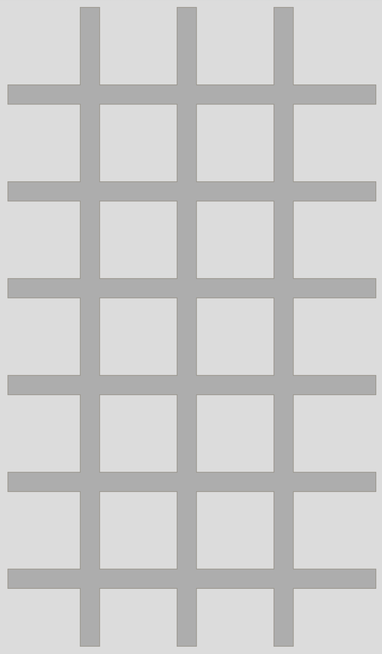
NEW CARBON-NEUTRAL KOPLI DISTRICT IN TALLINN

STUDENT: KARL-JOHAN JAKOBSON

SUPERVISOR: KIMMO SAKARI LYLYKANGAS

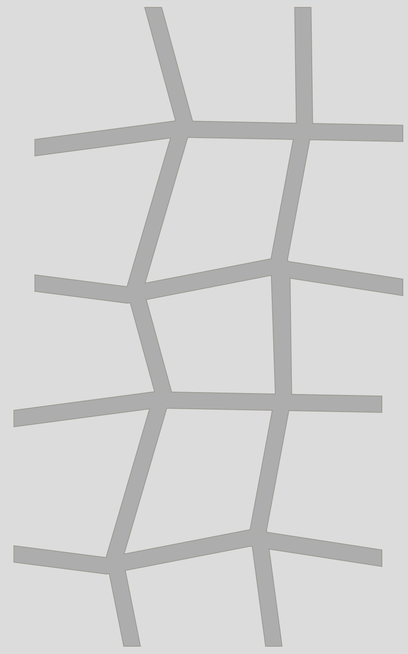
ROUTE

STRICKT CITY GRID



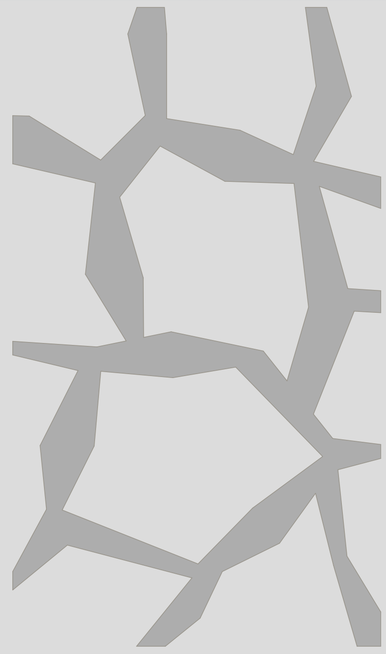
STRICKT CITY GRID IS MAINLY ORIENTED FOR CARS AND VEHICLES THAT ARE MOST COMFORTABLE TRAVELING IN STRAIGHT LINE. PEDESTRIAN COMES LAST IN THIS SYSTEM WITH CROSSROADS IN EVERY STREET JUNCTION. THE GRID CAN LOSE PEDESTRIAN'S SENSE OF LOCATION.

LOOSE GRID



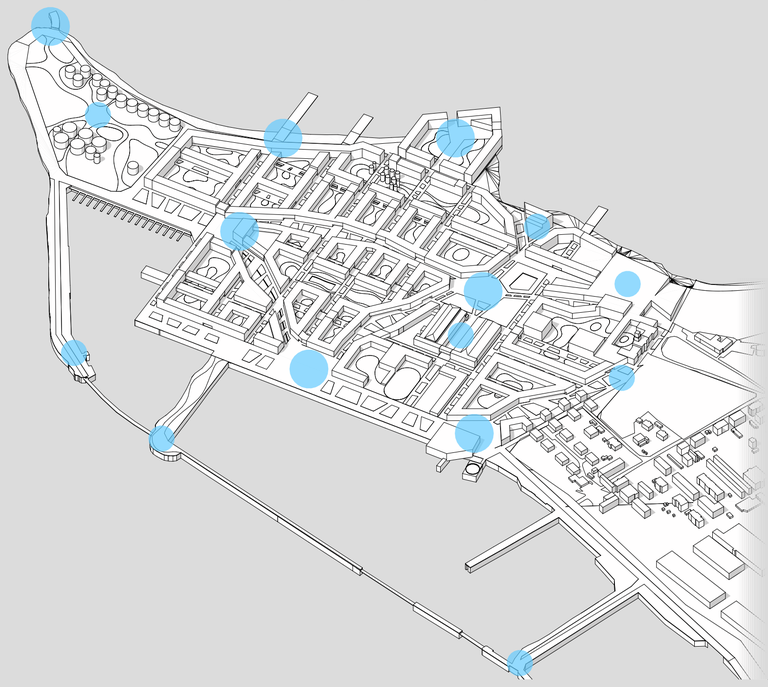
THIS CITY GRID CAN BE CHARACTERIZED AS BEST OF BOTH WORLDS SINCE IT IMPLEMENTS STILL LOGICAL VEHICLE MOVEMENT BUT ALSO CONSIDERS SOME EXCITMENT FOR PEDESTRIANS AND LIGHT TRAFFIC.

FREE-FORM GRID "ROUTE"



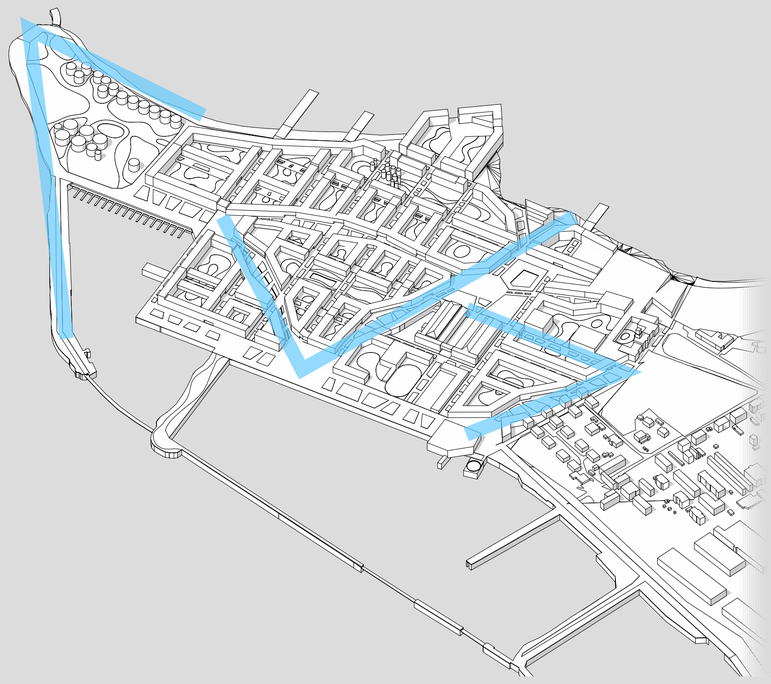
THIS TYPE OF FREE-FORM CITY GRID IS ORIENTED TOWARDS PEDESTRIANS AND LOW SPEED TRAFFIC. IT HAS DIFFERENT CUTS AND UNEXPECTED TURNS THAT MAKE THE CITYSCAPE INTERESTING AND ATTRACTIVE ON THE PEDESTRIAN SCALE. THE GRID IMPLEMENTS SURPRISING SMALL SQUARES THAT GROW OUT OF THE GRID NETWORK.

POINTS OF INTEREST



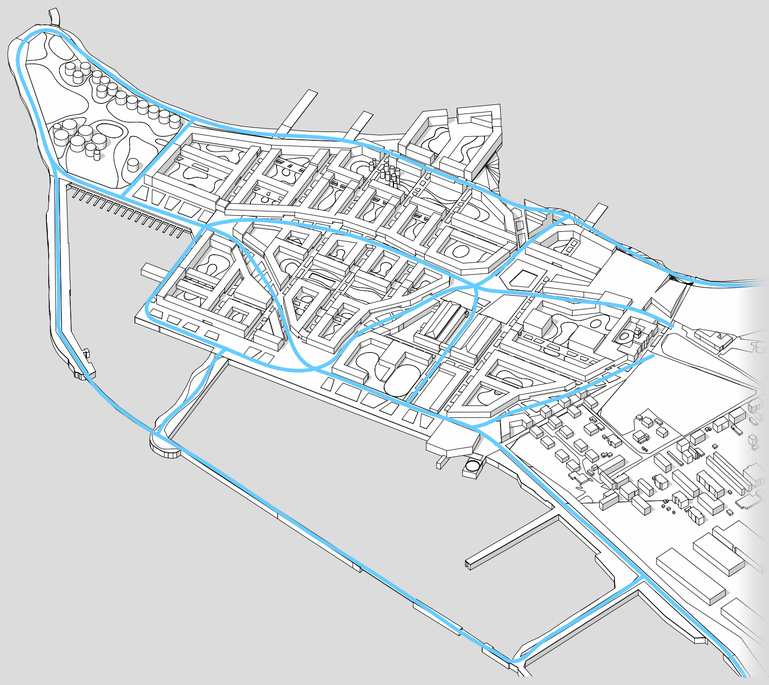
THE POINTS OF INTEREST HAVE BEEN CHOSEN BY PEDESTRIAN MOVEMENT'S COMFORT. THESE POINTS HELP TO IDENTIFY THE WHOLE PLANNING AND CREATE UNEXPECTED SPACES WHERE NO OTHER PLACE IS THE SAME.

CONNECTIONS



CONNECTIONS ARE MADE BY CREATING IMPORTANT ACCESS ROUTES TO MORE POPULAR POINTS OF THE PLANNING AREA.

PEDESTRIAN BOULEVARD



PEDESTRIAN BOULEVARD CREATES THE ULTIMATE WALKING AND BIKING ROUTES IN THE PLANNING AREA. IT ALSO CONNECTS THE FUTURE GREEN NETWORK OF TALLINN AND CUTS THROUGH THE AREA ITSELF.

PHASING

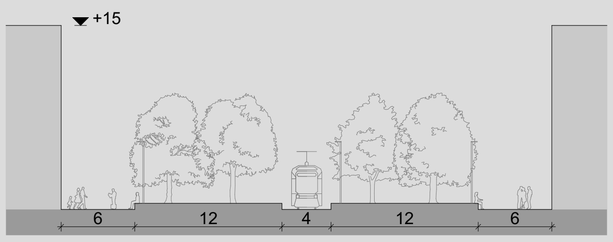
PHASE I - 2030 - STARTUP

PHASE 2030 INCLUDES:
- DEMOLISHING MOST OF EXISTING BUILDINGS
- INFRASTRUCTURE DEVELOPMENT SUCH AS TRAM LINE, TRAM DEPOT, TRAM POWER SUPPLY AND PARKING HOUSE
- 50% OF ENERGY PRODUCTION INFRASTRUCTURE: WIND TURBINES, SEA HEAT PUMPS, SOLAR THERMAL ENERGY AND WAVE ENERGY CONVERTERS
- RECONSTRUCTION OF HALF THE EXISTING SILOS FOR ENERGY STORAGE
- CENTRAL AREA DEVELOPMENT INCLUDING UNIVERSITY, SCHOOL, KINDERGARTEN, OPERA THEATRE, EXISTING CENTRAL BUILDING AND SOME RESIDENTIAL AND OFFICE BUILDINGS
- PEDESTRIAN BOULEVARD AND MAIN CONNECTIONS ON THE AREA
- GREENERIES CONNECTED WITH THE FIRST PHASE AREA

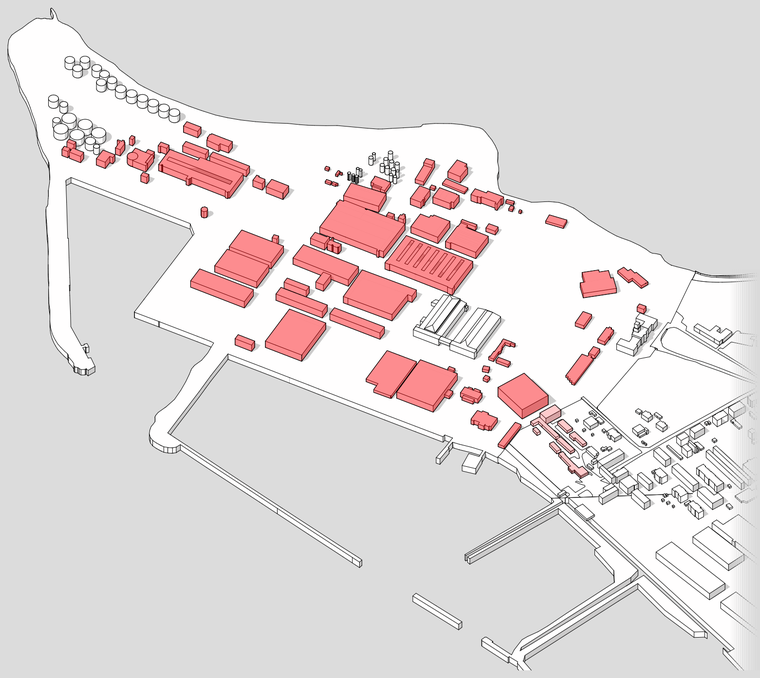
PHASE II - 2040 - IMPROVING

PHASE 2040 INCLUDES:
- MAIN RESIDENTIAL, OFFICE AND BUSINESS QUARTERS DEVELOPMENT
- CONSTRUCTION OF THE REST OF THE ENERGY PRODUCTION INFRASTRUCTURE
- RECONSTRUCTION OF THE REST OF THE SILOS FOR ENERGY STORAGE
- GREENERIES CONNECTED WITH THE SECOND PHASE AREA
- STORM WATER COLLECTION PONDS

STREET SECTION 1
1:300



DEMOLITION SCHEME



DEMOLISHING BUILDINGS
PERSPECTIVE DEMOLISHING BUILDINGS

STREET SECTION 2
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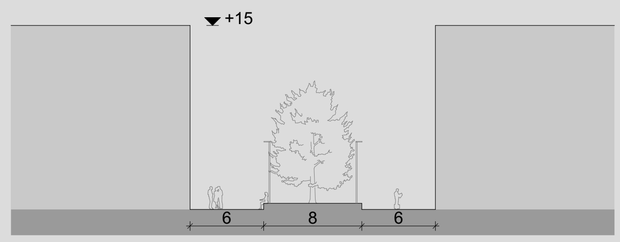
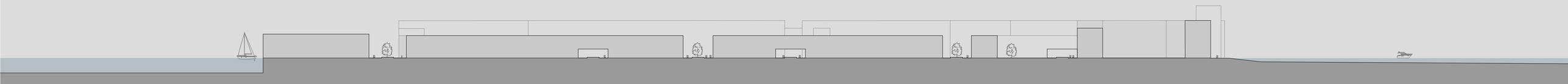


MASTER SECTION 1:1500



1:3000

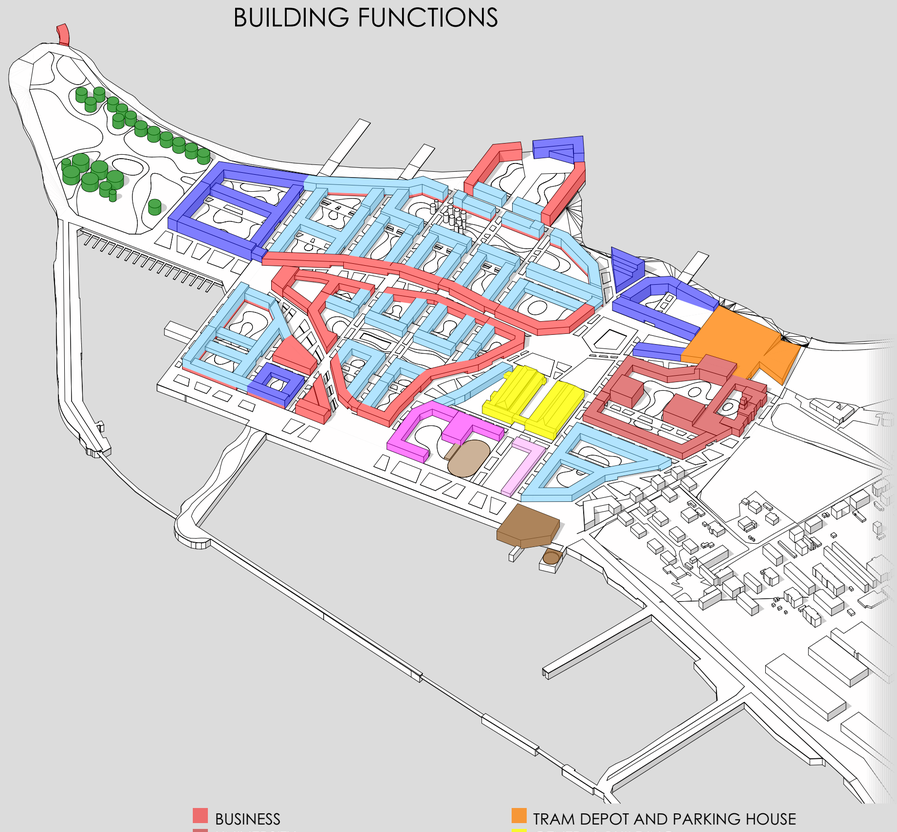
MASTER PLAN - 2050

100 M

TOTAL LAND AREA:	741 000 M2
PLANNED GREENERY:	188 000 M2
BUILDINGS GROSS AREA:	626 388 M2
FAR:	0,85
UNDERGROUND AREA:	0 M2
4-STOREY BUILDINGS:	70%
5-STOREY BUILDINGS:	13%
6-7 STOREY BUILDINGS:	17%
RESIDENTS:	9100
PARKING SPOTS:	4000
BOAT PARKING SPOTS:	200

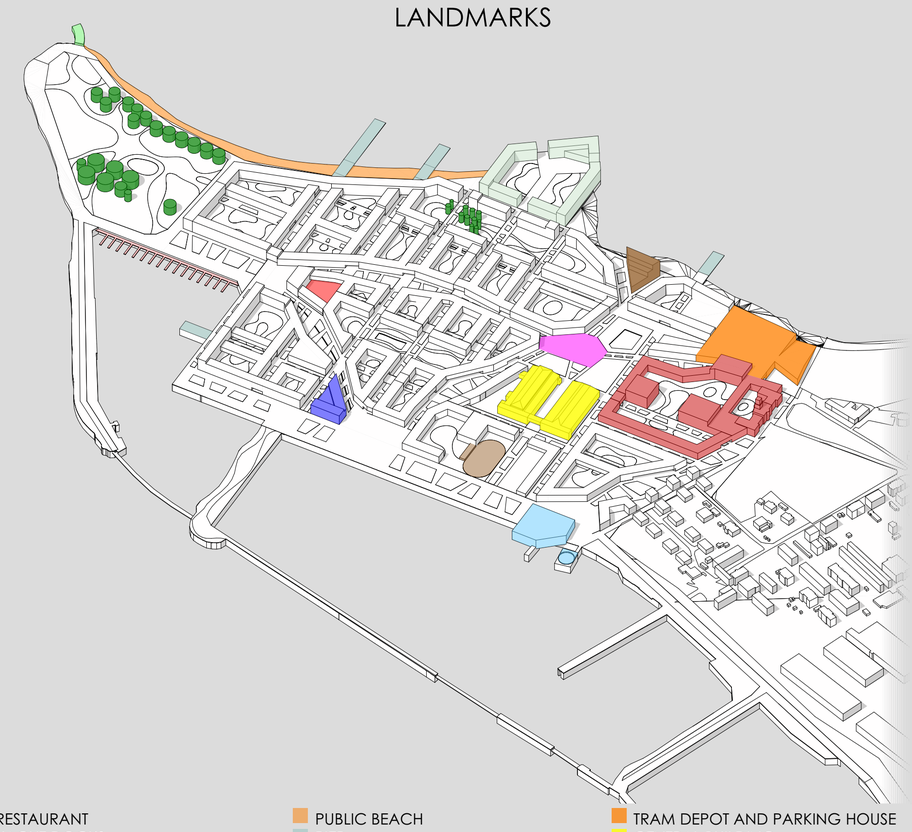
PLANNING SOLUTIONS

BUILDING FUNCTIONS



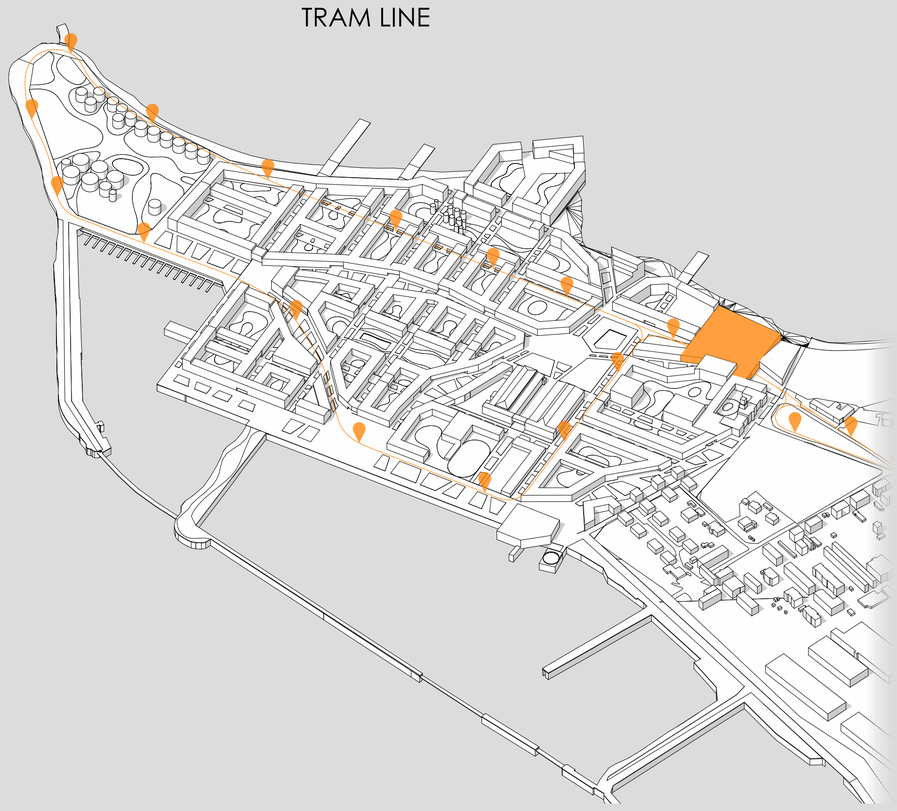
- BUSINESS
- UNIVERSITY
- RESIDENTIAL
- OFFICE
- ENERGY STORAGE SILOS
- OPERA THEATRE WITH AMPHITHEATRE
- TRAM DEPOT AND PARKING HOUSE
- CENTRAL BUILDING
- STADIUM
- KINDERGARTEN
- SCHOOL

LANDMARKS



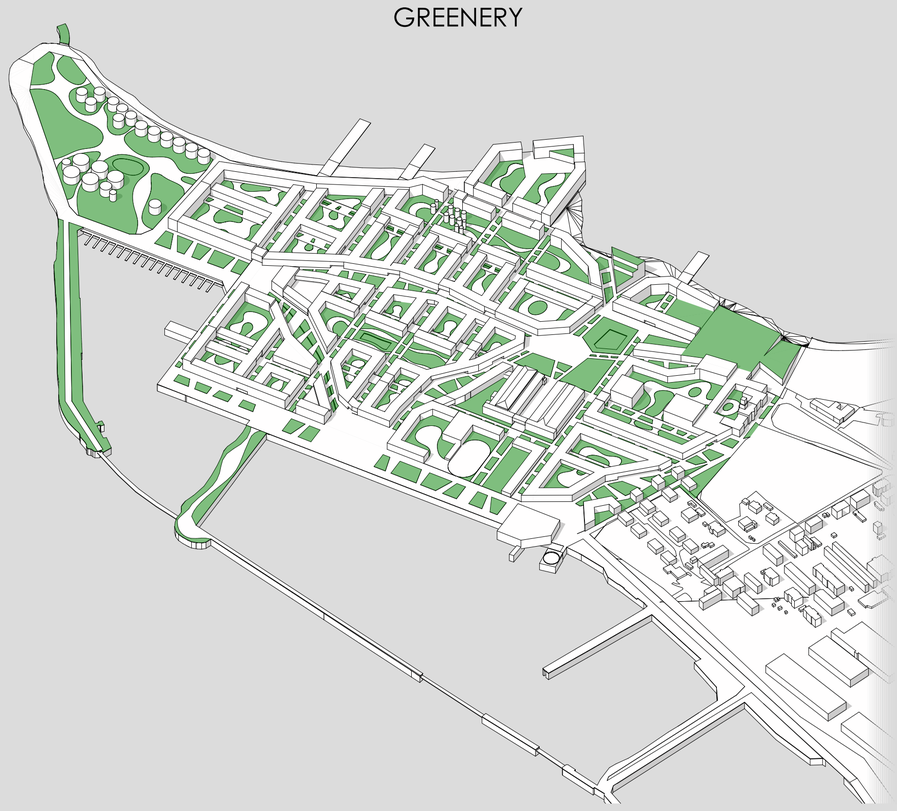
- RESTAURANT
- YACHT DOCKS
- INNER SQUARE
- SEMI-OPEN SQUARE
- MALL
- PUBLIC BEACH
- PIER
- BASTION
- ENERGY STORAGE SILOS
- SPECIAL OFFICE FACILITY
- TRAM DEPOT AND PARKING HOUSE
- CENTRAL BUILDING
- STADIUM
- UNIVERSITY COMPLEX
- OPERA THEATRE WITH AMPHITHEATRE

TRAM LINE



- TRAM DEPOT AND PARKING HOUSE
- TRAM LINE
- TRAM STOP

GREENERY



- GREENERY

CARBON NEUTRALITY

The problem of climate change and global warming today is very much acknowledged by most of the countries in the world. The Paris Agreement is a cornerstone for binding the countries intentions to reduce GHG emissions and achieve climate neutrality by 2050.

To create a realistic plan, three planning phases are proposed: 2030, 2040 and 2050. Solutions for achieving carbon-neutrality can be done step-by-step and do not need all the financing at once.

Created as an example of carbon-neutral city district in Kopli, the thesis project proposes guidelines and regulations to achieve carbon-neutrality in Tallinn's district example. These can be used by city planners, architects and municipalities.

In Kopli area's case, carbon neutrality is achieved by creating a new city district that produces excess carbon neutral energy that is exported outside the target area. There are also more regulations regarding traffic and infrastructure, land-use change and buildings energy use.

The planning area is a car-free zone. The residents can still own a personal car but it must be stored to the parking area at the side of the planning site. The planning site itself has no long-term parking spaces for residents. There are temporary exceptions for emergency and other service vehicles like police, ambulance, garbage trucks and taxies. Banning the biggest portion of traffic in the area reduces emissions caused by vehicles drastically. The planning area has an existing tram depot in the eastern side of the site. The existing depot will be demolished and a new tram depot integrated with the parking facility will be built.

The planning area will be free of asphalt. The existing asphalt will be sent to recycle and the brownfields will be covered with greeneries and trees. Pedestrian and emergency transport routes will be covered in natural stone, reused concrete from the area and wooden chips for walkways.

As the Helsinki Energy Challange winning study shows, the most reasonable solution for re-thought energy production is using sea heat pumps in the Baltic sea that can provide up to 50% of a city's heat needs on Helsinki's example. Additionally solar thermal energy collection, thermal energy storages, district heating grid and wave energy converters will be used. (Helsinki Energy Challange, 2021)

Since the site is surrounded by the Baltic Sea from three sides, it can easily house the sea heat pumps that circle the warm and cold water accordingly and store the harvested energy in the thermal energy collection silos on the tip of the peninsula. Solar thermal energy collection panels will be used on the roofs of the buildings. Wave energy can be used to create electricity with wave energy converters. Swedish wave energy industry Eco Wave Power states that their products can create an energy output of 30 kW/m. (Eco Wave Power, wave energy, global resources)

Existing silos on the northern tip on the peninsula and on the north-eastern side of the site can be used to store created thermal energy.

Nine offshore wind turbines are proposed to be built in the sea. In total, these turbines produce about 72 000 000 kW of energy yearly.(Editor, 2021)

Buildings will be built from renewable materials that can act like carbon storages, for example timber and recycled materials. Other less efficient materials regarding carbon-neutrality are low-carbon bricks (made from re-using materials from coal power plants), green concrete (with recycled materials from demolishing buildings) and green tiles (over half of the materials can be used as recycled materials). (Climate Technology Centre & Network, n.d.)

The planning project proposes a parking building integrated with tram depot, school, kindergarten, university complex, opera theatre, yacht docks, public square, beach and different landmark buildings.

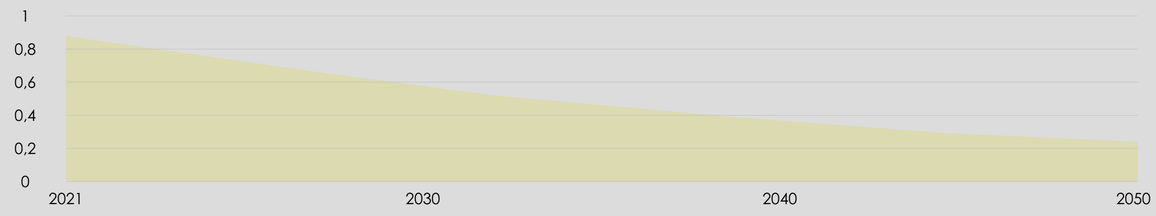
The density of the living space is calculated based on Tallinn's avarage living area per resident that is 28,5 m2. For comparison, Helsinki's avarage living area per resident is 34,1 m2 and in Stockholm 37,24 m2 (Tallinn 2035 Development Strategy, 2021). The planning area's living space per person is calculated 30 m2.

ELECTRIC VEHICLE POPULARITY GROWTH ASSUMPTION

(ASSUMPTION IS BASED ON IEA ELECTRIC VEHICLE TRACKING REPORT 2020)

Electric vehicles are estimated to grow in popularity according to IEA tracking report. This means more vehicles can use carbon friendly energy produced on the site.

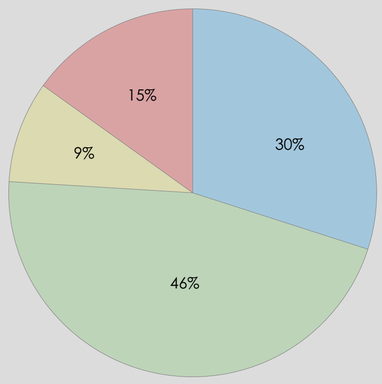
ESTONIAN ELECTRICITY GRID DEVELOPMENT ASSUMPTION



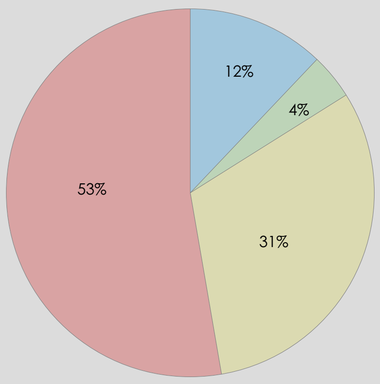
(ASSUMPTION IS BASED ON COVENANT OF MAYORS DATASHEET 2017)

Estonian grid electricity emission factor is expected to have a linear development from 0.875 kgCO 2 /kWh (2020) to 0 kgCO 2 /kWh (2050) in accordance with the national carbon neutrality studies by Stockholm Environment Institute.
In 1990 it was 2,436, in 2012 it was 1,594 and in 2017 it was 0,908 according to Covenant of Mayors datasheet 2017.

VAUBAN, FREIBURG MODAL SHARE 2003

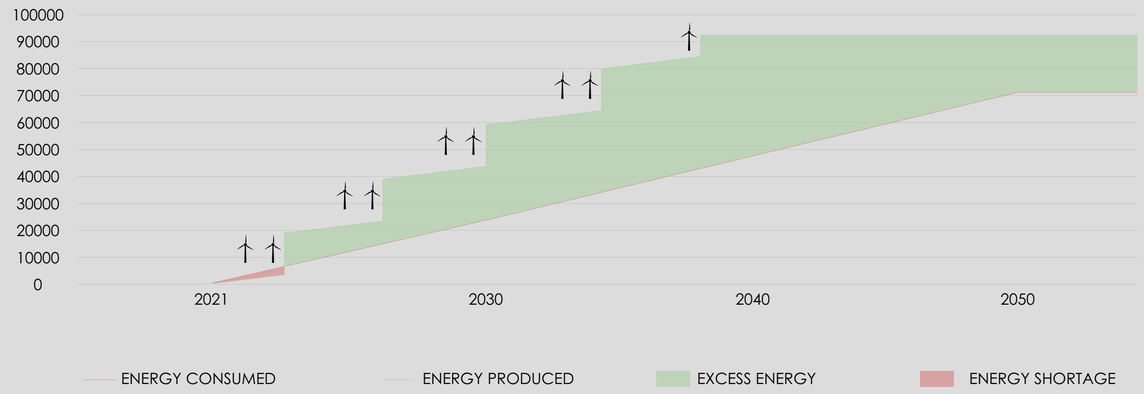


TALLINN RESIDENT'S MODAL SHARE 2018



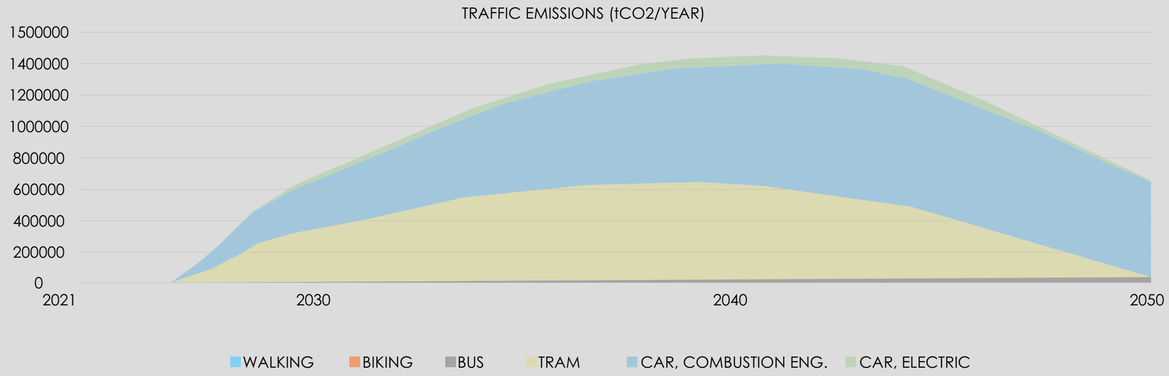
The site uses similar modal share to Vauban, Freiburg in Germany. It is a working modal share that is taken as a target, although public transport (tram) usage can be expected higher in real life. Tallinn resident's modal share (from Maanteeamet) for comparisson.
Emission factors for modes of transportation (kgCO2/person, a)
Walking: 40.0; biking 7.1
Energy consumption of electric vehicles (kWh/person-km)
Tram 0.24; EV, car 0.10
(From LIPASTO unit emissions database)

ENERGY BALANCE (MW/H)*A



Energy balance shows produced and exported energy and it's difference. Excess energy is exported via Estonian electricity grid to compensate for CO2 emissions and strive for carbon neutrality.
LCA emission factors (tCO2-eq/MWhe)
Solar PV: 0.020; windpower: 0.007
(From Covenant of Mayors, technical annex for SEAP template instructions)

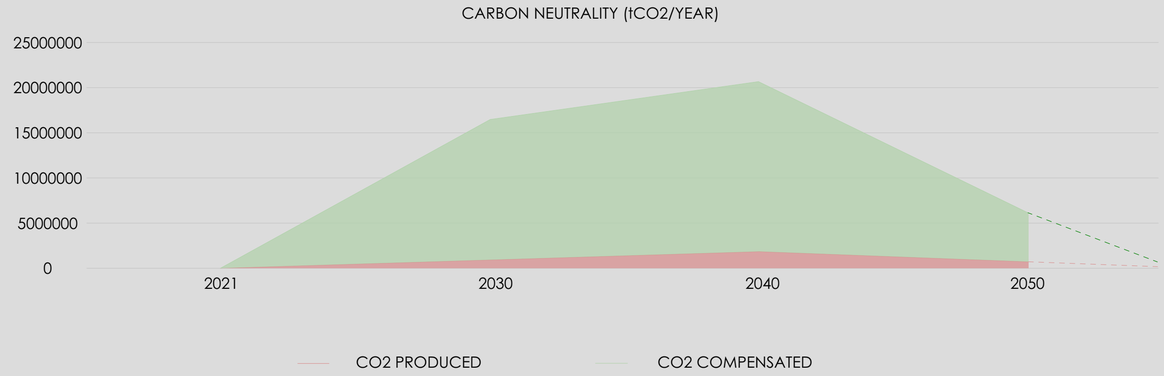
TRAFFIC EMISSIONS (tCO2/YEAR)



(NOTE: THIS CALCULATION IS DONE IN tCO2/YEAR NOT tCO2e/YEAR)

Traffic emissions are calculated according to proposed modal share above. Estonian electricity grid development and electric car popularity growth is taken into account.
Emission factors for Estonian cars with a combustion engine. Bus, diesel: 10.26; car, gasoline: 130.1
(From Eurostat database 2019)

CARBON NEUTRALITY (tCO2/YEAR)



Carbon neutrality can be achieved as soon as energy production export exceeds consumed energy margin. This is calculated in CO2 emissions produced and compensated according to Estonian electricity grid emission factor. The grid emission factor is assumed to develop for the better, so at some point in the future, the site will no longer be carbon neutral via excess energy export.