BUILDING METABOLISM

DEFINITION OF THE MAIN METABOLIC ASPECTS
FOR ADVANCED ECOLOGICAL BUILDINGS

Graduate School of Urbanism
shukhov lab

DEFINITION OF THE MAIN METABOLIC ASPECTS FOR ADVANCED ECOLOGICAL BUILDINGS

MASTER PROTOTYPING FUTURE CITIES

GRADUATE SCHOOL OF URBANISM,
NATIONAL RESEARCH UNIVERSITY HIGHER SCHOOL OF ECONOMICS

Faculty: Elena Mitrofanova, Vicente Guallart
Supervisor: Vicente Guallart

Students:
Altynai Nogoibaeva, Anna Budnikova,
Michael C. Omona, Neeraj Mazumder

Moscow 2018

·Graduate ······
·School ·········
·of Urbanism ···

INDEX

SELF-SUFFICIENT CITY
1000 PEOPLE BLOCK PROTOTYPE

The Challenges of the developing world are too often neglected and urban planners are unable to cope with the challenges of growing city populations. Today's urban needs are insufficiency and poor management of resources.

Moscow as a city with a population of more than 12 million - is also has a high number of both ecological and social problems. Despite the fact that government pursues a policy of conservation of natural resources and energy efficiency, natural resources are used extremely irrationally and inefficiently. For example, today, the average water consumption in Moscow is 147 liters per day, which exceeds human needs by about 2.3 times. Despite the fact that this amount decreased by almost 300 liters compared to 2005, cities with distributed water supplies and recycling systems consume much less water (for example, Barcelona, London or Copenhagen).

It is proposed that the building models be looked at differently - as self-sufficient residential blocks modeled for Moscow, that would be autonomous and independent of the central infrastructure. The goal of this project is to identify the advantages of the planned distributed supply system, in contrast to the usual centralized systems in Moscow.

It is important to ensure the zero waste cycle in all of them and focuses on their interconnections and smart use. For example, if water is managed in an intelligent way by functioning in a closed cycle, all the waste water can be treated and the consumption rate lowered according to the actual population's needs. Thus consumption is lowered where possible by reuse of water and elsewhere by shared consumption.

DEFINITIONS

Urban metabolism is a framework for modeling complex urban systems' flows – water, energy, food, people, etc., considering it as an ecosystem. It can be used to analyze how urban areas function with regard to resource use and the underlying infrastructure, as well as the relationship between human activities and the (natural) environment. What is more, it can be used to shape the urban environment in a more sustainable way. (Fischer Kowalski, 2002)

Sustainable development is the organizing principle for meeting human development goals while at the same time sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society depend. Sustainable development, or sustainability, has been described in terms of three spheres, dimensions, domains or pillars, i.e. the environment, the economy and society. (Cerin, P. 2006)

Centralized city infrastructure is the process by which the city infrastructure and administrative processes, especially those pertaining to planning and decision-making, are concentrated within a particular location or group, maintaining critical decision-making within the city's Central Administrative Core, for instance, the Mayor's office.

Decentralized city infrastructure - activities of institutions, particularly those regarding planning and decision-making, are distributed or delegated away from a central, authoritative location or group. It also means that the infrastructure is likewise spread across the territory of the city, forming multiple centers each of which is self-sufficient and self-sustaining with the capacity to facilitate the needs of the residents.

Distributed city infrastructure, further down, a decentralized systems evolves into a distributed system. This implies a network of multiple self-sufficient blocks interconnected between themselves to form a network ensuring connectivity between all nodes.

LAYERS

Mobility

Existing types of transport that use fossil fuels for power are the main cause of pollution within cities. In this proposal, since citizens would have the option to work near their residences, private cars would be replaced by shared electromobiles, drones, etc. running on solar energy. This would allow the city to give more space to pedestrians.

Energy

Currently, the production of energy by plants outside the cities, where fossil fuels are burnt, increases CO^2 emissions. Renewable energy would allow the system to be decentralized and provide a sustainable environment with clean air. Citizens can have the possibility to manage their resources by producing and storing energy within the building complex.

Water

Poor management of resources and insufficient water infrastructure causes a number of urban problems. If water is managed in an intelligent way by functioning in a closed cycle, all the waste water can be treated and the consumption rate lowered to meet the actual population's needs.

Food production

Urban dwellers depend on the supply of food from the rural areas since these processes happen outside of the city. If food is produced locally, the cost of transportation and production would be lowered and more people would be able to have access to clean local food. It is also proposed to use rainwater and solar energy to provide this.

Matter

The waste produced in cities usually goes to landfills outside the country of provenance. In a circular economy products or resources are reused for the maximum value rather than for the landfill.

Information

A building operating system (OS) would optimize the utilities and power consumption. For overall efficiency, integration of the sensors and utilities is key. The data generated gives a building efficiency profile.

CENTRALIZED SYSTEM
MOSCOW

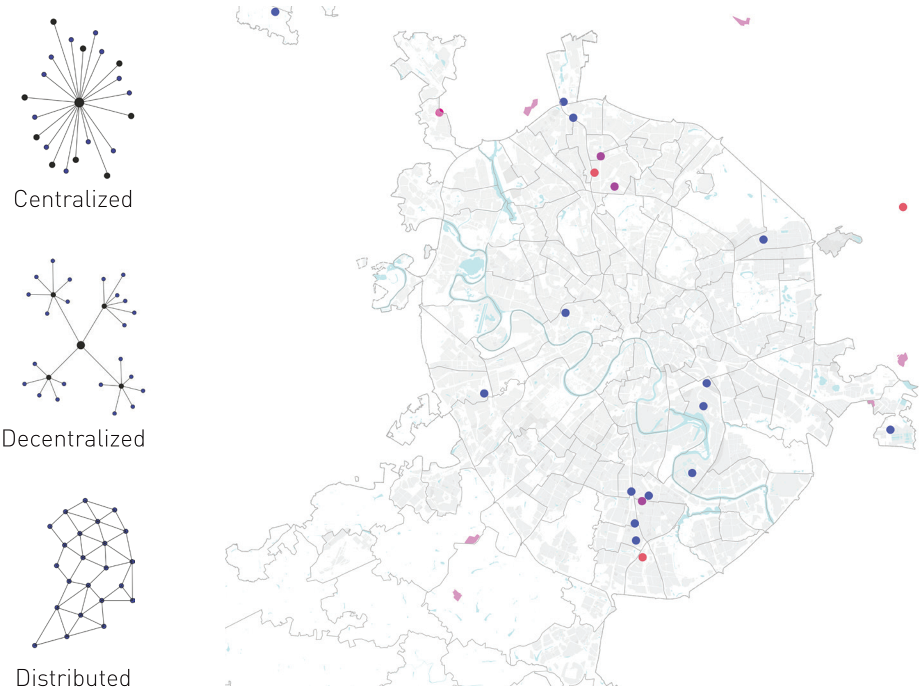


Figure 1
City infrastructure

Moscow's highly centralized system does not function according to energy efficiency principles, which require the ability to make adjustments to meet individual needs. Energy efficiency has become a Moscow's priority based on the Skolkovo policy. For example, the government is interested in privatizing the heating sector and attracting international partners. However, Muscovites cover only two-thirds of the cost of producing heat.

Currently, Moscow could be characterized by:

- huge travel distances
- centralized infrastructure
- time wasted in transit
- inefficient resources use
- lack of social interaction

CURRENT MOSCOW INFRASTRUCTURE IN DIAGRAMS

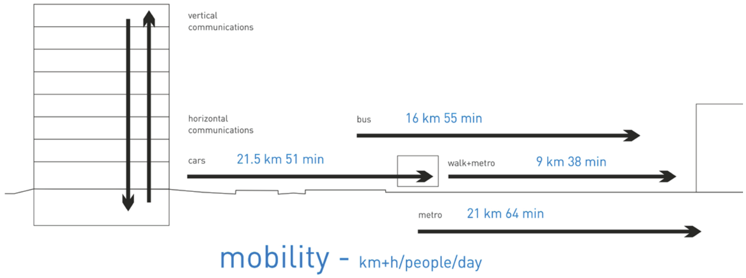


Figure 2
Centralized mobility infrastructure and daily consumption per capita.

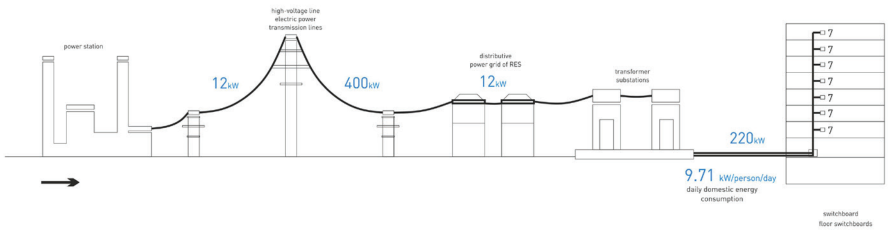


Figure 3
Centralized energy infrastructure and daily consumption per capita.

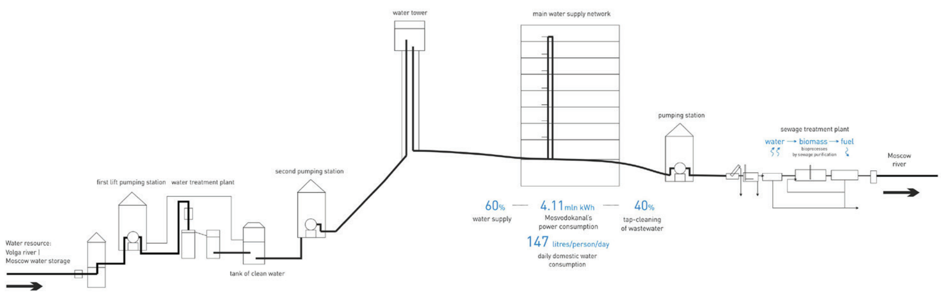


Figure 4
Centralized water infrastructure and daily consumption per capita.

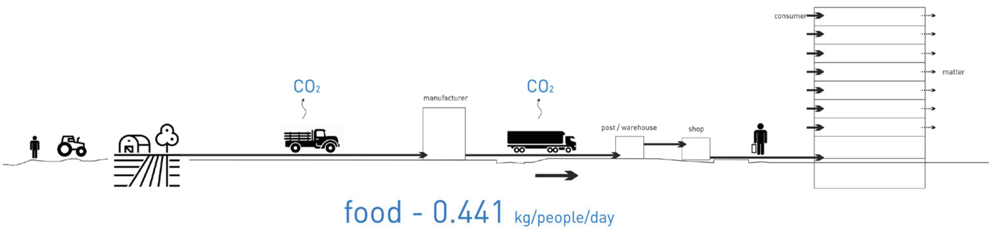


Figure 5
Food production infrastructure and daily consumption per capita.

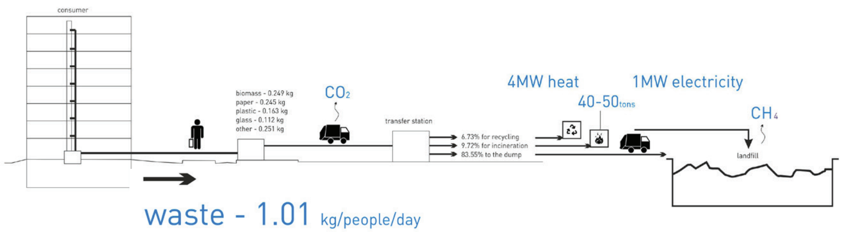


Figure 6
Waste management infrastructure and daily waste production per capita.

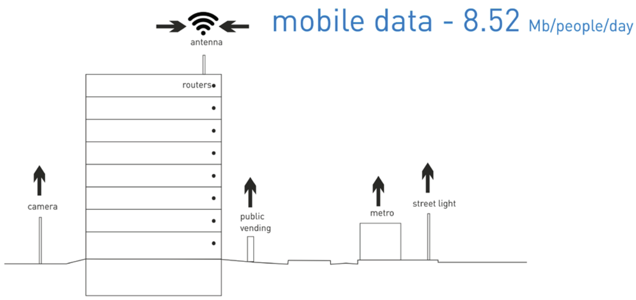


Figure 7
Data generation infrastructure and consumption per capita

ENERGY
consumption
per capita
average | daily

Total: 5819 kW/h

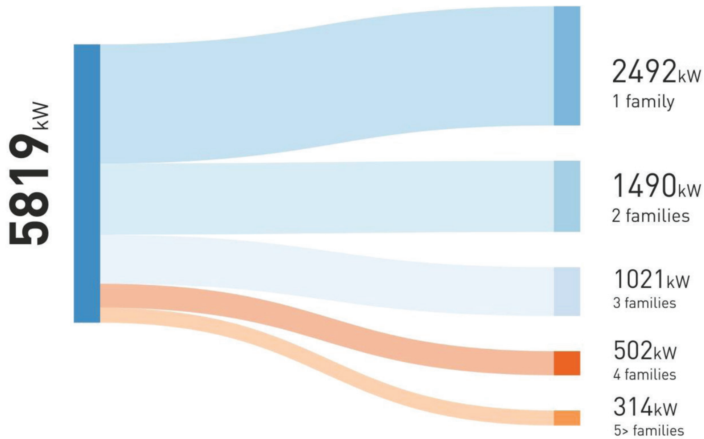


Figure 8
Sankey diagram. Daily energy use per capita.

WATER
consumption
per capita
average | daily

Total: 147 litres

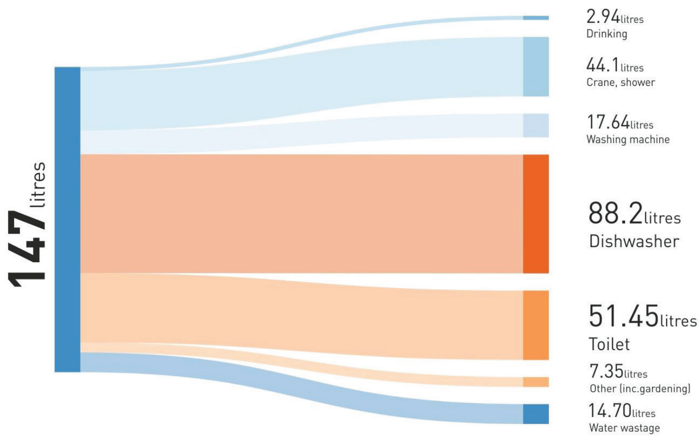


Figure 9
Sankey diagram. Daily water use per capita.

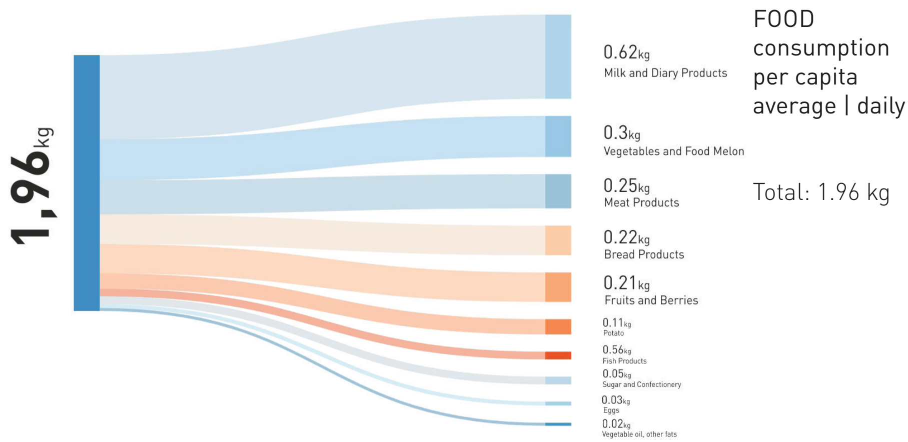


Figure 10
Sankey diagram. Daily food consumption per capita.

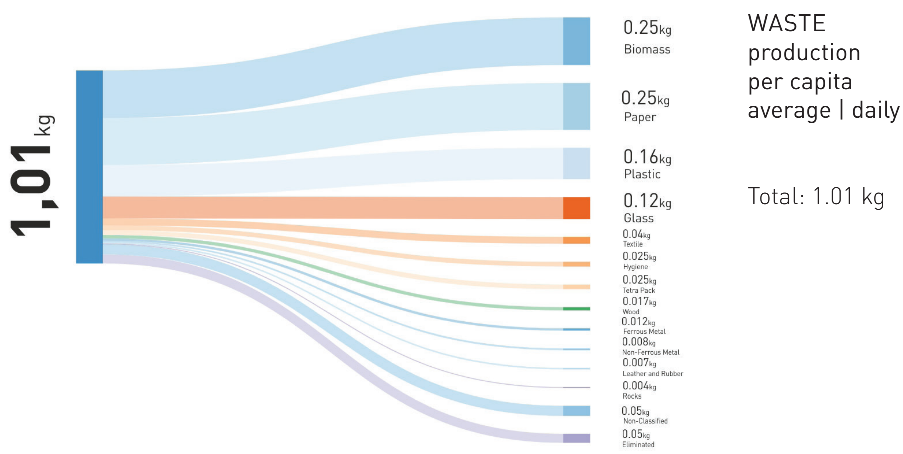


Figure 11
Daily waste production per capita.

MOBILITY

MOBILITY
LAYER ANALYSIS

Mobility is the ability to get to point B from point A, in which there are a lot of factors that matter. Citizen mobility is affected by such factors as quality of environment, availability of parking lots, comfortable public transport, convenience of routes and many others.

The Economics of the city is based on its mobility and various options should be available to support it. For logistics companies mobility is a key factor and it should be predictable. For citizens it's important to provide local mobility to achieve routine needs with comfort and global mobility for participation in urban life. Local mobility is focused on the neighborhood scale and is based on the quality of human-powered transport. Global mobility on the other hand is based on district interconnections and motorized transport.

There are three types of existing transport – private, public and shared. A Major portion is human-driven; however, self-driving cars are currently being tested. The Moscow Transport policy is to reduce number of vehicles on the road, by motivating people to use public network. Mobility is a key factor of air pollution and land use – up to 70% of emission produced by cars. In car-oriented cities free space very often becomes parking space. In big cities mobility shouldn't be an element of status, but rather an efficient system that provides a major function in the most effective way.

The critical nature of the Mobility Layer is highlighted by the fact that all city processes which are physical in nature would in one way or another require logistics for moving the physical item from place to place. This challenge is further compounded in highly centralized urban environments by the dense transportation arteries that take up a significant part of urban space. This documents assesses the existing logistical infrastructure which is made of transportation routes and various vehicles with the intention of determining ways to optimize these routes and where possible eliminate redundant logistical processes by initiating smarter design of infrastructure, distributing services so as to ensure that the pedestrian culture is revitalized and prioritized over other modes of conveyance.

TYPES OF TRANSPORT

Existing transportation types powered by fossil fuels are the main source of cities' pollution.

Electric cars, buses and trolleys are among the more eco-friendly of existing modes of transport.

Public transport

Shared transport

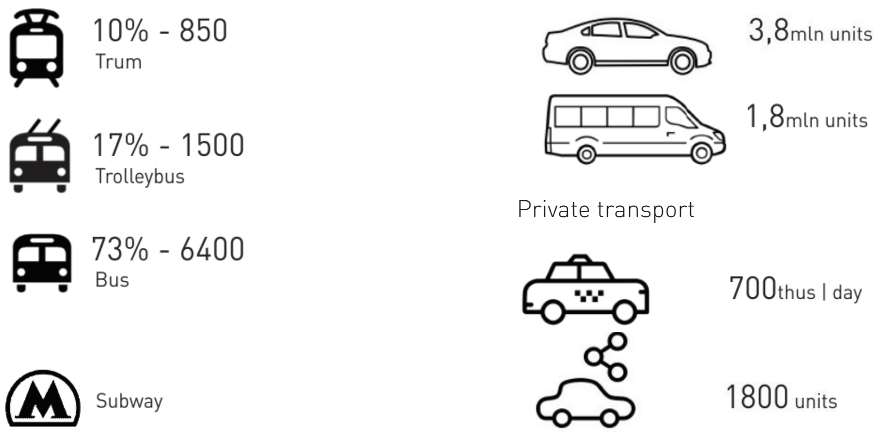


Figure 12
Types of transport.

PARKING PARAMETERS

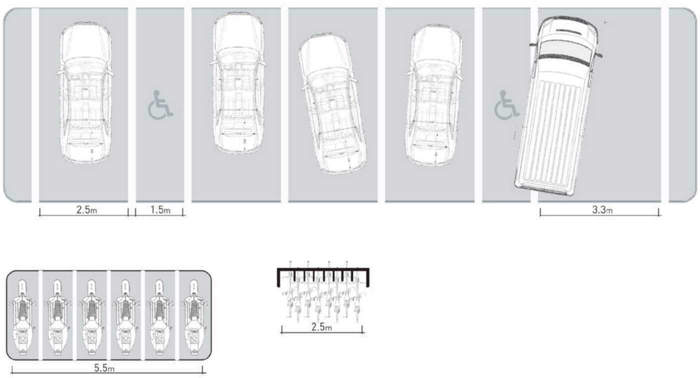


Figure 13
Parking parameters.

- Locate designated parking spaces in convenient location in relation to entrance and exits.

- Make sure ticket dispensers are accessible, understandable and usable.

- Include intercom and display for ticket machines.

DISTANCE
average | daily

Total: 18 km

TRAVEL TIME
average | daily

Total: 106 min

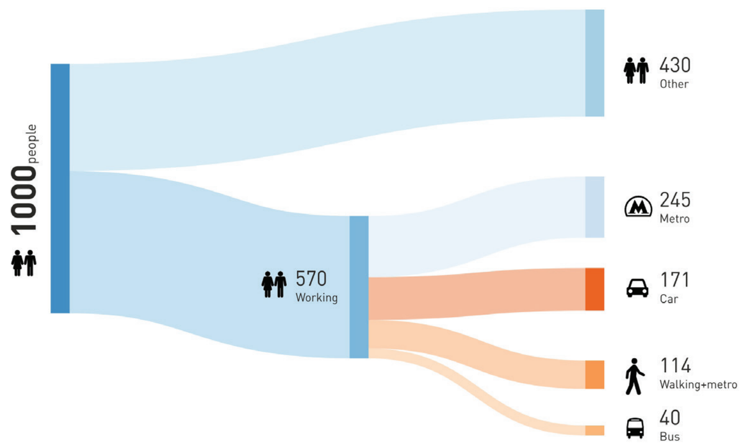


Figure 14
Sankey diagram.
Types of transportation used by 1000 people.

TRAVEL ROUTES

Work
More than fifty percent of Muscovites work. An average citizen spends almost an hour to reach work. He travels 18 kilometers on average. Contrary to the assumed stereotype, only 30% actually use cars.

Education
Urban planning policy stipulates that schools should be accessible within 500 meters and kindergartens within 250 meter. Ideally, schools should be within walking distance for pupils. Otherwise, parent usually choose schools located along their route to work.

Services
Most of polyclinics, gyms, cinemas, etc are located within areas of pedestrian accessibility.

Leisure
Shopping malls used to be a place for prolonged leisure not long ago. However, the trends are changing, people choose alternative leisure styles, thus avoiding or reducing consumerism. With revitalization of parks and new pedestrian routes, walking has increased. Unfortunately new walking routes only exist at the center.

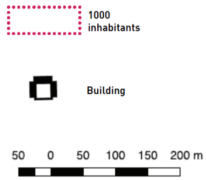
Shopping
In Moscow there are some distributed food chains of different scale for everyday use. Also there are hypermarkets for holiday trip. Local stores are appearing in last time, but also in format of chains. Very few retail streets are compensated by huge malls, where dozens of brands are located under one roof.

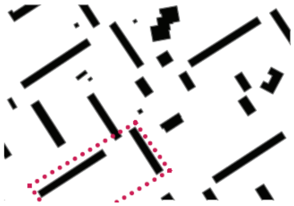
LIVING AREAS

1730
500 inhabitants
Kuznetsky Most - 13000 per km2

1930
200 inhabitants
Sokol Village - 16000 per km2

1960
3000 inhabitants
Izmaylovo - 20000 per km2





1970
7000 inhabitants
Lavochkina st. - 14500 per km2

1980
6000 inhabitants
Fili - 9500 per km2

Figure 15
Density of residential areas.

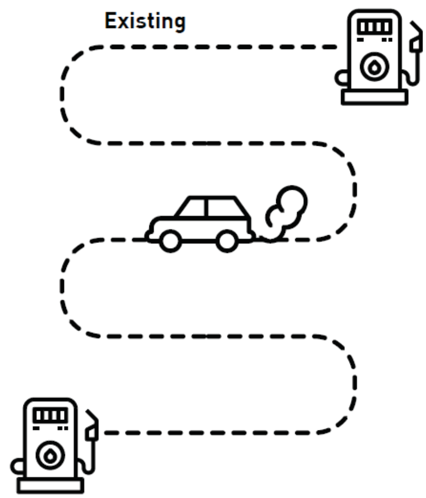
Last mile is a term used in supply chain management and transportation planning to describe the movement of people and goods from a transportation hub to a final destination in the home.

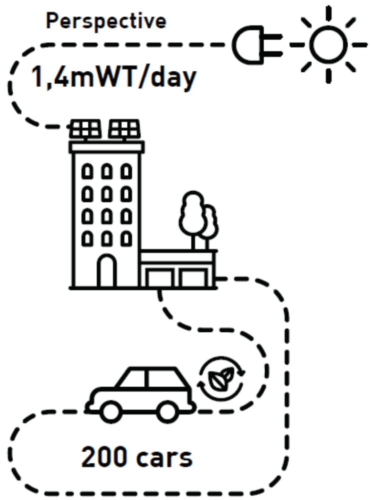
Transporting goods via freight rail networks and container ships is often the most efficient and cost-effective manner of shipping. However, when goods arrive at a high-capacity freight station or port, they must then be transported to their final destination. This last leg of the supply chain is often less efficient, comprising up to 28% of the total cost to move goods. The main challenges of last mile delivery include minimizing cost, ensuring transparency, increasing efficiency, making delivery frictionless and improving infrastructure. Retail companies like US based Amazon and China based Alibaba have researched and deployed drones for delivering goods purchased Online to consumers. Amazon has also set up lockers in some urban centers as a way of consolidating packages. Automated parcel delivery is becoming a popular option these days. Europe has led the way in this with Germany, Britain and Poland being the first markets for these services.

Last mile" has also been used to describe the difficulty in getting people from a transportation hub, especially railway stations, bus depots, and ferry slips, to their final destination. Traditional solutions to the first mile problem in public transit have included the use of feeder buses, bicycling infrastructure, and urban planning reform. Other methods of alleviating the last mile problem such as bicycle sharing systems, car sharing programs, pod cars (personal rapid transit), and motorized shoes have been proposed with varying degrees of adoption. Late in 2015, the Ford Motor Company received a patent for a "self-propelled unicycle engagable with vehicle", which is intended as a last mile commuter solution. Bicycle sharing programs, however, have been widely successful in Europe and Asia, and are beginning to be implemented on a large scale in North America.

Last mile concept can be implemented between place of living and big transport hub. It's important not only to provide better public infrastructure or better place of living, but to combine them and to create seamless design. Average distance to metro in Moscow is 1.42km. Another important factor of local centers development is ability to use alternative types of transport. The only way to activate last mile is to combine better place for living with better city infrastructure.

Substituting fossil fueled vehicles by electric ones can we move from a classic model to the self-sufficient cycle. To provide 200 users everyday usage of their cars it's necessary to produce 1,4mWt*h of energy per day with solar, wind or any other "green" energy available at block.





ALTERNATIVE TYPES OF TRANSPORT

Electro chair
Honda Uni

510 x 315 x 620mm

Weight: 25 kg
Max speed: 6 km/h

Mono-wheel

448 x 419mm
D360 mm

Weight:11,4 kg
Max speed: 24 km/h
Distance*: 30 km

Scooter Segway i2

650 x 630mm

Weight 37 kg
Max speed 20 km/h
Distance: 32 km

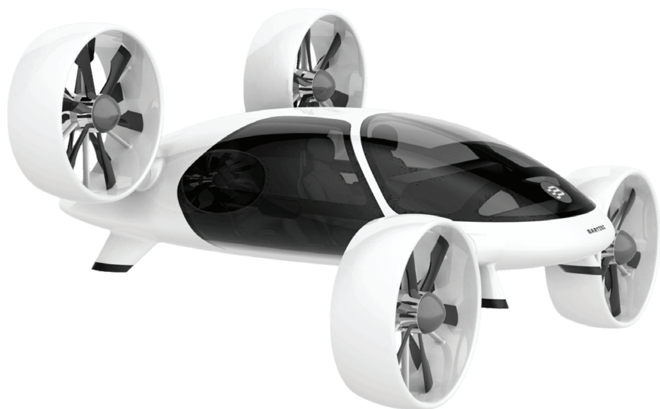
Electric skateboard

965 x 200 x 127mm

Weight 6.8 kg
Max speed 35 km/h
Distance: 11 km

Flying cars

Dock Station
6 000 x 6 000 mm



Requirements:

- noise protection
- parking and charging (solar panels)
- landing platform 6 x 6 m (4 times smaller than a helipad)
- dedicated public elevator to access the roof
- aerocar can fly in altitude range of 1000-2000 m

Dock station
1 500 x 1 500 x1 000 mm

Drone | Type 1

5 kg
735 x 735 x 550 mm
Distance 15 km
Load : 2 kg

Drone | Type 2

12 kg
780 x 780 x 550 mm
Distance 15 km
Load : 5 kg

Horizontal communication

Lane Transit Open
Gallery Leisure Semi-open
Foyer Meeting Closed
Corridor Connection Closed
Atrium Relax Semi-open
Passage Retail Open

- Pedestrian environments are logical and clear to understand
- Avoid gaps and vertical deviations between paving slabs greater than 5mm
- Keep any break in surface or gap such as a drainage gulley no greater than 10mm and perpendicular to line of travel
- Prevent accidents at changes in level to side of access route with kerb upstands, barriers or guardrail
- Design surfaces to drain water effectively.
- Sufficient lighting to provide clear vision.

Vertical communication

Staircase 5,3X3 m
33 persons/minute
Elevator 1,1X1,4 m
1 m/s
60 seconds
Ramp
1:12 = 8% = 4,80

- Avoid changes of level within a story for new buildings
- Design and maintain stairs to provide safe access at all times even if rarely use
- Install passenger lifts convenient means of vertical circulation
- Consider improving controls, signaling, safety and communication devices, and surface finishes in existing lifts

SELF-SUFFICIENT BLOCK MODEL

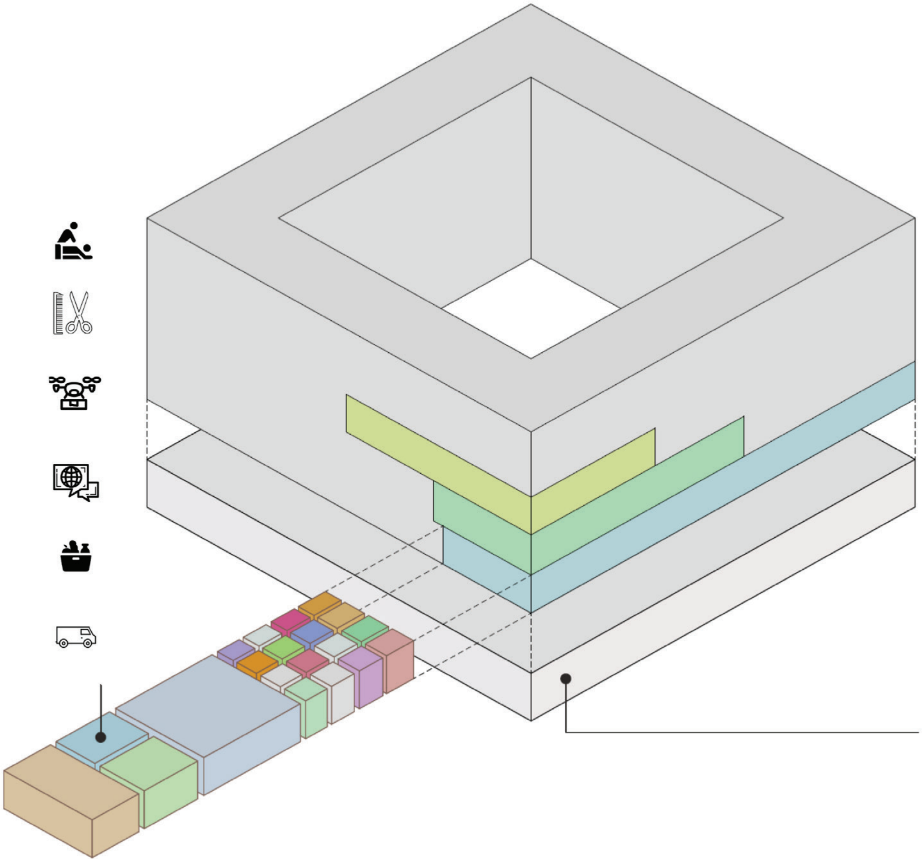


Figure 16
Mobility | Self-sufficient block proposition.

Basement, equipped with ramps and elevators can be better place for bicycle and other "last mile" transport storage. The underground parking required to store 500 bicycles in basement 600m2 is needed and to store 300 cars 6000m2 is needed.

ENERGY

The energy system in Russia was developed during the 1960's and the intensive process of energy system development during 1970-80's i.e the oil and gas industries relied largely on existing deposits and infrastructure. As of 2006, no new refineries had been built over the previous 15 years, and geological exploration had ceased entirely for the previous several years. Extraction efficiency from existing deposits is extremely low.

In 2003 a law was passed, aimed at restructuring the energy sector substantially. It called for extensive privatization of energy provision and the elimination of the Unified Energy System. In 2006 plans called for encouragement of foreign investment in power generating infrastructure. [Library of Congress, 2006] Russia in the present day still has the lowest rate of energy efficiency among all European countries, according to experts and has seen little recent progress. Potential savings on pumping equipment alone could reduce total energy consumption by up to 20% and save billions of dollars. But general inertia and a lack of expertise hinder improvements.

Russia's minuscule use of renewable, at 3.6 percent of total energy consumption, is a black spot amidst a global surge in the use of green technology, which accounted for more than 18.3 percent of the world's energy supply in 2014, according to the International Energy Agency. That gap is mainly due to Russia's historical dependence on its vast reserves of fossil fuels which since the beginning of the energy sector, had been the major source for distribution of electricity and heat to its cities and also their centralized supply of electricity and heating which according to present day standards are seen as outdated. Although there are huge wind, hydro, geothermal, biomass and solar energy resources. The challenges of scaling up Russia's use of renewable energy are significant as they are limited to specific regions. But even then it would be wrong to say that renewable cannot be implemented in regions which have a lower capacity of production. They can still make a major impact by reducing the load on the existing energy suppliers and reduce the total dependency on the central energy grid.

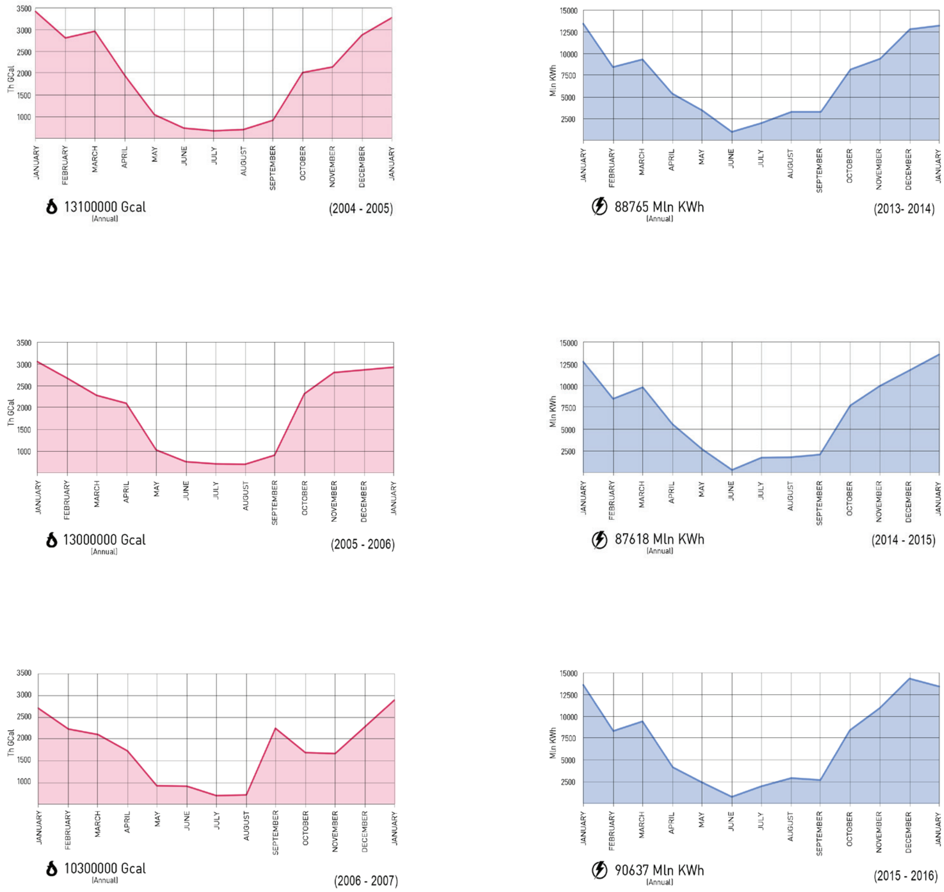


Figure 17
Annual energy consumption
in Moscow and peak seasons

source: Rosstat

In a city like Moscow, the consumption of electricity is largely dependent on the seasonality and the drastic change in temperature where the dark and cold winter months require an increased supply of heating and lighting compared to the summer months which are warm and brighter (see Figure 17). The general climatic condition of Russia is defined by a long and harsh winter climate but these seasonal fluctuations indirectly affects the overall production and consumption of Electricity. The least amount of energy for heating is spent during the months of July to August, however a considerable amount of energy is spent on individual ventilation and air conditioning but a lot less is spent on lighting. The maximum amount of energy for heating is spent during the months of September to December. Ironically, during the entire heating season from September to March, electricity is spent to supplement the heating of the house with the help of individual heaters due to poor thermal insulation of the building and large heat losses.

Although this is not the only factor which determines the consumption of energy. If we look into the consumption statistics for the city of Moscow, the demand for electricity consumption has been gradually increasing over the years and it is expected to increase by 1% per year or even less, due to the stopping of energy-intensive production and the withdrawal of consumers from the unified energy system.

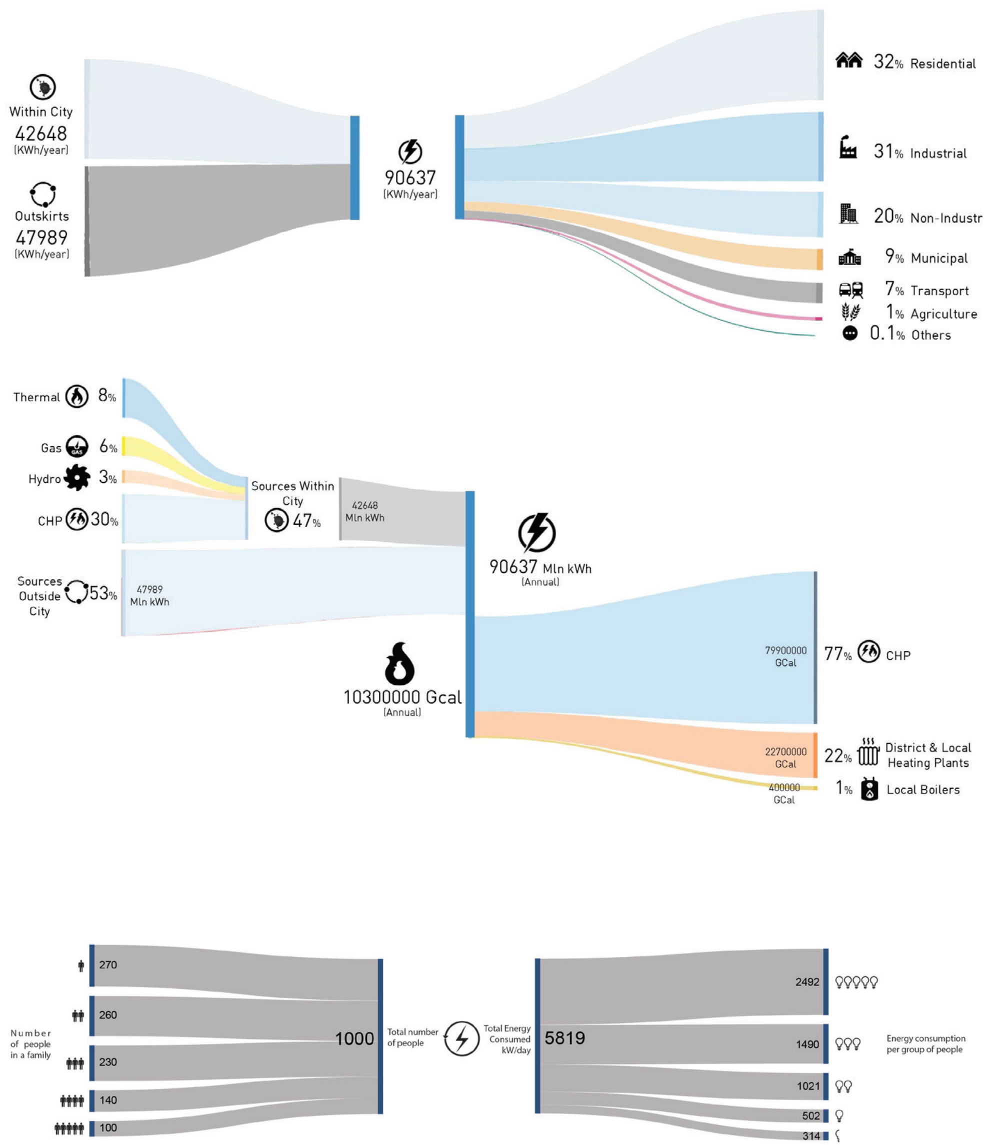


Figure 18
Sankey diagram.
Total energy consumption per capita in Moscow

ELECTRICITY GENERATION - MAP

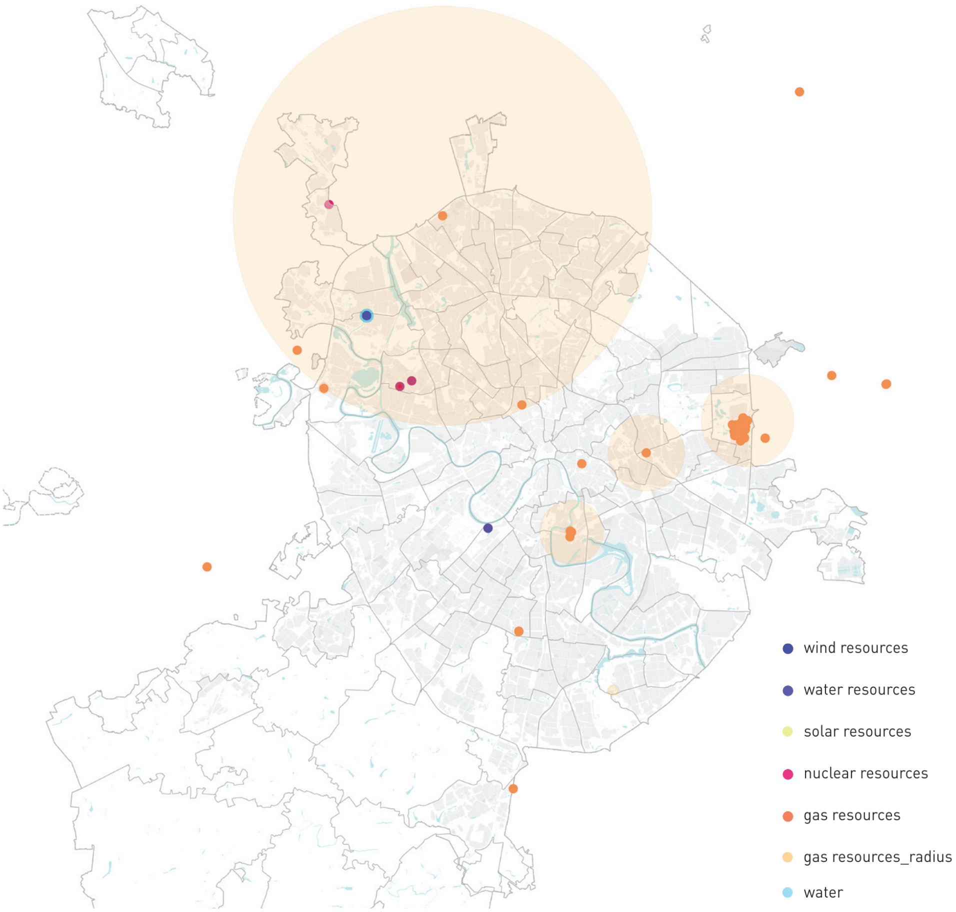


Figure 19
Map. Electricity production in Moscow

The map shows the various sources of production of electricity within the city of Moscow with the radius indicating the intensity of production in the station. Almost all the power stations located within the city supply a power of 220kV or 110kV which are suitable to be distributed for the city.

CENTRALIZED WATER HEATING FACILITIES - MAP

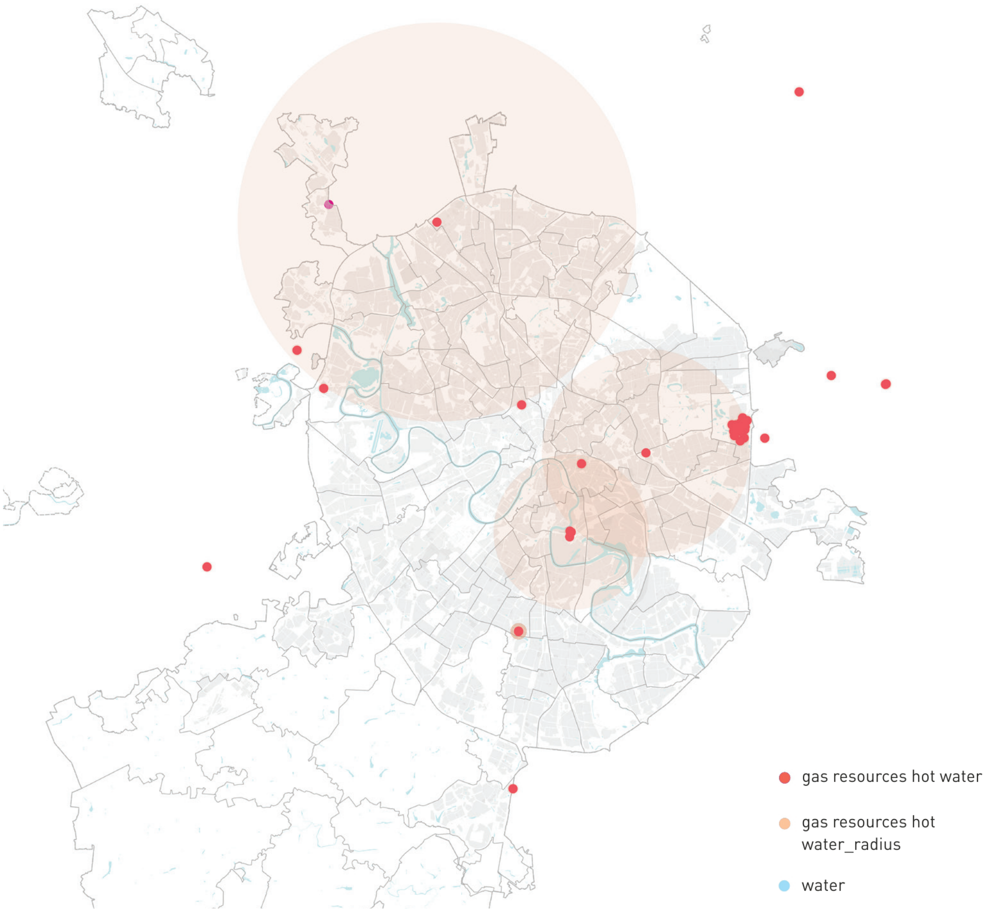
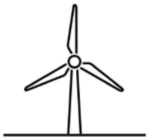


Figure 20
Map. Water heating facilities in Moscow

Water heating for the city is usually done using residue heat from the power stations or from Boiler stations located within the city. For power stations which produce the heat simultaneously along with electricity, the intensity is reflected in the radius of circle in the map while others are small plants or Boilers working independently.



Wind turbine with horizontal axis of rotation

Wind turbine with vertical axis of rotation

Wind turbine with horizontal axis of rotation		Wind turbine with vertical axis of rotation	
1*1* 1.5m	Require the installation of powerful foundations	**metal base**	Dont't require the installation of powerful foundations
10% 25%	Produces energy 10% in summer and 25-30% in winte rof the nominal capacity of the wind generator	**40% 70%**	Produces energy 40% in summer and 70% in winte rof the nominal capacity of the wind generator
300t	Has a lot of weight 200-300 tones	**70-900kg**	Light weight
150m	Should stand in the distance from other buildings	**0m**	Can be located directly on the building
4m/s	The minimum wind speed is 1.5 m/s	**1,5m/s**	The minimum wind speed is 1.5 m/s

Based on dimensions and environmental requirements, wind turbines with a horizontal axis of rotation are more suitable for placing on a scale of large urban stations outside the urban environment.

Based on small dimensions and minimum requirements for wind speed and the environment are most suitable for installation in a city on the roofs of a tall house, since they do not require a foundation and this option is suitable.

SOLAR AND WIND ENERGY POTENTIAL IN MOSCOW

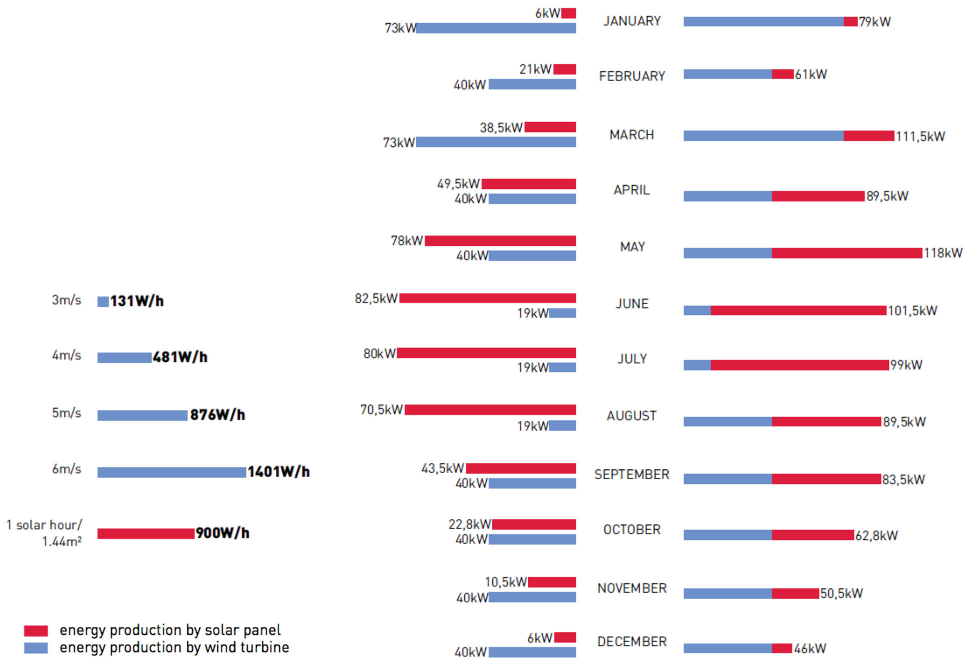


Figure 21
Solar and wind energy potential in Moscow

Use of renewable energy is a major concern for the city when the entire industry is dependent only on gas and oil. Analyzing the specifications of current day technology of solar and wind energy harvesting appliances along with the climate statistics of Moscow city, the combination of a Single Residential Scale Wind Turbine and a Solar Panel can generate almost 1900 KWh of electricity in one Year.

BIOMASS ENERGY POTENTIAL IN MOSCOW

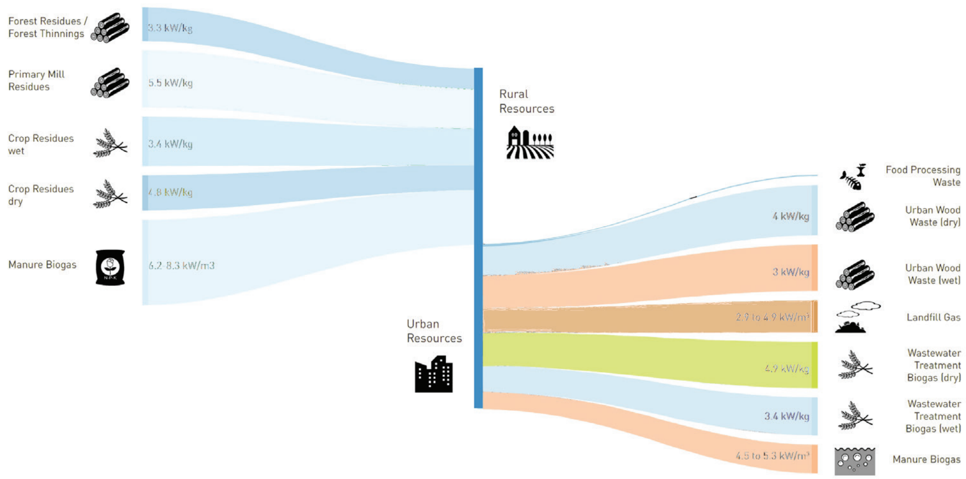


Figure 22
Sankey diagram.

source: Biomass Combined Heat and Power Catalog of Technologies (U. S. Environmental Protection Agency Combined Heat and Power Partnership)

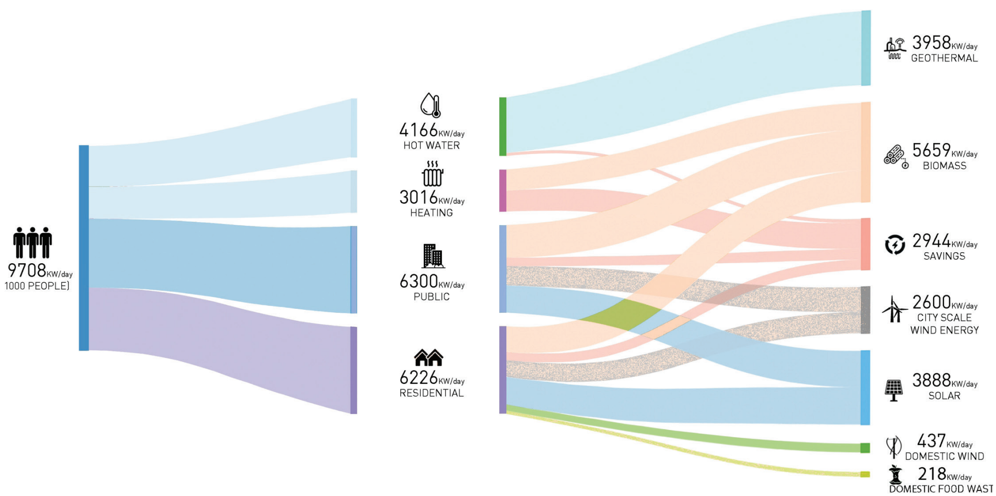


Figure 23
Sankey diagram.
Energy supply proposal for 1000 people

If energy is used efficiently within the residential sector along with the implementation of smart home systems and along with energy efficient appliances ensuring near zero energy consumption, then for a 1000 people system almost 2900kW energy can be saved per day and with a total need of 19708 kW per day for a typical residential block consisting of Public space on the first floor and residential above.

From available resources, if a system was to be created from renewable resources, Geothermal can produce almost 3900 kW/Day with a production output of 3kW per 1kW energy supplied. 1886 Kg of Biomass can produce almost 5659 kW/Day with production output at 3kW/Kg. 3888kW/Day from solar panels with a total of 2777 Panels (2.7 Panel per person) with an output rate of 1.4kW per panel.437 kW/Day from domestic wind turbines using a total of 350 turbines with output rate of 1.25kW per turbine. And finally 218kW from food waste at output 109Kg/Day.

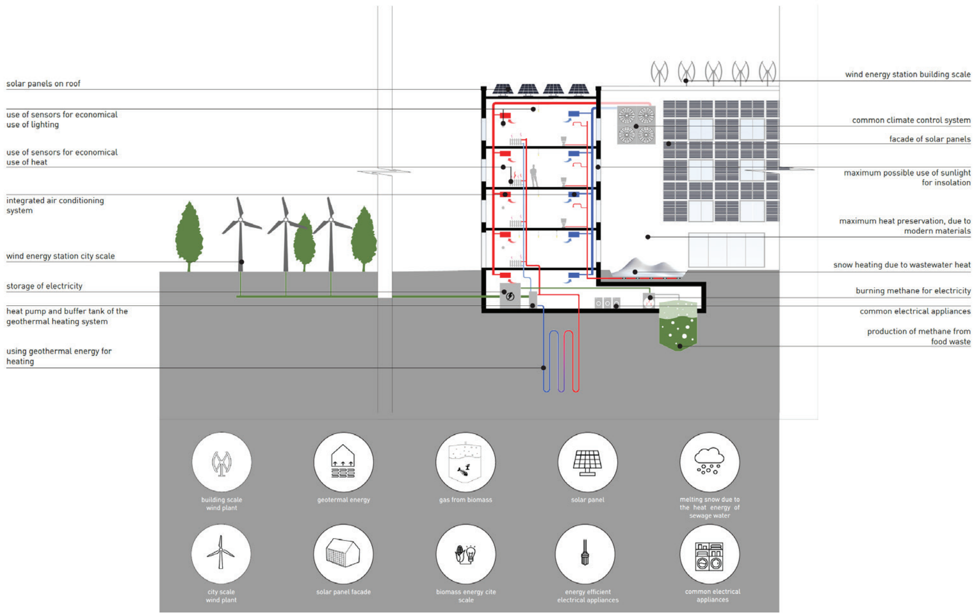


Figure 24
Solar and wind energy potential within block.

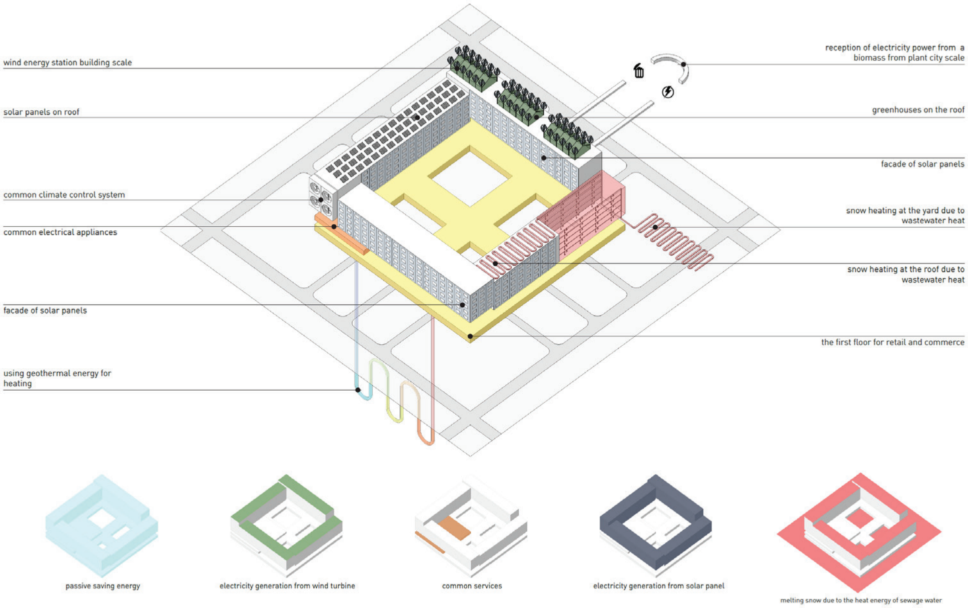


Figure 25
Energy | Self-sufficient block proposition.

WATER

WATER
LAYER ANALYSIS

Challenges of the developing world, in particular those related to urban water distribution and sanitation systems are too often neglected and the infrastructure is unable to cope with the growing city population. The lack of access to freshwater, coupled with water resources depletion is a primary causes of water contamination and water-borne diseases. Today's urban environment faces a major challenge terms of insufficient resources as well as poor management of resources. Moscow as a city with population of more than 12 million likewise faces a similar problem. Despite the fact that water sources' reserves are 2.5-3 times higher than the city's drinking water needs, natural resources are used extremely irrationally and inefficiently. Today, average water consumption in Moscow is 147 liters per day, which exceeds human needs by about 2.3 times. Despite the fact that this number decreased by almost 300 liters compared to 2005, cities with decentralized water supplies and recycling systems have much lower consumption (for example, Barcelona, London or Copenhagen).

Rainwater and snow can also be considered as alternative sources of water. Today, for example, 35 snow melting stations process up to 14.4 million cubic meters of snow into thawed water. However, Moscow authorities don't yet use this snow potential, and they are taking other measures to improve energy efficiency in the capital. Thus, the task is to develop a self-sufficient block in Moscow based on principles of saving natural resources and smart use of water. It is proposed to provide a zero wastewater cycle in the city on the basis of a residential block's prototype for 1,000 people. If water is managed in an intelligent way by implementation of a closed cycle, all the waste water can be treated and the withdrawal rate lowered to meet the population's actual needs. In this, the main goal is to reuse all treated water and also to facilitate where possible, the implementation of shared domestic water consumption. It is proposed to use the potential of water resources and its key features in Moscow and in Russia as a whole. The derived potential is based on the existing infrastructure of the city with established service radii and relevant data on their capacity. It is calculated that daily amount of shower gray water with adding of average precipitation can offset the daily amount of waste black water.

TOTAL WATER WITHDRAWALS IN MOSCOW

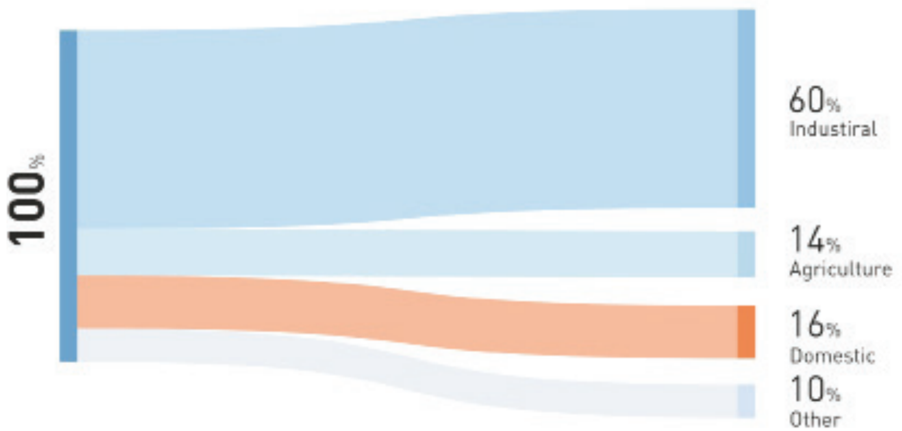


Figure 26
Sankey diagram. Total water consumption in Russia

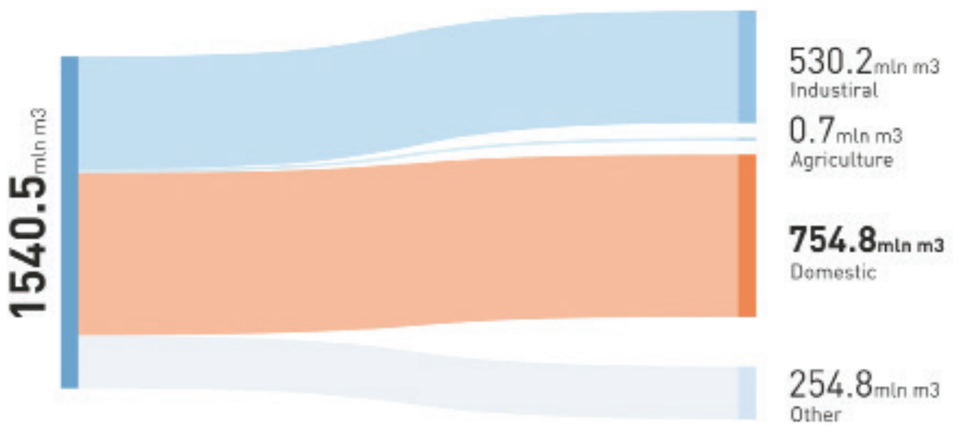


Figure 27
Sankey diagram. Total water consumption in Russia

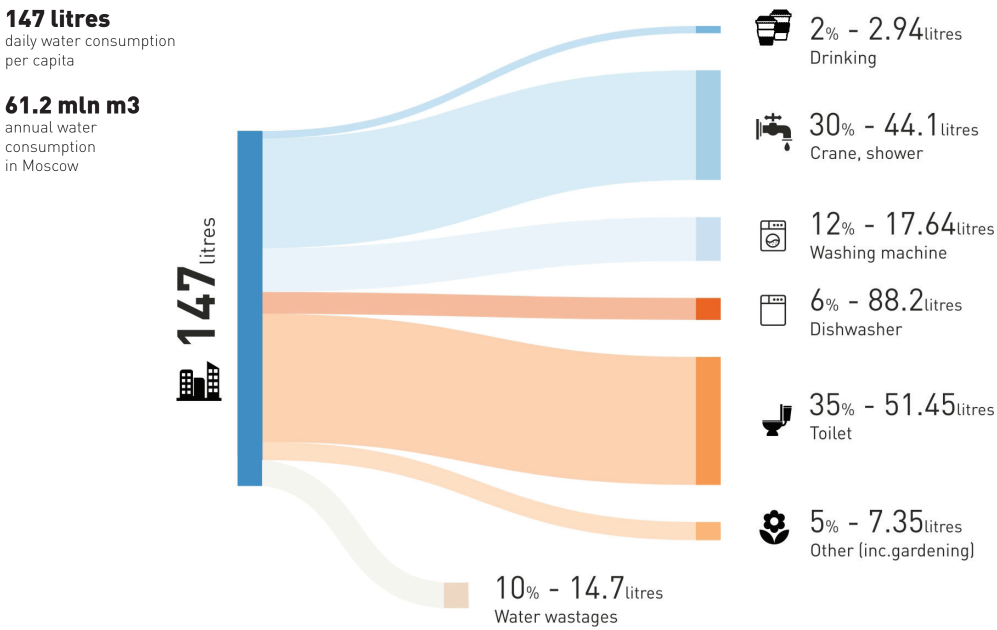


Figure 28
Sankey diagram. Total water consumption in Moscow per capita

Water withdrawals - freshwater is taken from ground or surface water sources, either permanently or temporarily, for all types of use (industrial, public, irrigation, cooling of electric power plants, etc.)

Total withdrawals is proportional to the population amount. Most of the water from 1540.49 million m3 was used for drinking and domestic needs (49%) - not technical water supply for customers, both public and individual use.

The water amount that is withdrawn from the source is the water intake, and the amount that is returned is called the water discharge. The difference between water intake and water discharge is the amount of consumption.

The total amount of water that is used is the water use. The difference between this water use and water intake is the recirculated water amount. The recirculated amount is an indicator of recycling rate and which in turn is an indicator of water efficiency.

WATER SUPPLY INFRASTRUCTURE

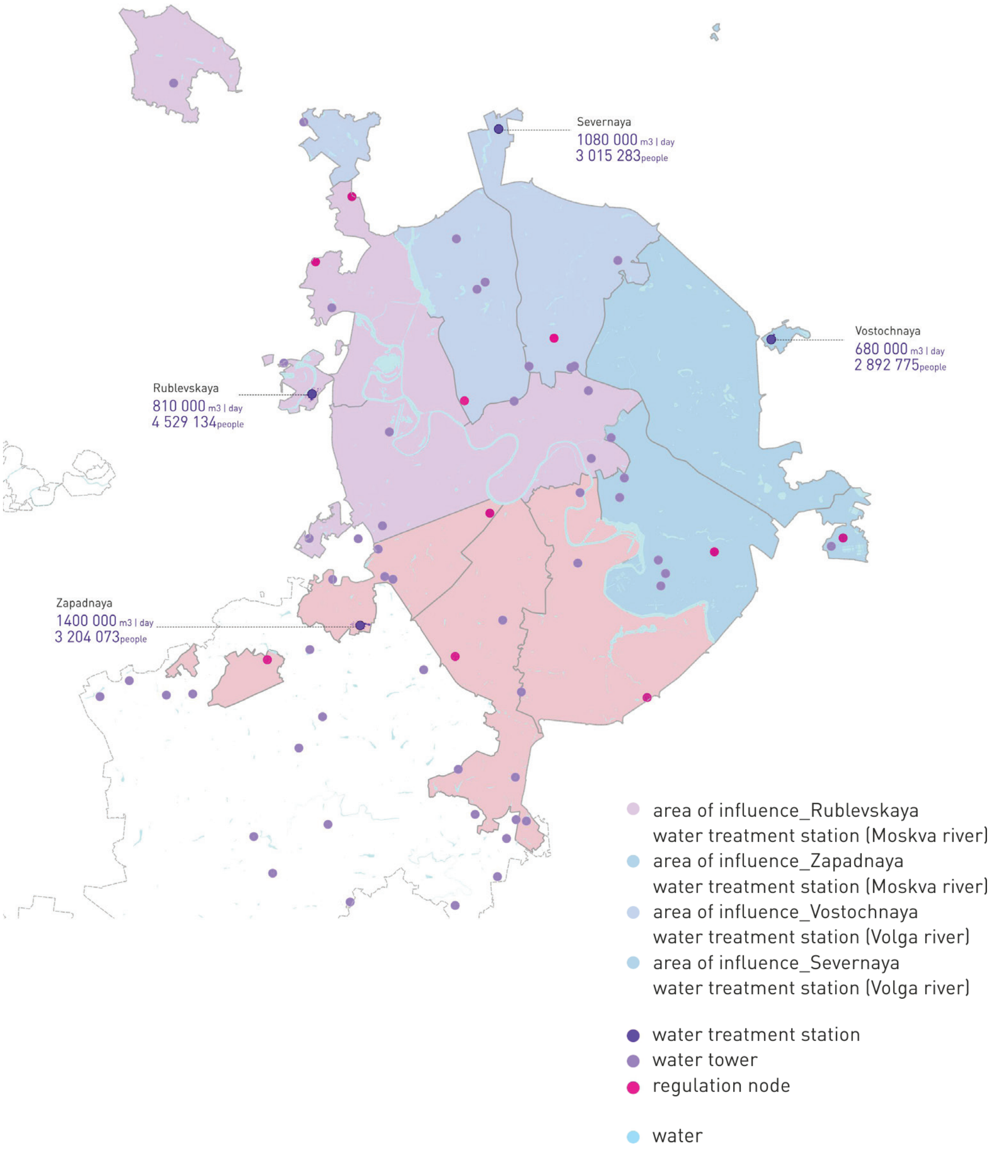
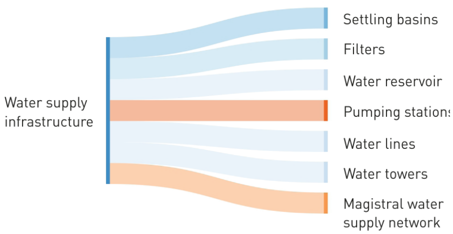


Figure 29
Map. Water supply infrastructure.

Water supply

Moscow city has a centralized water supply system. Today there are 4 water treatment stations that purify drinking water for 4 urban districts. (Rublevskaya, Western, Northern, Eastern). After cleaning, the water passes through the regulating units (11 pcs.), and is then conveyed through water towers to consumers. Towers control the amount of water - at night when consumption is less, the pumps draw water into the towers, and vice versa. Then water from the house in the form of sewage runoff goes to the treatment facilities in the Moscow area and after the bio-cleaning is conveyed back into the river.



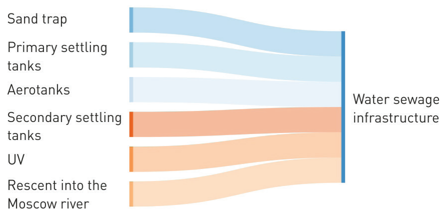


Figure 30
Sankey diagram.
Water supply infrastructure and sewage infrastructure/

WATER SEWAGE INFRASTRUCTURE

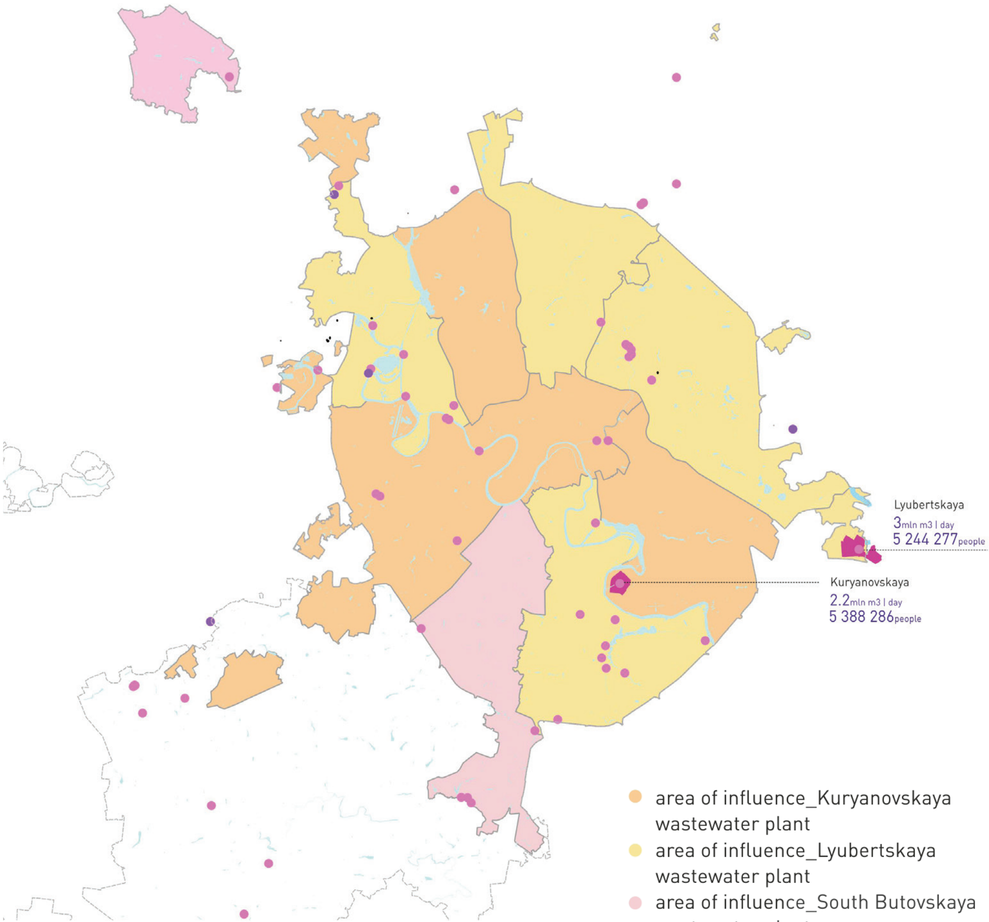
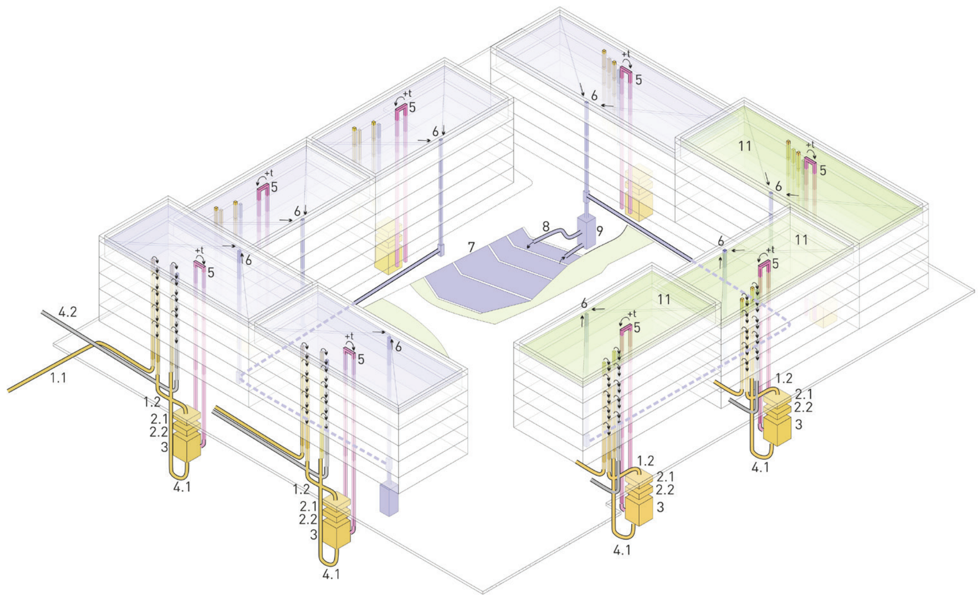


Figure 31
Map. Sewage infrastructure.

Problem	Solution	Role
	biogas production (water treatment plant)	water to energy
	snow as water resourse (melting by wastewater's heating)	water production
water inefficient use (unused potential)	system of wastewater recycling	water smart use
low water quality (freshwater depletion)	water collection systems (outside and inside)	water production
economic wastage		
	ponds and landscape wet elements that purify and collect water	water treatment
	facade panels that harvest water, absorb-purify it, have algae for energy production	water treatment water production water to energy



1.1 - freshwater supply	5 - snow melting by warm water supply to the roof	water supply, grey water recycling
1.2 - grey water pipes	6 - precipitation collection	hot water circulation, snow melting
2.1 - primary filtration	7 - landscape storage (wetlands)	black water tap
2.2 - secondary filtration	8 - irrigation (summer)	water collection, pond
3 - storage tank, heat pump	9 - water storage	landscape, green roof, food production site
4.1 - grey water recycling	11 - green roof, food production site	
4.2 - black water tap for treatment		

Figure 32
Water | Self-sufficient block proposition.

67120 litres
of water saved by recycling in Moscow per 1000 people

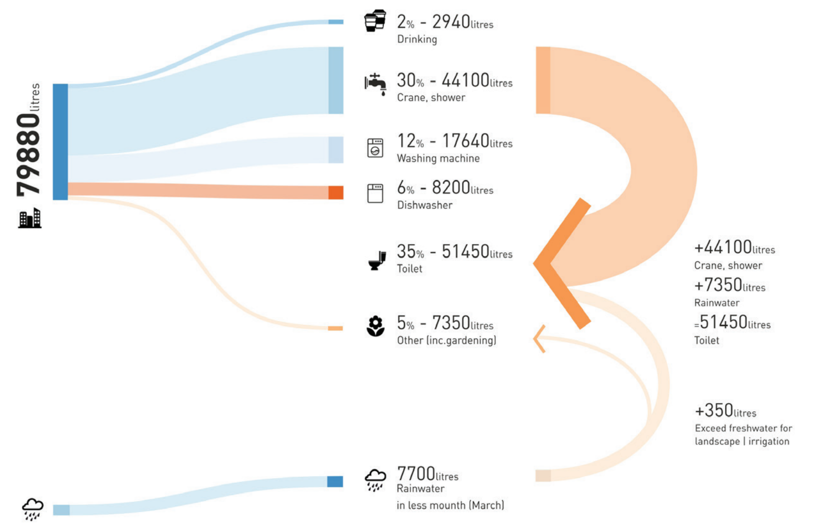


Figure 33
Sankey diagram. Zero water waste cycle during month with the lease precipitations.

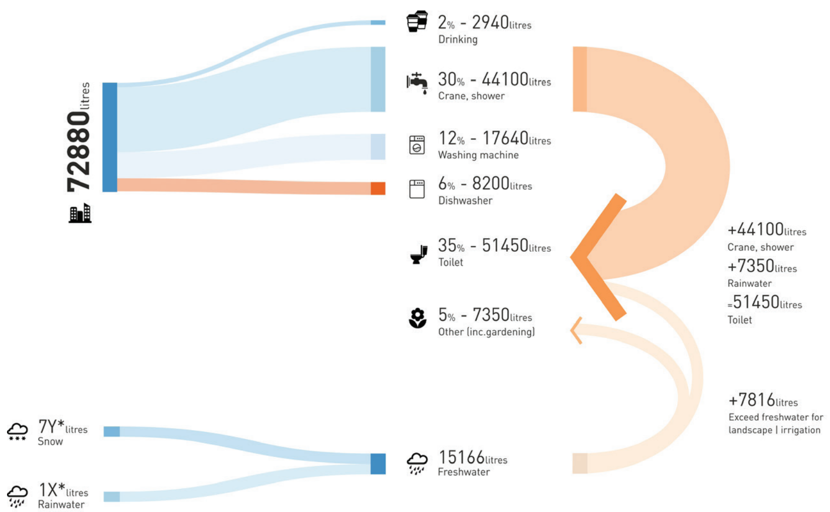


Figure 34
Sankey diagram. Annual average zero water waste cycle.

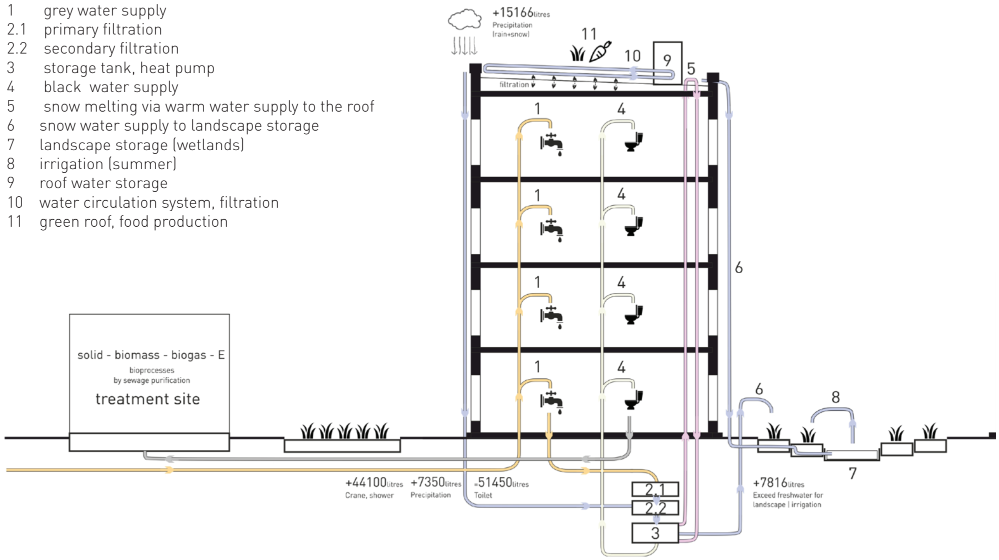
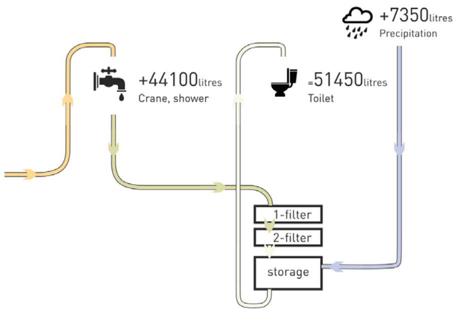
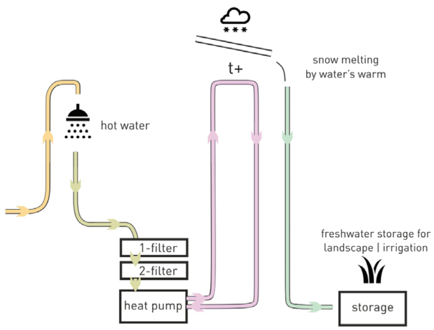


Figure 35
Water | Self-sufficient block
proposition section.



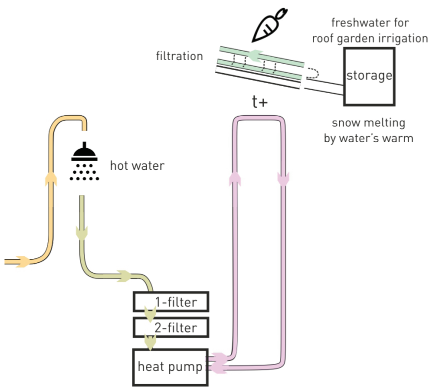
1 grey water supply
2.1 primary filtration
2.2 secondary filtration
3 storage tank, heat pump
4 black water supply
5 rainwater collection
6 irrigation (summer)

Figure 36
Water recycling section.



1 grey water supply
2.1 primary filtration
2.2 secondary filtration
3 storage tank, heat pump
4 snow melting by warm water supply to the roof
5 snow water supply to landscape storage
6 landscape storage (wetlands)
7 irrigation (summer)

Figure 37
Recycle process -1.
Zero wastewater cycle.



1 grey water supply
2.1 primary filtration
2.2 secondary filtration
3 storage tank, heat pump
4 snow melting by warm water supply to the roof
5 roof water storage
6 water circulation system, filtration
7 green roof, food production

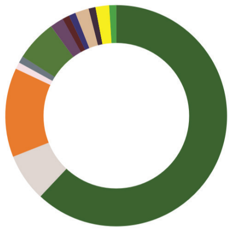
Figure 38
Recycle process -2.
Snow melting | garden.

FOOD PRODUCTION

For the first time in history, the population of people living in the cities of the world have exceeded that of people living in rural areas. In growing cities, the demands of society change rapidly. Earlier scientists could make predictions about the society for the next 50 years but at present no one takes the initiative to make such a prediction not even for ten years ahead. According to Willie Muller, the world today is changing the logic of industrial production. The types of industrial process including serial production and the division of its stages into different regions and countries is gradually being replaced by a type when everything is done using local raw materials within local industrial sites. "Old industrial logic needs to be simplified as it destroys the planet. While fortunately, the ecological components of production have started creating importance in the minds of people". The other side of local production is the creation of urban biomass. Currently, scientists have been increasingly discussing about the fact that modern cities need to 'fit into nature' again. For example, in New York they have already developed urban farms, which grow vegetables necessary for local residents.

"Can we imagine that we will be able to grow everything necessary for food inside the city or maybe in greenhouses or buildings with artificial lighting? Perhaps large corporations that possess the necessary technological solutions and capabilities have already reflected on this". The infrastructure pertaining to food production within the current urban environment has always been located at the periphery of the city and in many cases food is even imported from beyond the nation's boundaries in spite of the fact that technology is available to ensure food production within the city. This is primarily because of the cost implications that come with the mentioned technologies, whereas production of food within the city may not be feasible on the individual scale owing to land constraints, this challenge can be overcome by initiating collective farming facilities designed to share the resources and facilities. In such a scenario for instance, green farming on the roof could be a starting point for initiating the culture of shared farms that could be administered by the building administration and shared by tenants willing to tend to such farms.

FOOD PRODUCTION IN MOSCOW REGION



Structure of acreage **Total acreage area = 595500 ha**

Fodder crops 63,2%
(37636 ha.)
Other 7,6%
(4526 ha.)
Wheat 13,5%
(8039 ha.)
Rye 0,2%
(119 ha.)
Triticale 0,4%
(238 ha.)
Barley 6,2%
(3692 ha.)
Oats 1,8%
(1072 ha.)
Corn 0,2%
(119 ha.)
Legumes 0,3%
(179 ha.)
Rapeseed 2,7%
(1608 ha.)
Mustard 0,2%
(119 ha.)
Potato 2,4%
(1429 ha.)
Vegetables 1,3%
(13 ha.)

Structure of meat production **Total output = 191600 tons**

Bird meat 71,2%
(136419,2 tons)
Pork 19%
(36404 tons)
Beef 9,1%
(17435,6 tons)
Mutton and goat 0,4%
(766,4 tons)
Other 0,3%
(574,8 tons)

Figure 39
Food production structure in Moscow region 2015

Russia is one of the world's largest food-importing countries having purchased more than $40 billion worth of food, beverages, and agricultural products in 2013. Some food processors purchase more than 70 percent of raw materials for manufacturing food products from abroad before the food ban. Lack of raw materials pushed manufacturers to switch to alternative foreign suppliers or substitute the traditional ingredients by locally produced raw materials. The Russian Government has made import substitution and development of domestic agricultural production a national priority.

Russia's food processing industry had been growing steadily since 1998. During 2005-2012 annual growth rate of the industry (CAGR) totaled 165 percent. The food processing sector has garnered special attention by the Russian Government and market analysts have stated that it could soon become one of the highest yielding sectors in Russian agriculture. Government of Russia provides targets for improving the efficiency of enterprises, to provide diversification of production and to improve the competitiveness of manufactured products.

In 2016 harvest smashed records, making Russia the world's leading grain supplier. Meat and dairy are also seeing production volumes increase across the board too.

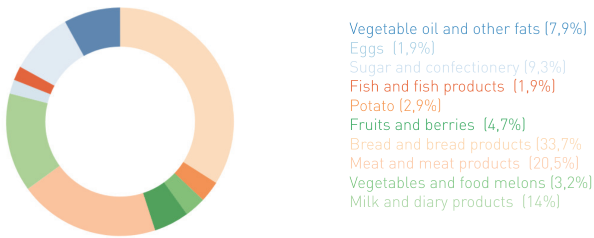


Figure 40
Percentage of nutrient value.

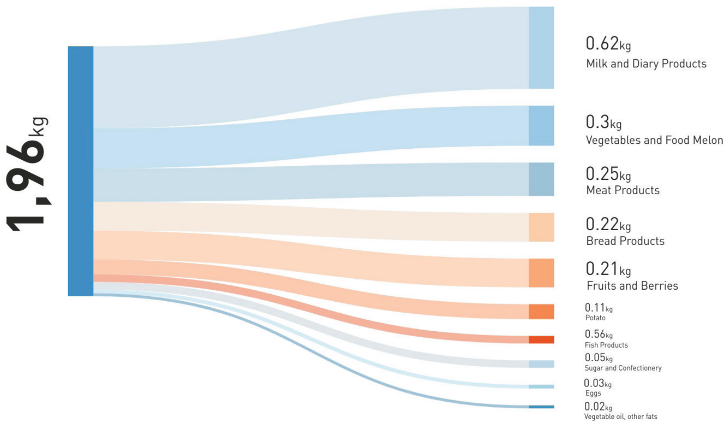


Figure 41
Sankey diagram. Daily average food consumption per capita.

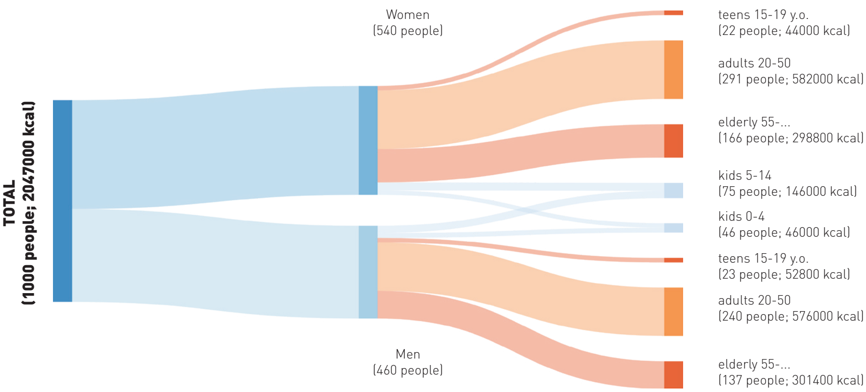


Figure 42
Sankey diagram. Daily calories required per capita.

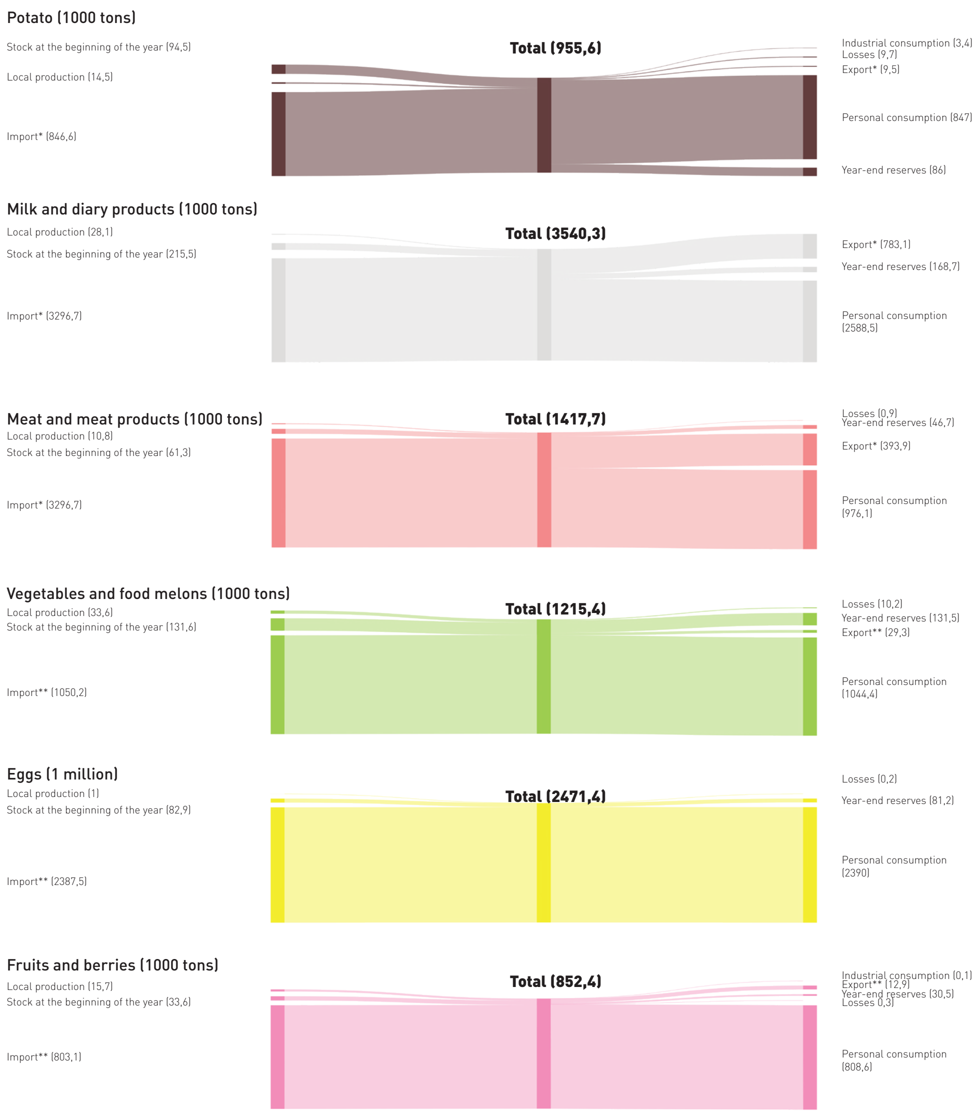


Figure 43
Sankey diagram.
Resources and products use.

*Between subjects of Russian Federation

MARKETS | FAIRS MAP

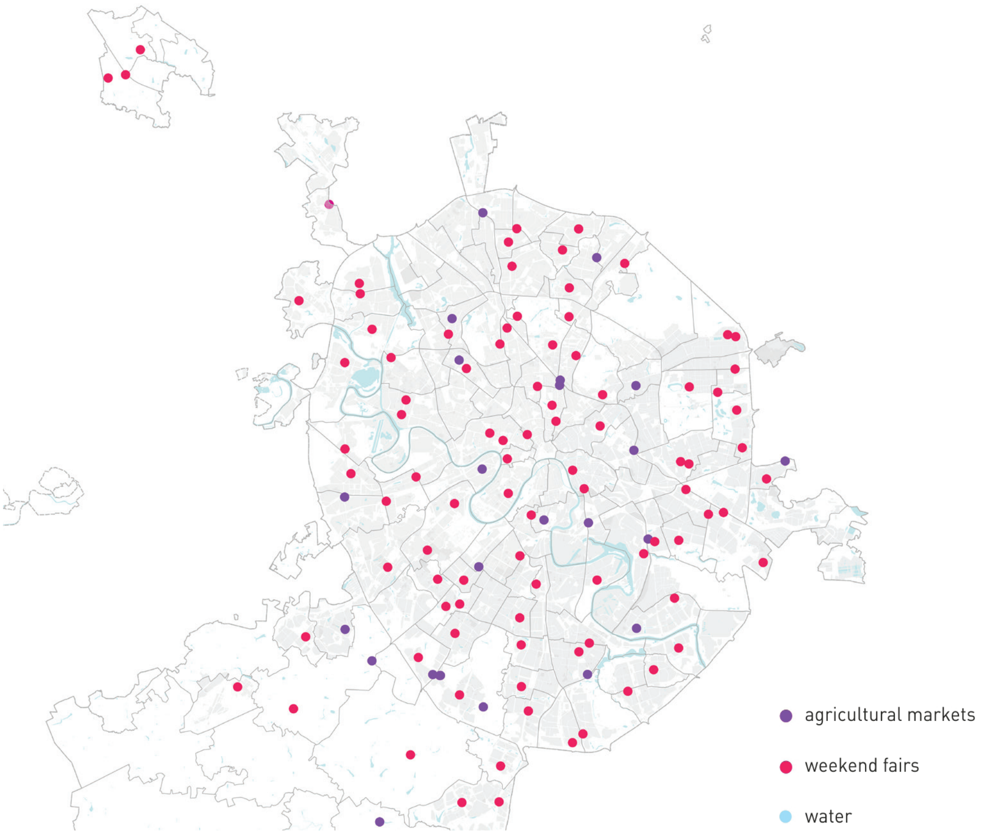


Figure 44
Map. Markets infrastructure.

By virtue of their proximity to consumers, urban farms stimulate local economy by circulating income throughout the region. Without a complicated distribution network, farmers are more connected to their market and able to adapt quickly to demand, maximizing profit. In addition, many of these organizations are structured in a way that brings additional benefit to the community and support. Smaller scale, local markets provide the opportunity for farmers to foster more unique varieties of produce. These farms preserve biodiversity by cultivating heirloom varieties or those with lower shelf-stability. The proximity and connectedness to market allows for fresh, nutritious produce to become available to communities that have never had access to this in the past.

FOOD PRODUCTION
PROPOSAL

Reducing CO_2 emissions By localizing produce, urban farms cut down on the significant amount of fossil fuel consumption necessary to transport, package and sell food. The average meal has traveled 4,200 miles just to get to your table. Urban agriculture helps consumers reduce their "footprint" by providing the opportunity to purchase food that was grown within their community.

Innovative Techniques As city spaces lack the wide-open fertile grounds of traditional farming methods, urban farmers are tasked with finding creative solutions to dealing with challenges like waste, space, resources, and energy. Because of this, more efficient innovations are created to improve the quality and quantity of food that can be produced with the least amount of resources.

Job creation From window box herb gardens to large community spaces, these farms create opportunities to involve the community. Urban farms create job (and volunteer) opportunities in big cities, where poverty and hunger are often persistent issues.

Economic growth By virtue of their proximity to consumers, urban farms stimulate local economy by circulating income throughout the region. Without a complicated distribution network, farmers are more connected to their market and able to adapt quickly to demand, maximizing profit. In addition, many of these organizations are structured in a way that brings additional benefit to the community and support to low income populations by stabilizing food costs and in many cases, offering discounted or free produce.
Community building Gardens create more than healthy, delicious food. Urban agriculture brings people together with a common interest — food. The overall health of a community is benefited by increasing its capacity to create an environment that truly sustains its residents. Most urban farming projects require a high level of social organization, giving many individuals in the community a vested interest in its success.

Public health Increasing populations of people in cities suffer from malnutrition and a variety of other diet-related health issues. Bringing nutritious food to local communities has many direct health benefits

Food quality Smaller scale, local markets provide the opportunity for farmers to foster more unique varieties of produce. These farms preserve biodiversity by cultivating heirloom varieties or those with lower shelf-stability. Many urban farms also adopt charitable models in an effort to support communities in need through direct donation or by providing either discounted or free produce.

Education By involving children and adults alike in education around sustainable, local agriculture, farmers increase the health of our future food systems.

Green space Lastly, agriculture in cities provides more green space. This contributes to the health of city ecosystems in a variety of ways. Greenery adds aesthetic appeal, reduces runoff from precipitation, provides restful spaces for the community, and counters the heat island effect by fixing carbon through photosynthesis.

URBAN GARDENING

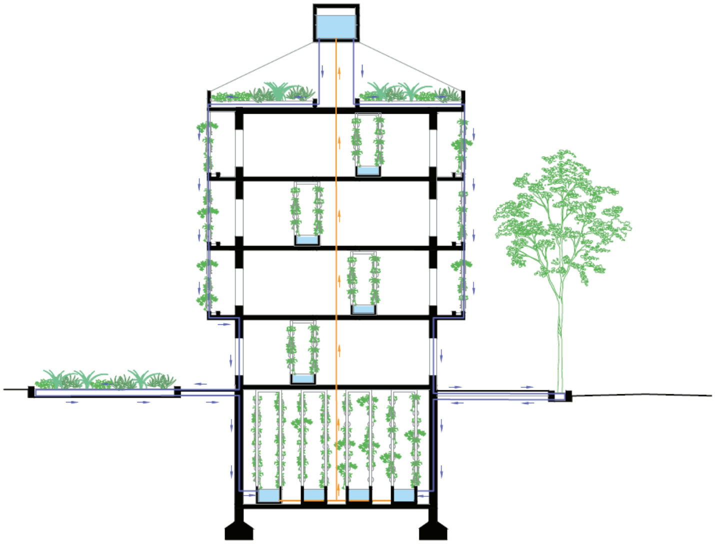


Figure 45
Food production |
Self-sufficient block
proposition section.

The infrastructure pertaining to food production at in the current urban environment is alway located at the periphery of the city and in many cases food is even imported from beyond the nation's boundaries in spite of the fact that technology is available to ensure food production within the city. This is primarily because of the cost implications that come with said technologies.

Whereas production of food within the city may not be feasible on the individual scale owing to land constraints, this challenge can be overcome by collective farming facilities designed to share the resources and facilities. In such a scenario for instance, green farming on the roof could be a starting point for initiating the culture of shared farms that could be administered by the building administration and shared by tenants willing to tend to such farms.

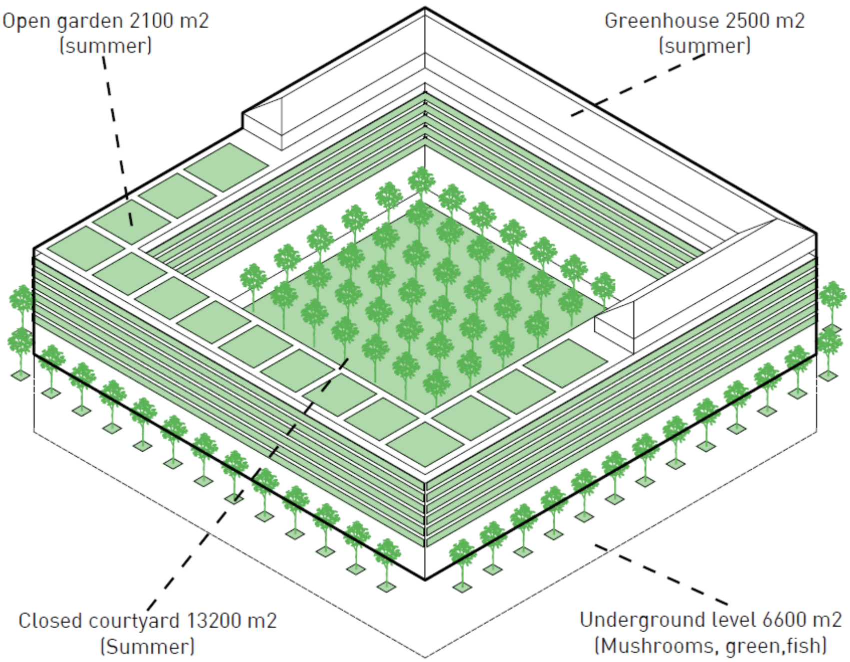


Figure 46
Food production |
Self-sufficient block
proposition.

MATTER

The world population is currently growing by approximately 83 million people each year (UN, 2017). With steadily increasing population, growing consumption levels, the global waste heap is getting bigger and bigger. The world's raw resources are getting exhausted and the planet is running out of the land that could be used for landfills.

The increase in waste generation is most apparent in urban areas. More than 50 percent of the world's population currently lives in cities and this number is expected to rise to around 70 percent by 2050. Cities concentrate a high level of economic activities, with higher incomes and therefore high levels of consumption. This, in turn, is reflected in the considerable volume of waste produced annually compared to other areas. Processes in the world were originally dominated by natural forces, however with a rise of industrialization and urbanization the natural system gradually became pervaded by technologies that mobilized people, goods and information at an ever increasing pace (Floating Horizon, 2018). Cities generate a vast proportion of gross domestic product (GDP) that brings together large flows of goods, services, materials and energy into concentrated locations. This diverse network of flows in cities is called urban metabolism (UM).

It is the responsibility of people as a consumers and producers, to rethink the consumption and production patterns as these elements are connected together. In places where it seems appropriate, there should be a modification of trends as well as reshaping the further developments of our society into more sustainable pathways. As a by-product of our activities, waste can represent a significant burden for human society and the environment. The most obvious way to begin reducing such a burden is through finding opportunities to use waste as a resource and adopting the ideas of 'closing the loop' and evolving from the approach of 'cradle-to-grave' to 'cradle-to-cradle'. The waste management sector can effectively contribute towards generating national income. All actors need to think in terms of integrated waste and resource management on both local and global scales. Many options have been and are being developed to translate this shared responsibility into an effective measure.

In science, matter is anything that has mass and takes up space. Within context of the city and Urban Metabolism (UM), matter and particularly matter cycle is the crucial cycle of the biological and technology matter that allow cities to achieve self-sufficiency. The key characteristics of matter cycle is to sustain the balance between the resource consumption and waste production to avoid urban problems such as resources depletion, environment pollution and waste generation which usually occur during rapid urbanization processes, especially in mega-urban agglomerations.

The challenge of matter cycle is to be able to transform waste into resources in a sustainable way resulting in reduction of necessary inputs and elimination of wasteful outputs that is dubbed as "closing the loop". In C2C model, all materials used in industrial or commercial processes—such as metals, fibres, dyes—fall into one of two categories: "technical" or "biological" nutrients. Technical nutrients are strictly limited to non-toxic, non-harmful synthetic materials that have no negative effects on the natural environment; they can be used in continuous cycles as the same product without losing their integrity or quality. In this manner these materials can be used over and over again instead of being "down-cycled" into lesser products, ultimately becoming waste.

Biological Nutrients are organic materials that, once used, can be disposed of in any natural environment and decompose into the soil, providing food for small life forms without affecting the natural environment.

Gathering information on humans material consumption is important, as many of today's most pressing environmental problems are directly linked to our material use. Today, total global consumption of renewable and non-renewable natural resources amounts to more than 70 billion tonnes per year. The use of fossil fuels is the main cause for global warming and climate change, harvest of biomass (timber, agricultural products) entails land cover and land use changes with negative impacts on biodiversity as well as water scarcities, the use of metals and chemicals causes toxic impacts on ecosystem and human health.

Human beings need (non-)renewable materials to cover their basic needs such as food and dwelling; but moreover, human also need materials to maintain their lifestyles which are often closely linked to the ownership and use of various consumer goods. The assumption is that the satisfaction of these needs increases life satisfaction or "happiness". To meet this need of constant update, the most manufacturing employ the strategy of 'planned obsolescence' - a shortening product's lifespan, manufacturing 'made to break' items or single-dose goods which responds to related consumption behavior and undeniably leads to an increase in resource consumption and consequently more waste. The search for profitability drives manufacturers and producers to look for 'shortcuts' in production methods thus saving resources, energy and time which only becomes problematic when durability is deliberately sacrificed for the sake of production gains.

MUNICIPAL WASTE MANAGEMENT

Commonly, there are three ways of managing solid waste in the city: by dumping, by incinerating and by recycling. In Moscow and in Russia as a whole, waste dumping is the most popular approach of dealing with municipal waste. Over eighty percent of the solid waste is being sent to landfills located in Moscow region due to the inefficient recycle infrastructure and the lack of recycling culture. Recycle is the procedure by which we take surplus materials which we no longer need and turn them into new useful products and there are many types of recycling. When we recycle, we save our raw materials, reduce the usage of our energy, cut down on air pollution and water pollution and have the opportunity to lower greenhouse gas emissions. In Moscow, there are total of 516 separate waste collection places which collects 497 380 tons of sorted waster per year. Waste incineration plant is one of the waste-to-energy approaches. There are 3 functioning waste incineration plants in Moscow with total capacity of 770 000 tons of solid waste per year. Total electricity of 26.7 MW is produced by "Ecotechprom Waste Incineration Plant".

2017 was declared to be the year of ecology, the objective of which was to draw attention to the problematic issues that exist in the environmental and improve the state of the country's environmental security.

PROS
Low cost of construction, low operational cost

CONS
Requires large territory allocation, long service life, requires reclamation.

PROS
Reduction of waste sent to landfills by ten times, cost-effective - combustion energy is converted into energy for consumption.

CONS
Technically complicated, requires expensive air filtering systems, long service life.

PROS
Minimizing harmful impact on the environment, cost-effective (recovering secondary raw products).

CONS
High cost of construction, high operational cost, requires separate waste collection infrastructure.

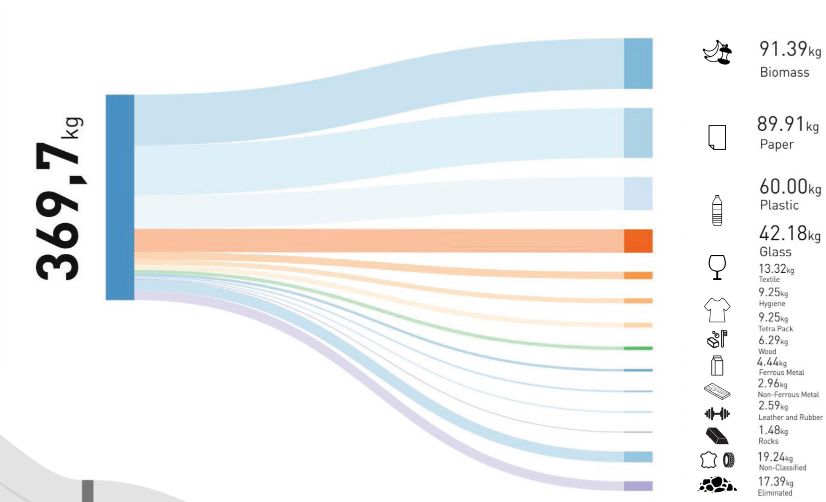


Figure 47
Sankey diagram.
Waste per capita.

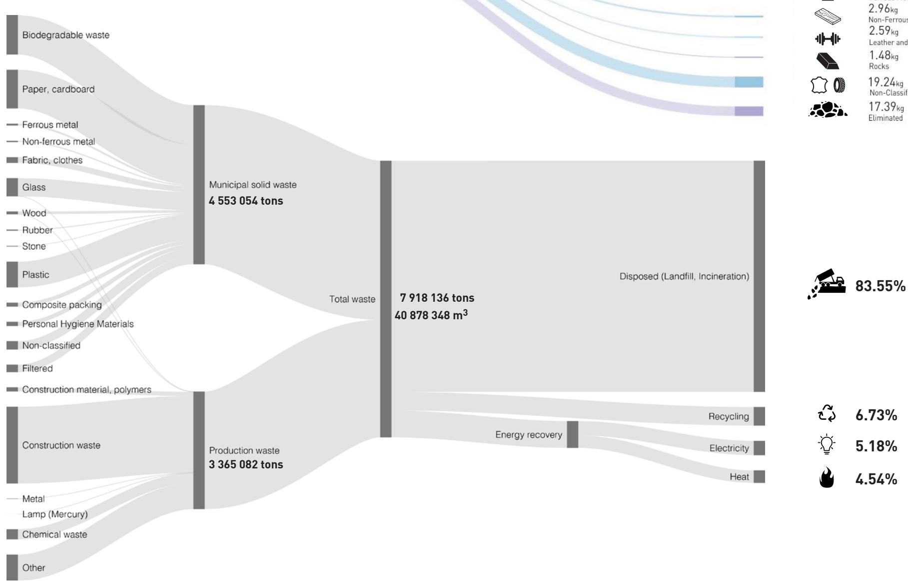


Figure 48
Total waste produced and
managed in Moscow (2016).

According to the city standards for solid waste, Moscow estimates only 272 kg of waste per capita per years. However, the person in Moscow on average generates around 370 kg of solid waste which makes slightly more than 1 kg of waste daily. 24.7 % of personal waste is a biomass, 24.3% is paper, 16.2% is plastic, 11.4% is glass and 24.9% others that include rubber, ferrous and non-ferrous metals and on. With contemporary system, the quantity and quality of recovery is staying low since the fall of soviet union.

SOLID WASTE MANAGEMENT INFRASTRUCTURE

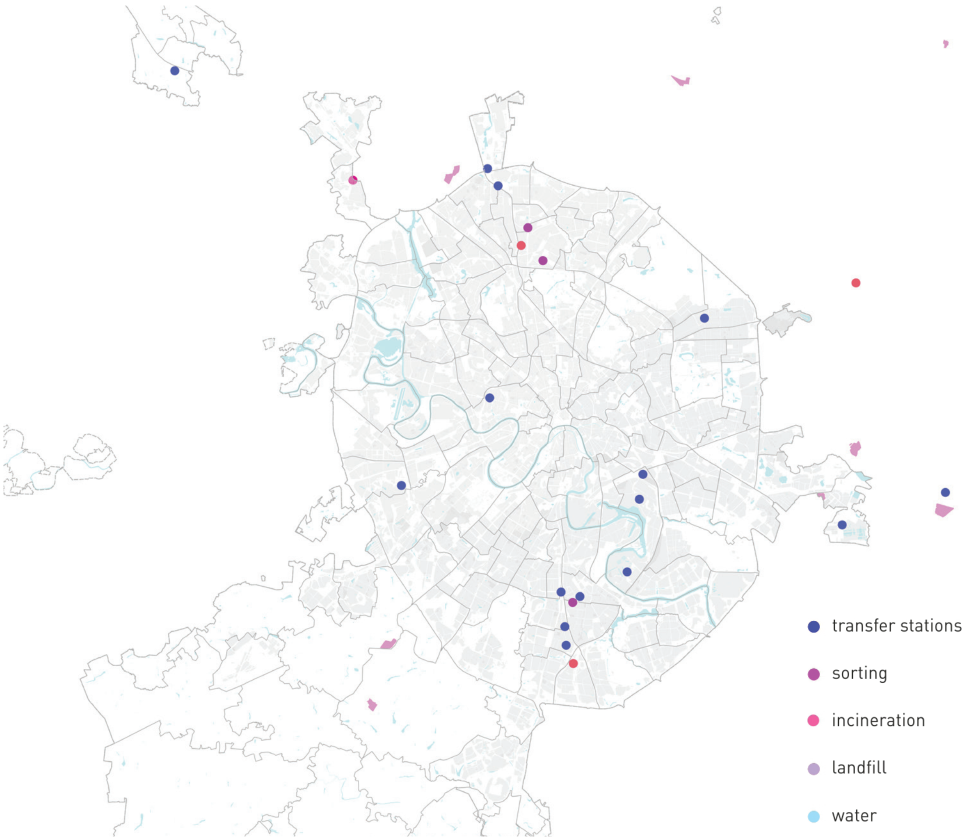


Figure 48
Map. Solid waste management in Moscow.

Russian Federation regulations assesses and classifies wastes according to different hazard classes: class 1 - extremely hazardous, class 2 - highly hazardous, class 3 - moderately hazardous, class 4 - low risk, and class 5 - almost harmless.

Moscow annually generates almost eight million tons of waste, more than half of which comprises the municipal solid waste. This type of waste comes from residence and small businesses. With current infrastructure and resident's lack of waste separation habit, Moscow manages to recovers as secondary resource only 6.73% of the waste. Out of 9.62% of total waste, the heat and energy produced.

MATTER
PROPOSAL

There is a high potential for recycling waste especially on the local scale. Environmentally local recycling has clear advantages: less transport, less primary raw materials extraction and associated environmental impacts. Appropriate facilities, however, are not available everywhere due to the substantial financial resources required (mainly technology and energy costs). In addition local businesses may not have a use for locally available scrap materials. Trading recyclables at a larger scale consequently seems necessary. In order to 'close the loop', the block is designed to efficiently recycle with an emphasis on biomass waste that can be used for secondary uses like composting and generation of methane, and plastic waste that will be recycled into prototyping materials at Fablab.

In addition, the facility prioritizes the shared economy over consumerism and individual ownership, thereby promoting "access over ownership".

Plastic 60 kg per year → Sorting → Shredding → Material stock → Design → Fabrication

techniques:

molding
extruding

Types of plastic

polyethylene, terephthalate

high-density polyethylene

polyvinyl chloride

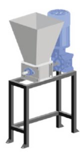
low-density polyethylene

polypropylene

polystyrene

other plastic

Open source machines by preciousplastic.com



Shredder machine

Plastic waste is shredded into flakes which will be used in the other machines to create new things. You can select the output size of these flakes by changing the sieve inside the machine to create different patterns and processes.

Extrusion machine

Extrusion is a continuous process where plastic flakes are inserted into the hopper and extruded into a line of plastic. These lines can be used to make new raw materials such as 3d printing filament.

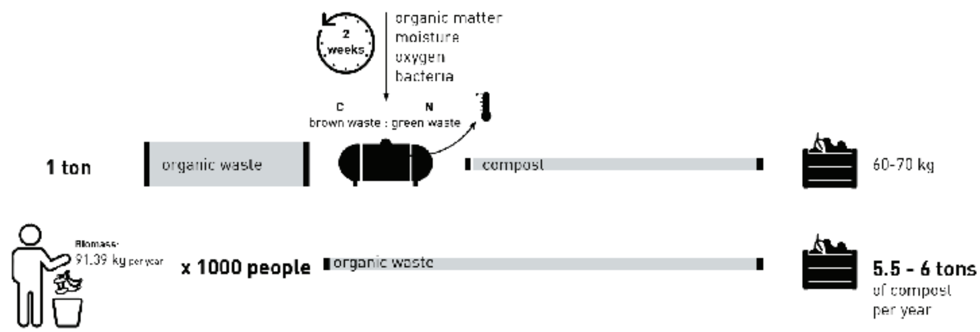
Injection machine

Plastic flakes are heated and injected into a mold. It's a relatively quick process which is well suited for creating small objects repeatedly. You can make the molds completely yourself by using CNC mills or lathes, or by simply welding them.

Compression machine

Plastic is heated inside the oven and slowly pressed into a mold with a carjack. Well suited for making large and more solid objects, the oven itself is also a great machine for prototyping and making plastic tests with.

Figure 49
Plastic waste management proposal.



Composting is a vital and necessary sustainability strategy for reducing waste, closing the nutrient cycle, and preventing air pollution that causes climate change.

An efficient compost pile is a careful balance of dry or brown things that contain carbon (like leaves, straw, or paper) and wet or green things that contain nitrogen (like food scraps or rabbit droppings).

Over 100 organic items can be used for compost. Items from kitchen such as fruit scraps, egg shells, tea leaves, rice, cereals and on. Fats should be avoided. From shower things such as hair from your hairbrush, trimmer, nail clippings,cotton swabs made from 100% cotton and cardboard. Pet-Related such as fur from the dog or cat brush, feathers, horse, cow or goat manure and dry dog or cat food, fish pellets.

Organic waste generally loses about 60% of its weight in water during composting and some more in carbon dioxide. The output of compostable waste ranges from 6-15%.

Figure 50
Organic waste
management proposal.

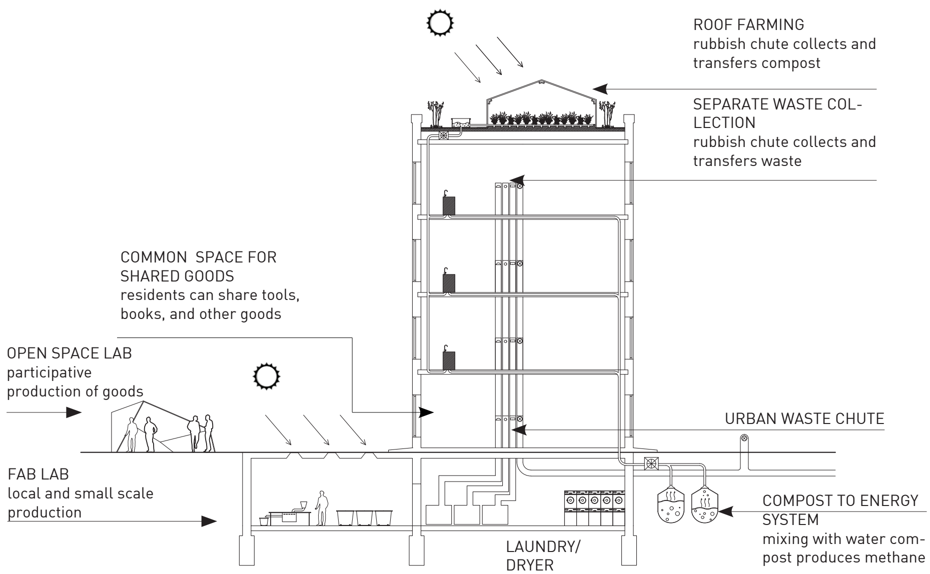


Figure 51
Matter. Self-sufficient block proposition section.

List of household goods that could be shared

Tools
- allen wrenches
- ladder
- electric screwdriver
- drill

Cleaning
- vacuum cleaner

Cooking
- high power blender
- espresso maker
- ice cream maker
- popcorn machine
- bread maker
- yogurt maker
- food dehydrater
- juicer
- a large cooler
- BBQ (on wheels)
- coffee roaster
- deep fryer

Yard
- leaf blower
- snow shovel
- rake
- hoe
- shovels
- trowels
- wheelbarrow

Sports/Fitness/Hobbies
- sports/fitness
- camping gear
- small inflatable raft
- ski clothes
- surfboard
- fishing gear
- trampoline
- binoculars

Clothes
- washer and dryer
- sewing machine
- iron

Travel
- giant rolling suitcase
- travel guides

Fun/Entertainment/Electronics
- playing stations (PS4, kinect and on)
- projector
- table games
- karaoke machine
- copier/printer

Furniture
- inflatable mattress
- folding chairs
- folding table
- card table

Health
- humidifier
- massage chair
- massage table
- emergency preparedness kit

Figure 52
List of household goods that can be shared via physical or virtual spaces.

- Local waste management factories
- Heat production
- Food production

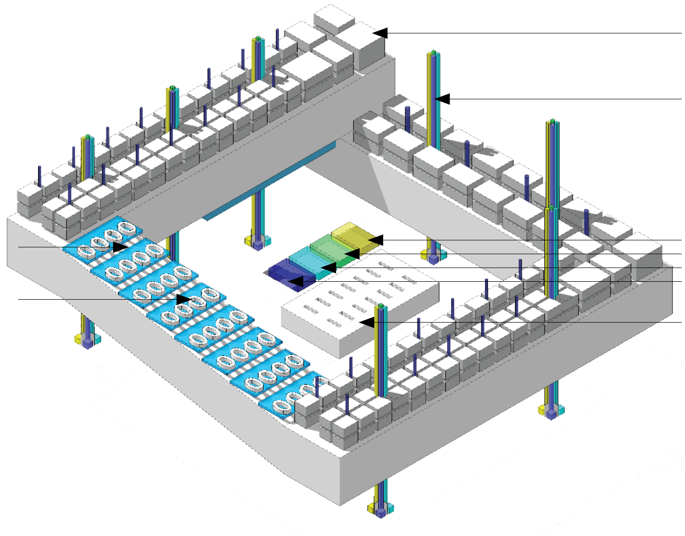


Figure 53
Matter. Self-sufficient block proposition.

INFORMATION

Moscow City is currently implementing ICT based technology into the framework of the City's Infrastructure which forms the basis for the assessment of its performance in terms of implementation of various sensor platforms, Smart Infrastructure as well as integration of these units into a functional IOT (Internet of Things) platforms.

Information generated is subsequently used for various logistical and administrative tasks. There are several parallel programs running as part of various administrative initiatives, for instance, ITS (Intelligent Transport Systems) solutions are being implemented with encouraging results which show a 10 - 15% increase in traffic speed efficiency from a baseline of 19 km/h. This system likewise increased the search time for parking space by 65%, reduced fuel emissions and consumption by a quarter and generally provides the city authorities with real time data essential for the simultaneous implementation of multiple logistical tasks. To this 1200 safety cameras are installed all over the City. Admittedly, Moscow's traffic infrastructure and road network is poorly equipped to handle such rates. The ITS is intended to be integrated with other administrative agencies' information systems. Another system that is being implemented is the Moscow Active Citizen Platform. In recent developments, Moscow's Active Citizen Platform which is an Online platform which allows for public opinion to be factored into municipal processes, by providing opportunities for assessment of public opinion on the basis of polls conducted, promotion of innovation and citizen involvement by providing chances for their ideas and inputs to be considered. This allows active citizen participation for instance in the naming of Zaryadye Park, for which public opinion was collected. Since the introduction of Moscow's Active Citizen Platform, which allows citizens to influence city management decisions and its urban transformation was used by nearly 1.9 million citizens in 2014, with 2,800 polls conducted and more than 87.2 million opinions gathered. Users using at peak load times could cast as much as 1,000 votes per minute. The administration currently implements block chain technologies in the e-voting platform and in doing so it intends to assess the functional vulnerabilities of this rising technology. This will allow for increased transparency and credibility of the system (Smart Cities World, 2018).

The functional vulnerabilities of this rising technology. This will allow for increased transparency and credibility of the system. All citizens with this app become part of a peer to peer node in a network which is intended to optimize the city administrative process. However there are concerns with regards to privacy. This is a major argument against the use of such platforms and any subsequent proposals would have to be made with inbuilt security aspects to dissuade the exploitation of user data by such actors without the express consent of the clients, thereby ensuring the client's privacy rights are not infringed upon.

For purposes of decentralization, multiple open source systems and platforms are freely available. Other vulnerabilities of centralized IoT based platforms include:

- Lack of transport encryption. Data conveyed over unsecured networks can be read by parties on said network.
- Insecure Network services. This could allow unauthorized parties to gain access to the network.
- Insecure Cloud Interface. IoT devices are usually networked in a cloud interfaces since the cost implications of hosting the massive data flows would otherwise render such a project "non-feasible.

It is on the basis of the cited vulnerabilities and inadequacies, that the proposal for distributed networks are being tabled. Distributed Network Architecture for IoT allows for localized administration of platforms in accordance with the specificities of the site to which they are deployed, thereby making the system highly scalable and highly tolerant of network failure as well as bandwidth shortages.

DATA GENERATED BY CITY INFRASTRUCTURE

A wide array of data points are generated in the various logistical and administrative processes of Moscow City. The Data derived can be used to inform logistical decisions, carry out smart planning on the basis of cited data as well as eliminate redundancies. However, this information first has to be collected and analysed to determine these trends. The system that facilitates the collection of this Data is comprised of actual physical elements (sensors), connected within a network to form the Internet of things, which has for some time now been considered the most profound transition in technology and whose applicability varies in range and scope from e-commerce, retail and logistics to smart cities and healthcare.

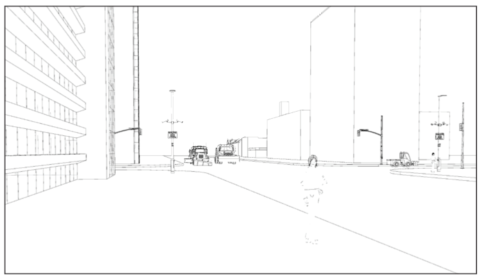
It is widely acknowledged by leading experts in the field, that the technologies pertaining to Big Data and the subsequent big Data analysis are still in their infancy. This is evident by the current surge in Data visualization platforms directed at analysis of Big Data. Without these solutions, the Data generated would be useless. It is therefore plausible to say that within a city's metabolic process, the layer of "INFORMATION" is analogous to the Central Nervous System in living organisms, the same being Network. The data generated within the IoT can be analysed to determine hidden patterns in collective activities of groups of people for the purposes of establishing solutions that are intuitive to the needs of the people. Needless to say, concerns with regards to privacy and ethics would have to be addressed within the social context.
It is estimated by some that the intensity of sensors deployed will increase by a trillion by the year 2030 [1a]. This is evidence of the fact that the systems being proposed are relevant and even critical to the performance of any solutions that would stand the test of time. In contemporary terms, these are often synonymous with "Smart City" Initiatives.

The components can be categorized thus:

- IoT | Networked & Interconnected devices
- Info-Com | Data transfer capable devices
- Data - Digital Information

With this array of INFORMATIONAL platforms, the Citizen has become more aware of his environment, has more options with regards to choice of living conditions, and is able to voice these choices on a number of platforms, thereby forming a part of the social consensus. This provides an unprecedented opportunity to assess and subsequently develop intuitive ecosystems (the city) that will cater for the actual needs of the citizen.

THE EXISTING SCENARIO
is rapidly changing:



The 3D Cityscape:

This is the Spatial platform that makes up the physical aspects of the city, including all the infrastructure, the mobility and energy platforms, the industry etc.

HOUSEHOLD COMPONENTS | SMART DEVICES

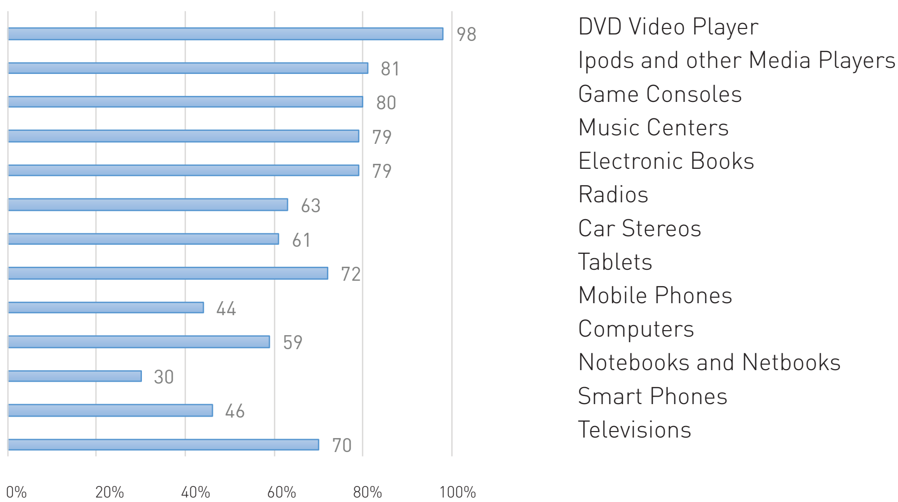
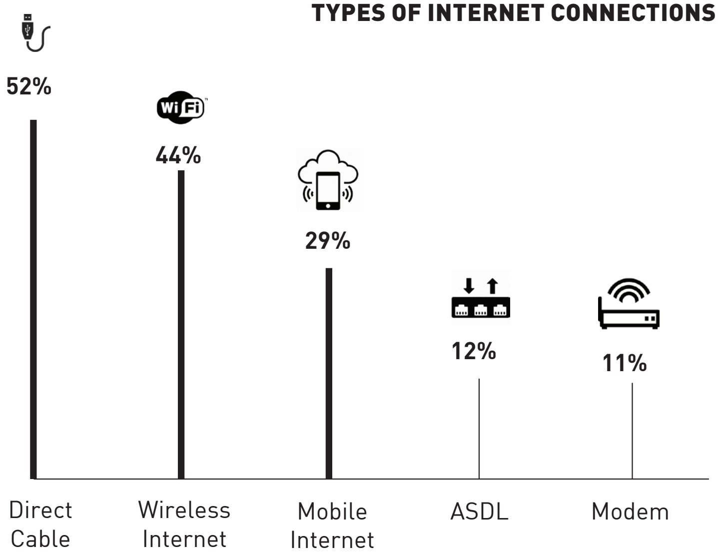


Figure 54
Household smart devices.

TYPES OF INTERNET CONNECTIONS = PERSONAL NETWORK



The average household has access to a network as indicated above and the number of smart devices is ever increasing.

Figure 55
Types of Internet connection.

HOUSEHOLD DEVICE USAGE PROFILE

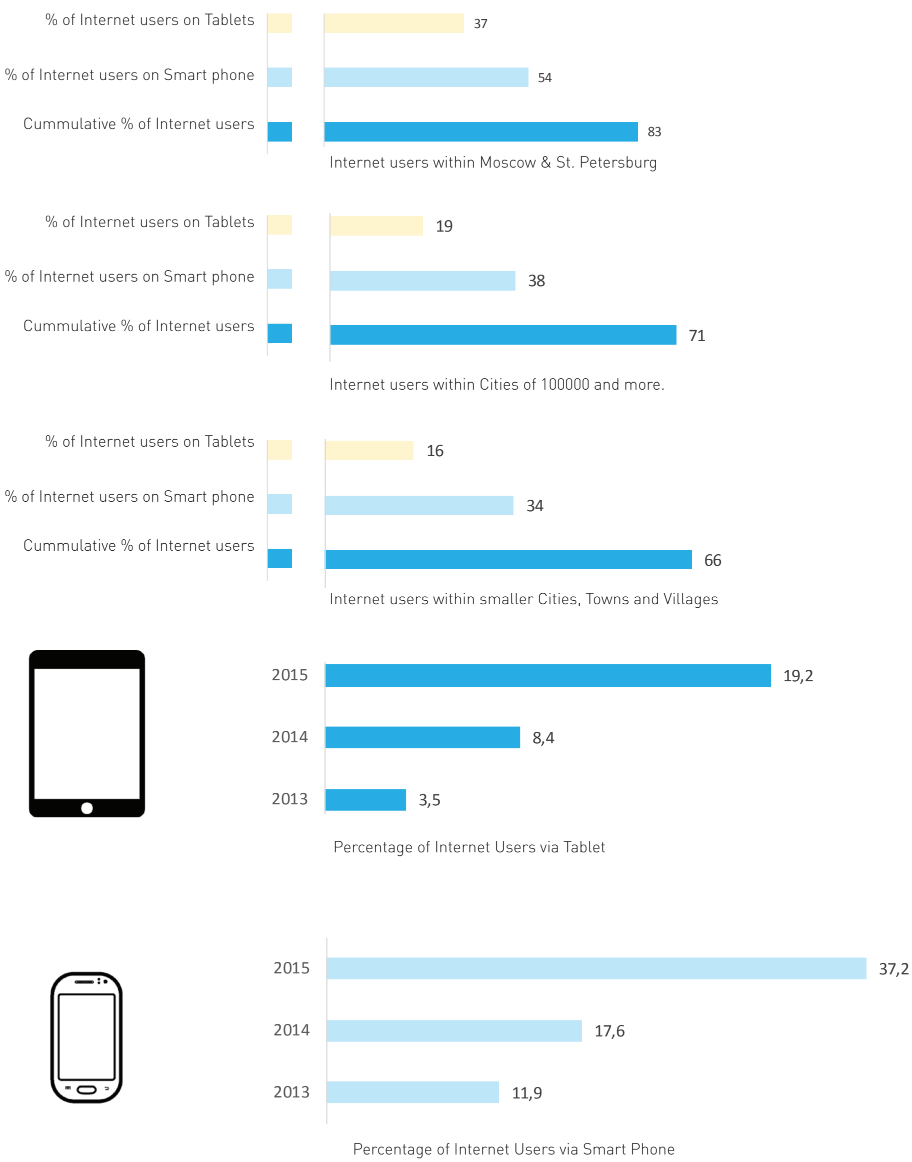


Figure 56
Benchmarking. Household device usage profile.

INFORMATION
PROPOSAL

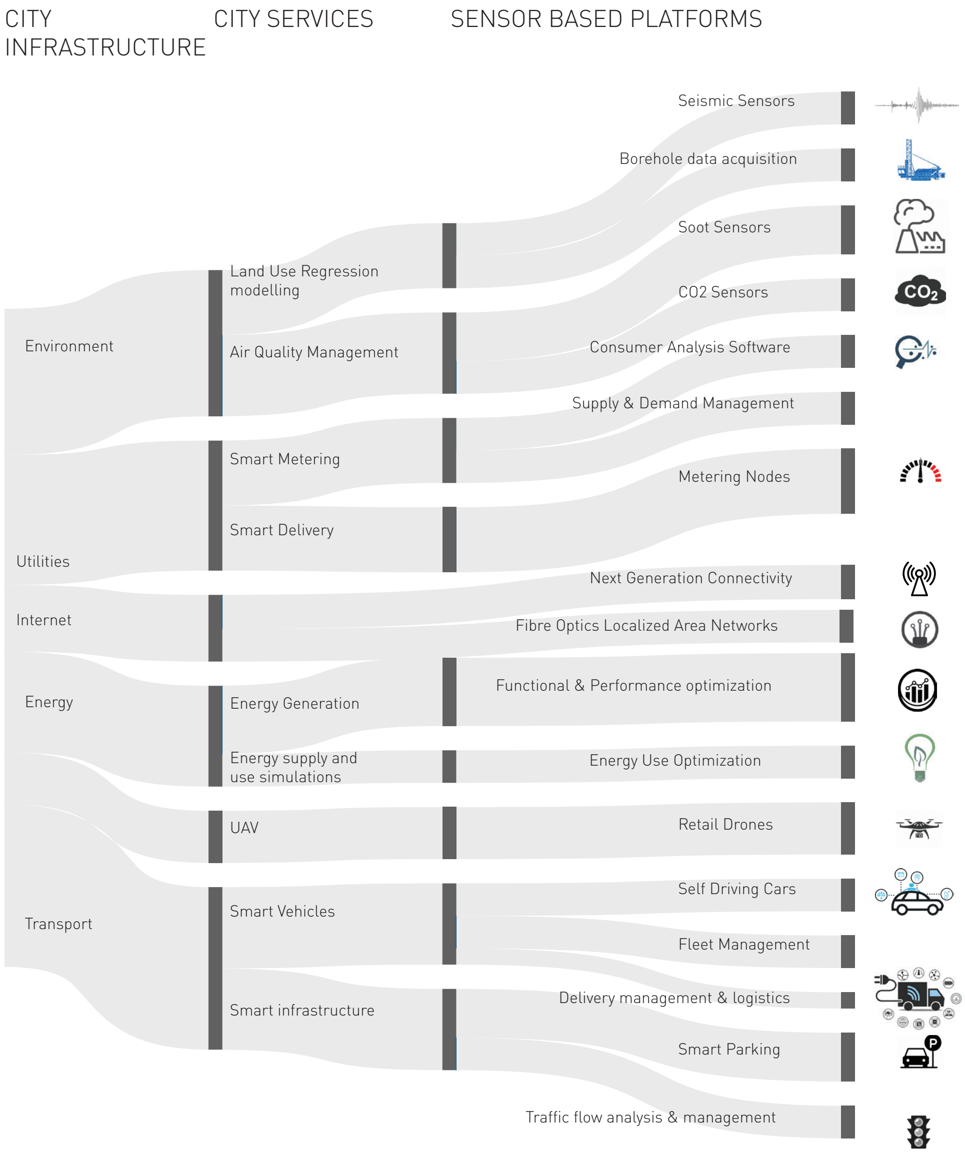
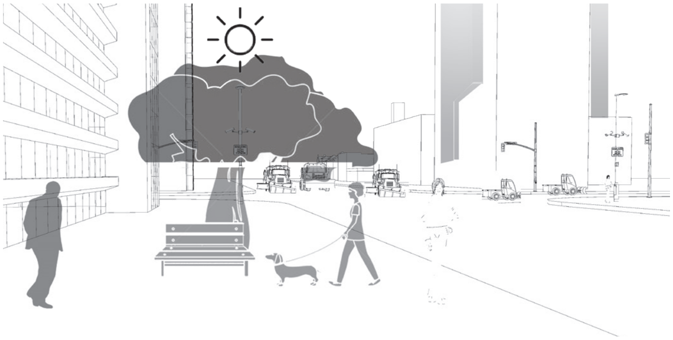
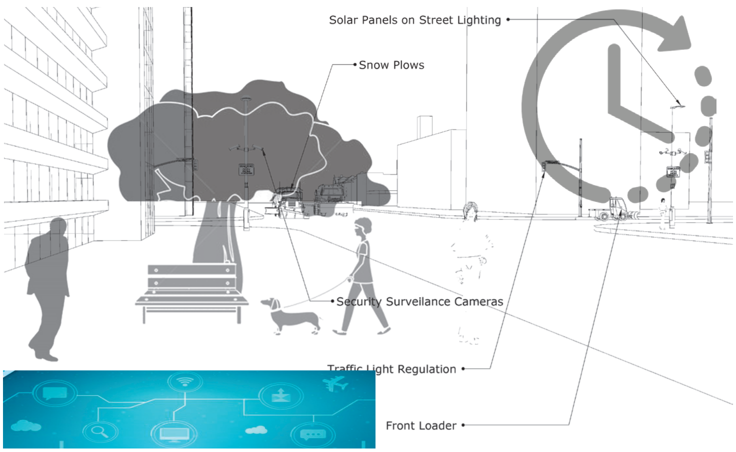


Figure 57
Sankey diagram. Information.



The 4D Cityscape:

The fourth dimension of Urban infrastructure as viewed within and enabled by an IoT based platform would be a temporal-spatial visualization. The analytics would take into consideration the changes to an environment over time - This is the analytical layer of the city IoT.



The 5D Cityscape:

The fifth dimension of Urban infrastructure is formed by an overlay of intelligent systems onto the 4D infrastructure. This is the essence of Smart Cities.

SENSOR BASED PLATFORMS

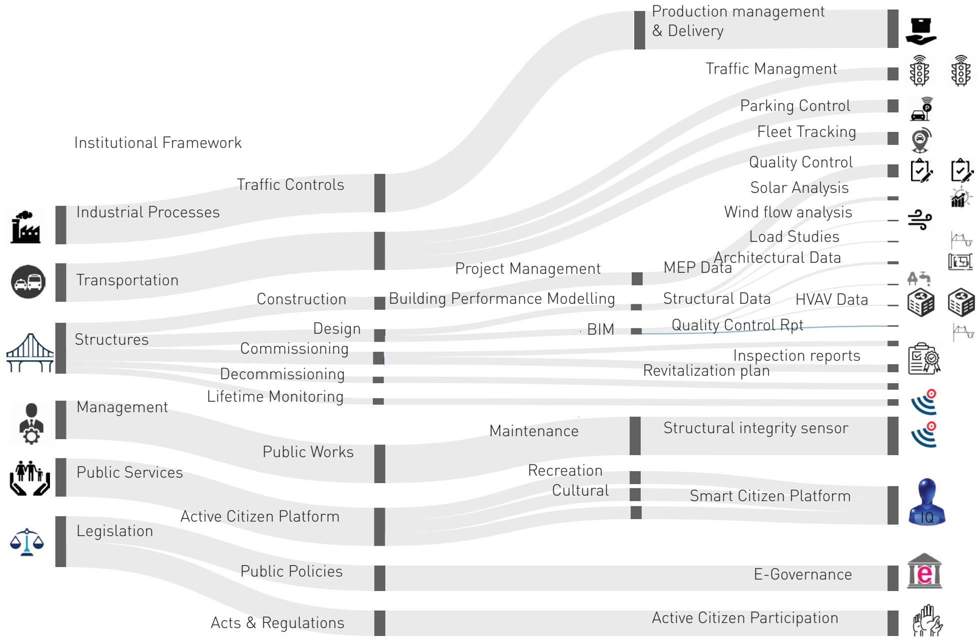


Figure 58
Sankey diagram. Sensor based platform proposition.

On the scale of the city block it is evident that there are a multitude of sensors and Internet capable elements both in terms of hardware and software. However, to date these platforms are segregated. They cannot provide a holistic profile. This means that the systems are inefficient in their exploitation and that there is a large vacuum that can be filled by initiating the interconnectivity of these elements. This will save time and resources once the system is connected between various nodes.

The proposal therefore is to have an operating system capable of handling, administering and coordination activities between stakeholders and relevant parties who would otherwise have to resort to physical communication for clarification.

THE FOLLOWING SCHEMATIC ILLUSTRATES THE DISTRIBUTION OF SMART INFRASTRUCTURE A PROPOSAL FOR IMPLEMENTATION WITHIN A BUILDING BLOCK.

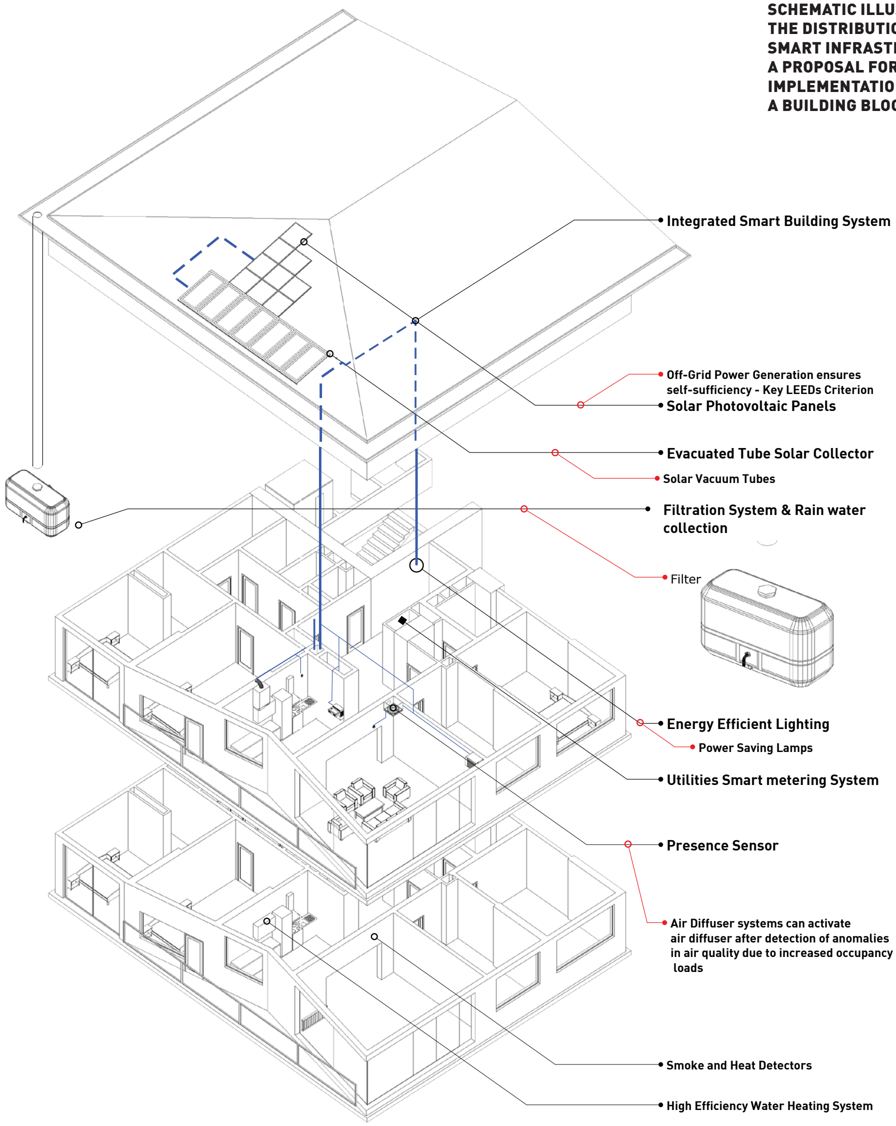


Figure 59
Distribution of smart infrastructure proposal section.

CONCLUSION

The centralized system is heavily dependent on the efficient passing on of information down the chain of command, without loss of fidelity. However, in reality it is often the case that instructions are not efficiently communicated to subordinate institutions.

In this instance, the distributed system is more effective in that such decision making is conducted at the distributed hubs and implemented there as well without loss in fidelity. This eliminates the bureaucratic mechanisms that define Centralized systems, thereby ensuring time saving in implementation of projects and saving the associated costs thereby incurred.

Resource distribution in Centralized Systems are neither effective nor efficient on the City scale, and the situation is even worse on the block scale. With the Distributed System, this situation is more eliminated by the fact that services and resources are locally sourced. This means that there are no discrepancies between centers on the localized levels, since the services and infrastructure are contained locally.

Actors at the provincial level are usually excluded in Centralized Systems, whereupon the voices of the locals are not effectively voiced. The opposite is true of the distributed system, whereby the local actors are most involved and the voices of the citizens are more optimally represented. This means that the implementation of policies, infrastructure or platforms are done with consideration of the input of the society for which said items are intended.

Considering the inadequacies of Moscow's currently hyper-centralized distribution of infrastructure, services and resources, the proposal of a distributed system is evidently justified. A distributed system would facilitate a easier access to services, resources and infrastructure, which would otherwise have to be accessed through complex transport networks. It is therefore evident that the distributed system would eliminate excessive loads on the existing transport networks.

The distributed system being proposed would likewise make available other services which would otherwise be unfordable to the average citizen. Such services include facilities such as FabLabs" which would individually be costly to procure and maintain. The facilities would therefore be affordable at the scale of a thousand people and would be centrally managed at the scale of a thousand people. This system facilitates and prioritizes access to resources services and infrastructure over the current scheme of private ownership. The connectivity between all the blocks ensures a more efficient distribution of resources, services and infrastructure and this in turn increases the city's efficiency.

REFERENCES

1. Cengiz C. (2013) Urban Ecology. DOI: 10.5772/56314
2. Fuentes-Pila J., José Luis García. (2015). Best Practices for Improving Energy Efficiency (in agro-industries). URL: https://www.researchgate.net/publication/303767337
3. Viktoria R. Bityukova, Maria S. Savoskul, Pavel L. Kirillov, Natalia A. Koldobskaya. (2003) TRANSFORMATION OF ENVIRONMENTAL PROBLEMS IN MOSCOW: SOCIOLOGICAL DIMENSION. Faculty of Geography, Lomonosov Moscow State University. DOI: 10.15356/2071-9388_04v09_2016_06
4. Prototype for self-suficcient city. (2015-16). IAAC. Barcelona
5. Hydrogrid. Infraestructura Inteligente para la Eficiencia del Agua. (2015-16). IAAC. Barcelona
6. Research Group of the Department of Urbanism – Delft University of Technology . Urban metabolism. URL: https://urban-metabolism.weblog.tudelft.nl/what-is-urban-metabolism/
7. Foster, J. (2003). Between economics and ecology: Some historical and philosophical considerations for modelers of natural capital. Environmental Monitoring and Assessment. 86 (1–2): 63–74. doi:10.1023/A:1024002617932. PMID 12858999.
8. McDonnell, M. J.; Pickett, S. T. A. (1990). Ecosystem structure and function along urban-rural gradients: An unexploited opportunity for ecology". Ecology. 71 (4): 1232–1237. doi:10.2307/1938259. JSTOR 1938259.
9. Steiner F. (2008) Human Ecology: Overview. USA. URL : https://www.sciencedirect.com/science/article/pii/B9780080454054006261
10. Rosstat. Territories, population database. (data of last access: March 2018) URL : http://www.gks.ru/
11. HYBRIDS I. High-Rise Mixed-Use Buildings. (2014). a + t 31, 2008. 168 p.
12. OECD Data. (data of access: March 2018) URL : https://data.oecd.org/water/water-withdrawals.htm
13. World bank (data of last access: March 2018) URL: https://data.worldbank.org/indicator/ER.H2O.INTR.PC?view=chart
14. Mosvodokanal. Sources of water supply. (data of last access: March 2018) URL: http://www.mosvodokanal.ru/water-supply/sources/
15. The regulation of water consumption in Moscow. (data of last access: March 2018) URL: http://cabinet-lawyer.ru/zhkx/normativ-potrebleniya-vody-na-1-cheloveka-bez-schetchika.html
16. Wikipedia. (date of last access: June, 2018). Sustainable development. URL: https://en.wikipedia.org/wiki/Sustainable_development
17. Water of Russia. Water consumption. Moscow. (data of last access: March 2018) URL: http://water-rf.ru/
18. Biomass Combined Heat and Power Catalog of Technologies (U. S. Environmental Protection Agency Combined Heat and Power Partnership). (date of last access: June, 2018) URL: http://www.qnpower.com/index.php
19. Smart Cities World. (2018). Moscow introduces blockchain e-voting. [online] Available at: https://www.smartcitiesworld.net/news/news/moscow-introduces-blockchain-e-voting-2365 [Accessed 9 Jul. 2018].
20. Decree of the Government of Moscow No. 9-PP dated January 15, 2008 https://www.mos.ru/authority/documents/doc/26218220/
21. Decree of the Government of Moscow No. 492-PP dated August 9, 2016
22. Source: ru.wikipedia.org/wiki/Список_полигонов_ТБО_в_Москве_и_Московской_области
23. http://www.solidwaste.ru/technologys/view/158.html
24. https://extension.illinois.edu/compost/process.cfm
25. https://www.nolo.com/legal-encyclopedia/free-books/sharing-book/chapter7-2.html
26. Open Street Map.