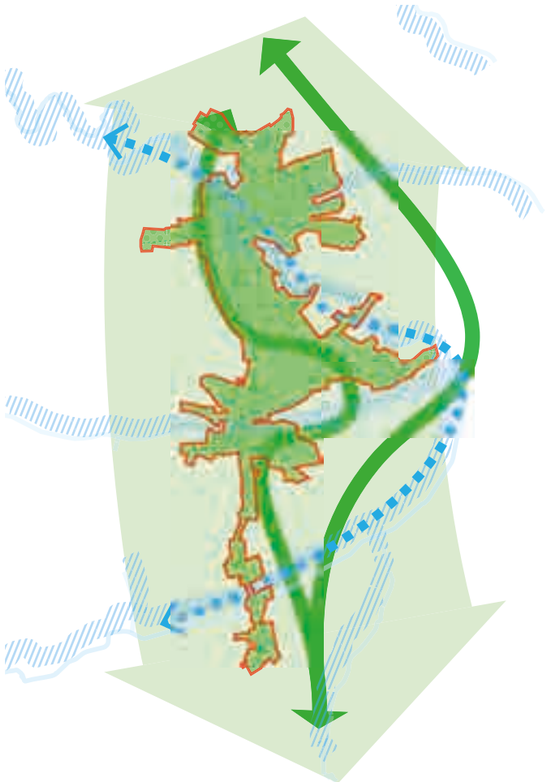
Steinfort: The Eco-village

How do you limit suburbanization to cultivate an Eco-Village?

Rather than only controlling spatial expansion beyond a boundary line, use other value variables to establish natural boundaries on land, water, greenery, and promote productive environmental values.

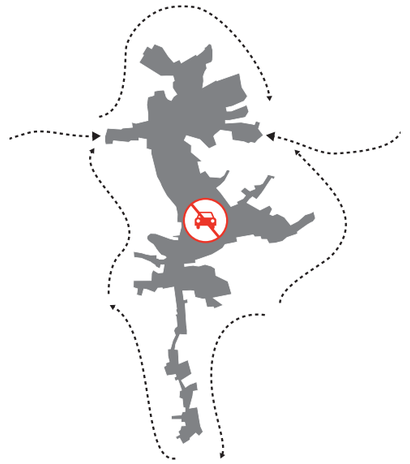
This strategy can also address discrete contextual challenges such as Steinfort's flood risks. Using this as an opportunity to improve river water quality, reduce soil pollution levels, simultaneously promoting natural connections, and carbon absorption.

In addition to addressing resilience in water systems, downgrading singular vehicular mobility infrastructure will reduce demand for new housing and real estate value, causing Steinfort's reputation as a commuter town to diminish. This will ensure high quality natural, green spaces inside and around Steinfort – a village "dipped" in green.



Eco-village Steinfort

1. Water buffer



2. Upgrade Slow mobility

3. Green network

4. Multi-layering production

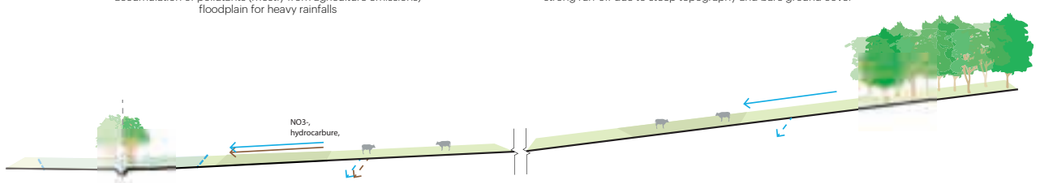
1. Water Buffer

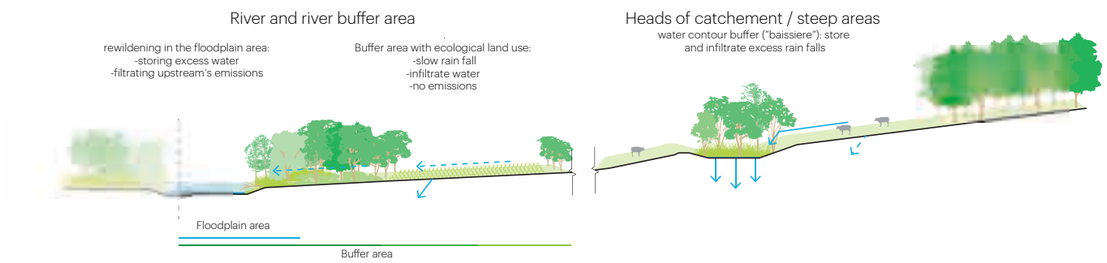
After defining Steinfort's boundaries, and respecting the space required for healthy ecologies, to create a sustainable basis for economic development a water buffer, or "Blue Belt" can address the following system risks by:

- Accommodating flash floods
- Improving water quality in natural streams and ground water
- Transforming Steinfort's green pockets into water parks with combination functions including water treatment, recreation, and safety

These "boundaries" improve two essential parts of Luxembourg's water system:

- At the head of the catchment area where topography is steep, with a landscape oriented to water retention
- In a 300m buffer area along the river streams with agro-ecological water buffer and flood-prone area rewilding



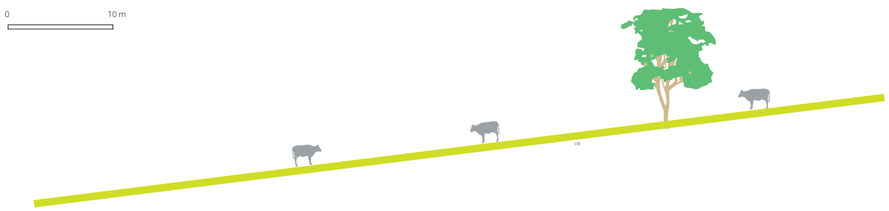


1.1 Retention landscape

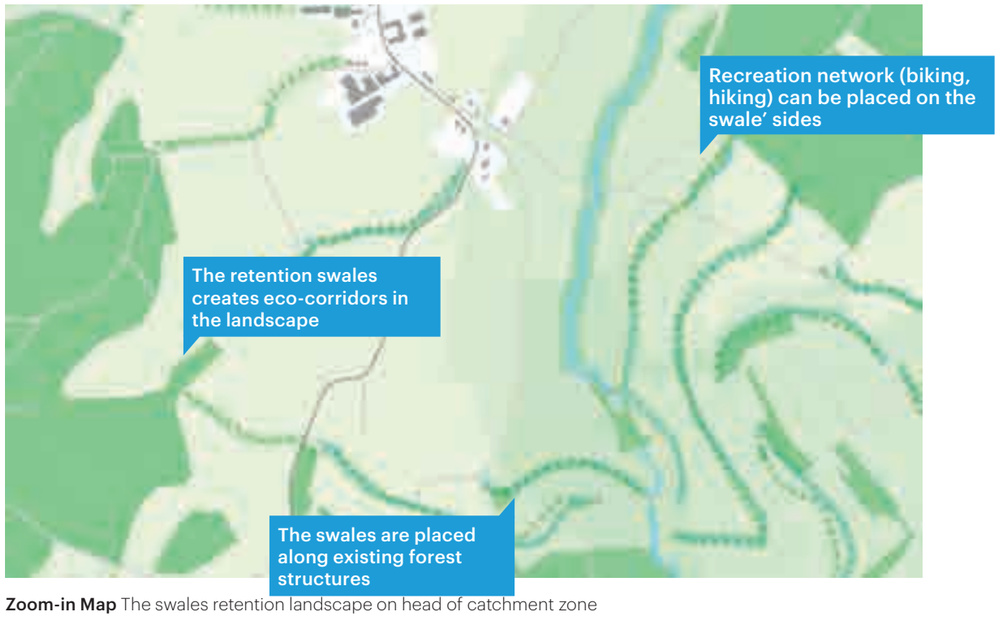
Flash floods create challenges in topography with steep terrain, as in the area surrounding Steinfort. To address flash floods and retain storm water, the following strategies will advance resilience:

- Place a water boundary at the heads of the water catchment area
- Construct terraces in the landscape with planting at the edge of terraces to absorb water run off, retaining and filtering water

In a water reservoir with a width of 25 m and a depth of 0.4 m, it is possible to buffer a 100 mm rainstorm with a graft at every 100 m. This level of rainstorm is equivalent to July 2021's heavy rainfall. Additionally, adding infiltrating subsoil and deep infiltration infrastructure captures excess runoff preventing dangerous downhill flow.



Current condition: Pasture land on steep landscape



Zoom-in Map The swales retention landscape on head of catchment zone

Swales retention landscape: Water management design merge with forestry and recreation purposes.

Collage of sawles retention landscape

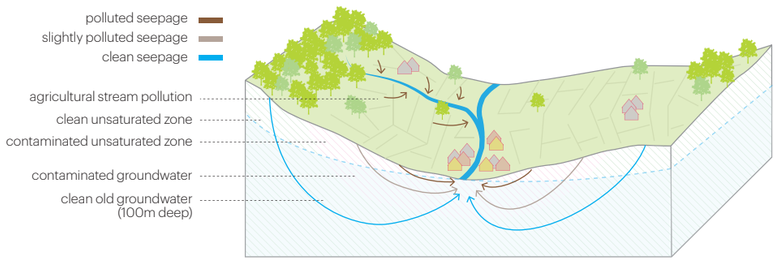
1.2 River buffers

The second “boundary” for Ecoptopia’s water system is along the streams. When looking at groundwater quality measurements, groundwater at a depth of 100 meters below ground level is of very good quality. In contrast, shallow ground water is often heavily polluted by agricultural effluent which enters streams through seepage. A buffer zone around the stream limiting agricultural effluent flow can prevent seepage into the water system. An estimated buffer width of an estimated 300 meters can facilitate this. It is possible to determine quality of water within this zone by testing infiltrated groundwater.

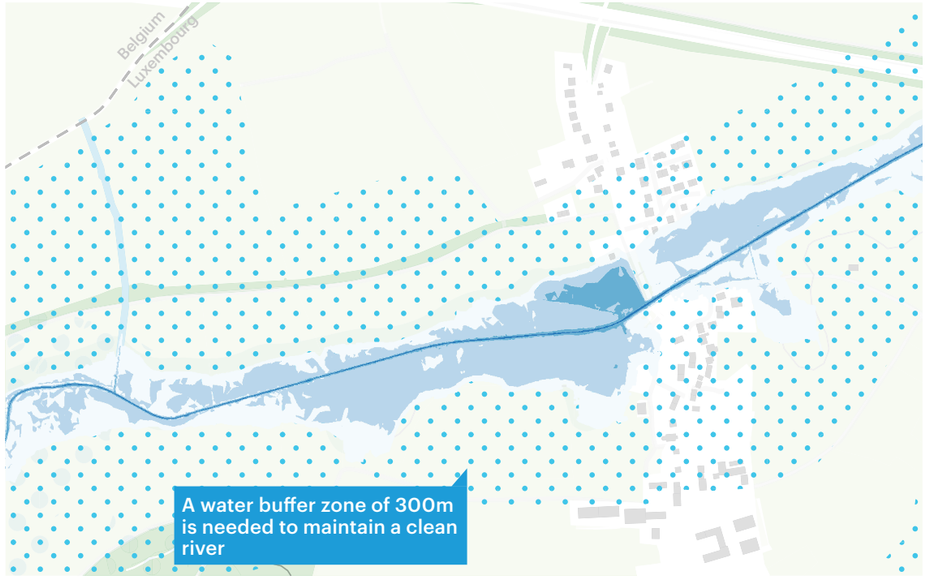
The flood risk area long streams of water – the ‘river rewilding’ prevents polluted seepage, and provides flash flood risk prevention with:

- Additional meandering and widening of the river stream stores
- Vegetation that slows down water run-off and facilitates infiltration

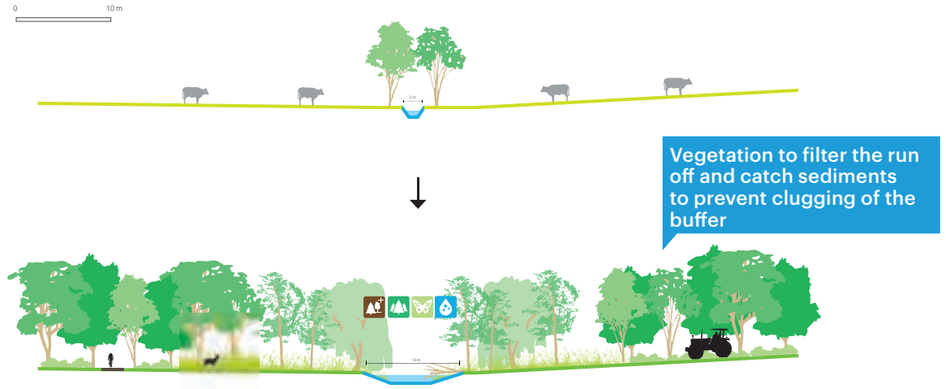
Implementing additional models of agro-ecology and energy cultivation within the 300m buffer can further multiply value, productivity, as well as the economic and environmental returns of this spatial allocation.



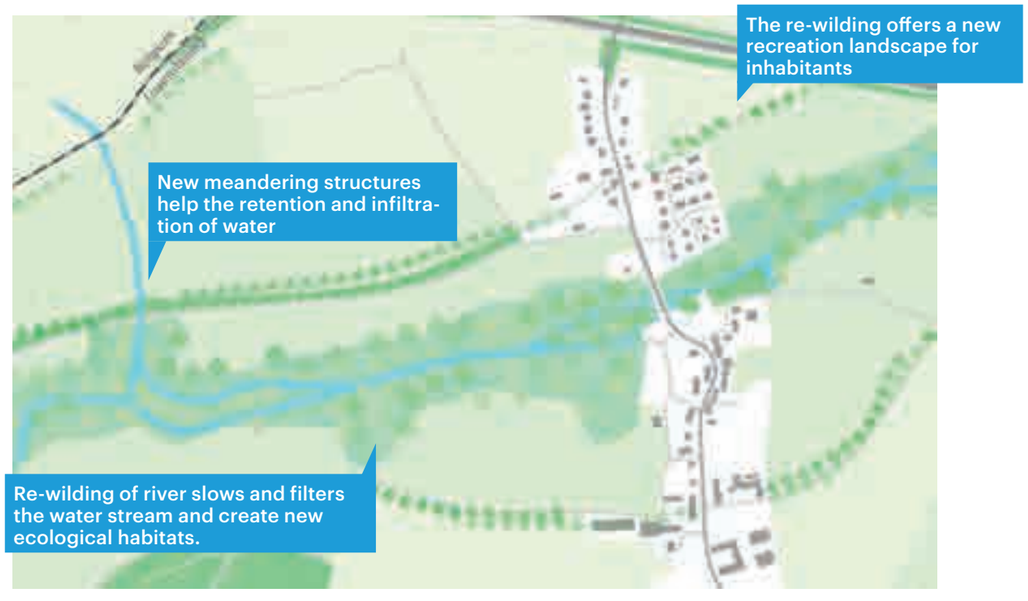
River buffer zone concept



Zoom-in Map Flood and renaturalisation Assessment



Re-wilding floodplain: Turning the flooding area to a natural wet forest.



Zoom-in Map River buffer re-wilding zone

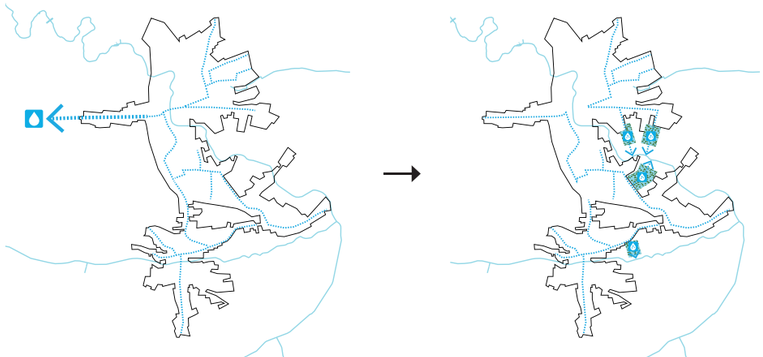
1.3 Water Park

The final intervention in Steinfort's water systems is the re-localization and renaturation of the waste water treatment system. This takes advantage of Steinfort's green pockets to transform them into waterparks with treatment, recreational, and water safety functions. The parks gather waste water and treat it through a series of terraces planted with phytoremediating vegetation, and then release it into the river Esch. This way, the filtered water can fulfill domestic uses, and the parks can serve a dual purpose as recreational spaces for residents.

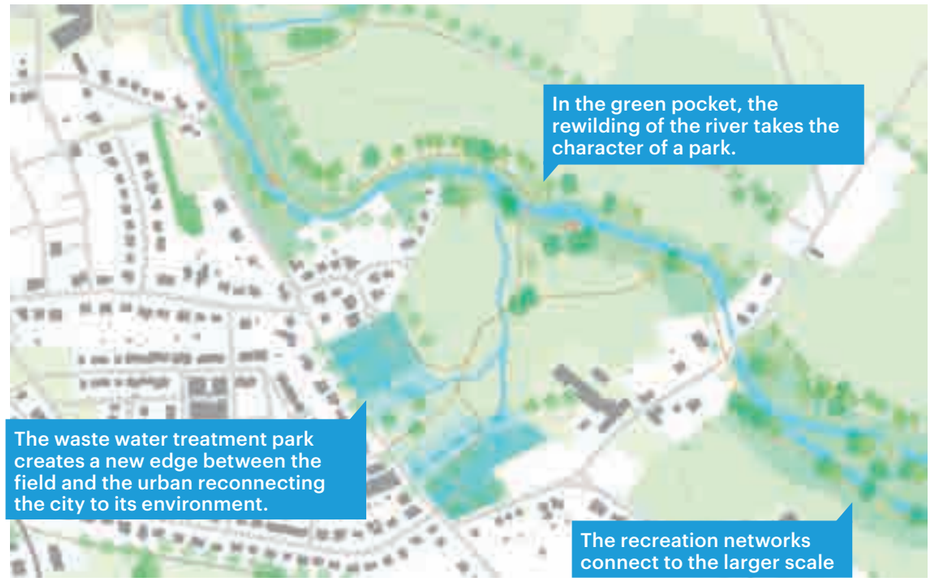
In 2021, Steinfort's waste water treatment is centralized and processed in a plant east of town. Using phytoremediation technology makes the system more energy efficient and localized.

The success of these spatial interventions depends not only on technology and innovations, but also behavioural changes that can include:

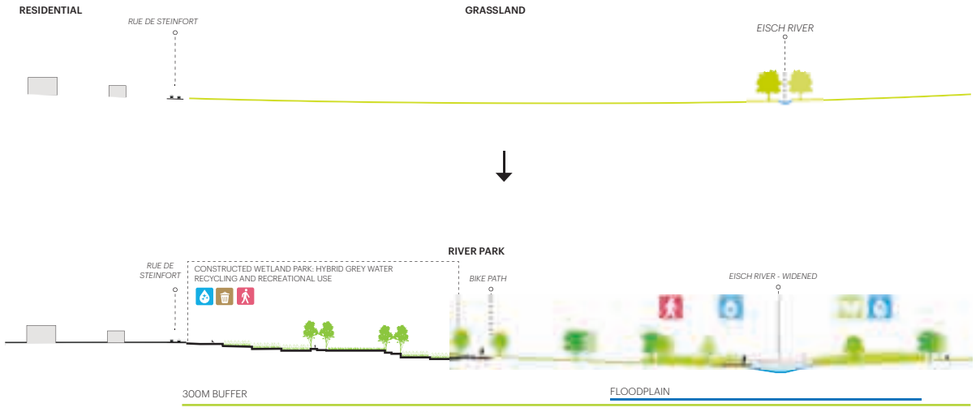
- Using eco-friendly products at home
- Using drinking water only for essential functions



Localizing water treatment system



Zoom-in Map Water Park on the intersection of Steinfort and Eisch river



Steinfort Water Park: Local waste water treatment combines with recreation and nature park

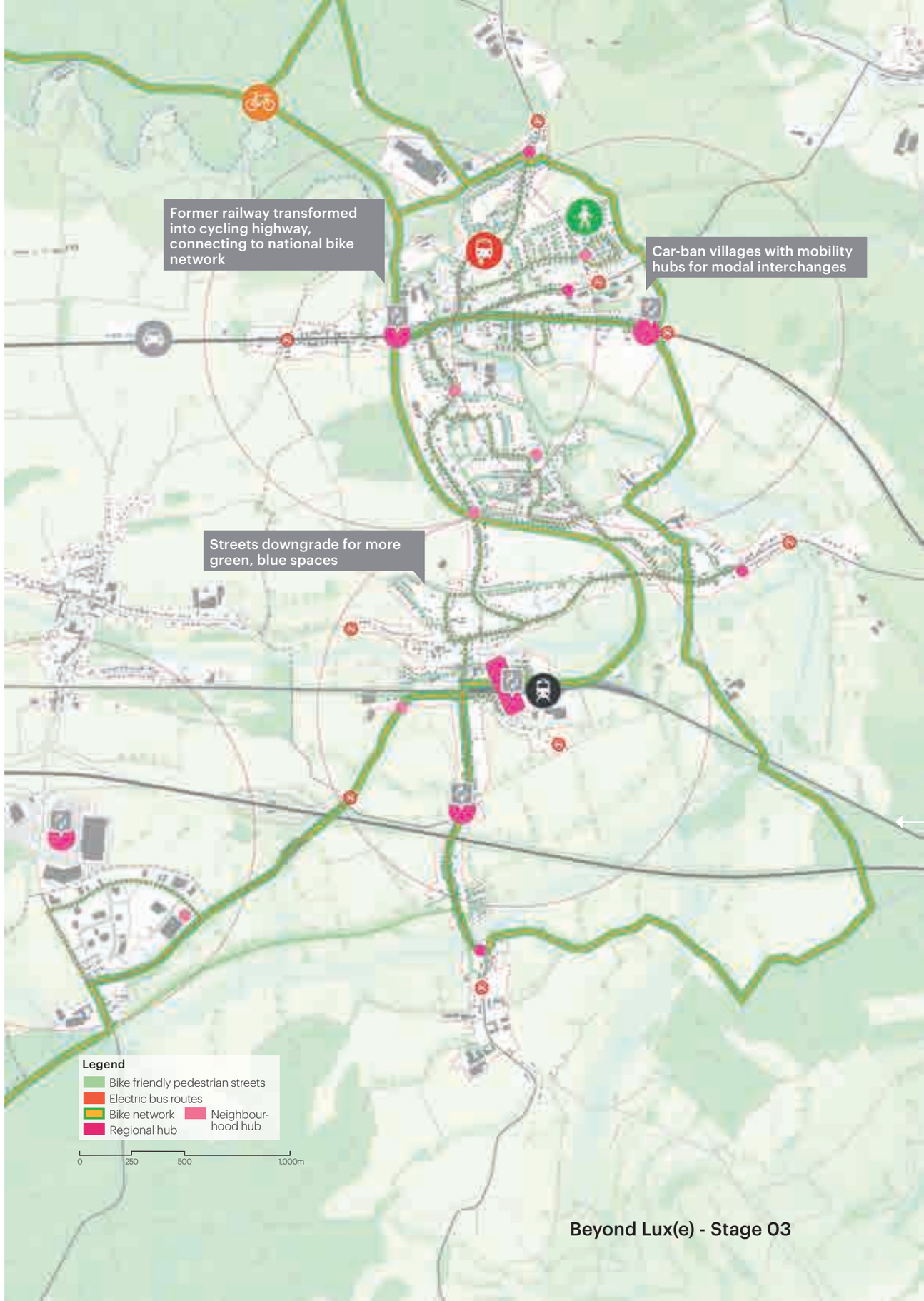
Collage of The Water Park landscape

2. Upgrade soft mobility

To reduce single vehicle use by making it a less-attractive mobility option, two main strategies are possible:

1. Create pedestrian-only streets and connect the town with soft mobility options (not only within the town-site, but also with nearby villages)
2. Locate multifunctional mobility hubs in strategic locations to facilitate mode changes

While the mobility transition requires powerful initiation from policy and governance, clear steps in the transition help to cultivate local support necessary for its adoption. With the phasing out of single vehicle use, public spaces will benefit from the additional space, improving livability, and quality of life. For example, transforming parking lots into activities hubs with shared community gardens benefits the community while also enhancing food security.



2.1 Soft mobility without cars and through-traffic

By removing vehicular road infrastructure in Steinfort, there is an opportunity to redefine its original hierarchy: the national road, the main town road, and neighbourhood streets. By removing private vehicles from all streets in future, with a strategic, step by step approach, through planned pilot neighbourhoods, streets, and lowered speed limits, governance can influence this shift.

Steinfort can further support this through the following strategies:

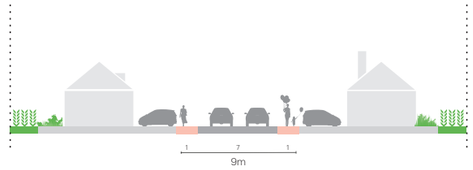
- Shared soft mobility services and on-demand local electric buses to support local public transportation
- National road: separate bike lanes on the national road shared along soft mobility services, as well as an on-demand local electric bus service to support local transportation demands
- Main roads: shared mobility spaces with extended free space for green or activity spaces on both sides
- Neighbourhood streets: pedestrianized streets with free space for green and activities, extending private spaces, or with larger public spaces in the centre of two-lane streets
- Utilize the former railway track as a cycling highway connecting Steinfort with other villages, and to the national bicycle network, for recreational and commuting purposes

Current condition

Railway track
Former Prince Henri Railway

National road
Route d'Arlon,
intersection Rue Collart

Main road
Rue de Kleinbettingen



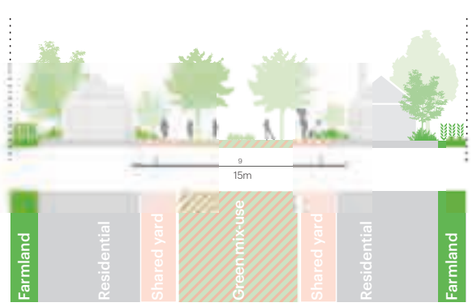
Neighborhood street
Op d Barriaer

Soft mobility streets

Cycling highway
Former Prince Henri Railway

Car-free National road
Route d'Arlon,
intersection Rue Collart

Shared mobility road
Rue de Kleinbettingen



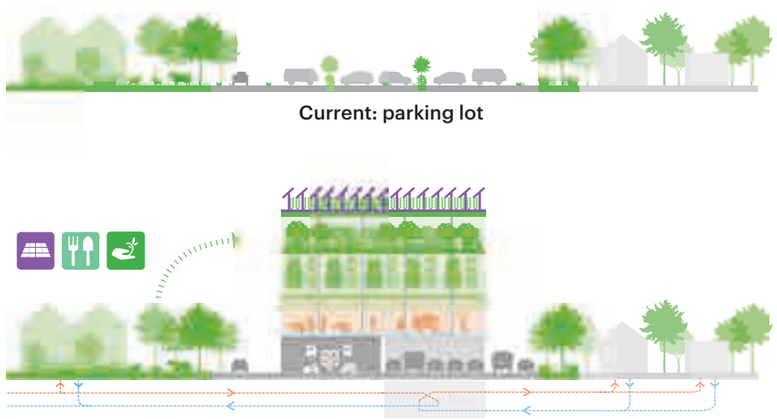
Neighborhood pedestrain street
Op d Barriaer

2.2 Multi-functional mobility hubs

In order to facilitate the mode shift from regional travel to local travel, the concept places regional mobility hubs in key mode exchange points. These include town entrances, train stations, or highway exits. Inserting smaller local hubs at the catchment point of a negihbourhood supports the reduction of the walking distance to final destination.

To maximize uses and ensure that these hubs act as attractors, catalyzing the shift, the mobility hubs will integrate different functions.

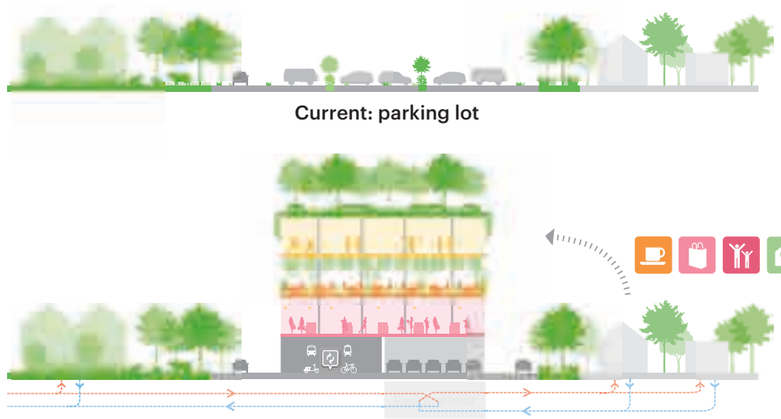
At the beginning of the transition, there will be an estimated 1000 parking spaces, but with shifts in habit, demands will change, and the old infrastructure will be replaced by shared mobility infrastructure. To this end, the hub's design itself should be flexible and complement its context. For example, augment a mobility hub located near farmland with agricultural production programs, add co-working and market space for the ones near neighbourhoods, or residual heat and water reuse stations in village centres.



Current: parking lot

Mobility + food production hub

Zoom-in Map Mobility+food production hub in Grass



Current: parking lot

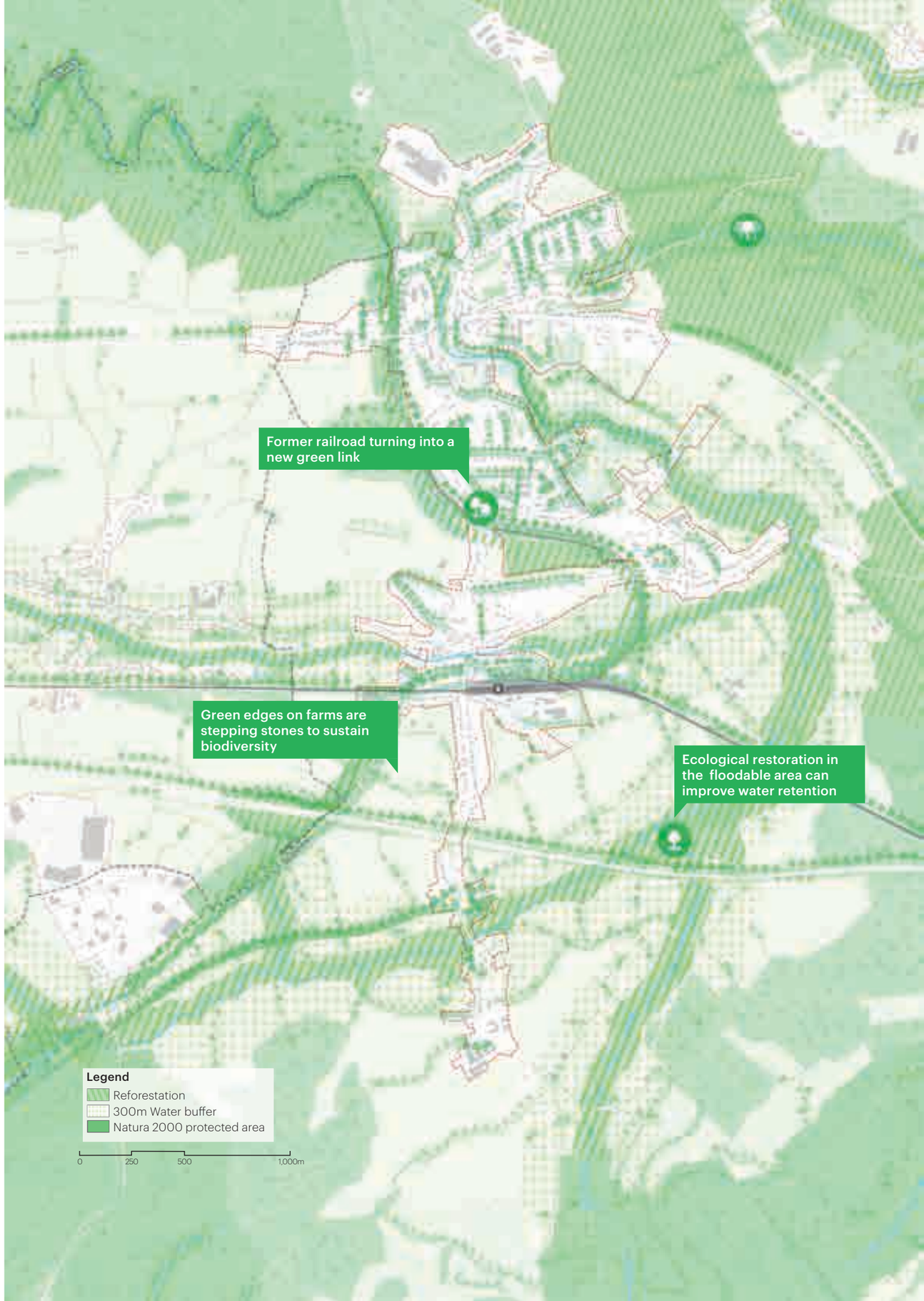
Mobility + sport & leisure hub

Zoom-in Map Mobility+sport & leisure hub in Steinfort

3. Green network

Extending Steinfort's green belt on the sectoral plan is in development, but the Ecotopia vision requires additional natural spaces for both capture and storage of carbon in the soil, vegetation, and in restoring and protecting area biodiversity.

To accomplish this, the vision proposes an extensive green network to expand coverage and connectivity of this part of Luxembourg's ecosystem. In continuing the concept of the green belt, a green network establishes a strong base of natural corridors which not only enhance connections through the landscape, but also through green streets and pockets of greenery in in the urban fabric. This helps to control urban expansion and consumption of natural areas, while also cultivating a productive landscape.



3.1 Green corridors connecting Natura 2000

A series of green corridors around the settlement forms the base of the rewilding green network and comprises four main components:

- Extending the “green belt” area on the east side of the town to include reforestry and renaturalization
- Enhancing renaturalization along the river flood zone where agricultural activities are at risk, creating a natural belt around and through the settlement area connecting serval fragmented forest patches in the area
- Transforming the former railway line come cycle highway into a green corridor
- Generating biodiversity through networked green edges on farming plots

Green edges connections on farms

Re-naturalized cycling highway

Re-wilding on floodplain

Extending green belt

Bocage landscape

Cycling highway in nature

Forestration along river stream

Re-wilding forest

3.2 Green streets

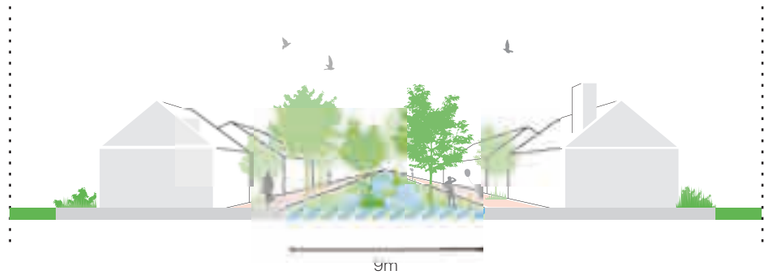
In addition to the greenification of the landscape, greenifiying towns will also be possible due to mobility downgrades and the freeing of old infrastructure for public space. On average, it is possible to free 4-6m from the width of the street from car lanes and car parking.

The freed spaces can serve multiple purposes including new streetscapes covered in greenery, linear water parks, community gardens, and private farming spaces close to home, all of which can be collectively achieved within local communities.

In addition to greenifying urban hardscaping, it is possible to greenify building facades and roofs enhancing carbon capture, urban biodiversity, and health and well-being of residents.

Community farming street: Free-up space on both sides of the street can be an extension of the frontyard of each houses for local community gardens.

Agriculture street Bagneux by MVRDV



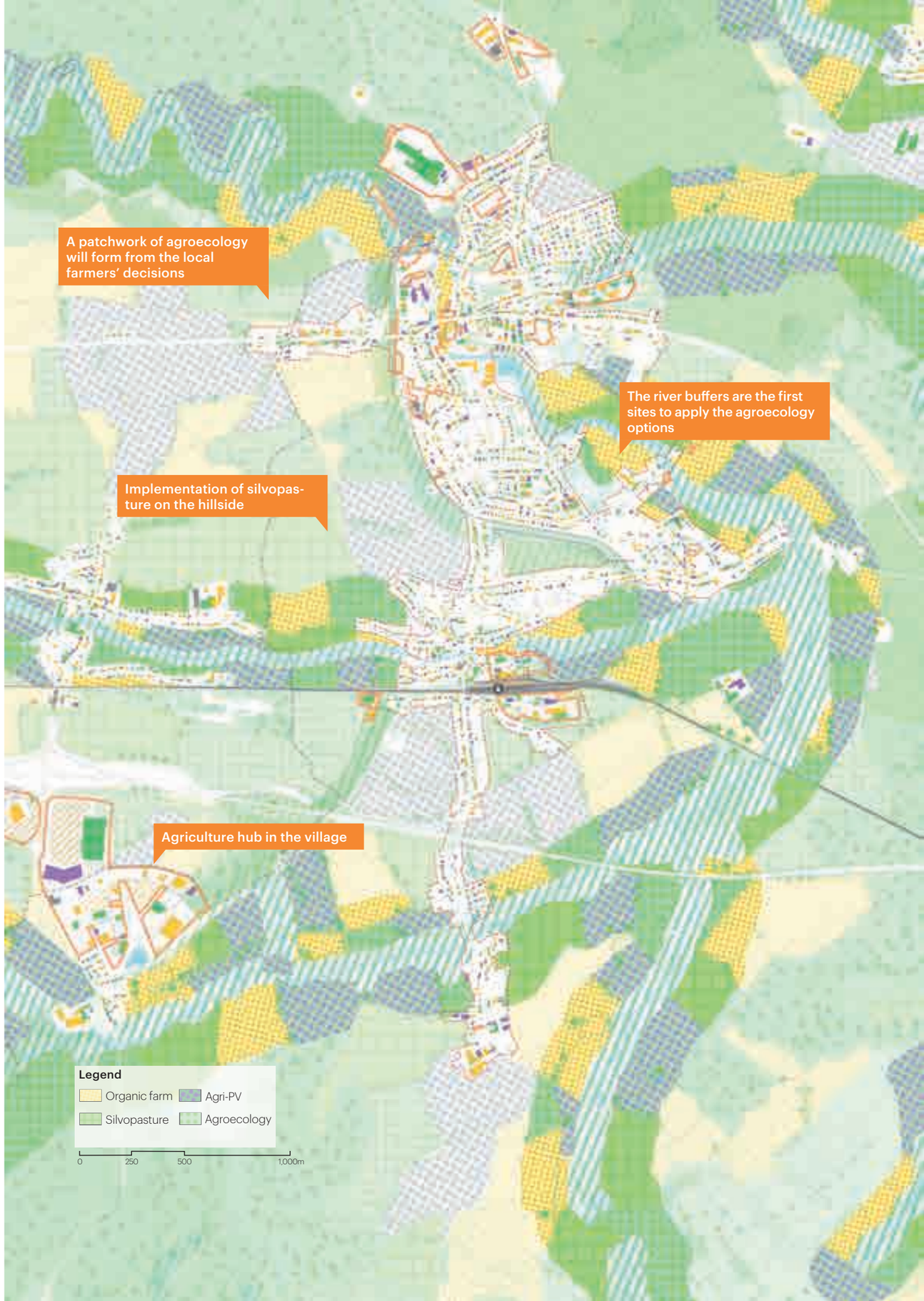
Green and water street: A linear collective re-wilding and water retention landscape through the neighbouring for nature and public spaces for recreation activities.

Water street Eindhoven City Center by MVRDV

4. Multi-layering production

As a systems-based approach the multi-layered strategy also incorporates the 300m river water buffer around agricultural land. It demonstrates that further productive development of Steinfort's landscape is possible, including the enhancement of the agricultural hinterland surrounding the town (Agriculture Plus), and the urban environment within it (Urban Plus).

This serves the ultimate vision of Eco-topia, which is that every square meter of space contributes more than a singular value, maximizing economic, social, and environmental value.



4.1 Agriculture plus

Extending the productive capacity of agricultural spaces has great potential given the significant overlapping functions that agricultural activities present. For example, the 300m water buffer zone around agricultural land accommodating effluent seepage will inspire further transformation managing water systems and promoting biodiversity. Augmenting this with eco-agrology, and no-emission farming facilitates the productivity transition, and the strategy can further employ numerous examples of the multi-layered use of agricultural spaces.

Examples of layered uses include:
- Agroforestry, which is ideal for plots close to existing forested areas
- Silvopasture, which is ideal for more hilly topography
- Agrivoltaics, which mixes PV and farming

Governmental support for local farmers will help them transition from current unsustainable farming methods to those in line with this vision. As a precedent of this change, the water buffer's intervention will inspire further transformation as its multi-layered productive capabilities demonstrate potentials.

Current: pasture

Silvopasture

Solar pasture

Silvopasture

Solar pasture

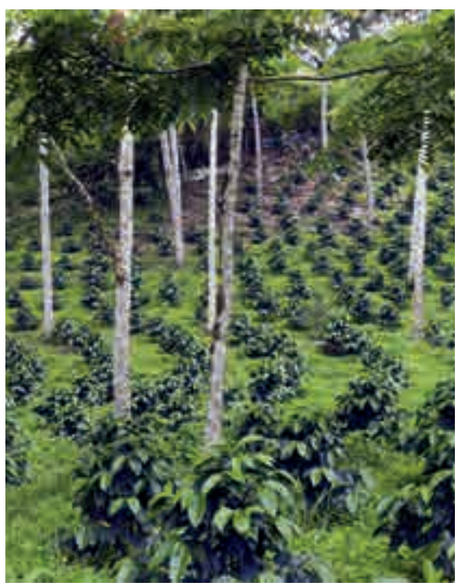
Current: arable land

Argoforestry

Fruitforest

Stacked farming

Agrivoltaic



Agroforestry

Agrivoltaic with fruite trees

4.2 Urban plus

Multi-layered intervention in Steinfort's urban area begins with the re-use or re-development of existing paved spaces, including logistics spaces, parking lots, and post-industrial areas.

Rather than building more real-estate or loose commercial functions, the Urban Plus vision transforms this same land into an agricultural hub with stacked, intensive farming and established local food production chains.

By upgrading existing and new buildings over time, the plan improves on energy performance, also with the integration of energy production, and urban farming on roofs or gardens. For example, a deeper roof structure would enable flexible future use for productive purposes.

Current: urban area

Urban + PV panels

Urban + agroforestry

Urban + stacked farming

Solar roof

Urban farming

Current: undeveloped urban land

Food processing hub

Stacked farming hub

Aqua-integrated farming hub

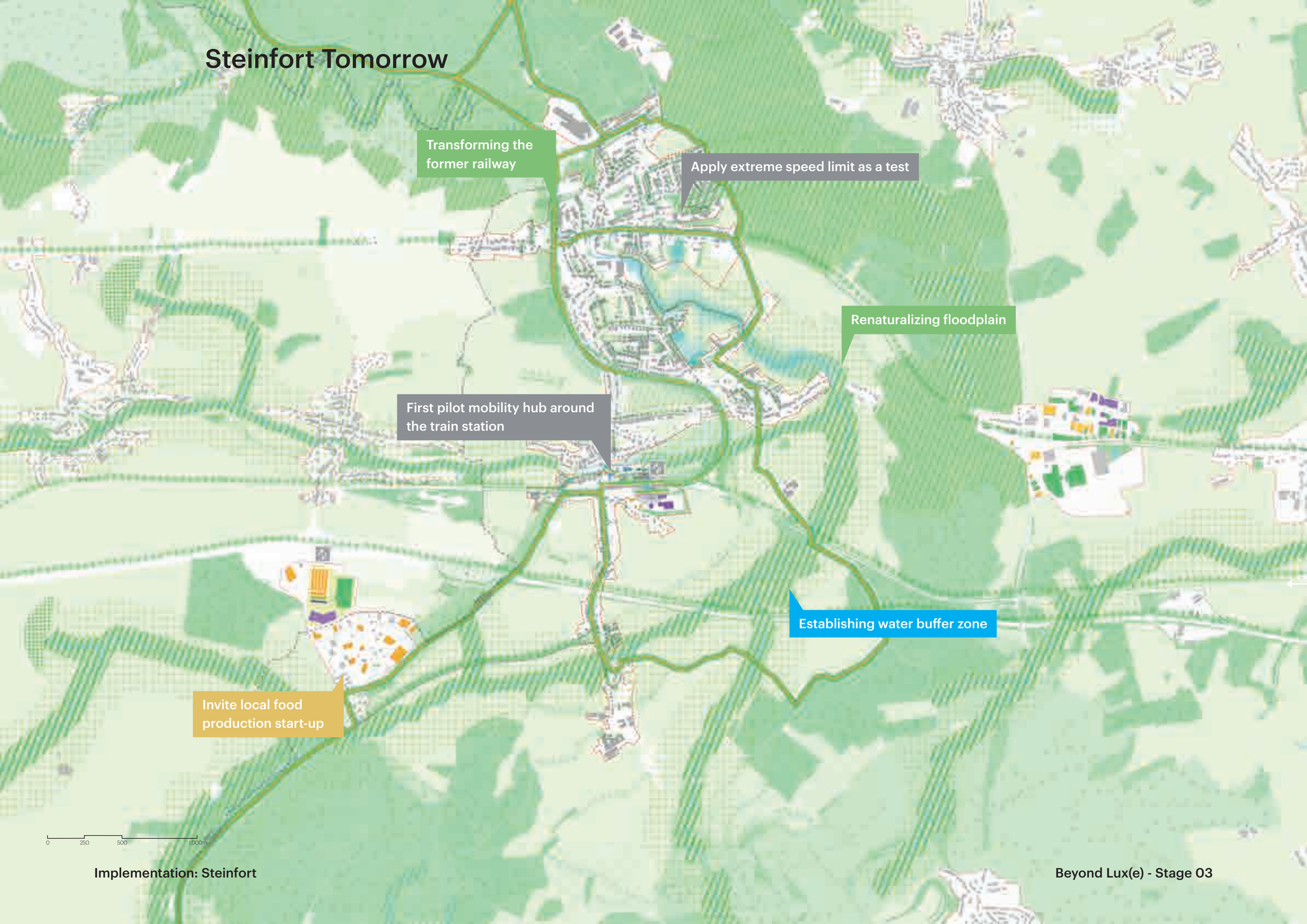
Eco-friendly food processing

Vertical farming

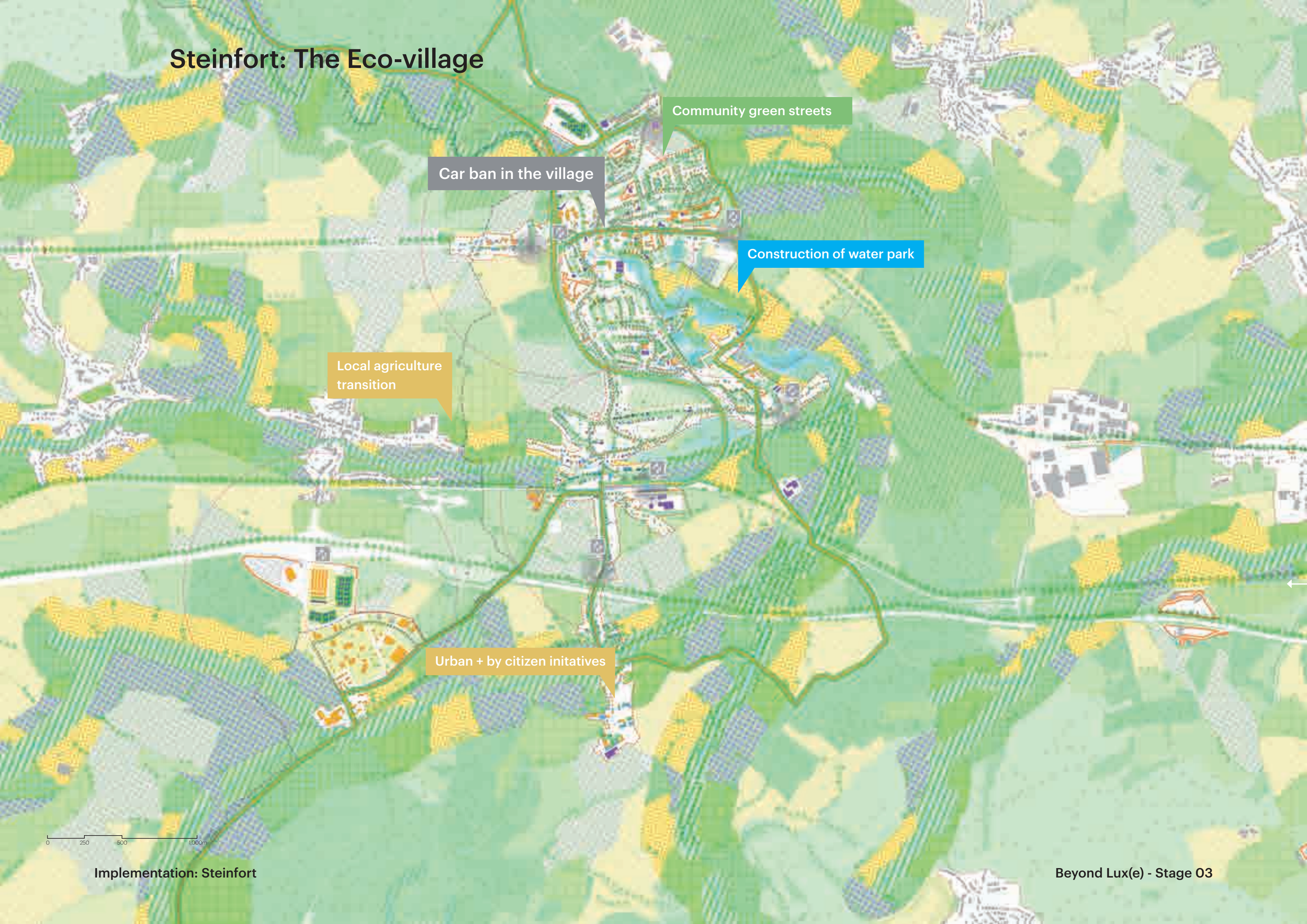
Steinfort in Transition

Steinfort Today

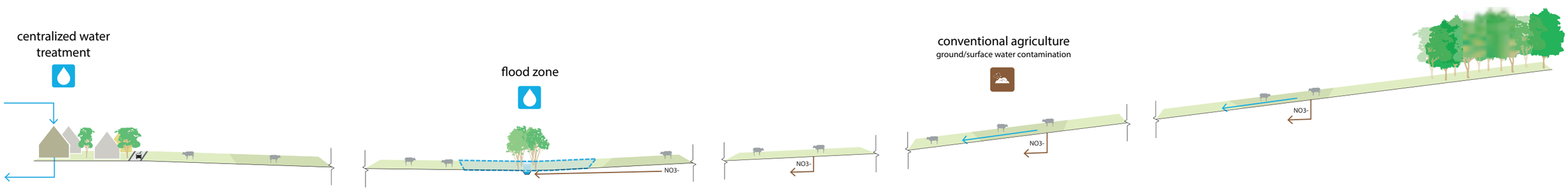
Steinfort Tomorrow



Steinfort: The Eco-village



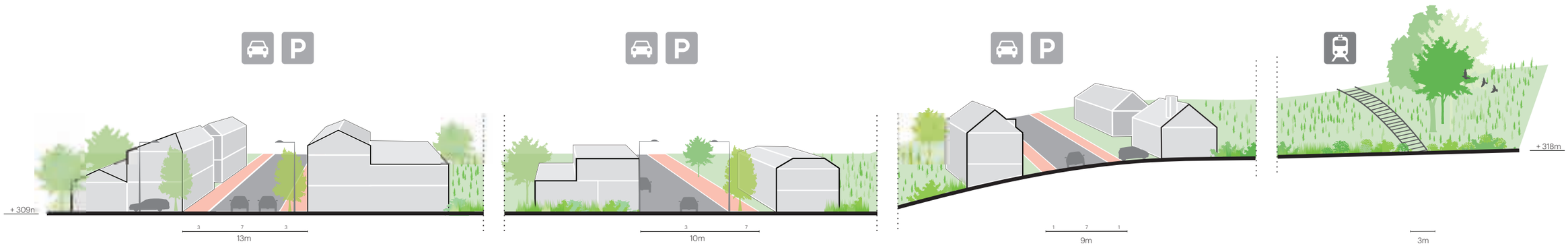
Steinfort: The Eco-village



Exisiting situation | Nature and Landscape

Ecotopia Vision 2050 | Nature and Landscape

Steinfort: The Eco-village



National road
Route d'Arlon,
intersection Rue Collart

Main road
Rue de Kleinbettingen

Neighborhood road
An de Wisen

Railway track
Former Prince Henri Railway

Exisiting situation | Urban environment

Car-free National road
Route d'Arlon,
intersection Rue Collart

Shared mobility road
Rue de Kleinbettingen

Neighborhood green street
An de Wisen

Cycling highway
Former Prince Henri Railway

Ecotopia Vision 2050 | Urban environment

Steinfort Now

Steinfort Tomorrow

Steinfort Ecotopia:
The Eco-village

Implementation Esch-sur-Sûre

Esch-sur-Sûre Valley
Eschdorf: Eco-Landscape Booster
Esch-sur-Sûre in Transition

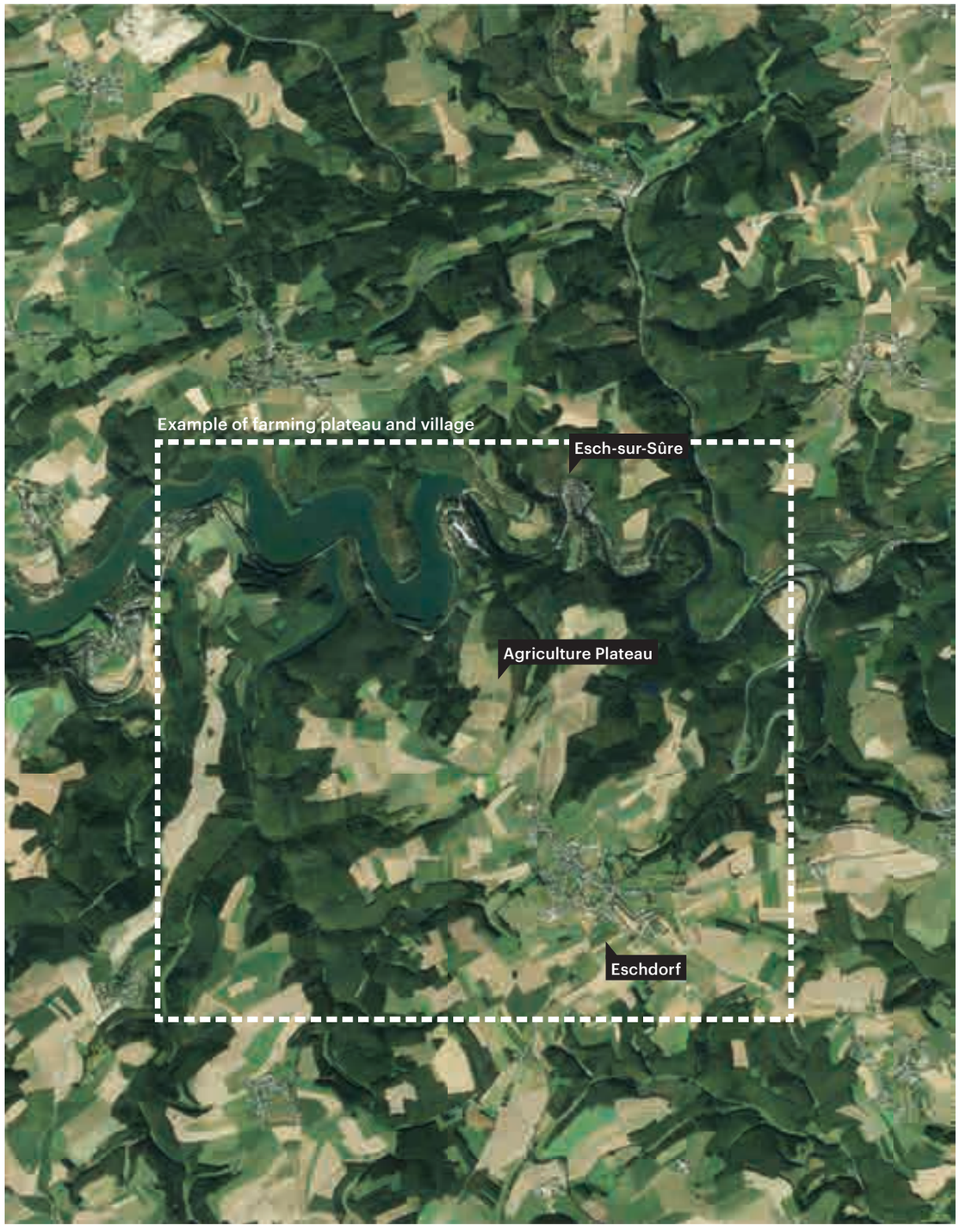
3

Regional zoom: Esch-sur-Sûre Valley

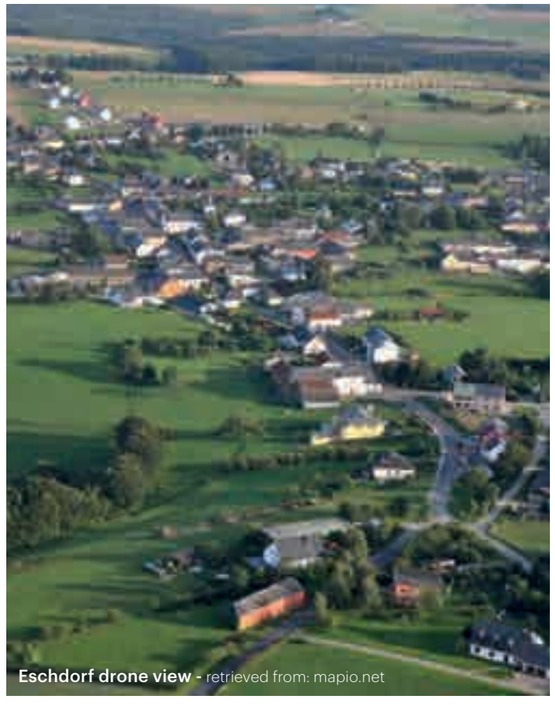
The Upper-Sûre lake - Photo by Christophe Van Biesen.

Agriculture plateau - Photo by Getty Images.

Site zoom: Eschdorf



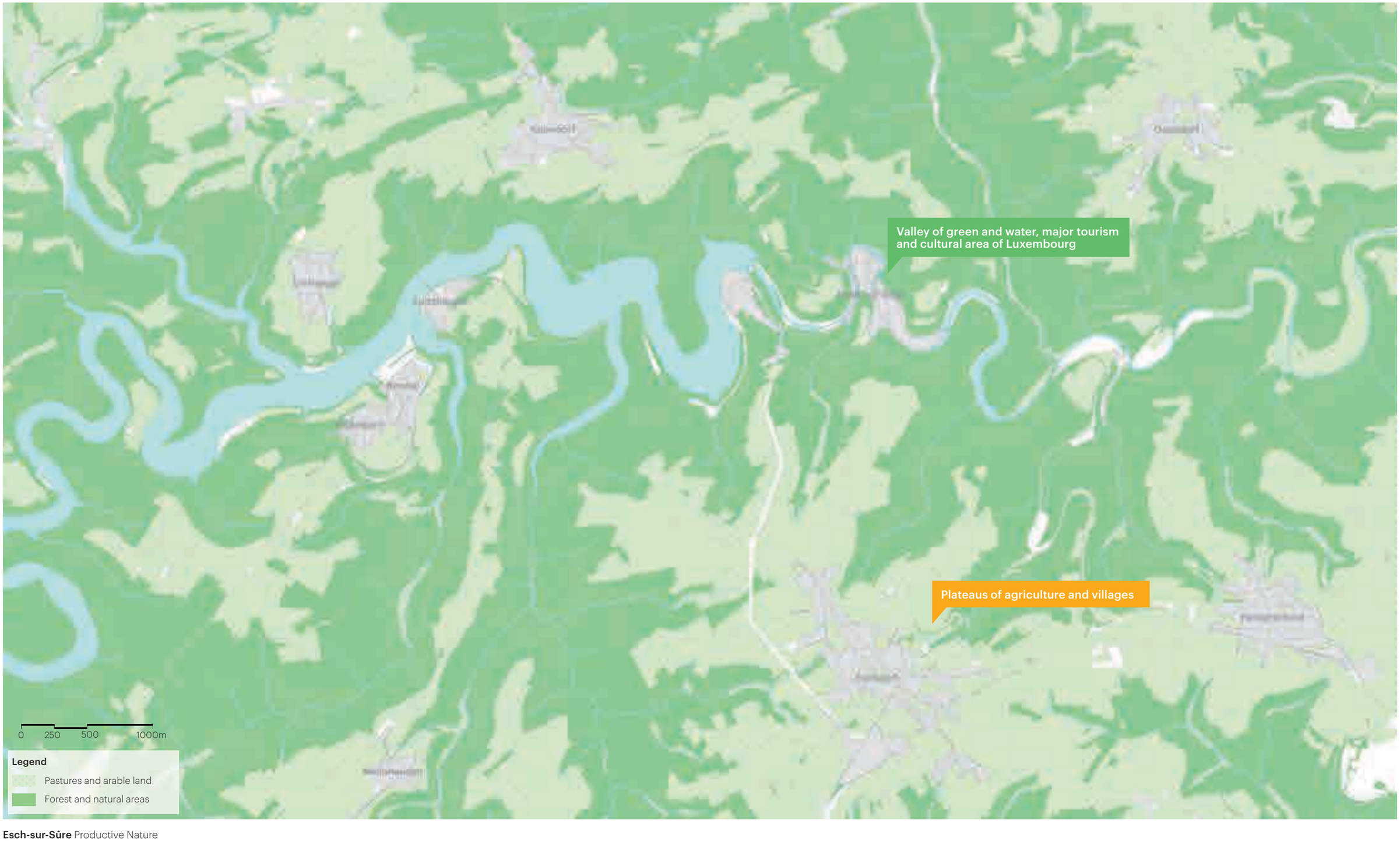

Esch-sur-Sûre view from the valley - photo by Roberto Braam.


Eschdorf drone view - retrieved from: mapio.net


Eschdorf new water treatment station - retrieved from SEBES.

Esch-sur-Sûre Valley

Esch-sur-Sûre Valley



Esch-sur-Sûre Productive Nature

Protecting the natural valley

The Esch-sur-Sûre has the largest reservoir, and largest body of water in Luxembourg, Upper Sûre Lake (Lac de la Haute-Sûre), as well as significant natural resources in its extensive reserve area. These areas present valued resources for residents and tourists alike, and are a prime focal point for cultural and leisure activities.

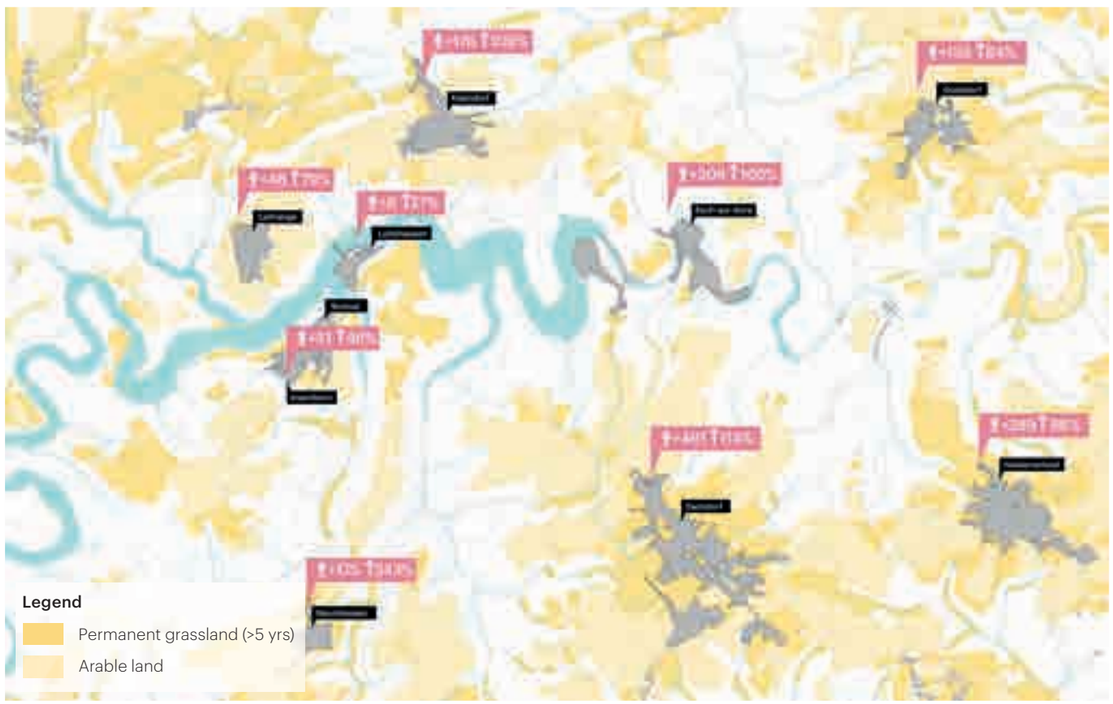
Most importantly the reservoir is critical to sustaining the Luxembourg population as an important source of the country's potable water; however, agricultural activities on neighbouring plateaus threatens water quality. In addition, though it was once a productive forest, outlying areas around the reservoir's natural areas have diminished with changes in industry and practice. Reviving these could generate sustainable forest management practices (banning clear cutting) to cultivate a mixed natural forest condition, and protect the water supply.

Green coverage and Natura 2000 area

Development on the plateau

At one time small hamlets serving agricultural communities, villages in the area are rapidly growing due to Luxembourg City's prohibitive housing prices, and improved vehicular infra-structure, making commuting an easy option. These villages have experienced more than 100% growth over the last 30 years, with real-estate development overtaking several transitional villages.

At the same time agricultural land (pasture and fodder) intensifies with new technologies and innovations, which threatens soil and water quality. As a result the plateaus' small-scale landscape features have eroded, so agricultural landscapes appear barren - a stark contrast with the wooded, lush valleys.



Water resources Risks on water quality

Nature + productivity

The Esch-sur-Sure has a beautiful natural landscape, but its rich resources can play a larger role in Luxembourg's decarbonization than simply being a recreation destination. Decarbonization strategies can incorporate natural forces such as wind, gravity, photosynthesis to support energy storage, food security, sustainable building material production, carbon capture and storage, in addition to nature preservation and leisure uses.

To do this, re-evaluate current land use to assess its productive potential, and set clear boundaries on village expansion. The effective synergy of natural and productive systems in the landscape plan can serve as a strong example for the northern Luxembourg / Ardennes region, inspiring further transition.

Nature + Productive Vision

Nature + Biodiversity, Water and Eco-tourism

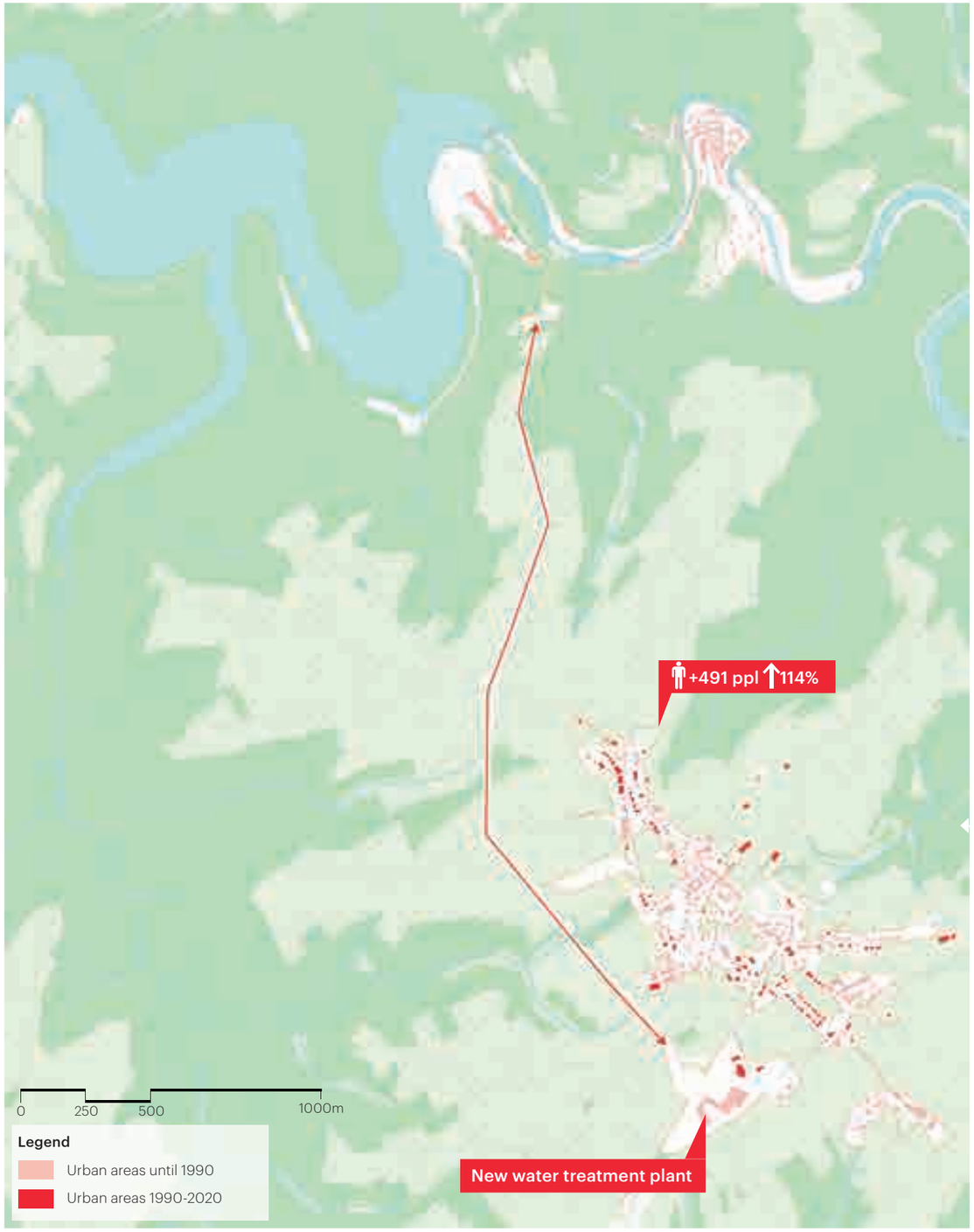
Productive + Energy, Agriculture and Eco-tourism

Eschdorf: Eco-Landscape Booster

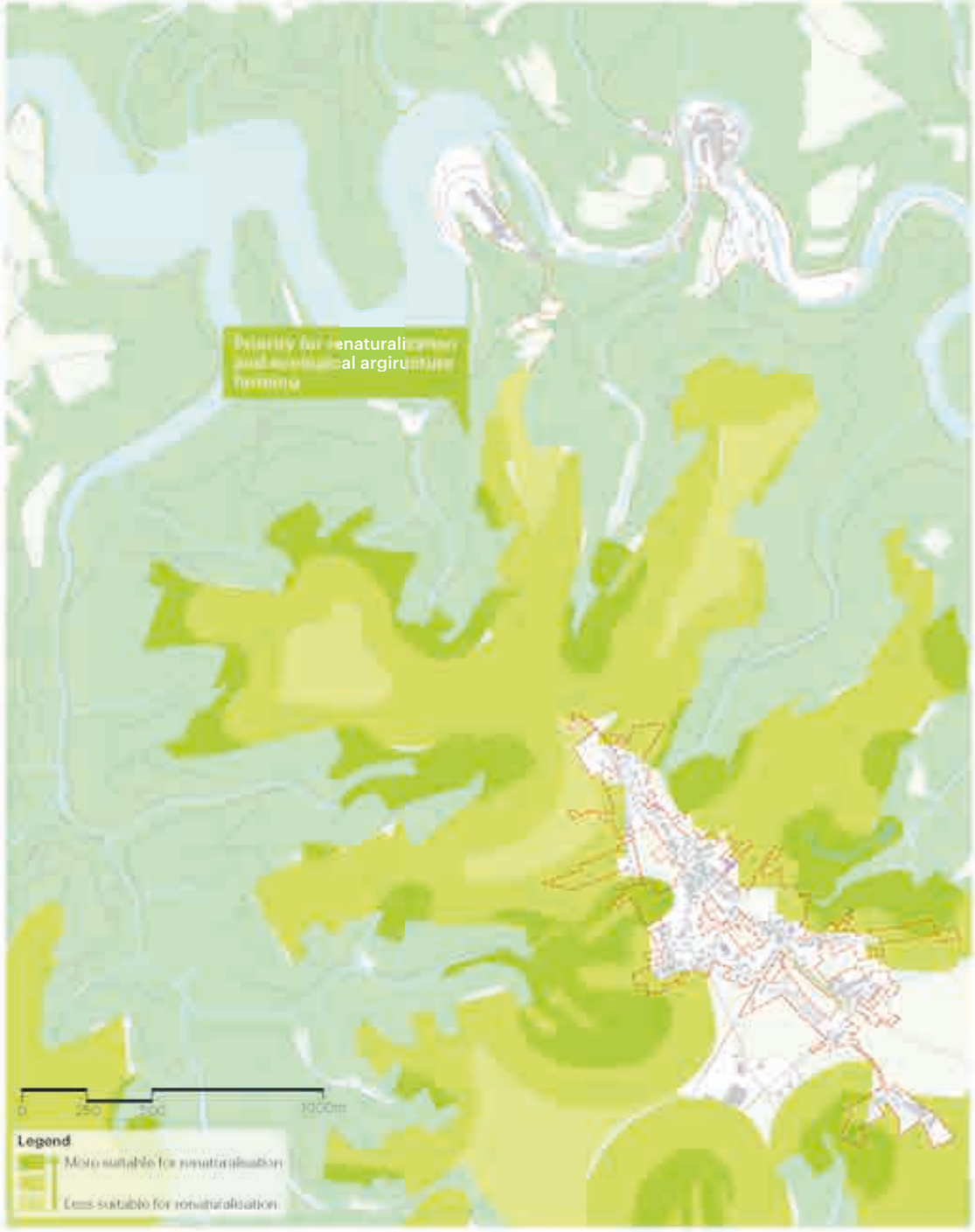
Eschdorf

Esch-sur-Sûre Productive Nature

Anaylsis | **Urban expansion in farming village**



Anaylsis | **Water quality risk**



Applied scenarios in Esch-sur-Sûre

Water buffer around the reservoir
= xx km²

+

Re-naturalization
= 1700 km²

+

Energy landscape
= 1079 km²

+

Mixed-use and eco-agriculture
= 6007 km2
(Agroforestry = 1600 km2)

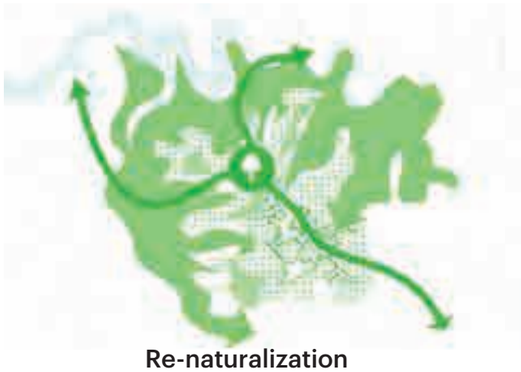
Esch-sur-Sûre: Eco-Landscape Booster

In consideration of this great potential, the agricultural plateaus can connect and contribute to the beautiful landscape of Esch-sur-Sûre in the following ways:

- Use energy, food and timber production as tools to improve landscape quality
- Enhance smart recreation and tourism, capturing the benefit of tourism, and leveraging this not only for the nature reserve but also for the village and agricultural activities
- Connect sustainable activities and the decarbonization transition to the national/ global interests and enable the local communities to actively participate in their mobilization

Success of the Eco-landscape-by-design vision requires a combination of clear boundaries and top-down guidance, particularly for energy infrastructure.

Eco Eschdorf



Re-naturalization

Energy landscape

Eco-tourism

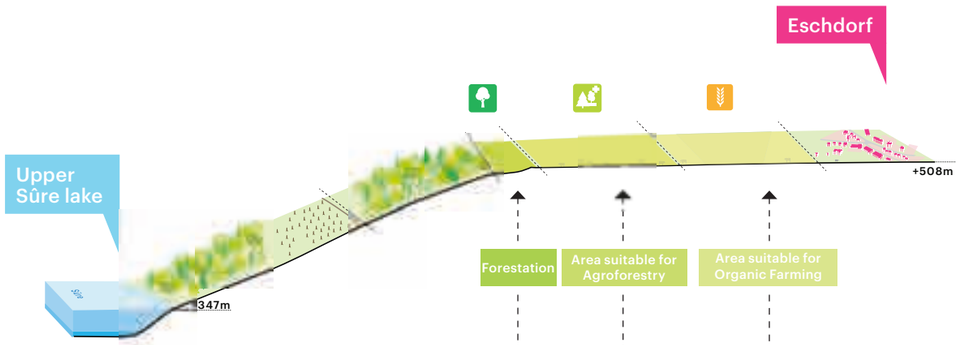
1. Re-Naturalization

Understanding that land-use significantly impacts water quality, as intensive farming activities in close proximity discharge effluent into nearby streams, allocating space along streams for productive forests can provide a buffer from the farmland. At the same time these can enhance economic, and environmental potentials through agroforestry, timber production, as well as carbon sequestration.

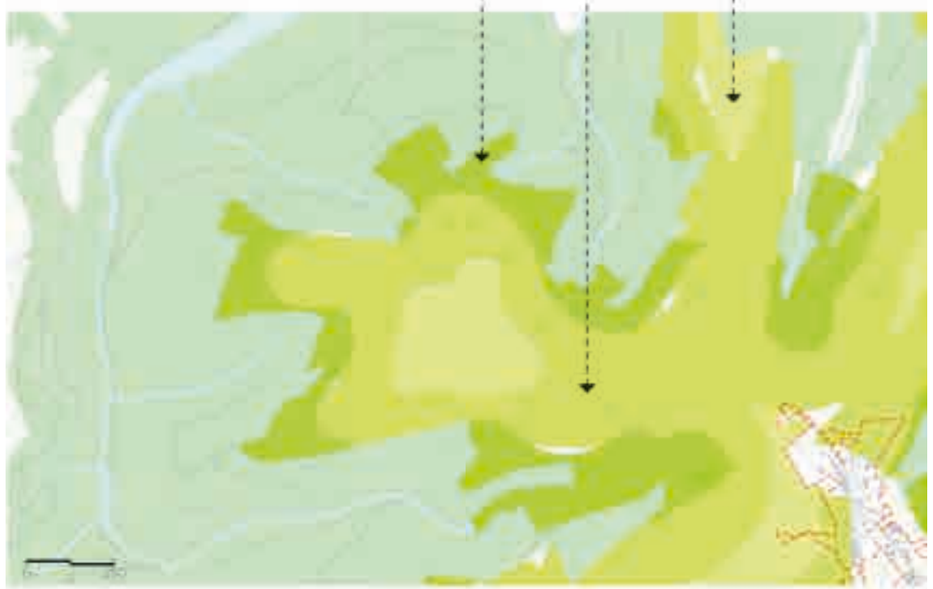
Planting mixed forests with native deciduous trees enhances resilience and biodiversity, improving the long term health of the forested areas. While the forest provides a buffer preventing effluent discharge into streams, agricultural practices nearby must also transition to organic practices.

1.1 Reforestry in water buffer zone

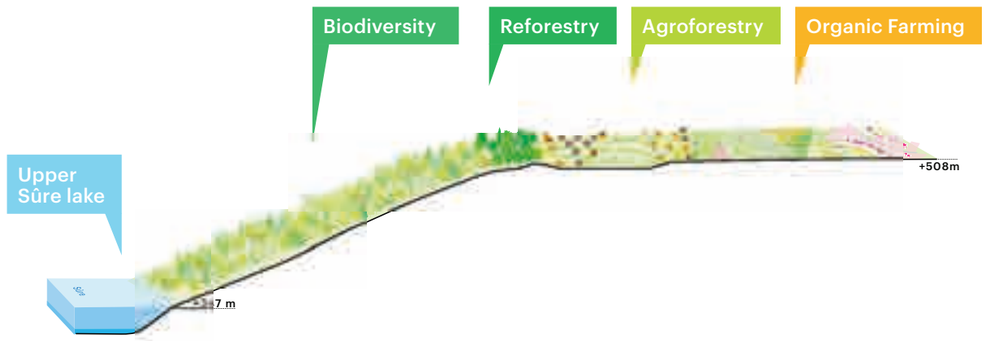
A forested buffer will minimize the impact of agricultural activities on water quality. Informing the scope and extent of this buffer zone using a large-scale GIS tool, integrating it in local topography. Using land management approaches like agroforestry near the new forest's edge can create a gradient of activity extending from agricultural areas to the forest integrating the growing of trees with crops or livestock. Implied in the forest interventions is the transition from clearcutting practices and mono-cultural forests to the cultivation of biodiverse forest systems.



Existing: Both the section and the zoom-in map show the results of the renaturalisation potential.



Zoom-in Map Renaturalisation Assessment



The Proposal follows the analysis that investigates the terrain, river buffer zone and soil quality.

Silvopasture - Image from Cornell Extension**.**

Ellwood Canyon Farm, Santa Barbara.

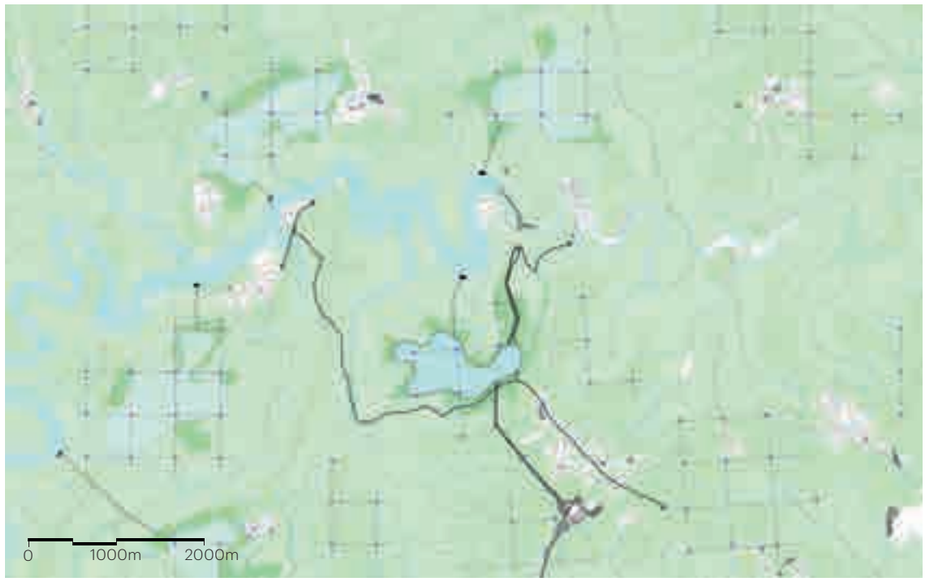
2. Energy landscape

Transitioning to a future fueled by renewable energy sources in 2050 requires more than 700km2 of land dedicated to wind energy production in Luxembourg. The topography of northern Luxembourg and the Ardennes lends itself nicely to wind energy harvesting and pumped storage hydroelectricity as an added layer to the productive capacity of agricultural land.

According to preliminary calculations, more than 100km^2 of the Esch-sur-Sûre region's plateaus have considerable potential for wind energy infrastructure offering more than 4000 GWh of renewable energy per year.

Besides the renewable production, the future demand of temporary energy storage to buffer the energy production and consumption demand is a key for a sustainable energy system. Taking the advantages of height difference between the valley and plateaus, the plateaus surrounding the Upper-Sûre-Lake could be a perfect location for hydrostorage developments.

The scale of this infrastructure, while intimidating, can potentially enrich the landscape at the highest point of the topography. This requires careful and consistent landscape guidelines, controlling the scope of market-driven development.



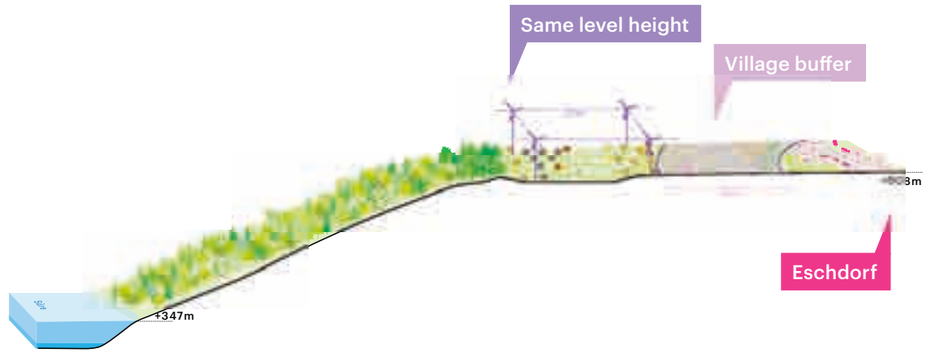
Potential sites for hydrostorage on the plateaus around Upper-Sûre-Lake: max. installed capcity of 5.6 GW

2.1 Energy + Agriculture Landscape

As all plateaus have a consistent elevation, at the high point of the landscape, in this context it is possible to develop a landscape of energy production and agriculture overlaying with each other. There are three options: applying PV panels on agricultural land, setting up a grid of wind turbines on the plateaus, and the combination of both. Developing the energy grid with the local community encourages initiatives that maximize benefits of this infrastructure to serve the interests of local farmers and citizens.

Option 1: Solar panels on agricultural land
High solar (PV) panels can be set up on grazing land and farmland, as a second layer of production.

Green plants under solar PV panels, Japan - By solarjournal.jp



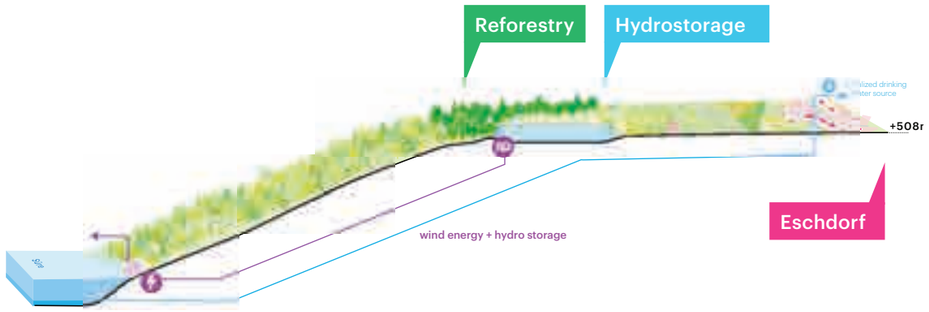
Option 2: Wind turbine landscape on the plateaus
Wind turbines are distributed following a 500m grid, except on the forest and the buffer to the village.

Farm of the Future in Lelystad - By Agroecology & Technology Field Lab.

2.2 Hydro-storage

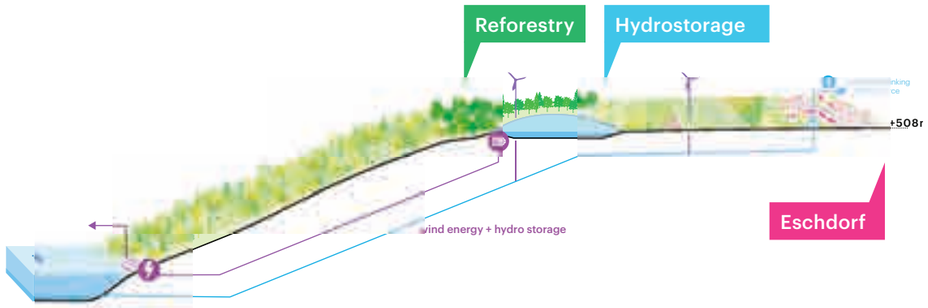
The limitation of wind and solar energy is dependence on weather conditions. This unpredictability does not always align with consumption patterns. Balancing energy resources on a national scale helps to mitigate shortfalls, and energy storage can offer additional support to fill temporary gaps.

The elevation difference between the Upper Sûre Lake and the plateaus around it (120-150m) can accommodate a hydrostorage system, with the Upper Sûre Lake functioning as a lower lake for several pumped-storage hydroelectricity plants. Placing pumped-storage hydroelectricity plants on the edges of the plateaus can be integrated into the landscape as beautiful natural lakes resembling the Vulkaneifel landscape to the east or the Plateau des Mille Étangs to the south.



Hydro-storage shape proposal 1: Area less suitable for re-naturalization
The shape of the lake in this proposal stems from the renaturalization analysis.

Dauner Maare - By GesundLand Vulkaneifel/D. Ketz.



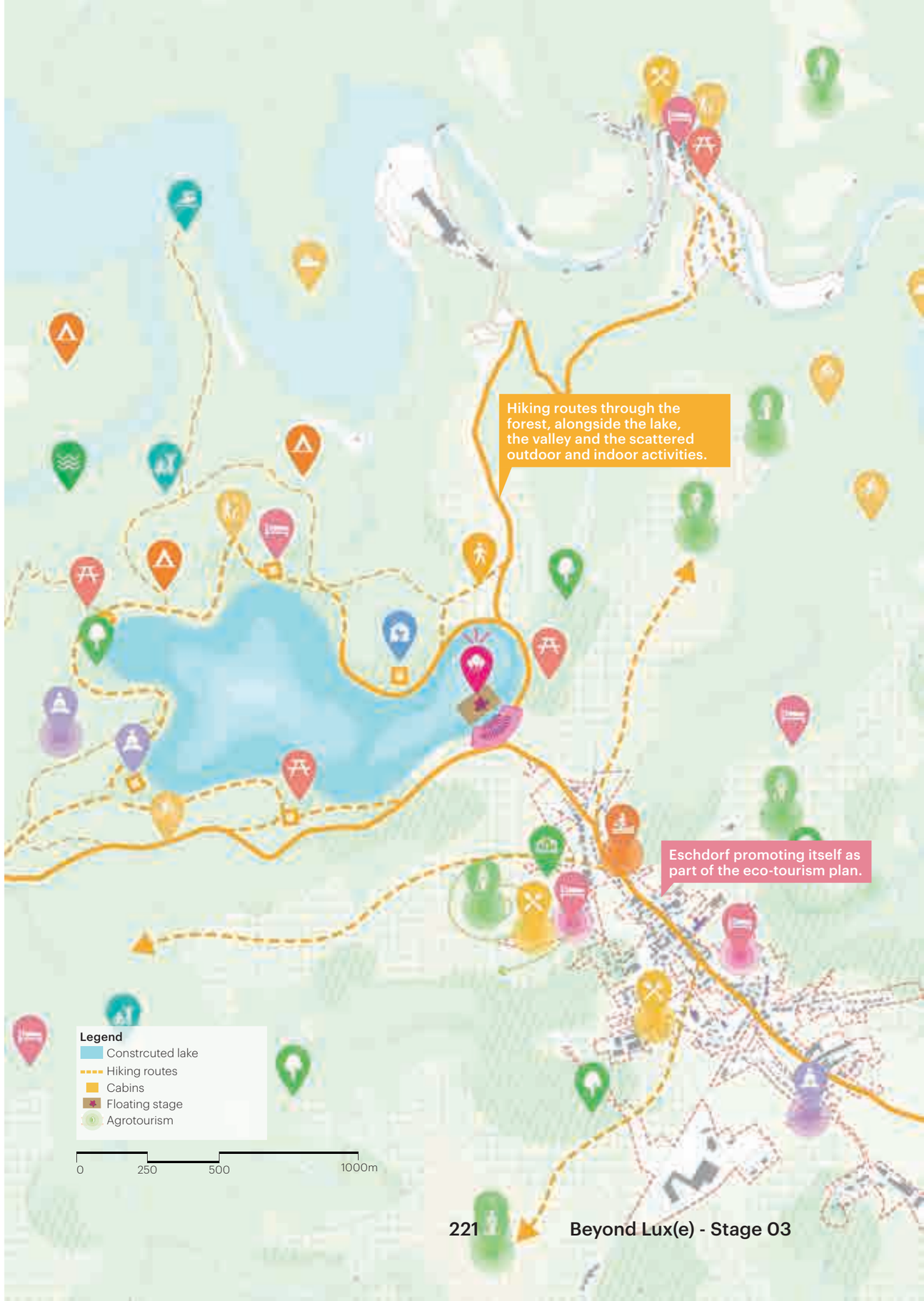
Hydro-storage shape proposal 2: Geometry
The shape of the lake in this proposal is a pure geometric form that marks itself as land art.

Seneca Pumped Storage Generating Station near Warren, Pennsylvania.

3. Eco-tourism

Within this new, powerful, energy-rich landscape and sustainable agricultural practices, a village such as Eschdorf can develop into a hub of eco-tourism that links well with the natural reserve in the valley. Vacant buildings in the village can be repurposed for cultural and local commercial activities, and organic farms can support educational, and experience-based agro-tourism activities, encouraging visitors.

New hydro-storage lakes can also serve as hotspots for eco-tourism on the plateaus providing access to re-wilded valleys that accommodate extensive nature-oriented recreational activities such as hiking, cycling, and camping.



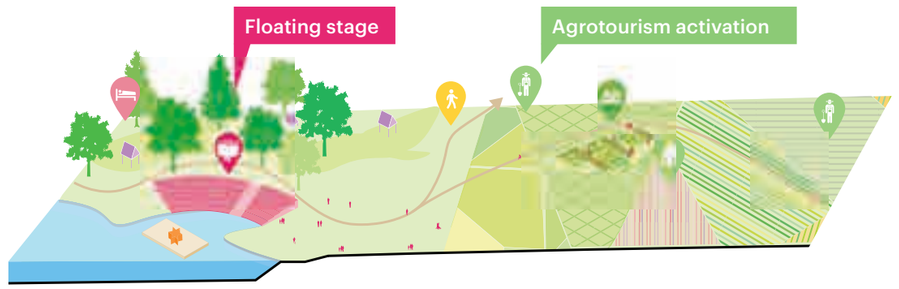
3.1 Hydro-park

A hydro-storage lake must not only serve energy storage purposes, but should also support intensive recreational facilities, maximizing the use of space and resources. Additional attractions such as hotels, spas, open-air theatres, and an activated village-side waterfront promenade. These can become exceptional architectural and cultural places of interest complementing the traditional natural landscape of the north.

“The Forest Front” Cabins with beautiful yet respectful architecture will create a unique spatial experience.

Helen & Hard Woodnest Treehouse - By Sindre Ellingsen

Lammassaari Boardwalk - By Mila Huisman Decopic.



“The Stage Front” A fabulous atmosphere brought forward by activities and events, embeded in the landscape throughout the valley. Among them the temporary floating theater.

Mulini Beach- By Studio 3LHD.

Floating stage in Bregenz, Austria.

Esch-sur-Sûre in Transition

Esch-sur-Sûre Today

Esch-sur-Sûre Tomorrow

Local energy collaborative development

Policy support for re-naturalization on river heads

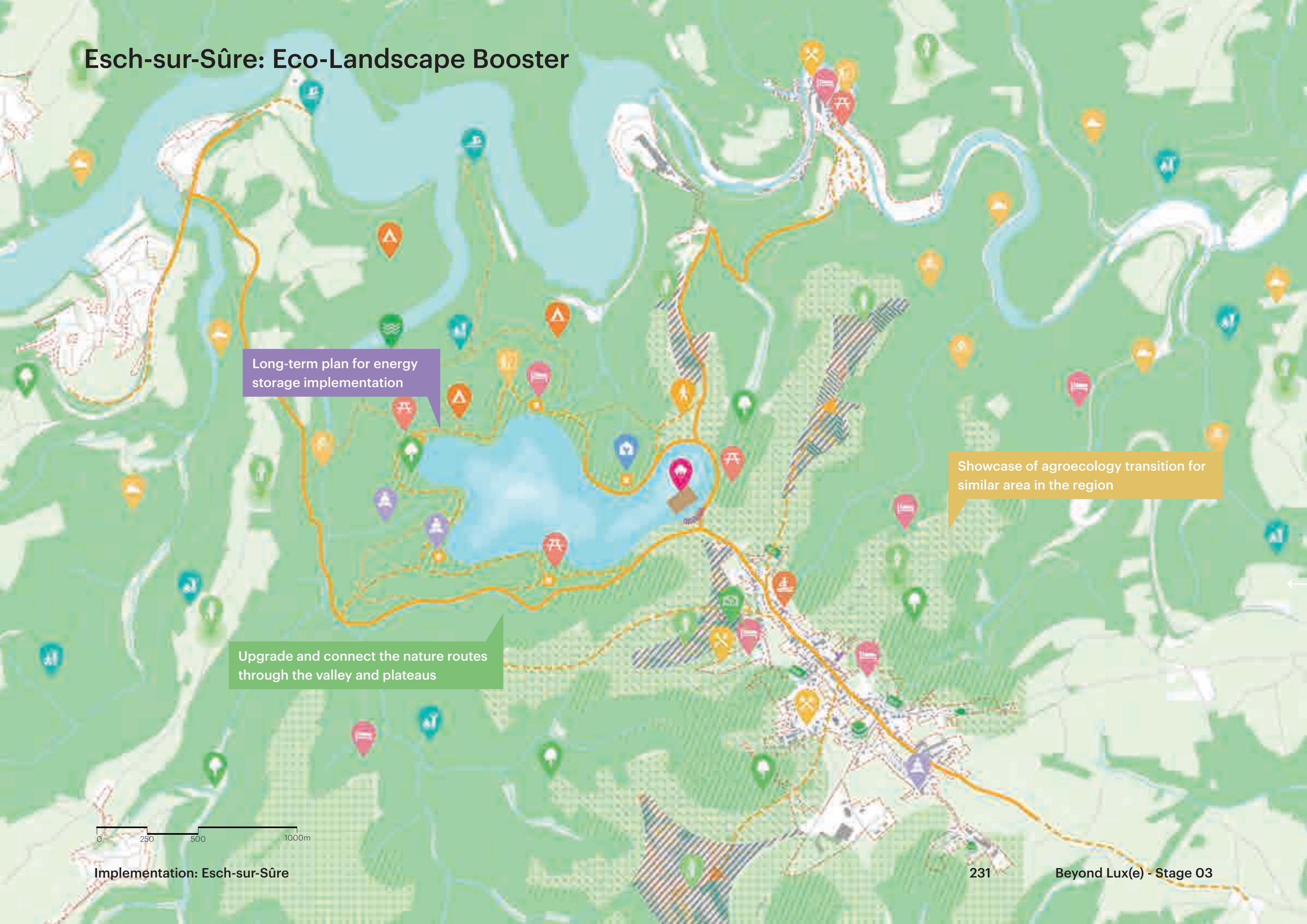
Vacant/downgraded buildings re-use for eco-tourism

Establishing benefit to local farming for protecting water quality

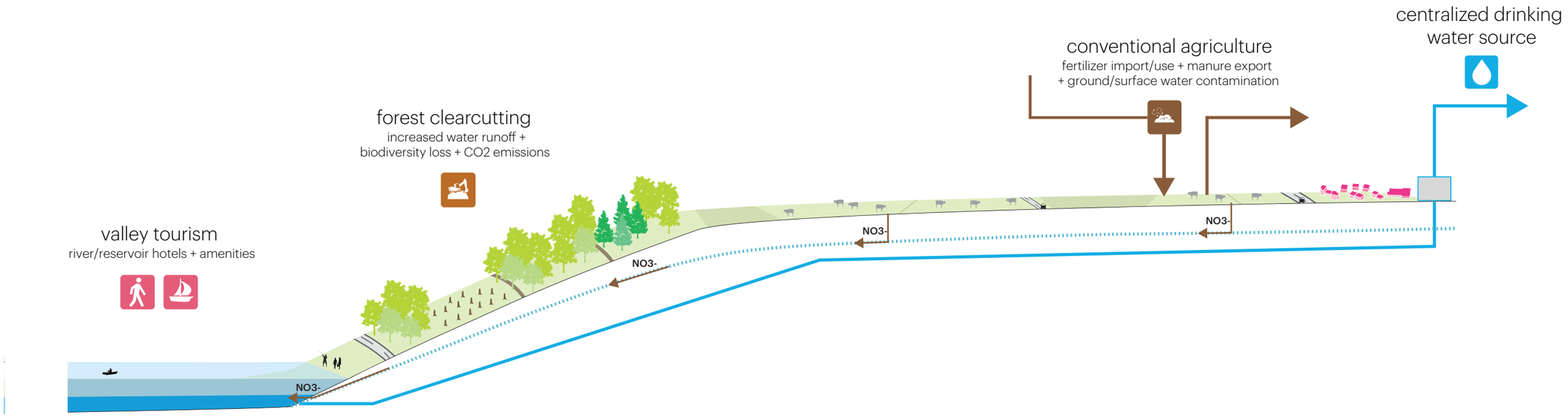
Organic argicutlure experiment

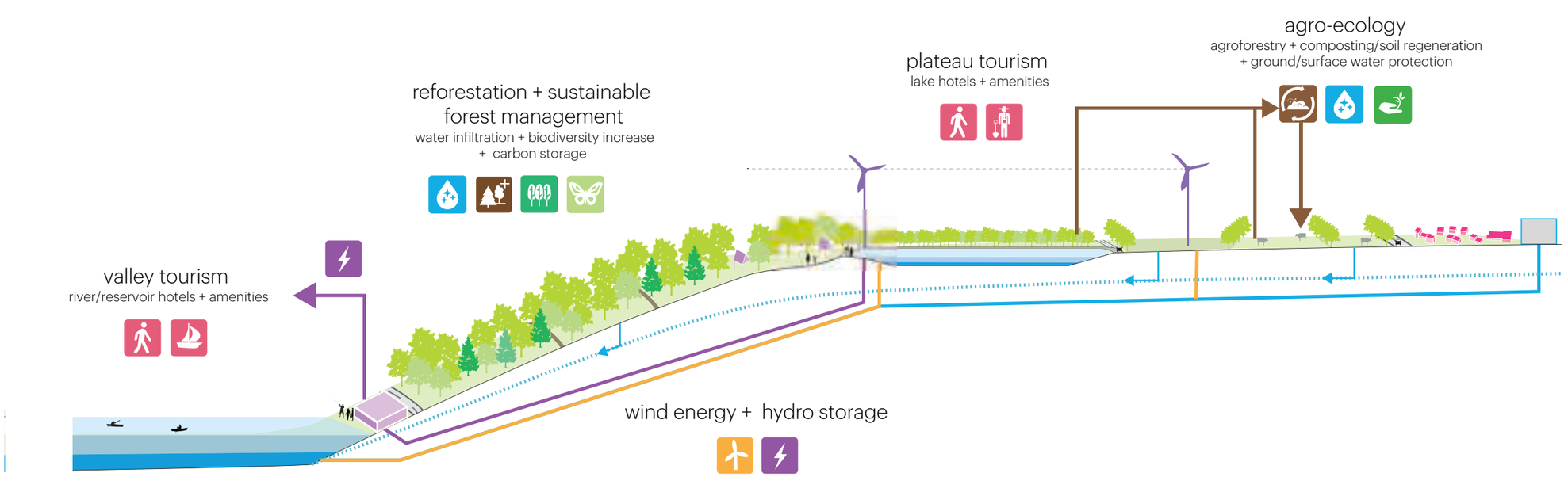
0 250 500 1000m

Esch-sur-Sûre: Eco-Landscape Booster



Esch-sur-Sûre: Eco-Landscape Booster





Esch-sur-Sûre Now

Implementation: Esch-sur-Sûre

Esch-sur-Sûre Tomorrow

Implementation: Esch-sur-Sûre

Esch-sur-Sûre Ecotopia:
Eco-Landscape Booster

Lux+ in Action

Transition approach

Towards a transformative governance mix with concrete interventions

Reflections

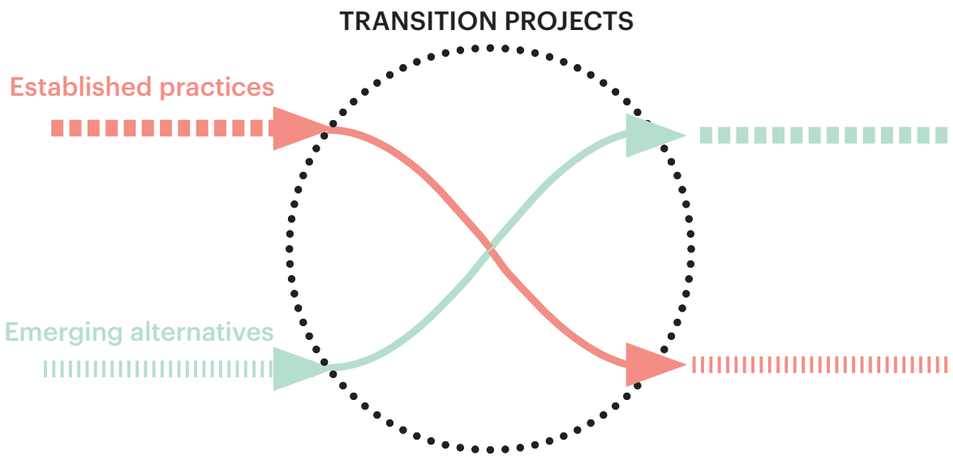
4

Transition approach

A transformative governance mix

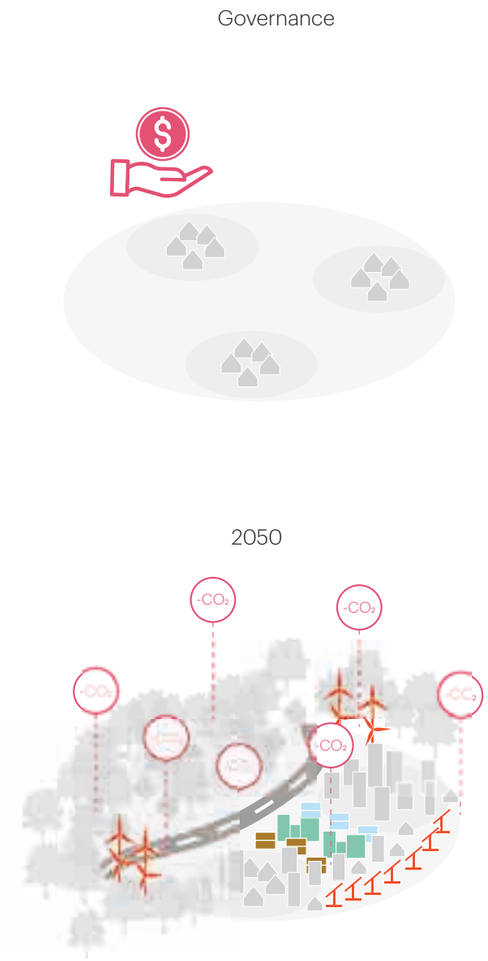
This report leaves no doubts regarding the challenge Luxembourg is facing to transition towards the Eco-topia we envision. Luxembourg is currently on a truly unsustainable trajectory, and has only a short time to fundamentally pivot its economy and society. This report also comes at a time of increasing societal urgency and growing support for transitions, and a call for robust transition policies. A first sign of this is the attitude of the ministry itself, pushing the proposal to become truly visionary and radical. The team has also experienced this when speaking to people on the ground, working on desired transitions in their daily context. They share with us both their hope and frustration in changing Luxembourg at a bottom-up level.

We live in interesting times, where there is a growing urgency and awareness of transitions. When it comes to urgency, we are being confronted with the negative impacts of unsustainability and our vulnerability more directly, as seen with the flooding of the summer of 2021. When it comes to awareness, we see sustainable alternatives emerging and becoming more visible on a daily basis as electric cars take over the road and solar panels take over our roofs. It is the simultaneous coming together of the realization that the existing is no longer possible, and the emergence of alternatives that bring together a willingness to act and a believe that change is possible. It is this combination of dynamics that also form the core of our governance approach: to support emerging alternatives to become the norm and to actively phase out unsustainable practices.

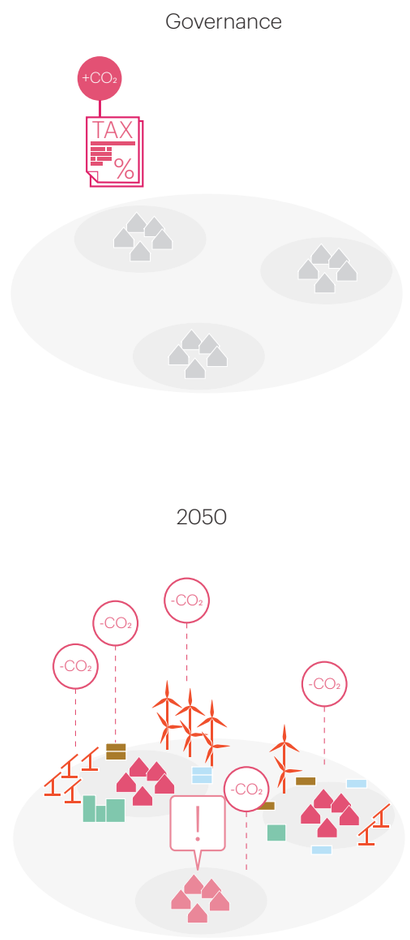


Two governance scenarios

How does the proposal achieve the Ecotopia? To get a better understanding of the possibilities the government of Luxembourg has to steer and guide the transition, we present two extreme governance scenarios that reflect a departure from opposing but complementary theories of change.



Scenario 1: top-down transitions



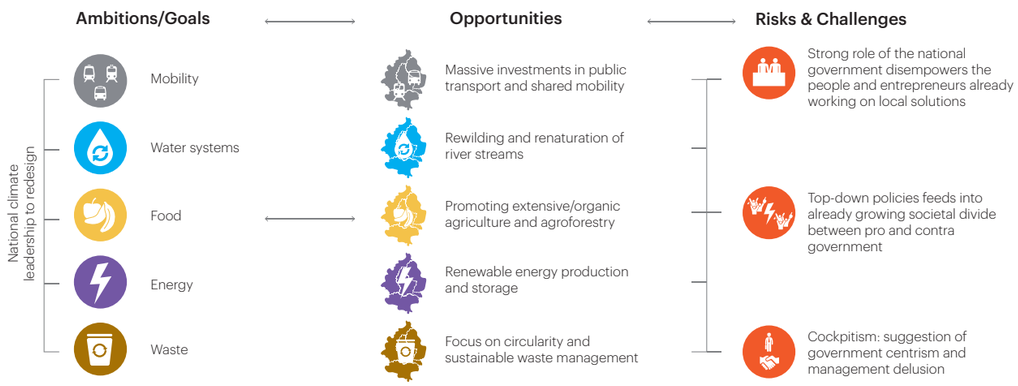
Scenario two: bottom-up transitions

Scenario 1: top-down transitions

Scenario 1 begins with the premise that a strong national government can bring all the expertise together and decide what is best to regenerate the ecosystems of the functional region. This governance approach creates coherent and well-designed solutions. For instance, massive investments in public transport, rewilding the Ardennes, agroforestry that is both productive and improves the biodiversity, renewable energy production and storage in strategically chosen locations, and the creation of rivers and streams that enhance climate adaptation and can be of drinking quality, form integrated facets of the solution.

This is a scenario that resonates with widespread calls for strong and concerted government action. It is a scenario that might lead to a large group of satisfied citizens that feel that the government takes good care of them by clearly explaining to them why these interventions are in the society's best interest in the long term. This builds a sense of belonging and citizens who are proud to be from Luxemburg. Significant investments to redesign the mobility, food, energy, waste, and water systems are possible because of economies of scale. But the strong role of the national government is also disempowering the people and entrepreneurs who were already working on local solutions. The societal divide between pro and contra government grows.

More fundamentally, this scenario ignores how challenging the policy task for the national government will be in practice. Transitions are long-term social change processes that largely take place outside the direct sphere of influence of the ministries. The term 'transition management' quickly gives rise to the suggestion of government centrism and management delusion. As if a social transition is a plane, with a cockpit, a navigation system and a pilot who is 'at the wheel'. But steering in transition, as it turns out time and again, requires new forms of influencing that do not put the government at the center but are mainly aimed at accelerating and steering social dynamics that are already visible in practice.



Scenario two: bottom-up transitions

Scenario two begins with the premise that there are already many desired transition practices in motion, but that they are hardly visible, do not get enough attention, or that we simply do not recognize them as such. This governance approach creates intervention that supports the alternatives that we already see emerging, such as, shared mobility options, energy cooperatives, community supported agriculture, urban community gardens, repair cafes, fab labs, etc. This is a scenario that resonates well with all those people already working on transitions in the making. It's a scenario that will empower particular groups of citizens that feel that the government is finally supporting them in their actions to bring Luxembourg into a truly sustainable trajectory. It allows local communities to self-organize. It bolsters the local identity and creates strong social networks in which people take care of each other. But the strong entrepreneurial role that communities and businesses take in this scenario also results in inequalities, where successes are based on the local competencies, resources and/or luck. Those who are not as competent, well-funded or lucky, will be left behind.

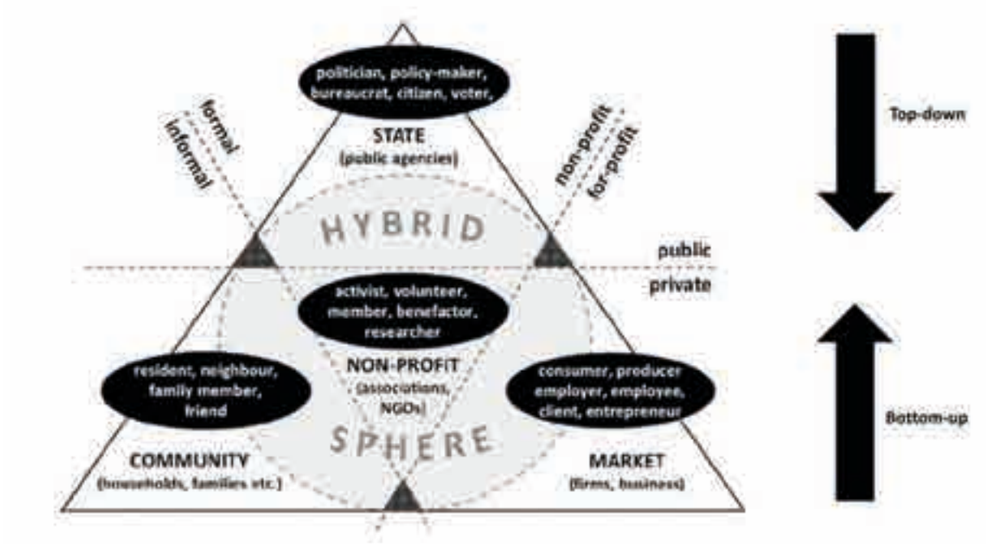
More fundamentally, it runs the risk in becoming too naive about the underlying power dynamics that shape societal change – or inertia. It creates government policy that supports grassroot initiatives without creating the right framework conditions for them to succeed or addressing the institutional barriers they face. It will create a lot of innovative activities in Luxembourg, but without providing these frontrunners with a serious prospect for fundamental change. In every region, different types of solutions will emerge, but it will take a long time before they become dominant practice as the fossil fuel-based options simply remain more attractive for the time being. Furthermore, without proper coordination and support, the variety of local alternatives disconnect on a national level with no economies of scale.

Towards a transformative governance mix with concrete interventions

Towards a transformative policy mix

The two scenarios obviously were developed as extrapolations and explore the pros and cons of both approaches. In reality, both are present at the same time and combinations of both approaches, tailored to the specific contexts, topics, and challenges are required. If Luxembourg is to become truly sustainable, it will be through a shift towards sustainable practices at the local level that are completely aligned with the local climate, geography, culture, resources and so on. But this will only happen if the institutional, and thus top-down, conditions are favourable to achieving this.
In moving forward, we need to depart from a traditional understanding of bottom-up (as local, small, and citizen-led) and top-down (as government-led, technocratic, and hierarchical). Achieving desired transitions will require experimentation and transformative change across all levels. 'Top-down' in this transition perspective implies an institutional design that translates the vision for a sustainable future into concrete principles, conditions, rules and timelines. This creates space for all levels of society to enter a process of transformative change reinventing daily life and how it is organized.

'Bottom-up' then refers to the entrepreneurial and learning-by-doing logic through which people reinvent the way economy and society work within their own context. Whether it is citizens in their neighbourhood, civil servants in their departments, managers in their businesses, or staff in schools and universities; everyone is part of Luxemburg in Transition.



Policy mix in practice | Slow mobility

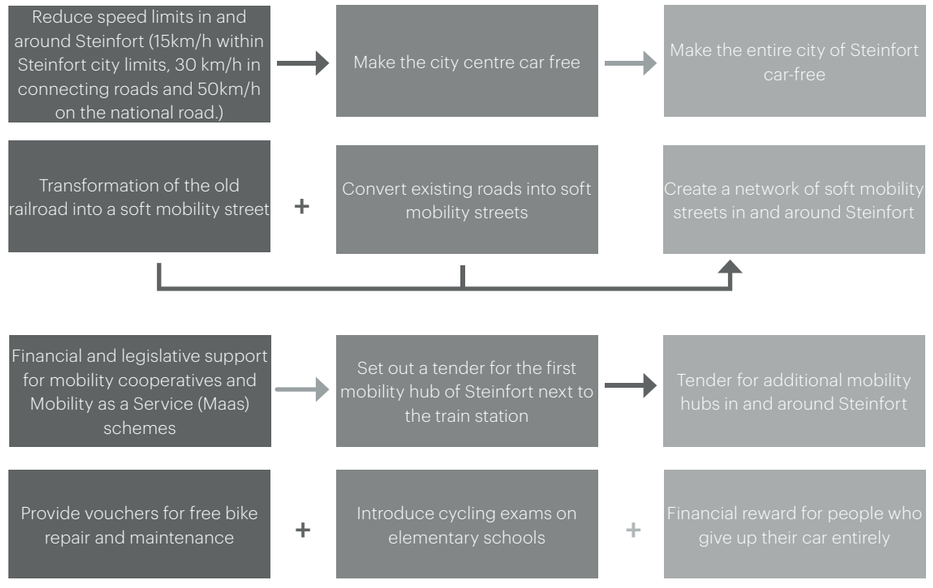
Our vision for the mobility system of Steinfort in 2050 implies that in the future, each individual will make different choices on a daily basis as to how, when, and why they move. This change cannot take place without the bottom-up dynamics of societal change where people themselves change their daily practices in sometimes radical ways.

This demands a broad strategy empowering frontrunners who are already making these changes, for instance through subsidizing people who get rid of their cars, facilitating mobility cooperatives or Mobility as a Service (MaaS) schemes, and the promotion of bike culture through the active support of bike maintenance and repair shops or introducing cycling exams for elementary schools.

But changing daily mobility patterns bottom-up is not easy, as Luxembourg already experienced when the ministry launched an app facilitating carpooling: people were ready to share their passenger seat, but not ready to give up their own car. Time and time again we learn that changing daily mobility patterns also demands top-down decisions in infrastructural investments, road regulations, and fiscal incentives. For this transition to succeed, we also require strong government leadership to redirect mobility away from car-centric models towards a multi-modal mobility system based on a combination of cars, bikes, trains, busses, and other forms of soft- and micro-mobility.

The Steinfort Example

Mobility Transition



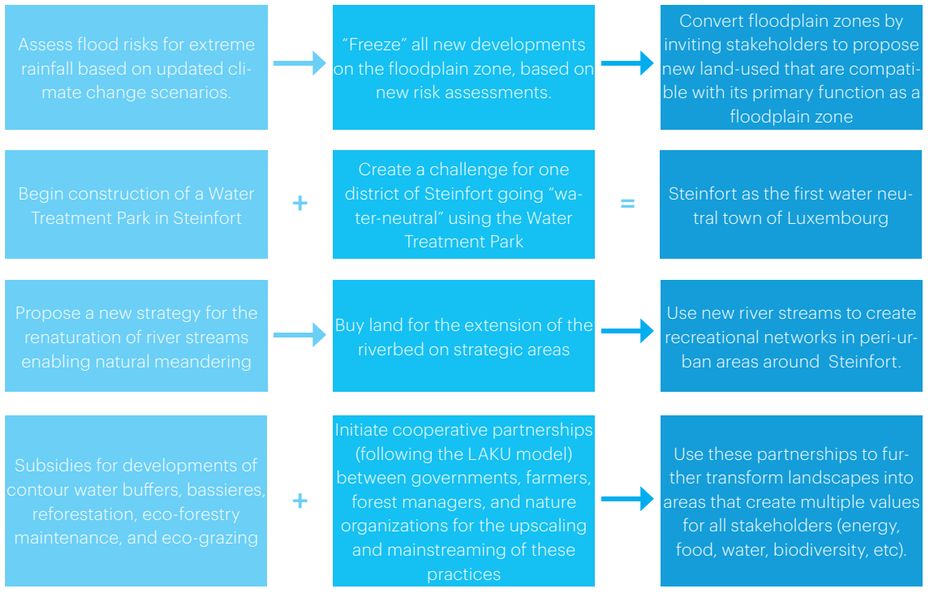
Policy mix in practice | Water buffer

Creating climate adaptive landscapes demands a myriad of interventions, such as contoured water buffers, riverbed extension to renaturalize rivers, baissieres, and new widely adopted practices such as eco-forestry maintenance and eco-grazing. These require the involvement of all stakeholders and calls for a 'bottom-up' incentive and subsidy schemes that allow farmers and other landowners to adopt climate and water sensitive landscape design.

But the transformation of the landscape will be of such a scale that it also demands a national strategy for spatial planning. Think of nationally allocated land for floodplain zones, rewilding, and retention landscapes, or the creation of nationally-orchestrated green corridors and strategically chosen water parks, such as in the proposal for Steinfort.

The Steinfort Example

Water Buffer



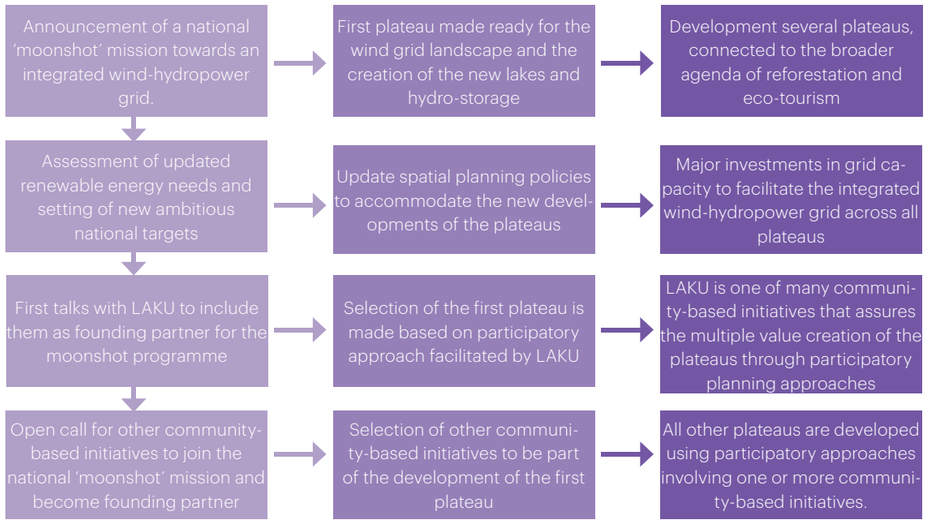
Showcase in practice | Energy landscape

The energy landscape as proposed for the plateaus of Esch-sur-Sure are at first sight a good example of a top-down governance approach. These present a well-planned and designed energy landscape with a wind grid in combination with the creation of new artificial lakes for hydro-storage, and connection to broader agendas of reforestation and eco-tourism. These are the kind of 'national missions' that typically demand active government participation and leadership.

However, the region of Esch-sur-Sure also has a history with national missions, as the artificial Upper Sur Lake is also the main source of drinking water for the country. This historic cooperation between (national) governments, water companies, nature organizations, and farmers has not been without difficulties. The foundation of LAKU, a cooperation where all stakeholders work collaboratively on finding solutions, is widely recognized as a successful governance intervention and resembles the more bottom-up governance style empowering local people, farmers, and environmental organizations. These more participatory approaches are a prerequisite for enabling the multiple value creations we envision.

The Esch-sur-Sûre Example

Energy Landscape



Recommendations

Conclusion

With one of the biggest ecological footprints per capita in the world, Luxembourg is on a truly unsustainable trajectory, for which there is one direction: stop and change. Luckily, it is still possible for Luxembourg to discontinue the current unsustainable development pathway and enable new pathways for sustainable development. It has a vibrant economy that can bear the costs of transformation and an innovative financial sector that can function as a catalyst for change. Furthermore, its countryside provides a great basis to build on, with natural systems that are still in relatively good shape.

In this report, we provided an ecotopian vision for Luxembourg future that is both ambitious and realistic. This proposal demonstrates what this future could look like for Steinfort and Esh-sur-Sure, and identified a number of interventions that can begin today. But these places are not unique. They have been selected because they are exemplary for Luxembourg: Steinfort because of its (sub)urban character, and Esch-sur-sure because of its rural character. Many of the proposed solutions are transferable to other places.

Looking forward, Luxembourg's government's central task is to recognize both the urgency of and potential for change, and demonstrate the climate leadership this world needs. In this final chapter, we briefly reflect on the main findings of this report by extrapolating the results from two case studies into three more generic calls for action: starting transition experiments, setting boundaries, and nurturing a culture of collective citizenship.

Start transition experiments

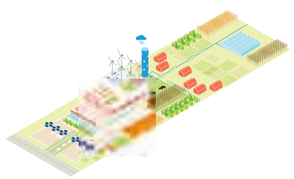
The Eco-topian vision put forward in Chapter two and three might seem overwhelming. This is because these represent a fundamental and sometimes radical shift from the current dominant ways of thinking, organizing, and doing. In Chapter 4 we show that these visions can be made accomplishable through small steps that incrementally mobilize in the near future. Despite these steps being small, they form a break with current practices and try to challenge and question dominant values and paradigms. They challenge people to look at a subject differently and thus promote a broader cultural change, attempting to contribute to a new vision for the future.

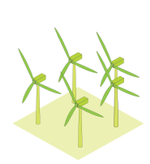
Our first call to action for the government of Luxembourg is to make work of these transition experiments, such as the first car-free neighborhood, a water treatment park in Steinfort, and the re-development of the plateaus of northern Luxembourg which combine wind power with reforestation, hydro-storage and eco-tourism. This proposal does not treat them as isolated 'pilot projects' but presents them as part of an integral transition strategy where together these initiatives form the seeds of change for the envisioned Eco-topia.


the stacked farming


the mobility hub


the rewilded forest

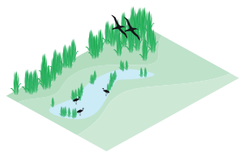

the agriculture hub

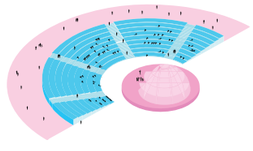

the energy landscape


the agroforestry


the soft mobility service


the community garden


the water buffer landscape


the floating stage


the mix-use development


the agrotourism

Set boundaries

The proposal's second call to action sets clear boundaries to protect Luxembourg's natural ecosystems, as a sole focus on transition experiments and the new and exciting concepts they offer will not be enough. The world's population continues to push the overall planetary boundaries beyond its limits. The time to start stemming this curve is now and Luxembourg must begin by defining clear boundaries of its current economic development trajectory. From our case studies, we extrapolate the following boundaries that demand immediate attention from the Luxembourg government.

- **Car-centered mobility**. Automobility is a huge problem, with car ownership per capita being one of the highest in the world, and traffic jams being persistent problems. Concretely, setting boundaries means slowing down or stopping traffic in cities and towns, limiting investment in road expansions or in new road infrastructure, and re-purposing existing infrastructure for soft mobility.
- **Intensive livestock agriculture**. Intensive dairy farming and animal food production shapes Luxembourg's agricultural landscape. This has considerable impact on land-use, biodiversity loss, water quality, and greenhouse gas emissions. Concretely, setting boundaries means no additional dairy farm permits and a gradual phase-out towards a sustainable cattle herd size that the land can support.
- **Uncontrolled urban sprawl**. There are many economic incentives that drive people from the city to the countryside. At this moment, this leads to uncontrolled urban sprawl and increased traffic from commuters. Concretely, setting boundaries means to appoint nuclei/centers for urban growth in the main cities of the Lux functional region. Outside these cities, we need to drastically limit real-estate development. This is important to both preserve the natural landscape, and to limit mobility patterns within and between the countryside and the cities.
- **Vulnerable waterways**. Much of the water infrastructure, such as existing river streams and dikes, have not been adapted to the climate of the (near) future. Luxembourg must return to the drawing board and design boundaries that respect the space needed for water and ecology, thus becoming more resilient to drought and flooding in the future. Concretely, this means "freezing" floodplain zones for (further) economic development, renaturation of river streams, and extension of the riverbed.

Nurture a culture of well-organized collective citizenship

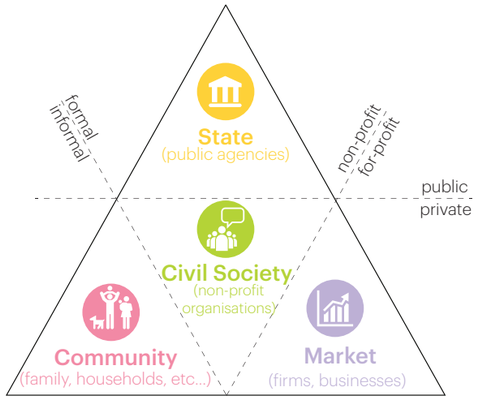
For transitions to succeed, we need action from all parts of society: the state, the market and the community. Whether it is citizens in their neighborhood, civil servants in their departments, managers in their business or staff in schools and universities; everybody is part of Luxemburg in Transition. We are delighted to see that the ministry is showing commitment to this, asking our team to create bold visions for the future, and challenging us to propose radical ideas. But transitions that are merely carried out by the state will not succeed.

The government of Luxembourg is aware of this and, as most governments have done, have many policies in place to create a healthy business environment, incubating and stimulating startups, and initiating pilot projects to unleash the potential of the private sector. An exemplary institution is the chamber of commerce, a public institution with its role and mission confirmed by law, protecting and defending the interests of businesses and the Luxembourg economy. The government does this by advocating a business-friendly legal framework, supporting the creation and development of companies and startups, acting as a service provider to businesses and the public, informing the public, and driving the debate on all matters relating to economy and business.

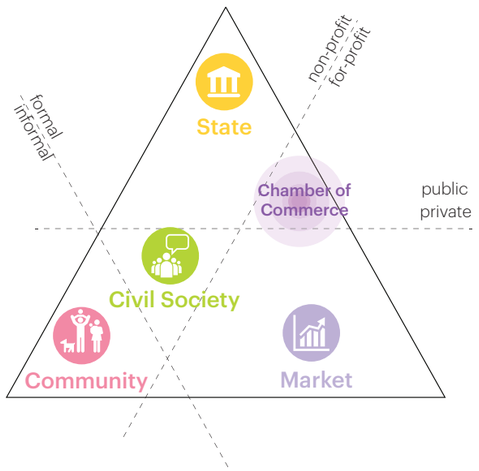
However, throughout our research, we have not found a similar engagement with community-led grassroots initiatives. This is a missed opportunity as we observe many grassroots initiatives that are already building the future vision, from energy cooperatives to community supported agriculture (ref: team UniLux phase 2). However, these initiatives have some difficulty staying afloat, let alone growing and scaling. They remain small, fragmented, unprofessional, informal, and with little impact or influence.

This is a well-documented problem in Luxembourg. As Doerr (2019) suggests, the general government culture of Luxembourg makes it difficult for grassroots initiatives to experiment with transformative alternatives. For instance, the cooperative movement is not strong and organized enough in Luxembourg to have political weight, and a cooperative and friendly environment has never been created. There is also a deeper governance gap that sidelines many people living in Luxembourg. Today, around half of the country's population does not hold a Luxembourgish passport. Moreover, many of Luxembourg's policies directly affect the people in the greater Luxembourg that have little to no influence on these. Doerr observes that this creates increasing tensions, as citizens have little democratic opportunities to participate in the development of their neighbourhoods. Community-led action has a valuable contribution to make as these offer arenas for political participation, and for people to engage directly within their immediate surroundings in a meaningful way.

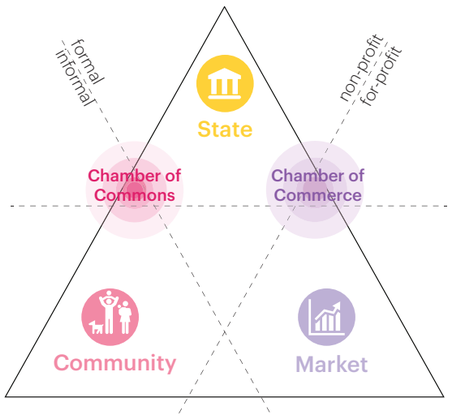
Our final call to action is the foundation of a **chamber of commons** for the vocal and structural support of community-based transition forces. This idea has been proposed before but has bever materialized. As such, Luxembourg can be the first country that could have such an institution. The chamber of commons could strengthen community-led transition forces by making the 'informal' (what you do as a neighbour or resident) more formal (i.e. organize yourself in associations or cooperatives), thereby strengthening civil society and rebalancing the power relations between community, market, and state logics.



Ideal Situation:
a healthy balance between market, state and community logic.



Current Situation:
The market logic is dominant. The state puts a lot of effort into creating a healthy business environment through initiatives such as chamber of commerce.



Future Situation:
Through the chamber of commerce, the state puts equal effort into the vocal and structural support of community action and a vibrant civil society. The balance of power is restored.

Design of the Chamber of Commons

We propose that the structure of the chamber of commons can be similar to the structure of the chamber of commerce. This means that we suggest the foundation of a public institution with its governance and activities (role and mission) confirmed by law.

Governance:

- **Mission:** the vocal and structural support of community-led action and civil society to further the just sustainability transitions.
- **Members:** free membership for foundations, cooperations, and associations that endorse the mission of the Chamber of Commons.
- **Territorial focus:** members can come from the greater Luxembourg area. This means the chamber is also open to members from Germany, France, and Belgium.
- **Funding:** as this is focused on for-profit organization, the chamber of commons justifies financial support by the national and local governments of Luxembourg.
- **Chamber:** 10 members elected for 5 years, with one chair.
- **Secretariat:** an agency with staff to organize and execute all activities

Activities:

- **Recognition:** priority is to recognize the importance of community-led action and to create a healthy commons-friendly climate, just as it is a government priority to nurture a healthy business climate.
- **Visibility:** creating a taxonomy of what we understand as commons-friendly initiatives (cooperatives, associations, foundations). Creating a registry of all different categories and map current initiatives.
- **Structural support:** support professionalization, networking, education etc. Address dilemmas like scaling and professionalizing while maintaining cooperative values.
- **Vocal support:** support advocacy and lobbying. This chamber will be the place where members can signal structural bottlenecks. The Luxembourg ministry is obliged to at least respond to the concerns raised, just as is the case with the chamber of commerce.

Develop the monitor for collaboration:

Emissions & decisions

Urban area

No more land Intake

Building performance upgrade

Mixed-use planning

L01.1

L

Set urban boundary

XX km² — XX km²

L01.2
Super-city(s) & Eco-villages

XX km² — XX km²

M

M01.
Mixed-use city

XX km² — XX km²

S

S01.
Existing building upgarde

XX km² — XX km²

Mobility

Multimodel instead of car

Non-emission mobility

Reduce trips and commuting

L02.1

L

Strengthen city connection

XX km² — XX km²

L02.2
Reduce mobility in rural area

XX km² — XX km²

M

M02
Local soft mobility network

XX km² — XX km²

S

S02.
Multifunctional mobility hub

XX km² — XX km²

Water

Reduce water use

Retain rainwater

Ensure quality local water system

L

L03.
Water buffer

XX km² — XX km²

M

M03.1
Flood area renaturalization

XX km² — XX km²

M03.2
Local retention landscape

XX km² — XX km²

S

S03
Building water capture and retention

XX km² — XX km²

Energy

Reduce energy use

Green energy

Local production and storage

L05.1

L

Energy landscape (Solar)

XX km² — XX km²

L05.2
Energy landscape (Wind)

XX km² — XX km²

M

M05
Energy storage

XX km² — XX km²

S

S05
Solar roofs

XX km² — XX km²

Agriculture

Plant-based diet

Eco-farming

Short supply chain

L06.1

L

Mixed-use agriculture

XX km² — XX km²

L06.2
Agroecology

XX km² — XX km²

M

M06
Urban/stack farming

XX km² — XX km²

S

S06
Local production hub

XX km² — XX km²

Forest

Sustainable forestry

Max. capture and store

Connecting nature

L

L04.
Max. reforestation & biodiversity

XX km² — XX km²

M

M04.1
Ecological forest with selective harvesting

XX km² — XX km²

M04.2
Green streets

XX km² — XX km²

S

S04.
Green roofs & facade

XX km² — XX km²

Colophon

Colophon

Bidding Team

Consultant
Researchers/advisors transition governance

Main Contractor
Urban + Spatial Planning

Consultant
Landscape design

Sub-Consultant
Sustainability

Sub-Consultant
Mobility & Infrastructure

Sub Consultant
Water Management

Sub-Consultant
Geo-mapping/Spatial analysis

MVRDV
MVRDV

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Director
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