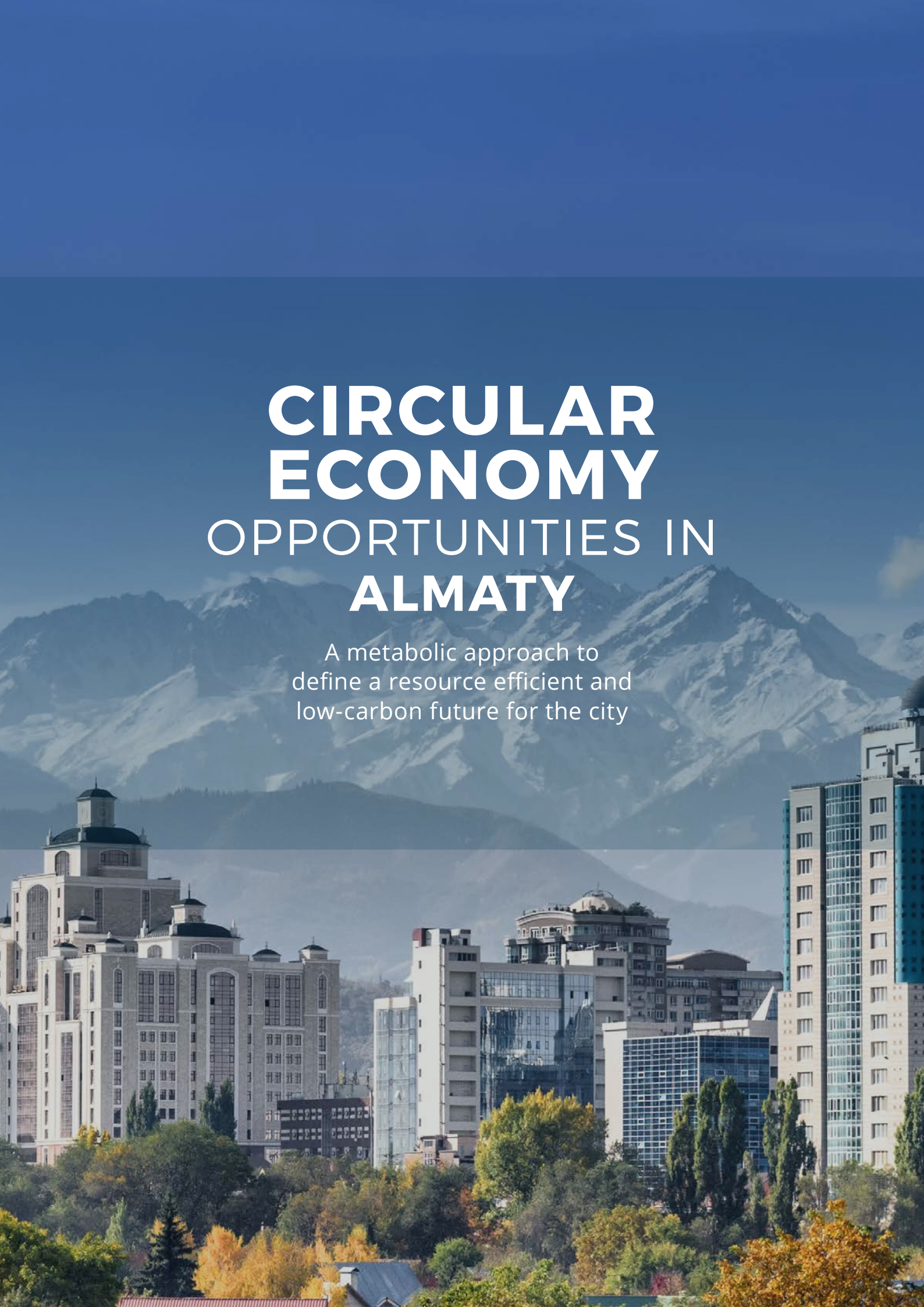

CIRCULAR ECONOMY OPPORTUNITIES IN ALMATY

A metabolic approach to define a resource efficient and low-carbon future for the city

COLOPHON

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shifting paradigms

The circular economy concept offers a promising set of strategies to redefine development through the lens of metabolic efficiency and set course on a resource efficient and low-carbon future. Shifting Paradigms maps out and visualises the resource flows and asset utilisation in an organisation or jurisdiction. From there stakeholder can set priorities and identify the most promising circular economy opportunities. Rather than optimising the individual elements of a linear "take-make-waste" supply chain, Shifting Paradigms focusses on the interaction between the elements in a system and across sectors.

CIRCLE ECONOMY

The mission of Circle Economyis to accelerate the practical and scalable implementation of the circular economy. Circularity has a key part to play in shaping a visionary and practical future for our planet. It is about becoming inspired by the biological processes of nature while retaining value at the heart of every design, manufacturing, and consumer decision from renewable energy and remanufacturing of used parts, to the ability for reusedesigned into everything we consume. Our tools and programs facilitate decision making and action plans for businesses and governments in a wide range of sectors. Alongside our powerful network of members, strategic partners, sponsors and donors we seek to inspire the hearts and minds of the main stream, from cities and corporations, to entrepreneurs and innovators.

CSPC

The Centre for Sustainable Production and Consumption (CSPC) is an independent non-governmental organization founded in January 2005 within the framework of the TACIS Project "Cleaner Production in selected CIS countries: Moldova, Georgia and Kazakhstan". Its mission is to develop and implement sustainable production and consumption practices in industry and agriculture, and the promotion of a preventive approach to environmental protection, with use of best available technologies and innovation at national and local level.

FABRICations.

Fabrications adopts a "Research by Design" approach to explore the potential for better urban systems. In each project, FABRICations substantially invests in research to expand the relevant knowledge-base to provide the most purpose-driven solutions. To assess the accuracy of our research and proposals, FABRICations regularly forms alliances with other practices, which comprises of a strong and effective network of professionals, consultants and institutions. FABRICations has been awarded with prestigious prizes including the Prix de Rome for young architects (2010), the Green Architecture Competition (2014) and the ASLANY Merit Award (2015).

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EMSD is a network of change agents and decision makers from think tanks, multinational corporations, and the financial sector. Our members jointly develop and implement solutions for sustainable economic development in emerging economies through consultation, dialogue, and research. We bring these solutions into national and international fora, contributing to the global sustainability transition and the protection of global public goods.

FOREWORD

Bauyrzhan Kydyrgaliuly Baibek
Mayor of Almaty City

The development priorities for the Republic of Kazakhstan are part of the Concept for the transition to a “green economy” and include optimizing the use of resources, improving the efficiency of environmental protection, and creating a “green” infrastructure.

The Akimat or municipality of Almaty aims to improve the environmental situation by implementing measures to reduce the level of air pollution, improve the efficient use of water resources, creating a modern system of management and processing of solid household waste. All these measures should help turn Almaty into a city that is comfortable for the life of the population and attractive for business development.

Almaty City Akimat supports initiatives which promote the introduction of green economy strategies in the region, including the project “Circular economy opportunities in Almaty (Green Economy)” for the city of Almaty and adjacent territories, carried out by an international consortium with the Kazakhstan NGO Center for Sustainable Production and Consumption and the Dutch companies Shifting Paradigms, Circle Economy and Fabrications. Such projects help strengthen international cooperation and share positive experiences, as well as fostering a dialogue between all stakeholders to achieve the principles of sustainable development.

This metabolic analysis of resource flows in the city is the first of its kind among the Commonwealth for Independent States. Almaty City Akimat hopes that as the result of the analysis and the subsequent implementation of the recommendations will help improve the ecological situation in Almaty and in the surrounding region.

We wish the project participants success with their efforts and a mutually beneficial cooperation in the implementation of the principles of “green economy”!

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SUMMARY

APPLYING THE CIRCULAR ECONOMY CONCEPT IN ALMATY

The circular economy is an economic concept that aims to decouple economic growth from resource use, making material use regenerative, rather than depletive. It does so by proposing strategies which optimise the use of existing assets and materials, thereby reducing the use of primary materials and lowering the output of harmful waste. By focussing on what's already available, and altering the design of new products and assets, the circular economy concept can help Kazakhstan define a development pathway which diversifies the economy, reduces its reliance on imports and inspires private sector growth based on the 'mining' of secondary materials, rather than delving ever deeper into its primary natural resources.

Almaty is a sensible starting point for a circular economy analysis. The city is geographically important as an economic centre of Central Asia and has a long history of managing the wealth of resources which are extracted in Kazakhstan. Next to this, the private sector can position Almaty as an important station on the Belt and Road Initiative which connects Central Asia with markets in China and Europe.

The circular economy is far from new to Almaty though. 'Green growth' is the term under which Kazakhstan defines and implements its sustainable development ambitions. These ambitions resonate well with the emergence of companies and grassroots initiatives which are successfully tapping into underused assets and material resources. The overview of existing circular practices in this report, demonstrate that the city is already on a path to a circular future.

UNDERSTANDING THE URBAN METABOLISM

In order to achieve a circular economy, there is a need to understand the flow of materials and where they can be closed. Analogue to a living organism, a city needs clean air to breathe, healthy food and clean water to live, energy for thermal comfort and mobility and durable materials to deliver houses, vehicles and other long-lasting consumer goods. Mapping out the 'metabolic system' of a city, helps understand how a city uses material resources to deliver valuable services to its inhabitants, like nutrition, shelter and mobility, and identify opportunities for improvement.

In this report, data visualisations help comprehend and appreciate the metabolic system of Almaty, opening a circular development perspective which cuts across sectors and industries. It thereby attempts to step away from searching isolated solutions for individual sub-problems within sectoral, company or even jurisdictional boundaries. It aims to find more systemic solutions whereby resource use is efficient by design, hoping to contribute to making Almaty an even more pleasant place to live.

Tangible next steps for the short term indicate how Almaty can move away from the linear take-make-waste economic model. Although this model has enabled impressive economic growth in the past, its adverse impacts, like loss of soil fertility, deterioration of urban air quality, climate change and plastic pollution, make it unfit to support further growth of human wellbeing.

Many of the recommendations are not technical per se, but rather propose new directions for urban planning and governance, opportunities for deeper cooperation amongst industries and ways to ensure that new urban districts become vibrant, attractive and even meaningful places to live in.

Republic Square, Almaty.

MATERIALS WHICH FEED ALMATY, ENABLE ITS GROWTH AND WHICH ARE PROCESSED THERE

Apart from agricultural production, the Almaty region has little primary extraction. Its processing and construction industries, as well the material consumption by its citizens, rely mostly on imported resources. To comprehend the relation between the circular economy and climate change. The metabolic analysis of Almaty includes data on territorial emissions, and data on upstream or consumption-based greenhouse gas emissions.

Resource use in Almaty is dominated by fossil fuels, biomass and carbon-intensive construction materials. The total amount of minerals, biomass and metals used in the city is 5.6 million tonnes. Fossil fuel use for thermal comfort and mobility are responsible for around 11 million tonnes of CO_2 emissions from the city. The carbon footprint of materials which are imported into the city, notably construction materials, is with 17 million tonnes of CO_2 emissions even larger.

When considering the fuels and materials which are used and consumed in the city, the circular economy targets up to 42% of the carbon footprint of the city. This is the part which is emitted upstream in the value chains which feed the city.

For a better understanding of these figures and the underlying flows, the metabolism of Almaty has been analysed from three different angles:

1. **Agriculture and food processing.** These are the assets and flows of materials which provide nutrition to the city. This focusses on organic resources but includes the life cycles of food, drinking water and its associated packaging.

2. **Construction.** This is about how the city grows. It looks at the types, origin and end-of-life fate of construction materials, as well as the greenhouse gas emissions associated with building heating and the carbon footprint of imported construction materials and fuels.

3. **Industry:** This is about what is processed in Almaty, regardless of whether it is consumed or used in the city, or rather exported.

AGRICULTURE AND FOOD PROCESSING

In a circular future for the agriculture and food processing sector in Almaty, organic residues are collected, whether they are from agriculture, industries or even households, and used to regenerate soils, make new food products or provide alternative packaging materials.

Kazakhstan aims to improve food security and substitute imports with local products. Using available organic resources, including residues, allows Almaty to produce locally what would otherwise be imported. The business rationale behind this is that local products have a competitive advantage over imports, since they require less transport. New initiatives, ranging from tomato and cucumber production on hydroculture, associated gas to heat greenhouses, to using chicken manure and straw for mushroom production, already tap into waste flows, or use more resource efficient production methods.

The national government is supporting Almaty to nearly double its agricultural production and processing capacity by 2020. The additional capacity will also produce new organic residues. The material needs of the new farms and factories should be mapped out and matched with future waste streams from other companies within or even outside the sector. Only then, the agricultural cluster can operate as a system which is resource efficient by design.

Next to this, the use of synthetic inputs can be minimised by making optimal use of natural processes at farm level. The growth ambitions of the agricultural cluster create a risk for further intensification and related erosion of natural capital in the region, notably the soil. Closed cycle farming, making use of natural biodiversity, investing in soil quality with tailored compost and equipping greenhouses with hydroculture and biological pest control can help increase yields, while reducing synthetic input and water use. A remaining barrier for closed cycle farming is that the use of mineral fertilisers is subsidised, while the use of organic alternatives is not.

Industrial symbiosis is the concept which connects residue streams from one company, with the resource needs of another. Where there is no direct demand for certain organic materials, they can be processed into biodegradable packaging materials, biofuels or soil enhancers. When operating as a cluster, securing attractive yields for the short and long-term becomes a joint interest for farms and food processing industries alike. Composting food processing residues into a soil enhancer, or pressing organic fibres from farms into packaging materials are concepts where farms and processing industries find joint added value.

For the city, the growing agricultural cluster offers recreational activities outside the city boundaries. The Almaty MasterPlan could even allow for some of the food production to take place close to the city, offering dense urban districts a mix of land use types which provides space for living, recreation and work. Many of the new residents of the city come from rural areas in Kazakhstan. Providing space for urban farming or land sharing schemes, allows them to retain a connection with the land and perhaps practice small-scale subsistence farming. At an even smaller scale, in the basements of residential buildings, this can also start with producing mushrooms on collected coffee grounds.

CONSTRUCTION

In a circular construction sector demolition sites supply part of the material demand for new buildings, and existing buildings are preserved and used for as long as possible, making demolition a last resort option. Where new and additional construction materials are needed to support the growth of the city, regenerative materials, flexible and modular construction methods have an advantage in a competitive bidding process, encouraging project developers to construct buildings with the least possible environmental impact, throughout the whole lifecycle of the building.

The construction sector has a large carbon footprint. Most of its greenhouse gas emissions take place outside Almaty, in the cement kilns and blast furnace from which the construction materials originate. Since the city is growing, new construction is inevitable. To meet the demands of a growing population, sustainable construction methods and materials can lower the carbon footprint of urban growth. It could even turn the build environment into a net carbon sink, while perhaps also creating an even more pleasant living environment by using regenerative materials like wood.

Next to this, the call from the citizens of Almaty to maintain the architectural and embedded cultural heritage of the city is growing louder and is finding a response from the government. Renovating, rather than demolishing, existing buildings can reduce the demand for new, carbon-intensive construction materials. It also invites architects to seek an interesting blend between traditional and contemporary design. Arguably, exploring the tension between traditional and contemporary architecture make a more interesting city. This also applies to spatial planning, which traditionally integrated buildings with vegetation and orientated the city towards the surrounding landscape.

Design is the starting point of building an energy efficient city. Passive design can bring the energy demand of buildings down with 70%, also for high-rise buildings. Design could also anticipate the integration of existing building elements, like remanufactured building facades from demolished buildings, or allow for modular and flexible design, whereby the construction takes place in an industrial setting off-site, and the construction site itself is merely a location for the final assembly.

Design can also facilitate modular construction methods, whereby the building is constructed in an industrial setting off-site or can provide flexibility when the building can accommodate different purposes. Circular construction concepts can be encouraged by the government when providing them with an advantage in a competitive bidding process.

INDUSTRY

In a circular industrial sector in Almaty, companies retain ownership and take responsibility for a product throughout its lifetime, supporting its durability and usability with predictive maintenance, efficient use, and repurposing or remanufacturing after the use phase. Recycling rather than landfilling becomes the last resort option, applied only when the value of the configuration of the product no longer exceeds the value of its embodied materials.

Industries in Almaty are recycling around 113,000 tonnes of material or around 13% of all solid waste produced. Recycling is already avoiding an estimated 173,000 tonnes of CO_2 equivalents, by reducing the demand for primary resources. However, residents seldom see what their separation efforts bring. Labelling products from recycled materials, or even allowing communities and workshops to make their own products or construction materials from secondary resources, recycling or repurposing becomes more tangible and valuable to a broader population.

The municipality can provide physical space to initiatives which give products and materials a second life. Buildings that are temporarily vacant can accommodate the creative design industry which could repair or repurpose secondary products. Other options with a high visibility and degree of community engagement, are the crowdsourcing of plastic materials for recycling into aesthetic building facades or tiles, or encouraging the existing repurposing waste materials into playgrounds.

At local workshop or multinational industrial scale, remanufacturing can extend the lifetime of products and components. The presence of light industry and repair expertise could be the basis for developing a remanufacturing hub for vehicles, car parts, furniture and perhaps even equipment like pumps and boilers. This would allow industries to obtain a role, not just in the first point of sale, but also in transactions with second and even third users.

Taking this a step further, the producers could retain ownership. That is where service models provide an alternative to sales models. The advantage is that the producer of the product, has an incentive to provide a product which lasts, requires little maintenance and has a high end-of-life value. Next to an investment in product durability, service models can also be an investment in building a long-term customer relation based on delivering a service rather than a product.

OTHER SECTORS

A transition to a more circular and low-carbon Almaty defines new opportunities for the food industry, manufacturing and construction. Other sectors have role in supporting the transition.

The public sector could become an even stronger facilitator and enabler of circular business models. The national government can provide strong incentives to improve resource efficiency, potentially coordinating with circular policy initiatives in the EU and China. Both public revenues, notably taxes, and government spending should be aligned with national sustainability ambitions. Revenues from environmental levies can be used to lower labour taxes. Circular economy business models are often labour intensive. Low labour taxes can facilitate such activities while tapping into domestic, rather than imported resources.

The Almaty municipality can also facilitate the transition to a more circular economic system by providing space for local production and small-scale industries or design workshops which harvest and create value out of locally available resources and products. This is where the circular economy resonates with urban master planning and participatory ways of decision-making. In addition, circular procurement can give companies with circular business models a decisive competitive advantage.

Circular strategies often ask for new financial models. Service models, for example require more upfront financing than business models where selling a product is the primary source of revenue. Service models are not new though, and often financial institutions can find the right expertise with bankers operating in other sectors.

Scientific institutes from Almaty have supported the regeneration of the Aral lake, and established competitive sustainable brands, amongst others in the dairy industry. In the transition to a circular agricultural cluster, scientists can help develop compost with the right ratio of carbon and fixed nitrogen, and help the sector apply industrial symbiosis principles and be resource efficient by design.

The education sector provides the fundamental tools and mental models for future generations to tackle the challenges decades in the future. Schools and universities are already promoting awareness of environmental challenges and circular solutions by hosting Do It Yourself plastic recycling equipment, participating in UNDP initiatives on e-waste and educating children on Doughnut Economics with gaming. Simple starter kits for kitchen-scale mushroom production on coffee grounds, can also show the value or organic residues and playgrounds from secondary resources can turn waste into sheer joy.

Finally, this report can be considered a first quantification of circularity in Almaty. With this first quantification at hand, the city could convene private and public sector stakeholder around a joint circularity ambition, whereby an independent entity could track progress by monitoring resource flows and quantities. This could help sustain progress also in the long run.

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THINKING IN FLOWS AND STOCKS

0.1 METABOLIC ANALYSIS TO COMPREHEND A CIRCULAR FUTURE

The resource and energy efficiency of an economy is more than the sum of the efficiencies of all its components. Decoupling economic growth from resource and energy use, requires understanding how the individual components operate, but above all, it asks for oversight of how individual elements interact and work together to deliver a diverse set of services to society.[1]

By mapping out the flows and stocks of a jurisdiction, the focus shifts from environmental issues and short-term priorities to the performance of the overall system and "the development of an integrated development perspective that includes all levels and sectors".[2]

Making an inventory of flows and stocks is like looking at a single jurisdiction as a 'metabolism'. This is the new paradigm for understanding resource efficiency and the underlying causes of environmental issues in cities[3] and regions.[4] It helps understand how materials, products and assets perform and interact, in order to optimise and achieve synergies between systems. Large amounts of data on resource use and assets are required to oversee how flows of minerals, biomass, metals, fuels, water and assets like buildings, vehicles and means of production work together to create value.

Data visualization is an effective means to help stakeholders develop a consensus on the current situation, and from there explore the challenges and opportunities.[5] Some of the first examples of this approach are from Brussels in 1977.[6] More recent work covers Rotterdam[7], Albania,[8] Bilbao[9] and the Dutch region of North Holland North[10] and Lao PDR.[11]

Building on a joint understanding, circular economy strategies can help decouple economic growth from resource use, making material use regenerative, rather than depletive. It does that by proposing strategies which reduce the input of virgin materials, improve the use of existing assets and reduce the output of harmful waste. The circular economy concept is an opportunity for Kazakhstan to connect its green growth ambitions with the latest practical insights from efforts to step away from incremental improvements, towards gradually transitioning to a system where products and services are resource efficient by design.

0.2 ALMATY AS A CIRCULAR HUB ON NEW CARGO ROUTES

Almaty is a sensible starting point for a circular economy analysis in Central Asia. The city is geographically important as an economic centre of Central Asia and has a long history of managing the wealth of resources which are extracted in Kazakhstan. This importance will grow further as city becomes a hub on the Belt and Road Initiative, connecting Central Asia with markets in China and Europe. This new cargo infrastructure has the ambition to significantly shift the flow of resources through new routes.

Next to this, the circular economy is relevant to Almaty since:

1. It is an economic opportunity to further develop its competitive advantage.[12] It can also reduce dependence on revenues from raw material exports by making better use of existing national resources, labour, skills and assets.

2. It guides the agenda on the Belt and Road Initiative. The Belt and Road Initiative connects China and Europe, two markets which have high and clearly stated circular economy ambitions. If Kazakhstan pro-actively invests in circular products and services, it can use the circular ambitions of these two regions to accelerate its own green growth agenda.

3. It steers innovation and establishes new forms of collaboration between businesses and customers. Circular business models aim specifically at delivering value through public access and use, avoiding the environmental impacts and inefficiencies associated with ownership.

4. It informs urban development. A circular city is a lively city. Many growing cities create 'sleeping districts' where there is little activity at street level. New urban areas can become more vibrant when they provide room for activity and employment in local remanufacturing, crafts and creative industries.

5. It helps reduce the environmental footprint and create environmental awareness with a positive narrative of change.

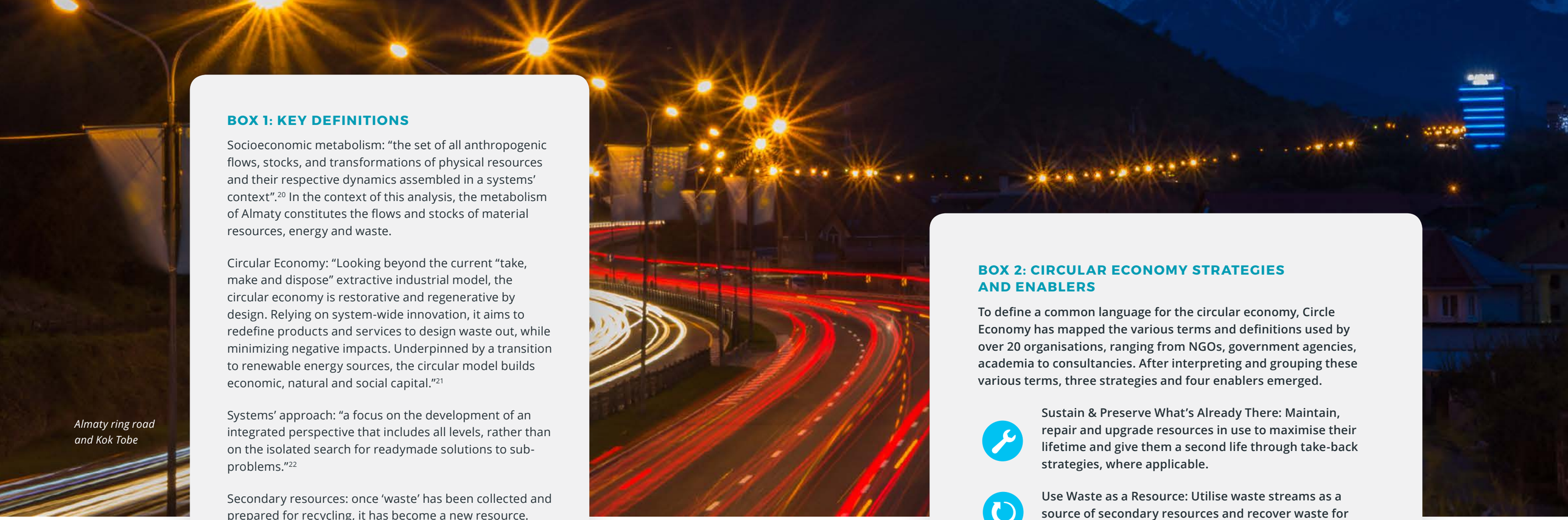
0.3 RESOURCE USE AND CLIMATE CHANGE

When envisioning a long-term development perspective for a city, resource efficiency and greenhouse gas (GHG) mitigation should be addressed in tandem. To feed our world economy, roughly 84 billion tons of raw materials each year are extracted. This is 32 kilograms per person per day. This extraction rate is already exceeding planetary boundaries, but population and economic growth might push this figure to a staggering 186 billion tons per year by 2050.[13] Some resources are already near depletion. In metal extraction, this is evidenced by declining metal content of ores,[14] and causes increasing volatility of resource prices.

A major share of the resources which we extract are the fossil fuels which contribute to climate change. In practice, most of these fuels are used to extract, transport and process materials and products. An estimated 67 per cent of global greenhouse gas emissions are related to material management.[15] In result, only the mutually reinforcing combination of low-carbon development and resource efficiency, can shift our world economy to a 2ºC or even 1.5ºC pathway.[16] Kazakhstan has set a target to reduce the energy efficiency of its GDP with 25% by 2020 and 50% by 2050.[17] To achieve that goal, reducing and optimizing the use of carbon intensive materials within the country, is crucial.

Apart from the environmental arguments, the circular economy also makes economic sense.

For some sectors, effective decoupling of resource use from economic growth is enough to bring greenhouse gas emissions in line with the ambition to keep global warming within 2ºC.[18] This opens a development perspective where lower dependency on material resources and fossil fuels can create the financial savings which accelerate economic development. In the public debate, it is often overlooked that the economic benefits of resource efficiency and low-carbon development exceed the near-term costs of shifting to a 2ºC emissions pathway.[19]



Almaty ring road and Kok Tobe

BOX 1: KEY DEFINITIONS

Socioeconomic metabolism: "the set of all anthropogenic flows, stocks, and transformations of physical resources and their respective dynamics assembled in a systems' context".[20] In the context of this analysis, the metabolism of Almaty constitutes the flows and stocks of material resources, energy and waste.

Circular Economy: "Looking beyond the current "take, make and dispose" extractive industrial model, the circular economy is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimizing negative impacts. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural and social capital."[21]

Systems' approach: "a focus on the development of an integrated perspective that includes all levels, rather than on the isolated search for readymade solutions to sub-problems."[22]

Secondary resources: once 'waste' has been collected and prepared for recycling, it has become a new resource. This is a secondary resource, which is different from a primary resource which originates from extractive industries like mining.

BOX 2: CIRCULAR ECONOMY STRATEGIES AND ENABLERS

To define a common language for the circular economy, Circle Economy has mapped the various terms and definitions used by over 20 organisations, ranging from NGOs, government agencies, academia to consultancies. After interpreting and grouping these various terms, three strategies and four enablers emerged.

Sustain & Preserve What's Already There: Maintain, repair and upgrade resources in use to maximise their lifetime and give them a second life through take-back strategies, where applicable.

Use Waste as a Resource: Utilise waste streams as a source of secondary resources and recover waste for reuse and recycling.

Prioritise Regenerative Resources: Ensure renewable, reusable, non-toxic resources are utilised as materials and energy in an efficient way.

Rethink the Business Model: Consider opportunities to create greater value and align incentives through business models that build on the interaction between products and services.

Design for the Future: Adopt a systemic perspective during the design process, to employ the right materials for appropriate lifetime and extended future use.

Incorporate Digital Technology: Track and optimise resource use and strengthen connections between supply-chain actors through digital, online platforms and technologies.

Team Up to Create Joint Value: Work together throughout the supply chain, internally within organisations and with the public sector to increase transparency and create shared value.[31]

0.4 CIRCULAR ECONOMY STRATEGIES

Circular economy strategies aim to decouple economic growth from resource use, making material use regenerative, rather than depletive. It does that by reducing the input of virgin materials, improving the use of existing assets and reducing the output of harmful waste. The circular economy builds on, and combines, concepts like Cradle to Cradle,[23] the Blue Economy,[24] the Performance Economy,[25] Industrial Ecology [26] or Industrial Symbiosis,[27] and Biomimicry.[28]

A circular economy taps into the tremendous economic potential embedded in the materials which societies use. Capturing this value of materials, products as well as in the buildings and infrastructure which represent the in-use stock of a society, is the driving force behind circular business models.

Most business models are linear, since most materials are extracted, used only once and then disposed of. This leads to degradation of natural capital through issues like climate change,[29] deteriorating urban air quality, water pollution and soil degradation. Numerous multinational and smaller companies are moving to a circular economy business model[30] to secure future access to resources and harness the unused and low-cost material potential in our economy.

READERS GUIDE

This report describes the current trends and developments, as well as ambitions of Almaty. An analysis of resource use, asset use and waste disposal by the city was discussed in a series of sector workshops, expert meetings and interviews to determine focus areas and identify promising circular economy strategies. The report is structured as follows.

1 CURRENT SITUATION, DEVELOPMENTS AND AMBITIONS

This part describes the current situation in in Almaty, and important trends into the future. It also highlights which policies and development ambitions of the city, and the national government, align well with a transition to a more circular city.

2 CIRCULAR ECONOMY OPPORTUNITIES

There are usually only a few activities which provide the physical materials and products which a city needs. Part 2 focusses on three material intensive cross-sections of economic activities in Almaty. It shows which resources they use, what products they produce and what happens with these products at the end of their lifetime. Data visualisation also helps comprehend how the use of products, materials and half fabricates relate to greenhouse gas emissions in Almaty and within the value chains that feed the city. No city starts from zero. Therefore part 2 highlights existing circular initiatives.

3 CIRCULAR ECONOMY STRATEGIES AND NEXT STEPS

The most promising circular opportunities have been identified in discussions with stakeholders in Almaty. These are described in part 3. The strategies were selected based on their material potential, their ability to avoid environmental impact and their connection with the trends, developments and ambitions described in part 1.

After publication of this report, the circular economy strategies can be put into practice with compelling pilot projects. The next steps can be to define a municipal circularity ambition, using the benchmark measurements in this report as basis. The circular economy strategies can help reconvening. stakeholders around the most promising opportunities. They can form a coalition of which can lead to actual implementation.

1 CURRENT SITUATION, DEVELOPMENTS AND AMBITIONS

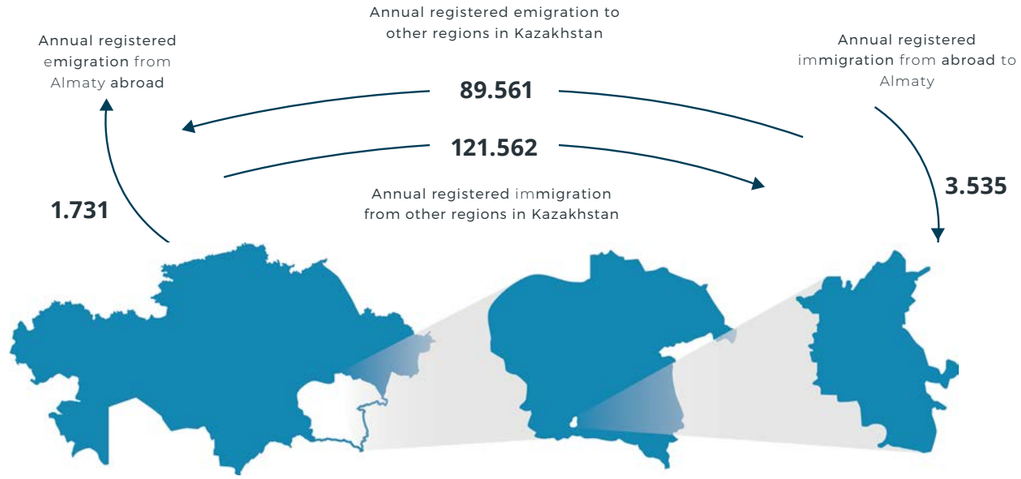
1.1 INTRODUCTION

Part 1 is an introduction to the political, socio-economic and environmental situation in Almaty. It sets priorities for the analysis in part 2 and recommendations in part 3. The environmental situation points at where material value is lost, in the form of emissions to air, water or soil. The socio-economic situation describes which sectors or economic activities are most important to Almaty in terms of added value and jobs. This first part also provides an overview of relevant trends and developments in infrastructure, import and export, demographics and land use.

1.1 ALMATY AT A GLANCE

Almaty is the largest city in Kazakhstan and in Central Asia it is second only to Tashkent. The city grew from around 100,000 inhabitants in 1940 to 1.9 million in 2017. The actual number of residents may be even higher, as many immigrants from rural areas and from abroad relocate without registering.[32] For Kazakhstan, there are estimates that the population of 18 million excludes 2 million unregistered migrant workers.[33]

The growth of the city is mainly due to urbanisation or the migration from other regions in Kazakhstan. This trend is likely to continue, since share of the population living in urban areas in Kazakhstan is around 25%. As comparison, this is below that of all OECD countries, except Slovak Republic.



KAZAKHSTAN

POPULATION
18 million

ESTIMATED UNREGISTERED MIGRANT WORKERS
2 million

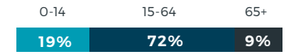
WORKFORCES
889,606

ALMATY AGGLOMERATE
2.9 million

ALMATY CITY
1.9 million

ANNUAL NET POPULATION GROWTH DUE TO MIGRATION
1.6%

COMPOSITION BY AGE



EMPLOYMENT PER SECTOR TYPE

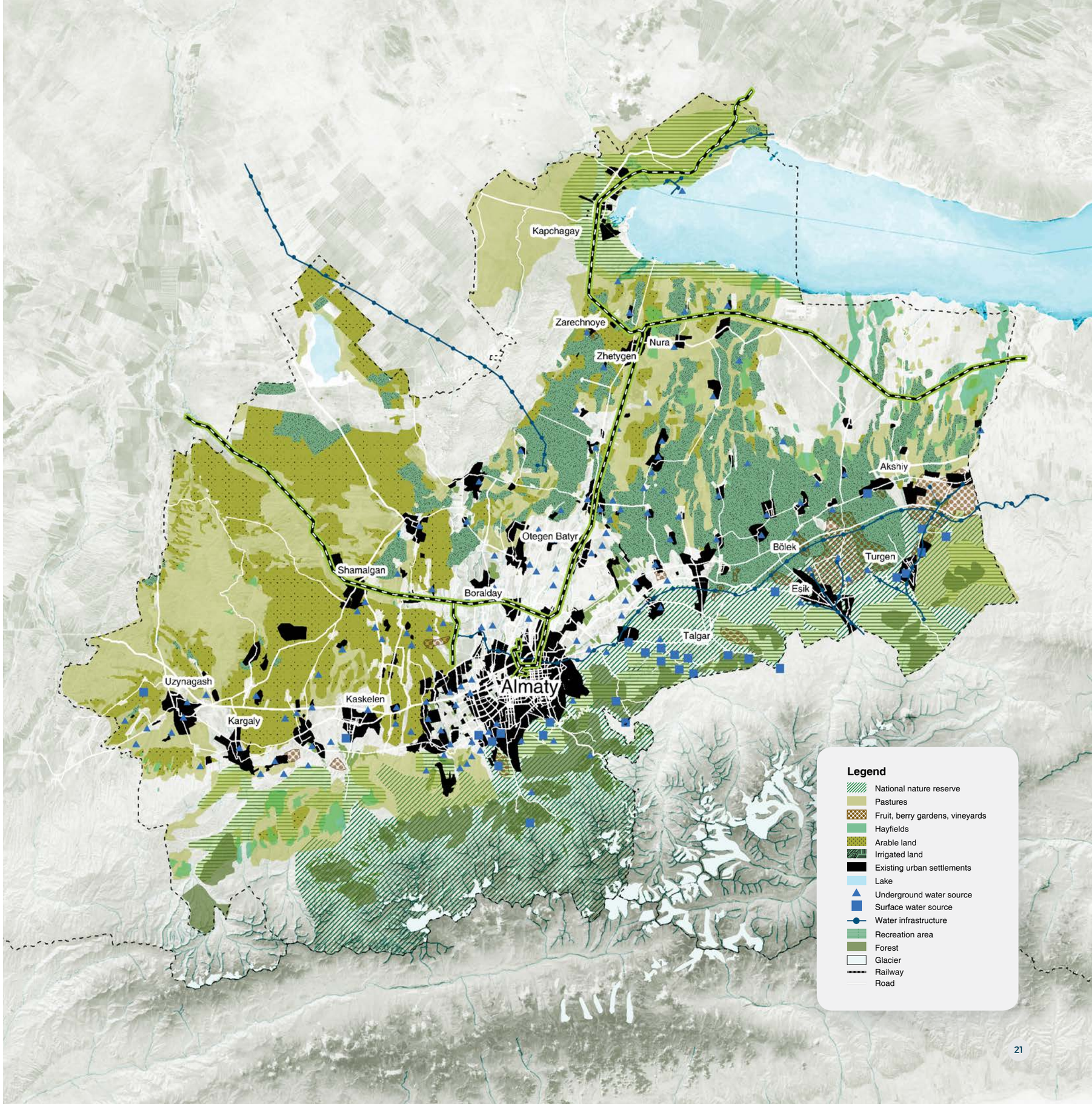
Resources used for this infographic [34]

1.2 SPATIAL CONTEXT

Almaty is the largest city in Kazakhstan, located in the southeast in a valley. The city has abundant fresh water, forests, natural reserves and recreational possibilities. The southern and eastern outskirts of the city border the Tien Shan mountain range. While the city is located at 700 to 900 metres above sea level, Pik Talgar, with its 4,979 metres, is only 30 kilometres away.

Glacier water gathers in the large and small Almatinka rivers which run through the city. They provide drinking and irrigation water and cool the city in summer, when temperatures can exceed 30 °C for several days in a row. The humid continental climate pushes temperatures down in winter to -8 °C.

Environmental pollution ranks first in the list of concerns by citizens or Almaty. While the mountains give the city its fascinating scenery, they also limit the airflow. Aggravated by the construction of high-rise buildings, air pollution from traffic and industry stays in the city,[35] which causes health issues.[36] The high share of non-communicable diseases in Kazakhstan, such as cardiovascular diseases, cancer and respiratory diseases could point at environmental aggravations or causes.[37] While in the past power and heat generation, and industry were the main sources of air, and even soil,[38] pollution, private car traffic has taken over as the main polluter.



Almaty city within the larger Almaty agglomerate [39]

1.4 SOCIAL-ECONOMIC AND ENVIRONMENTAL DATA PER SECTOR

The growth of the population of Almaty started during the Second World War, when the Soviet Union relocated workers and large industries to Kazakhstan, including the Almaty region. Some industries have moved out since then. What remainsed are light industries like food processing industries, textiles and furniture and heavy industries for construction materials and machinery.

Although the city handed over the national administration to the new capital Astana in 1997, Almaty managed to retain its relevance as financial and trading centre. Since the turn of the century it added new economic activity in machinery and, textiles, agriculture and food processing, glass and metals.[40] These are also the city's development priorities. Almaty prioritises high-tech manufacturing industries, agriculture, tourism, construction and pharmaceuticals for further development.[41]

These figures shows for each of the 14 more prominent sectors in Almaty how much they contribute to the Gross Regional Product employment. This is the left side of each graph. On the right side they show, how much resources each sector uses, waste it disposes and territorial C02 emissions emit.

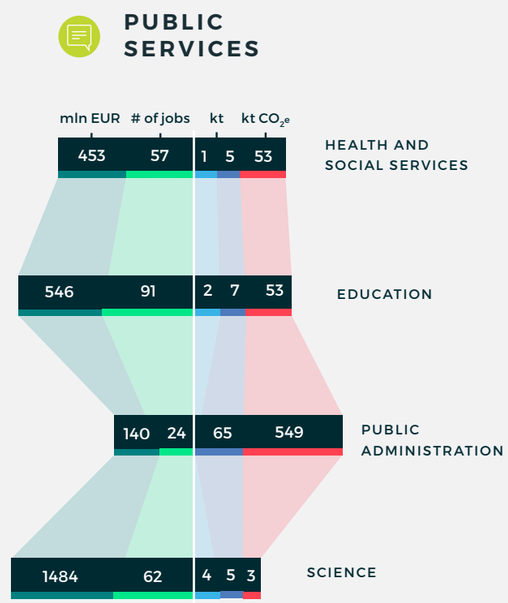
Public, commercial and financial services create most economic value in Almaty and provide most of the employment. The most important sector from a socio-economic perspective is trade and vehicle repair.

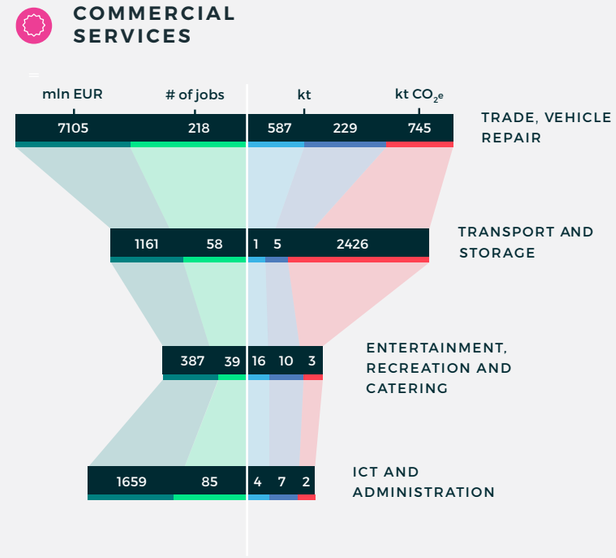
The industry, agriculture and resource extraction, utilities and construction sector have the largest environmental impact. The recycling industries are included in the industry sector, as well as the waste which yet remains unused. This way, the underused potential of collected household waste, or the potential of waste prevention, is attributed to the industry sector. The greenhouse gas emissions related to the use of residential buildings is allocated to the construction sector. Reducing the energy consumption of buildings is largely an issue of building design, renovation and the technologies and materials used in the construction sector.

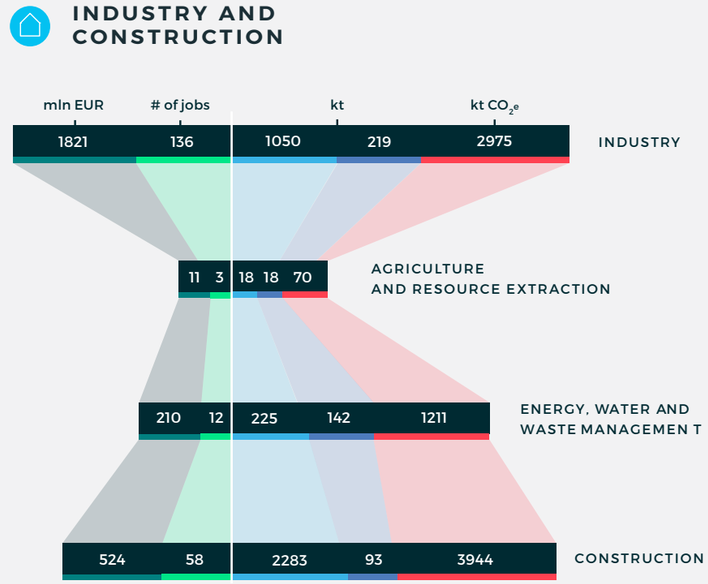
The largest volumes of greenhouse gas emissions in Almaty are from the industry and construction sectors. Industry is also the second largest employer in the city.

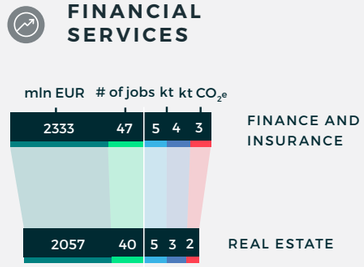
Resource use is largest in agriculture and resource extraction, industry and construction.[42]

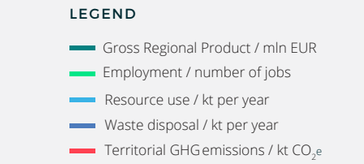
A circular economy can create new jobs in services, recycling, repair and remanufacturing.[43] Already now, 77% of jobs are in services. In a circular economy, that share can grow further.











Contribution of the 14 most prominent sectors in the city of Almaty to the gross regional product, employment resource use, waste disposal and territorial CO_2 emissions.[34]

1.5 TRENDS AND DEVELOPMENTS

Almaty is a highly dynamic city which experienced remarkable economic growth since 2000. The Gross Domestic Income per capita, which shows to what extend the economic growth benefitted the population,[44] increased from EUR 1,121 to EUR 10,755 between 2000 and 2013. In the period from 2006 to 2016 the country's middle class grew from 10% to 25%, while poverty rates dropped from 55% at the turn of the millennium, to 20%. The two main cities, Almaty and Astana have benefitted most from these national trends.[45]

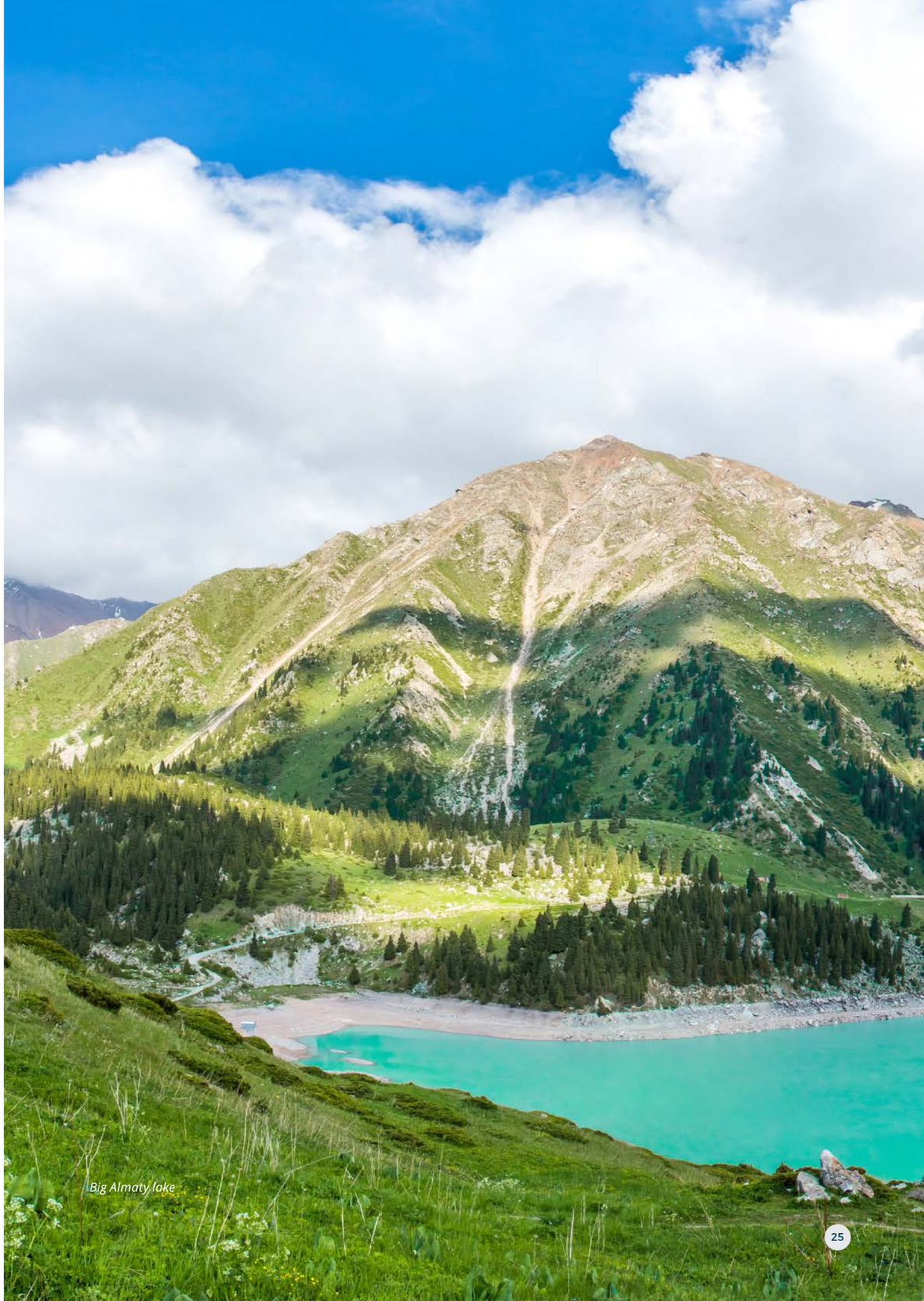
The growth is vulnerable to changes in international commodity prices. After 2013 the situation changed. Although the country withstood the 2008 financial crisis remarkably well, its Gross Domestic Income declined with 34% between 2013 and 2017,[46]revealing Kazakhstan's vulnerability to international commodity prices, notably oil. Still, the country outperformed its Central Asian peers and neighbouring China.[47]

Only when achieving more diversified growth, Kazakhstan will be able to sustain its inclusive growth model.[48] Since revenues from resource extraction strengthen the national currency, they raise the prices of other domestic products. This reduces their ability to compete on international markets. This issue is also referred to as 'Dutch disease'.

Slowing the rate of absorption of resource revenues can reduce the symptoms of Dutch disease. The Kazakhstan national welfare fund Samryk Kazyna[49] has a role to play there. Following the example of the Sovereign Wealth Fund in Norway it turns resource revenues into long-term investments. The government can draw down no more than the fund's expected annual returns.[50] Samryk Kazyna invests mainly in domestic assets and can, or perhaps should, play an important role in supporting the transition to a circular economy.[51]

Climate change is a growing concern. In Central Asia temperatures are rising faster than the global average, affecting agricultural output. This pushes the prices for basic commodities up and aggravates socio-economy disparities. Like in other places, it has also been referenced as underlying cause of social unrest in the region.[52]

Almaty is well integrated into international trade flows. Since neighbouring China is imposing bans on waste imports, also Kazakhstan is incentivised to process waste locally and develop its material potential. In 2017 China already banned the imports of 24 types of waste, like plastics and paper, extending the ban in 2018 with 16 new products and announcing further restrictions in future.[52]



Big Almaty lake

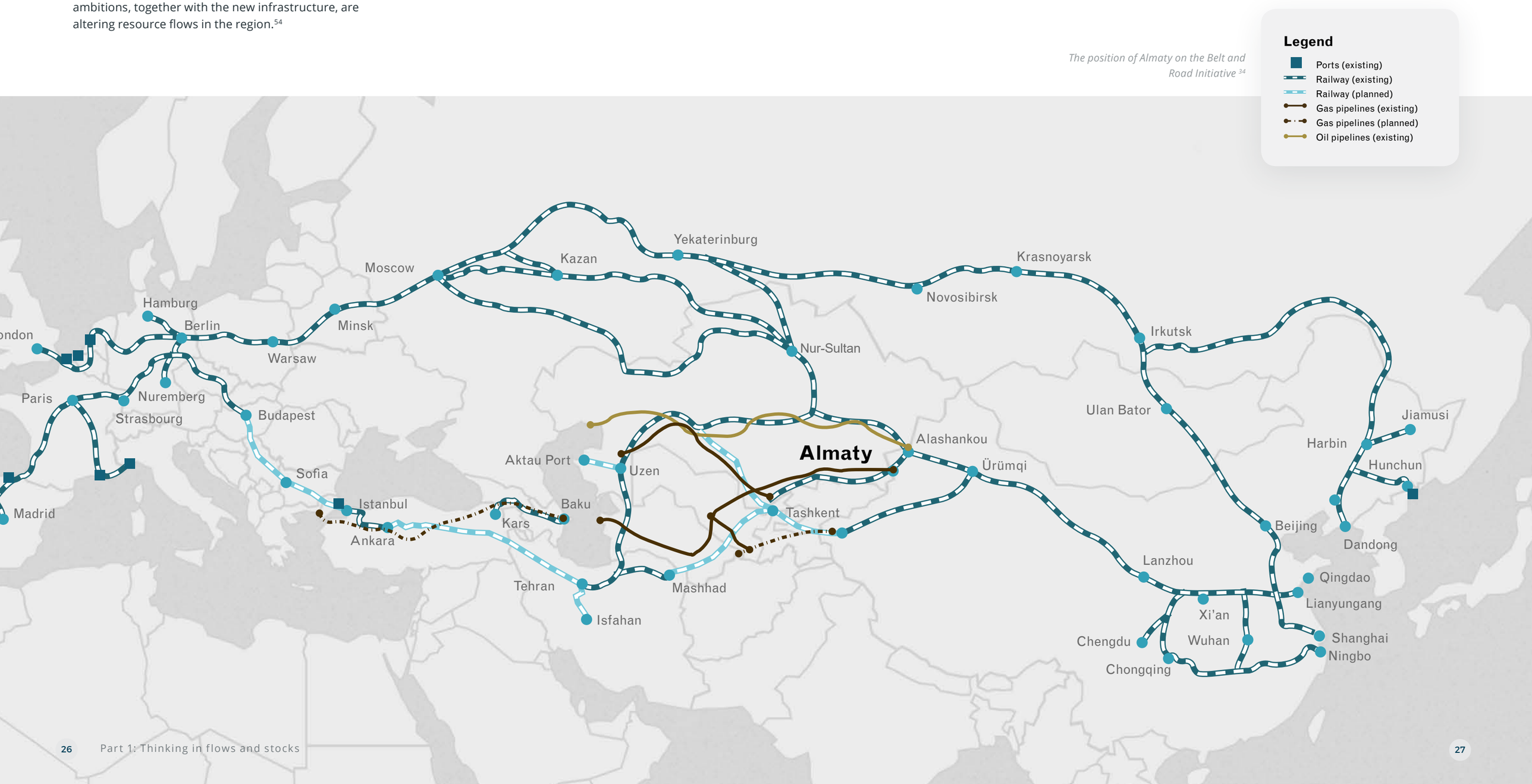
1.6 CENTRAL STATION ON THE BELT AND ROAD INITIATIVE

In 2013 the Chinese president Xi Jinping announced the Belt and Road Initiative, a EUR 889 billion investment in road,[53] train, pipeline, glass fibre cable infrastructure and ports. This 'New Silk Road' includes investments in about 60 countries and will connect China with the rest of the Eurasian mainland.

Almaty is an important station on the Belt and Road's cargo routes which connect China with Europe, two regions with high circular economy ambitions. These ambitions, together with the new infrastructure, are altering resource flows in the region.[54]

If Almaty pro-actively invests in circular products and services, it can use the circular ambitions of the European Union and China to accelerate its own green growth. Setting clear sustainability targets and criteria can also help avoid, that access to new markets becomes a new driver for the export of raw materials, prevents diversification of the economy and stimulates the growth of environmentally damaging extractive and linear industries.

The position of Almaty on the Belt and Road Initiative [34]



The improved connectivity of Kazakhstan with neighbouring countries eases the export of national products. There are concerns that China will use the new infrastructure to find markets for products where it has overcapacity, like steel, cement and aluminium. Kazakhstan should be careful not rely too heavily on China's production assets, but make sure that it builds up its own manufacturing and ancillary services around transit infrastructure.[54] Positioning Almaty as a Central Asian circular economy hub, can help ensure that the trains stop in this city.

The Belt and Road Initiative creates competitive challenges. Products from Kazakhstan should travel both in the direction of China and Europe, to avoid reliance on a single country as buyer of its commodities. For example, Chinas has already become the sole buyer of Turkmen gas. Next to this, China is planning to expand its mineral, energy, food and textiles industries, including the establishment of a cotton industry in Xinjiang. These are all sectors and products which are important to Central Asia.[54]

Chinese investments in Central Asia also consider hydropower, whereby China could use the large hydropower potential in the region, to cushion power shortages in Xinjiang, its western province. Water remains a sensitive topic for the region and China adds yet another interest into this resource. Kazakhstan has already expressed its concerns over the diversion of water from the Ili river, which contributes to drying up of Lake Balkash north of Almaty.[54]

Finally, the Belt and Road Initiative requires aligning policies to allow for an efficient flow of goods, fuels and data. This policy alignment is an opportunity to agree on standards, policies and cross-border procedures which support, for example, the reverse logistics which are required for reuse, remanufacturing and recycling.[55]

Railroads in Kazakhstan

1.8 POLITICAL AND PUBLIC AGENDA

Kazakhstan has adopted an ambitious green growth strategy which could benefit from incorporating circular economy strategies and international circular policy experience. National policies can be instrumental in the transition to a circular economy, by stimulating or demanding resource efficiency through an adjusted tax regime, extending the responsibility of producers and facilitating the types of cooperation which a circular economy requires.[56]

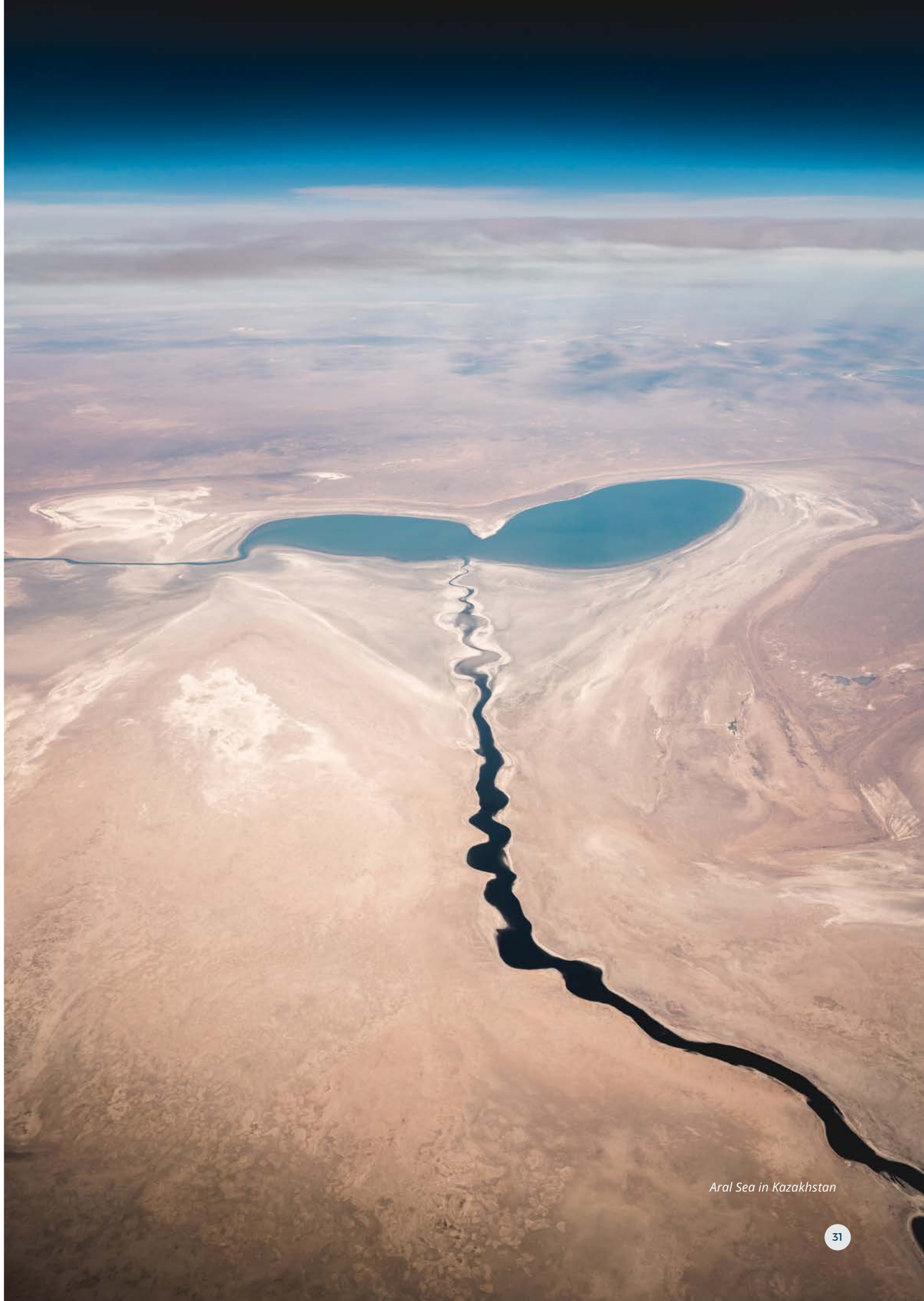
Almaty hosts a population with a growing commitment and movement to make Almaty an even more attractive city to live in.[57] The city is challenged by environmental issues, of which air quality, waste management and water scarcity are the most pressing. In response, it launched an open consultation process to continuously refine its development ambitions for 2020 (called 'Almaty 2020').[58] 'Almaty 2020', defines the main task of the city to stay one of the main drivers of economic growth in Kazakhstan. Other important topics on the agenda are to improve the general ecologic situation of the city, solve parking issues and fight corruption.

In the period from 2011 to 2018, the city administration responded to growing concerns over air quality with reforming the transport system. It completed and opened the first metro line, whose construction has started in 1988, it reduced speed limits and replaced the numerous taxi vans with a coordinated Bus Rapid Transit system, with busses running on compressed natural gas. It also introduced the first bike lanes and cleared the way for pedestrians.[59] This has inspired a modal shift away from private cars and taxis to public and non-motorised transport,[60] moving towards a low-carbon transport system.[61]

The national government supports Almaty region with its ambitious green growth plans.[62] Green growth is one of the pillars of the Kazakhstan 2050 strategy to become one of the 30 most developed countries in the world.[63] [64]

Scientific institutes from Almaty support environmental policy development and evaluation. An example of successful government intervention is the decimated Aral lake. This lake had reduced 10-fold in size due to the irrigation of cotton fields from rivers that feed it, eventually exposing 40,000 square kilometres of saline seabed.[65] The use of persistent pesticides grossly exceeded averages in other countries.[66] In result, the exposed soils were also contaminated.

Investments in curbing environmental degradation and restoring some of the wildlife in and around the Aral lake have paid off.[67] The construction of the Kokaral dam, raise water levels with 3.3 metres, brought salinity down from 30 to 8 grams per litre and increased fishing catch from 1,300 tons in 2006 to over 8,000 tons in 2018. The project was supported with scientific research from Almaty and co-funded by the World Bank.[68]



Aral Sea in Kazakhstan

2 CIRCULAR ECONOMY OPPORTUNITIES

2.1 INTRODUCTION

Part 1 showed that food value chains, construction and industrial processing are the economic activities with most material throughput. These are the focus of a deeper analysis of material use in the city of Almaty in this part 2. For the food value chains, or agriculture and food processing, the analysis considers materials which are consumed in the city. For construction the focus is on materials which are used to expand and improve the city and for industry, the focus is on all materials which are processed in the city. The analysis for industry includes products or semi-finished products which are produced in Almaty and then exported.

The three cross-sections of activities in Almaty are not mutually exclusive, since industry includes the production of construction materials and food processing. Rather they are three different angles to economic activities in the city.

Part 2 ends with an assessment of circular economy opportunities in other sectors which are less material intensive. These sectors are important through their role in facilitating circular business models

2.2 MAPPING OUT RESOURCE FLOWS

The materials which are included in the Material Flow Analysis are biomass, minerals, metals, fossil fuels, greenhouse gas emissions and water. The flows have been quantified with statistical data from the statistics bureaus of the national government and Almaty municipality. Data has been collected on extraction, import, processing and production, consumption, construction, waste management and exports.

Data gaps were filled with other statistical sources, academic and grey literature. By connecting the flows at product level and breaking them down into different resource types, they can be traced from their origin to their final destination. Since the aggregated mass of all materials should be maintained during the different conversions, comparing the flow totals in each part of the value chain allowed for cross-checking.

Six types of materials are distinguished

Fossil fuels are the gas, liquid and solid fuels, notably gas, coal and gasoline. These fuels are used primarily in the transport sector and for the generation of heat and electricity.

Biomass flows include food products, from vegetable and animal origin and the wood, rubber and paper which is used to make products like furniture, construction materials, window frames and packaging.

Water flows include the rivers and rainwater which flow through the city, part of which is cleaned and used as drinking or irrigation water and discharged downstream.

Minerals are mostly mineral construction materials, such as cement, tiles and bricks. It also includes oil-based products like chemicals, fertilisers and the bitumen used in road construction.

Metals include raw and processed metals and products thereof, varying from iron plates, copper wiring to vehicles, machinery and metal building structures.

Emissions are greenhouse gas emissions, the majority of which is carbon dioxide or CO_2 following by methane or CH4

Two sources of material are distinguished.

Import refers to materials and products which are imported into the city. These originate from wells, quarries, mines or fields outside the city boundaries. In the case of agricultural production, import is from locations outside the boundaries of Almaty province.

Extraction refers to the production of technical resources through extraction with mines, wells, or with forestry or agriculture. When these activities take place within Almaty province, they fall under extraction.

Next to mapping out which materials are used, a Material Flow Analysis also shows what happens with waste or products after their use.

Landfill is where secondary resources or waste is diverted to a landfill site. Due to the mixing of resources and their degradation over time, a lot of the value is lost. In addition, organic material that is landfilled decays under anaerobic conditions, which leads to methane emissions. Methane is a potent greenhouse gas.

Waste water treatment is the processing of waste water to remove pollutants. This typically involves removing suspended solids and organic materials.

Discharge is where the treated waste water, but also river water which passes through the city is discharged into surface water.

Digestion refers to the part of the organic material or food which is used by organisms in the city as a source of water, energy, protein or minerals. This is partly discharged through the sewage system, but some mass can not be traced back in flows leaving the city.

Recycling refers to the waste which is recovered for processed and the reuse of materials. Throughout the recycling process, value is lost which was embedded in the original product, rendering recycling a suboptimal waste treatment method although better than landfilling.

Finally, also the greenhouse gas emissions are quantified. Four types are distinguished.

Territorial greenhouse gas emissions are the emissions which occur in Almaty. These stem from the combustion of fossil fuels or anaerobic digestion of organic materials.

Embedded greenhouse gas emissions are emissions which took place outside the city, during the production of goods and materials which are imported.[69] Where these goods and materials are exported again, these emissions are referred to as **Exported greenhouse gas emissions**. If these imported goods and materials are consumed in Almaty, they can be attributed to the consumption-based emissions of the city. These are labelled **Upstream greenhouse gas emissions.**

2.3 RESOURCES FLOWING IN AND OUT

Input

Every year, the city of Almaty uses 11 million tonnes of biomass, minerals, metals and fossil fuels. This includes all materials which are imported into the city, and the agricultural production and extraction of fuels in the Almaty region. Import represents around 63% of all materials consumed, which are mostly fossil fuels.

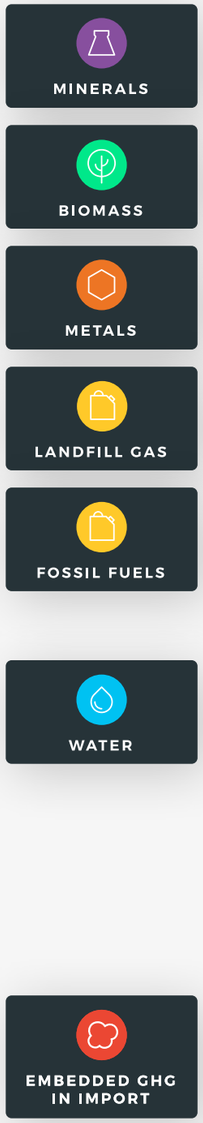
What is imported into the city ranges from raw materials, to semi-finished and final products. All the effort and energy that goes into making the products that are transported to Almaty, represents a significant environmental footprint. Looking at the greenhouse gas emissions alone, 17 million tonnes of CO_2 emissions take place when making these products and materials. These are referred to as 'upstream' emissions or emissions which are embedded in the products and material which are imported into the city.

Half of the 17 million tonnes of CO_2 equivalents embedded emission is related to products which are consumed in Almaty. The remainder is related to products which may undergo processing but are then exported and consumed elsewhere.

Next to the material inputs, around 8.6 million m3 of water flows into the city. This originates from the mountains and mostly flows directly through the city via the three rivers. Only a small fraction of 225,000 m3 is diverted to produce drinking water.

With 30%, water is another large flow. This is mostly from rivers running through. The remainder are fossil fuels with 19%, which is in size comparable to the 20% of biomass, minerals and metals used in Almaty annually.

When comparing the sheer sizes of the different flows, 47% are upstream emissions related to imported products. When only including products which are consumed in Almaty, this share goes down to 8.6 million tonnes of CO_2 equivalents, or 31% of total resource use attributed to the city. This figure seems large, but it confirms a finding in the 2019 Global Emissions Gap report, which states that 44% of global greenhouse gas emissions are related to the extraction and primary processing of materials. The remainder comes from the production, assembly, delivery, usage and eventual disposal.[70] Since Almaty has only few heavy industries, the emissions during extraction and processing take place elsewhere.



output

From the output of materials, around 113,000 tonnes are recycled. The remainder is landfilled or digested. The digested fraction includes, for example, the moisture fraction in food and beverages, which can not fully be traced back in measured output flows. The recycled fraction is mostly paper,[71] metals, [72] glass,[73] and plastics.[74] Most of this is recycled in Almaty region.

Out of all resources consumed in Almaty, 1.7 million tonnes is added to the total product and building stock in the city. This stays there for long term use. It enables physical growth of the city and increases the material wealth of its population. The 1.7 million tonnes is a relatively large share. It confirms that Almaty is rowing both in economic and spatial terms.

The 5.4 million tonnes of fossil fuels flowing into the city, create 11 million tonnes of territorial CO_2 emissions during their combustion. The water vapour released during combustion is ignored in this overview. Together with the methane emissions from the landfill, total territorial greenhouse gas emissions are 12 million tonnes of CO_2 equivalents. To put the 12 million tonnes into perspective; this is 1.5 times more than the amount of water flowing through.

Out of the 17 million tonnes of CO_2 equivalents which are embedded in imports, 50% leave the city again through export. These emissions can be attributed to end-users in other locations. The remaining 8.6 million tonnes of CO_2 equivalents can be attributed to consumption in Almaty.

In result, the total greenhouse gas emissions are a combination of 12 million tonnes of CO_2e emissions from Almaty territory and 8.6 million tonnes of CO_2e in upstream emissions.

2.4 RESOURCE USE

This full overview of material use in Almaty shows what happens within the city with all materials used annually. When reading it from left to right, and starting at the top left, it shows that the majority of biomass, minerals and metals is processed before they are either consumed or exported. The amount of resources which are eventually consumed in Almaty is roughly the same amount as what leaves the city again as exported products.

Further down, the yellow lines show that fossil fuels are not processed. They are imported and directly consumed, or rather combusted, to deliver heat, energy and propel vehicles to provide mobility. Water is also hardly processed and most of it simply flows through.

The red flows at the lower section of the graph show the embedded gas emissions in imported goods and materials. These are related to the mining and processing of all biomass, metals, minerals and fossil fuels which are imported into the city. The graph also indicates which of these embedded emissions is related to materials which are processed in Almaty, and subsequently, further to the right, which are eventually consumed in the city or exported to end-users elsewhere.

This shows that the carbon footprint of all resource consumption in Almaty stems for 58% from the combustion of fossil fuels in the city. The remaining 42% is from the use of products and materials in the city which emitted greenhouse gas during their production elsewhere. Circular economy strategies target this 42% which climate policies tend to leave untouched.

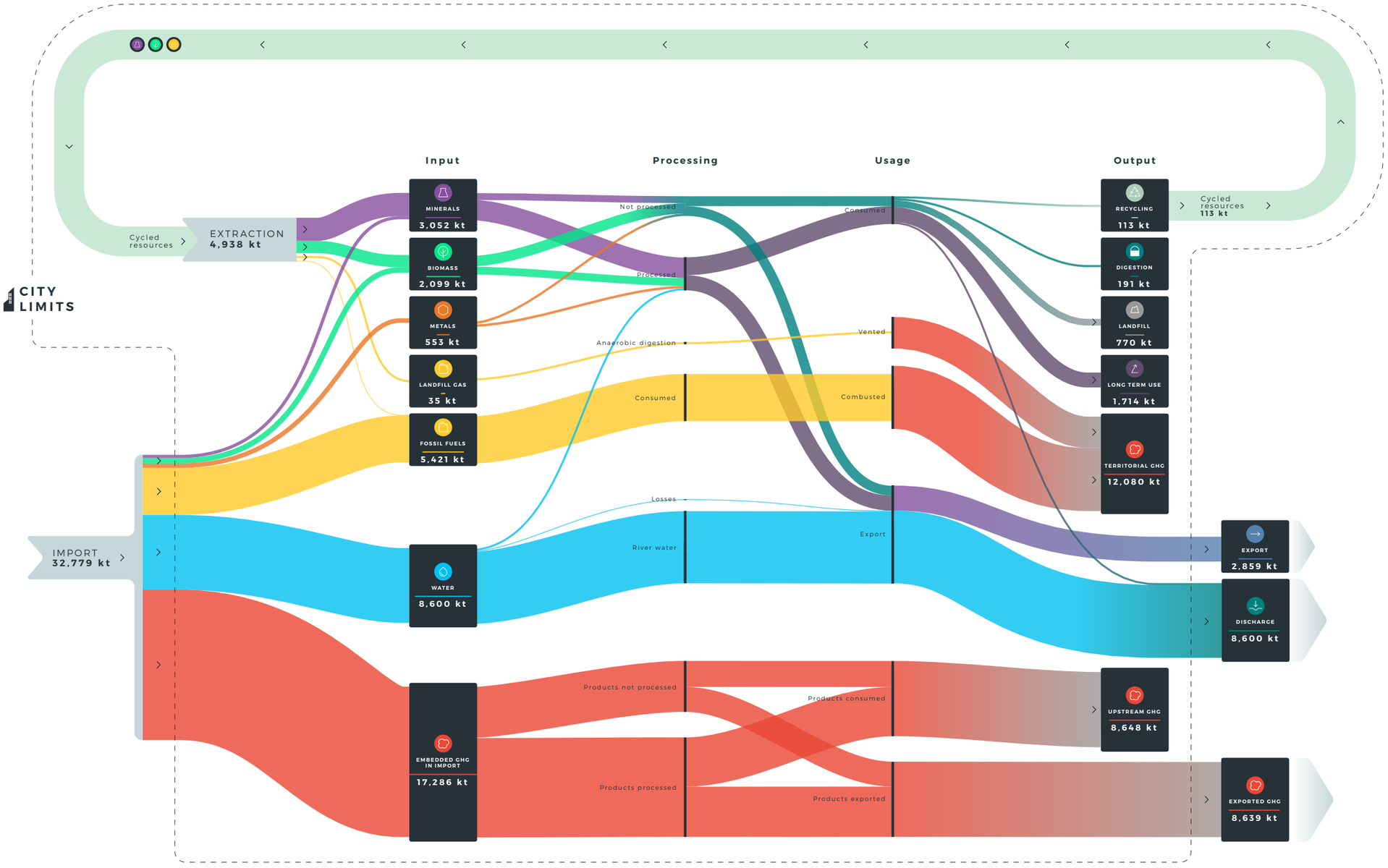


Diagram showing resource import, extraction, usage and final destination across all sectors in Almaty.[34]

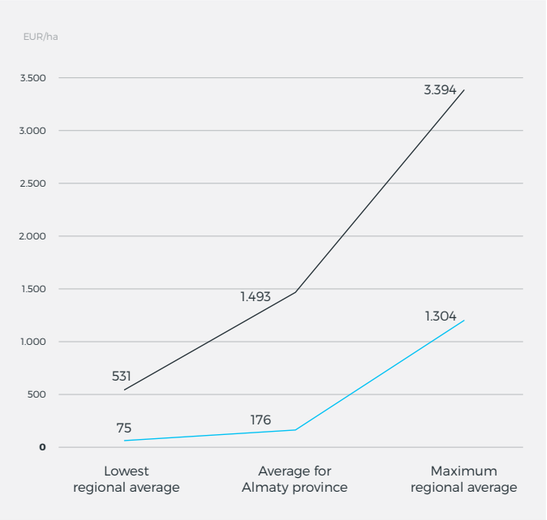
2.5 AGRICULTURE AND FOOD PROCESSING

Kazakhstan is a net importer of food products when expressed in monetary value. The country, including the Almaty region, is striving to increase agricultural production with 50% and substitute imports to help Kazakhstan become 80% self-sufficient by 2020.[75] Since some of the food is imported from countries as far as Poland, Israel and the Netherlands. Import substitution will reduce the transport related carbon footprint of food consumption in the country.

Kazakhstan is investing in organic food production. It developed its own organic production labels to increase value. Estimates of the amount of arable land which can be considered organic vary between 13.6 million and 303,381 hectares.[76] The difference may come from the extent to which the data includes the large area of pastures, which can be used for cattle, sheep and horse breeding. The production of organic products is about 300 thousand tons, of which 62 thousand tons is exported, mostly to the European Union, Russia and Ukraine.[77] [78]

Almaty oblast or province has 8.6 million hectares of agricultural land, of which 1.0 million arable, and the remainder pastures. Out of the arable land 0.4 million hectares are irrigated, including 86 hectares of greenhouses.[79] The frost-free period varies between 195 and 265 days in the south of Kazakhstan. This limits the cropping period to a single season, from March to October.[80]

RETURNS PER HECTARE (EUR/HA)

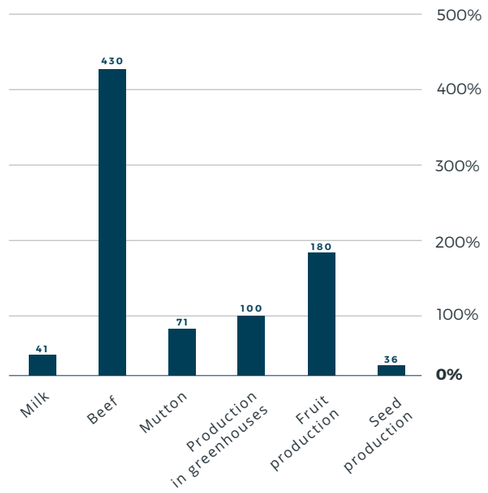


Source returns per hectare (EUR/HA)[34]

The returns per hectare vary substantially between the different regions in Almaty province. This points at differences in conditions and actual land use, but also at potential for improving yields considerably.

The value of agricultural production from Almaty province increased from EUR 1,120 million to EUR 1,510 million in the four years preceding 2017. Growth ambitions are high, both in agricultural production and processing capacity. When realised, they will tip the balance for Almaty from being a net importer, to becoming a net exporter of food in just a few years. To achieve this growth, Almaty province is expanding the land surface under cultivation, investing in agricultural technologies and processing capacity and attracting foreign investors. Already in 2017, around 33% of the value created by industries in Almaty was from food processing.

PLANNED GROWTH IN ANNUAL OUTPUT (TONNE/YEAR) FROM 2017-2027



Source planned growth in annual output (tonne/year) from 2017-2027[81] [82]

Conventional, intensive agricultural production in the past has had significant adverse environmental impacts. Currently an estimated 75% of the territory of Kazakhstan suffers from degradation and desertification, 33% from salination[83] and over 14% of pastures can no longer be used. In the Almaty region, an estimated 800,000 hectares suffer from soil erosion.[84]

Agriculture in Kazakhstan.

2.6 AGRICULTURE AND FOOD PROCESSING: RESOURCES FLOWING IN AND OUT

Input

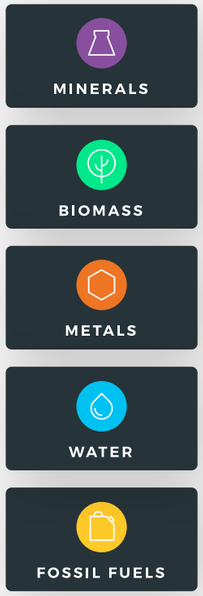
Resource use in food consumption, includes its packaging.[85] An estimated 644,000 tonnes of food is accompanied by around 221,000 tonnes of packaging along the value chain.

The biomass includes packaging from regenerative sources like paper and carboard, while the remainder are food and beverages.

The metals include aluminium and steel cans, and the mineral input includes packaging made of plastic and glass.

Around 225,000 tonnes of drinking water are extracted from sources in the mountains and wells in the city.

Finally, the historic disposal of organic material in the landfill creates decay under anaerobic conditions. This makes the landfills in Almaty a source of methane. This an interesting energy source, which is not used yet.



output

The first output is the 225,000 tonnes of water which is discharged. This is water which is collected in the sewage system. The treatment of sewage water in a waste water treatment plant produces around 48,000 tonnes of sludge. This is fertile material but can be polluted with heavy metals and medicines. In Almaty this sludge is landfilled.

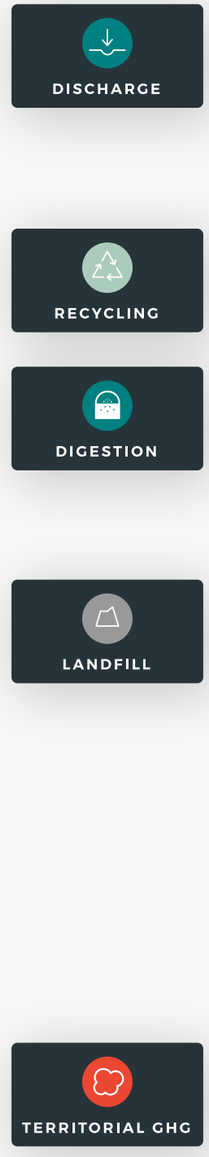
Around 73,000 tonnes of packaging waste is recycled. This is mostly from paper which is used as packaging material. The remainder is from recycled metals, glass and plastics.

Part of the organic material or food is used by organisms, mostly the human population, in the city as a source of water, energy, protein or minerals. This is partly discharged through the sewage system, but some of the mass can not be traced back in flows leaving the city. This is marked as 191,000 tonnes which is digested.

Most of the organic waste, around 600,000 tonne per year, is disposed of in landfills. This entails the loss of valuable nutrients and organic material. Where the organic waste is from imported goods, companies are by law prohibited to use the waste for beneficial purposes. In result, waste from coffee or chocolate production whereby the beans have a foreign origin, is landfilled.

The disposal of organic waste is a source of methane emissions and creates odour nuisance. The methane emissions from landfills in Almaty are estimated to amount to 35,000 tonnes. Since methane is a potent greenhouse gas, this equals 879,000 tonnes CO_2 equivalents.

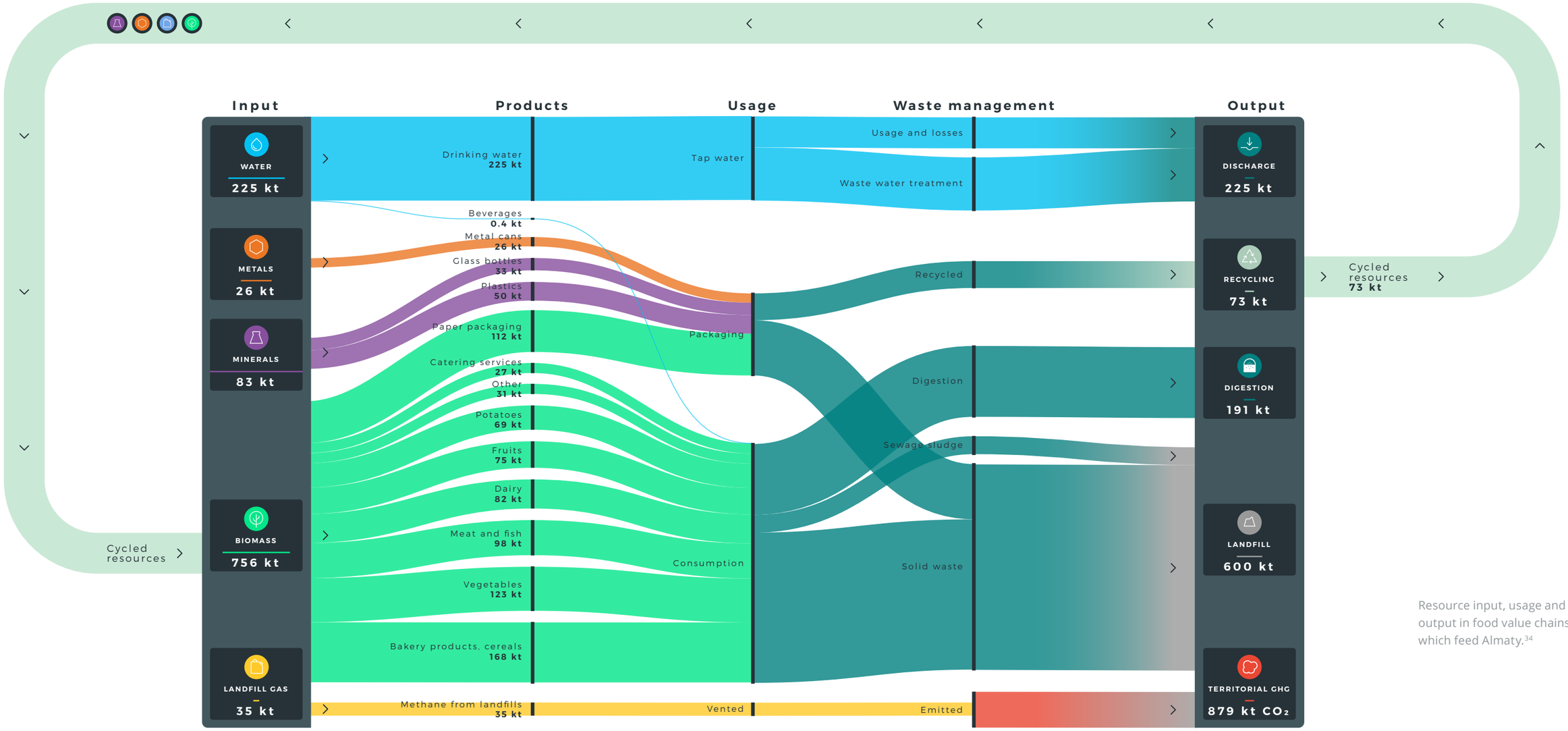
Agricultural and food processing industries produce large volumes of organic waste, like manure from chicken farms, vegetables and fruit from packaging industries and markets, waste from chocolate production. The actual volume is unclear, and each company manages its own waste. Just the nine companies which attended the project workshops already produce 90,000 tonnes of organic residues per year.



2.7 AGRICULTURE AND FOOD PROCESSING: RESOURCE USE

This graph shows all resources used to provide nutrition to residents of Almaty. Organic residues are hardly used, although they are a valuable source of nutrients.

Next to this, Almaty uses significant amounts of packaging material, of which a growing share is recycled.



Resource input, usage and output in food value chains which feed Almaty.[34]

2.8 AGRICULTURE AND FOOD PROCESSING: CURRENT INITIATIVES

Existing initiatives in Almaty region focus on the promotion of clean and organic agricultural production and improving the connection between the city and its surrounding agricultural areas. Almaty is also seeing first initiatives to use organic residues to produce agricultural commodities which were previously imported.

Sustainable dairy value chain

Amiran is a sustainable dairy brand from the village of Shymbulak, just a few kilometres outside Almaty. It developed a fully organic value chain and a product without preservatives. The company has 1870 hectares of land and produces 8.6 million litres of milk. It originates from the scientific Academy of Nutrition.

Stores with organic food

Quan produces its own organic fruit and vegetables in Almaty region[86] and was part of a temporary project to test the market for organic products.

Mushrooms on organic residues

Mushrooms are typically imported to Almaty but the first companies are setting up their own production, substituting expensive imports. KazEcoFood LLC installed its own composting installation[87] to produce 500 tonne champignons, per year.[88] The company Agaricus composts chicken manure and straw for mushroom production.

Inspiring organic production

Arba Eco Ayul[90] was a temporary initiative in Karakemer, east of Almaty, to stimulate organic production. Volunteers were invited to support the production of organic vegetables and fruit. Once the project successfully inspired other initiatives, it was terminated.

Reforestation

The Assartogai project[91] is a reforestation project on 70 hectares of degraded land. Next to planting trees, the area will have a nursery to support other reforestation activities in the region.

Permaculture: apple orchards

Rais Baksha has been founded by Arsen Rysdauletov, which established an organic apple orchyard east of Almaty. Margulan Seisembaev is yet another entrepreneur which set up an 80-hectare organic orchard, 70 kilometres east of Almaty. It produces cherries, apricots, peaches, nectarines, plums, grapes and strawberries.[92]

Drones and precision agriculture

Flyworx[93] provides drones to map out agricultural land and assess its quality. This supports precision agriculture, whereby agricultural inputs for soil quality, nutrients or weed and pest control are applied only where needed. This reduces the input, while increasing yields and retaining soil quality.

Organic wine

Arba Wine[94] is a 200 hectares vineyard near Almaty, where organic wine is produced. The company has been set up by a former Minister of Finance. They also organise 'agro tours' to the wine yards and wine production facilities to showcase their organic ambitions.

Paper from hemp

Paper is imported in Kazakhstan. The country supported a pilot to produce hemp near Almaty, whose fibres could be used to produce domestic paper.[95] KazHemp currently produces 6,000 tons of fibres,[96] and is targeting textiles as a future purpose.[97] Hemp can also be used as an alternative construction material.[98]

2.9 CONSTRUCTION

Almaty is expanding. The overall floor surface is growing with 3% per year, or 2 million square metres. The growth is driven by migration from rural areas in Kazakhstan, migration from other countries and by a gradual growth of the average residential space per person. Seeing the pace of growth, some citizens are concerned over the quality of new buildings,[99] including their ability to resist earthquakes.[100]

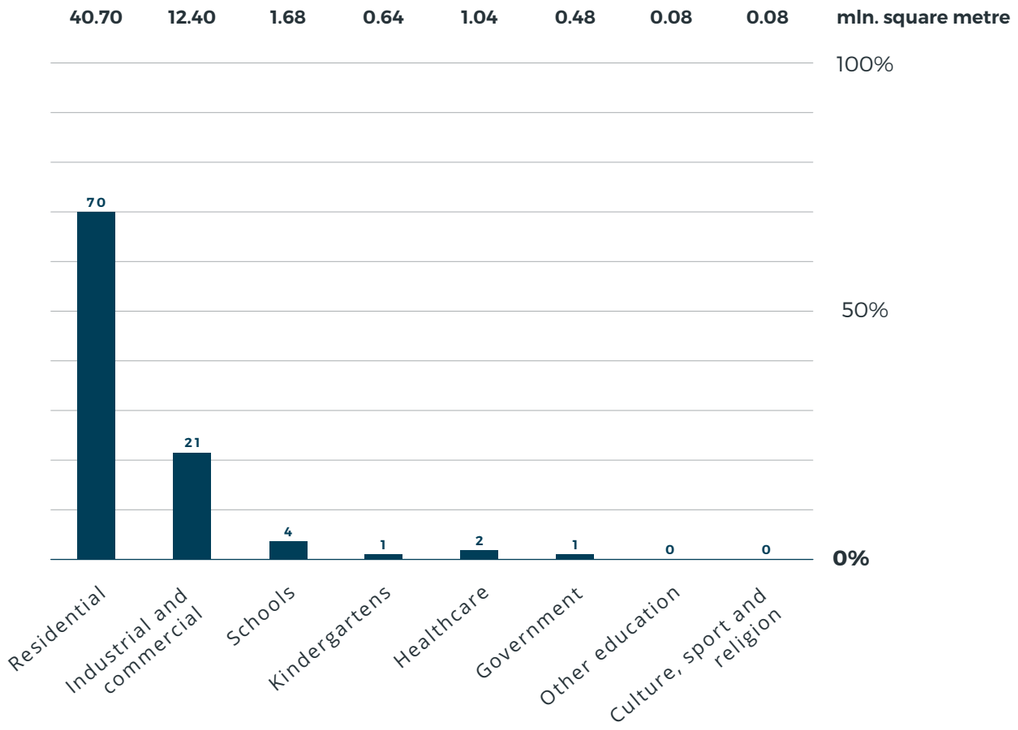
The plans for the development of the Almaty agglomeration until 2050 include the establishment of additional extractive and light industries to produce construction materials. The plans foresee the production of construction materials, energy efficient building panels and windows near Almaty, while obtaining cement and stone materials from neighbouring Zhambyl province.[101]

Real estate prices are rising in Almaty. Recent increases in prices have pushed many houses out of reach for middle income budgets. With 97% Kazakhstan has one of the highest home ownership rates in the world, even though this statistic may not include informal or unregistered renting. Urban development is dominated by low-density, relatively uncoordinated growth and conversion of agricultural land into residential areas.[102] Through its masterplan, the municipality aims to get a better grip onto the growth of the city.

Almaty inherited a district heating system which distributes heat from cogeneration plants, where the residual heat from power generation is used to heat the city. The city is investing in the replacement of the district heating pipes, as well as the thermal efficiency of the housing stock. Still, around 64% of the water and sanitation network needs repair or replacement.

Almaty municipality plans to demolish around 500 houses in the 5 years after 2019. Most of these houses are two floor houses from the years between 1950 and 1960. The buildings should make way for high-rise buildings. The plans are facing opposition from citizens and experts, expressing concerns over the loss of cultural heritage.[103]

TOTAL FLOOR SURFACE BREAKDOWN



Source total floor surface breakdown[34]

Construction in Kazakhstan.

2.10 CONSTRUCTION: RESOURCES FLOWING IN AND OUT

Input

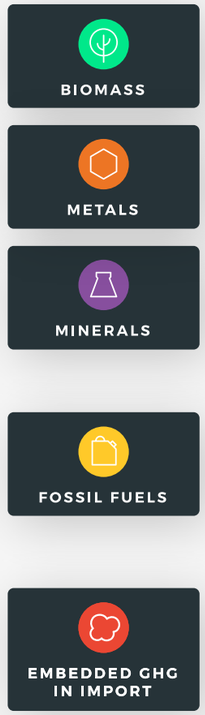
In the construction of new buildings and infrastructure Almaty uses around 286,000 tonnes of biomass, mostly wood, 80,000 tonnes of metals and 1,456 tonnes of minerals. The minerals are mostly concrete. The share of biomass is relatively high.

The construction minerals are extracted from Almaty region or imported from other regions like nearby Zhambyl province. The total extraction of sand, gravel and other rock materials in Almaty province is estimated at 37 million tonnes. The 1.5 million tonnes which is used to expand the actual city of Almaty is only a small part of this. The remainder is probably used for infrastructure in the province.

Heating buildings is consuming 39% of all fossil fuels entering the city. Around three quarter of this is coal. The remainder is gas. A very small part of the fossil fuels is used in road construction for its material, rather than calorific qualities.

Some of the wood waste from construction and industry, including old pallets, are used in the lower parts of the city for building heating. The combustion of wood, including impregnated wood, is contributing to air pollution.[104] The actual amount of wood residues which is combusted for heating is unknown.

Around 6.3 million tonnes of CO_2¬ emissions are embedded in imported construction materials which are used to grow the city. That is 73% of all embedded emissions associated with the consumption or use of imported goods and materials in Almaty.

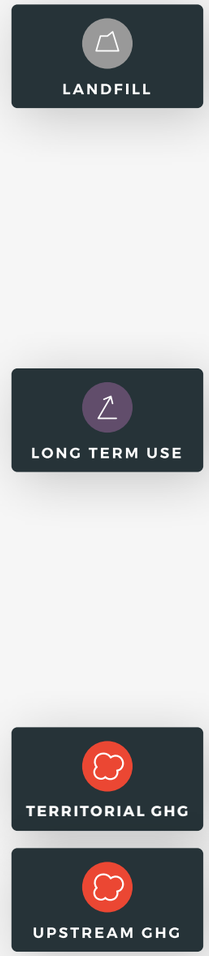


output

An estimated 79,000 tonnes of construction material are landfilled, but the actual quantity of waste from the construction sector is uncertain. There is relatively little demolition taking place and recent demolition plans face public and political opposition.[105] Where demolition does take place, or where renovation of apartments creates waste, this is often disposed of by small waste collection companies or used locally as filler to level the terrain. Most of these activities proceed unregistered. There is no data which points at the recycling, or even downcycling of construction materials.

The most important material result of all construction activities in the city is expansion or ‘long term use’. This is over 1.7 million tonnes per year, and consists of minerals, biomass, metals and some fuels. These construction materials are typically stored in new buildings and infrastructure for decades. As a growing city, Almaty has a relatively large share of new construction. This also explains why there is relatively little demolition taking place. Around 88% of the turnover is in the construction of new buildings, 6% in renovation, 6% in maintenance and less than 0.1% in demolition.

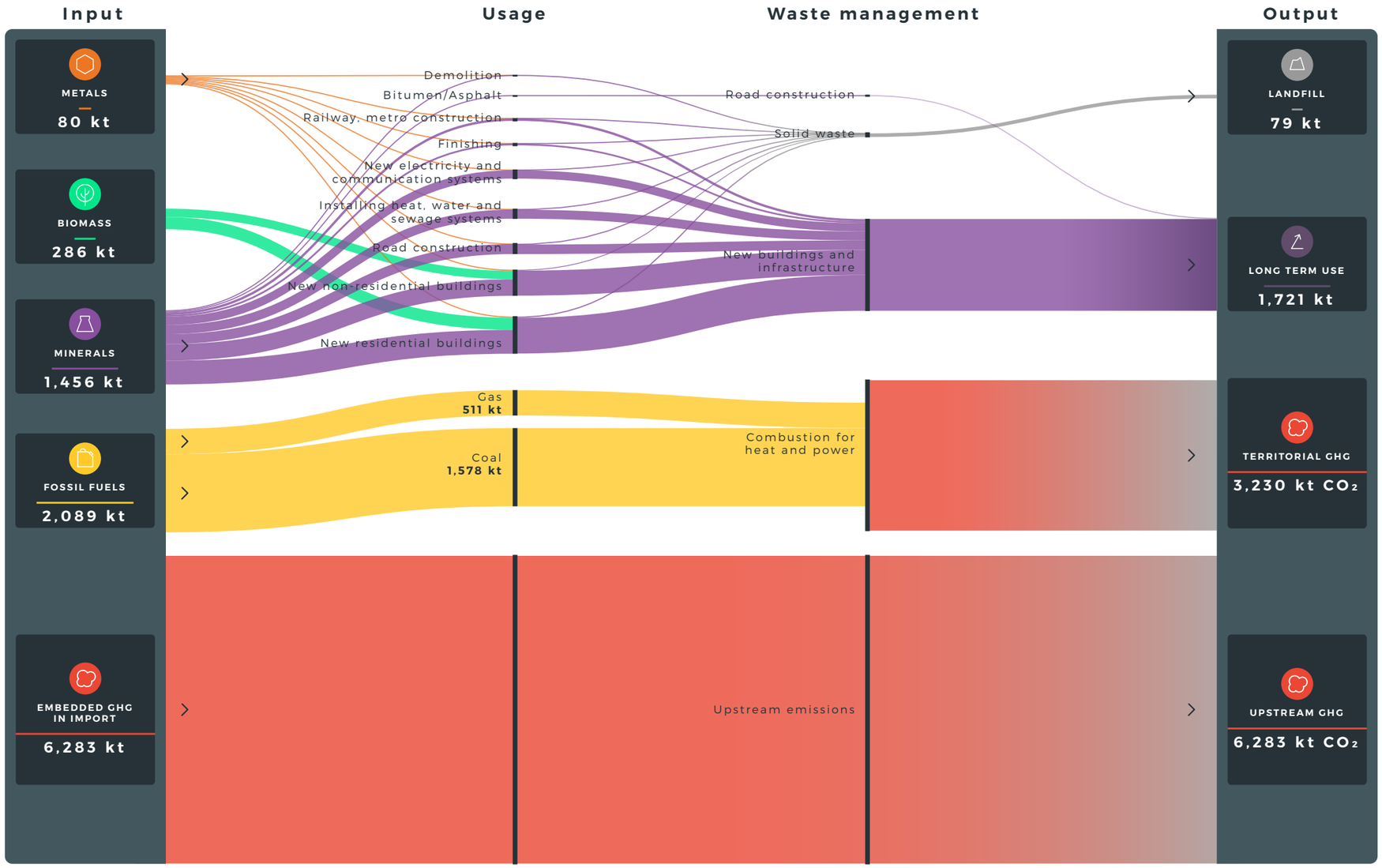
The heating of buildings is responsible for 3.2 million tonnes of CO_2 emissions per year. The design of new buildings could lock in the large amount of energy used in the city for building heating and power. Taking this reasoning even further, the urban planning of the city also defines future transport distances which people need to cover from home to work, family or leisure. This directly affects the fuel use in the city and the quality of its air. Which people need to cover from home to work, family or leisure. This directly affects the fuel use in the city and the quality of its air.



2.11 CONSTRUCTION: RESOURCE USE

The material flows in the construction sector show that 33% of the stock addition is in the construction of residential buildings. 23% is non-residential buildings and the remaining 44% goes into new transport, communication and heat, water and sewage infrastructure.

A small fraction of the fossil fuels used in the construction sector fulfils a material function. This is the bitumen which is used for asphalt. The remainder goes into the combined heat and power stations and the booster stations in the district heating system.



Resource input, usage and output in the construction sector of Almaty.[34]

2.12 CONSTRUCTION: CURRENT INITIATIVES

The construction sector hosts several inspiring initiatives to support sustainable construction, engage citizens in major decisions on the future design and lay-out of their city and to showcase the use of waste materials to construct new, temporary buildings.

Training construction professionals

The Kazakhstan Green Building Council[106] is training construction professionals in green building principles and certifies building according to national and international sustainability standards. It aims to have all new buildings in Kazakhstan according to net zero emission standards by 2050.

Almaty MasterPlan[107]

Almaty GenPlan is developing a Masterplan for the city. It engaged Gehl people,[108] a Danish architecture bureau for public spaces to help create a 'City for people'. Urban planning is instrumental in designing a city where resources are used efficiently, by minimising transport distances, and facilitating waste collection and recycling.

Almaty Development Centre

The Almaty Development Centre[109] is supporting the sustainable socio-economic development of the city. They run the city's Smart City[110] programme and launched a portal for government service called Open Almaty.[111] When moving to a new office they pioneered an open office concept, breaking with traditional office lay out of the city administration.

Active citizenship to shape the 2020 agenda

WeAlmaty[112] is an initiative from the British Council which aims to help the city of Almaty to realise its 2020 development vision around culture, business and active citizenship. The British Council support local authority leaders to work with civil society and enabled cooperation and joint action between civil society organisations, local authorities and the private sector, towards developing a 'smart city'.

Preserving architectural heritage

ArchCode is a platform where citizens can vote for the preservation of the architectural heritage which the city inherited from the Soviet Union. It aims to create a public debate on the value of architectural landmarks, engaging citizens in decision on preservation, renovation or demolition.

Promoting cycling and ecotourism

Velo Friends[113] is an open platform to promote cycling in the city of Almaty. It lobbies for improving bike safety, expanding bicycle infrastructure[114] and trains children. It has been involved in opening new bike lanes and closing streets for motorised traffic.

Yurt from used pallets

In Nur-Sultan, a group of engaged citizens build a yurt, a traditional nomadic tent, from used pallets, showcasing the potential of wood and used materials as construction material.[115] [116]

Roadmap for low-carbon cement

The EBRD developed a technology and a policy roadmap for a low-carbon cement sector in Kazakhstan.[117] The roadmaps identified technological opportunities to further lower the carbon footprint of cement production and provided policy recommendations to stimulate their adoption.

2.13 INDUSTRY

Light industries in Almaty provide 15% of employment, while using 25% of the resources entering the city. Around 33% of turnover in industry is in the production or processing of food and beverages, 27% in vehicles and machine production and 11% in construction materials

Kazakhstan is investing in industries with a higher added value under the 'Industrialisation plan' initiative.[118] Already in 2013, the projects under this programme accounted for 0.5% of the country's Gross Domestic Product.[119]

The investments aim to promote exports of non-primary products, produced in more sophisticated factories to meet the needs of more demanding customers. Main drivers for growth of industries are machine building, food processing and the production of construction materials.[120]

All these industries are represented in Almaty. In 2018, as part of the 'Industrialisation plan', Kazakhstan opened a new welded piped factory in Almaty, railway wheel production plant in Pavlodar and sheet glass factory in Kyzylorda.

Medeo Skating Rink

2.14 INDUSTRY: RESOURCES FLOWING IN AND OUT

Input

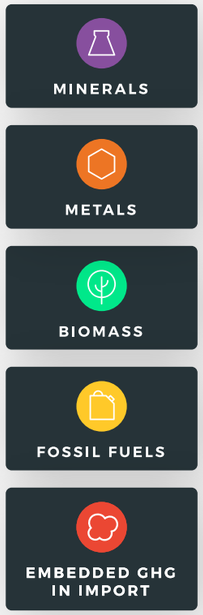
The production of 2.3 million tonnes of concrete construction materials far exceeds the volumes of biomass and metals processed. In terms of input, the production of construction materials is by far the largest industrial activity in Almaty.

Industries use 328,000 tonnes of metals.

The biomass used by industries in Almaty is mostly wood and paper, with the remaining 0.5 million tonnes being food products.

Industries use an estimated 1 million tonnes of fossil fuels, contributing to direct emissions in the city. Around two thirds is coal. The remainder is natural gas.

The products which are imported into Almaty and which are processed there, have an upstream or embedded carbon footprint of 11 million tonnes of CO_2 equivalents. This is mainly due to the import of metals and minerals which are extracted and produced in blast furnaces, cement kilns and other heavy industries elsewhere.



Output

Out of the industrial waste in Almaty, parts of the paper, glass, metal cans, scrapped cars, tires light bulbs, electronic appliances and some textiles are recycled. The Karasai landfill has recently installed a waste sorting facility. it aims to recycle around 7% to 8% of the 480,000 tonnes of waste received annually. Next to this, there are various private initiatives and charities which collect secondary products and materials. Most of this is also processed into new products in Almaty itself.

A small fraction of the industrial output is digested in Almaty.

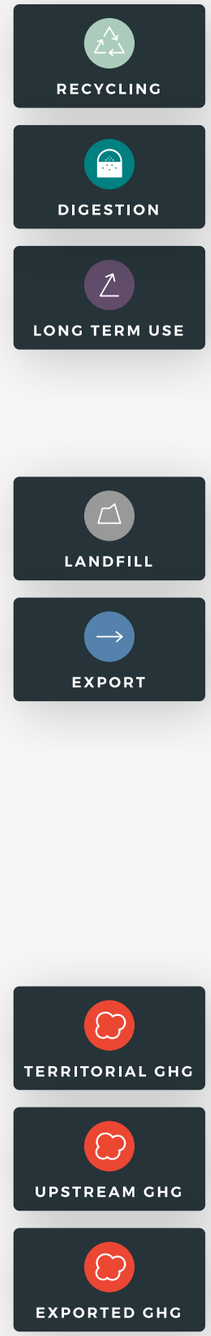
An estimated 291,000 tonnes of residues from industries in Almaty is landfilled. This includes direct industrial waste but also the disposal of good produced by industries which are disposed off after used, like food and short-lived products like packaging materials.

There is one landfill in Karasai, near Almaty, while there are around six dumpsites in use. The dumpsites report on waste collection volumes but, in order to be entitled to accept larger waste volumes for disposal, they tend to inflate the amount of waste which they recycle. The official waste statistics report around 680,000 tonne per year of which only 13,357 is from industry. [121] That seems an underestimation in absolute terms, as well as on the share of waste which likely originates from industries.

Over 1.8 million tonnes is added to the city's growing stock of buildings and long-lasting consumer goods. This is mostly in new construction but includes consumer goods which last over a year, like vehicles, laptops and furniture.

Direct emissions from fuel combustion by industries amount to 3 million tonnes of CO_2 equivalents.

Out of the emissions embedded in products which are processed in Almaty, 5.7 million tonnes of CO_2 equivalents are embedded in products which are both processed and consumed in Almaty. Another upstream 5.8 million tonnes of CO_2 equivalents are related to export. These are embedded emissions of the 1.5 million tonnes of products which are consumed or used in other parts of Kazahkstan or other countries.



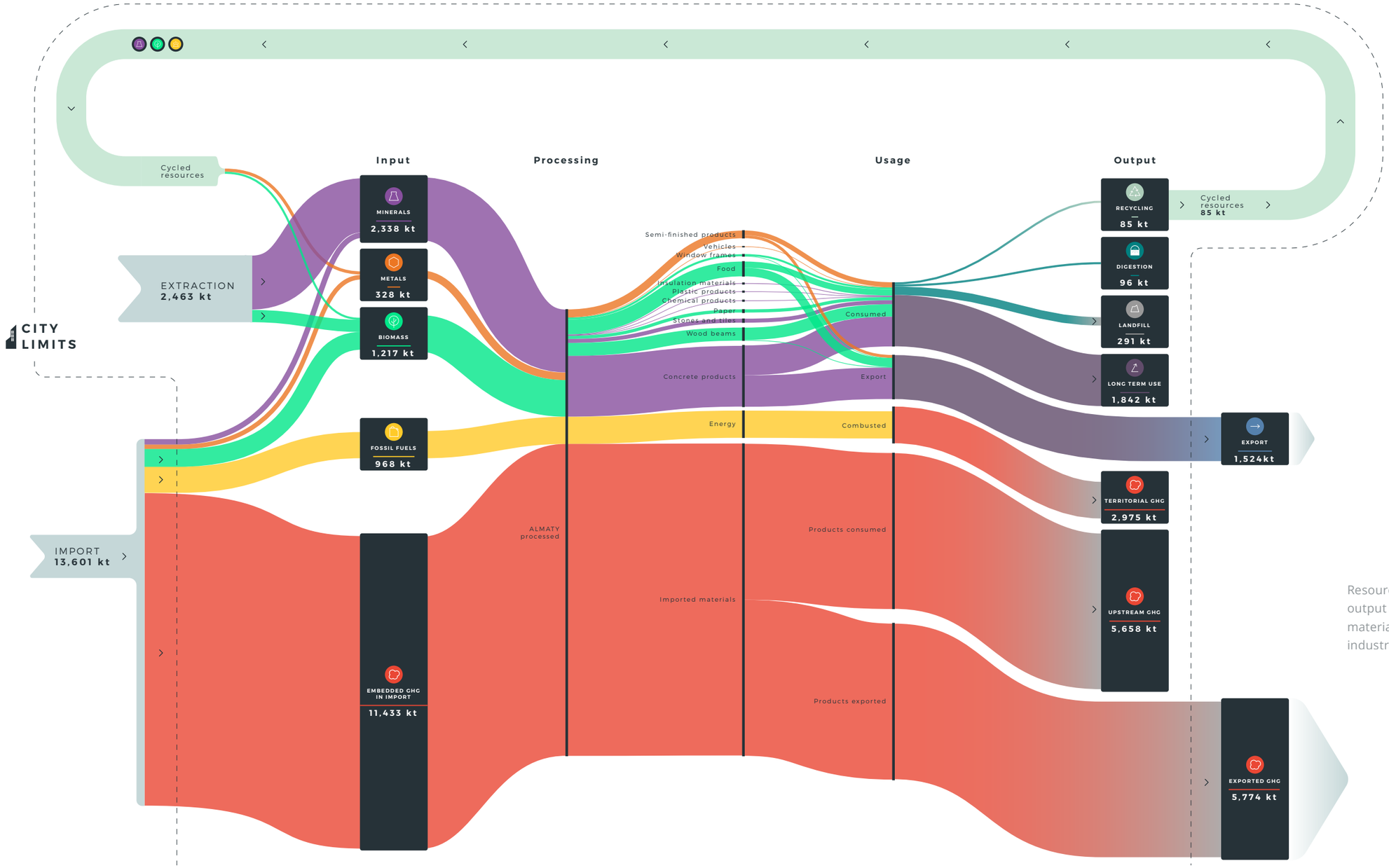
2.15 INDUSTRY: RESOURCE USE

Industries mainly use minerals that are used to produce products which are then exported. The average mineral content of exports is high, due to the large share of concrete products. Also the products consumed within Almaty contain mostly minerals, which find a long term application in the city's new buildings and infrastructure.

Wood and paper industries process significant volumes of biomass, matching the total amount of the food proces. Most of this wood is used in construction.

Of all materials processed in the city, around half is consumed in the city and the other half is exported.

Almaty is recycling around 113,000 tonnes of materials every year. This avoids 173,000 tonnes of CO_2 emissions embedded in products which would otherwise be made from new, primary resources. Most of the avoided emissions stem from recycling scrap metals. [122]



Resource input, usage, output and destination of materials used in Almaty industries.[34]

2.16 INDUSTRY: CURRENT INITIATIVES

To regulate waste disposal, Kazakhstan has introduced a ban on the landfilling of glass, plastics and paper. This ban was preceded by the introduction of Extended Producer Responsibility, whereby levies on cars, tyres, electronics, paper, plastics and glass pay for their collection and processing after use.[123] This has accelerated the growth of initiatives which extract and retain value from residues.

Extended Producer Responsibility

Since 2016 Kazakhstan imposes a fee on certain products and materials. This fee is used to pay for the collection and processing of these products at the end of their lifetime. Operator ROP[124] (Extended Producer Responsibility is abbreviated as 'ROP' in Russian), is responsible for most of the collection.

Green Economy Association

KazWaste[125] is an association with 50 members, all supporting the Green Economy in Kazakhstan. Their goals are to improve the quality of life, avoid environmental degradation and develop a modern waste management sector in Kazakhstan.

Paper production and recycling

Kagazy Recycling[126] is a paper production and recycling company. It collects recycled paper through its subsidiaries.

Using secondary materials

Kazakhstan Waste Recycling sorts and recycled 5,000 tonne of secondary raw materials per months, notably paper, aluminium cans, polyethylene, plastic bottles and household chemicals. The have 23 collection points in Almaty city and 7 more in the region, all solar powered. They pay for the materials which they receive. With its 168 employees it aims to collect all paper waste in Almaty.

Recycling scrap metal

KazFerroSteel[127] in Almaty produces new metal products from scrap metal. It processes around 30,000 tonne metals per year.

Secondary plastic granulates

Raduga[128] produces plastic products from both primary and secondary granulates. It sources secondary materials in Almaty, and processes them into products like clothes hanger, post and garbage bags.

Playgrounds from recycled materials

Eto dvor[129] collects secondary materials and launches creative sessions with residents to turn them into a playground.

Recycling electronics, plastics and rubber products

PromTechnoResource[130] recycles office equipment, fluorescent lamps, illiquid assets and production waste. They work on a contract basis and assess the content of precious metals in waste.

Grassroots plastics recycling

Using the 'Do It Yourself' plastic recycling equipment from Dave Hakkens,[131] Rocket Plastics build its own small plastics recycling workshop. It also placed a bicycle which propels a plastics shredder in a large mall in Almaty. With these initiatives, and by working with schools, they create public awareness. Their next step is to widen their impact by seeking cooperation with large beverages brands.

2.17 UTILITIES, PUBLIC, COMMERCIAL AND FINANCIAL SERVICES

Circular initiatives are not limited to the food value chains, industry and construction. Also in public, commercial and financial services there are initiatives to accelerate the transition to a circular economy.

Public services: Healthcare, education, public administration and science

Almaty Urban Air[132]

Publishing live air quality data revealed that during rush hours, the concentration of harmful particles can exceed 5 to 6 times the norm, contradicting official government statistics. This has engaged a growing community of citizens in a public debate on environmental policies, and the ownership of data.[133]

Lectures and meetings on urban issues

Urban Talks provides a platform for meetings on urban development. It aims to create an active community of citizens around specific topics, like environment and construction.[134]

Urban platform for community engagement

Urban Forum[135] engages in discussions on the development of Almaty and puts important topics on the municipal agenda. Topics include urban architecture, child-safe street design and comparing cities in Kazakhstan with European peers.

Piloting e-waste recycling with schools

Kazakhstan produces 343,000 tonnes of electronic waste per year. Their disposal in dumpsites pollutes soil and ground water.[136] In 2017, UNDP helped collect seven tons of electronic waste at schools in Almaty and delivered it to certified recycling companies.[137]

School children exploring planetary boundaries

EKOphi[138] is a sustainability education project in Kazakhstan. Its objective is to develop an understanding of sustainability while fostering critical thinking, inquiry and responsibility. Through gaming, it makes school children familiar with the concept of Kate Raworth's Doughnut Paradigm, environmental impacts and plausible solutions.

Utilities: Energy, waste and water management

Sorting plant at Almaty landfill

In 2018 Almaty opened a sorting plant at the city's main landfill. The capacity of the plant is 550,000 tonnes of waste per year and it can extract 8 to 10% of recyclable materials while creating 530 jobs.[139] Waste management company Tartyp is one of the shareholders.

Commercial services: Transport and storage, Wholesale, retail trade and vehicle repair

Public transport

Mobility as a service is not a new concept and it has been the underlying principle of public transport also in Almaty. The city is investing in public transport to reduce the movement of private cars and improve air quality.

Bike sharing

Kazakhstan's National Wealth Fund Samruk Kazyna supported the introduction of, Almaty Bike,[140] a bike sharing system in Almaty. Announced in 2015,[141] within just one year the system reported to have 273 bikes on the road, distributed at 50 stations.[142]

Car rental and sharing platforms

Doscar[143] and Anytime [144] provide car rental services, whereby the cars are located at dedicated parking lots throughout the city. They can be accessed with an application or pass. Car rental and car sharing models can reduce the need for parking space.

2nd hand exchanges

Darmarka[145] is a periodic event in Almaty where people bring their unused clothes, books, electronics or toys. When bringing something in, they can take items with them in return. What's left at the end of the day goes to the TEPLO charity.

Collecting used clothing

Almaty-based charity TEPLO collects textiles for people in need, through a network of collection boxes in the city and through Darmarka.[146]

Car remanufacturing and cores trading

Altyn Orda and Barakholka are markets outside the city boundaries where mechanics provide car repair services.[147] Almaty is also a trade hub for car parts.[148]

Financial services

The Green Economy Transition (GET) provides financing to projects that advance the transition to an environmentally sustainable, low-carbon economy, and which help to avoid depletion of natural assets.

Almaty pallet playground

3 CIRCULAR ECONOMY STRATEGIES AND NEXT STEPS

3.1 INTRODUCTION

Part 1 described the ambitions, trends and developments which will have a material impact on resource use in Almaty. Part 2 showed the outcome of an analysis of resource use and waste production in the city, by mapping out resource flows in sectors where most of the resource extraction, manufacturing and processing take place.

In this third part, the result of data analysis in the previous sections, as well as the suggestions from experts and stakeholders consulted through interviews and workshops, are combined into a series of recommendations on circular economy strategies. The strategies tap into the larger flows of secondary resources and existing underused assets. Other strategies aim to replace the use of primary resources where their production, use or disposal is particularly harmful to human health or the environment.

The road to a circular Almaty involves both the ambitious, large-scale urban master planning and industrial solutions, as well as the grassroots initiatives which provide technical solutions and support community engagement. While not shying away from sketching a circular vision, this chapter also draws up short term next steps.

The global economy is far from circular.[149] However, it is important that we develop a shared vision of a circular future, including its socio-economic and environmental implications. This also applies to Almaty. A shared vision of a circular future allows it to develop a narrative of how its citizens want to live, work, travel, eat, recreate and interact with each other in a way that improves the quality of live while respecting fundamental planetary boundaries. Having a clear vision makes it much more tangible which new concepts to develop, new ideas to try out, services, business models to adopt and supportive policies and incentives to implement.

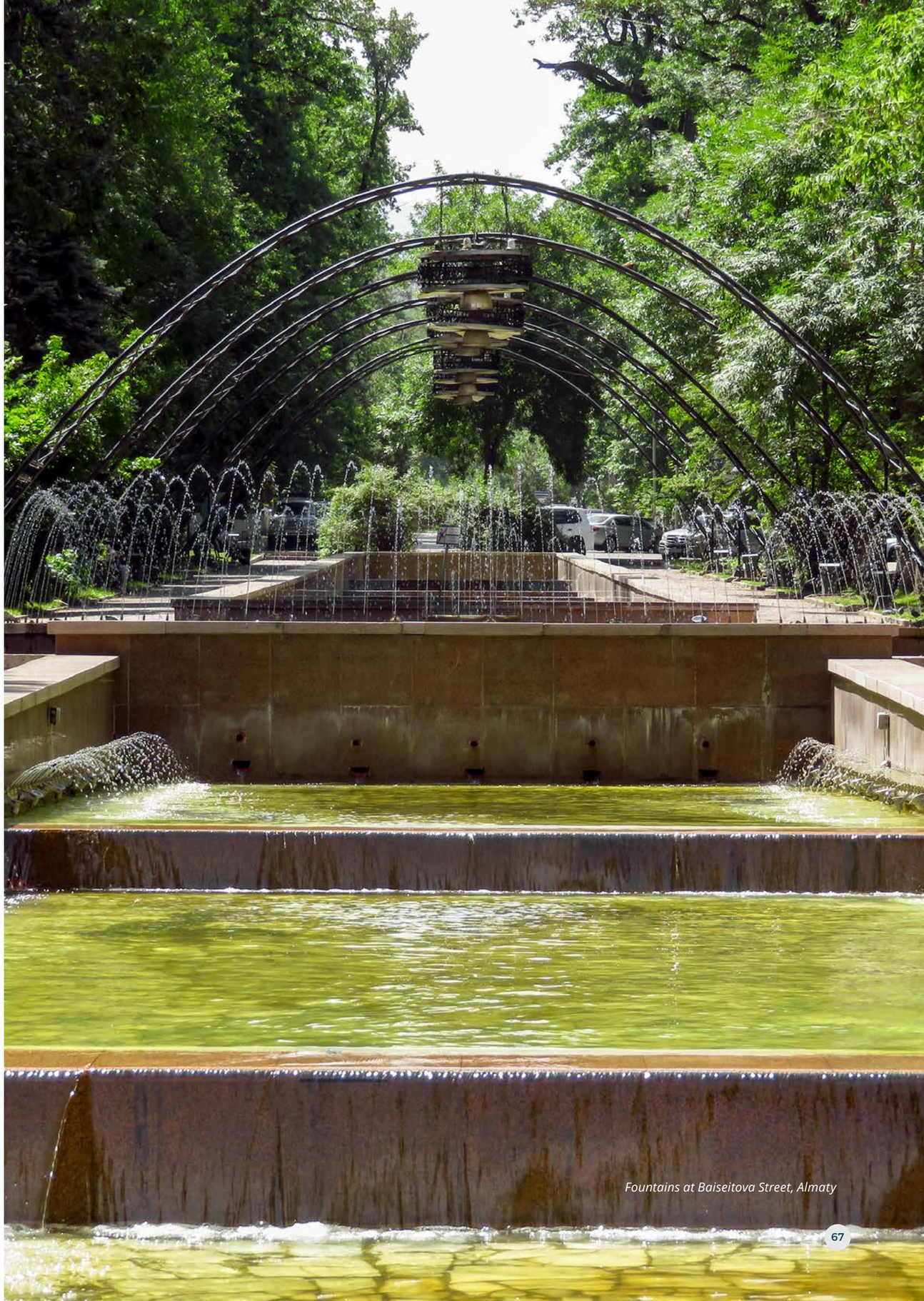
The recommendations per sector start with describing applicable circular economy strategies. They then describe the spatial implications for Almaty agglomerate and the opportunities which they offer at 'street level'.

3.2 AGRICULTURE AND FOOD PROCESSING: CIRCULAR ECONOMY STRATEGIES

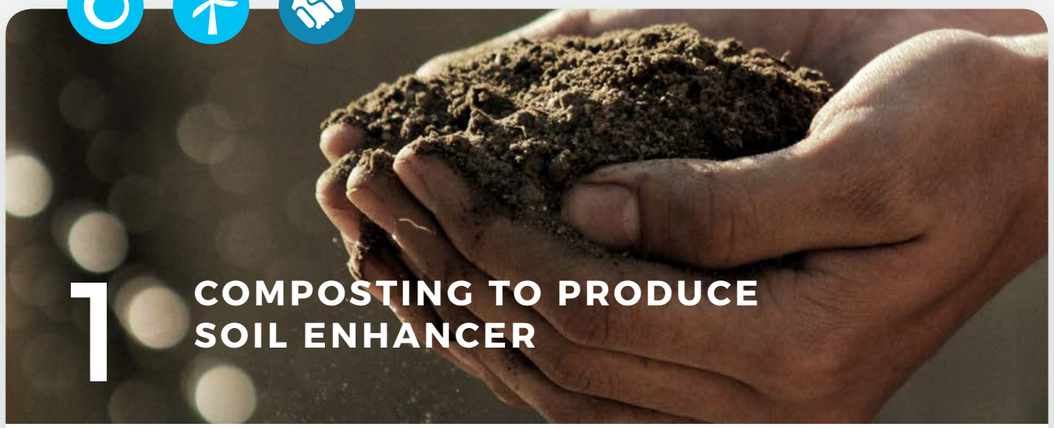
In a circular future for the agriculture and food processing sector in Almaty, organic residues are collected, whether they are from agriculture, industries or even households, and used to regenerate soils, make new food products or provide alternative packaging materials.

The national government is investing in increasing agricultural production and processing capacity. These investments will 'lock in' the material efficiency of the food value chains in the region for many years to come. It is important to map out how these investments will alter resource flows and take a systemic perspective to optimise resource use and minimise waste. Next to this, Almaty oblast or province can only become the food supplier of Central Asia, when it also invests in the soil.

Important strategies towards an efficient, low-carbon food production system are the substitution of synthetics inputs with organic residues, closed loop production processes, industrial symbiosis and the production of degradable packaging. Already now, the growing output of organic products, demonstrates how yields, quality and profitable businesses can be combined with sustainable production methods.



Fountains at Baiseitova Street, Almaty



1 COMPOSTING TO PRODUCE SOIL ENHANCER

Strategy description

Use organic residues, in particular if they are larger volumes of consistent quality, to produce a biofertilizer or soil enhancer. A balanced mix of different types of organic residues[150] can create a compost that is tailored to the needs of the soils in Almaty province. The mix of input materials could include manure, food and vegetables from both farms and processing industries.

In locations with a lack of energy sources, anaerobic digestion can be used rather than composting. An anaerobic digestor produces methane which can be used as an energy source.

Investing in soil quality can help bring mineral inputs down and avoids that farmers are paying for products that provide services which were, at least partly, provided for free by the soil.[151] Increasing soil organic content prevents further desertification and salination, reduces irrigation needs and restores soil organic carbon.[152] [153]

Next steps

A pilot can be launched to use compost as a soil enhancer. Scientific institutes can support with defining the optimum compost characteristics and measuring its impact on yields and soil quality.

Trust is key. Farmers are very careful with what they apply on land since soil is their main asset. By making the farmers part of the initiative at an early stage, or perhaps inviting them as even shareholders, they can verify and influence the quality of the input materials.

Organic waste from food processing and intensive chicken farming is specifically interesting since they represent:

- large volumes,

- a consistent flow with predictable seasonal changes,

- clean flows which, contrary to household waste, can be obtained as a pure organic fraction.

These fractions can be mixed to obtain the optimal ratio of carbon and fixed nitrogen in the eventual compost product.

Finally, the subsidy difference between the use of synthetic and biofertilizer creates a financial barrier for the use of organic fertilisers. When removing subsidies on imported synthetic fertilisers, or placing organic alternatives on equal footing, compost can become a viable alternative.

2 CLOSED CYCLE FARMING

Strategy description

Permaculture, crop rotation and producing combinations of agricultural products in polyculture systems can help bring down the amount of synthetic input and water use per tonne product.

Permaculture is the development of a system of species or polyculture which provide food products, resembling natural ecosystems rather than the monoculture of annual crops.[154] Aquaponics is a combination of conventional raising of aquatic animals, notably fish, in combination with cultivating plants in water in a hydroponics system. The two systems operate in a balance, whereby by products from the animals are used to fertilise the plants. The water can be recirculated, which is already common practice in many hydroponics greenhouses, in which products grow on nutrient rich water, rather than soil.

Examples are Ecoferm,[155] where animal manure and CO_2 are used to produce algae. An urban example is the LokDepot aquaponics rooftop farm in Basel.[156] Combined with the introduction of predator insects as a natural enemy[157] of species which feed on the crops, greenhouses can be operated without the use of pesticides.[158]

Next steps

The concepts of horticulture, organic permaculture[159] and producing food on hydroculture or substrate are not new to Kazakhstan. Almaty has a strong permaculture history, notably to produce fruit. The first greenhouses have recently been built in Almaty[160] and find a viable business model even in remote places like Aktobe.[161] Building on existing practices, the next step lies in upscaling and further improving existing initiatives, rather than piloting something new.

3 INDUSTRIAL SYMBIOSIS

Strategy description

Waste is food. Where residues can no longer be used at the farm, they can be used as feedstock for other products. For example, where agricultural production does not meet aesthetic standards of human consumption, it can be used as animal feedstock. As agricultural production in Almaty region intensifies, it is important to cluster companies in a way that they can take full benefit from each other's residues at low costs.

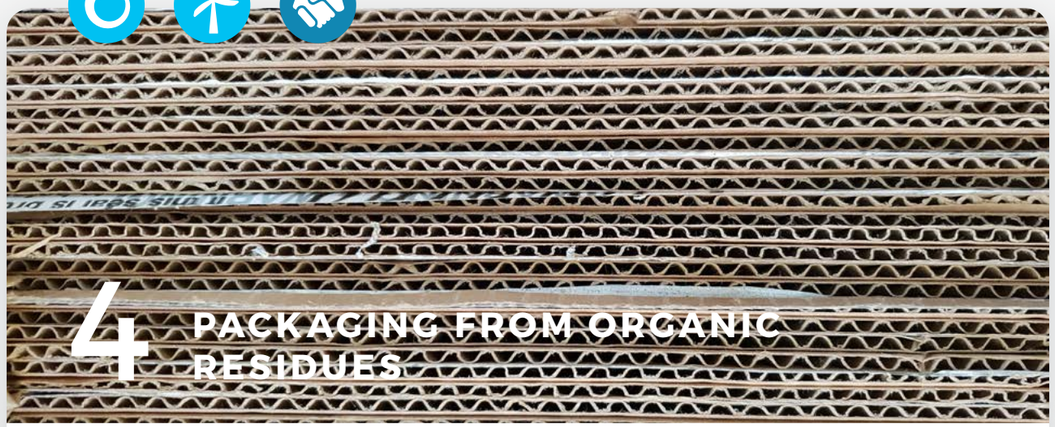
This argument applies to agricultural production and to food processing industries. For example, beer breweries produce beer bussel, which is typically used as animal fodder. It can also be used in bread production. On the other hand, old bread can be used in the beer brewing process to substitute malt.[162] The presence of wood processing and paper industries also opens the option to collect fibres and use them in the paper production process.[163] Other examples are where chicken manure and straw or coffee ground are used to produce champignons or more exclusive mushroom types.[164]

The concept is not limited to food industry though. A steel mill which supplies slag as a clinker substitute to cement kilns[165] is an example which can reduce greenhouse gas emissions from the heavy industries which supply construction materials to Almaty.[166]

Next steps

The next step could be to consider industrial symbiosis opportunities in the planning of the locations of agricultural production and agricultural processing industries. To better connect residue flows, processing steps can be introduced like composting or anaerobic digestion, or even refining. In a biorefinery different fractions in the organic residues can be separated. The fibres can be separated from the protein and moisture. The liquid fraction is rich of nutrients and can be used as fertiliser or perhaps even thawing agent. The protein can be used as animal feedstock and the fibres can be used to produce packaging or even construction materials.[167]

Another approach is to directly connect companies with each other. This is where a beer brewery and bakery can exchange beer bussel and bread residues to tests the substitution of their raw materials at pilot scale.



4 PACKAGING FROM ORGANIC RESIDUES

Strategy description

Why should packaging last longer than its content? Agricultural residues can be used to make packaging materials.[168] A farmer or processing company could pack its products in packaging materials which are made from its own waste. After use, this packaging could go into the organic waste fraction, be processed into a soil enhancer and find its way back to its origin.

Next to this, agricultural residues can be used to produce materials beyond packaging alone, like paper,[169] insulation materials[170] and even car dashboards.[171]

Next steps

The development of packaging from organic waste can start with a small pilot whereby fibres are mechanically extracted from residues and processed. Merely pressing the fibres is sometimes enough to make a packaging material.

A more direct approach is to repurpose packaging materials from agricultural processing industries. The Almaty-based chocolate factory Rachat receives cocoa beans in jute bags. Since these bags are imported, law prohibits the company to use them. The bags are currently landfilled. Opening a dialogue with legislators on use of waste materials from imported origin, can make this jute material available for a new purpose.

Once the business approach has proven itself, companies could even venture into the production of biobased materials, moving beyond packaging alone. Ecovative[172] is an example, using mycelium for furniture and packaging materials.

3.3 AGRICULTURE AND FOOD PROCESSING: ALTERING RESOURCE FLOWS

When using all organic materials and diverting them from landfill, this reduces odour nuisance from landfills and reduces the 35,000 tonnes of methane which landfills are emitting into the atmosphere. Methane is a potent greenhouse gas.

Instead, organic waste is diverted to processing locations, where it is used to produce a compost or sludge which is free from pollutants and which has the right ratio of carbon and nitrogen. Agricultural enterprises can distribute it over their land to increase the soil organic matter.

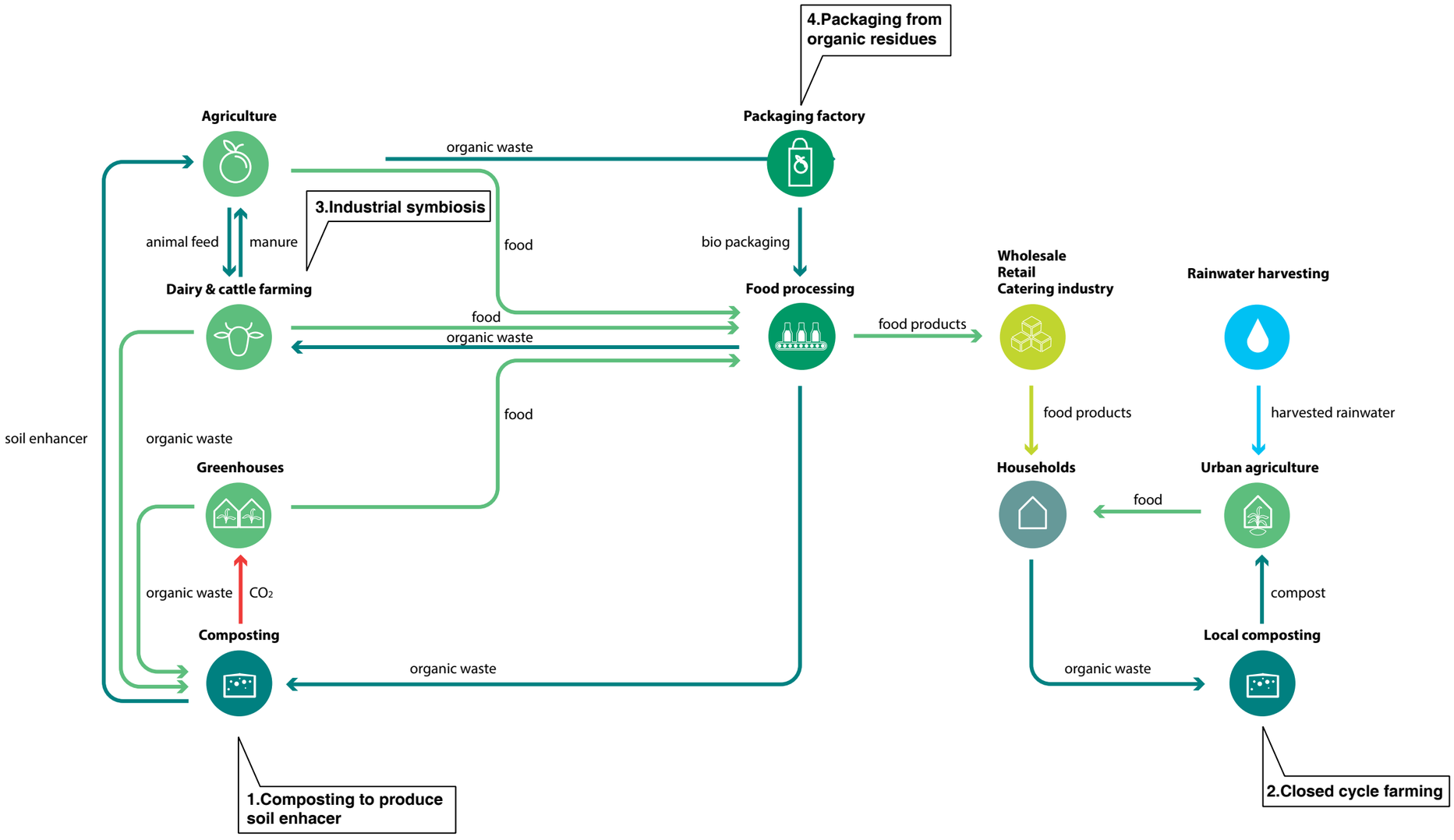
This can increase yields and improve water retention. Reducing irrigation helps avoid salination issues. In addition, an organic soil enhancer can enhance soil life. Bacteria, fungi and soil organisms make nutrients in the soil available for vegetation and can halt the development of plant diseases. This in turn reduces the need for carbon intensive products like fertilisers and pesticides, which in Kazakhstan are typically imported.

This strategy can make a significant contribution to reducing greenhouse gas emissions. It avoids emissions[173] in three ways:

1. reducing emissions from fertiliser production, and industry which is responsible for 1.2% of global greenhouse gas emissions,[174]
2. reducing the emission of nitrogen oxide from the use of synthetic fertiliser,[175]
3. sequester carbon in the soil,[176]
4. effective organic waste and manure management can reduce methane emissions.[177]

Estimates for Central Asia are that increasing soil carbon can remove 16.6 million tonnes of carbon per year out of the atmosphere.[178]

In a similar manner, the use of locally sourced, natural alternatives for plastic or other packaging materials avoids greenhouse gas emissions associated with the production of mineral packaging materials. A challenge there is that the alternative packaging should preserve and protect the food product as well as the conventional material. If it does not, shortening the number of days at which the food can be stored, may increase food waste.



3.4 AGRICULTURE AND FOOD PROCESSING: SPATIAL STRATEGY

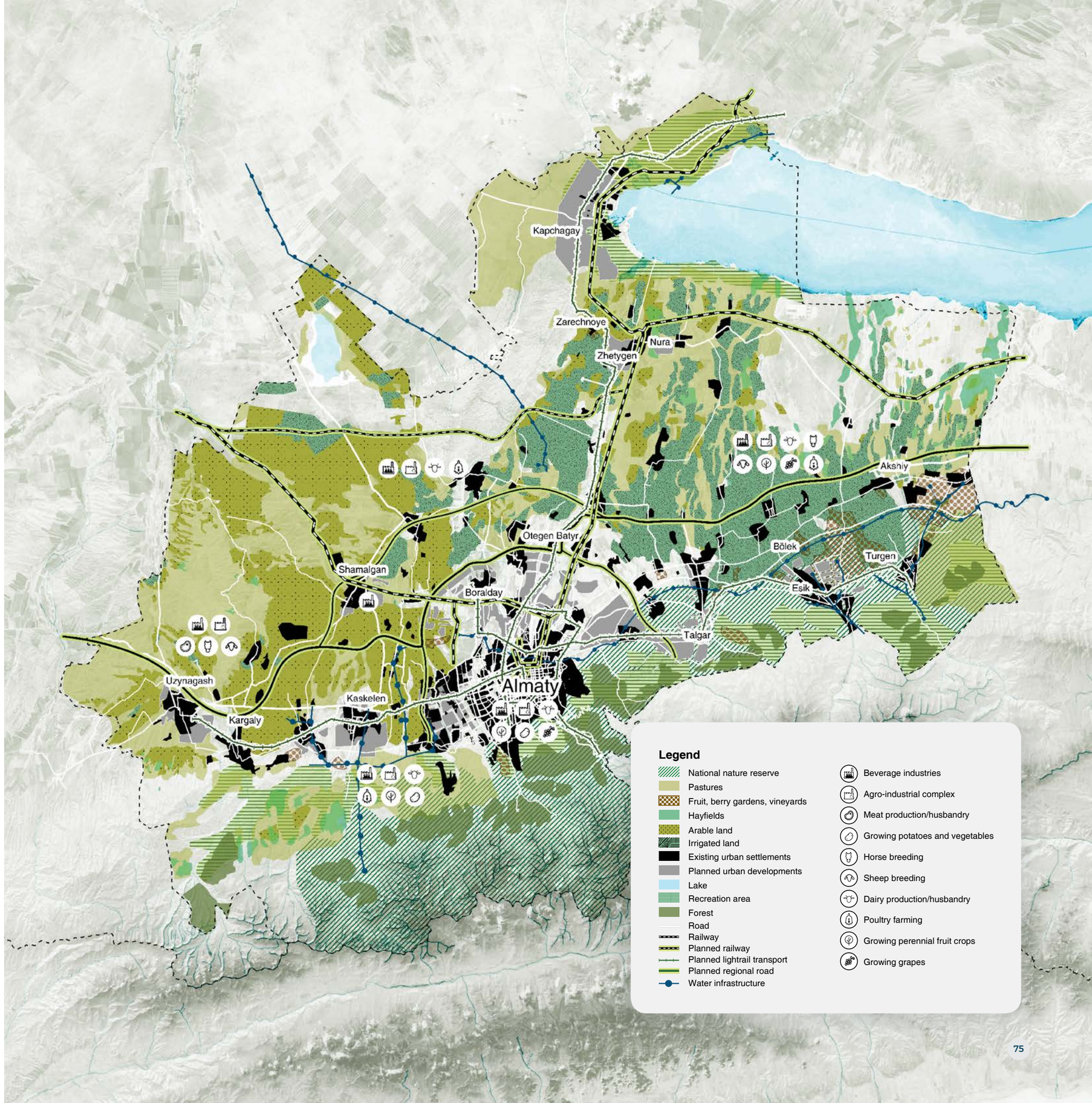
Almaty is surrounded by a patchwork of different agricultural activities, ranging from pastures, orchards to irrigated and intensely cultivated agricultural land.

The growing agricultural sector can provide the city of Almaty with an outward perspective by adding new recreational options. Some organic farms are inviting citizens to their farms, to showcase what they are doing, and even attract voluntary labour from the city.

The outward perspective is already supported by new infrastructure which connects satellite towns with Almaty. It could also be a rationale for expanding the existing bike lane network through the residential districts surrounding the city, the 'sleeping districts', and connect the city with the agricultural areas. These bikelanes can be placed at a distance from the main roads, to provide for a scenic and quiet ride into the surrounding agricultural and forestry landscape.

Closer to the city, the sub-urban or peri-urban spaces of Almaty agglomerate can provide dedicated agricultural functions, perhaps focused on regenerative practices while creating ecological zones which provide services like water purification or buffering.

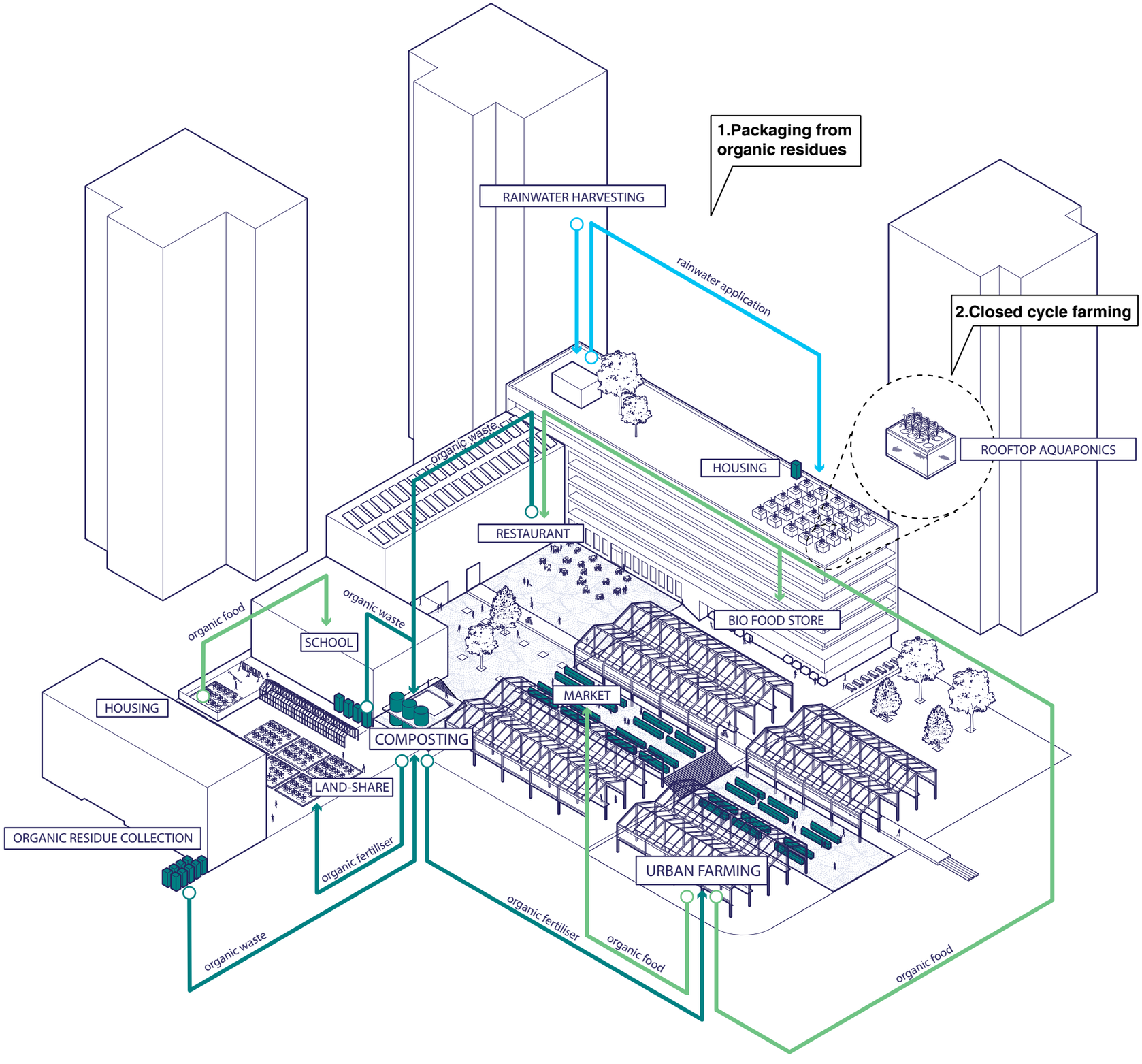
In a country with a high urbanisation rate, planning for combinations of land use functions, allows people which recently moved from rural areas into the city, to maintain a connection with the land and subsistence farming. Providing space for local initiatives, like urban farming or even aquaponics can help create a sense of community and cohesion in the new residential areas. At even smaller scale, in the basements of residential buildings, this can start with producing mushrooms on collected coffee grounds



3.5 AGRICULTURE AND FOOD PROCESSING: CIRCULAR FUTURE

In a circular Almaty, some of the food production can even take place within the city limits. That allows citizens to recreate or find low cost food close to home. This could range from food forests or parks where people can pick their own fruit and vegetables, to restaurants in rural areas which serve locally produced products and even greenhouses within urban courtyards. A multipurpose development for dense urban districts can balance recreation, living and working with convenience.

Other options are to use derelict buildings for agricultural purposes like vertical gardening or mushroom production. Semi-private community gardens or landshare schemes[179] can incorporate recreational activities and create common, accessible spaces for citizens. A landshare is a scheme whereby owners of land close to new or existing residential areas rent out their land to urban citizens for cultivation. Such initiatives can tap into the organic residues produced by communities to enhance soil quality and increase production. This avoids that new and existing districts only provide a residential function, whereby its citizens must travel to reach locations for work, grocery shopping or leisure.



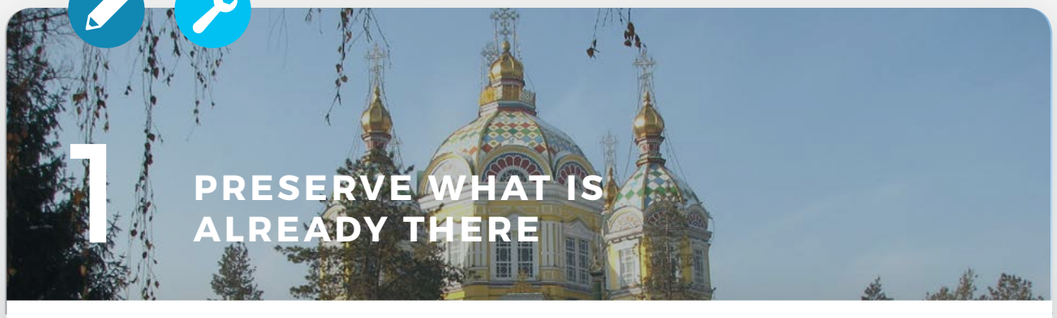
Combining agricultural activities with recreation can help create a deeper awareness of the intrinsic value of agricultural production and organic residues, perhaps preparing the city for future initiatives to separate waste fractions and further reduce food waste.

The name of the city Almaty stems from the old name ‘Alma-Ata’ which means ‘father of apples’ in Kazakh. The symbolic value of bringing the apple trees back to the city is large. Since people are concerned about the impact of air pollution on the safety of food products from the city itself, these can best be placed in the city’s outskirts. Permaculture, combinations of vegetation which make the trees more resilient, would keep the use of synthetic inputs to a minimum. This is important in general, but particularly where production is relatively close to residential areas.

3.6 CONSTRUCTION: CIRCULAR ECONOMY STRATEGIES

In a circular construction sector demolition sites supply part of the material demand for new buildings, and existing buildings are preserved and used for as long as possible, making demolition a last resort option. Where new and additional construction materials are needed to support the growth of the city, regenerative materials, flexible and modular construction methods have an advantage in a competitive bidding process, encouraging project developers to construct buildings with the least possible environmental impact, throughout the whole lifecycle of the building.

An expanding city can create a building stock that is future proof. This starts with design. Almaty already hosts various organisations which are training construction workers on sustainable building practices, preservation of architectural heritage, incorporating social and environmental aspects in urban planning and building a city that is there for its citizens.



1 PRESERVE WHAT IS ALREADY THERE

Strategy description

The existing building stock shows the rich cultural memory of Almaty, each representing the narrative history of specific decades and centuries. Those stories give the city its aesthetic and touristic appeal, well beyond the boundaries of the golden quarter neighbourhood.

In general, limited lifetime does not apply to buildings. The preservation of architectural heritage around the world is perhaps the most striking example of how lifetime extension can preserve buildings for centuries. Renovating historic buildings can preserve the city's historic narrative and sense of identity, which is the main argument behind recent resistance against the demolition of buildings from the Krushchev era,[180] echoing earlier outcries to preserve hutongs in China.[181]

Where mere renovation is insufficient to meet modern requirements,[182] architecture can seek to develop an interesting blend of traditional and contemporary architecture.[183] A blend of old a new can help preserve the cultural heritage, the historic integration of buildings and vegetation and the orientation of the city towards the surrounding landscape.

Next steps

For urban development initiatives within the existing city, Almaty municipality can challenge project developers and architects to submit proposals which ambitions for growth and renovation, while preserving as much of the cultural heritage, configuration and perhaps materials which are already available on-site.

An example of a public procurement where preservation of cultural heritage, a spatial narrative and reusing available materials on-site, is the development of the Bijlmer area in Amsterdam.[184]

2 SUBSTITUTE CARBON-INTENSIVE MATERIALS

Strategy description

Around 73% of the embedded emissions of Almaty are in construction materials used for new construction. The extent to which energy efficiency and industrial symbiosis can lower the carbon footprint of concrete and steel faces prohibitive technical limitations.[185]

Regenerative construction materials provide a low-carbon alternative. Kazakhstan aims to increase forest cover, also near Almaty. As forests mature, they can provide wood for the production of industrial construction materials, like Cross Laminated Timber.[186] Rather than emitting CO¬2 to produce cement and steel, wood stores carbon for the whole lifetime of the building.[187] Wood structures can also be very earthquake resilient.[188] [189]

Neighbouring China is already investing in renewable construction materials.[190] It is also exploring the use of composites of wood and bamboo.[191] Construction material and design companies like Stora Enso from Finland,[192] Sumitomo Forestry from Japan[193] and Ramboll in the UK[194] are using wood as renewable resource for contemporary architecture.

Next steps

In the short-term Almaty could develop a showcase project which demonstrates how the use of wood-based construction materials can contribute to lowering the carbon footprint of construction, while providing safe and comfortable buildings. Almaty has a long tradition of building with wood and host a sizeable wood processing industry. As local forests mature, Almaty region can expand its own production of industrial timber products.

A circular showcase building or structure can demonstrate the versatility of wood-based structures. International examples are the Metropol Parasol[195] in Sevilla and Circl[196] in Amsterdam.

For the long run, low-carbon construction materials will need to see their environmental benefits translated into a competitive advantage over concrete and steel. Kazakhstan has introduced an Emission Trading Scheme[197] as its main policy instrument to meet its greenhouse gas reduction commitments under the Paris Agreement.[198] Unfortunately, the system faced political opposition and was suspended in 2017. For the long run, stable and well-enforced national policies, like a carbon tax, can help tip the balance in favour of low-carbon construction materials.[199]

3 PASSIVE DESIGN

Strategy description

39% of the energy use in Almaty is related to heat production. The design of a building can be such that the influx of energy is optimised in winter and largely blocked in summer. The orientation of a building to the sun can take advantage of the different angles which the sun has in different seasons. In the Golden Quarter the distance between buildings is optimising light influx, which already is a passive design principle.

The building design can also support a natural airflow. Combined with proper insulation, energy efficient design can drastically reduce the energy use of a building.[200]

Passive design is often associated with modern, detached villas, but its principles can just as well be applied to high-rise buildings, like at Cornell tech in New York.[201] This building used pre-fabricated panels for the exterior,[202] a common practice in Kazakhstan.

Next steps

Almaty municipality can play a decisive role in enforcing sustainable and energy efficient building design. Primarily by using stringent building energy efficiency targets in the bidding process for the allocating of areas for real estate development. Although this may increase the costs of new buildings, the costs during the usage phase will be reduced. This will lower the energy bull for the users for many decades to come.

4 MODULAR DESIGN AND CONSTRUCTION

Strategy description

Modular building design is where modules are factory build and merely assembled onsite. Modular buildings can also be built faster, cheaper and with less nuisance at the construction site, since most of the actual construction takes place in a factory. When buildings have a modular design, the residual value when the building no longer has a function, can be positive since the modules can find a new application at a construction site elsewhere.

Neighbouring China sees a strong push towards offsite construction methods.[203] Other examples modular construction practices are Modulex[204] in India, Ursem[205] in the Netherlands, Park2020[206] a cradle to cradle business park near Amsterdam and Finch Buildings.[207] The latter is combining wood with modular industrial production and assembly techniques,

Next steps

Modular building design competes with conventional construction methods. The advantage of modular and flexible designs is that they both mitigate the risk that a building becomes obsolete. When financing a building with a modular design, the construction company could even agree on a take-back scheme, guaranteeing to buy the modules back when the building is no longer needed.

Already in the short term, companies which supply modules can gain a competitive advantage in competitive bidding processes since they can offer shorter construction periods, monetise the benefits of offsite manufacturing and a higher residual value.

5 URBAN MINING

Strategy description

Where demolition of larger structures is inevitable, Almaty could consider demolition sites as an ‘urban mine’, where valuable materials can be recovered.[208] Some can be recycled but ideally full structures are extracted to find a new purpose in a new building. This requires timely coordination of demolition and construction activities and mapping out future needs and supply of secondary construction materials.

Examples are the façade panels from existing buildings. They can undergo a remanufacturing process in the nearby panel factory. Their integration into a new building may require aligning the design of the new building to fit existing structural elements.[209]

Recycling options are expanding as technologies advance. A smartcrusher in the Amsterdam harbour is grinding concrete while recovering its original homogenous elements: sand, gravel, hydrated and unhydrated cement.[210] For materials which can no longer be reused, such recycling allows for the recovery of the original ingredients of concrete.

Kazakhstan is supplier of a wide range of raw materials, which is valuable expertise also when tapping into secondary resources. In practice, the mining of metals from ores sometimes requires the same technologies as the mining of valuable materials in residual flows.[211]

Next steps

In a first step, the municipality, land owners or project developers should incentivise contractors to tap into secondary resources. This could start with allowing demolition companies enough time to:

1. Asses what valuable elements and materials are in the building, unless that information is already available,[212]
2. Disassemble a building rather than ‘tearing it down’, to harvest what is of value,[213]
3. Find a new purpose or market for construction materials which have a residual value.

In future, designated areas for the storage of secondary construction materials, or a secondary materials marketplace, can help overcome temporary issues with matching supply and demand.

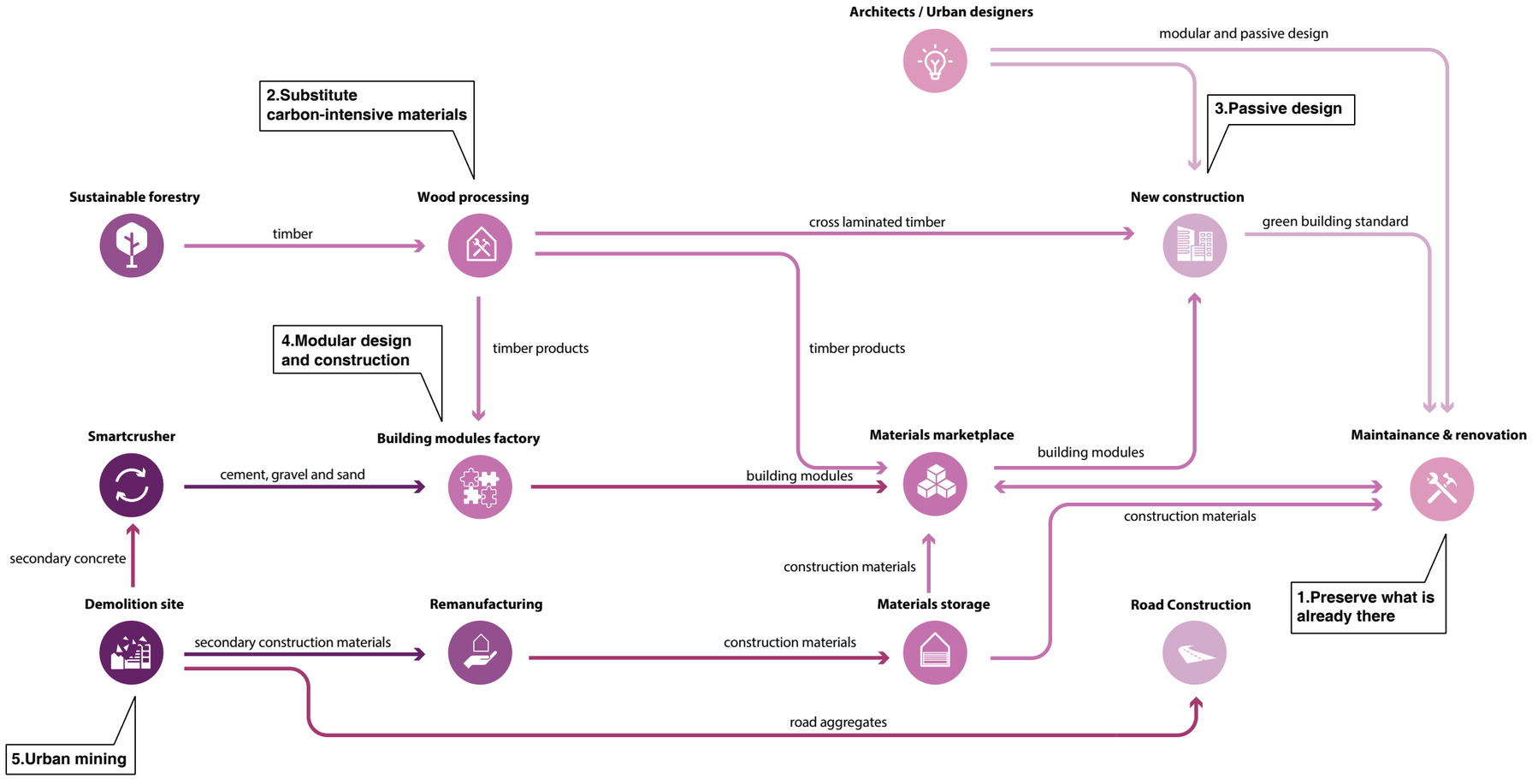
3.7 CONSTRUCTION: ALTERING RESOURCE FLOWS

The carbon footprint of the construction sector in Almaty is relatively high, mostly due to the import of carbon intensive construction materials and due to the energy used for building heating. Since most construction materials are extracted and produced in Kazakhstan, lowering these embedded or upstream emissions will contribute to national greenhouse gas mitigation targets.

When wood substitutes re-enforced concrete, the mitigation impact could reach 2 to 9 tonne CO_2 per tonne timber applied during construction.[214] Research in nearby China shows that in colder regions, wooden structures can also reduce energy consumption by over 30%.[215] Next to this, the production of wood as a source of fibres and construction materials near the city can help prevent further soil erosion.

Next to using low-carbon construction materials, improving the energy infrastructure can lower the distribution losses, which are now about 22%. Distribution losses in Almaty are equal to all energy use in the residential sector. Furthermore, retrofitting and improving building insulation can reduce heat supply to residential buildings with 35% to 45%. Consumption-based billing can cut another 5%.[216] These measures target territorial greenhouse gas emissions within or close to the city and contribute to improving air quality.

In new construction, efficiency targets can be far more ambitious than in the existing building stock. A passively designed building can have an energy consumption which is 60% to 70% below standard. Case examples in comparable climatic conditions show that reductions of 73% in high-rise passive design are realistic.[217]

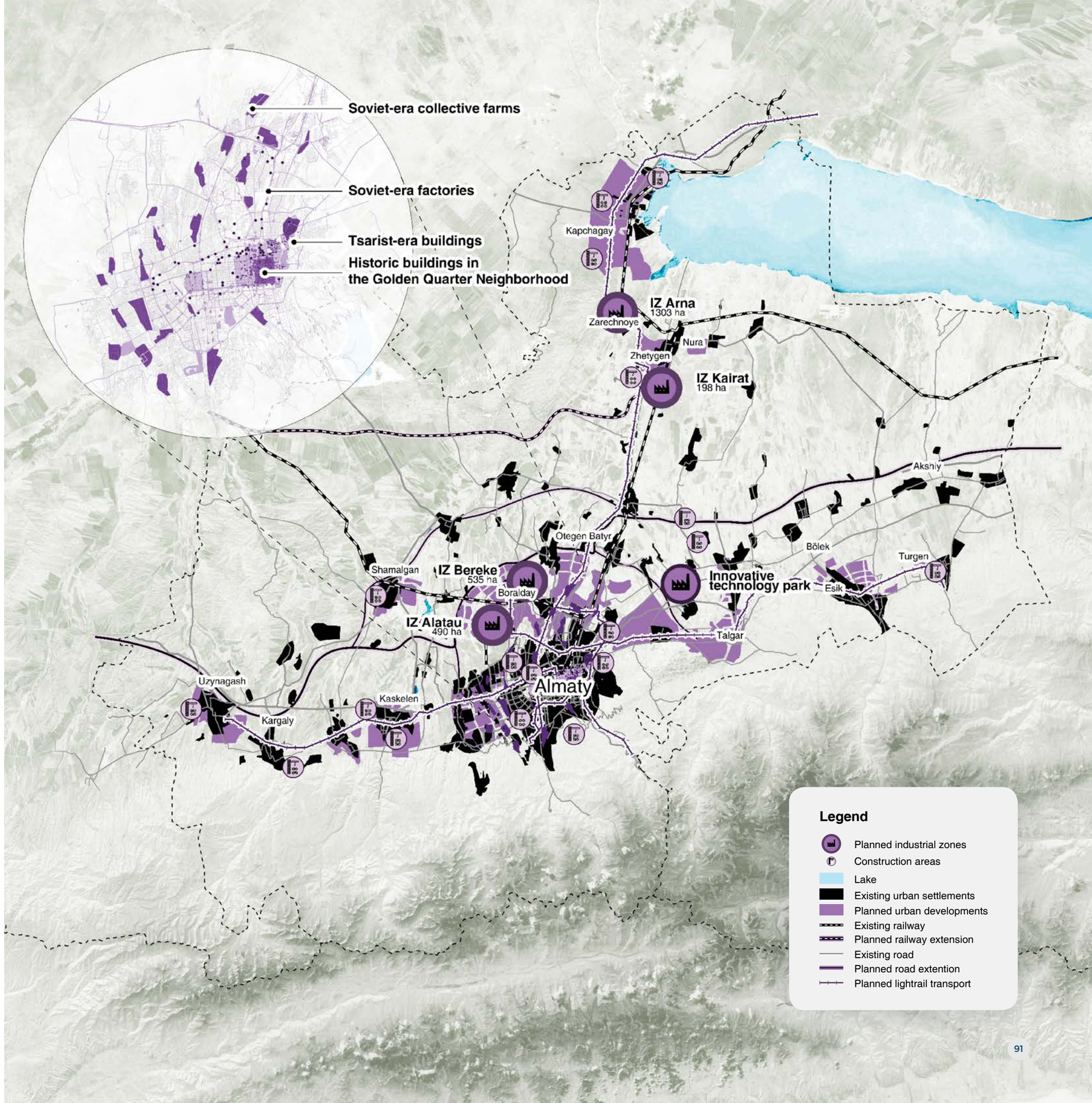


3.8 CONSTRUCTION: SPATIAL STRATEGY

The government is planning the development of the Almaty Agglomeration until 2050 in the Almaty Masterplan. It designated industrial zones to produce the necessary construction materials. The Alatau industrial zone will produce energy efficient building facades, concrete, windows and metal structures. Kapshagay will produce sandwich panels and gas blocks, Kaskelen concrete products and Talgar aluminium and plastic window frames. Cement and building stones will come from Zhambyl.[218]

Substituting carbon-intensive construction materials bio-based alternatives is a very effective mitigation strategy.[219] These materials can sustain their embodied carbon for the many decades of life-expectancy typical for a building, or durable consumer product. These materials can even replace highly carbon-intensive bulk products, such as metals and processed mineral elements, which so dominate material use in the construction sector.[220]

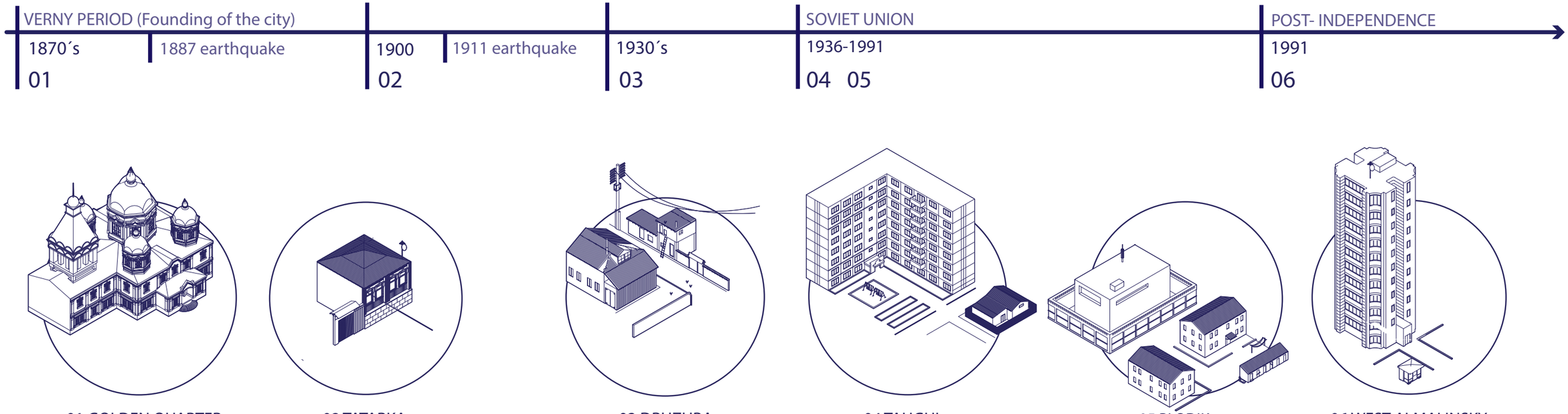
However, the production of wood, bamboo or other organic-fibre materials requires land and, consequently, competes with other services also dependent on that resource - such as food production, or residential real estate. Furthermore, global forest cover and aboveground biomass stock is still declining. This limits the potential to responsibly source woody biomass. The focus should be on countries which have stringent and well-enforced environmental legislation in place which ensures sustainable forest management. Kazakhstan is already on its way to develop a sustainable forestry operation.[221]

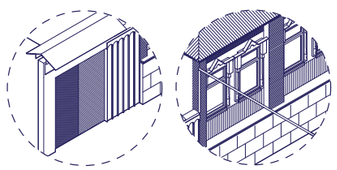


3.9 CONSTRUCTION: EXISTING BUILDINGS

Understanding and valuing the architectural heritage of the city of Almaty, helps make informed choices of what can be maintained and what can be replaced. Arguably, what makes Almaty unique is the historic integration of buildings, vegetation and its orientation towards the impressive surrounding natural landscape.

Each section of the city carries its own identity. Although the focus is typically on the Golder Quarter, a quadrant in the centre of the city, other parts of the city reflect, or envelope, buildings from the tsarist period and collective farms and factories from the Soviet Union. This historic structure of the city can provide a basis for urban development plans, whereby demolition is considered a last-resort option.




Wooden slats as a traditional cladding method on building elevations, as well as wooden gates

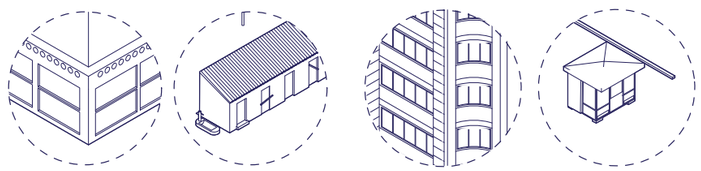
Window detailing


Dormers

Addition of elements through time


Corrugated metal used for fencing, roofs and gates

Limestone forming envelopes


(High) Concrete fences

Sheds and public taps

Aluminium cladding

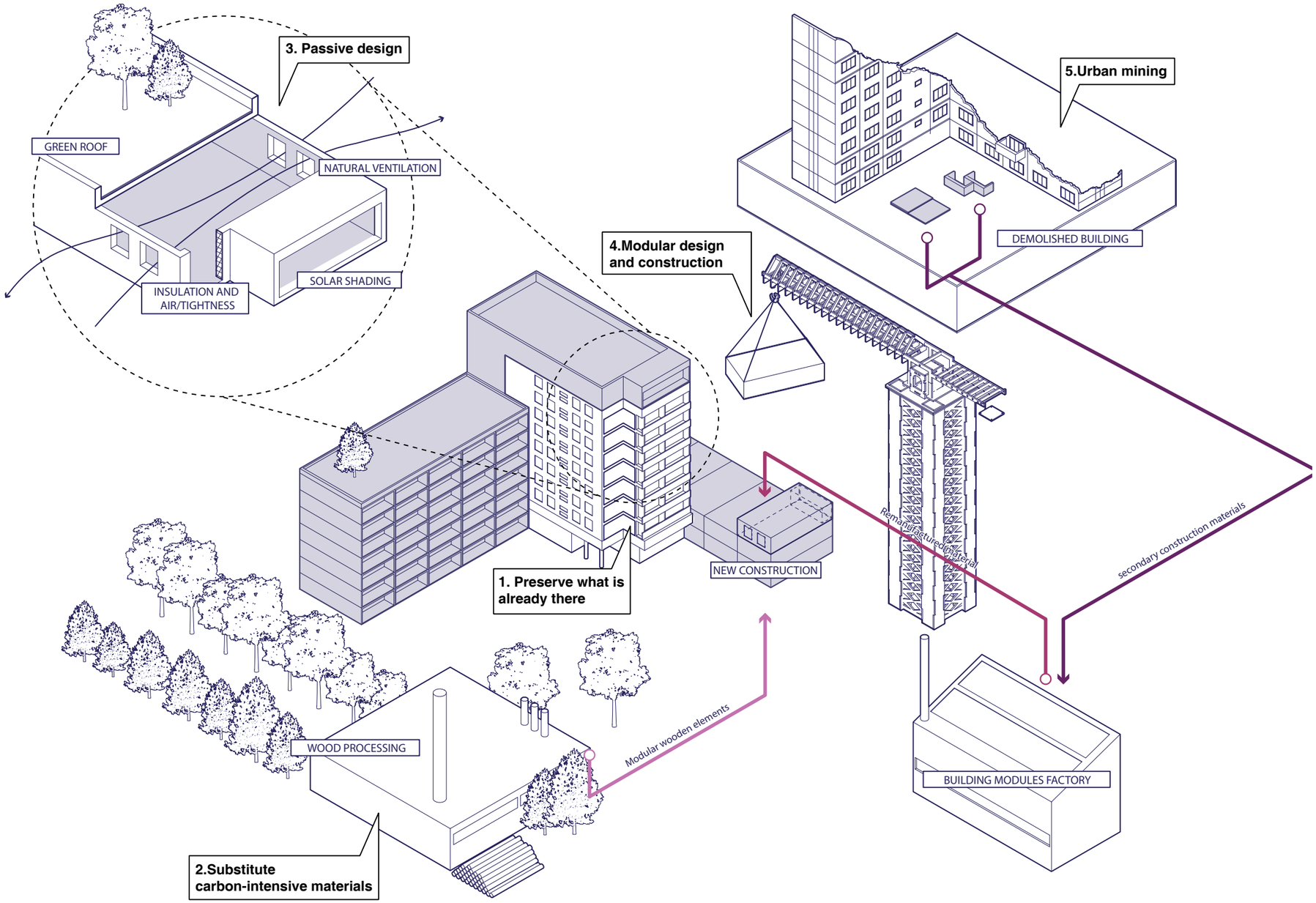
Kiosks

3.10 CONSTRUCTION: NEW BUILDINGS

A building with a passive design requires less energy to provide hearing, cooling and ventilation.

The existing wood industry and production of construction materials provide a solid basis for venturing into wood-based construction. This could be either by producing modules in an industrial setting, or producing wood beams, walls and floors.

Where demolition is inevitable, the building materials can undergo a remanufacturing or recycling process. The minerals can at least be crushed and used a s road filler or perhaps recycled to recover the mineral ingredients of the concrete. In the more advanced scenario, facades from old buildings can be remanufactured to a higher energy efficiency standard and reused in new buildings.

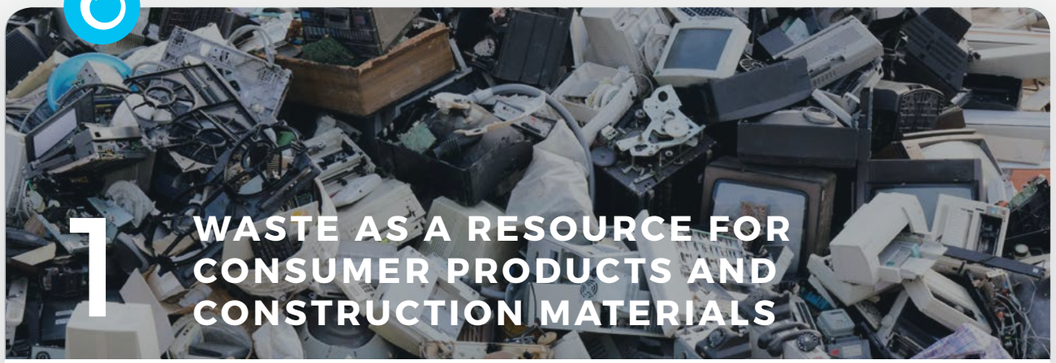


Zenkov Cathedral in Almaty, made out of wood.

3.11 INDUSTRY: CIRCULAR ECONOMY STRATEGIES

In a circular industrial sector in Almaty, companies retain ownership and take responsibility for a product throughout its lifetime, supporting its durability and usability with predictive maintenance, efficient use, and repurposing or remanufacturing after the use phase. Recycling rather than landfilling becomes the last resort option, applied only when the value of the configuration of the product no longer exceeds the value of its embodied materials.

Almaty hosts a range of recycling industries. Its paper industry is processing secondary paper, steel mills uses scrap metals and even glass is processed nearby. Only recovered plastics are exported for processing into granulates in another province. To demonstrate the value of recycling, the secondary origin of materials can be made more visible and explicit. Perhaps even some of the small-scale recycling, or reuse of recycled materials or products, can take place within the city to give these processes more visibility.



1 WASTE AS A RESOURCE FOR CONSUMER PRODUCTS AND CONSTRUCTION MATERIALS

Strategy description

Almaty has taken measures to increase the recovery and recycling rate of secondary materials. Next to the informal collection, professional companies are creating collection and processing infrastructure. However, residents seldom see what their separation efforts bring. When branding products from recycled materials, or even allowing communities to make their own products or construction materials, recycling becomes more tangible and valuable.

ReTuna[222] is a warehouse in Sweden where old goods and materials are repurposed through repair and upcycling. BMW[223] is using waste plastics for car parts and Eindhoven used crowdsourced plastics waste for the façade of a new building.[224] Other examples are where recycling centres also accept products with residual value and help find a new user in a physical warehouse or online marketplace.

Next steps

Building on existing initiatives, like Darmarka,[225] the city of Almaty can provide vacant space to start up initiatives based on the concept of ReTuna.[226] Such a repurposing warehouse can be combined with a new or existing recycling station.

The concept can even be tested in a temporary building which is vacant, or temporarily build for this purpose. When successful, the concept can be scaled and replicated into other parts of the city. An example is where a community is mobilised to collect and process plastic waste. The tiles for the showcase People's pavilion,[227] were literally 'crowdsourced' construction materials.

2 REMANUFACTURING

Strategy description

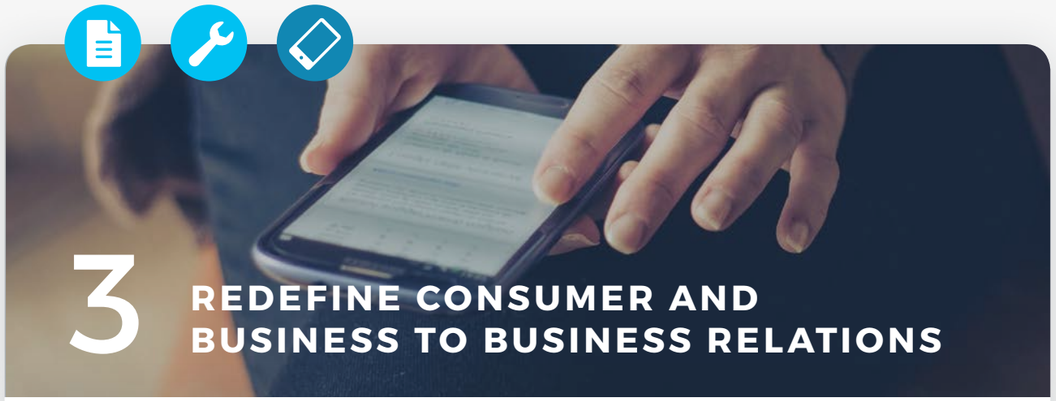
Almaty has retained its light assembly and manufacturing industry and it already has a large car repair centre at Altyn Orda.[228] The presence of light industry and repair expertise in Almaty, could position the city as a remanufacturing hub for vehicles, car parts, furniture like Gispen and perhaps even machinery, like pumps and boilers.

Renault,[229] for example, reported that its remanufacturing facility in Choisy-le-Roi, France, is giving the company an important competitive advantage. Another example is furniture company Gispen, which is upcycling old furniture into new products, like turning old closets into skype booths.[230]

Remanufacturing requires reverse logistics of secondary products and a connection with remote markets. The Belt and Road Initiative is improving connectivity. By lowering transport costs, it can help position Almaty as a remanufacturing hub which provides added value to used products.

Next steps

Remanufacturing can start small, at workshop level for furniture, clothing or bicycles.
For construction elements or vehicles, it soon becomes an industrial operation. This requires significant investment and rather starts with a thorough assessment of the market opportunities and business model.



3 REDEFINE CONSUMER AND BUSINESS TO BUSINESS RELATIONS

Strategy description

To have guaranteed access to resources and be able to incorporate reuse and remanufacturing into the business model, the producer could retain ownership. That is where service models provide an alternative to sales models. The advantage is that the producer of the product, has an incentive to provide a product which lasts, requires little maintenance and has a high end-of-life value.[231]

If sales are the primary source of revenue for a company, it could design a product with a limited lifetime in order to propel future sales.[232] Phrased differently: 'Ownership is only worthwhile if the asset appreciates'. When selling the service which a product provides, rather than the product, future business and customer relations will be based on relations, rather than transactions.[233]

Manufacturers can choose to provide furniture, boilers, pumps vehicles and many other products as a service, developing stronger customer relations, and allowing them to recover the product after use and repurpose it.

Service models are not new. Public transport is a common service model, and in Kazakhstan the concept is also venturing into the rental and sharing of bicycles and cars. Cities are also using service models to operate and improve their street lighting systems. International examples are Rolls Royce which invites airlines to pay per hour for the use of their jet and ship engines[234] and IKEA is exploring service models for furniture.[235]

Next steps

Service models can be tested on a small scale. They require a different customer approach, contractual relation and even financial model. These aspects are not new, but an organisation which wants to move to service models may not yet be familiar with them. Learning from peers and experts,[236] often in very different market segments, can provide the necessary comfort to take the step.

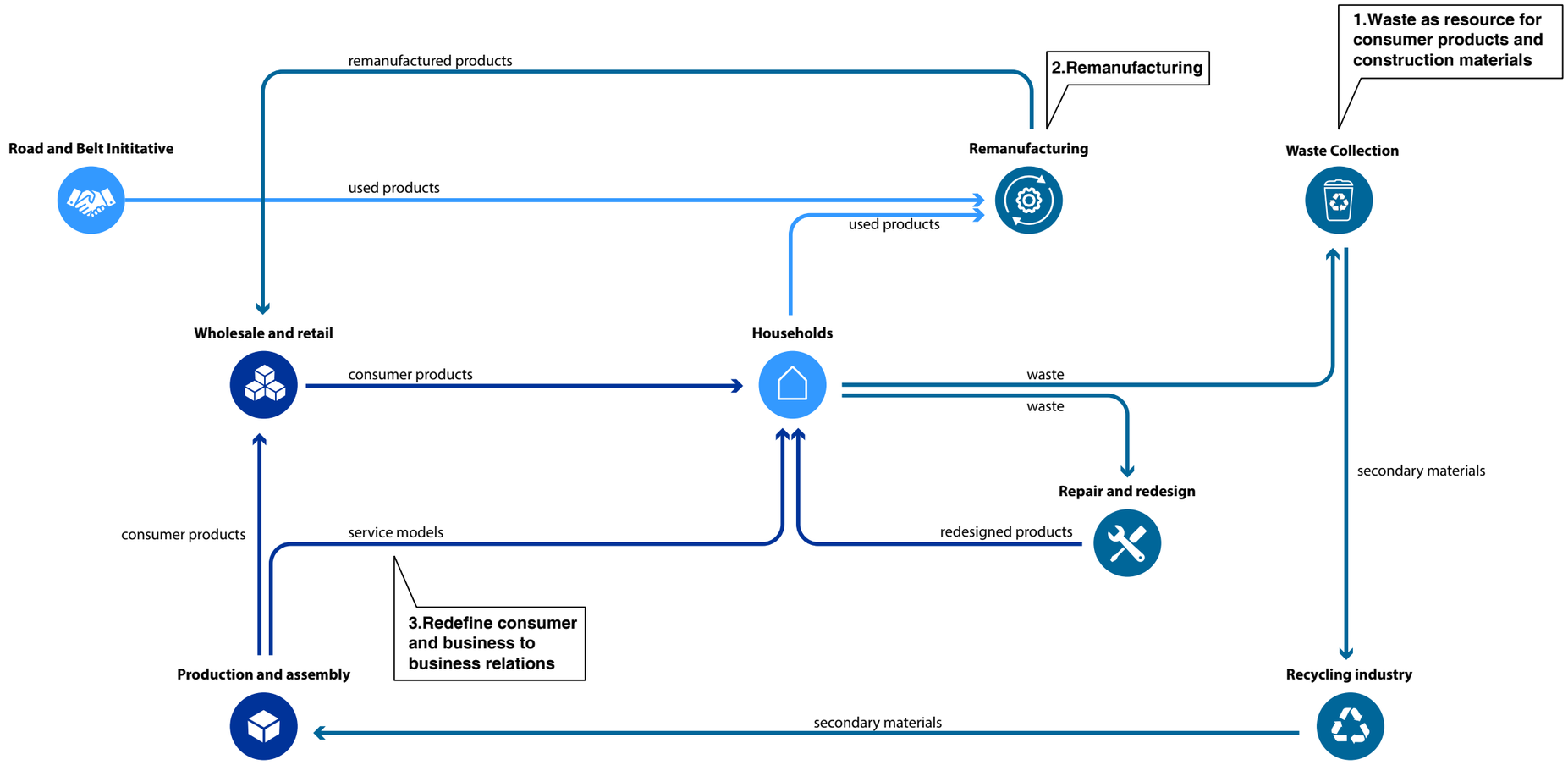
Charyn Canyon near Almaty.

3.12 INDUSTRY: ALTERING RESOURCE FLOWS

Recycling reduces greenhouse gas emissions for nearly all product and resource types. An analysis of 53 products and materials showed that for 49 of them, using recycled resources decreases GHG emissions, compared to producing the same amount of product with primary resources.[237]

By recycling an estimated 113,000 tonnes of materials, Almaty is already avoiding upstream greenhouse gas emissions with an estimated 173,000 tonnes of CO_2 equivalents. When expanding the recycling activities in the city, that figure will further increase. This way, Almaty can contribute to the national greenhouse gas mitigation ambitions.

When repurposing and reusing goods within the city, the lifetime of products is extended. This avoids the sourcing and processing of new primary materials to produce replacement products. Goods will circulate in the city for longer, reducing imports.

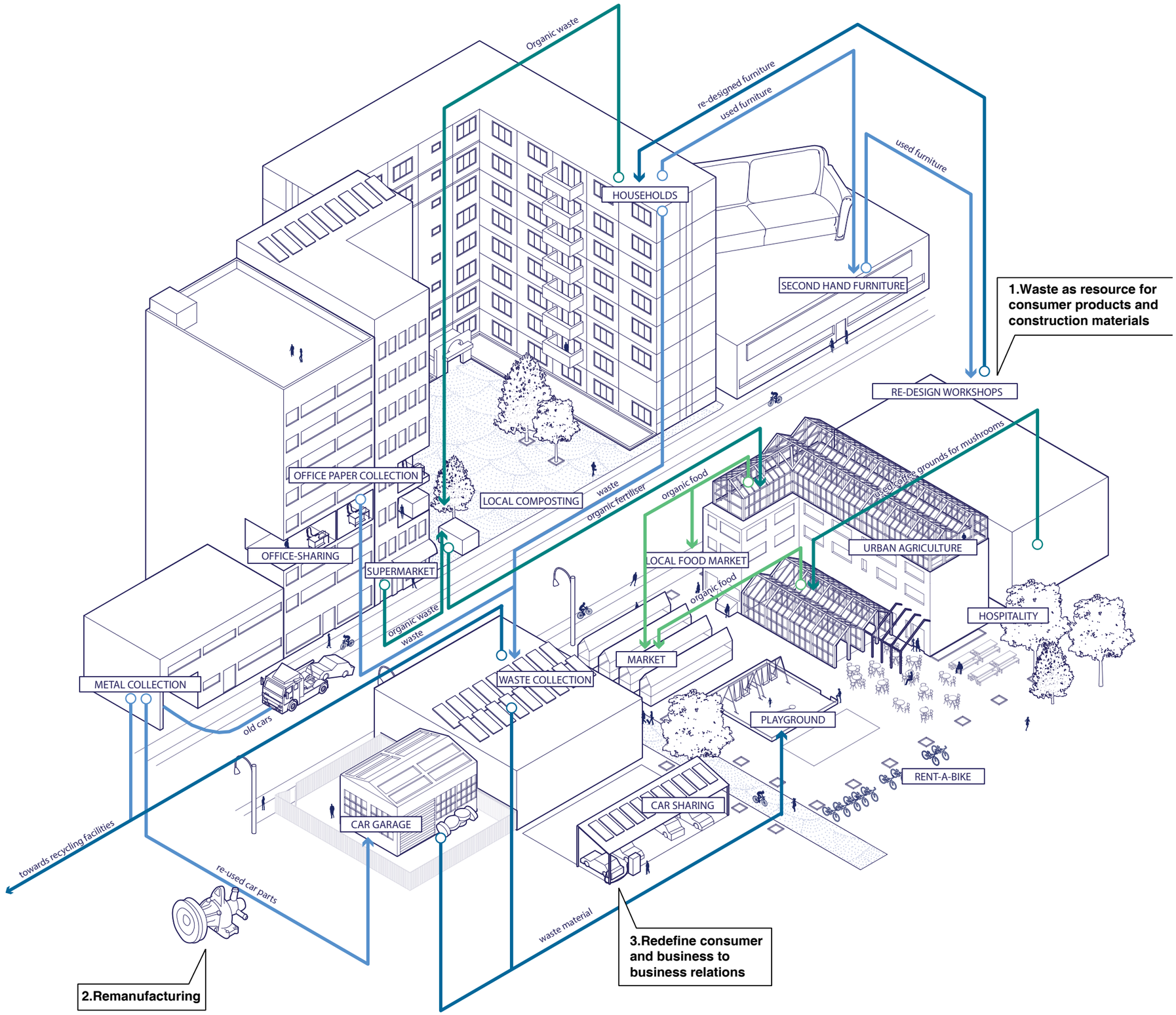


3.13 INDUSTRY: CIRCULAR FUTURE

In a circular future Almaty, smaller, light industries or workshops have a place in the city, providing vibrance and life to residential areas. Keeping creative workshops and small recycling initiatives in the city also gives people nearby access to a range of creatively designed, recycled and repurposed goods, at an affordable price. The urban masterplan could provide space for circular grassroots organisations to find a place to develop their business and expand when they are successful.

Refurbishing products in the city showcases the value of materials and products. A product typically embodies a range of materials, which are bought together in a configuration which people immediately recognise as a mobile phone, washing machine, car or a coat. The value of the configuration can be retained when a product is not just recycled, but repaired, reused and perhaps even repurposed for as long as possible.

In a circular Almaty the repurposing, redesigning and reusing of materials is not an activity hidden in industrial estates, but it takes place right where the products are used. Consumers can visit the workshops, either to purchase secondary goods or steer the design of their tailored made new piece of furniture. This provides employment to skilled craftspeople and designers, and puts secondary good, or products with a story, at par with new products.



3.14 UTILITIES, PUBLIC, COMMERCIAL AND FINANCIAL SERVICES: FACILITATING A CIRCULAR FUTURE

A transition to a more circular economy defines new roles for the food industry, manufacturing and construction. Other sectors have a clear role in supporting the transition to a more resource efficient, low-carbon economy. This section explores what their new roles could be.

Public services: Healthcare, education, public administration and science

Urban planning can give room for circular initiatives, allowing repair, repurposing and creative design industries to develop close to residential areas. Next to this, closed cycle agricultural concepts can also provide an outlet for harvested rainwater and organic residues in urban areas. Education has an important role in further improving awareness and developing an understanding of circular economy principles. Many circular ideas can be showcased in the classroom. For example, when making creative new products out of waste, recycling plastics with Rocket Plastics[238] or making mushrooms out of coffee grounds.[239] The government could help bring these elements into the curriculum.

Science has always had an important role in guiding the development of agriculture. The Academy of Nutrition helped set up the dairy brand Amiran. The Research Institute for Horticulture[240] supports farmers with applying effective production methods and selecting appropriate planting materials. Science can perhaps also assist the agricultural sector with finding the optimum mix of organic residues to produce a soil enhancer that is tailored to the current soil conditions in Almaty region.

A circular economy can be encouraged by the municipal administration by considering circular concepts in its urban MasterPlan and providing space for circular initiatives. Grassroots initiatives are important to support community engagement, target smaller resource flows at apartment block or community level, and create community awareness with a positive narrative of change. For grassroots initiatives to flourish, it is important that they are granted the regulatory and perhaps even physical space to test and develop their initiatives.

The city administration can also play a role in accelerating circular economy concepts through green or circular public procurement.[241] If the government integrates clearly defined sustainability criteria in the procurement of construction services, circular companies can gain a competitive advantage.

For the national government it is paramount that it provides the right tax incentives. A government needs revenue to operate but should collect these revenues from activities which they seek to discourage. This could include removing subsidies for resource extraction or the use of carbon intensive products like synthetic fertiliser. Ideally, the synthetic option is a last resort, when organic alternatives have been depleted. Revenues collected from removing subsidies on carbon intensive products, can be used to encourage sustainable and renewable means of production, for example, by lowering tax on labour and repair activities[242] and supporting the use of renewable resources.

During this analysis of 'Circular economy opportunities in Almaty' in 2018 and 2019, Kazakhstan was revising its green growth strategy and environmental code. The circular economy concept has not yet been fully considered when the earlier green growth strategy was adopted in 2013. The new revision is an opportunity to integrate circular policy principles and seek alignment with China and Europe.[245]

Utilities: Energy, waste and water management

Waste management companies are already investing in recycling. Composting however is not practiced at the scale which organic residue flows in Almaty allow. Almaty municipality is producing its own organic waste from the maintenance of parks and public spaces. That could be a starting point for composting or anaerobic digestion, allowing public services to close the organic nutrients cycle. Next to this, the methane from the organic material, which is already deposited in the landfill, can easily be tapped into as an alternative energy source.

Commercial services: Transport and storage, Wholesale, retail trade and vehicle repair

Transport and storage are already often provided as a service. Retail and wholesale could collaborate with second hand markets to position itself not only as a place for the first sale, but also when products seek a second or third user.

Financial services: Finance, insurance and real estate

Circular business models often require new financial models.[243] A service model requires more upfront financing than a sales model, and when separating usage from ownership, tailored insurance service can help reduce the financial exposure.[244] Likewise, flexible, modular real estate asks for similar flexibility from the real estate owner, and when financing a modular building the end-of-life value can be significantly higher than usual.

Finally, Almaty could perhaps use this analysis as a first quantification of its performance. Scientific institutes dedicated municipal departments or a newly established independent entity could continue monitoring resource flows and quantify a circularity ambition. Convening private and public sector stakeholder around a joint circularity ambition, and tracking progress with a monitoring programme, can sustain progress also in the long run.

4 CONCLUSION

The material flows in each of the material intensive sectors show that there is potential to make better use of existing materials. Next to this, each sector already supports a range of initiatives which rely on circular principles.

Agriculture and food processing

Agricultural commodities can be a renewable resource, when synthetic inputs and environmental impacts are minimised. Closing the cycle on renewable materials from agriculture and perhaps forestry is an underlying principle for a circular agriculture and food processing industry. When closing the cycle within companies, between food processing industries and farms, large volumes of organic waste can be avoided. The growth ambition of the agricultural sector is an opportunity to, already now, plan for a fully optimised flow of primary and secondary resources.

Diversifying agricultural production, tapping into urban resource flows and expanding sustainable production methods can also bring agricultural production closer to the city, giving it a more outward perspective. At agglomerate level this could include extending bike lanes to surrounding agricultural areas and expanding leisure activities like ecotours to organic farms. At the level of a city district or even courtyard, this involves local use of organic resources to produce food within or close to residential areas. This could be on collectively maintained soil or, landshare schemes with nearby land owners or in designated, more intensified facilities for aquaponics or greenhouses. An underlying objective is to avoid that residential areas only have a residential function, with limited interaction and activity at street level.

Construction

Design is the key to circular strategies in the construction sector. The very elementary principle of considering energy and resource use in the design phase of a building can bring down energy use with 70%, and turn the building into a net sink of CO_2, rather than a source of greenhouse gas emissions. This entails passive design, adjusting the design to incorporate secondary remanufactured construction elements and using construction materials from renewable rather than carbon-intensive origin. Replacing conventional materials with wood-based industrial products can avoid greenhouse gas emissions with 2 to 9 tonne of CO_2 per tonne wood applied. This will have a major impact on resource flows by optimising the use of locally available secondary and renewable resources rather than relying on materials which are imported into the region.

Preservation is a second element of a circular construction sector. Public opposition is growing against modernising the exterior of buildings or demolishing existing buildings with certain historic or cultural value. In its urban development, the city can either seek interesting combinations of traditional and contemporary architecture or integrate elements from demolished structures into new buildings. As a next step, the potential of sustainable design, with use of crowdsourced, renewable or even secondary construction materials can inspire a circular future for the whole sector.

Industry

Almaty hosts light and some heavy industries and most of the recycling activities which build on resources from the city are still located within the region. Next to this, there is growing interest in reusing products, both financially driven or attracted by the appeal of products with a story. Fully exploiting the use potential of a product, and perhaps repurpose it with creative design and crafts, can keep products out of the waste bin for as long as possible. The industrial approach to this is remanufacturing. This can be applied to car parts, furniture and even construction elements. Service models can support these approaches, by incentivising companies to produce products that last, allowing them to retain ownership and run take-back schemes.

At industrial scale, remanufacturing initiatives can take advantage of the enhanced connectivity offered by the Belt and Road Initiative. At workshop scale, circular economy solutions can help keep small assembly, design and repair activities within the city, avoiding that citizens need to travel far to access certain services, acquire circular products or get an interesting job.

Other sectors

The government could become the facilitator and enabler of economic development. This asks for new forms of governance and public capacity. The national government can provide the right incentives for improving resource efficiency. The tax regime and government spending should be aligned with national sustainability ambitions. Revenues from environmental levies can be used to lower labour taxes and facilitate labour intensive circular activities which tap into domestic, rather than imported resources.

Local governments rather have a role in providing space for local production and small-scale industries or design workshops which harvest and create value out of locally available resources and products. This is where the circular economy also touches upon urban master planning and perhaps allocating temporary locations to grassroots initiatives. Next to this, circular procurement can help make circular business models a decisive competitive advantage.

Education has an important role in engaging the next generation in the importance of sustainability. Some small and larger initiatives already mobilise schoolchildren to recycle materials and create new products. The government could help integrate more circular economy concepts into the curriculum.

Science on the other hand can help with the development or testing of circular solutions, tailored to the specific conditions in Almaty. This could range from finding the optimum mix of input materials to produce a soil enhancer through composting or anaerobic digestion.

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CIRCULAR ECONOMY
OPPORTUNITIES IN ALMATY

Almaty is the first city in Central Asia which underwent a circular economy opportunities analysis. The city is experiencing impressive economic growth and is re-establishing its position as an exporter of agricultural commodities. As an important station on the Belt and Road Initiative, Almaty sees its connectivity with Europe, China and other regions improving, easing international trade. Next to this, there is momentum as the city is expanding, and its government is gradually opening its urban planning to a public debate, tailoring the development of the city to the immediate needs of its citizens.

In agriculture, the most promising circular economy opportunities lie in diverting organic residues away from landfills and processing them into a soil enhancer or organic fertiliser. The agricultural production ambitions in the region will require investments in soil quality. Specific residues can also be used as substitute for products which are imported, further diversifying local production.

Local industries are already collecting and recycling a significant share of the mineral and metal residues. The improved connectivity to foreign markets through the Belt and Road Initiative can support extending the extension of manufacturing capacity with remanufacturing, whereby used products or components are refurbished as new. This could include car parts, furniture and even construction elements. Taking this even further, service models can support this approach, by incentivising companies to produce products that last, allowing them to retain ownership and run take-back schemes to offer the product to a second or even third user in, perhaps, different market segments.

Also within the city, designers and fabricators can tap into secondary products and to repair, repurpose and redesign them into fashionable new products. Circular economy concepts can help keep small assembly, design and repair activities within the city, avoiding that citizens need to travel far to access certain services, acquire circular products, or simply get a satisfying job.

Circular strategies in the construction sector are based on passive design, adjusting the design to incorporate secondary remanufactured construction elements and replacing carbon-intensive construction materials with materials of renewable origin. This starts with design. Merely considering energy and resource use in the design phase of a building can bring down energy use with more than half. Design can also open opportunities for the use of secondary and renewable construction materials, potentially turning the building into a net sink of CO_2.

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