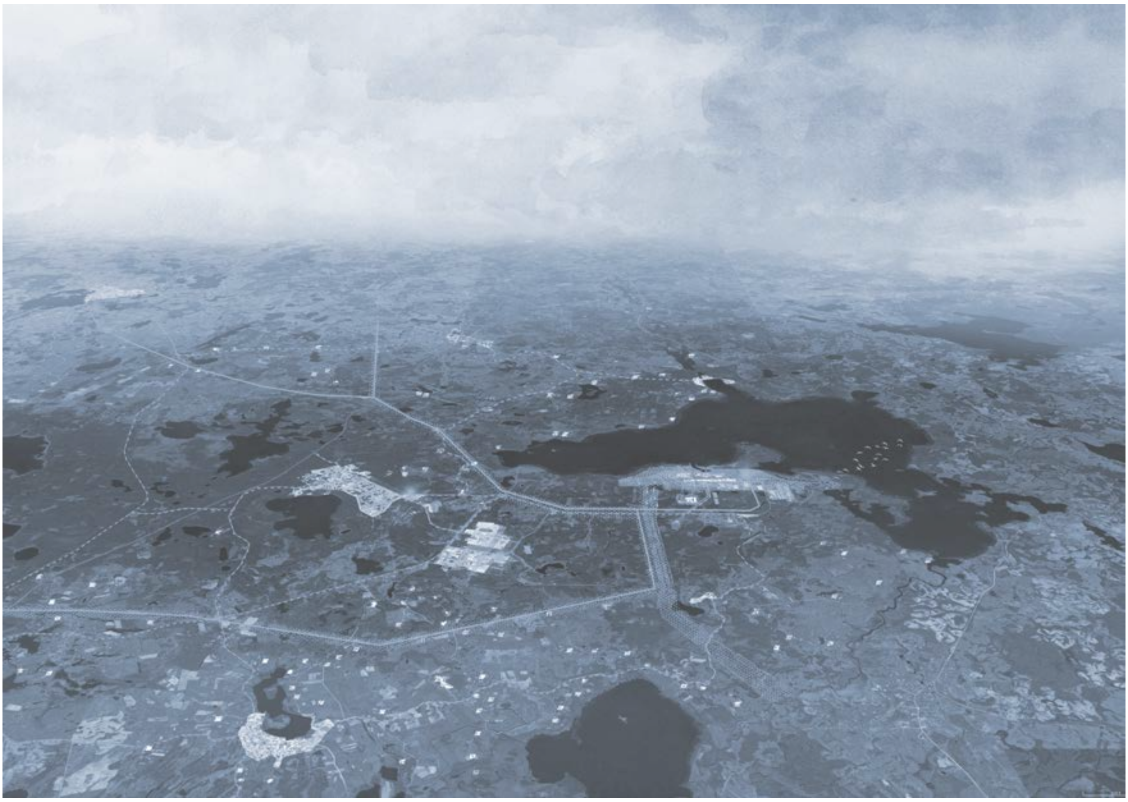

From Atomgrad to Atompark
Upcycling a nuclear energy landscape

COLOPHON

From Atomgrad to Atompark
Upcycling a nuclear energy landscape
P5 Report of MSc Urbanism thesis

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P5 REPORT

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Delft
2016

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1. INTRODUCTION

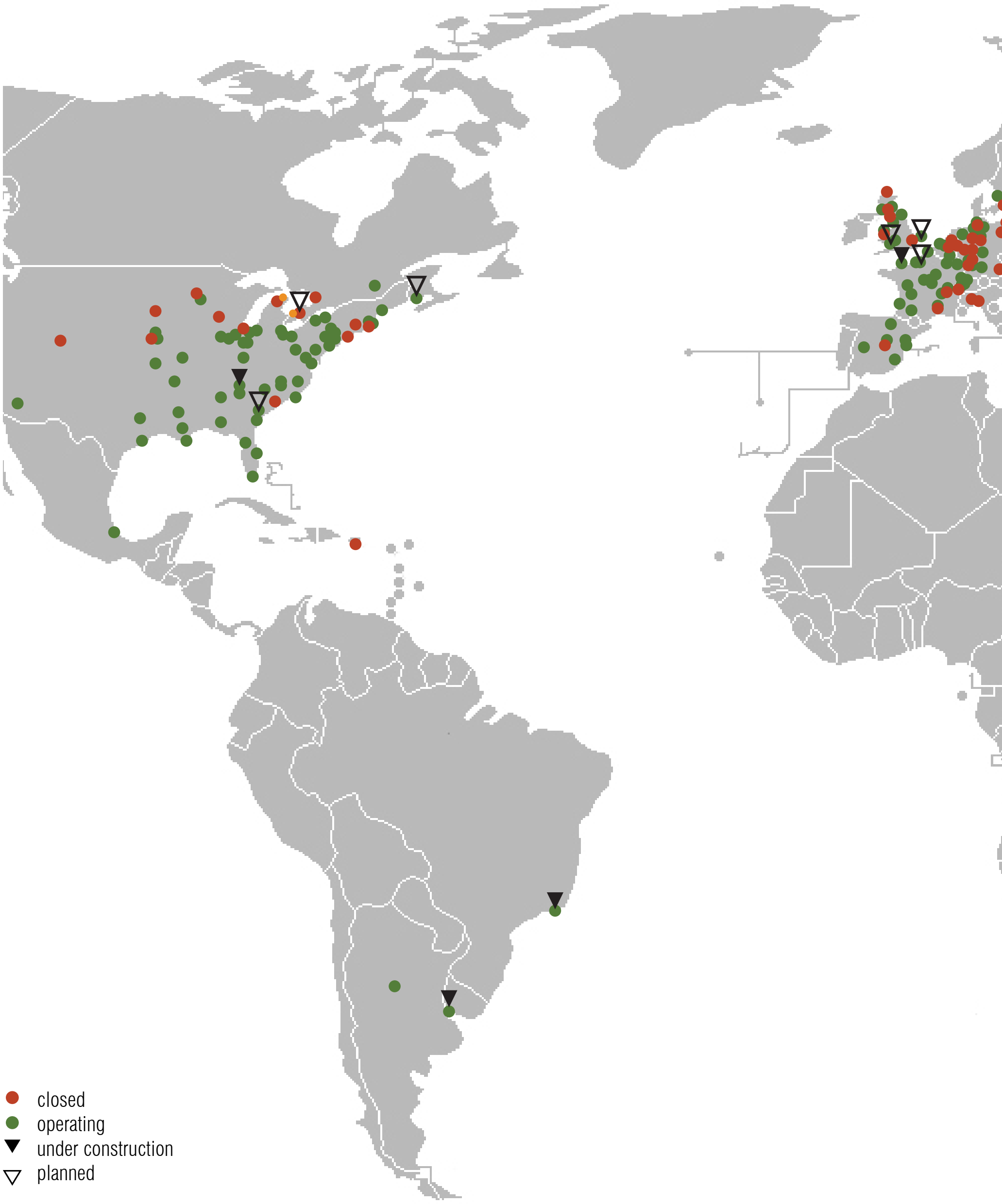
1.1.
CONTEXT OF THE PROJECT

The nuclear power is established since 1950s. Due to positive attitude towards nuclear energy lots of nuclear plants were built in 1960-1970s, in so called Atomic Age. Huge residential areas were constructed as parts of existing cities or as completely new towns in order to house highly educated nuclear power plant workers. The latter is mainly the case in the Western part of the former Soviet Union and America. This new urban-technological phenomenon have a specific term – Atomgrad. Atomgrad, as historian Wendland defines, is a small industrial city (from 30,000 to 80,000 inhabitants) designed to serve the needs of large commercial nuclear power plant (Wendland, n.d.). Now there is a time when due to political decisions, accidents or the end of operation time approximately 150 of nuclear facilities in the world are decommissioned or facing decommissioning, which makes the future of satellite settlements uncertain.

The project case, Visaginas, is one of such atomgrads with its nuclear facility under decommissioning.

Tabl.1. The list of Atomgrads in the World

City	establishment	Nuclear facilities	Country
Agidel	1980	Nuclear power plant Bashkiria	Russian Federation
Aktau	1961	Aktau nuclear power plant	Kazakhstan
Balakovo	1762	Balakovo Nuclear Power Plant	Russian Federation
Bilibino	1955	Bilibino nuclear power plant	Russian Federation
Desnogorsk	1974	Smolensk nuclear power plant	Russian Federation
Enerhodar	1970	Zaporizhia Nuclear Power Plant	Ukraine
Yuzhnoukrainsk	1976	South Ukraine Nuclear Power Plant	Ukraine
Kamskije Polyany	1981	Nuclear power plant Tatarstan (Kama)	Russian Federation
Kurchatov	1968	Kursk Nuclear Power Plant	Russian Federation
Kuznetsovsk	1973	Rivne Nuclear Power Plant	Russian Federation
Mezamor	1969	Metsamor Nuclear Power Plant	Armenia
Netishyn	1984	Khmelnitsky nuclear power plant	Ukraine
Novovoronezh	1975	Nuclear power plant Novovoronezh Novovoronezh Nuclear Power Plant II	Russian Federation
Obninsk	1956	Obninsk Nuclear Power Plant, IPPE	Russian Federation
Ozersk	1945	Mayak, nuclear power plant South Urals	Russian Federation
Polyarnye Zori	1968	Kola nuclear power plant	Russian Federation
Pripyat, Slavutich	In 1970, 1986	Chernobyl Nuclear Power Plant	Ukraine
Saretschny	1957	Beloyarsk nuclear power station	Russian Federation
Scholkine	1978	Crimean Atomic Energy Station	Ukraine
Seversk	1949	Sibirskaya nuclear power plant	Russian Federation
Sosnovy Bor	1958	Leningrad Nuclear Power Plant Leningrad Nuclear Power Plant II	Russian Federation
Teplodar	1981	Nuclear thermal power station Odessa	Ukraine
Chistye Bory	1979	Nuclear power plant Kostroma	Russian Federation
Udomlya	1961	Kalinin Nuclear Power Plant	Russian Federation
Visaginas	1975	Ignalina nuclear power plant, Visaginas Nuclear Power Plant	Lithuania
Volgodonsk	1950	Rostov Nuclear Power Plant, nuclear equipment	Russian Federation
Sillamäe	1502	chemical factory that produced fuel rods and nuclear materials	Estonia
Paldiski	1783	a Soviet Navy nuclear submarine training centre	Estonia
Kurchatov		Nuclear testing site	Kazakhstan
Oak Ridge, Tennessee	1942	Manhattan Project.	USA
Los Alamos, New Mexico		Manhattan Project.	USA
Gold Coast Historic District (Richland, Washington)	1943	Manhattan Project.	USA
Mercury, Nevada	1950	Nevada Test Site	USA


closed
operating
under construction
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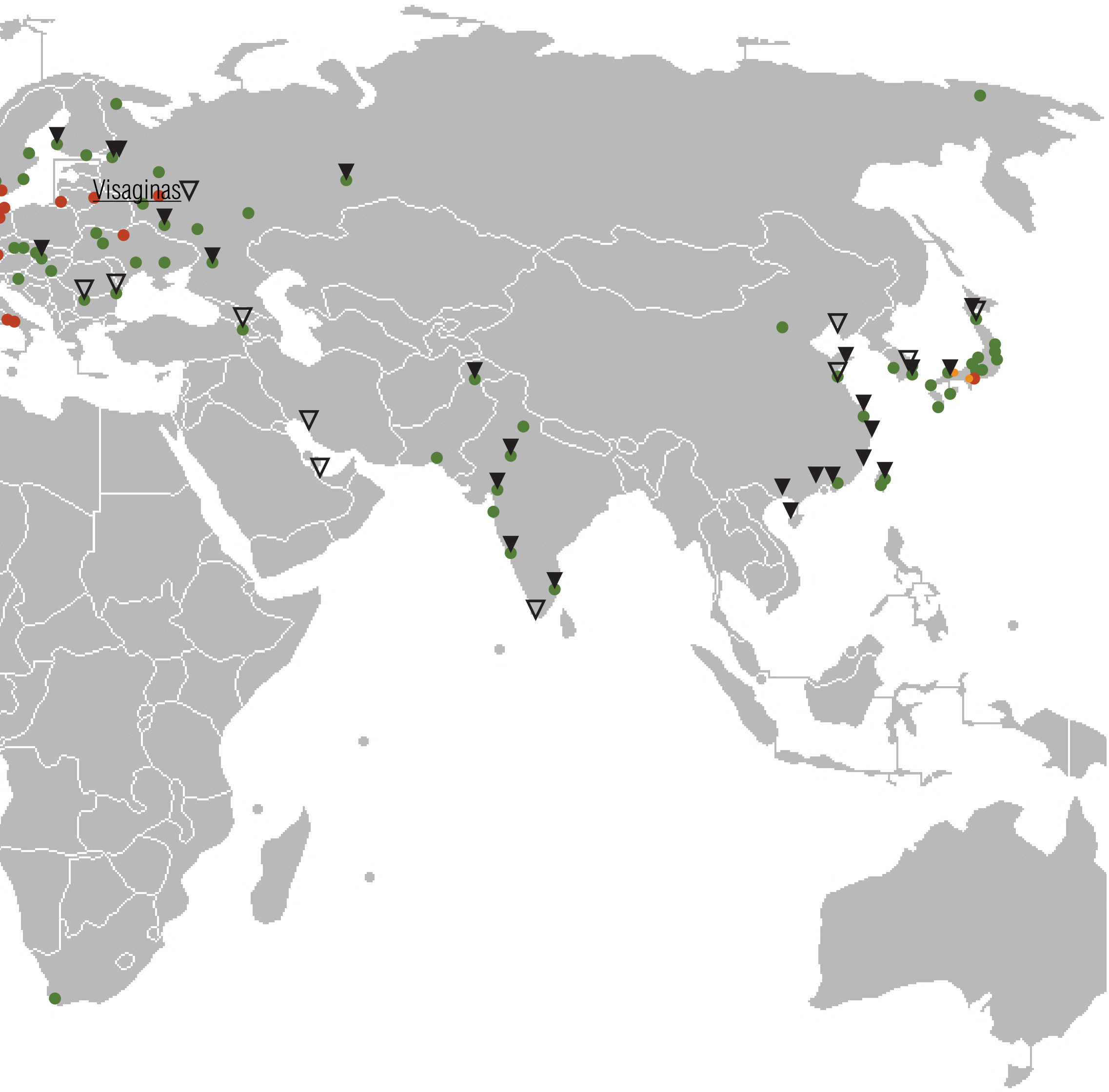

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Fig.1. The situation of nuclear power plants in the World

Reactors closed following damage in an accident or serious incident (11)

Country	Reactor	Type	MWe net	Years operating	Shut down	reason
Germany	Greifswald 5	VVER-440/V213	408	0.5	11/1989	Partial core melt
	Gundremmingen A	BWR	237	10	1/1977	Botched shutdown
Japan	Fukushima Daiichi 1	BWR	439	40	3/2011	Core melt from cooling loss
	Fukushima Daiichi 2	BWR	760	37	3/2011	Core melt from cooling loss
	Fukushima Daiichi 3	BWR	760	35	3/2011	Core melt from cooling loss
	Fukushima Daiichi 4	BWR	760	32	3/2011	Damage from hydrogen explosion
Slovakia	Bohunice A1	Prot GCHWR	93	4	1977	Core damage from fuelling error
Spain	Vandellos 1	GCR	480	18	mid 1990	Turbine fire
Switzerland	St Lucens	Exp GCHWR	8	3	1966	Core Melt
Ukraine	Chernobyl 4	RBMK LWGR	925	2	4/1986	Fire and meltdown
USA	Three Mile Island 2	PWR	880	1	3/1979	Partial core melt

Reactors closed prematurely by political decision or consideration (27)

Country	Reactors	Type	MWe net each	Years operating each	Shut down
Armenia	Metsamor 1	VVER-440/V270	376	13	1989
Bulgaria	Kozloduy 1-2	VVER-440/V230	408	27, 28	12/2002
	Kozloduy 3-4	VVER-440/V230	408	24, 26	12/2006
France	Super Phenix	FNR	1200	12	1999
Germany	Greifswald 1-4	VVER-440/V230	408	10, 12, 15, 16	1990
	Muelheim-Kaerlich	PWR	1219	2	1988
	Rheinsberg	VVER-70/V210	62	24	1990
Italy	Caorso	BWR	860	12	1986
	Latina	GCR	153	24	1987
	Trino	PWR	260	25	1987
Japan	Fukushima Daiichi 5	BWR	760	33	2011
	Fukushima Daiichi 6	BWR	1067	32	2011
Lithuania	Ignalina 1	RBMK LWGR	1185	21	2005
	Ignalina 2	RBMK LWGR	1185	22	2009
Slovakia	Bohunice 1	VVER-440/V230	408	28	12/2006
	Bohunice 2	VVER-440/V230	408	28	12/2008
Sweden	Barseback 1	BWR	600	24	11/1999
	Barseback 2	BWR	600	28	5/2005
Ukraine	Chernobyl 1	RBMK LWGR	740	19	12/1997
	Chernobyl 2	RBMK LWGR	925	12	1991
	Chernobyl 3	RBMK LWGR	925	19	12/2000
USA	Shoreham	BWR	820	3	1989

Tabl.2. The list of nuclear power plants under decommissioning

Reactors closed having fulfilled their purpose or being no longer economic to run (109+1)

- prot= prototype, exp= experimental, * = ran approx full-term

Country	Reactor	type	MWe net each	Start-up	Years operating each	Shut down
Belgium	BR-3	Prot PWR	10	1962	24	1987
Canada	Douglas Point	Prot PHWR	206	1967	17	1984
	Gentilly 1	Exp SGHWR	250	1971	6	1977
	Gentilly 2	PHWR	638	1982	30	2012
	Rolphton NPD	Prot PHWR	22	1962	25	1987
France	Bugey 1	GCR	540	1972	22	1994
	Chinon A1	Prot GCR	70	1963	10	1973
	Chinon A2	GCR	180	1965	20	1985
	Chinon A3 *	GCR	360	1965	25	1990
	Chooz A	Prot PWR	305	1967	24	1991
	Brennilis EL-4	exp GCHWR	70	1967	18	1985
	Marcoule G-1	Prot GCR	2	1956	12	1968
	Marcoule G-2	Prot GCR	39	1959	20	1980
	Marcoule G-3	Prot GCR	40	1960	24	1984
	Phenix *	FNR	233	1973	37	2010
	St Laurent A1	GCR	390	1969	21	1990
	St Laurent A2	GCR	465	1971	21	1992
Germany	Juelich AVR	Exp HTR	13	1968	21	1989
	Uentrop THTR	Prot HTR	296	1985	3	1988
	Kalkar KNK 2	Prot FNR	17	1978	13	1991
	Kahl VAK	Exp BWR	15	1961	24	1985
	MZFR	Exp PHWR	52	1966	18	1984
	Groswelzheim	Prot BWR	25	1969	2	1971
	Lingen	Prot BWR	183	1968	10	1979
	Niederaichbach	Exp GCHWR	100	1973	1	1974
	Obrigheim *	PWR	340	1968	36	2005
	Stade *	PWR	640	1972	31	2003
	Wuergassen	BWR	640	1972	22	1994
Italy	Garigliano	BWR	150	1964	18	1982
Japan	Fugen	Prot ATR	148	1978	24	2003
	Genkai 1	PWR	529	1975	40	2015
	Hamaoka 1	BWR	515	1974	26	2001
	Hamaoka 2	BWR	806	1978	25	2004
	JPDR	Prot BWR	12	1963	13	1976
	Mihama 1	PWR	320	1970	45	2015
	Mihama 2	PWR	470	1972	43	2015
	Shimane 1	BWR	439	1974	41	2015
	Tokai 1 *	GCR	137	1965	33	1998
	Tsuruga 1	BWR	341	1970	45	2015
Kazakhstan	Aktau BN-350	Prot FNR	52	1973	27	1999
Netherlands	Dodewaard *	BWR	55	1968	28	1997
Russia	Obninsk AM-1	Exp LWGR	6	1954	48	2002
	Beloyarsk 1	Prot LWGR	108	1964	19	1983
	Beloyarsk 2	Prot LWGR	160	1968	22	1990
	Melekess VK50	Prot BWR	50	1964	24	1988
	Novovoronezh 1	Prot VVER-440/V210	210	1964	23	1988
	Novovoronezh 2	Prot VVER-440/V365	336	1970	20	1990
Spain	Garona	BWR	446	1971	42	2012
	Jose Cabrera *	PWR	141	1968	38	2006
Sweden	Agesta	Prot HWR	10	1964	10	1974
UK	Berkeley 1-2 *	GCR	138	1962	26	1988-89
	Bradwell 1-2 *	GCR	123	1962	39	2002
	Calder Hall 1-4 *	GCR	50	1956-59	44-46	2003
	Chapelcross 1-4 *	GCR	49	1959-60	44-45	2004
	Dungeness A 1-2 *	GCR	225	1965	41	2006
	Hinkley Pt 1-2 *	GCR	235	1965	35	2000
	Hunterston A 1-2*	GCR	160	1964	25	1989-90
	Oldbury 1-2*	GCR	217	1967	44	2011-12
	Sizewell A 1-2 *	GCR	210	1966	41	2006
	Trawsfynydd 1-2 *	GCR	196	1965	26	1993
	Wylfa 2*	GCR	490	1971	41	2012
	Windscale	Prot AGR	28	1963	18	1981
	Dounreay DFR	Exp FNR	11	1962	18	1977
	Dounreay PFR	Prot FNR	234	1975	19	1994
	Winfrith	Prot SGHWR	92	1968	23	1990
USA	Big Rock Point*	BWR	67	1962	35	1997
	BONUS	Exp BWR	17	1964	4	1968
	CVTR	Exp PHWR	17	1963	4	1967
	Crystal River	PWR	860	1977	35	2013
	Dresden 1	BWR	197	1960	18	1978
	Elk River	BWR	22	1963	5	1968
	Enrico Fermi 1	Prot FNR	61	1966	6	1972
	Fort St. Vrain	Prot HTR	330	1976	13	1989
	Haddam Neck*	PWR	560	1967	29	1996
	Hallam	Exp sodium cooled GR	75	1963	1	1964
	Humboldt Bay	BWR	63	1963	13	1976
	Indian Point 1	PWR	257	1962	12	1974
	Kewaunee*	PWR	566	1974	39	2013
	Lacrosse	BWR	48	1968	19	1987
	Maine Yankee*	PWR	860	1972	25	1997
	Millstone 1	BWR	641	1970	28	1998
	Pathfinder	Prot BWR	59	1966	1	1967
	Peach Bottom 1	Exp HTR	40	1967	7	1974
	Piqua	Exp Organic MR	12	1963	3	1966
	Rancho Seco 1	PWR	873	1974	15	1989
	San Onofre 1*	PWR	436	1967	25	1992
	San Onofre 2*	PWR	1070	1982	31	2013
	San Onofre 3*	PWR	1070	1983	30	2013
	Saxton	Exp PWR	3	1967	5	1972
	Shippingport	Prot PWR	60	1957	25	1982
	Trojan	PWR	1095	1975	17	1992
	Vallecitos	Prot BWR	24	1957	6	1963
	Yankee NPS*	PWR	167	1960	31	1991
	Zion 1-2 *	PWR	1040	1973	25	1998
	Sturgis FNPP	PWR	10	1967	9	1976

1.2.
MOTIVATION OF THE STUDY

The decisions made on a political level influence our built environment. The interest in relationship between design and its underlying forces was the trigger point for choosing Design as politics as graduation studio.

The state's energy profile is a political question. The ongoing debate on the future of nuclear energy in Lithuania and the decision to decommission Ignalina nuclear power plant raised the question for spatial implication of this process. The further research revealed the relevance of the project internationally. There are many nuclear facilities in the world that are being decommissioned at the moment creating uncertainty of the future for their satellite cities. It is still not too late to search for sustainable development possibilities of such sites in order not to waste the social capital, infrastructure and networks that nuclear power plants developed during their operation.

The search for sustainable transition from town reliant on external allocation of resources and workforce to town with multi-scalar and multilateral determination of resources and workforce, spatial transformations of new towns relates with my personal belief that urban form should be able to adapt to changing socio-economic situation.

In addition to this, the knowledge generated in graduation thesis could be transferred to other relevant urban questions, for instance, transformations of post-industrial new towns, shrinking cities, conversion and heritage questions of industrial areas, urban economy and ecology, changes of spatial form of allocation of resources.

1.3.
THEORETICAL FRAMEWORK

> *"The theoretical framework is the structure that can hold or support a theory of a research study. The theoretical framework introduces and describes the theory that explains why the research problem under study exists."*
>
> *(Swanson, 2013)*

Theoretical framework is structured under three main topics:

1. **Utopia of Atomic Age** which started in 1945 with the first nuclear bomb. Nuclear technology was considered as a huge innovation with potential threat. To diminish a negative attitude, positive aspects of nuclear technology were praised. In 1953, U.S. President D. Eisenhower made a speech "Atoms for Peace", in which he announced the program to use nuclear energy to provide power in developing countries (Eisenhower, 1953). Following this, 1960s-1970s was the period for major constructions of nuclear facilities which created urban technological phenomenon - atomgrad (Wendland, n.d.). Atomgrads were exemplary cities with well developed cultural and sports facilities, green living environments, healthy and educated population, which, as a paradox, feared less the radioactivity impact to their health than decommissioning of nuclear facility. Such cities served as a tool for political propaganda supporting Atomic Age (Brown, 2013) until Chernobyl disaster. Paul Bracken (2012) claims that we have entered second Nuclear Age because of reemergence of nuclear technology. In terms of energy production, new generation nuclear reactors will be small scale, factory produced, safer or initially safe (nuclear fusion). It is a high time to raise a question how Second Atom for Peace utopia would affect our built environments, especially in atomgrads which are most likely to reorient themselves to new generation of nuclear energy.

2. **Transformability** theories and their relevance to nuclear power plant cities. Transformability being part of resilience thinking seeks for building the capacity for a city to shift to new development directions by defining and evaluating in time and in terms of opportunities resources of the city. The key aspects of transformability - novelty and diversity at a first glance contradicts to mono-functional, secluded new towns. However, further research shows their ability to develop the transformability attributes through time and pass the socio-economic transition, except for the cases of nuclear disasters. Nuclear facility cities share the set of several transformability features, such as strong communities of workers, highly educated people, diverse learning platforms, strong nature of the buffer landscape in safety protection zones. Transformability looks at thresholds, crisis as "windows of opportunity for novelty and innovation" (Folke et al., n.d.) by recombination of sources of capital, know-how and knowledge. The research and constant update of the knowledge about city's resources is the precondition that helps in urban planning to know if, when, and how to conduct a transformative change to avoid seriously undesirable situations.

3. **Ecological urbanism** theories are based on modern approach to ecology where human beings are considered as part of nature and cities their habitats. As part of the nature, urban environment should be designed accordingly taking into account natural processes of air, earth, water, life and ecosystems, addressing challenges that put humanity at risk and at the same time increasing human health, safety, welfare, seek for meaning and delight (Spirn, 2014).There are several concepts of ecological urbanism:

1. Cities are part of the natural World
2. Cities are habitats
3. Cities are ecosystems
4. Urban ecosystems are connected

and dynamic

5. Every city has a deep structure of enduring context

6. Urban design is a powerful tool for adaptation

The second concept relates with the **biophilia** hypothesis which suggests that humans have an innate attraction to other living organisms and life's processes.

It also relates with the new approach to nature conservation that seeks to reestablish connections with nature which results in human beings regard for animals, plants and less appealing wild areas. (Wilson 1984)

1.4. PROBLEM ANALYSIS AND PROBLEM STATEMENT

Visaginas, one of the atomgrads, is highly dependent on its creation force - a nuclear power plant. The city was planned to thrive and serve the needs of large industry during its functioning (~30 years). **However, these short term plans are lacking long term vision,** how the city should develop after the decommissioning of its nuclear facility.

Dependence on political decisions made the city vulnerable and unprepared to disruptive change. The specifics of nuclear industry and danger of radioactive disasters put the decision making for the operation of Ignalina nuclear power plant on the international level. In 1999, with regard to EU opinion, Lithuanian Parliament with National Energy Strategy approved the shutdown of reactor Unit I until 2004, Unit 2 until 2009 - 15 years before the initial projected end of the operation ("Ignalina Nuclear Power Plant - History," n.d.). This created a shock not only for the town of Visaginas but also on the national level. Lithuania became highly dependent on the import of gas from Russia, which increases the country's political dependence. ("Nacionaline energetines nepriklausomybes strategija," 2012, Fig. 2) Energy generation from gas also increases the environment pollution and contributes to green house effect. **The decommissioning of Ignalina Nuclear Power Plant negatively affects not only economy of the city but of the country as well. INPP transforms from the biggest energy seller, to the biggest consumer.**

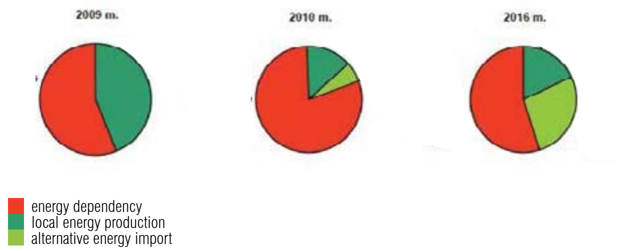
On the city scale, decommissioning of nuclear power plant causes the anxiety about the future which strengthens **emigration. Around 40 per cent of the population have already left the city (Fig. 3).** Comparing with the emigration situation in Lithuania, figures of the city of Visaginas is twice as much proportionally (Fig. 4, 5). There is a huge contribution of Ig-

Fig.2. The energetic dependency of Lithuania

Fig.3. The emigration in Visaginas

Fig.4. The emigration in Lithuania

Fig.5. The demographics in Visaginas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energy dependency
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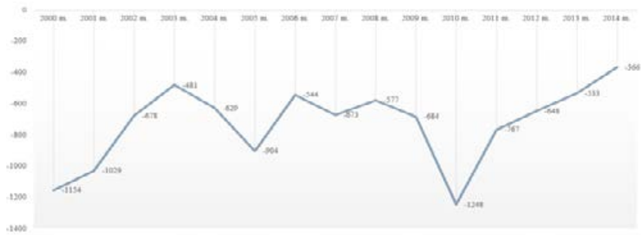
2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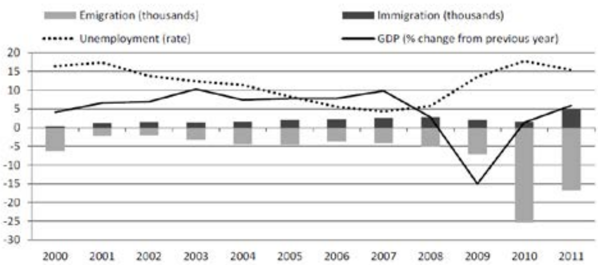
Emigration (thousands)
Immigration (thousands)
Unemployment (rate)
GDP (% change from previous year)
20
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0
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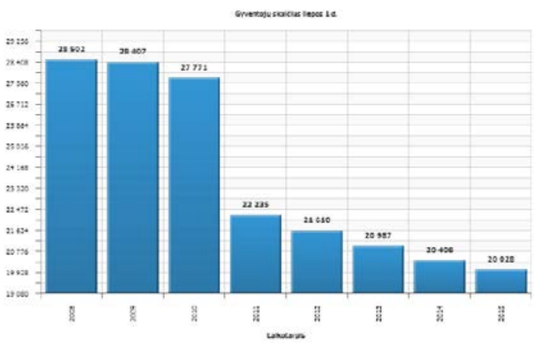
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5

nalina Nuclear Power plant which fires 200 people every year. They are mostly highly educated (Tabl. 3), well paid workers that seeks for jobs in similar fields of their expertise. However, due to their lack of ability to speak in Lithuanian it is hardly possible for them to find a job elsewhere in the region or in the country. **Residents are forced to move abroad and city is loosing "brains".**

Shrinking population creates **vacancy** in the city. Emigrants still owns the apartments in Visaginas and comes back occasionally for vacations. Most part of the year their residential property is left unused. Decrease in population result in decrease of cultural, educational and service institutions. Part of public buildings are empty and wait for new uses. **Lack of maintenance reduce their aesthetic values, structural capabilities and downgrade the public space around them.**

Ignalina Nuclear Power plant site is a large industrial site which equals the size of the town of 40 000 inhabitants (town of Visaginas). Nuclear power plant created huge infrastructure (Table 4), building complexes, sites that can be seen as a resource for the new developments, fertile ground for innovative solutions. In addition to this, Ignalina nuclear power plant is an unprecedented example of technological achievements of human beings. It once was the most powerful power plant in the world. The size and technology represents the beliefs of the First Nuclear Age society, However, **decommissioning options of nuclear facilities involves dismantling which creates huge amounts of structural and radioactive waste and diminishes the possible resources of the city.**

The nuclear power plant site and Druksiai lake contains higher radionuclide levels, which also might increase during the decommissioning process.

Tabl.3. The percentage of highly educated people

Tabl.4. The infrastructure created by INPP

Fig.6. The vacancy in Visaginas

Vilnius	80,5 per cent
Visaginas	79,4 per cent
Kaunas	76,9 per cent

Roads	142 km
Railway	50 km
Communication lines	390 km
Electricity lines	133 km
Thermal lines	164 km
Concrete	3 544 000 m3

6

There is a need for certain measures to diminish the environmental impact of released radionuclides.

Visaginas energy infrastructure was created for abundance of heat and electricity. The pipelines are oversized and looses huge amounts of energy increasing the energy costs 6 times. **After closing of nuclear power plant, the energy structure of Visaginas become insufficient and needs restructuring.**

The safety protection zones around nuclear power plant protected the land from further human interventions, which helped for the to thrive during the 25 years of INPP operation. The fear for radiation, slowed down developments in the INPP region extending the buffer landscape far beyond safety protection zones. When nuclear power plant is decommissioned, safety protection zones disappear which means the **possible threat to the natural qualities due to the change of the role of the buffer landscape** and future developments.

Problem statement

The decommissioning dismantles not only nuclear power plant structures, it deletes populations, cultural values, memories, threatens built structures in the city and opens question of the role of buffer landscape. How this process can be seen differently and open opportunities instead of causing threat?

1.5. RESEARCH QUESTION. SUBQUESTIONS. METHODOLOGY

RESEARCH QUESTION:

What a nuclear energy landscape should become after decommissioning of Ignalina nuclear power plant?

How the region could develop after decommissioning of nuclear power plant the taking into account its natural, cultural values, social, spatial capital and infrastructure created by INPP?

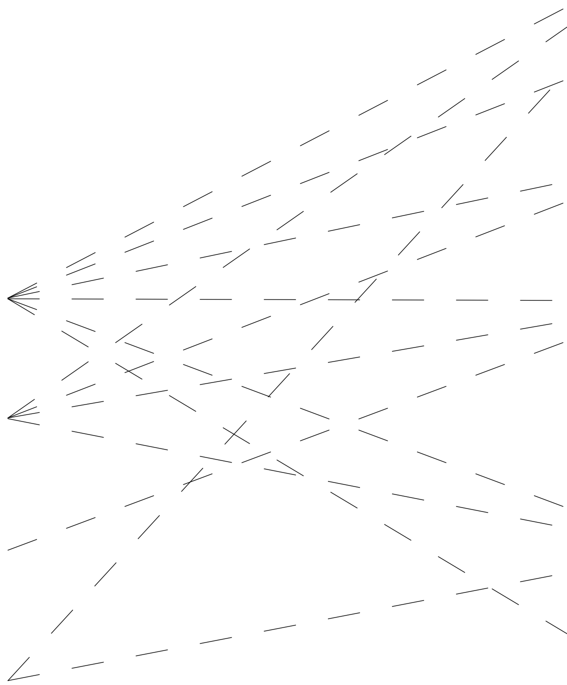
SUBQUESTIONS:

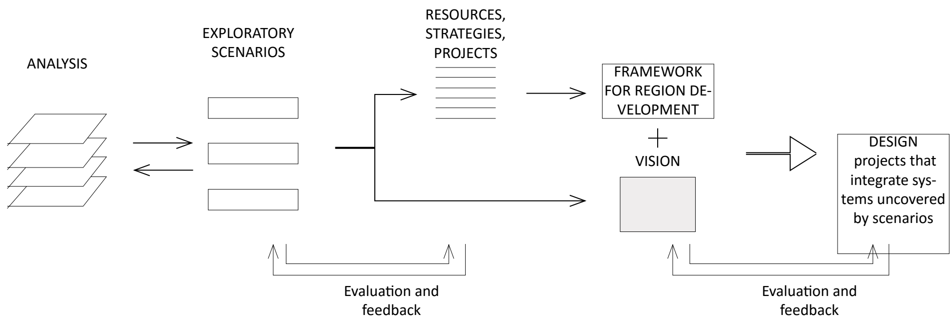
What are social capital and lifestyle patterns in Visaginas region?

What are spatial and functional qualities of Visaginas region in terms of structure, heritage and nature?

What does the decommissioning mean for the social structure, built and natural environment?

What are possibilities for reusing nuclear power plant built structures, the sites and processes?





METHODS and TOOLS

Exploratory scenarios for Visaginas development opportunities.

Theory essay as a tool research on transformability of nuclear facility towns, to identify attributes and resources that drives the positive transformation.

Mapping resources, places of opportunity for the synergy between technology, heritage and nature structures; culture patterns, elements of the Visaginas region, etc.

Literature review on legal strategic and spatial planning documents, decommissioning documents of nuclear power plant, radiation and ecology, case studies of other nuclear power plant cities, achievements in nuclear energy and alternative energy networks, industrial heritage, paintings and photographs of artists exploring Visaginas and nuclear power plants.

Interviews with locals as a tool to understand socio-economical situation, to test the urban design ideas; interviews with professionals that helps to understand their field of expertise integrated in the project.

Workshops with locals used for collective design tool for development scenarios of the city.

This methodology is supplemented by **Design as Politics methodology** which is based on series of lectures, workshops and excursion to Shenzhen for a broader understanding of the tendencies in a work market and relationship between industry, architecture and the city.

The method of scenarios is chosen because of uncertainty of future development of Visaginas due to controversy about nuclear energy and a lack of decision on the energy profile in Lithuania and Visaginas role in it.

Scenarios cannot be simply derived from inventories or analysis - they have to be designed (Rieniets, 2014). Scenarios reconsider decommissioning, transformations of INPP and its impact to the region. The principles for designing the scenarios are based tendencies, statistics, interviews, workshops, literature reading, site visits, impressions, decommissioning plans, tendencies in nuclear energy sector, spatial qualities of Visaginas region, social capital.

Scenarios define possible development paths which allow to draw the vision and identify resources: specific structures and situations which can be used or further developed in the future. Scenarios enable the description of the expected use of these resources by strategies and projects.

This is the combination of two scenario concepts: scenarios that produces a clear desirable future state and scenarios that creates the realm of opportunity, which goal is an open future (Rieniets, 2014). The latter aims for continual transformation of the city with no optimal end state which makes it difficult to provide verifiable arguments for evaluation. On the other hand, vision provide clean and transparent image of the end state, however, reducing the transformability. Combination of these two emerges in the shape of frameworks which contains the actual design issues and vision as a common objective.

The participatory workshop intended to collect the ideas and raise a discussion between inhabitants about how to improve the main public spaces in the city, adapt urban environment to the needs of inhabitants and a character contemporary Visaginas.

The workshop was held together with 4 students from Lithuania, Belarus and Germany with different professional backgrounds.

Sedulinos alley, a central street in town, was picked for as a case study for the participatory workshop. The map of Western part of Sedulina was produced to showing 80 different businesses located in the alley and one vacant space. It is a surprising number because going along Sedulina alley it felt empty.

10 people working in Sedulina alley were interviewed to find out their opinion about the alley. They appreciated Sedulinos alley as the "face" of the city with green areas, especially renovated parts of the street. All of the respondents are unhappy with the state of the pavement, ruined buildings and a lack of small architectural forms. The ideas proposed were to create playgrounds for children, install a public toilet, hold open air events, restaurants and cafés with outdoor terraces. Their thoughts were used as a complementary material for the map during the participatory workshop.

During the workshop, inhabitants pin their proposals, wishes. Examples:

- paths for skaters and cyclists
- Internet spots in public spaces
- an international library
- a multicultural cafe
- places for open air performances

The information was used in design proposals for main paths of the city.

Fig.7. The participatory workshop

Fig.8. The results of the workshop

7

8

1.6.
GOALS OF THE PROJECT. INTENDED PRODUCTS

"Work and industry have always inspired architects and urban designers to develop great ideas for our cities and buildings" (studio guide, pg 6.). Design as Politics studio challenges to consider city and architecture in the context of utopias they carry and realities they face. Urban phenomenon, closed cities, created by First Nuclear Age are facing changes in spatial structure and job market due to decommissioning of nuclear facility. Work, living and leisure places were highly separated, while in current tendencies the boundary between work and living is blurring out. Workers, who once were provided steady jobs, exceptional health care, sick leave, relatively high salaries, good housing, sports and cultural facilities, now faces precariat realities: work without contracts, with lots of insecurities and inability to build wealth. In the context of changes in job market and work environment **the project goal is to reconsider structure of Visaginas region as a case of nuclear energy landscapes, which are facing transition due to decommissioning of nuclear power plants and strengthen atomgrads economy, natural and cultural values by upcycling nuclear power plant region legacy.**

Research goals:

-to research Visaginas region development possibilities after decommissioning of nuclear power plant.

-to analyze what spatial and social consequences such developments would bring for the Visaginas region and its parts.

Subgoals:

-to question temporality of nuclear power plant and analyze what can be reused for energy generation.

-to research on heritage values of nuclear facilities and legal documents.

-to analyze environmental impacts of INPP.

- to understand the specifics of nuclear industry and integrate it to the design.

Design goal and intended products:

-to design the framework which provides guidance for developments in Visaginas region both in early and far future accompanied with design projects.

2. NUCLEAR ENERGY LANDSCAPE

2.1. LOCATION

Visaginas is located in Lithuania, Eastern Europe, in the sparsely inhabited, forested area full of diverse water bodies: lakes, swamps, marshlands, rivers. The region contains national parks, international nature frameworks (Natura2000).

The closest big city Daugavpils is in 30 km distance, in Latvia, accessible by good train connection and by car. Visaginas is also well connected to the capital Vilnius by train and can be reached in 2 hours.

The project area contains Visaginas municipality area and parts of neighboring municipalities which in functional or structural way strongly relates with Visaginas and Ignalina nuclear power plant.

Project context - INPP region - is the area where mobility, energy, nature structures and culture patterns of inhabitants of Visaginas extends. It is the area containing 3 municipalities in Lithuania and 1 in Latvia.

INPP REGION PARAMETERS:

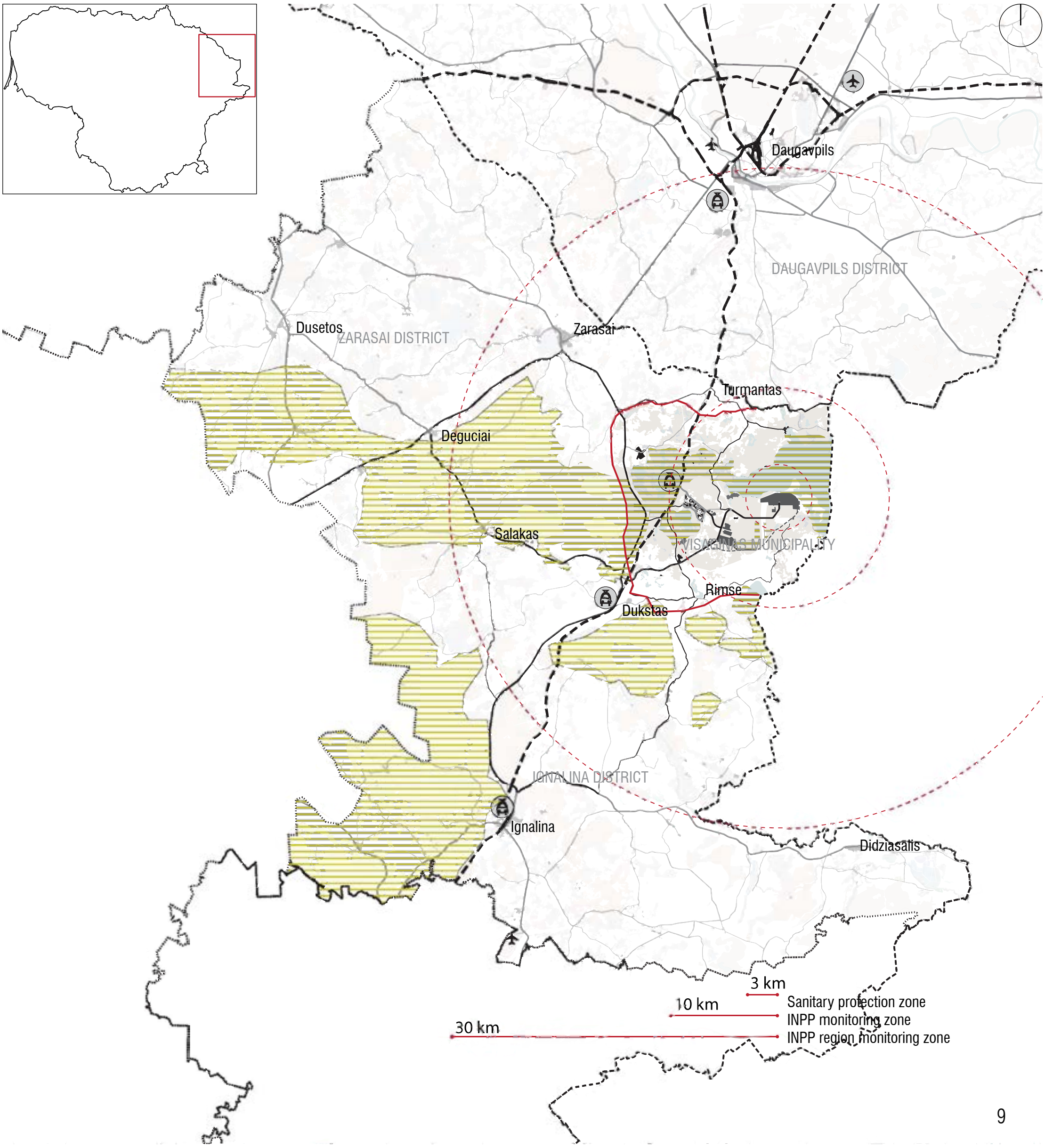
Municipalities: Ignalina district municipality (1447 km2), Zarasai district municipality (1334 km2), Visaginas municipality (58 km2), Daugavpils district municipality (2525 km2) (Latvia).

Area: 2839 km2 (without Daugavpils)

Population: 60 000 (without Daugavpils)

Protected areas: Natura2000, Aukstaitija national park, Grazute, Sartai, Sirvetos, Labanoro regional parks.

Fig.9. INPP region


Daugavpils
DAUGAVPILS DISTRICT
Dusetos
ZARASAI DISTRICT
Zarasai
Turmantas
Deguciai
Salakas
VISAGINAS MUNICIPALITY
Rimse
Dukstas
IGNALINA DISTRICT
Ignalina
Didziasalis
3 km
10 km
30 km
Sanitary protection zone
INPP monitoring zone
INPP region monitoring zone
9

2.2.
HISTORY

The nuclear energy landscape emerged due to specific requirements for the technology of the nuclear power plant: solid and stable soil structure and the proximity to huge water body. Sparsely inhabited area near Druksiai Lake was suitable and in ten years the region was transformed into a nuclear energy landscape resulting in landscape transformations: deforestation, drainage, the change of the soil structure, new roads and railway, dismantlement of 165 farmsteads (Storm, 2014).

The city was constructed collectively by residents. Engineers, scientists, women and men helped construction workers in order to speed up construction works. Visaginas was ongoing construction site during the whole 40 years of its existence. The collective spirit is also visible in the events and the decisions related with city's existence.

According to the initial plan, city should have been expanded to the north of the main city's axis to house workers of the third and fourth reactor. However, due to the Green Association protest, the reactor was never opened and later fully demolished.

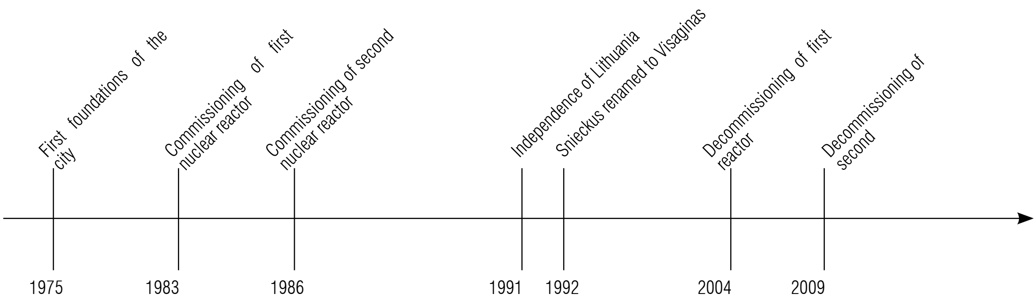
Snieckus (Visaginas) was a semi-closed town, which means that the entrance to the town was free but the longer stay was regulated.

> *It was "the borders that came over the people and not the people who came over borders."*
> *Inhabitant of Visaginas (Storm, 2014)*

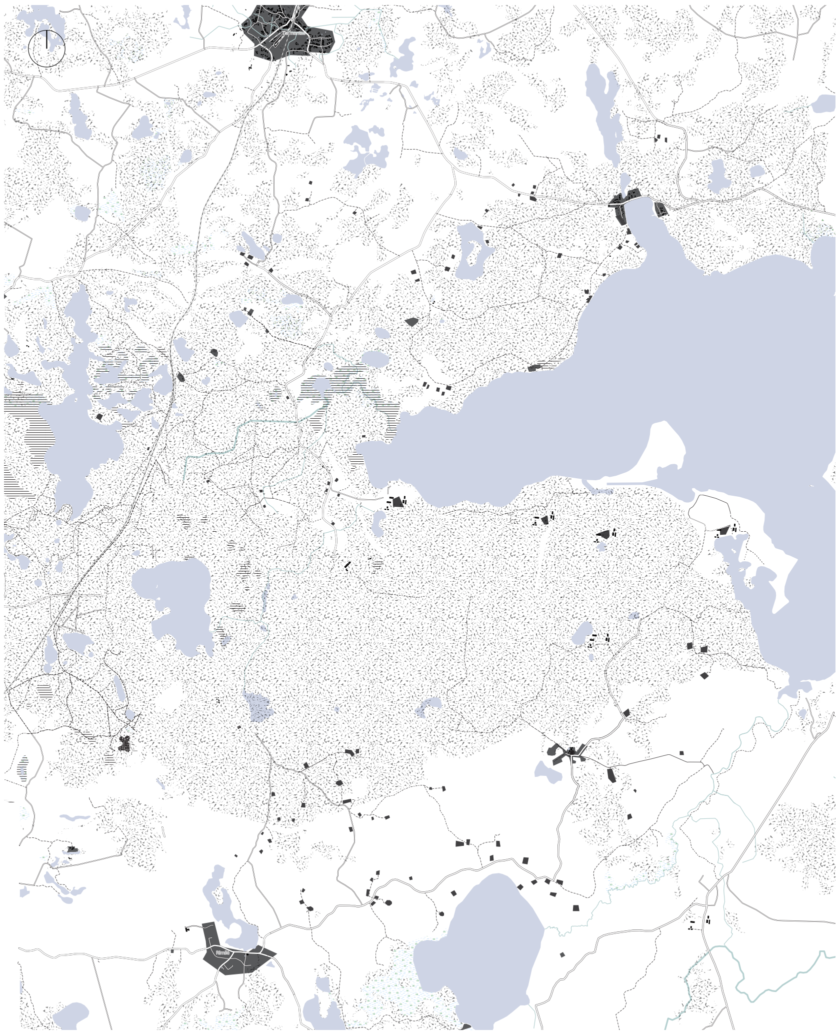
The overwhelmingly Russian-speaking multi-ethnic population of Snieckus (Visaginas) was seen as aliens in the context of ethnically homogeneous Lithuania, together with the large scale nuclear power plant as a symbol of Moscow's dominance (Storm, 2014). However, the attitude to the power plant changed several times from being seen as evil to a savior.

Fig.10. The timeline

Fig.11. Visaginas region before construction of INPP (in comparison, nuclear energy landscape in pg)


First foundations of the city
Commissioning of first nuclear reactor
Commissioning of second nuclear reactor
Independence of Lithuania
Snieckus renamed to Visaginas
Decommissioning of first reactor
Decommissioning of second
1975
1983
1986
1991
1992
2004
2009

10



11

For instance, Green Association which was against INPP, after Baltic countries got independent, saw INPP as valuable energy source and even was discussing its extension plans.

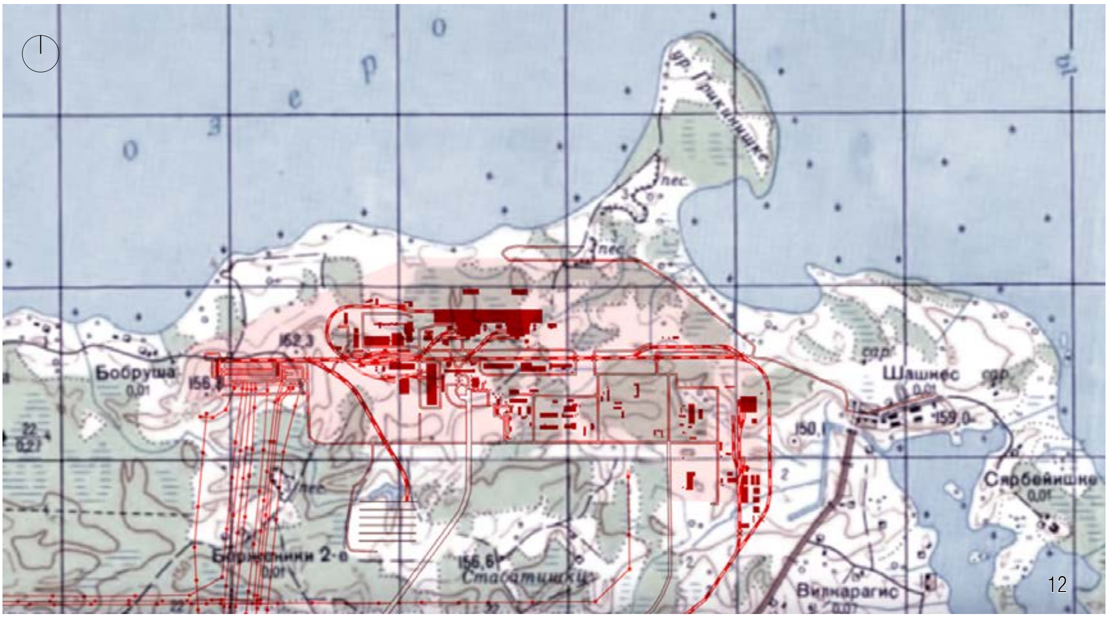
There were several events that influenced demographics of the city. The first came with the Independence of Lithuania in 1991. Citizens were afraid to lose their privilege position and the changes that new political system could have brought. The active community of Visaginas even wrote a letter to Gorbaciov asking to incorporate Visaginas into Russia. The concerns where soon eased by Lithuanian government which made an exception- citizenship was granted to all permanent residents of Visaginas, who wanted to stay (Storm, 2014). however, the new language regime was applied for Russian speaking inhabitants, new city government was formed mostly from Lithuanians who moved in to the city after independence. There was a tension between newcomers and locals that it is felt also nowadays. The further emigration periods came with the shutdown of nuclear reactors in 2004 and 2009.

The region was always dependent on the political decisions made on international levels, irrespectively whether it was Moscow's imperial desires or Brussel's fear for fallout. The shutdown of the power plant was the condition made by European Commission for the accession of Lithuania in the European Union. According the analysis, Ignalina nuclear power plant could have operated for 15-20 years more. Therefore Visaginas was not prepared for the economic transition expecting the extension of INPP operation time.

Today Visaginas is known as nuclear power plant town with achievements in education, sports and culture. It is the second city in the country containing the largest percentage of highly educated people. The living quality is considered similar as in the capital.

Fig.12. The comparison of the site before and after construction of INPP

Fig.13. The initial plan of Visaginas



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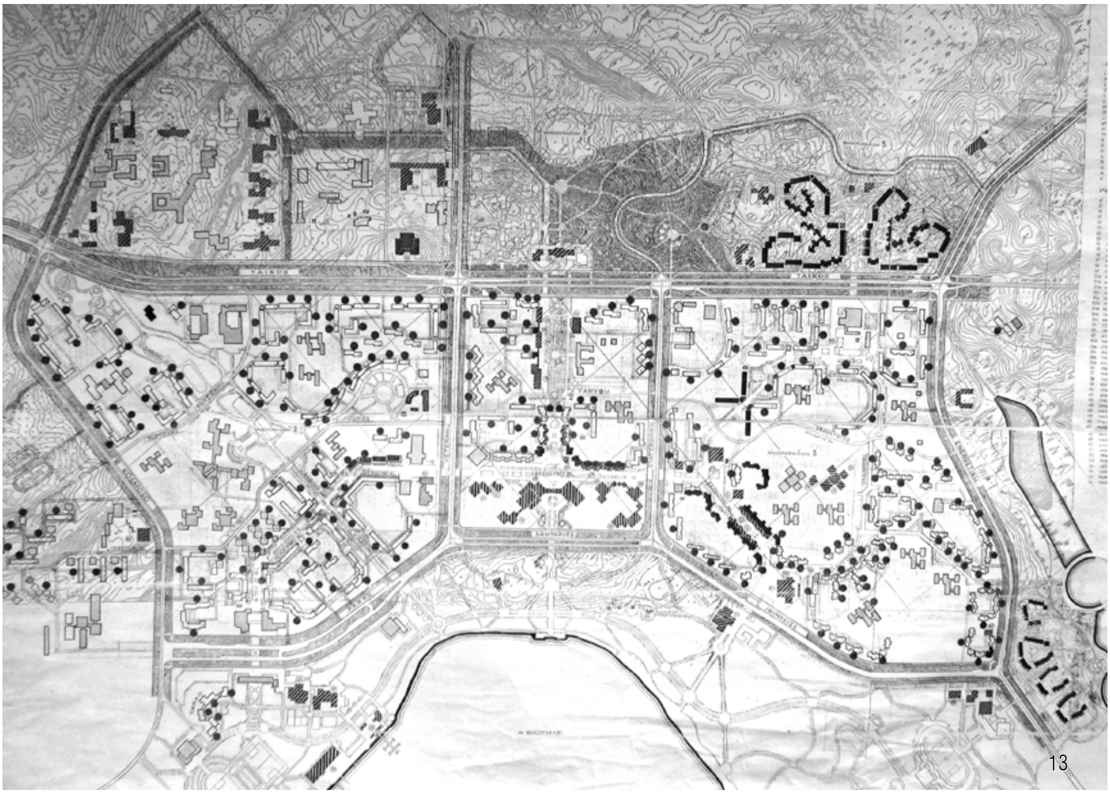

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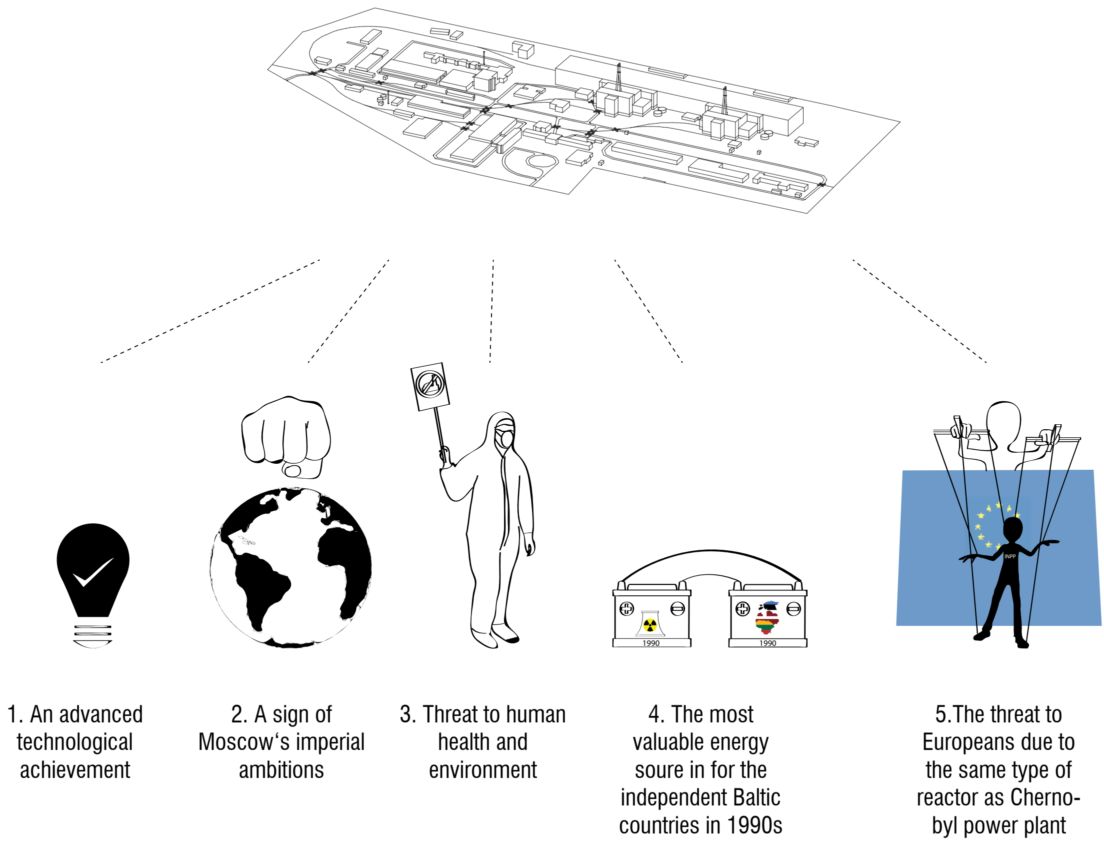

14

Fig.14. The change of attitude towards INPP

Fig.15. The event in Visaginas

Fig.16. The concert in Visaginas forest

Fig.17. The collective construction of the city and nuclear power plant

Fig.18. The construction of INPP

Fig.19. The landscape transformations due to construction of INPP

Fig.20. The landscape transformations due to construction of INPP

Fig.21. The landscape transformations due to construction of INPP

Fig.22. The landscape transformations due to construction of INPP


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2.3.
NUCLEAR ENERGY LANDSCAPE

The nuclear energy landscape is characterized by city size industrial sites, a new town, villages and homesteads scattered within a decent distance from nuclear power plant; sanitary protection zones, monitoring zones, large water-bodies, leisure places (collective gardens and health centers for nuclear power plant workers).

As most of nuclear energy landscapes, INPP region is part of the international and national nature frameworks. Safety regulation zones of INPP act as a protection zones as well, preserving natural (if only not affected by nuclear industry) features of the buffer landscape.

Fig.23. The nuclear energy landscape. In red: Ignalina nuclear power plant and auxiliary structures, safety zones.

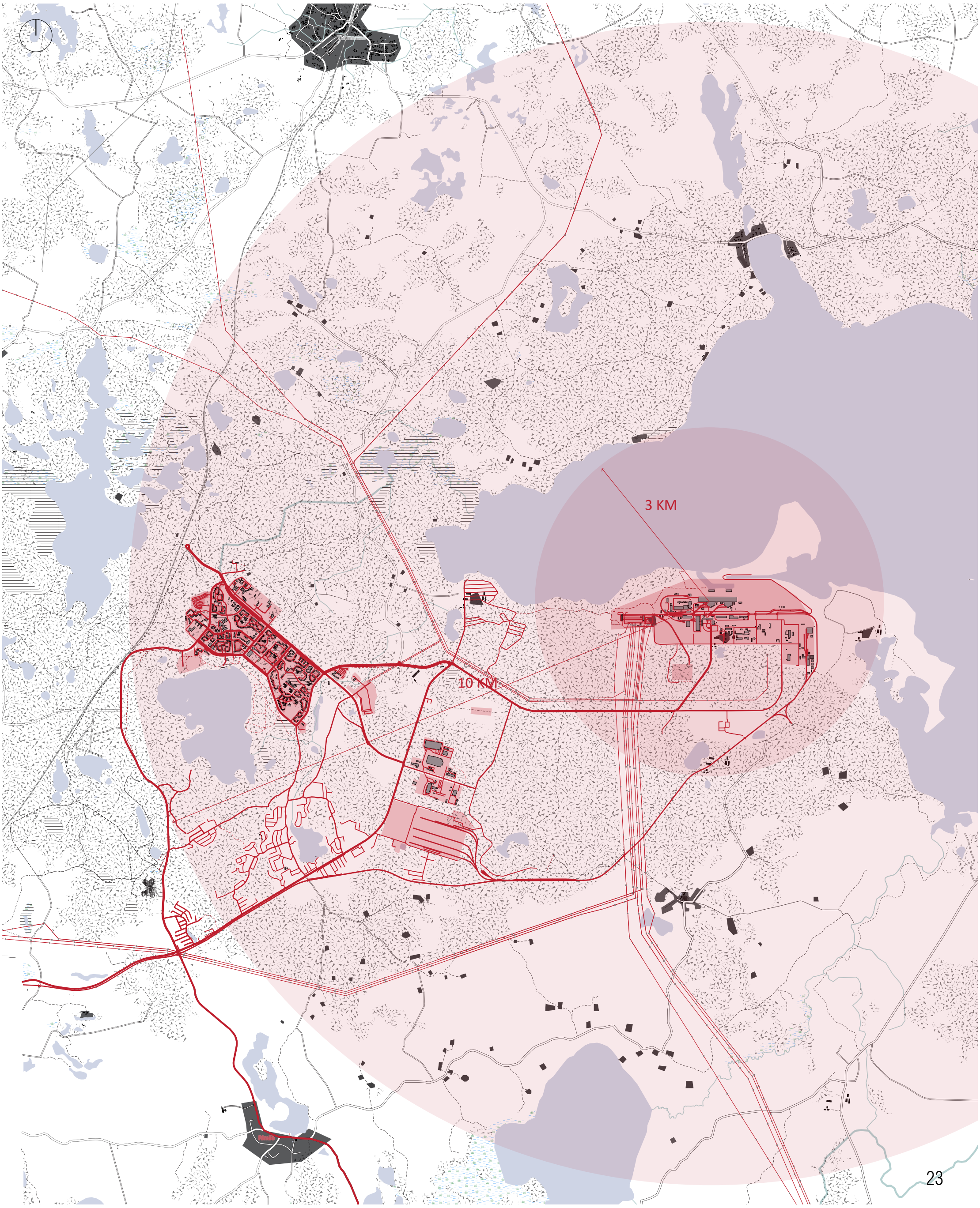

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Fig.24. Nuclear power plant

Fig.25. Industrial sites

Fig.26. Energy transmission corridors

Fig.27. Research and wellness centers

Fig.28. Town of Visaginas

Fig.29. Collective gardens

Fig.30. Villages

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Fig.31. Homesteads

Fig.32. Lakes

Fig.33. Forest

Fig.34. Marshlands

Fig.35. Derelict land

Fig.36. Mounds

Fig.37. Farmland

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Visaginas plan comprises of three parts - micro districts. Pedestrian alleys crosses the city longitudinally connecting all three micro districts and transversely connecting city with the lake and forest. Main public spaces and landmarks are located near these pedestrian alleys.

WALKABLE CITY. City was created as a compact urban unit, containing pedestrian alleys and cyclist infrastructure, which was the exception in the socialist planned car oriented cities.

DESIGNED WITH NATURE. The relief and trees were preserved. Different levels create uniqueness of spaces and divide them to smaller subspaces. Pine trees creates a resort feeling in the city.

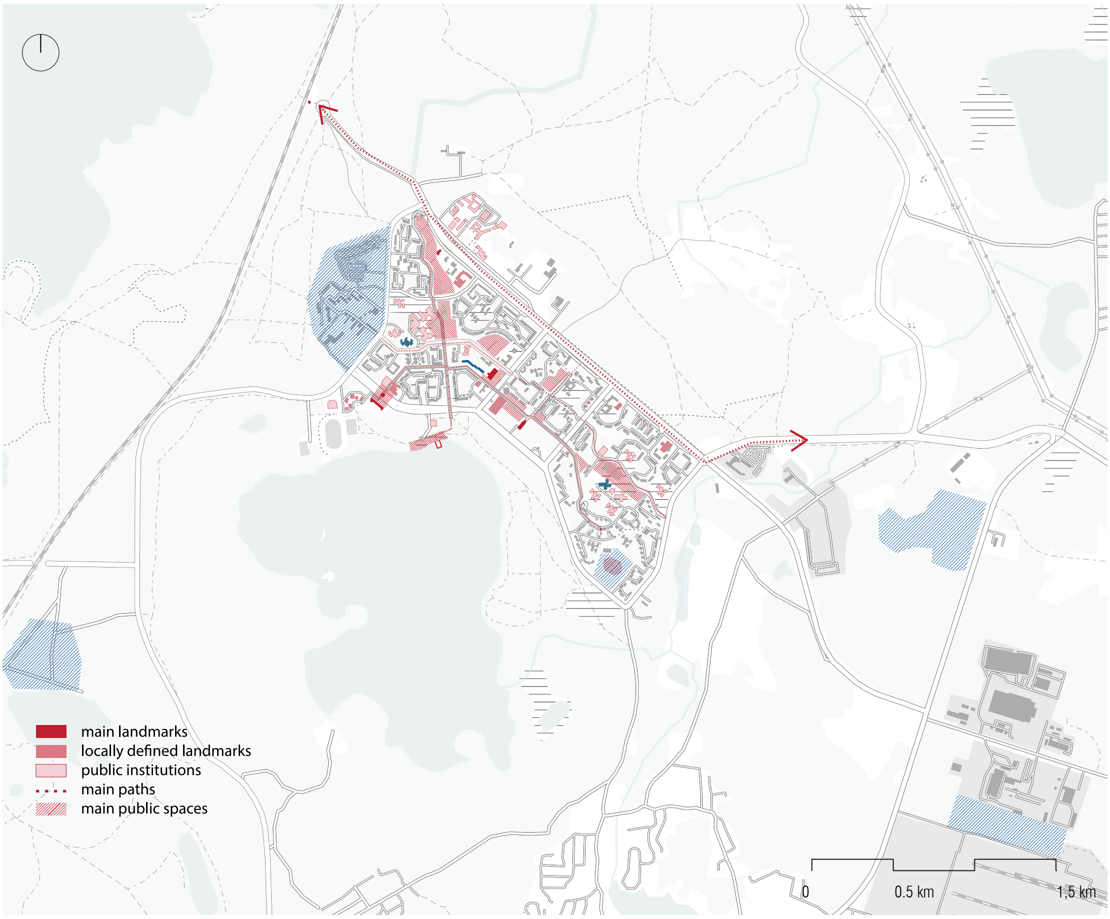
HIGH STREET. The pedestrian alley with commercial activities on the edges - this capitalism city feature was not common in socialist cities of that time.

UNIQUENESS IN STANDARD. City's architecture is a combination of standard prefabricated block of flats and designed brick architecture. Standard architecture follows several designs that are taken from other cities in Lithuania and former Soviet Union: Vilnius, Kaunas, Klaipeda, Obninsk, Gardin.

Residents find uniqueness in standard architecture. Several blocks have names. E.g. red single-storey houses in the picture are called "Three little pigs" (from the fairy tale) (Fig.44).

COURTYARDS WITH SMALL RETAIL OR SERVICES. The first floor of the standard housing blocks contain small scale retail or services for daily needs of the inhabitants of the block.

Fig.38. The composition of Visaginas


main landmarks
locally defined landmarks
public institutions
main paths
main public spaces
0
0.5 km
1,5 km

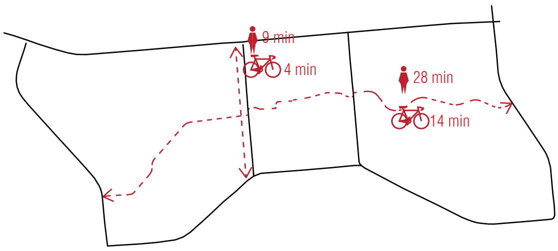


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Fig.39. The walkability in Visaginas

Fig.40. Sedulyno alley

Fig.41. Sedulyno alley

Fig.42. Residential buildings in Visaginas street

Fig.43. Aukstaitija hotel

Fig.44. Buildings in Taikos street

Fig.45. Residential buildings in Pusu street


42


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Ignalina nuclear power plant site is the size of the city of Visaginas. It contains structures and facilities related just with INPP operation.

INPP is a large company, currently employing 2100 workers (used to have 5000). Nuclear power plant provides steady jobs for its workers for the whole operation time. Most of Ignalina power plant workers participated in its construction and had been working there since its commissioning. Therefore it was a psychological challenge to decommission and dismantle what once they have created.

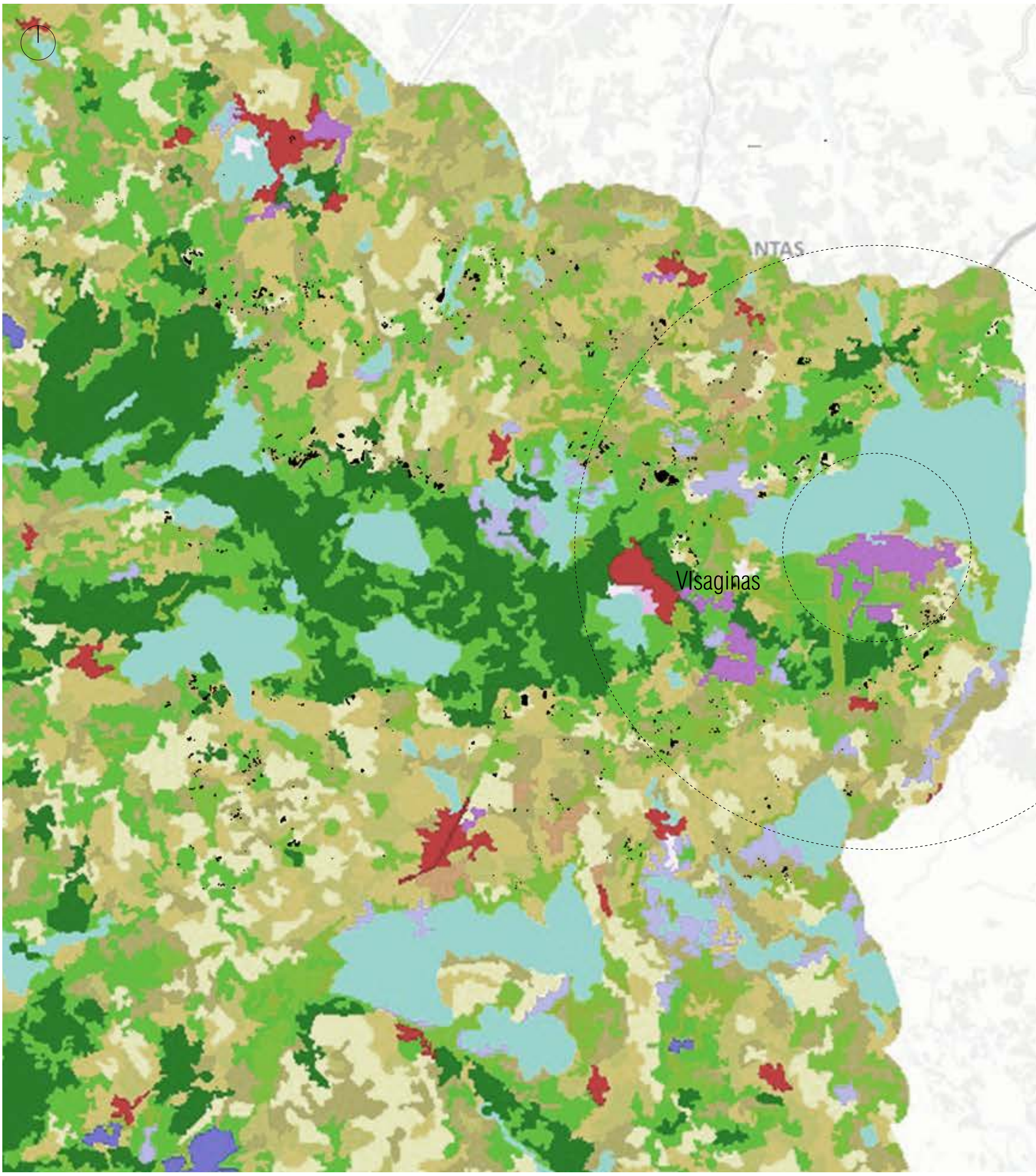
INPP used to be a company that contained all the necessary services under the roof of one institution. During the decommissioning, some functions are outsourced to private companies. In Western Europe this compact structure of the company existed from the very beginning of nuclear facility operation.

Even if the power plant is being decommissioned, it is still a “citadel”, closed and guarded place bounded with 3 m high concrete wall, with areas of restricted entrance around it.

Fig.46. INPP site

The land cover analysis of the region shows its structure - the forested and laky belt crossing agricultural lands. Some of them where abandoned due to construction of INPP. Derelict agriculture lands inside and outside safety protection zones have the tendency to be located on the edge of forested land, inside or on the edge of international nature framework, in small irregular plots, not suitable for the industrial agriculture. Their location and morphology could be an opportunity for alternative farming methods that connects to nature consolidation and protection.

Fig.47. Land cover



47

unwatered cultivable land
fruit and berry plantation
pasture
complex agriculture land
cultivable land

water current
water bodies
coast lagoon
sea

leafy forest
coniferous wood
mixed forest
natural meadows
heath
bush
dunes
poor vegetation cover
continental marshes
peat

continuous urrbanized areas
non-continous urbanized areas
industrial sites
Roads and railway
harbour
airport
mineral
wastelands
construction sites
city greenery
sport sites

derelict land

2.4.
CULTURAL HERITAGE

The area contains mostly elements that remained from the very first inhabitants of this land, such as settlements, mounds, barrows, manor houses; or the war, like bunkers, because of strategic position of the region.

The structures of the decommissioned nuclear power plant are not considered as industrial heritage yet, because industrial heritage in the Department of Cultural Heritage in Lithuania is a developing field. Though, they do have architectural, technological and cultural values with reference to The Nizhny Tagil Charter for the Industrial Heritage (2003).

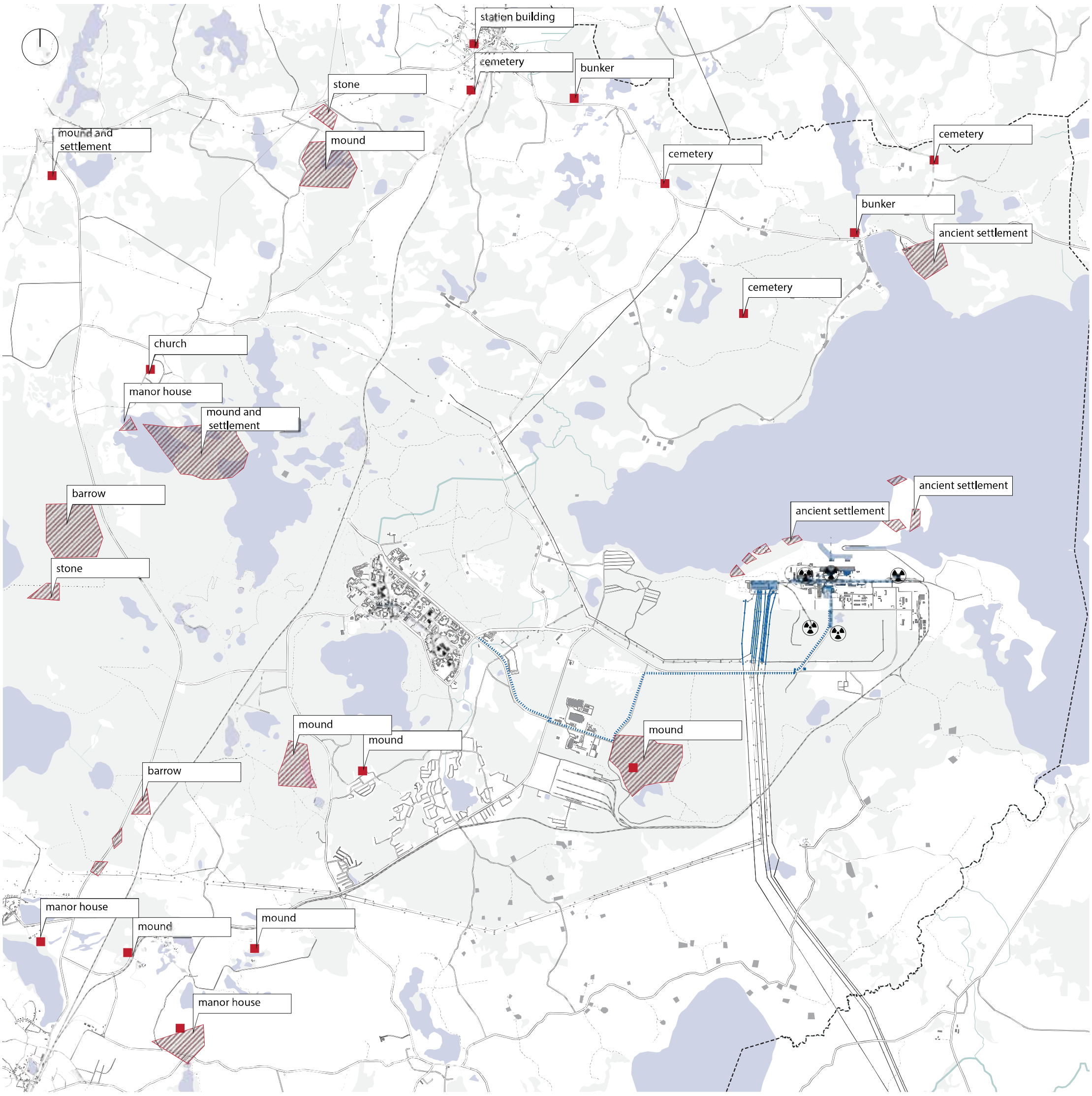
Ignalina nuclear power plant could be primarily seen as structural and technological achievement.

> *"Ignalina nuclear power plant used to be the most powerful power plant in the world and it is written in Guinness record book"*
>
> *("Ignalina Nuclear Power Plant - History," n.d.)*

Its cultural values could be recognized through the impact it made to environment representing the mentality of the people in the 1960s-1970s, the First Nuclear Age. Firstly, the city of Visaginas was built as an outcome of nuclear power plant. Visaginas is considered a successful example of socialist city in terms of urban design and architecture. Moreover, it houses specific population - highly educated, multi-ethnic, relatively young population. In addition to this, restrictions for activities in Sanitary Safety Zone around nuclear power plant protected surrounding natural land from human activities and increased biodiversity.

Nuclear power plant site is characterized by large scale structures inserted in very natural landscape that creates a unique environment with contrasts. The composition of the industrial complex and infrastructure, tells a story while moving trough sequence of spaces, uncovers the interrelations of INPP buildings and the processes.

Fig.48. Cultural heritage. In red - existing, in blue - industrial heritage.


station building
cemetery
bunker
stone
mound and settlement
mound
cemetery
cemetery
bunker
ancient settlement
cemetery
church
manor house
mound and settlement
barrow
stone
ancient settlement
ancient settlement
mound
mound
mound
barrow
manor house
mound
mound
manor house

The heat pipeline is a ribbon leading to nuclear power plant site. It builds the tension and makes you wait for the culmination - nuclear reactor, which can't be easily reached due to architectural barriers "gates" and a "wall".

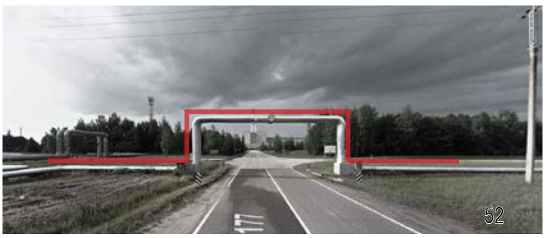


Fig.49. INPP longitudinal axis

Fig.50. The sequence of spaces

Fig.51. The sequence of spaces

Fig.52. The sequence of spaces

Fig.53. The sequence of spaces

Fig.54. Elements of the complex

Fig.55. Elements of the complex

Fig.56. Elements of the complex

Fig.57. Elements of the complex

Fig.58. Elements of the complex

Fig.59. Elements of the complex

Crossing of two main axis, linear elements and arrangement of reactors defines domination of longitudinal axis.

Longitudinal axis is shaped by the buildings on both sides. They create crenelated silhouette. The space is filled with punctual and linear technical elements which cuts the space into smaller subspaces.

Above ground structures make the links between buildings and processes visible.

The colors are defined by materials - concrete steel. Technical structures are painted in red or white. Red color is used to highlight important technical structures. Calm color scheme creates the relationships with the surrounding nature. Especially this is visible in autumn.

Nature is trying to get into the nuclear power plant site, but is stopped by physical barriers.

Representative public spaces for workers with signs of control - loudspeakers.

60

61

62

" Once you are in reactor, you don't see, don't feel radioactivity. Just the sound of Geiger counter in the silence from time to time remembers about the place you are in"

the author

Fig.60. Gigantic energy transmission corridors

Fig.61. The nuclear reactor

Fig.62. Marathon of World's nuclear power plant workers

Fig.63. The sign leading to INPP

Fig.64. The Geiger counter in the city

Fig.65. Artefacts

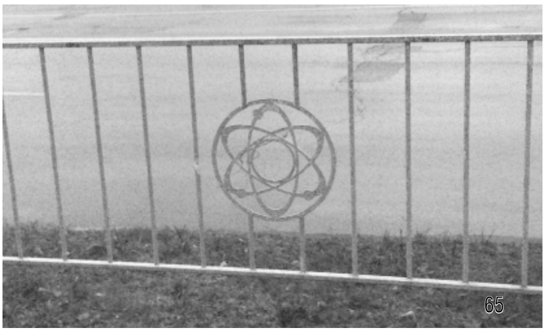
Fig.66. Artefacts

Fig.67. The mural in Visaginas

Fig.68. Breus Alexey. Wreck of Chernobyl Titanic

63

64



65

JŪSŲ DRAUGAS

III BLOKAS

RESTORANAS PICERIJA

66

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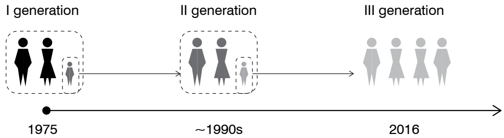
2.4.
POPULATION

In 1972 nuclear scientists, construction workers, both single and with families came to Visaginas to build INPP and the city. Atomgrad's residents were privileged social group in the context of Soviet union, bringing innovation to "forgotten" lands, therefore the city was filled with high quality education, health care, cultural services, that during 40 years of town's existence raised active and standing-out population dominated by nuclear scientists, artists, sportsmen.

Fig.69. Generations in Visaginas


I generation
II generation
III generation
1975
~1990s
2016

DAILY PATTERNS

There are several social groups in the city with different lifestyles. The design takes into consideration existing and emerging patterns of residents of Visaginas region.

I generation

This social group have settled lifestyles, that emerged due to the rhythm of INPP, have strong relationship with nature, most of them owns collective gardens and spend their free time gardening or traveling all over the world, because their relatively high salaries allow it.

II generation

Nuclear power plant workers. They are even more mobile than their parents, traveling to neighboring cities on daily or weekly basis. They are city people, have weaker relation with gardening, but definitely appreciates the surrounding nature as a source for recreation.

People working in culture sector, artists. This group emerged when highly educated nuclear power plant workers demanded high quality and diverse cultural education for their children.

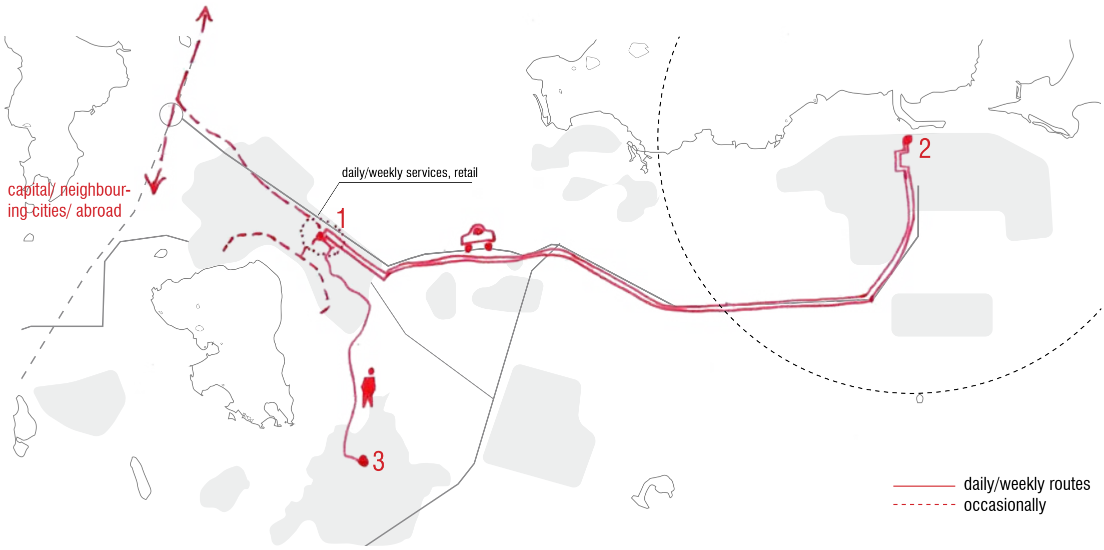
Artists are underestimated social group. Municipality wants to diminish their impact to the city.

III generation

Most of this social group is staying and living abroad and coming to Visaginas just for visiting their parents and for vacation. They see Visaginas as perfect place to grow children, but because of lack of jobs they are forced to search for work in other cities and even countries. They are the ones who are actively using public spaces and facilities, want to contribute to creation of city's image.

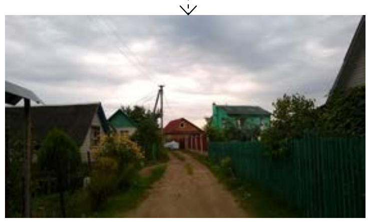
Fig.70. Lifestyle patterns of the first generation

I GENERATION



1. Home

2. Ignalina nuclear power plant



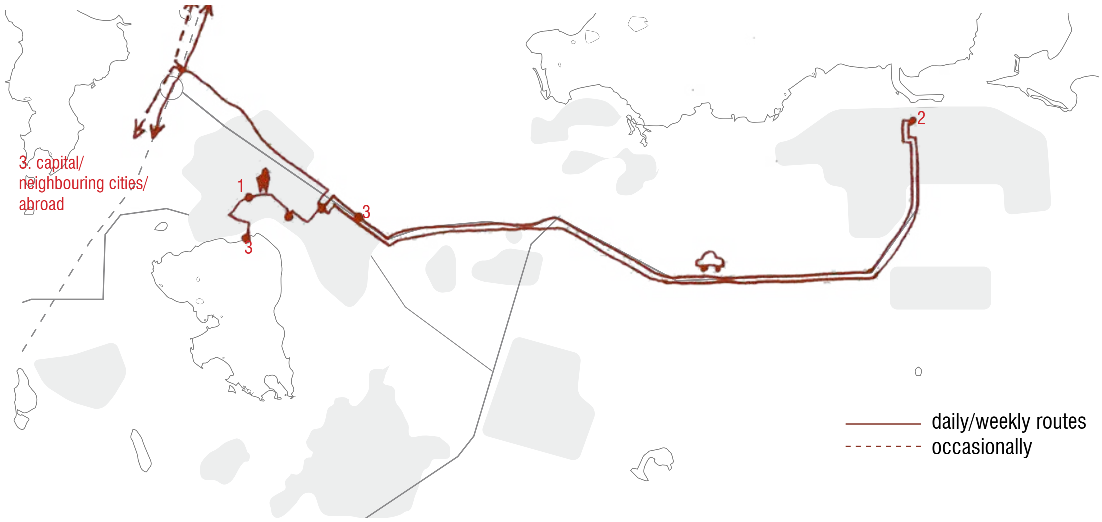
3. Collective gardens ("Daches")

Newcomers

These people came all over the world with different preferences for living environment and lifestyles, therefore they expect city to provide wide range of living and working environments ranging from very urban, to rural, natural to artificial.

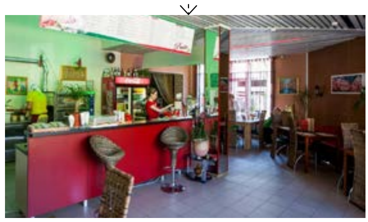
Fig.71. Lifestyle patterns of the second generation

II GENERATION



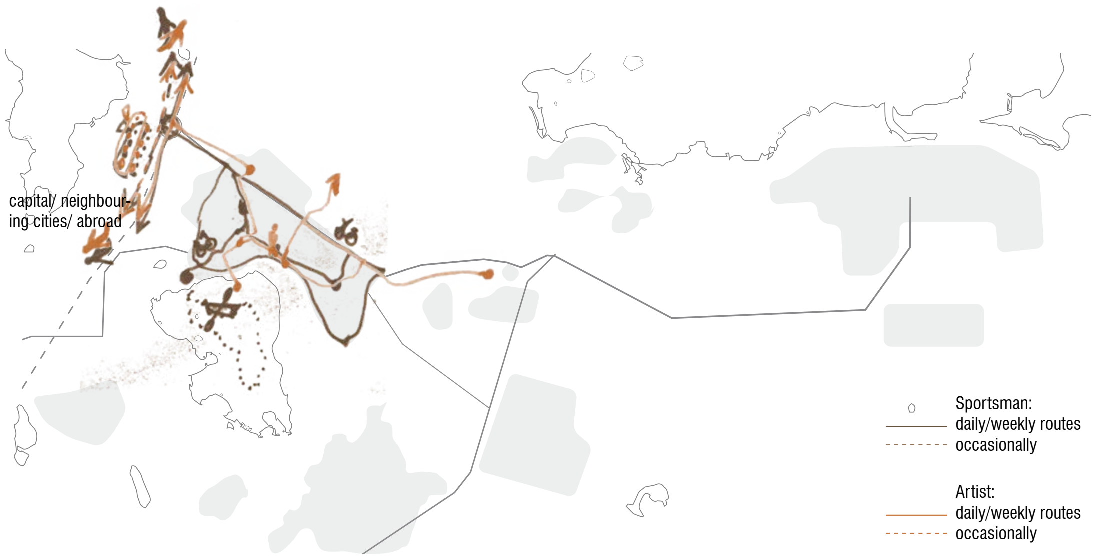
1. Home

2. Ignalina nuclear power plant



3. Cafe; strolling/ picnic in the nature;
cultural events, shopping in bigger cities

II GENERATION



ferstivals, culture events

abandoned buildings

nature

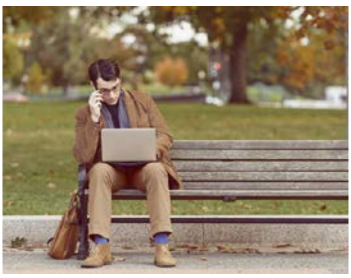
gymnastics, acrobatics, canoeing, kitting, etc.

Fig.72. Lifestyle patterns of the second generation

Fig.73. Lifestyle patterns of the third generation

III GENERATION


gardening in the city


working outside (brought from capital, European cities)


lunch, coffee break outside(brought from capital, European cities)


cultural events, shopping in bigger cities

NEWCOMER

cultural events, shopping in bigger cities

cafe

cultural clubs in other cities

Fig.74. Lifestyle patterns of the newcomers

Fig.75. The conclusion image of lifestyles in Visaginas

“You should see how busy it becomes in summer. The whole city is here”

Oksana

“There are places in the landscape to be ‘reserved’ for weekend picnic”

Mindaugas

“It’s [Vilnius] not far, just 2 hours by car or train”

Oksana

“I would like to go to work on foot or by bicycle”

Mindaugas

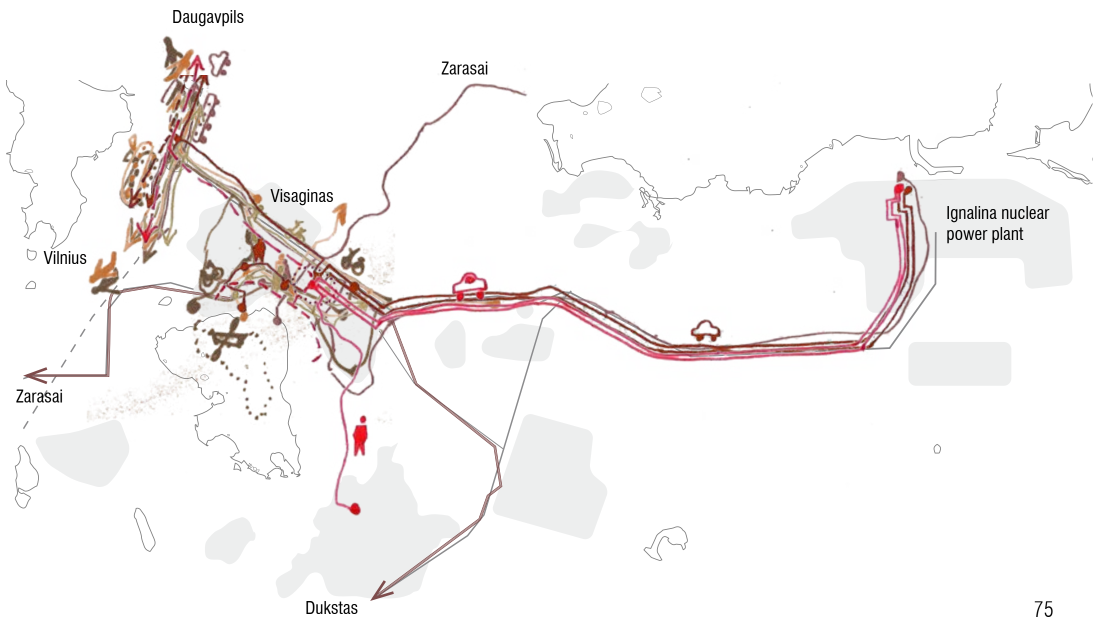
“We are not allowed to have lunch or work in the main outdoor public spaces”

Oksana

“Municipality does not allow us to use the building, even though it is empty”

Alex

lifestyle patterns
unfulfilled intentions



2.6.
RADIOACTIVITY

There are several radioactive sources in the region that contaminate or has potential to contaminate the environment:

- nuclear reactors

- waste landfills

- landfills of nuclear waste fuel

- hospital radiology sector

Most of contamination is located near Ignalina nuclear power plant site. Nuclear radiation don't stay in one spot and their impact can travel far. The impact zone of Druksiai watershed can be seen in the map.

Radioactive contamination in the region does not exceed the levels defined by environmental agencies. Graph shows the levels of radionuclides emitted to the air and water by INPP. In comparison, the average annual amount of natural background radiation that every person receives is 2,4 mSv/yr. Even though the levels of radionuclide pollution is relatively low, it did change the natural status of the land and could affect people and ecosystems in the close proximity to INPP if not treated well. Low contamination levels allows to use alternative methods, such as pytotechnologies, which both cleans the site and recovers the natural state of the site. In addition to this, phytotechnologies could work as a preventive measure for the leaks of radionuclides, as the practice shows.

Detecting radioactivity

Radioactive contamination is the form of contamination that at the low levels has no visible signs. Therefore the equipment is required to monitor and warn about radioactivity. INPP has tree zones: 3 km Safety protection zone, 10 km surveillance zone and 30 km monitoring zone that contains termoluminescent dosimeters. The town is additionally provided by Geiger Counter that acts as a symbol as well.

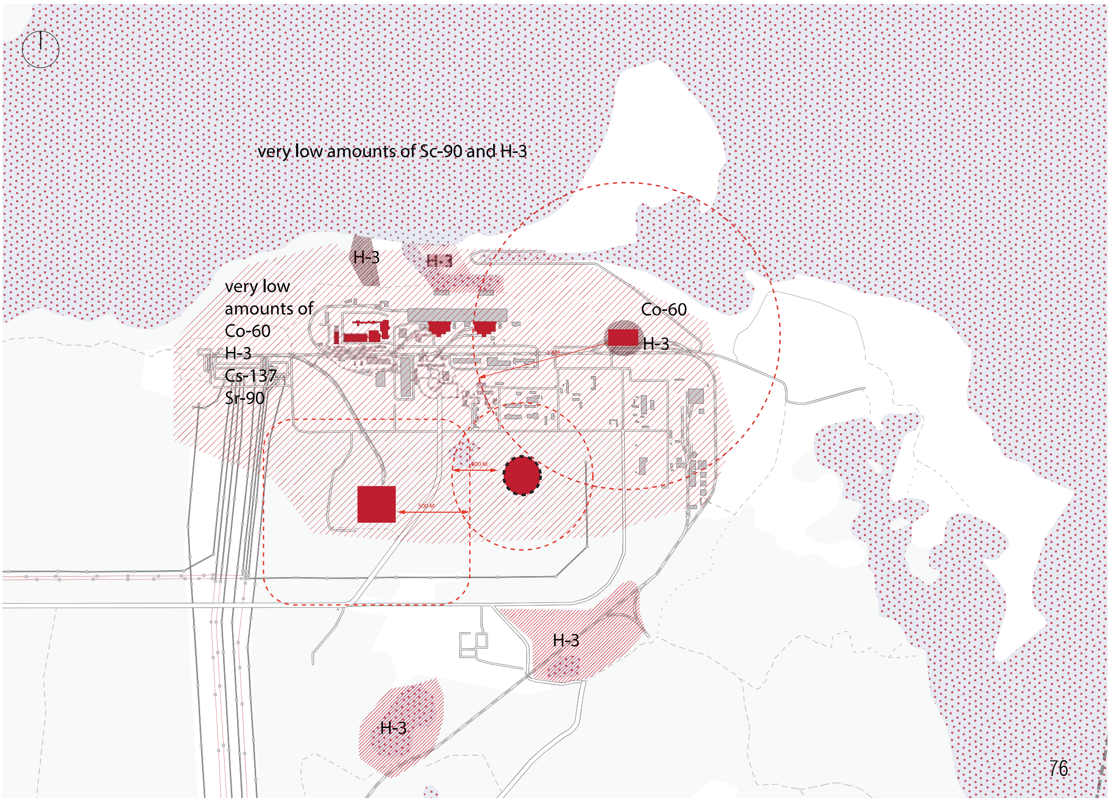
Tabl.5. Radionuclides specification

Fig.76. Radioactive sources and contamination

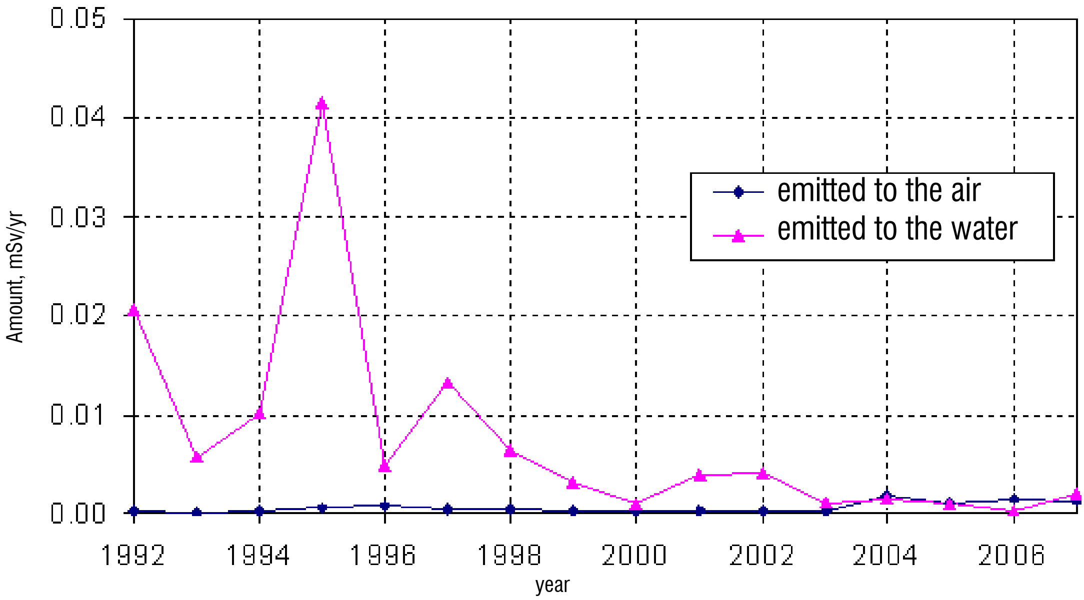
Fig.77. Radionuclide emission to air and water

Fig.78. Lake Druksiai belongs to the Dauguva catchment area. It outflows to the Baltic Sea via a 550 km long river continuum: Druksiai - Prorva - Druksa - Dysna - Daugava - Gulf of Riga.

Fig.79. Safety protection zones

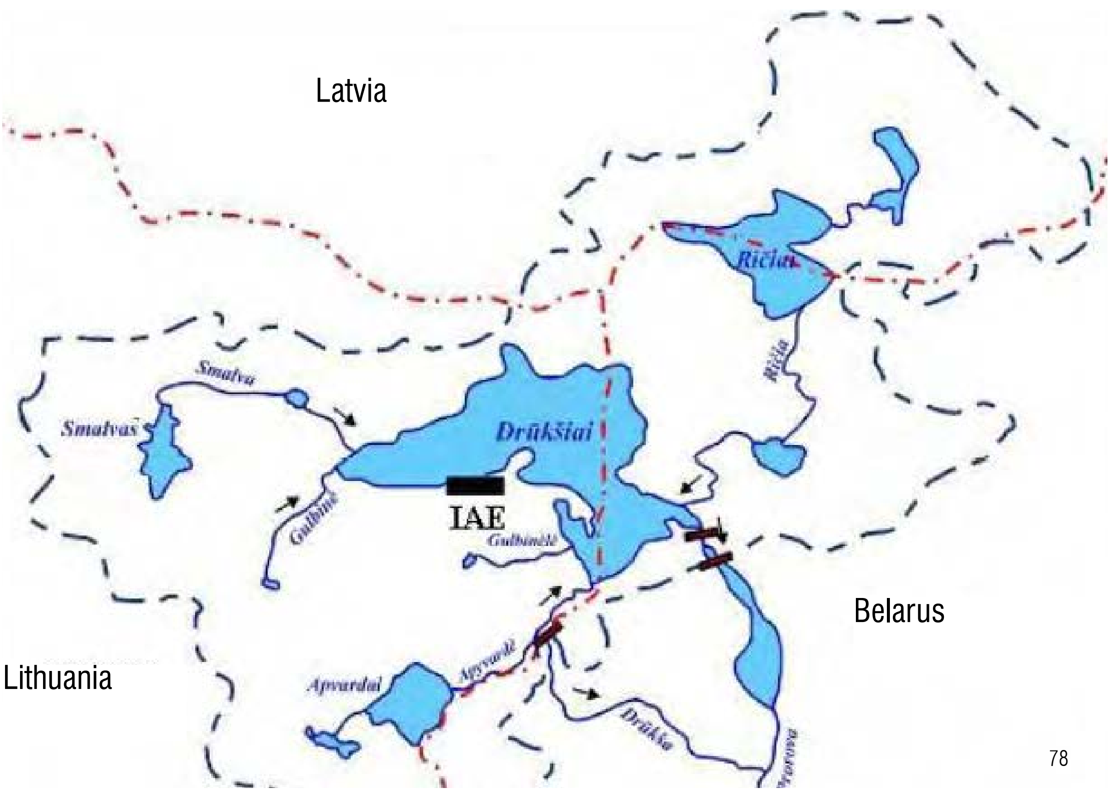

very low amounts of Sc-90 and H-3
H-3
H-3
very low
amounts of
Co-60
H-3
Cs-137
Sr-90
Co-60
H-3
H-3
H-3

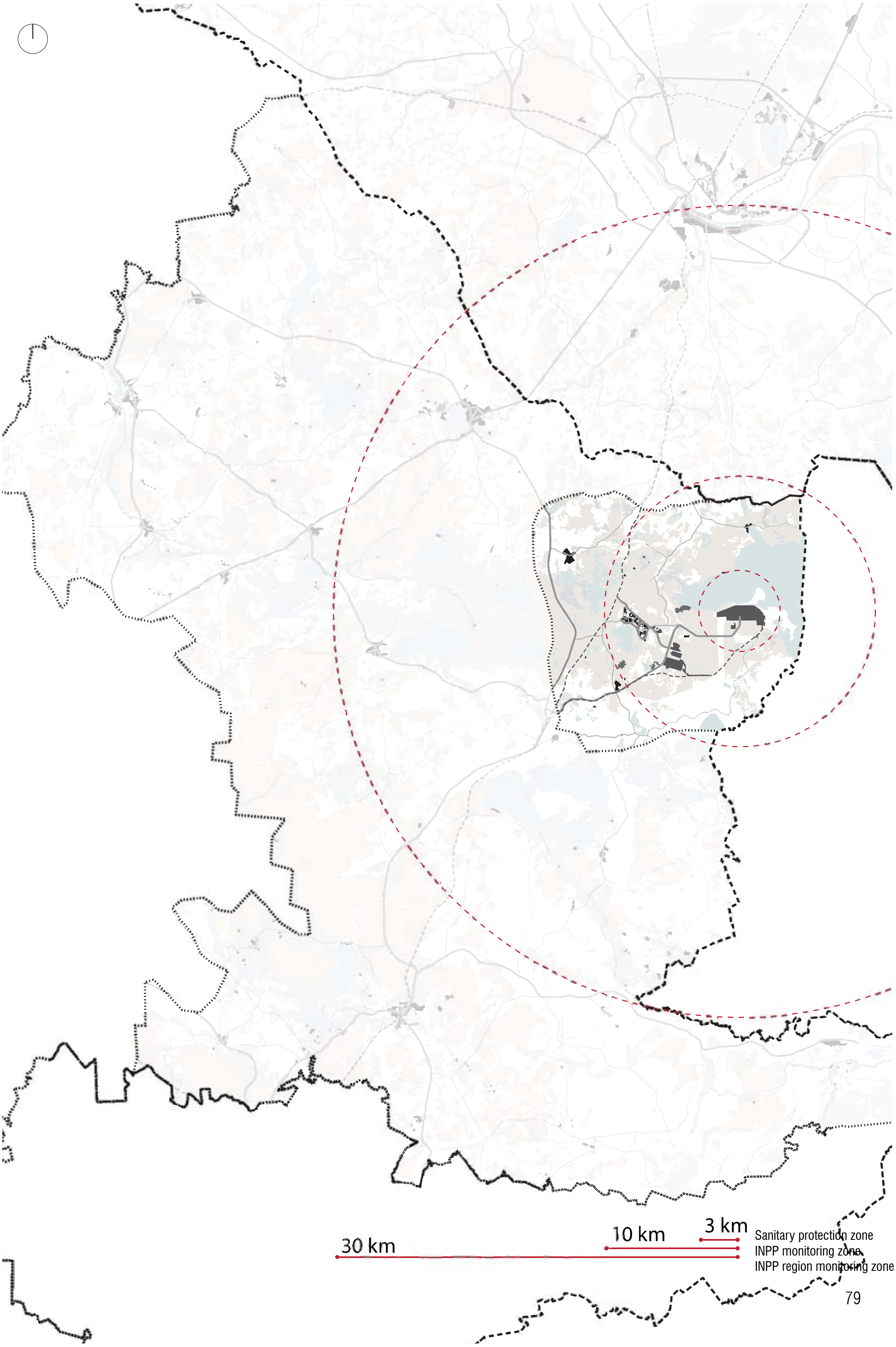
76


0.05
0.04
0.03
0.02
0.01
0.00
Amount, mSv/yr
emitted to the air
emitted to the water
1992
1994
1996
1998
2000
2002
2004
2006
year

77

	Half-life	Mode of Decay	Sources	Form	Harm
Cesis - 137	30.17 years	Beta and gamma radiation	**medical** devices (treating cancer) and gauges, **industry** (Geiger-Mueller counters); nuclear **reactors**, nuclear weapons **tests** (abroad. 1950s and 1960s)	a **crystalline powder**	**burns**, acute radiation sickness, and even death, increase the risk for **cancer**
Uranium-235	700 million years	Alpha particles, gamma radiation	**naturally** in nearly all rock, soil, and water; nuclear **reactors**	extremely heavy metal, silvery-white metal	**cancer** of the bone or liver, lung; **kidney damage**
Uranium-238	4.47 billion years	Alpha particles			
Strontium-90	29.1 years	Beta radiation	**medicine** (treat bone tumors) and **industry** (power source, gouges), nuclear **testing** and **fallouts** (abroad. 1950s and 1980s), nuclear reactor **waste**	**soft meta**l. can contaminate reactor parts and fluids.	
Cobalt - 60	5.27 years	Beta particles and gamma radiation	**medicine** and **industry** (e.g. leveling gauges, x-ray welding seams, food irradiation, a sterilization process), nuclear **reactors**	**solid material.** hard, gray-blue metal.	**skin burns**, acute radiation sickness, or death; **cancer**
Tritium	12.5 years	Beta particles	**naturally** due to cosmic rays interacting with atmos-pheric gases, nuclear **fusion reactors**, can be found in testing facilities, **landfills** (due to self powered lighting)	**gas** under con-trolled conditions, most common form is **liquid**	affect soft tissues and organs




30 km
10 km
3 km
Sanitary protection zone
INPP monitoring zone
INPP region monitoring zone
79

Cleaning radioactive pollution

Phytotechnologies applied not only to treat radionuclides but also other pollution that comes from industrial, medical, residential activities.

Phytotechnologies not only cleans the site but also improves soil structure and fertility, creating new habitats or expanding existing ones. Phytotechnologies as soft technologies can also be used as preventive measures.

In terms of radioactive pollution, phytotechnologies are able to immobilize, extract and biodegrade radionuclides.

Phytotechnology is chosen according three aspects: radionuclide involved, plant or microbial species that are best suited to deal with radionuclide, type of mechanism. The mechanisms can be seen in the table (Tabl. 6, 7).

Tabl.6. Phytotechnologies

Contaminant	Phytotechnology Mechanism						Applications									Scale				
	Phytosequestration	Rhizodegradation	Phytohydraulics	Phytoextraction	Phytodegradation	Phytovolatilization	Constructed Treatment Wetland/Aquatic Plant Lagoon	Field Crops/Gardens	Landfill Cover	Riparian Buffer	Tree Hydraulic Barrier	Tree/Shrub Plantation	Hydroponic Solutions	Sorption to plant tissues	Hyper-accumulation	Greenhouse	Laboratory	Field	Pilot	Full-scale
Organic Compounds																				
BTEX		✓	✓		✓	✓	✓	✓			✓							✓	✓	✓
Chlorinated Solvents		✓	✓		✓	✓	✓						✓	✓				✓	✓	✓
PCBs	✓	✓	✓	✓													✓		✓	
Munitions		✓			✓		✓	✓				✓	✓			✓	✓	✓	✓	
PAHs		✓						✓				✓						✓		
Pesticides	✓		✓				✓	✓		✓							✓		✓	
Petroleum Products		✓			✓	✓	✓	✓				✓					✓	✓		✓
Inorganics																				
General																				
Arsenic			✓	✓				✓	✓						✓			✓	✓	✓
Cadmium	✓			✓			✓	✓				✓			✓	✓	✓	✓	✓	
Chromium	✓			✓			✓	✓								✓	✓	✓		
Copper				✓			✓	✓					✓		✓	✓	✓	✓		
Nickel				✓			✓	✓							✓	✓	✓			
Selenium	✓			✓		✓	✓					✓							✓	
Radionuclides	✓	✓	✓	✓			✓	✓					✓		✓	✓	✓	✓		

Notes:

BTEX Benzene, toluene, ethylbenzene, and xylenes
PAH Polycyclic aromatic hydrocarbon
PCB Polychlorinated biphenyl
RDX Cyclotrimethylenetrinitramine
TNT Trinitrotoluene

TABLE 1
PHYTOTECHNOLOGY MECHANISMS

Mechanism	Description	Cleanup Goal
Phytodegradation	Ability of plants to take up and break down contaminants within plant tissues through internal enzymatic activity	Remediation by destruction
Phytoextraction	Ability of plants to take up contaminants into the plant and sequester the contaminant within the plant tissue	Remediation by removal of plants containing the contaminant
Phytohydraulics	Ability of plants to take up and transpire water	Containment by controlling hydrology
Phytosequestration	Ability of plants to sequester certain contaminants into the rhizosphere through release of phytochemicals, and sequester contaminants on/into the plant roots and stems through transport proteins and cellular processes	Containment
Phytovolatilization	Ability of plants to take up, translocate, and subsequently volatilize contaminants in the transpiration stream	Remediation by removal through plants
Rhizodegradation	Ability of released phytochemicals to enhance microbial biodegradation of contaminants in the rhizosphere	Remediation by destruction

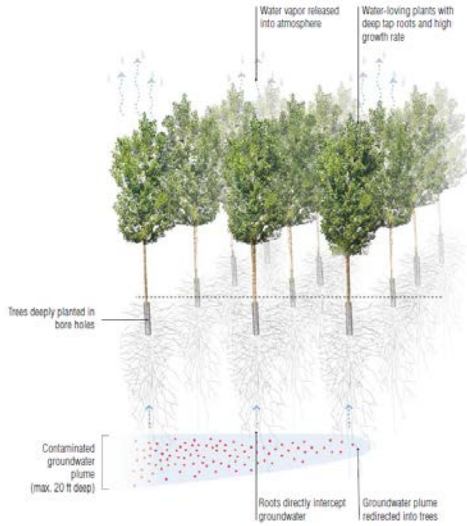
Source: Interstate Technical Regulatory Council (ITRC). 2009. Phytotechnology Technical and Regulatory Guidance and Decision Trees, Revised.

Tabl.7. Phytotechnology mechanisms

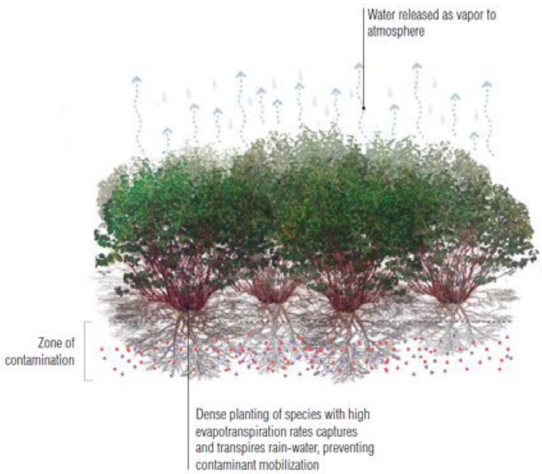
Fig.80. Ground water Mitigation Tree Stand (Phytohydraulics)

Fig.81. Evatranspiration Cover (phytostabilisation, phytohydraulics)

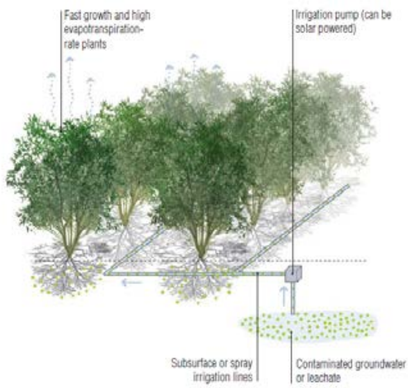
Fig.82. Phytoirrigation (rhizodegradation, phytodegradation, phytovolatilisation)


Water vapor released into atmosphere
Water-loving plants with deep tap roots and high growth rate
Trees deeply planted in bore holes
Contaminated groundwater plume (max. 20 ft deep)
Roots directly intercept groundwater
Groundwater plume redirected into trees

80


Water released as vapor to atmosphere
Zone of contamination
Dense planting of species with high evapotranspiration rates captures and transpires rain-water, preventing contaminant mobilization

81


Fast growth and high evapotranspiration-rate plants
Irrigation pump (can be solar powered)
Subsurface or spray irrigation lines
Contaminated groundwater or leachate

82

2.7.
DECOMMISSIONING

The decommissioning is a process of removing nuclear facility from service.

Decommissioning could happen in tree ways ("Nuclear Decommissioning: Decommission nuclear facilities," 2016):

1. Immediate dismantlement - the equipment is dismantled right after the termination of reactor and removal of radioactive waste.

2. Suspended dismantlement and safe conservation after the termination of reactor and removal of radioactive waste, there is safe conservation period before dismantlement of equipment (40-100 years).

3. Sarcophagus - the equipment is covered by concrete sarcophagus and kept for some time in order to reduce radioactivity due to natural nuclear fission.

IAE advised to follow the Immediate dismantlement model due to financial situation and use of knowledge of nuclear power plant workers. They built the power plant themselves therefore they are the ones who know the best how to dismantle it. The scope of the dismantlement is seen in the picture. After decommissioning process is finished, the INPP site still contains radioactive structures, with safety regulation zones.

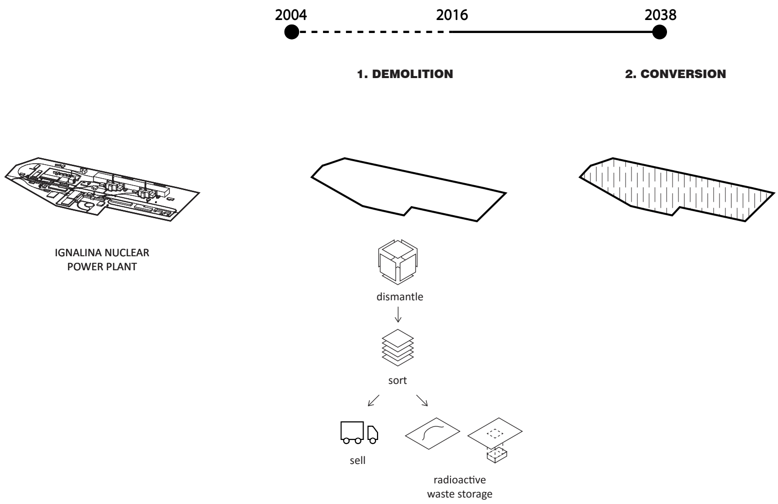
Project proposes alternative to decommissioning process. Instead of usual demolition and conversion process, preservation and reuse is proposed.

Decommissioning is perceived as an action that involves not only nuclear power plant site, but also the whole nuclear energy landscape.

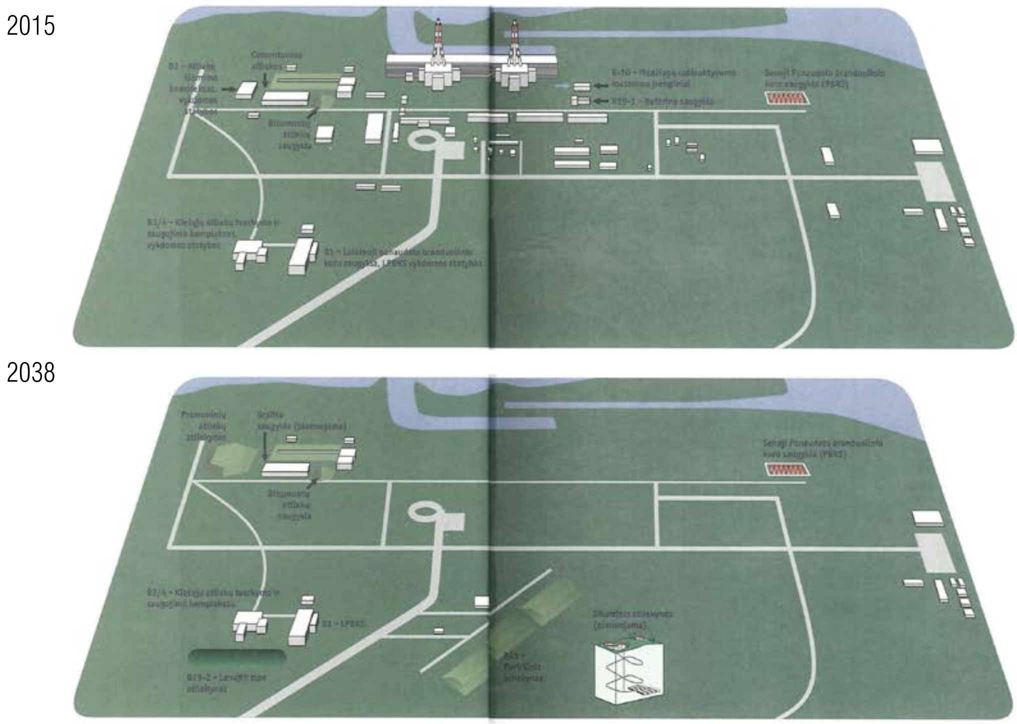
By proposing alternative decommissioning techniques, such as phytotechnologies and demolition with nature, decommissioning time extends, however it builds bonds with the site and opens opportunities for redevelopment.

Fig.83. Decommissioning process

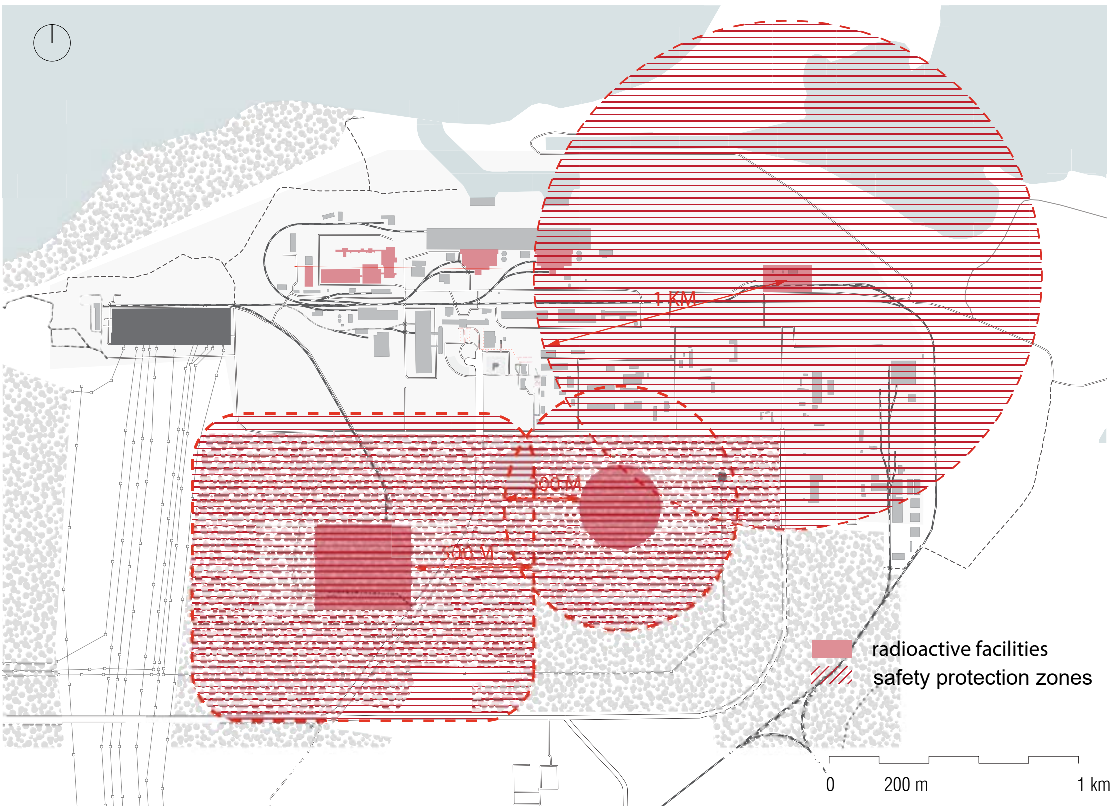
Fig.84. Decommissioning plan


2004
2016
2038
1. DEMOLITION
2. CONVERSION
IGNALINA NUCLEAR
POWER PLANT
dismantle
sort
sell
radioactive
waste storage

83


2015
2038

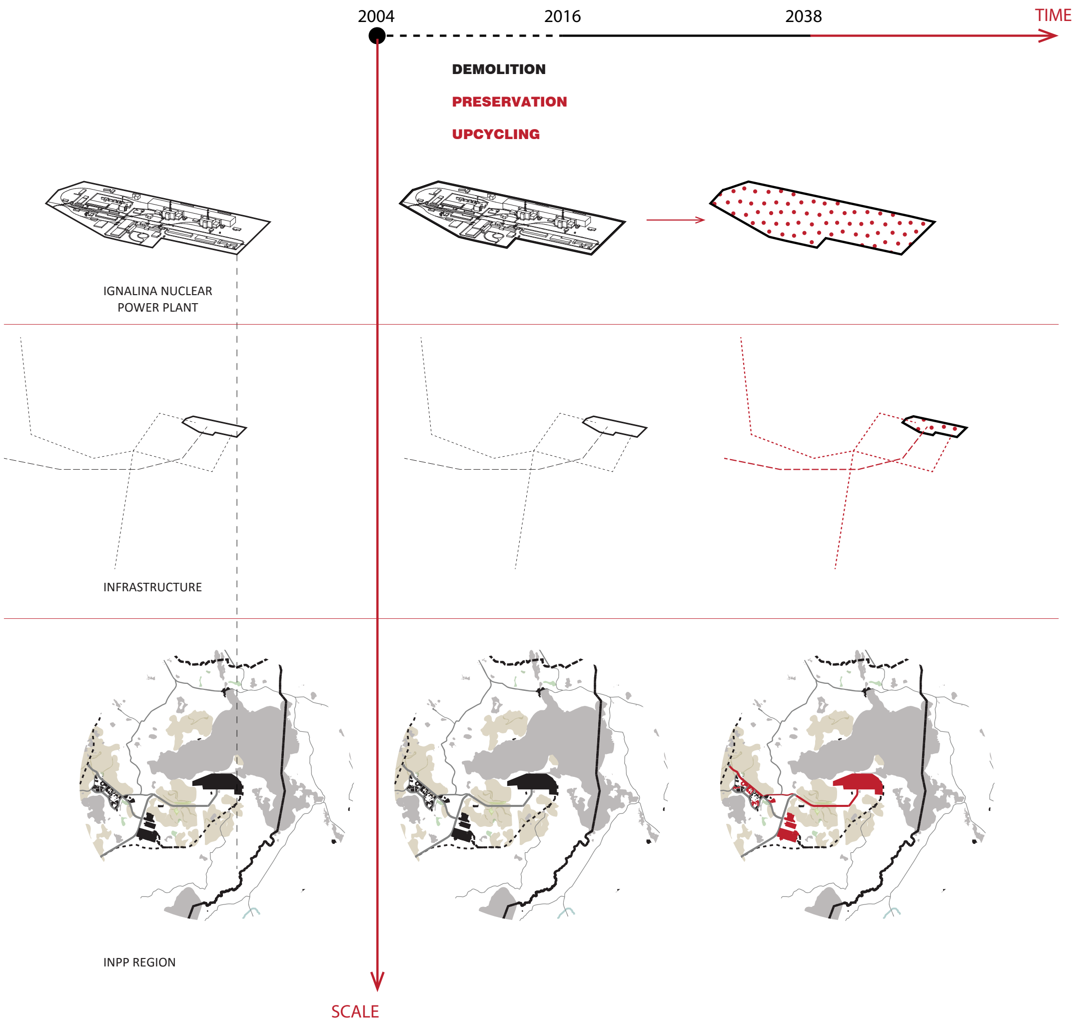
84



85

Fig.85. Remaining radioactive elements and their safety regulation zones

Fig.86. Alternative approach to decommissioning


2004
2016
2038
TIME
DEMOLITION
PRESERVATION
UPCYCLING
IGNALINA NUCLEAR POWER PLANT
INFRASTRUCTURE
INPP REGION
SCALE

3. EXPLORATORY SCENARIOS

3.1. EXPLORATORY SCENARIOS

Scenarios defines nuclear energy landscape development possibilities after decommissioning nuclear power plant. The decommissioning of INPP is unprecedented event - no such large power plant was ever decommissioned before, therefore there is no precise plan for decommissioning. It develops through time. The method of scenarios helps to test different development paths. Scenarios are defined and shaped according tendencies, statistics, interviews, workshops, literature reading and site visits, impressions. All this information generated conceptual images of scenarios. Combination of theses images defines Atompark.

Fig.87. Scenario representative pictures

Nature reserve

Energy park

Industrial heritage site

3.2.
NATURE RESERVE

What if... nature becomes dominant and overtakes nuclear industry sites, structures and vacant lots?

In other words, what if the nuclear energy landscape becomes a regional park?

This scenario is based on Visaginas location near international nature framework which has opportunity to be strengthened after decommissioning of nuclear power plant.

How should a restoration process happen?

What sites remain from nuclear industry? And how their impact could be diminished?

How nature preservation can add to city's economy?

The decommissioning process of the INPP results in demolition of its structures and uncovering natural processes that happens in the site, e.g. surface and subsurface water-flow which is now drained into pipelines and covered by soil or concrete.

There would be a remaining radioactive structures, such as nuclear waste storage, processing and management facilities. Phytotechnologies could be used to clean the pollution created by these facilities, recover the soil and prevent from further contamination. Cleaning process would also create workplaces in the region and give the revenues from biorefineries.

Another element could be biodiverse farm, which, research showed, is able to deal with the radioactivity and at the same time, produce food and restore and strengthen ecosystems. The method involves using Biodynamic preps, e.g. Barrel Compost, which is a special manure with crushed eggshells and basalt. Such farm would act as a environmental research center giving the knowledge for farmers in

Fig.88. Representative image of scenario


88

the region to let them contribute to the strengthening the nature.

One more element would be a allotment garden, based on culture patterns in the region, where the first generation and the youth of Visaginas tend to use allotment gardens to grow their food and as a relaxing activity. Allotments also provides wide range of ecosystem services, pollination, biodiversity that rank very high comparing with parkland.

All these elements could take up industrial sites, infrastructure and give them a new role of being a productive, healing landscapes both for people, flora and fauna in the region.

During this scenario the vacant buildings would be demolished, opening place for nature to expand in the city. The scattered urbanized areas around Visaginas gain the role of protecting and maintaining the natural landscape and therefore being subsidized.

The wild and untouched land could become an attractive place for tourists seeking for close relationship with nature.

Fig.89. Peaceful lakes

Fig.90. “Rented” places in the landscape

Fig.91. The forest inside the city

Fig.92. The forest just outside the city

Fig.93. Collective gardens as leisure activity

"Some research done on the Chernobyl nuclear disaster showed that the only foods that didn't have radioactive materials were those grown in organic gardens [precisely, biodynamic farms] that had a good level of mycorrhizal fungi on the root system and strong soil biology"

Elaine Ingham (Earth repair, 2014)

"AGs provide a wide range of ecosystem services in urban areas. Services related to pollination, food provision, biodiversity and recreation rank very highly on AGs [comparing to parks]."

(Speak,2015)

Projects related with this scenario would involve:

- the conversion of industrial and infrastructure sites to nature areas, food production and recreation lands by recovering nature structures that are hidden but persist in the region, with the typologies of biodynamic farms, allotment gardens, phytotechnologies, wildlife corridors.

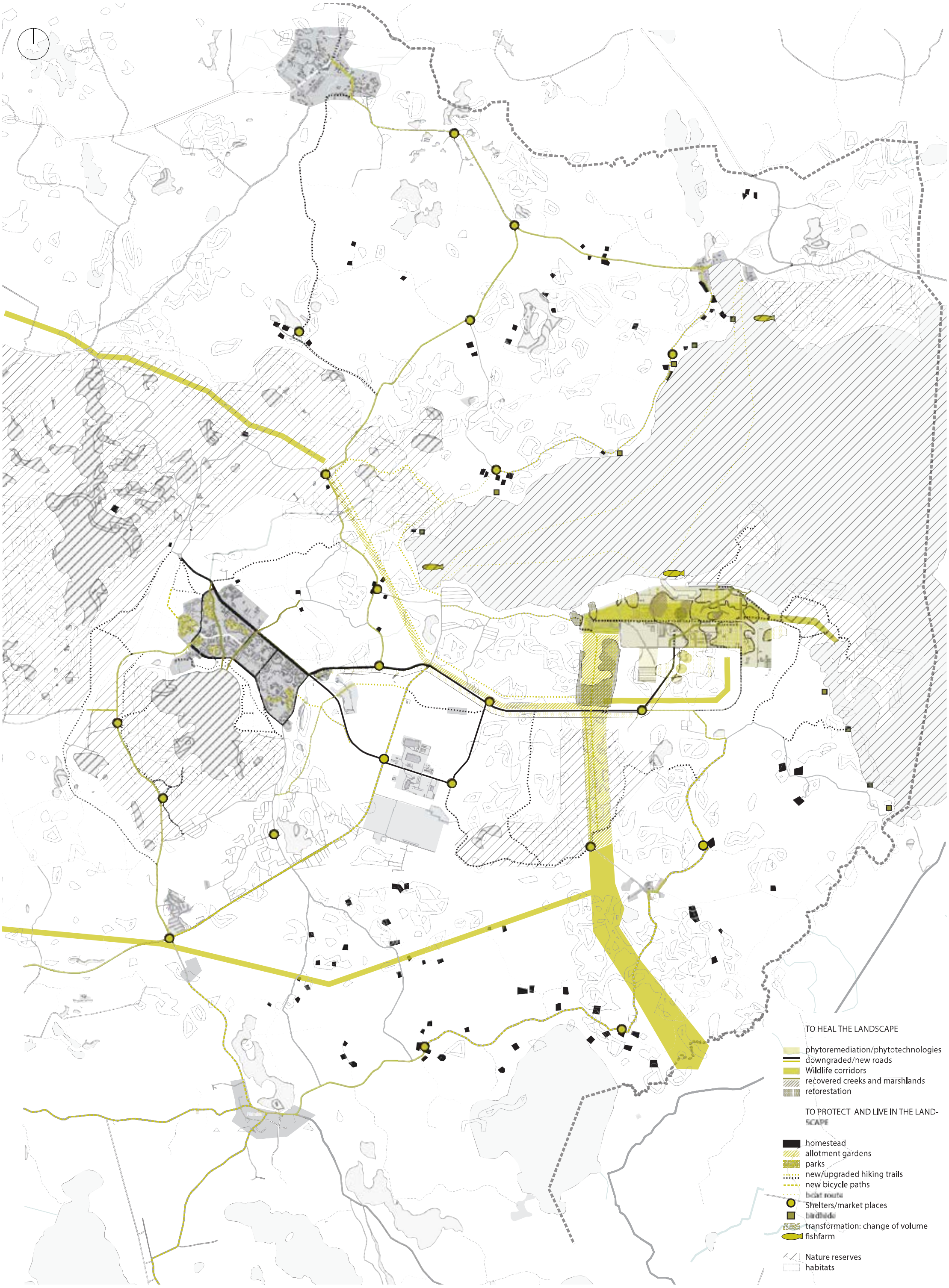
- penetration of the wilderness to the city both with plantation and water bodies and transformations of houses, urban fronts to strengthen the relationship between nature and urban environment.

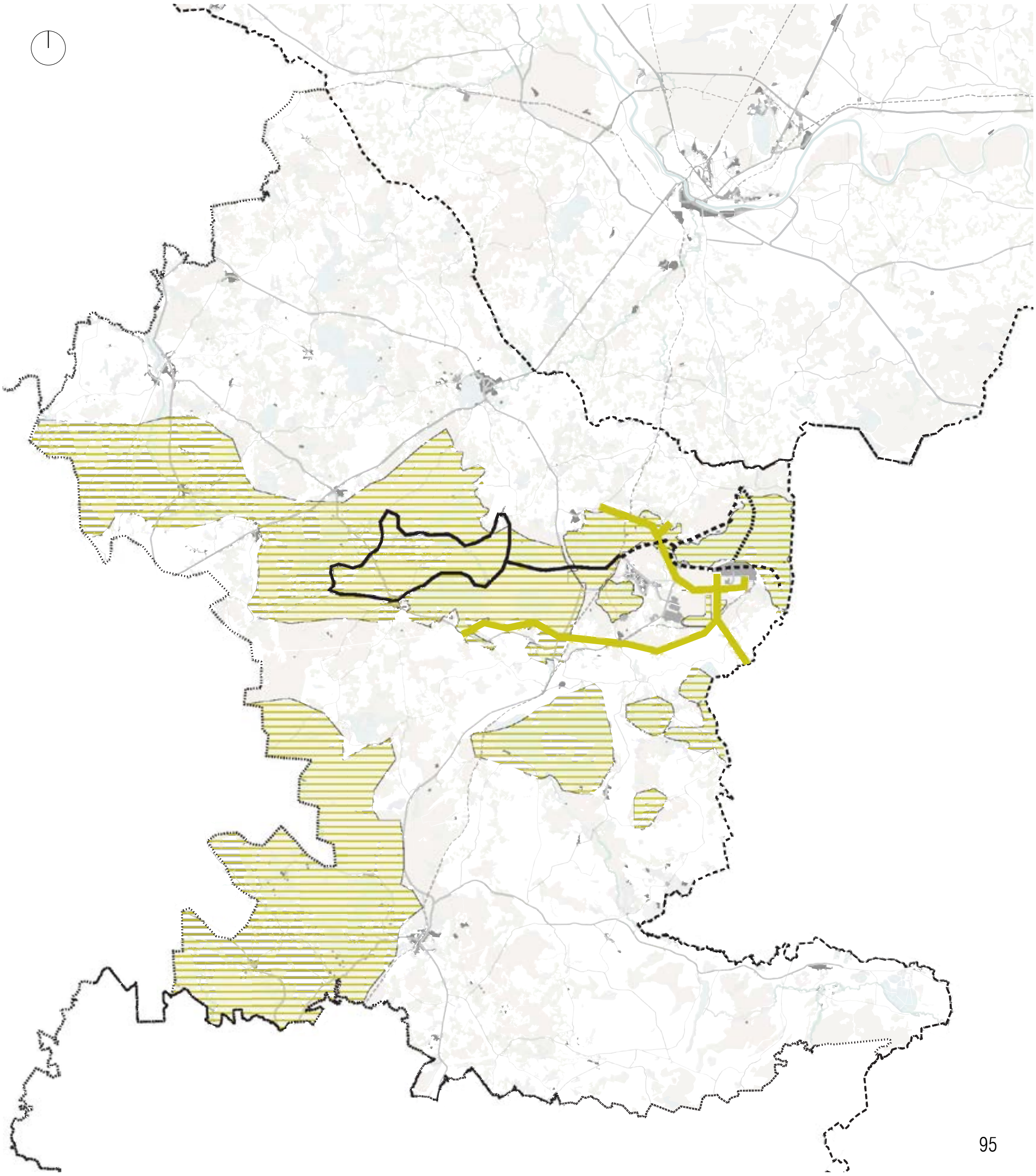
- Mobility strategy: building new paths to discover the nature that once was prohibited, downgrading roads to diminish the infrastructure impact to the environment and strengthen migration paths of species, new bicycle paths for people to wander in nature and for healthy living that is present in the region.

- structures for people to stay in nature without interrupting the wildlife.

- policies recognizing homesteads, allotments, biodynamic farming as means to protect and strengthen the nature.

Fig.94. The scenario plan


TO HEAL THE LANDSCAPE
phytoremediation/phytotechnologies
downgraded/new roads
Wildlife corridors
recovered creeks and marshlands
reforestation
TO PROTECT AND LIVE IN THE LAND-
SCAPE
homestead
allotment gardens
parks
new/upgraded hiking trails
new bicycle paths
boat route
Shelters/market places
birdhide
transformation: change of volume
fishfarm
Nature reserves
habitats



95

Fig.95. The scenario plan on regional scale

Fig.96. Conversion of nuclear power plant site

Fig.97. “Demolishing with nature”. Laying down cardboard and getting ready to sheet-mulch and build soil at Hayes Valley Farms

Fig.98. Collective gardens and wildlife corridors combined with energy transmission lines

Fig.99. Homestead taking care of the surrounding nature besides their farming activities

Fig.100. Bird-hides

96

97

98

99

100

101

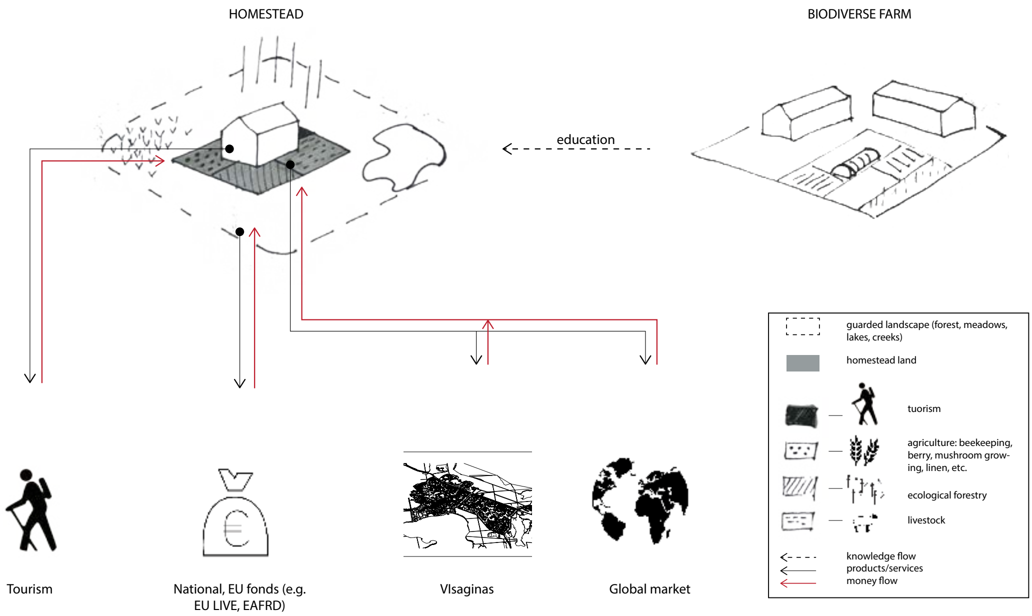
102

Fig.101. Transformations of the road between INPP and the city

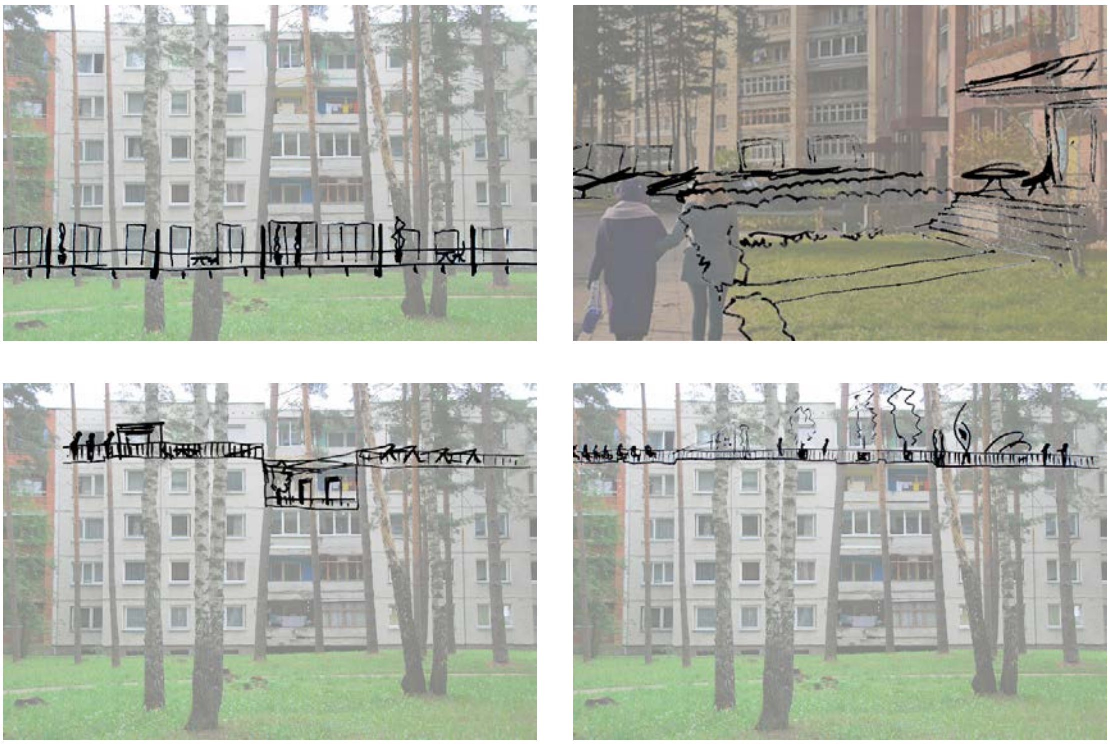
Fig.102. New path in marshlands

Fig.103. The homestead as a mean to protect the landscape

Fig.104. Transformations of buildings. Private terraces, connection to urban green. Semiprivate spaces and direct connection to apartments. Lowering of buildings, transformations of apartment block volume giving (semi) private outdoor spaces.


HOMESTEAD
BIODIVERSE FARM
education
guarded landscape (forest, meadows, lakes, creeks)
homestead land
tuorism
agriculture: beekeeping, berry, mushroom grow-ing, linen, etc.
ecological forestry
livestock
knowledge flow
products/services
money flow
Tourism
National, EU fonds (e.g. EU LIVE, EAFRD)
VIsaginas
Global market

103



104

3.3.
ENERGY PARK

What if... energy generation revives?

Visaginas has the all needed infrastructure for the energy generation. Infrastructure was built for 3000 MW power plant, serving to Lithuania and neighboring countries: Latvia, Belarus. City could turn into renewable energy generation, however then part of existing power plant employees, would emigrate due to lack of jobs related with their field of expertise. Therefore the scenario with new generation nuclear energy is considered.

Considering technological innovations in nuclear energy sector - nuclear fusion could be the type of energy production that both reuses the knowledge generated in the city and provides inherently safe, clean and inexhaustible energy source. Small scale nuclear reactors are developing faster and would allow energy transition from centralized to distributed energy generation.

Nuclear energy is always complemented by the research institutions in the nuclear state. One such Energy institute is located in the second largest city in Lithuania. The part of it, could be located in Visaginas, which provides concentration of energy related professionals. The new research center could employ former Ignalina nuclear power plant workers bridging their knowledge with newcomers. Visaginas has a potential to grow into energy high tech industry hub.

Maintaining nuclear energy science in Lithuania and Visaginas would be useful to find solutions to reuse waste fuel in the future.

Fig.105. Representative image of scenario


0.08
2.50
54%

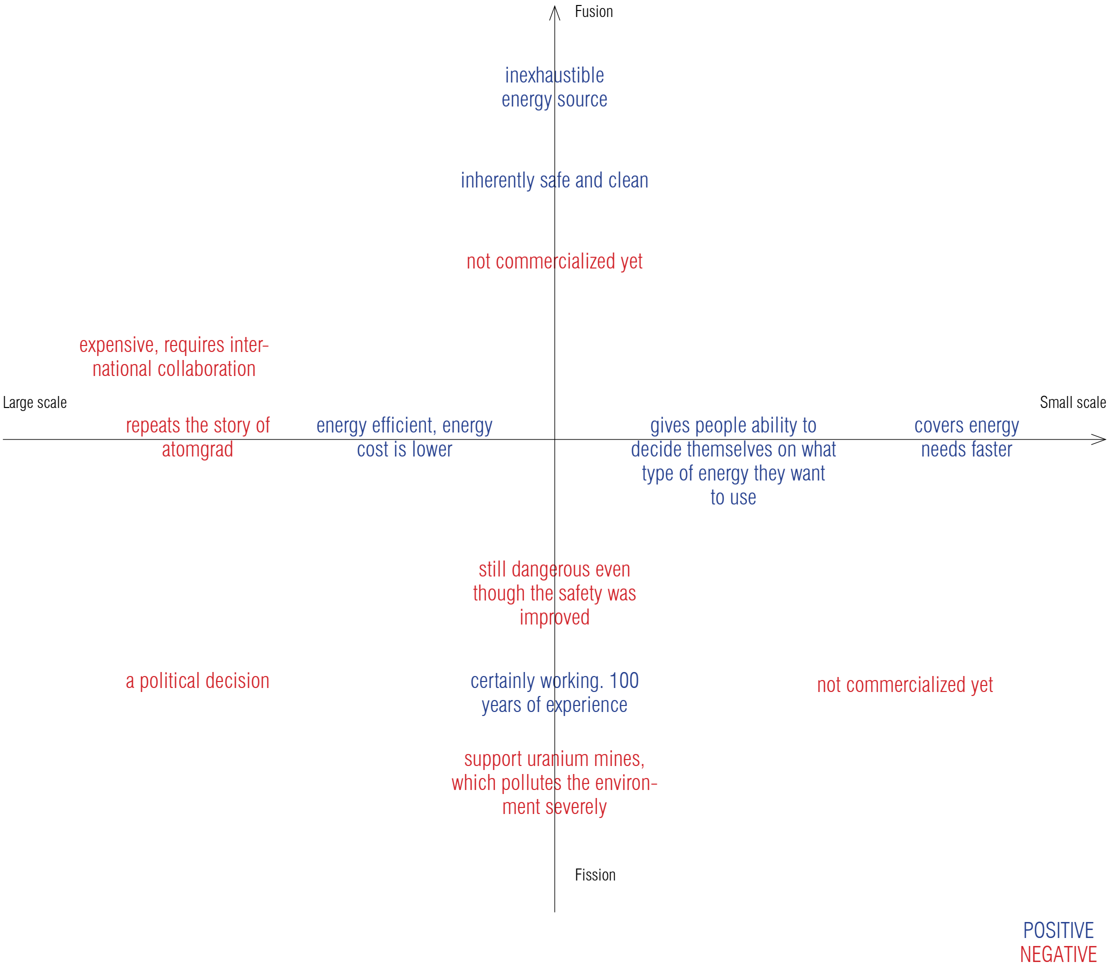
Reactor type in the pant	Scale and Power	Commercially available	Operation years	Safety	Economic feasibility	Fuel	Employees (construction/operation) on site	Waste	Uses	Supporting structures
Conventional nuclear fission reactors	50-1500 MW	now	30-60	threat of melt down, emissions of radioactive materials	cost-effective	Uranium, uranium dioxide	$\sim$5000/5000	high radioactivity used fuel, radioactive structures	plutonium production, electricity, heating	mines; enrichment, reprocessing, plants.
IV generation nuclear fission reactors	Large 700-1500 MW	now	$\sim$60 refueling every 5-10 years	much safer and cleaner than conventional	cost-effective	Uranium, uranium dioxide, MOX* TRISO**	$\sim$3500 (5 years) / $\sim$500	Used fuel (less than conventional), radioactive structures	hydrogen production, electricity	mines; enrichment, reprocessing, MOX fuel production plants, Storage of used fuel and radioactive structures
	Small 25-300 MW Medium 300-700 MW	$\sim$2020					$\sim$500 / $\sim$100		electricity, heating	-"-, reactor plants
Nuclear fusion reactors	Large 1 MW	$\sim$2040	$\sim$10years/ unknown	inherently safe	costly (10 bln euro ITER)	deuterium-tritium	$\sim$3000 / unknown	no fissile material, reactor structures might become radioactive during operation (very low radioactivity)	electricity, heating	Deuterium production, reactor production plants, Storage of very low radioactivity structures
	Small 5-100 MW	$\sim$2025	1 year		cost-effective		$\sim$20-150/ 15-200			

* fuel that consists of natural uranium, reprocessed uranium, or depleted uranium.

** tristructural-isotropic fuel, that has a kernel of uranium oxycarbide, surrounded by layers of carbon and silicon carbide

Tabl.8. Table nuclear reactors

Fig.106. Comparison of nuclear reactors


Fusion
inexhaustible energy source
inherently safe and clean
not commercialized yet
expensive, requires inter-national collaboration
Large scale
Small scale
repeats the story of atomgrad
energy efficient, energy cost is lower
gives people ability to decide themselves on what type of energy they want to use
covers energy needs faster
still dangerous even though the safety was improved
a political decision
certainly working. 100 years of experience
not commercialized yet
support uranium mines, which pollutes the environ-ment severely
Fission
POSITIVE
NEGATIVE

106

Referendum “I agree to the new nuclear power plant in Lithuania”:

Lithuania votes: “NO” 62 %

Visaginas votes: “YES” 65 %

Robert Scoble
Jan 27 · 4 min read

Here’s how small-town America is primed to beat Silicon Valley in innovation

As Rackspace’s Futurist I’m known as one of Silicon Valley’s top tech influencers. I didn’t say that, Ivy did.

So, when I say Silicon Valley is being beaten, and is at risk of losing more companies to small towns, here’s why. In the past week I’ve visited three of those towns, Urbana, and Champaign Illinois and Blacksburg, Virginia.

You might not know, but YouTube, Tesla, PayPal, Mozilla started in Urbana/Champaign at University of Illinois there, and Blacksburg is home to many of the leading thinkers of autonomous vehicles, and others, thanks to being the home of Virginia Tech.

107

Features of successful high tech industry towns according Robert Scoble (in read features that Visaginas has):

- affordable housing costs
- way of life much more friendly to families
- ‘livability gap’ filled - bars, music events, restaurants for enterpreneurs to hang out
- high speed internet
- high end facilities for researchers to use
- strong communities.
- universities
- large well-known companies
- newest technologies

73 % of the population is of working age

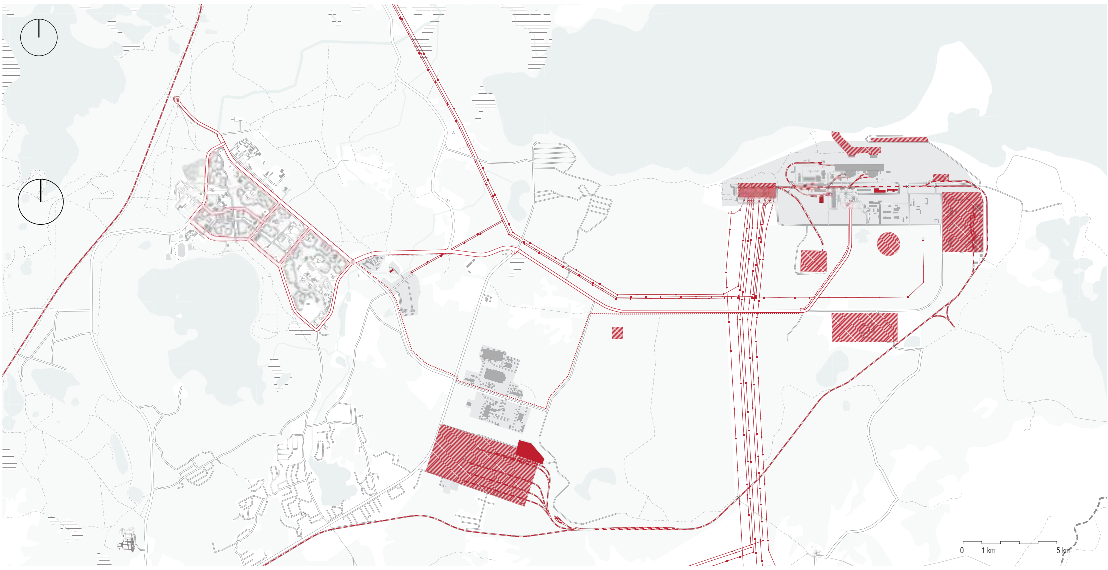
No. 2 by education level.

79.4 % of the population has higher education (mostly in the field of energy)

No. 1 by the number of nationalities – **43 nationalities**

Fig.107. The article of Rackspace’s technology futurist Robert Scoble

Fig.108. The map of energy infrastructure that can be reused



108

Railway
Roads
Pipelines to Visaginas
high volatege electricity lines

Projects related with this scenario would consider:

- reuse of existing energy structures

- construction of nuclear fusion power plants, related industries.

- Strategy for high tech industry eco-system.

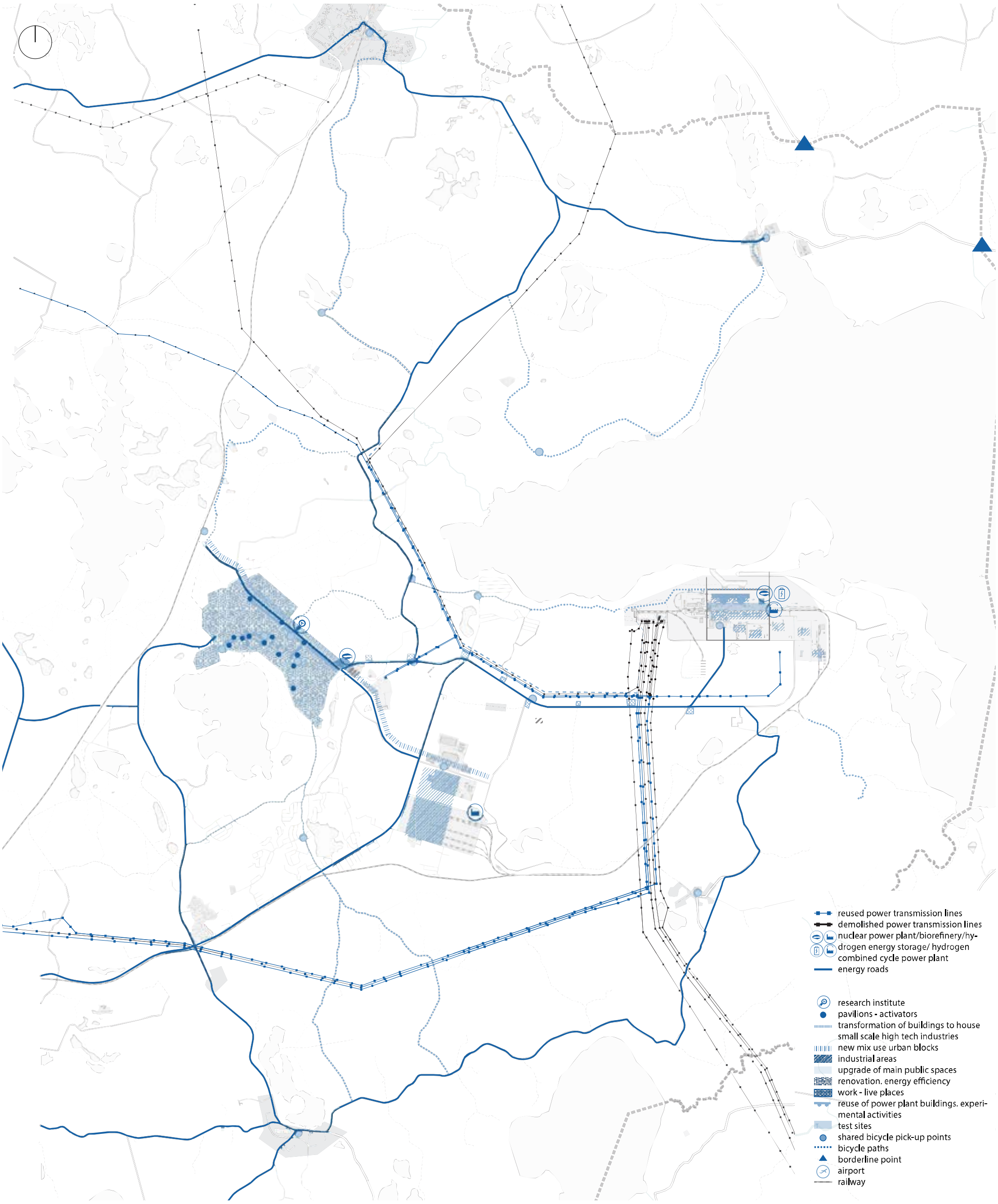
- connectivity and mobility: border connections, shared cars (later driver-less cars), bicycle paths, piezo-electric roads based on main people mobility paths.

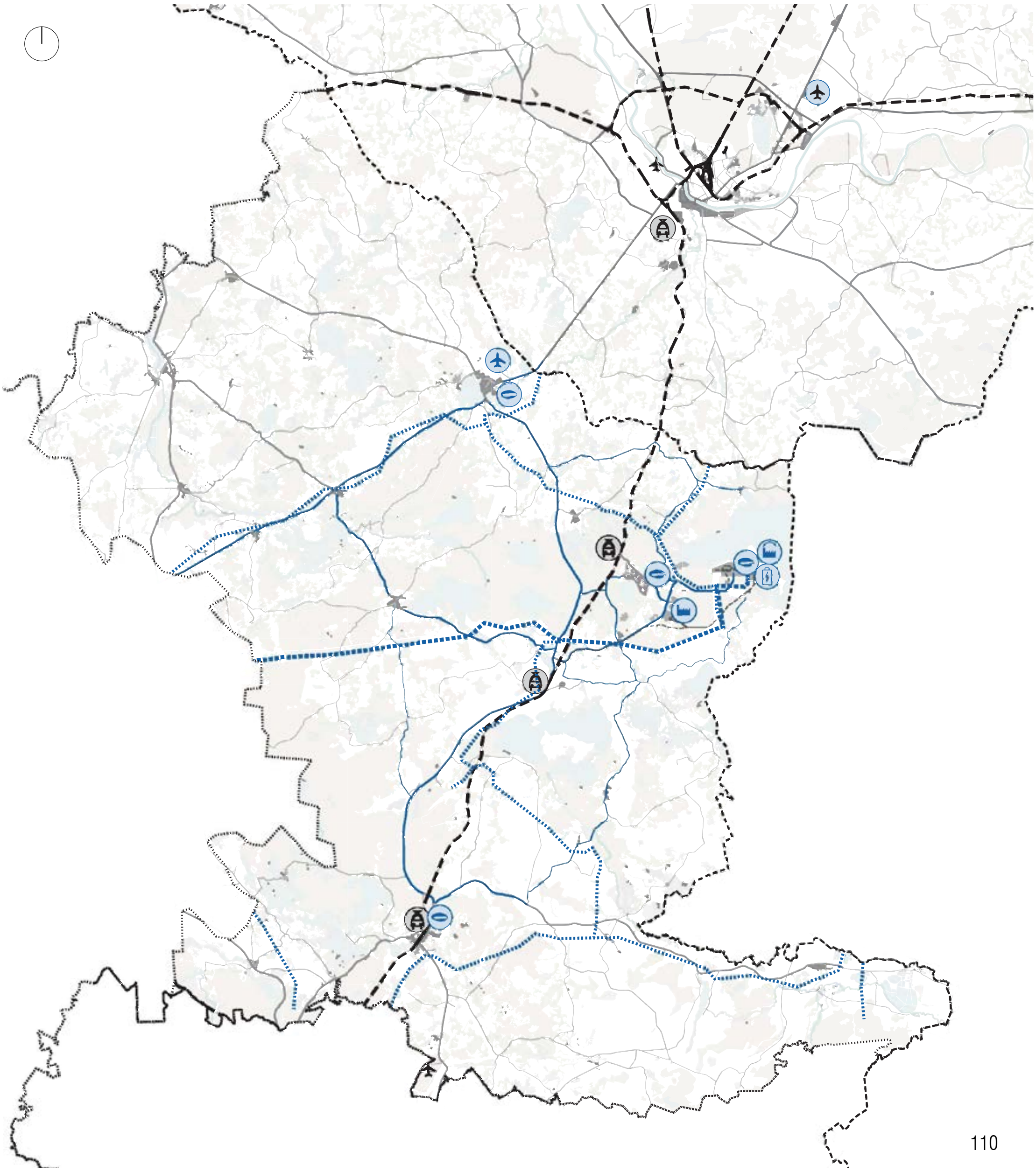
- development sites for new companies

- new Energy Institute

- transformations of apartments blocks to fit industries, increase energy efficiency and attractiveness of the buildings.

Fig.109. The scenario map

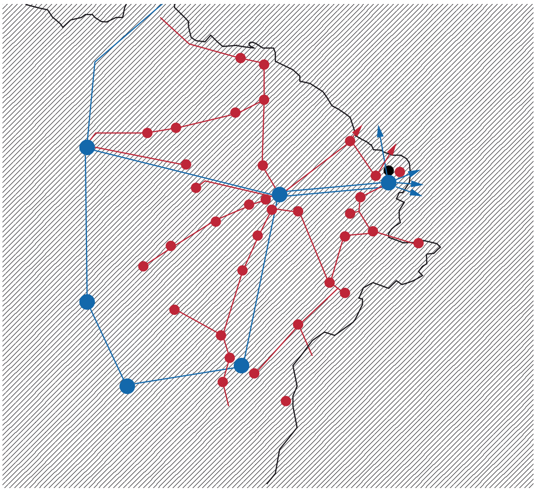

reused power transmission lines
demolished power transmission lines
nuclear power plant/biorefinery/hy-
drogen energy storage/ hydrogen
combined cycle power plant
energy roads
research institute
pavilions - activators
transformation of buildings to house
small scale high tech industries
new mix use urban blocks
industrial areas
upgrade of main public spaces
renovation. energy efficiency
work - live places
reuse of power plant buildings. experi-
mental activities
test sites
shared bicycle pick-up points
bicycle paths
borderline point
airport
railway

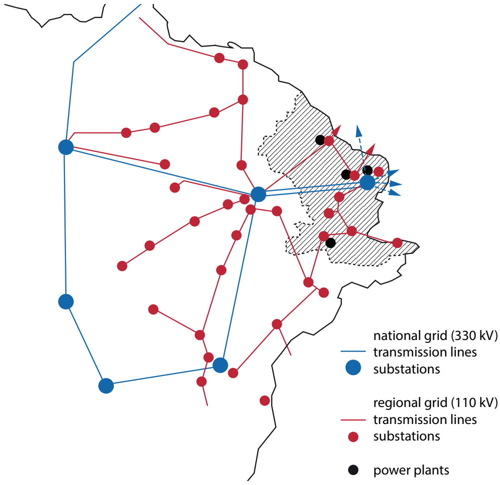


110

Fig.110. The scenario map on regional scale

Fig.111. The energy transition





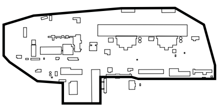
international grid → **regional grid**

3 000 MW power → 75 MW

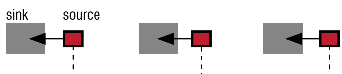
for 2 400 000 people → for 60 000 people

Fission → **Fusion**

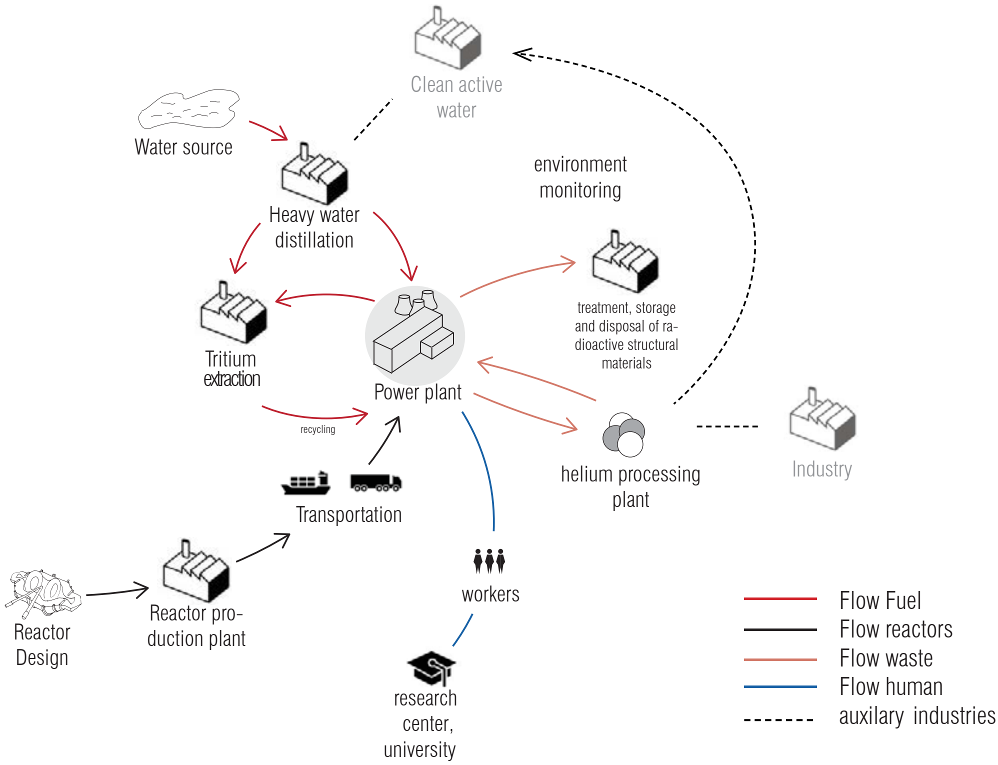
Centralized energy source → **Distributed energy source**



Ignalina Nuclear Power plant



- nuclear fusion,
- biorefinery,
- hydrogen combined cycle power plant

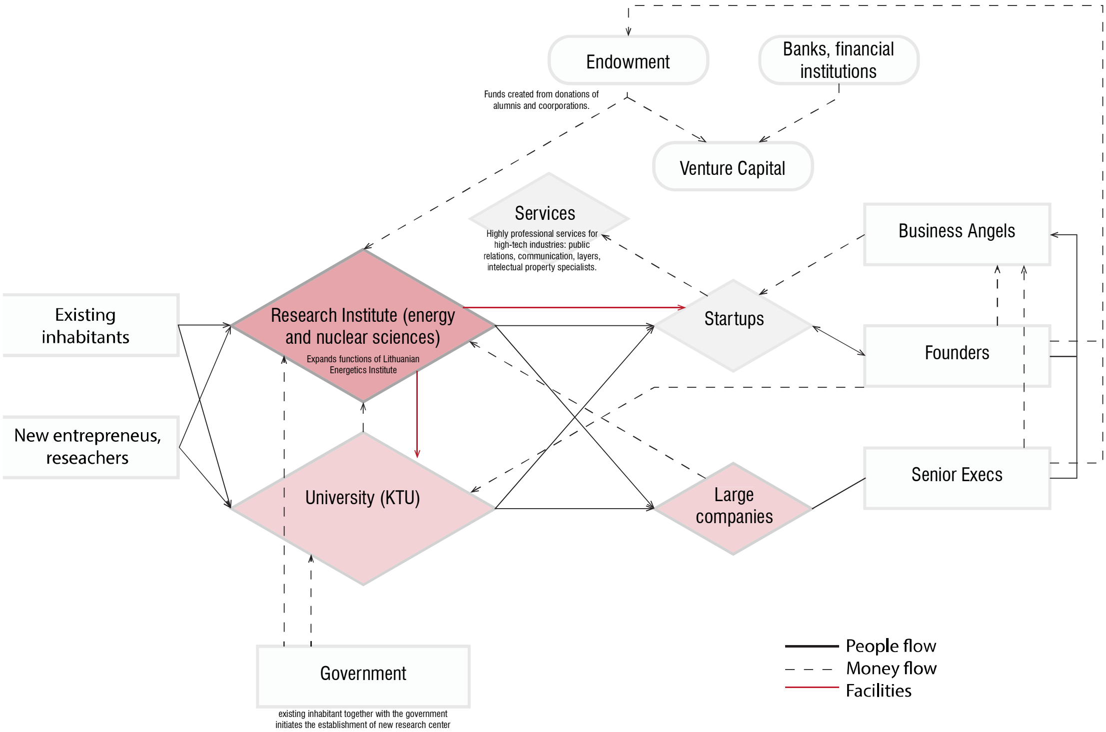


112

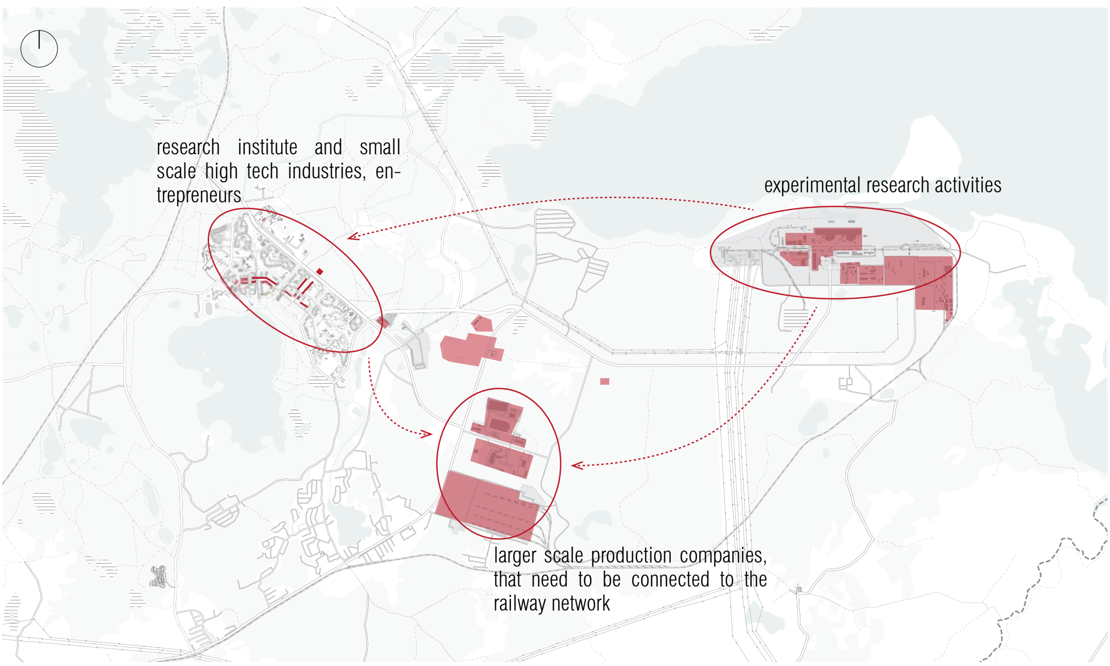
Fig.112. The nuclear energy industry cycle

Fig.113. The high-tech energy ecosystem

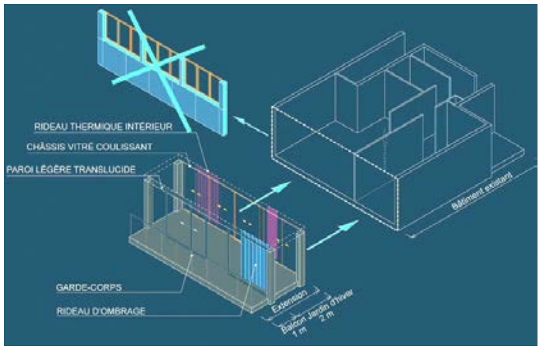
Fig.114. The relocation of work places


Endowment
Banks, financial institutions
Funds created from donations of alumnis and coorporations.
Venture Capital
Services
Highly professional services for high-tech industries: public relations, communication, layers, intelectual property specialists.
Business Angels
Existing inhabitants
Research Institute (energy and nuclear sciences)
Expands functions of Lithuanian Energetics Institute
Startups
Founders
New entrepreneus, reseachers
University (KTU)
Large companies
Senior Execs
Government
existing inhabitant together with the government initiates the establishment of new research center
People flow
Money flow
Facilities

113


research institute and small scale high tech industries, entrepreneurs
experimental research activities
larger scale production companies, that need to be connected to the railway network

114



115

116

Fig.115. Tour Bois le Prêtre, renovation of apartment blocks. Building, facade detail, interior view.

Fig.116. The example of transformation of urban front and new public space extending indoor activities.

Fig.117. Wifi pavilion. Outdoor working space.

Fig.118. Leica gallery, Prague. Mixed typology - gallery and cafe in one place. You cup of coffee is your ticket to the gallery.

Fig.119. Piezoelectric road.

Fig.120. RDM campus, Rotterdam


117


118


119


120

3.4. INDUSTRIAL HERITAGE

What if... the region is industrial heritage site?

Scenario derives from the impressions while visiting the site, industrial heritage analysis (Chapter 2.4), references, e.g. Richland National Monument (Annex).

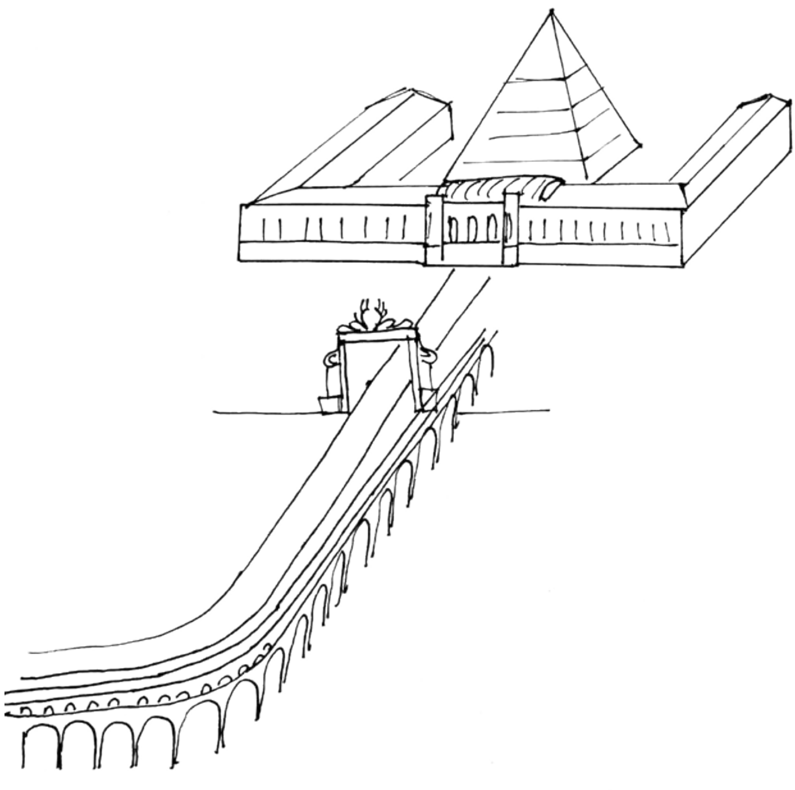
The city keeps the structures of industrial heritage that stands there as reminders of the ideology and the mindsets of the past, are open for the visitors to experience what was once guarded and inaccessible. The former INPP site would act as attractor to the city, housing not only educational and cultural activities related with history and heritage (museums), but also additional reuse to industrial structures for the playful outdoor art installations, studios, galleries, for artist that already exist in the city, or for those coming to, sport facilities and complexes., extending the onces in the city to INPP area, quays providing water related activities and connecting the site with settlements on the shore of the lake.

The region would become permeable providing new bicycle and hiking paths and connecting both industrial sites and the other cultural heritage objects in the region.

Extending from INPP site, the tourism infrastructure would develop in the city - accommodation, catering, bicycle share points, public spaces for events.

Post-industrial Visaginas region would become a place that suspends hostilities between the residents of Visaginas and the rest of Lithuania, provides a compromise - the place that still holds the memories of former nuclear power plant workers, but is no longer hazardous. With its exceptional structures, it is a place for unconventional tourists, to explore.

Fig.121. The representative image of scenario



121

Projects related with this scenario would consider:

- preservation of the first nuclear reactor, transformations of turbine halls and the second reactor

-the rest of the site buildings would be demolished or reused.

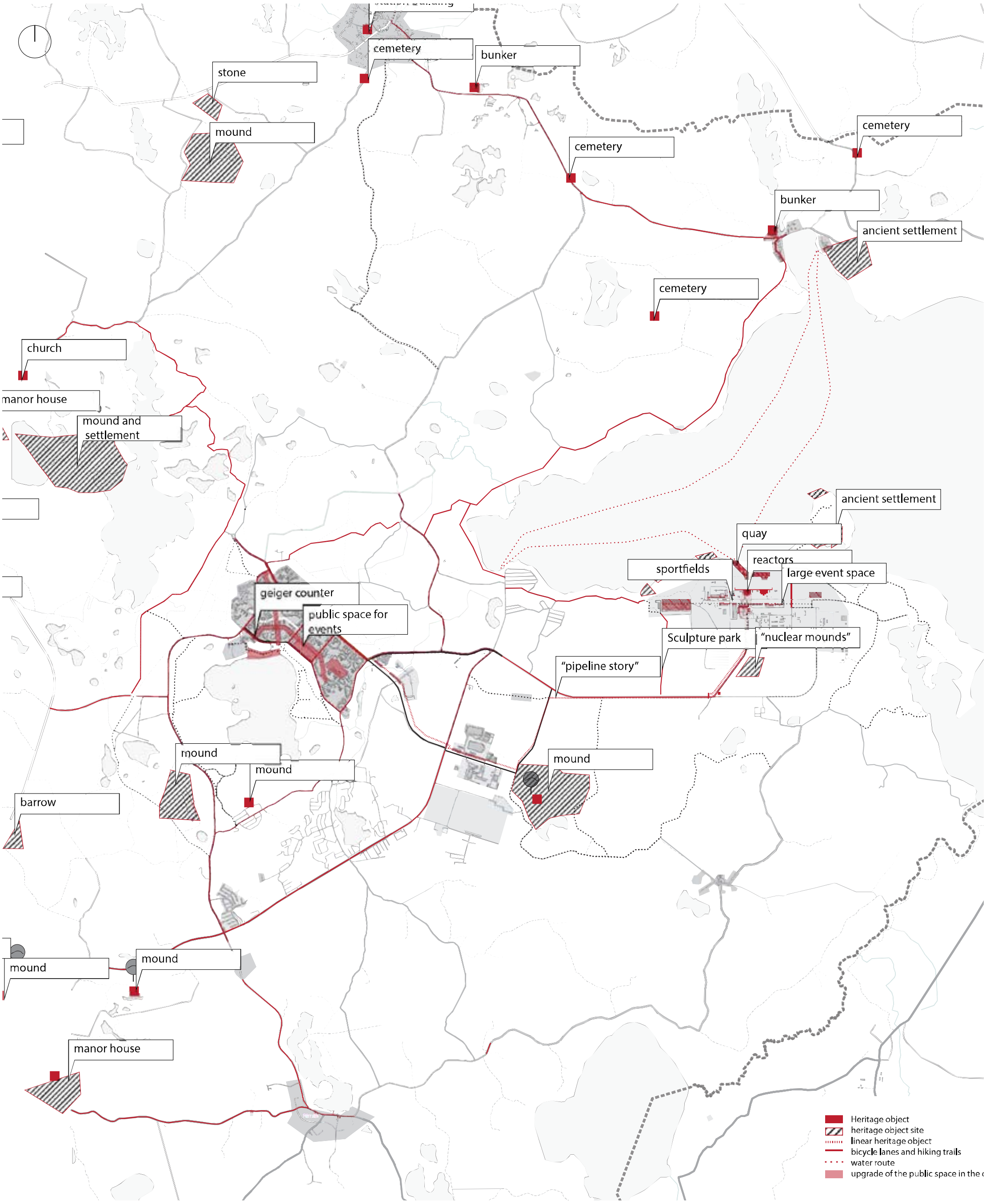
- the transformations of power transmission corridors near the power plant as part of the monument site

- transformations of the site: new sport-fields, exhibition places, quay

- new bicycle and hiking routes in the region

- upgrade of the public space in the city

Fig.122. The map of scenario



stone
mound
cemetery
bunker
cemetery
cemetery
bunker
ancient settlement
cemetery
church
manor house
mound and settlement
ancient settlement
quay
reactors
sportfields
large event space
geiger counter
public space for events
Sculpture park
"nuclear mounds"
"pipeline story"
mound
mound
mound
barrow
mound
mound
manor house
Heritage object
heritage object site
linear heritage object
bicycle lanes and hiking trails
water route
upgrade of the public space in the c

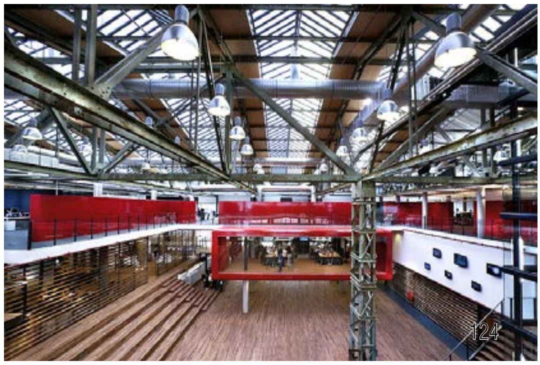


Fig.123. Tate modern, London

Fig.124. Mediawharf, Amsterdam

Fig.125. Duisburg park, Germany

Fig.126. Duisburg sports park, Germany

Fig.127. Square for art installations in C-mine, Genk

Fig.128. Parco-Dora-industrial-archaeology-Turin-7

Fig.129. Anti-radiation shelter

Fig.130. Electricity pylons as sculptures

Fig.131. Duisburg monument, Germany


127


129


128


130


131

4. VISION. FRAMEWORK

4.1. VISION

The vision for the Visaginas nuclear energy landscape come out of combination of three scenarios. Each of them upcycles part of spatial and social resources embedded in the history of the place, energy structures and knowledge, enhances values of rich nature and uncovers the potentials of the nuclear power plant to be seen as industrial heritage. The fusion of scenarios gives the potential to create a comprehensive plan, inclusive and leading the region grow from Atomgrad to Atompark.

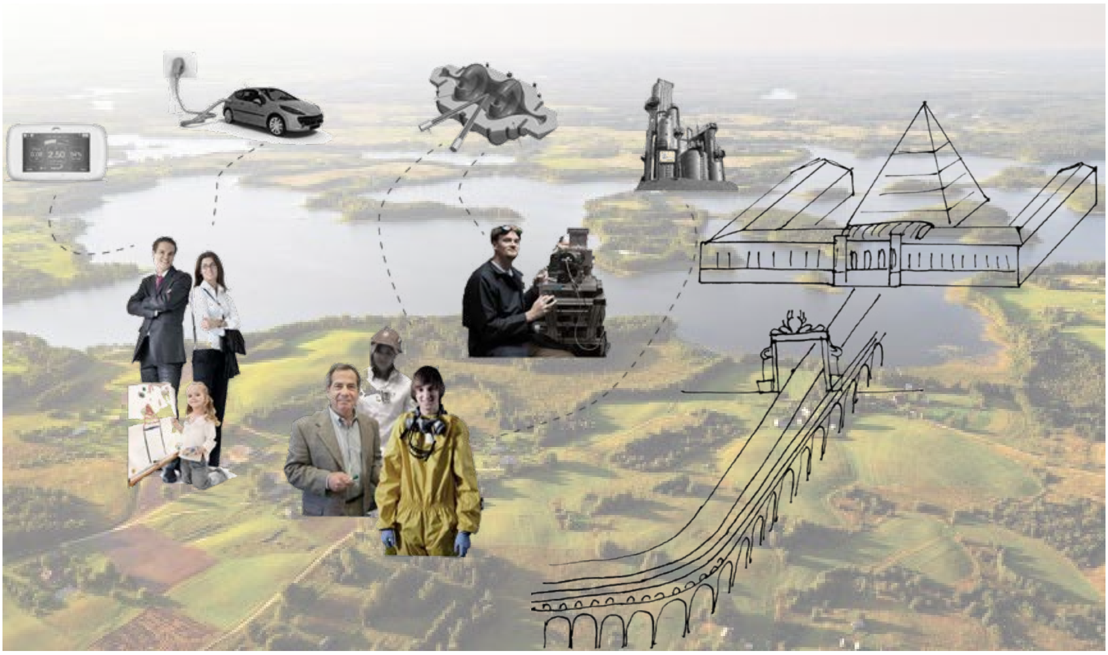
Atompark is perceived not just as a town, but as a regional city giving an importance to the scattered urbanized areas (homesteads, villages, collective gardens industrial sites).

The regional city where nature is part of it - a park with healing landscapes (wilderness, monument sites, collective gardens), containing sites for individual and communal stay in nature, which let residents and newcomers to experience it on daily basis without additional effort or the change of lifestyle. Experience it by simply commuting or actively participating in constructing the nature through new allotments and farming activities that increase biodiversity and strengthen international nature framework. The nature of the former nuclear energy landscape is special, it becomes a cradle for endangered species.

The layer of Atompark relates with an 'energy park'. Instead of deleting the nuclear energy presence in the region Atompark upcycles it with the sources that go along with nature. New energy sources, such as nuclear fusion, biorefineries, are small scale, integrated in buildings or nature structures, and instead of being visible from far distances, one needs to seek for them.

Connected with the energy generation, research facilities and high tech industries emerge in the region, reusing the knowledge of the existing workers and

Fig.132. The combination of scenarios

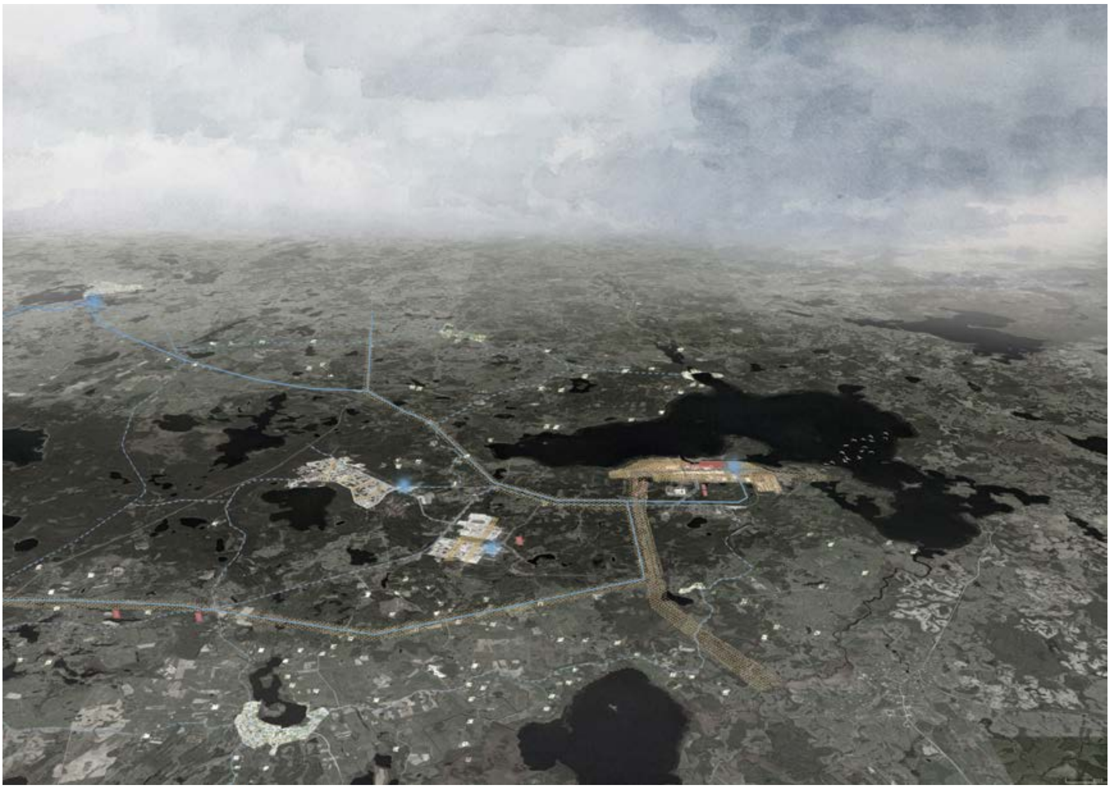


132

combining it with the knowledge of the newcomers. Variety of living environments are provided for new inhabitants, who are likely to be international people with diverse lifestyles.

The ‘Atom’ part of Atompark connects with the history of the place and tells the story about the First Nuclear Age with remaining structures from the former nuclear power plant. They still contain radioactive materials, but due to preventive measures and the power of control that is given to every inhabitant do not allow the contamination.

Fig.133. Atompark image



Atom$\boxed{\text{GRAD}}$ - Atom$\boxed{\text{PARK}}$

town

regional city
nature park
energy park
industrial heritage
park

$\boxed{\text{Atom}}$GRAD - $\boxed{\text{Atom}}$PARK

nuclear

4.2. SCENARIO CONFLICTS AND POTENTIALS

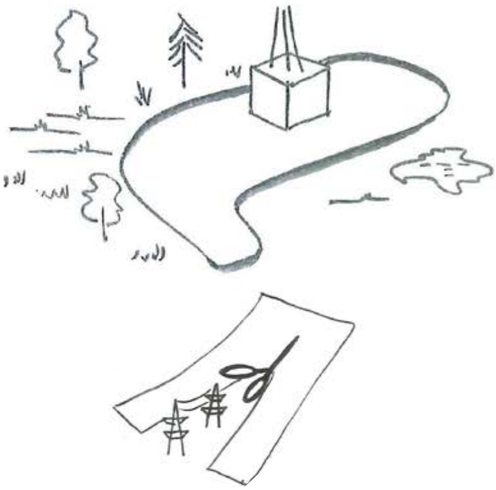
While combining scenarios, conflicts, as well as, potentials emerge. They are solved by projects and strategy layers.

Fig.134. The conflicts between scenarios

Fig.135. The potentials between scenarios

CONFLICTS

EXAMPLES OF PROJECTS

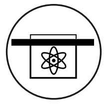


ENERGY × NATURE

large scale nuclear power plants makes huge visual and physical impact to the landscape. Due to cooling/ventilation towers visible from far distances and safety protection zones, huge impenetrable areas. Power-line corridors subdivide populations of species into meta-populations

HERITAGE × NATURE

some remaining radioactive structures are polluting the environment (e.g. waste fuel storage)

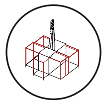


new nuclear power plant

new elevated path

phytortechnologies, phytoremediation

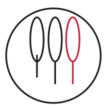
ruins, garden, demolition with nature



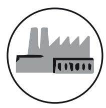
transformation

NATURE × INDUSTRY

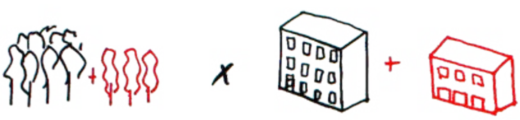
Industry pollute environment and usually is an island desolate island in terms of biodiversity



“porous forest”, reforestation, multimechanism buffer

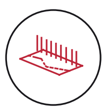


biorefinery



DENSIFICATION × MORE GREENERY

industry pollute environment and usually is an island desolate island in terms of biodiversity

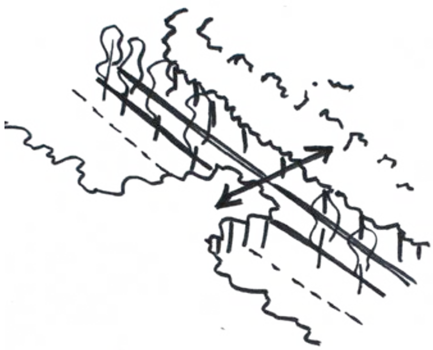


renewal of main public spaces

transformation. connection to outdoor space

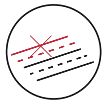
POTENTIALS

EXAMPLES OF PROJECTS



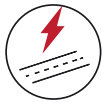
DOWNGRADING ROADS + ECOSYSTEMS

narrower car infrastructure corridors make easier for species to migrate.



downgrading road, energy road

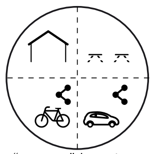
reforestation, plant buffer (regulate migration)



energy road

MOBILITY + ECONOMY

shelter for cyclists, and market place for vendors selling their products from allotment gardens

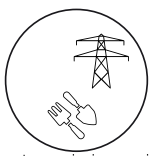


“square” in nature

shelter, market

ELECTRICITY +ECOLOGY CORRIDOR + FOOD

electricity transmission corridors are spaces that cut out the forested land and it could enhance variety of habitats and connect existing ones using allotments as means to increase biodiversity



energy transmission corridors to wildlife corridors, allotment gardens, energy trasmission

4.3.
STRATEGY

Strategy describes elements and the set of actions to build the Atomgrad by solving conflicts and uncovering potentials emerged while combining scenarios.

Strategy is comprised of 6 layers:

1. Sensing radiation

2. ‘New nature’

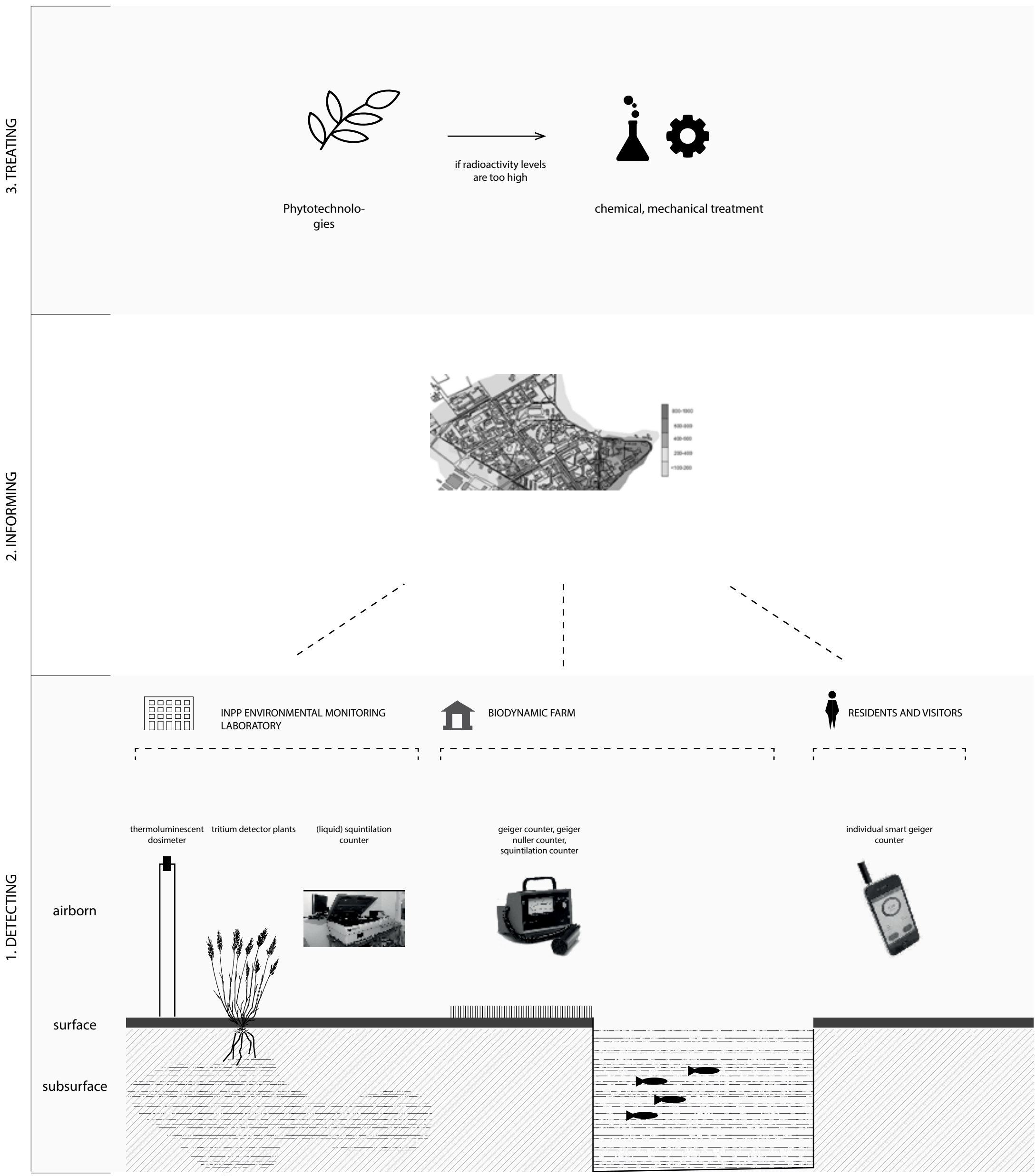
3. Mobility

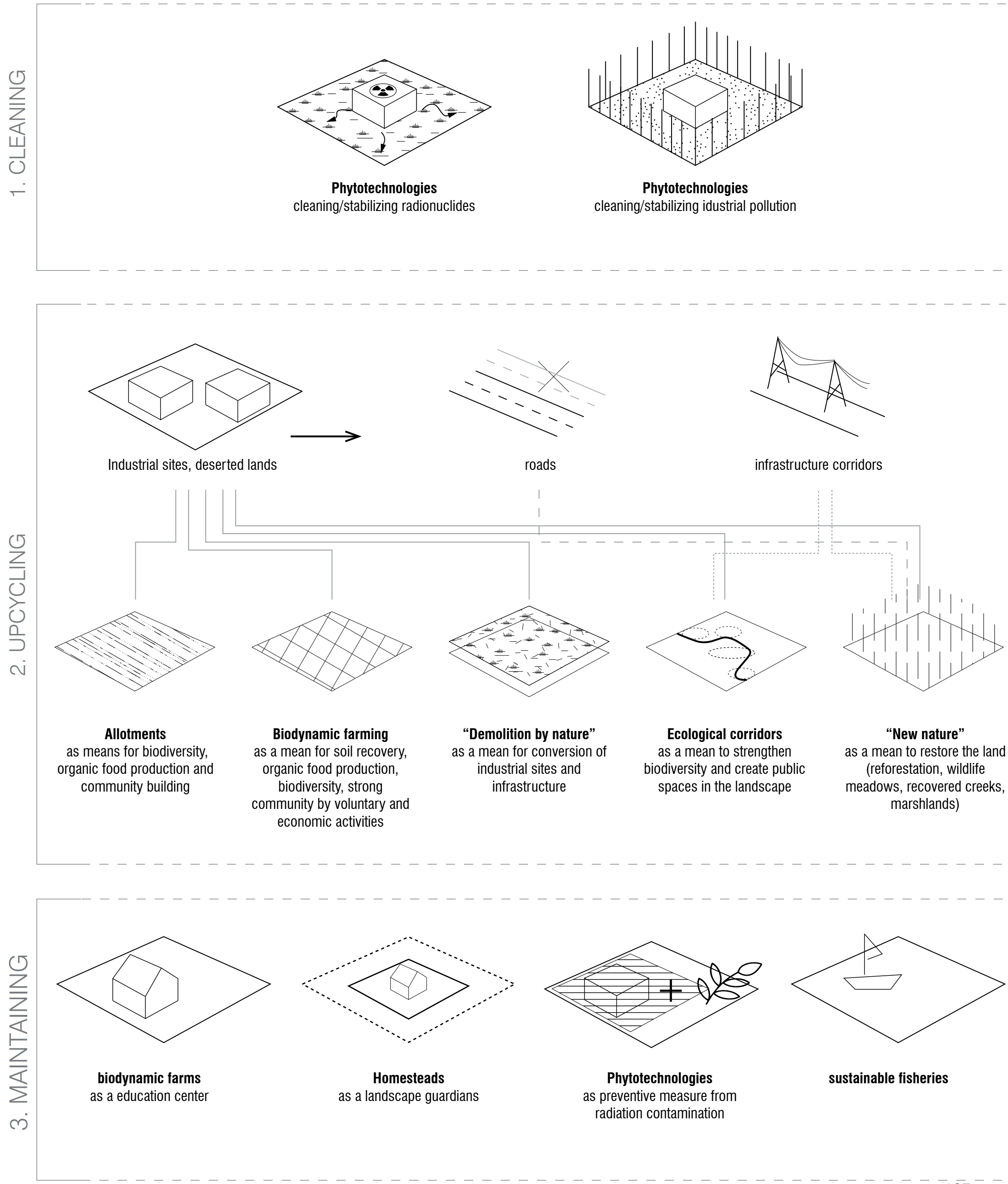
4. Energy transition

5. High tech energy industries

6. Industrial heritage

Fig.136. Sensing radiation


3. TREATING
Phytotechnolo-
gies
if radioactivity levels
are too high
chemical, mechanical treatment
2. INFORMING
1. DETECTING
INPP ENVIRONMENTAL MONITORING
LABORATORY
BIODYNAMIC FARM
RESIDENTS AND VISITORS
thermoluminescent
dosimeter
tritium detector plants
(liquid) squintilation
counter
geiger counter, geiger
nuller counter,
squintilation counter
individual smart geiger
counter
airborn
surface
subsurface

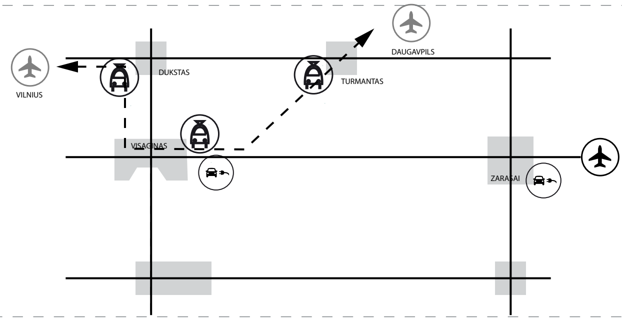


137

Fig.137. 'New nature'

Fig.138. Mobility

REGION NETWORK



peer-to-peer car sharing (autonomous vehicles in the future)

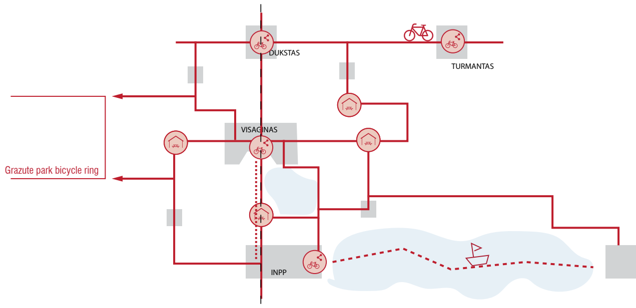
car charge points

new airport

station upgrade
frequent train connections with Vilnius and Daugavpils

connecting internationaly, regionaly

SLOW NETWORK



downgrade roads + bicycle path

bicycle paths

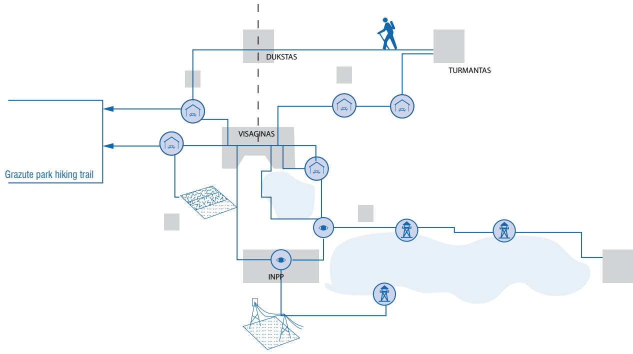
shared bicycle pickup points

shelter to hide from rain, to wait for pickup (every ~15min, 4 km)

ferry

connecting urbanized paths, industrial sites, penetrating areas that once was inaccessible, extendng leisure routes on the west side of the railway

HIKING NETWORK



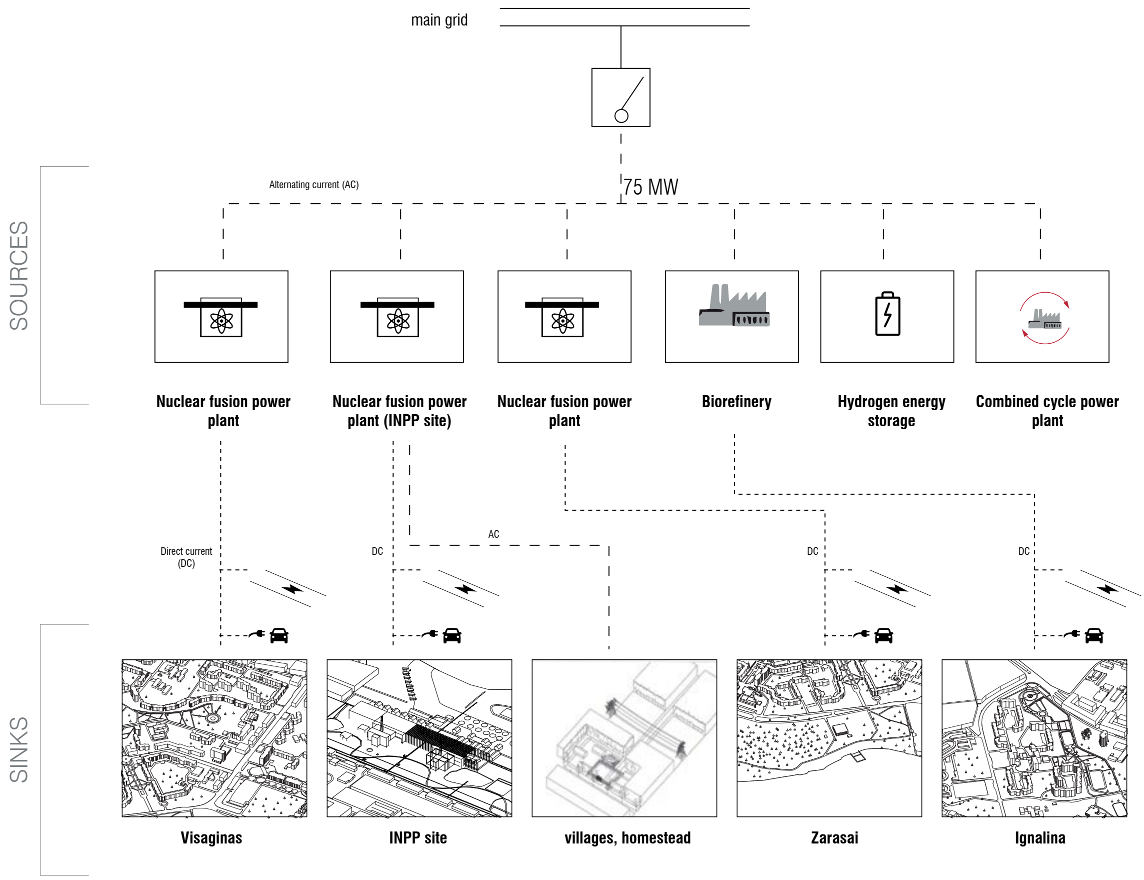
hiking routes

birdhides

watchtowers, panorama points

shelters to wait for pickup (every ~ 15 min, 500 m)

connecting city to nature, experiencing new public spaces in the nature for individual and communal stay

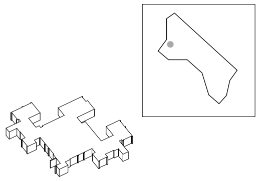


139

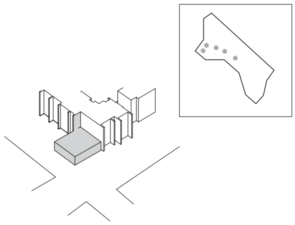
Fig.139. Energy transition

Fig.140. High-tech energy industry

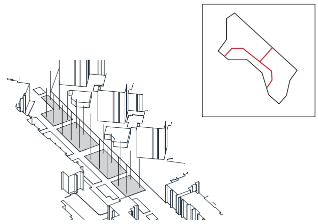
ACTIVATORS



Research institute
from the existing Energy research institute in Kaunas
Facilities
(conference, meeting rooms, labs)
Incubator
University
e.g. Kaunas Technology university

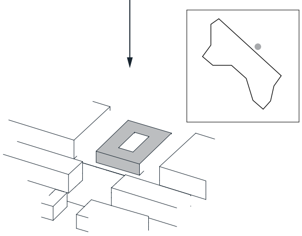


Pavilions/extention
places with public functions identified from workshops (e.g. multilanguage library) and facilities for high-tech industry workers (e.g. gallery/exhibition cafe, workshop

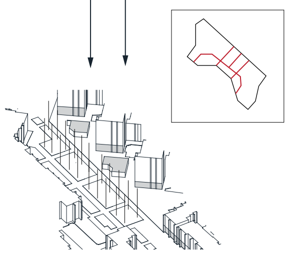


Street space upgrade
places for gathering, for stray, not only for transition. (e.g. to redesign streetscape, to add children playgrounds, trees, squares, pavement improvement)

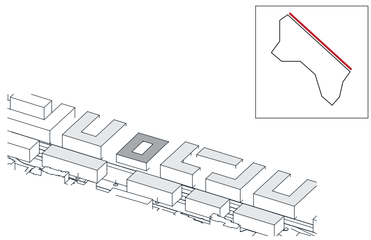
EXPAND



Research institute (new building)
from the existing Energy research institute in Kaunas
Facilities
(conference, meeting rooms, labs)
Incubator
University
e.g. Kaunas Technology university

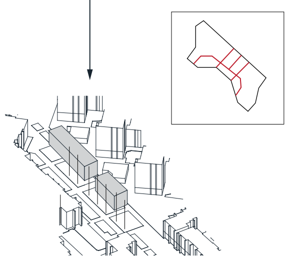


Street as incubator
street fronts are transformed to house small scale high-tech industries, pavilions/extentions provides facilities, public space serves as gathering space

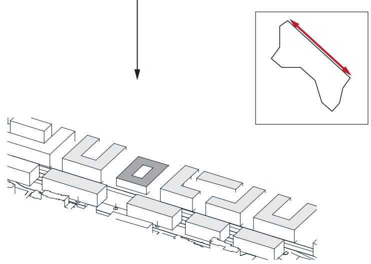


new mix-use urban blocks
new larger scale industries are incorporated into new urban blocks. New houses are built baugruppe principu

DENSIFICATION



New buildings
densify city’s fabric but preserving its identity as city built in forested landscape

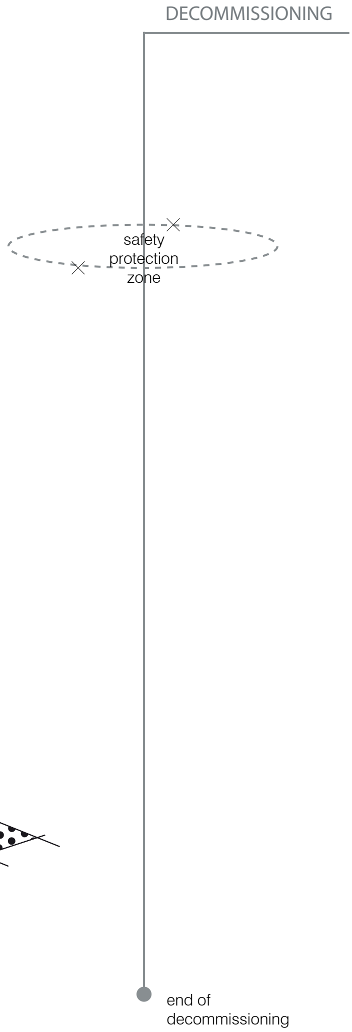


new mix-use urban blocks
new larger scale industries are incorporated into new urban blocks. New houses are built baugruppe principu

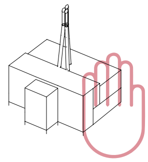
INPP site and its infrastructure it is enormous size. It would be a burden for the municipality to keep it just for cultural and educational purposes. Therefore the strategy proposes the way how to inhabit a mono-functional site and preserve valuable structures.

The challenge is defined by the industry itself. There are conflicting opinions about nuclear power plants. The education of the broad society is needed to raise appreciation of these sites. Opening site to the visitors and letting people contribute to decommissioning process would increase interest in the cultural, architectural, technological values of nuclear power plant.

Fig.141. Industrial heritage

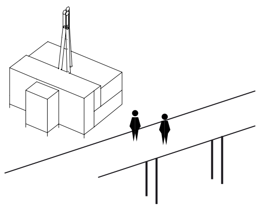


1.PRESERVE



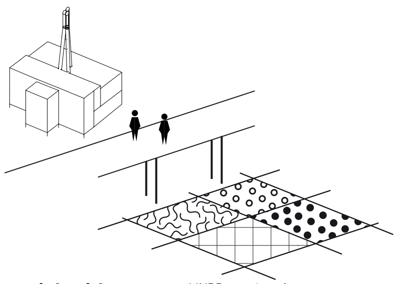
Change the initial decomissioning plan which aims to demolish all the structures of nuclear power plant

2.COME AND SEE



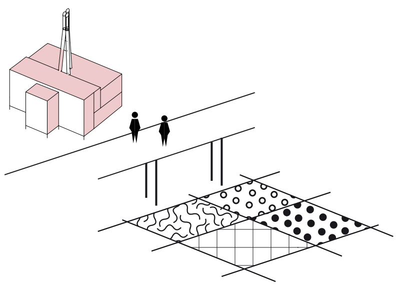
Elevated path that allows to visit the site without interupting decommissioning activities

3.TAKE AND DEVELOP



vacant industrial areas arround INPP are given for people to use - demolish and convert, reuse.

4.'ENERGIZE' POWER PLANT



reactors and turbine halls are reused for new activities, preferably for high tech industires, experimental nuclear fusion research connecting with 'High tech industries' strategy layer and using potentials of reactors and turbine hall buildings that provide a good shielding.

4.4. FRAMEWORK

The Framework combines strategies and projects that integrate industrial heritage, nature, energy generation and energy research structure to create an Atompark. Each project also adds to the system it is part of.(see picture)

The structural elements of the framework are sites, links and nodes, that defines spatial characteristics of the region.

Site is an area with specific morphology in defined boundaries.

Node is the space that is comprised of inter-crossing of paths, public space and the attractor/landmark next to it.

Link is a linear element connecting nodes. It is a complex element that includes mobility, energy, nature and/or heritage structures.

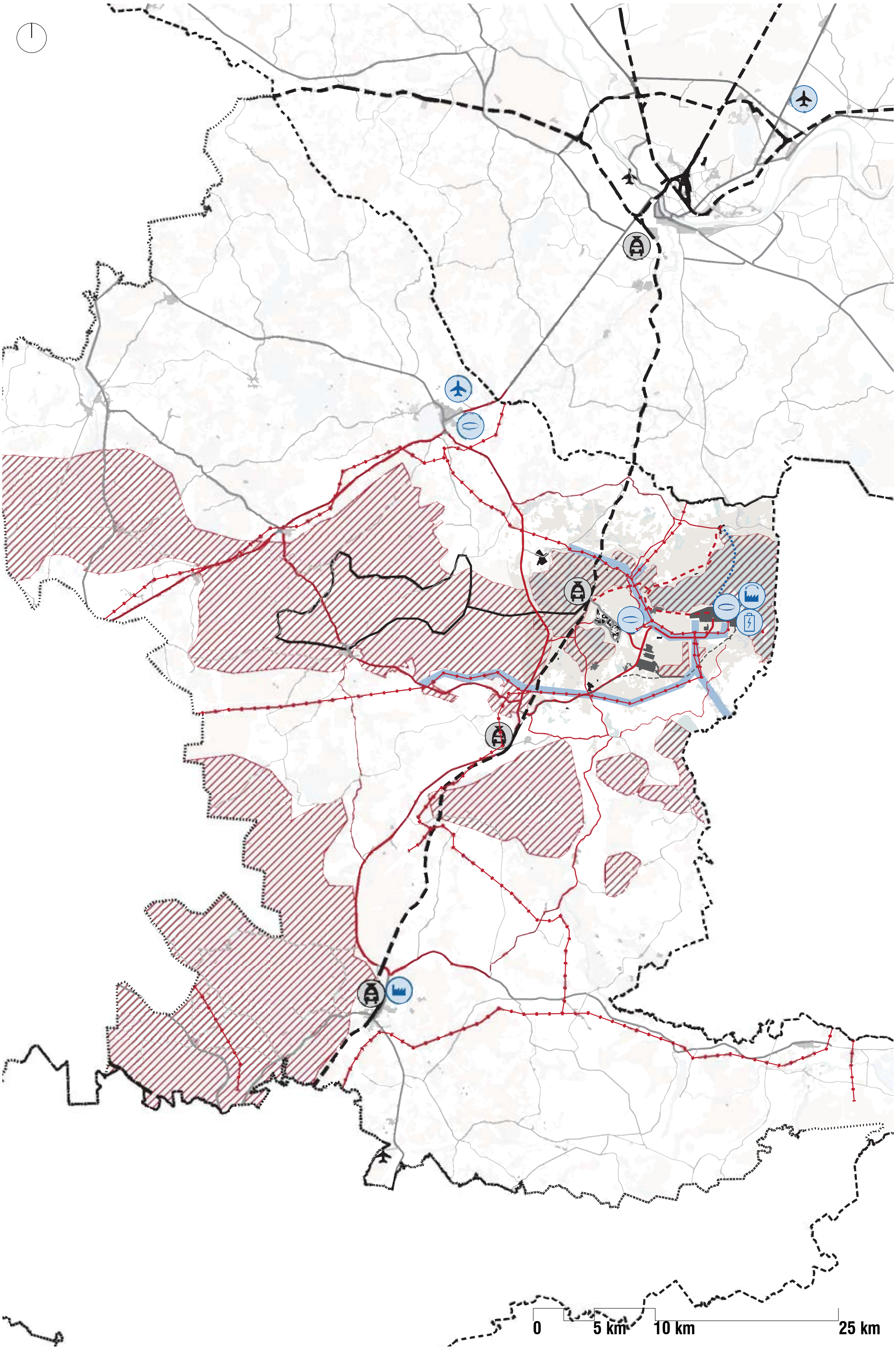
Projects are spatial interventions that builds up the 'sites', 'links', and 'nodes' through time.

Fig.142. The framework on regional scale

Fig.143. The framework

Fig.144. The framework elements: site, link,node

Fig.145. The example of a project and integration


0
5 km
10 km
25 km

ACTIONS

- reused
- transformed/strengthened
- new

STRATEGY LAYERS

Sensing radiation
'New nature'
Mobility
Energy transition
High tech industries
Industrial heritage

PATHS

- main city connections
- region connections
- strolling/bicycle path
- water route
- elevated path

NATURE structures

- water
- reserves
- habitats
- corridors
- connections
- phytotechnologies/new plants

INDUSTRIAL HERITAGE

- buildings
- infrastructure
- composition (axes, sequence of spaces, formants)
- symbols

ENERGY generation

- new reactors/biorefineries/hydrogen combined cycle power plant
- reused energy lines

ENERGY research

- new research center
- transformations buildings
- new temporary structures (activators)
- new permanent structures (development areas)

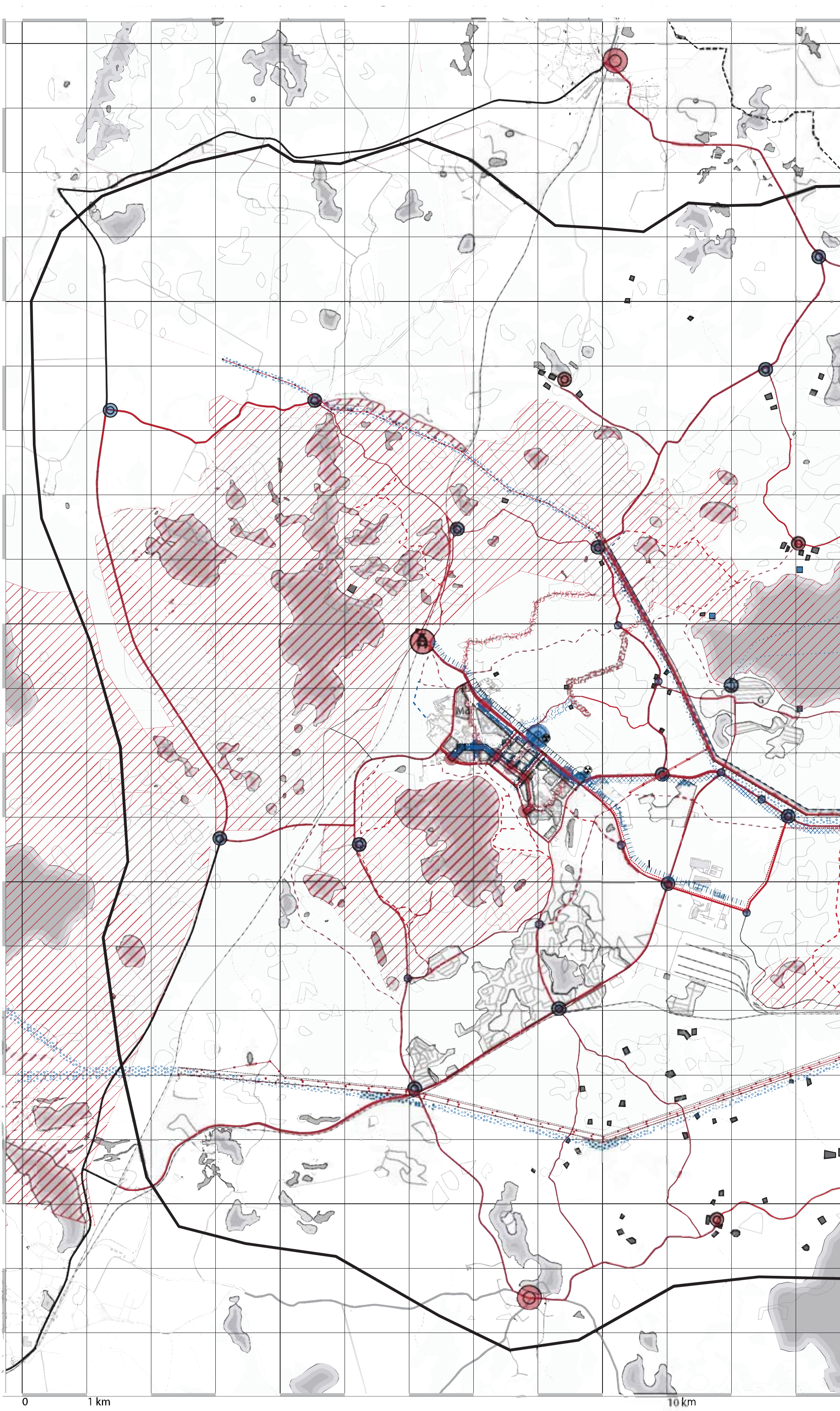
- sources of radioactivity
- thermo-luminescent dosimeters

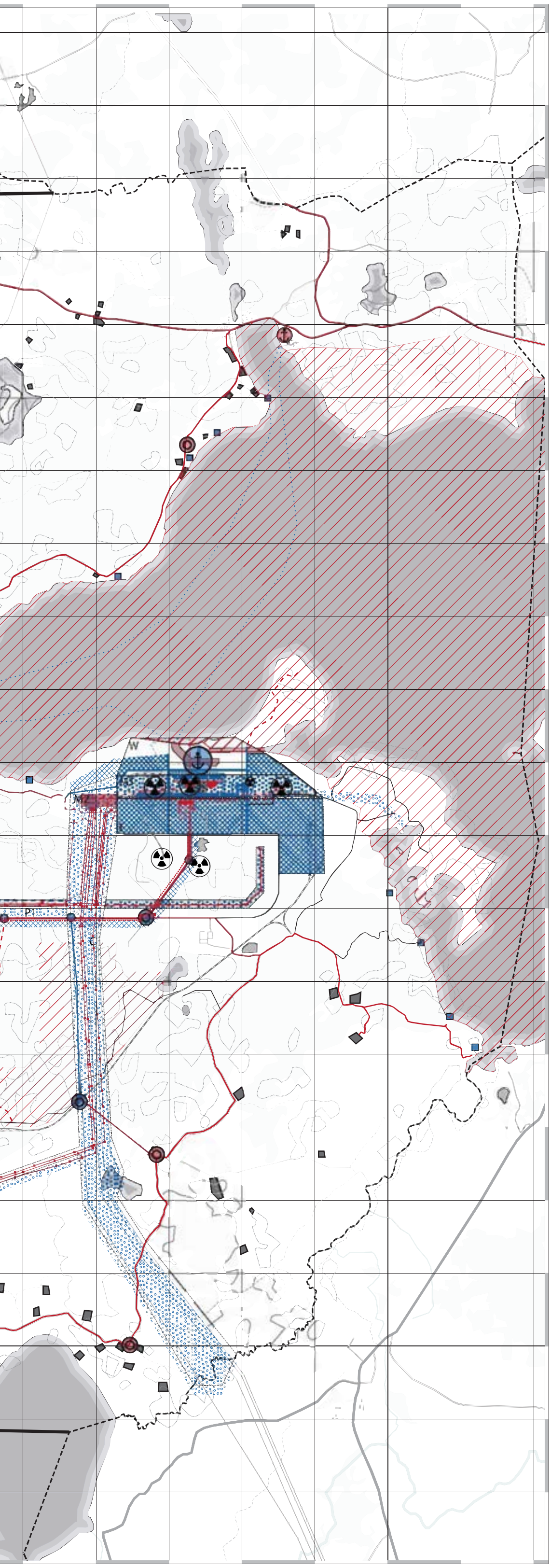
SITES AND LINKS (focus areas)

- W Waterfront
- M1 INPP monument of the First Nuclear Age (power plant site)
- M2 INPP monument "The Walk of Giants")
- F "Porous forest"
- C Complex transmission corridors
- P1 Path from INPP to the city
- P2 Visaginas main path
- P3 Visaginas secondary path
- P4 Visaginas pedestrian path
- M1 Micro-district
- G Collective gardens
- I New development paths

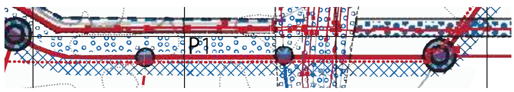
NODES

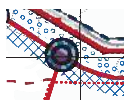
- station
- quay
- research institute
- "square"
- shelter
- homestead
- "Stay in nature"
- Region/local node





143





144

new elevated path

mobility
nature
culture
energy
economy
designed/ flexible

145

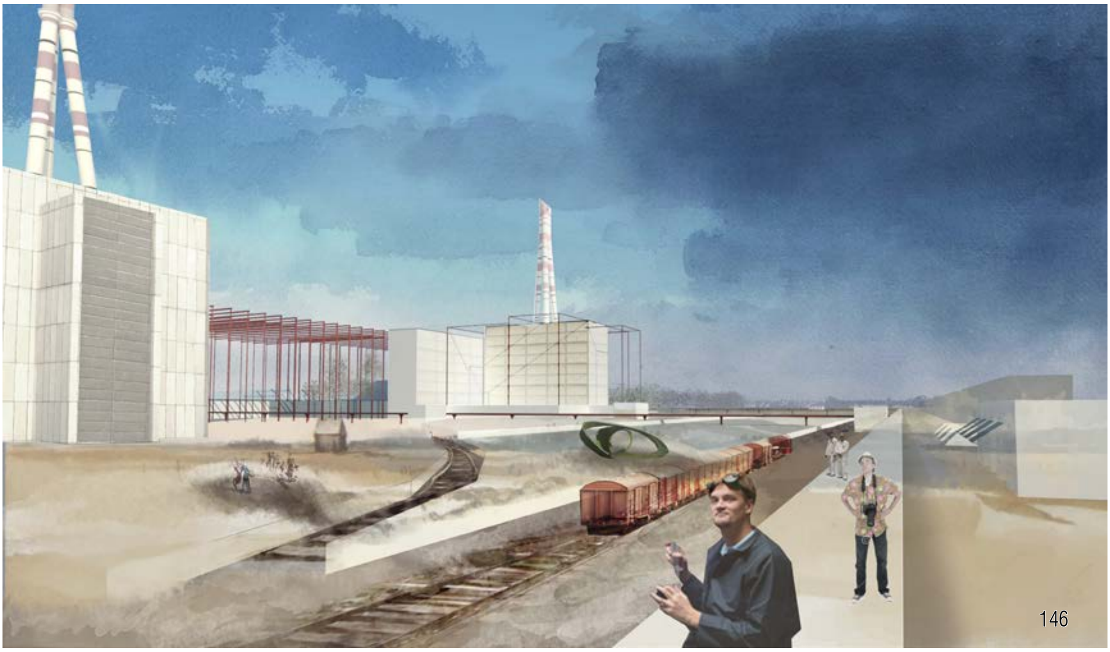


Fig.146. INPP monument site (T3)

Fig.147. The waterfront (T3)


147

Fig.148. The transformed turbine hall (T3)

Fig.149. 'Porous forest' (T2)


149

Fig.150. The new nuclear fusion power plant (T2)

Fig.151. "Walk of Giants" (T2)


151

Fig.152. The link between INPP and the city (T3)

Fig.153. 'Winter garden'. The pedestrian alley in the city (T3)


153

4.5.
PROCESS

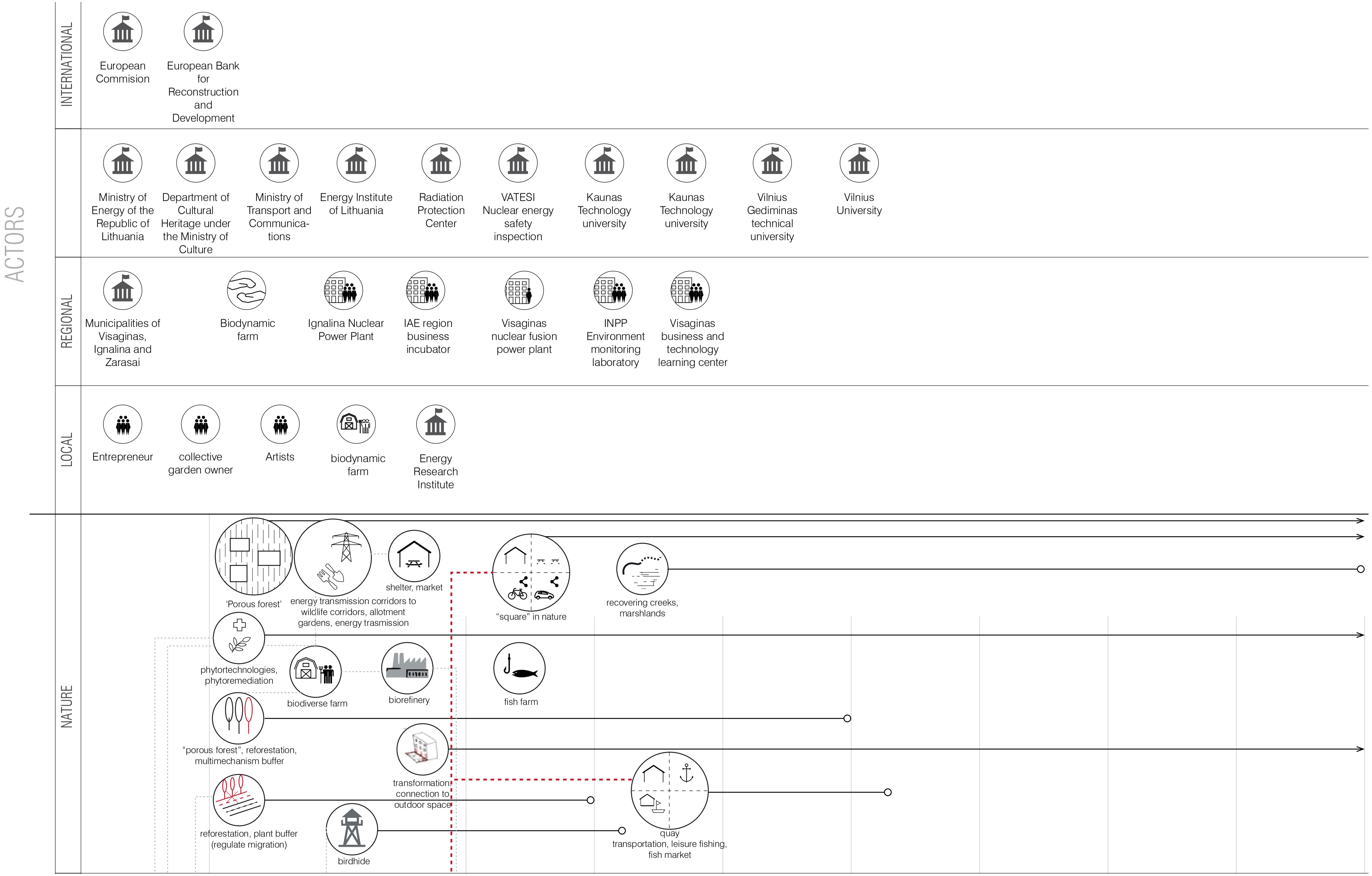
The alternative decommissioning process of nuclear energy landscape involves also local people providing them jobs and benefits, workspaces for activities that don't fit in the city (e.g. artists that are unable to get spaces for their studios in the city, sportsmen that use Druksiai lake). The important actors are the biodynamic farm that acts as an education facility on environment protection and the research institute that bridges the knowledge of the former power plant workers and new researchers, incubates energy related businesses.

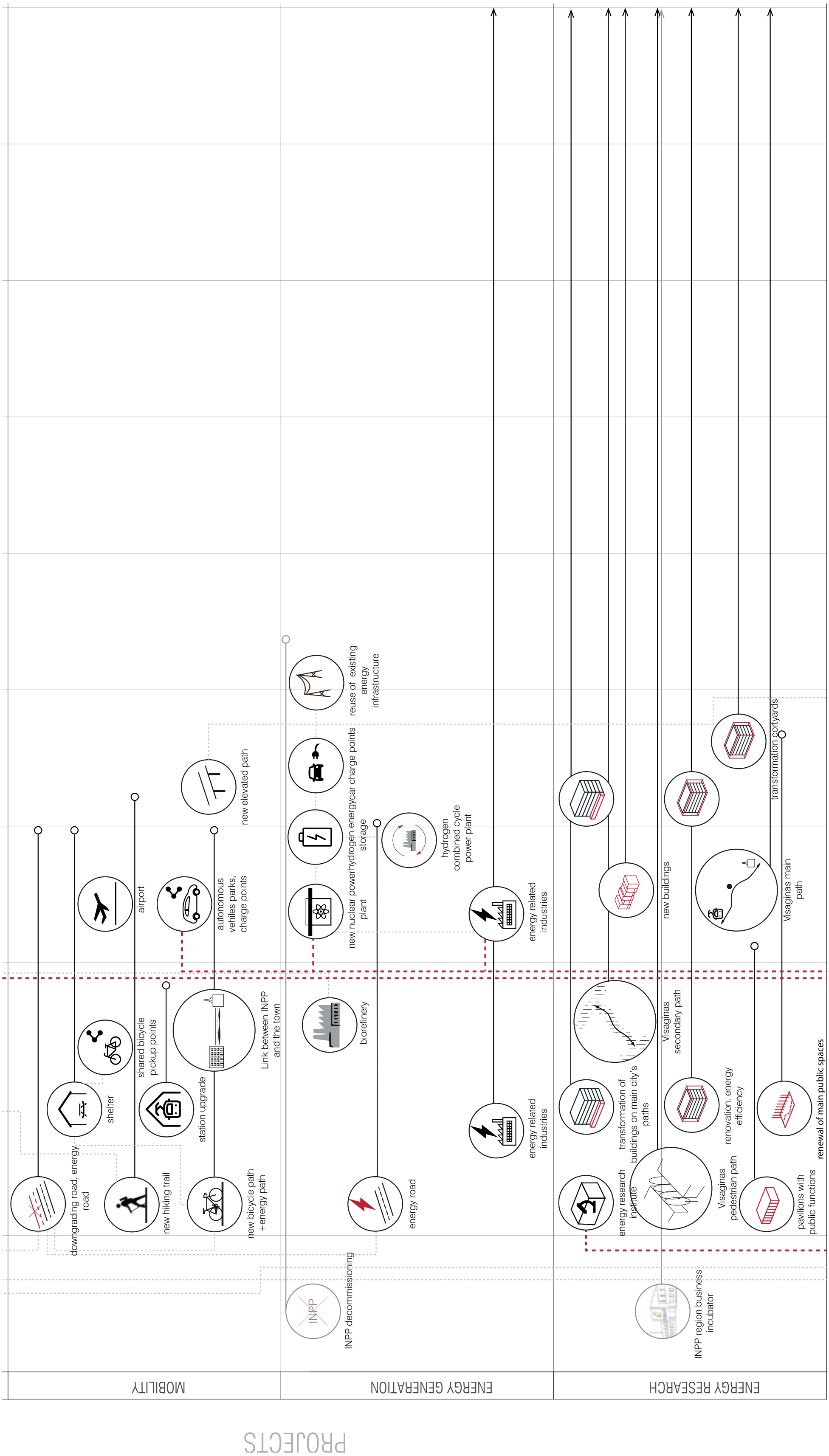
The alternative decommissioning process gives opportunity to avoid "citadel" effect of nuclear power plant, start to appreciate it and generate means for possible reuse. Opening up the site earlier, increases chance to reuse and convert structures also due to their better physical state. The process enables people to discover spaces in the region that once was inaccessible and give them a new meaning.

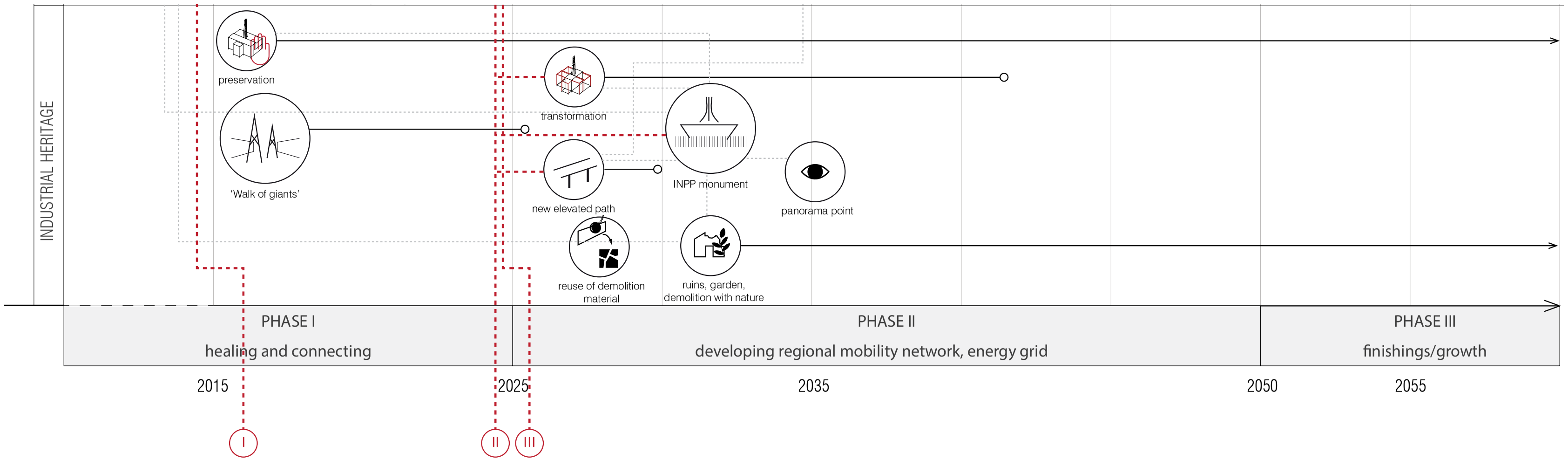
Time-line shows diversity of actors, public and private investors, local, regional, national and international institutions involved in the process.

Fig.154. Time-line and actor table

Fig.155. The process diagram


ACTORS
INTERNATIONAL
European Commision
European Bank for Reconstruction and Development
Ministry of Energy of the Republic of Lithuania
Department of Cultural Heritage under the Ministry of Culture
Ministry of Transport and Communica-tions
Energy Institute of Lithuania
Radiation Protection Center
VATESI Nuclear energy safety inspection
Kaunas Technology university
Kaunas Technology university
Vilnius Gediminas technical university
Vilnius University
REGIONAL
Municipalities of Visaginas, Ignalina and Zarasai
Biodynamic farm
Ignalina Nuclear Power Plant
IAE region business incubator
Visaginas nuclear fusion power plant
INPP Environment monitoring laboratory
Visaginas business and technology learning center
LOCAL
Entrepreneur
collective garden owner
Artists
biodynamic farm
Energy Research Institute
NATURE
'Porous forest'
energy transmission corridors to wildlife corridors, allotment gardens, energy trasmission
shelter, market
"square" in nature
recovering creeks, marshlands
phytortechnologies, phytoremediation
biodiverse farm
biorefinery
fish farm
"porous forest", reforestation, multimechanism buffer
transformation connection to outdoor space
quay transportation, leisure fishing, fish market
reforestation, plant buffer (regulate migration)
birdhide


PROJECTS
MOBILITY
ENERGY GENERATION
ENERGY RESEARCH
downgrading road, energy road
shelter
shared bicycle pickup points
new hiking trail
airport
station upgrade
Link between INPP and the town
autonomous vehiles parks, charge points
new bicycle path +energy path
new elevated path
INPP decommissioning
energy road
biorefinery
new nuclear power plant
hydrogen energy storage
car charge points
reuse of existing energy infrastructure
hydrogen combined cycle power plant
energy related industries
energy related industries
INPP region business incubator
energy research institute
transformation of buildings on main city's paths
Visaginas secondary path
new buildings
Visaginas pedestrian path
renovation, energy efficiency
Visaginas main path
transformation courtyards
pavilions with public functions
renewal of main public spaces



PROJECTS

ongoing projects

new projects

MILESTONES

I Research institute

II INPP gains non-nuclear object status (radioactive fuel is taken from reactors and stored, radioactive machinery is removed)

III Commercialisation of fusion reactors

ACTORS

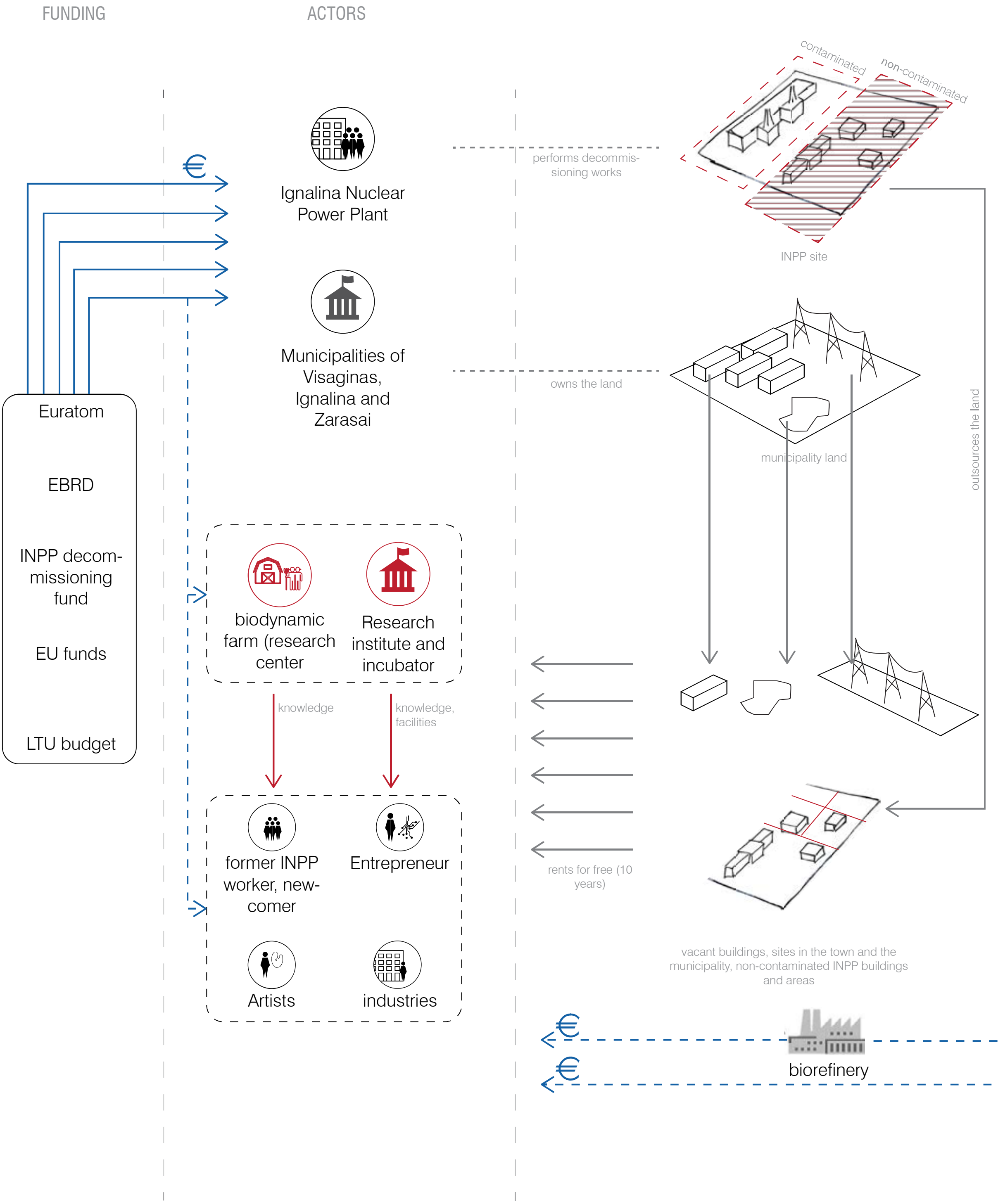
Government/ministry/institution

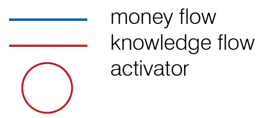
public institution

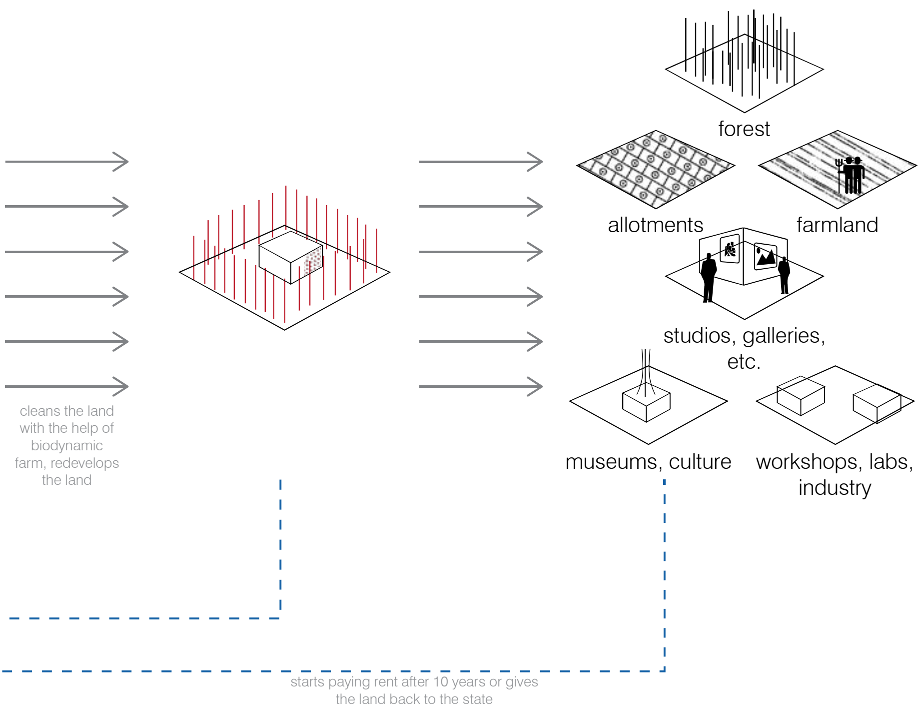
private institution

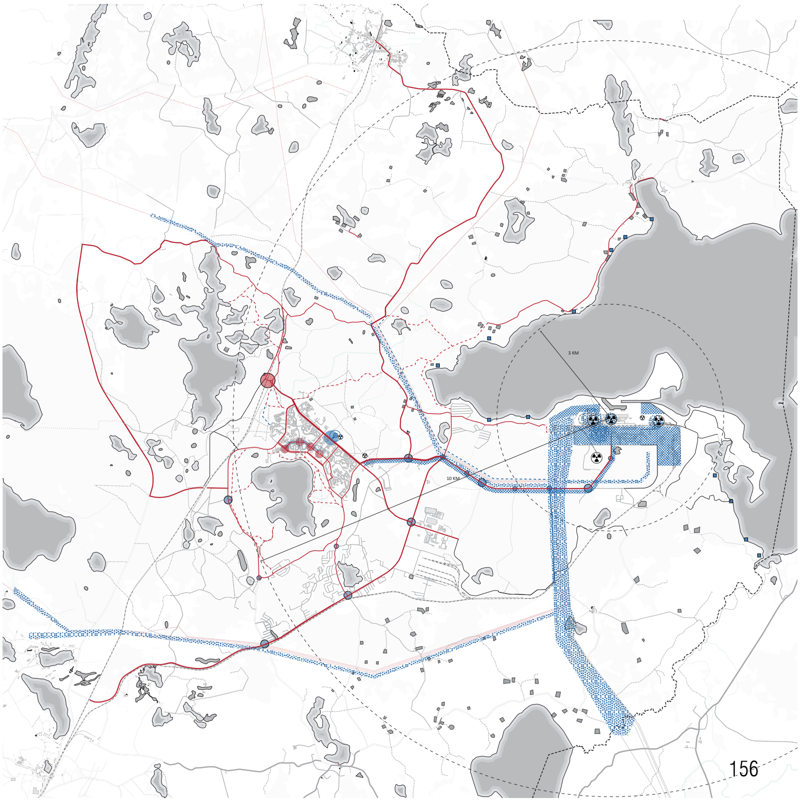
NGO

residents


FUNDING
ACTORS
contaminated
non-contaminated
Ignalina Nuclear Power Plant
performs decommis-sioning works
INPP site
Municipalities of Visaginas, Ignalina and Zarasai
owns the land
municipality land
outsources the land
Euratom
EBRD
INPP decom-missioning fund
EU funds
LTU budget
biodynamic farm (research center
Research institute and incubator
knowledge
knowledge, facilities
former INPP worker, new-comer
Entrepreneur
Artists
industries
rents for free (10 years)
vacant buildings, sites in the town and the municipality, non-contaminated INPP buildings and areas
biorefinery
€
€
€


money flow
knowledge flow
activator


forest
allotments
farmland
studios, galleries, etc.
museums, culture
workshops, labs, industry
cleans the land with the help of biodynamic farm, redevelops the land
starts paying rent after 10 years or gives the land back to the state



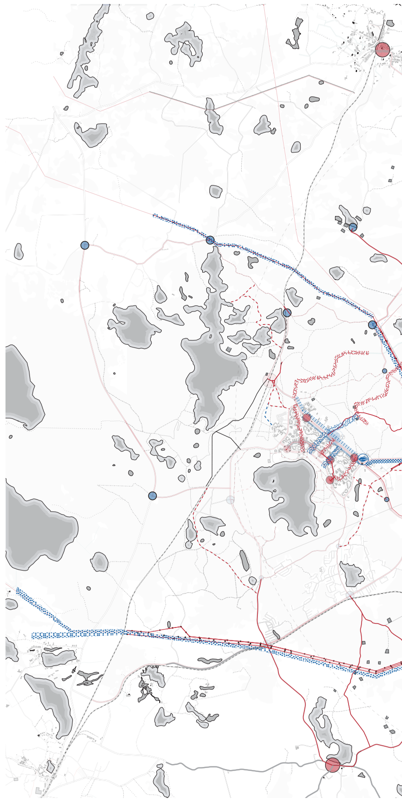
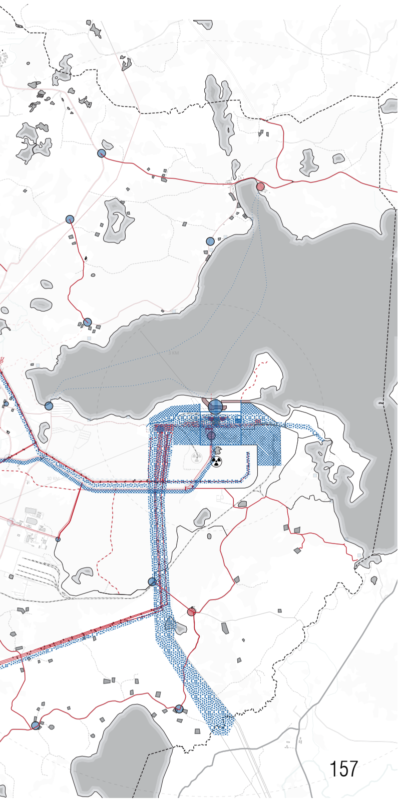


Fig.156. Phase I. Healing and connecting

Fig.157. Phase II. developing regional mobility network, energy grid

Fig.158. Phase III. finishings/growth



157

158

5. FRAMEWORK ELEMENTS

5.1.
SITES IN INPP AREA

The mono-functional industrial site is proposed to be transformed into a multi-functional park, where heritage, ecological, industrial, cultural activities, energy production and experimental research is placed.

It is therefore the "town" for work and living (temporary), for thrill seekers, former nuclear power plant workers, tourists, researchers, artists, farmers.

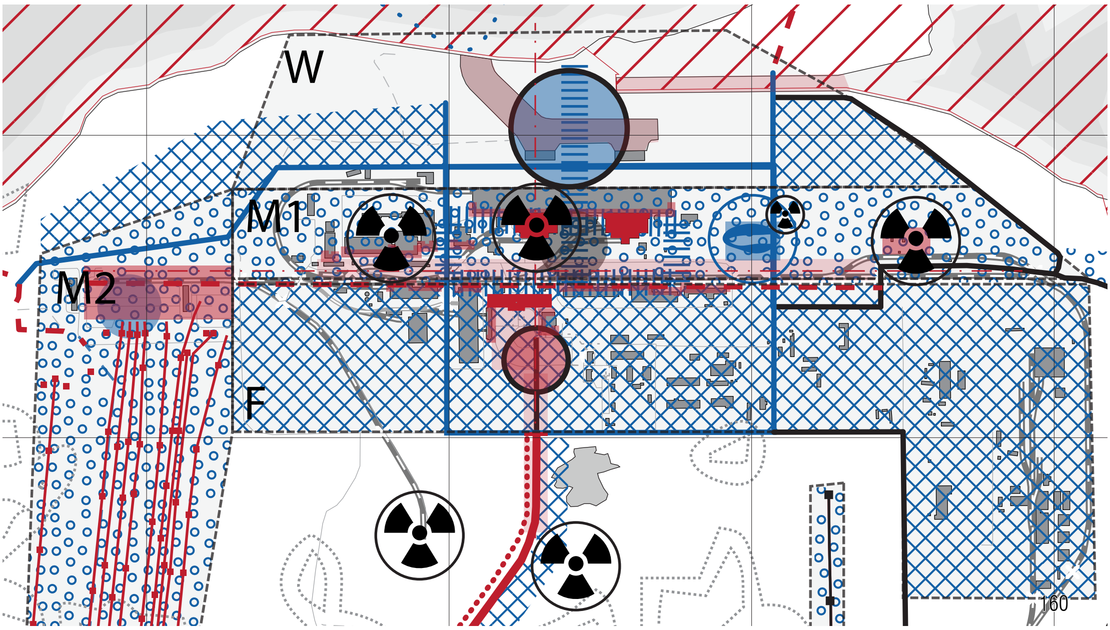
It is a site containing controversies - places for contemplation, and practicality, place where the past and the future meets, innovations are exhibited, site where monumentality and human scale interacts at the same time.

The nuclear power plant site shifts its role from being the "citadel" to becoming the "gates" to the "sea" by building new paths and visual connections.

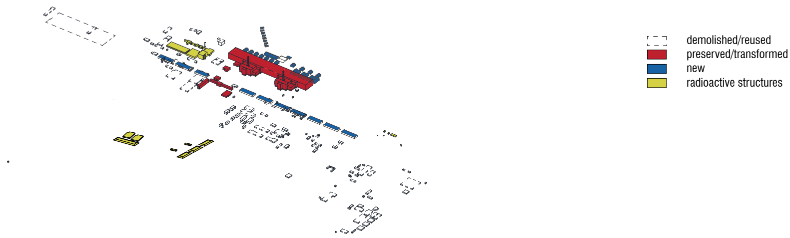
The spatial layout of INPP is influenced by relics of existing nuclear power plant. The transformed site is comprised of several linear character zones. The paths crosses them transversally, becoming linear stories, which guides visitors through the site and let them experience the change of atmospheres.

The projects are implemented on different time phases. The phases do not have fixed date, they are relative, dependent on milestones of decommissioning process of Ignalina nuclear power plant, technological innovations and implementation of activators.

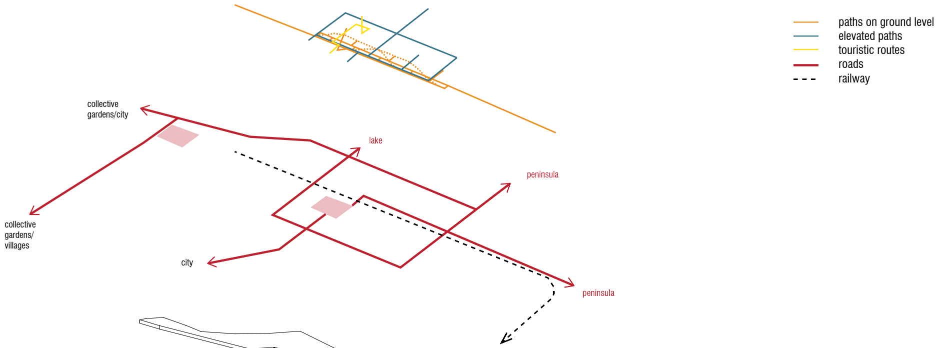

159


W
M1
M2
F
160

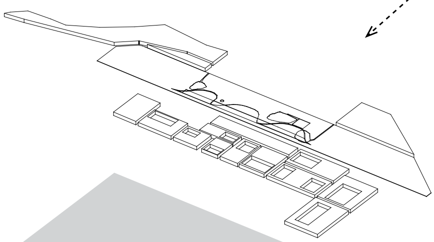
BUILDINGS



ACCESSIBILITY AND PERMEABILITY

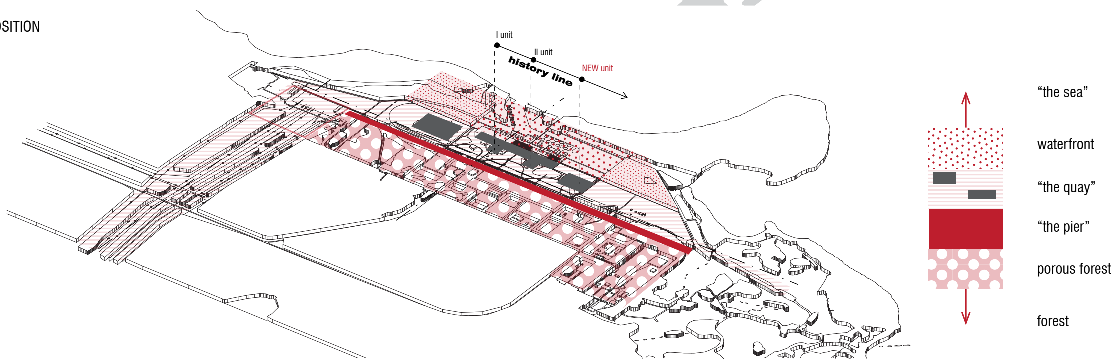


PHYTOREMEDIATION



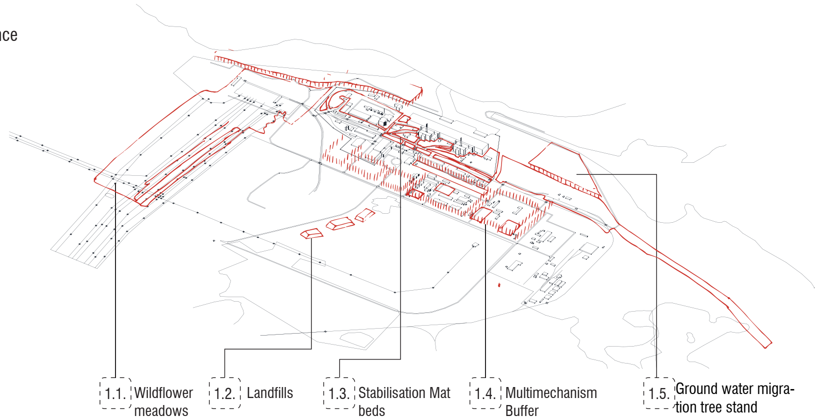
WATER

COMPOSITION



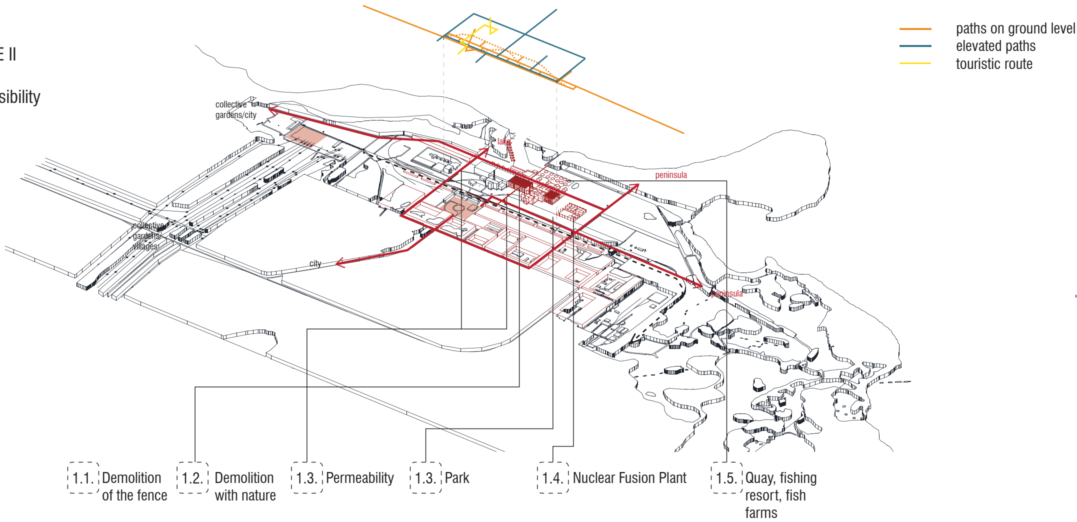
PHASE I

Cleaning/Clearance



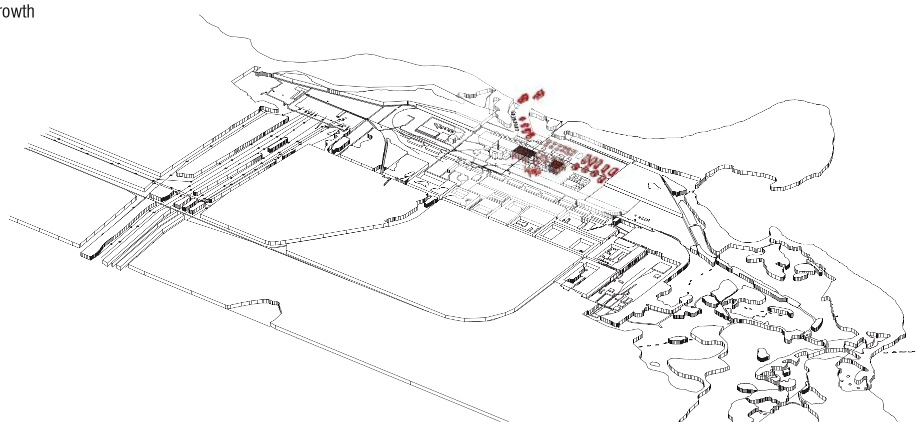
PHASE II

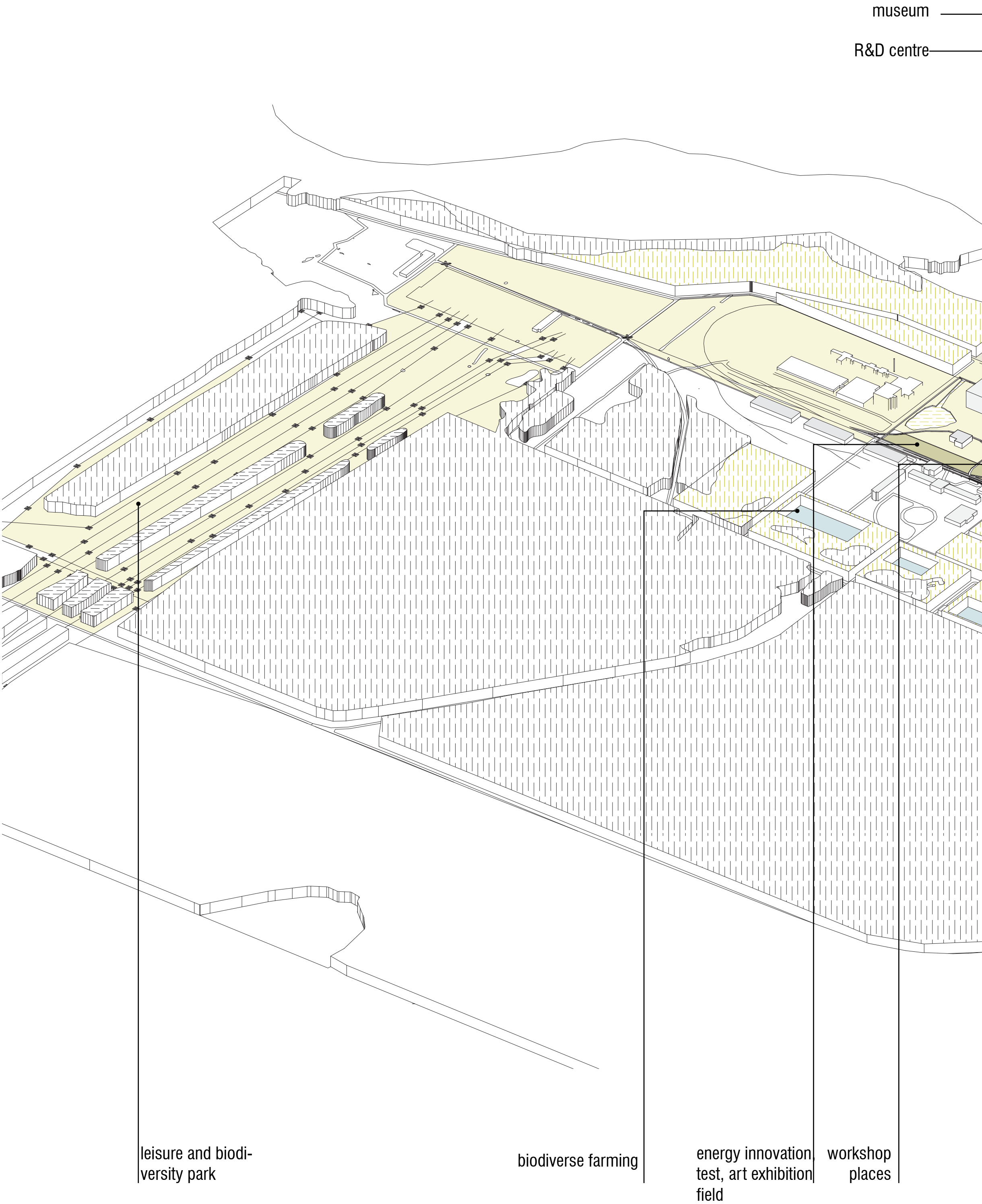
Accessibility

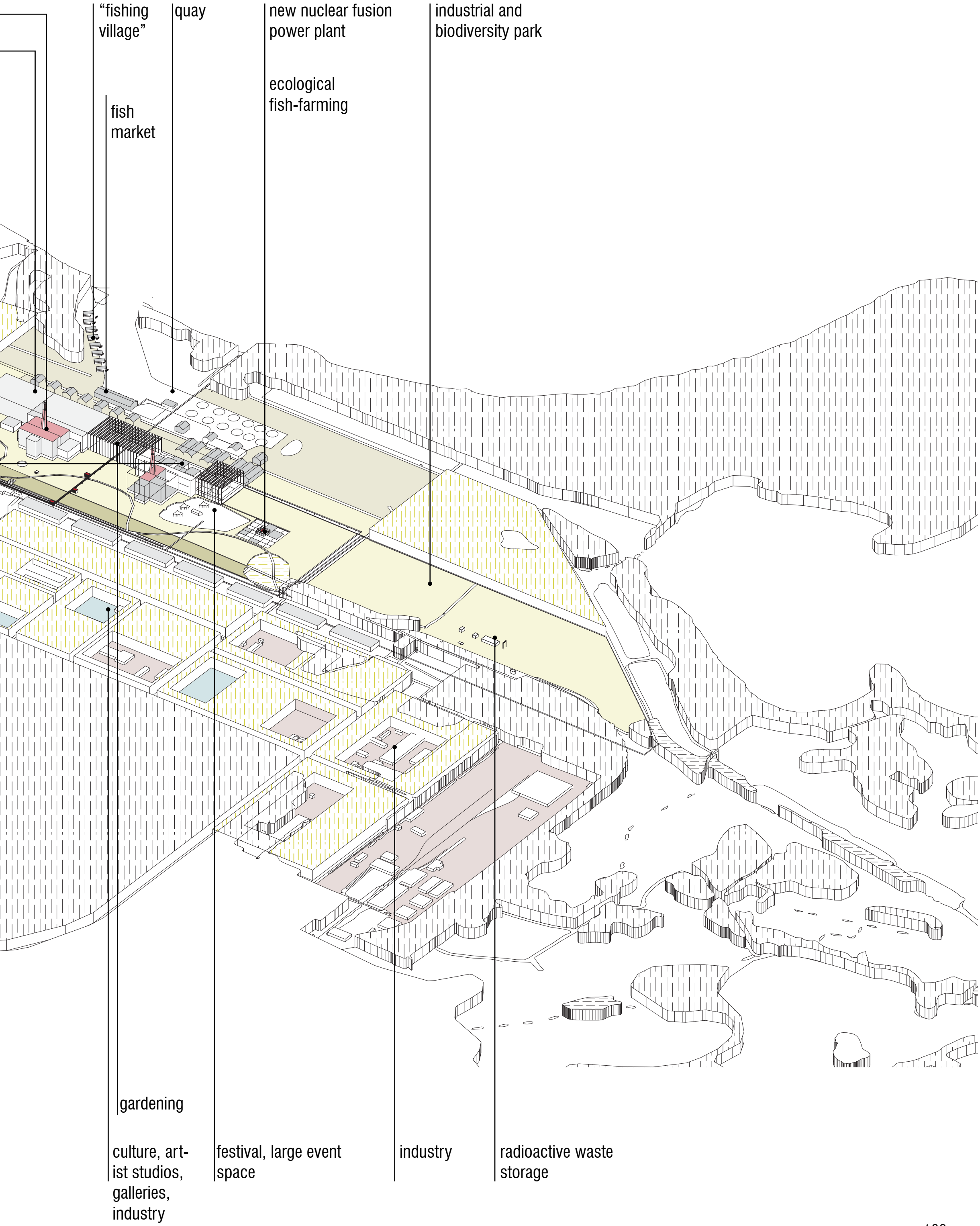


PHASE III

Limits of growth




museum
R&D centre
leisure and biodiversity park
biodiverse farming
energy innovation, test, art exhibition field
workshop places

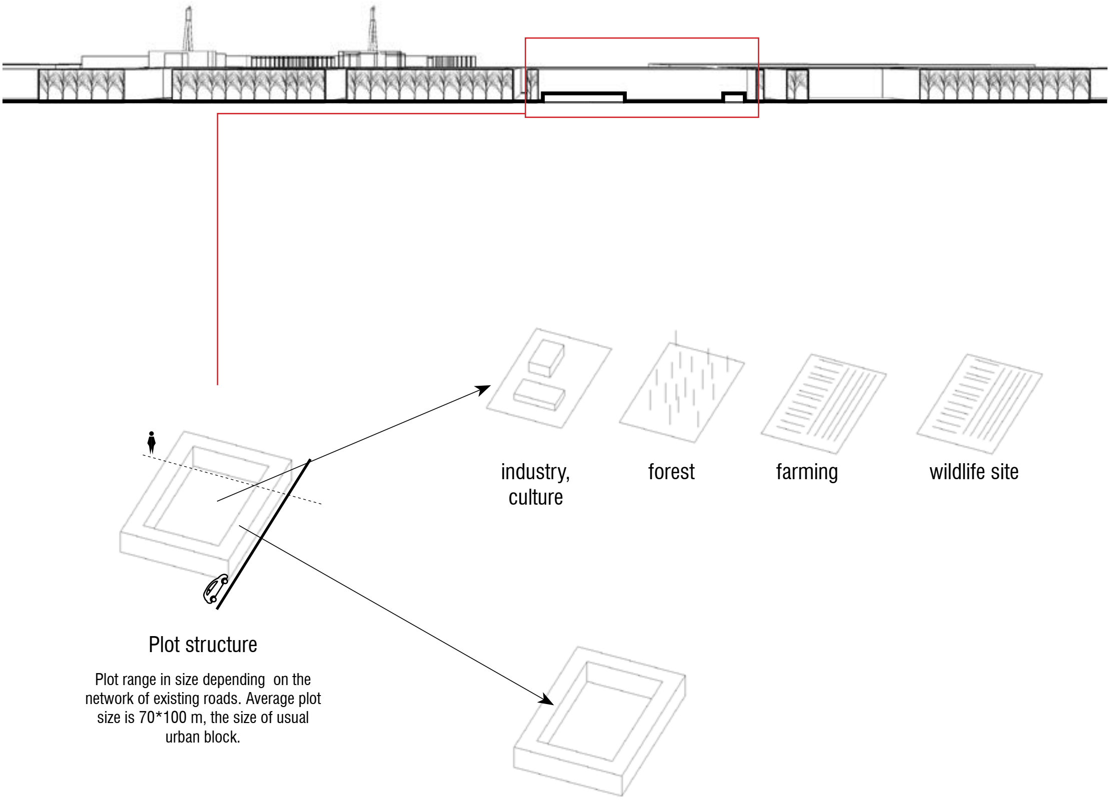

"fishing village"
quay
new nuclear fusion power plant
industrial and biodiversity park
ecological fish-farming
fish market
gardening
culture, artist studios, galleries, industry
festival, large event space
industry
radioactive waste storage

161

"Porous forest" is a transition space from forest to monument. Plots for different activities are shaped by trees, creating smaller spaces with local atmospheres connected by wandering path. Formants of the space are functional - applying methods of phytotechnologies, they prevent from the spillage of pollutants from site to site, therefore diverse functions are possible.

Buildings and sites in this zone is emptying due to decreasing amount of staff for decommissioning works of INPP. Vacant buildings and sites are allowed to be occupied by new companies or demolished (see Fig. 161). The land use is changed allowing more diverse activities - businesses, industries, farming and nature framework.

Fig.164. The section of 'Porous forest'


industry,
culture
forest
farming
wildlife site
Plot structure
Plot range in size depending on the network of existing roads. Average plot size is 70*100 m, the size of usual urban block.
Multi-mechanism buffer

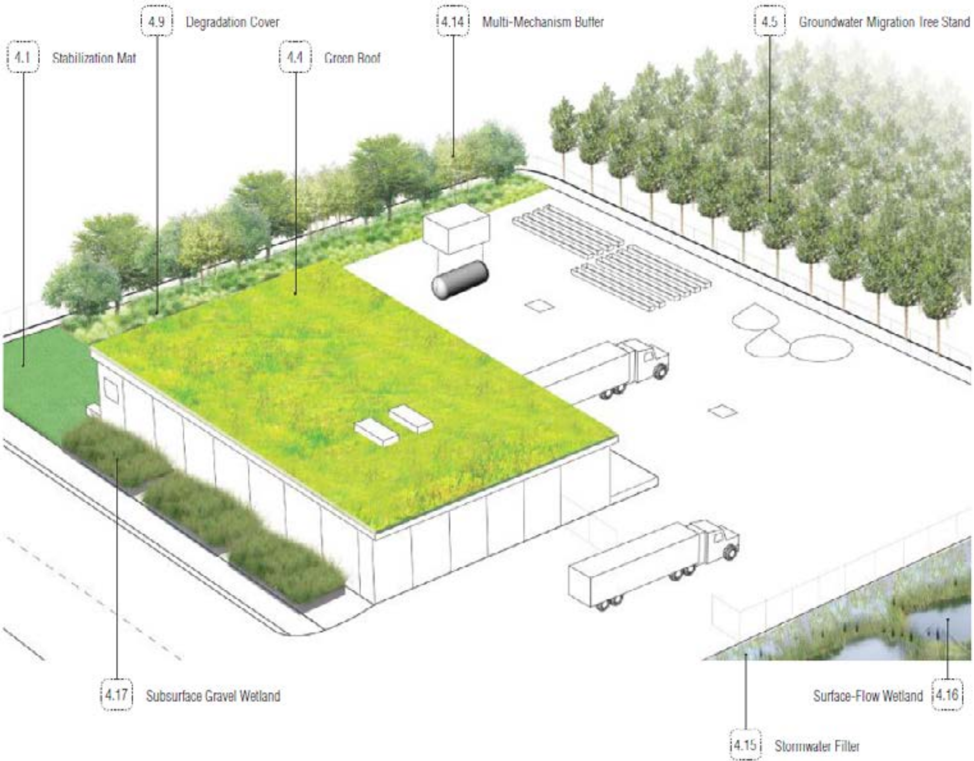


Fig.165. The example of application of phytotechnologies

Key	Typology	Description	Addresses
4.1 (p. 202)	Stabilization Mat	Where highly recalcitrant pollutants exist, vegetation with thick, fibrous root systems can be used to hold pollutants on site. Thickly established vegetation may prevent erosion and migration of pollution.	POPs, including PCBs; Metals
4.4 (p. 210)	Green Roof	Large, flat, industrial buildings are ideal locations for Green Roofs. The primary purpose is to evapotranspire water, preventing generation of stormwater that would otherwise run through the site, and pick up contaminants.	Stormwater vector
4.5 (p. 213)	Groundwater Migration Tree Stand	If contaminants leach into groundwater, consider tree stands downgradient of the plume to naturally pump up the water, degrading organic contaminants and/or filtering out inorganic pollutants. A detailed Water Mass Balance must be completed by an engineer to calculate how many trees will be needed to make the plume capture effective.	Groundwater vector: especially Petroleum and Chlorinated solvents
4.9 (p. 222)	Degradation Cover	Petroleum and chlorinated solvents may be able to be degraded through targeted plantings, especially when done soon after spills. This may be effective especially where old fuel tanks and barrels of organic liquids were stored.	Petroleum; Chlorinated solvents
4.14 (p. 227)	Multi-Mechanism Buffer	Heavily vegetated buffers along property lines can prevent pollution migration to adjacent land uses. Organic contaminants such as fuels and chlorinated solvents can potentially be degraded, while inorganics such as metals can be captured and held in soils. Particulate matter in air pollution can be filtered out onto leaf surfaces of select species. These vegetated areas can additionally serve important wildlife corridor functions.	All: see Ch. 3
4.15 (p. 235)	Stormwater Filter	Impervious surfaces prevail on industrial sites, and stormwater filters can be installed downgradient to filter out pollutants. Wherever possible, stormwater generated from industrial uses should be disconnected from city collection systems and treated on site. In stormwater filters, inorganic contaminants are filtered in the soil media, while organic contaminants may be degraded. Where de-icing activities occur, salt-tolerant species must be utilized; salt is not typically removed in these systems.	Within stormwater: Nutrients; Metals; Petroleum; Chlorinated solvents
4.16 and 4.17 (pp. 241 and 242)	Surface-Flow and Subsurface Gravel Wetland	Both manufacturing wastewater and site stormwater can be directed into Surface-Flow (open water) and Subsurface (gravel) Constructed Wetlands to remove pollutants. With proper design, contaminants may be mitigated. Where de-icing activities occur, salt-tolerant species must be utilized; salt is not typically removed in these systems.	Within wastewater and stormwater: Nutrients; Metals; Petroleum; Chlorinated solvents

"The pier" and "the quay" is an industrial monument space. The image of the monument was inspired by artworks (see page 59). Most of the artists who paint nuclear power plants associate them with ships. And indeed, there is similarity between a plant and a ship in scale, shape and practical aspects - nuclear power plants are dependent on the large water body to cool down reactors.

This metaphor of nuclear power plants as ships is embedded in the design. The meadow becomes a sea. Ships comes and leaves, their presence in the harbor is temporal. Nuclear power plants are relatively temporal structures as well - they are built, they operate, after that they are shut down and decommissioned (dismantled). This time dimension is visualized in the monument - first reactor stands with the full presence, the second is partly demolished, fading away and giving the dominance for the new type of energy production - nuclear fusion.

Preserved, transformed structures and ruins coexist together in the same monument space.

The monument space is the only wide and open space left in the power plant site. It can be perceived as a whole due to elevated paths. The ground level due to the high plants become a "maze" with small scale spaces within the large space. Reactors acts as a guiding elements.

Phytotechnologies, demolition with nature technique, recovering creeks and wetlands give spatial elements of the monument also a functional aspects. The radioactivity is handled with the help of nature, phytotechnologies are applied as a preventive measures for remaining radioactive structures on site. Part of the site is recovered to the former state increasing biodiversity, part of industrial structures reused for habitations of plants and animals.

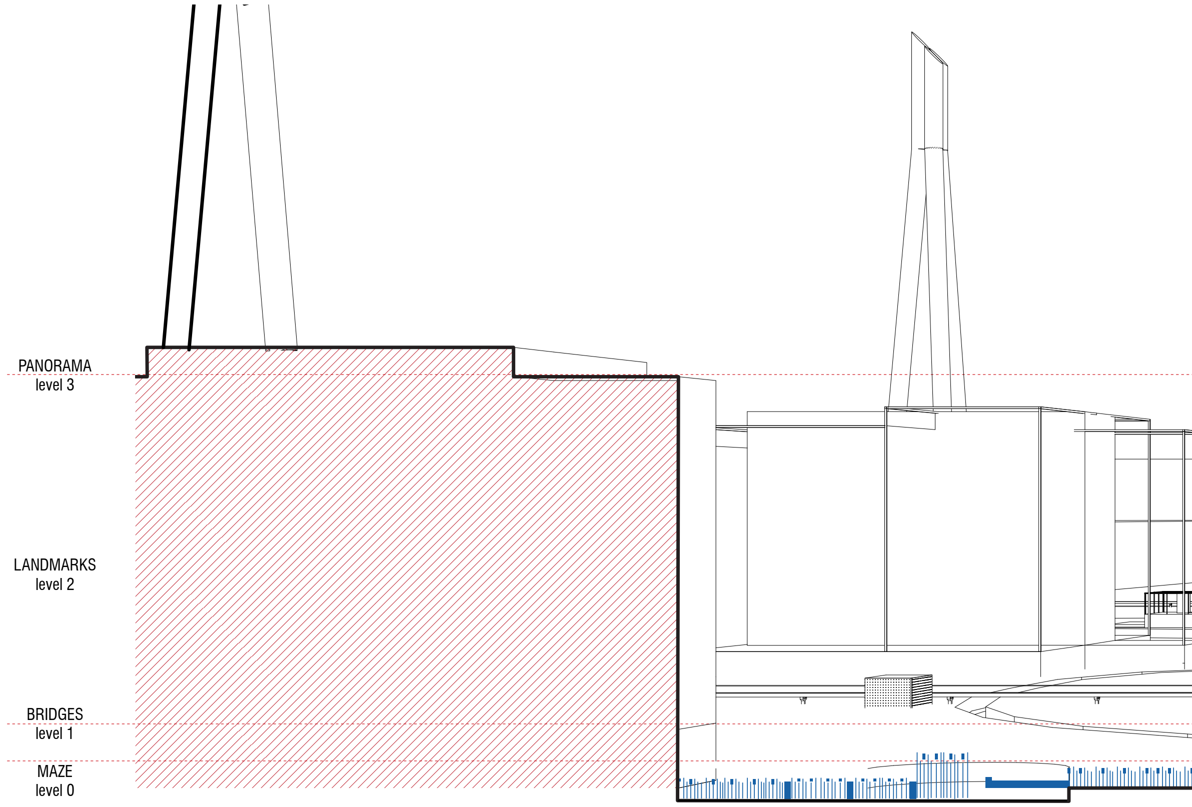
Fig.166. Nuclear power plant site

Fig.167. Nuclear power plant site

Fig.168. The transversal section through the monument space

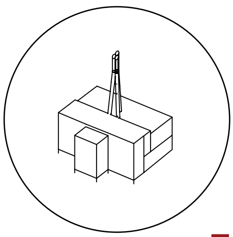

166


167



a meadow with high grass (T1)

a reused railway for paths (T2)



a preserved reactor (T1)

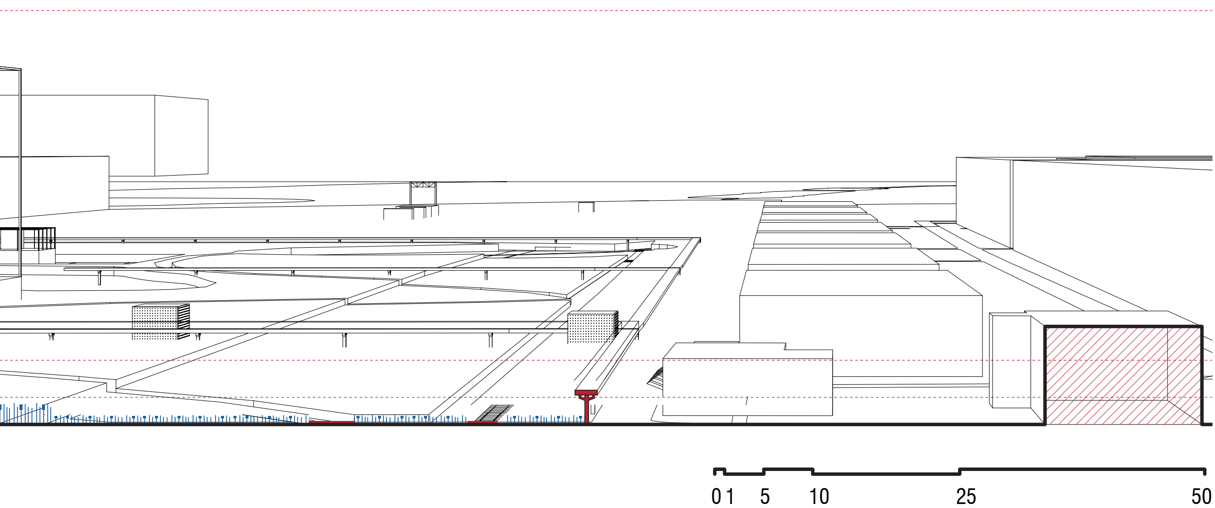
a constructed surface flow wetland (T1)

a recreated marsh-land (T2)

a turbine hall transformed into workshops, lab spaces (T2)

the “squares” public spaces in the landscape (T2)

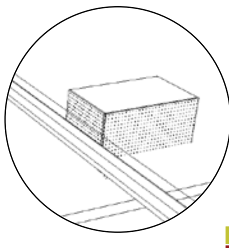
upcycled
new



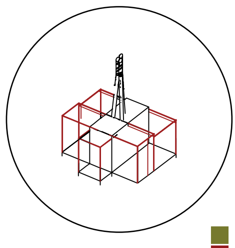
169

a partly dismantled turbine hall (opened views to the waterfront) (T2)

a panorama point (T2)

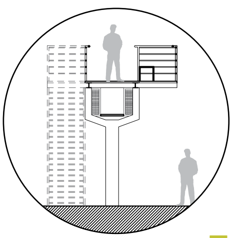


pavilions for facilities (scale measures) (T2)



a partly demolished reactor (T2)

demolition of the fence and reuse it for paving (T2)



a reused cable via-duct for path (T2)

temporary accommoda-tion (T3)

dismantle with nature

Existing pipeline and cable viaducts in Phase 2 are transformed into elevated paths. They allow people to visit the area without interrupting decommissioning and phytoremediation activities on site.

The new nuclear fusion power plants. The technological innovations allows us reconsider power plant design. The drop in scale, increase of safety, configuration of machinery are the measures that allow us to think about integration of power plants to surroundings. They no longer need to be a fenced industry, a desert of concrete.

New power plant is proposed in the site of former power plant. It occupies the area of projected 3rd reactor that was never built. The location is chosen both due to practical measures (soil is prepared for construction) and compositional ones. New reactor finishes the "history line" of preserved, partly demolished reactors and new reactor, which demonstrates the drop in scale due to technological innovations. The new power plant is partly underground, infrastructural connections are covered by green slab - extension of the wildlife park. It is an accessible public space.

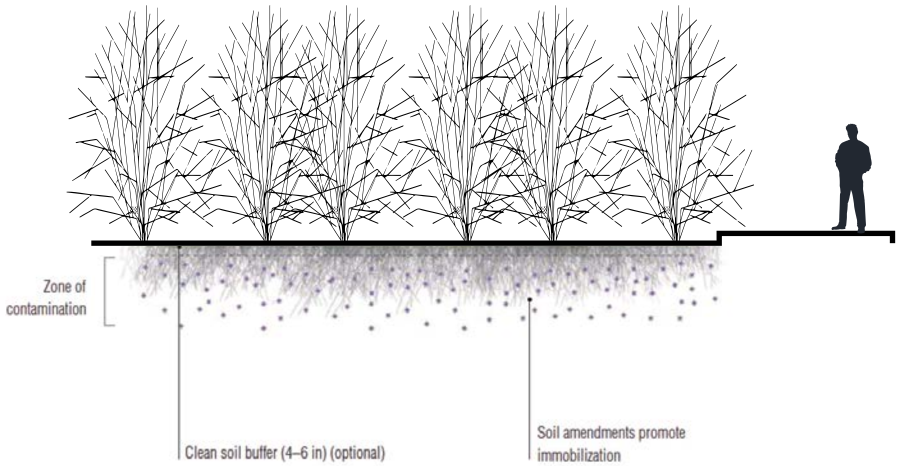
The buildings of reactors and turbine halls are preserved or partly demolished instead of full demolition as it is proposed in the initial plan of decommissioning. The first reactor is preserved in its initial state. Its turbine hall is adjusted to be reused as workshop and lab space for Research institute.

The second reactor and its turbine hall are partly demolished, opening connections between monument space and a waterfront, creating light working spaces and a garden which uses turbine hall bearing structures as a framework for plants, nature reclaim this part of the industrial building creating the story of emergence and disappearance, rebirth and decay.

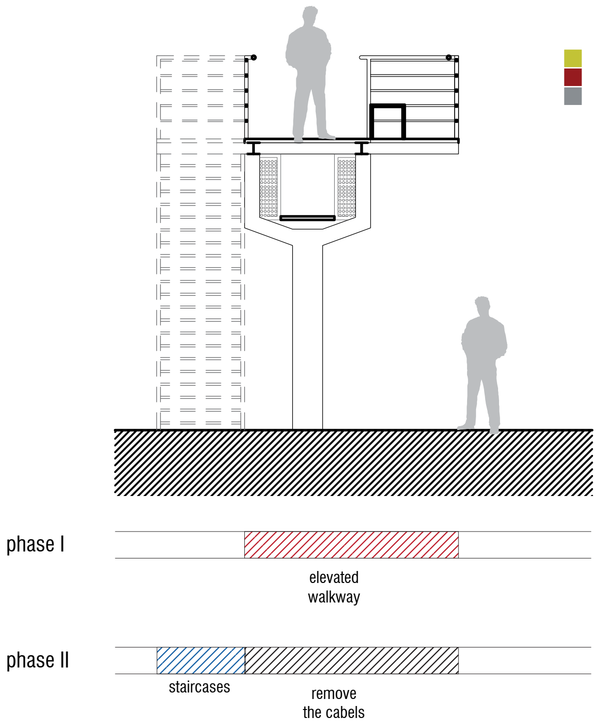
Fig.169. The phytoremediation

Salix
Willow

Phragmites australis
Phragmites



170



171

Fig.170. Pipeline viaduct.

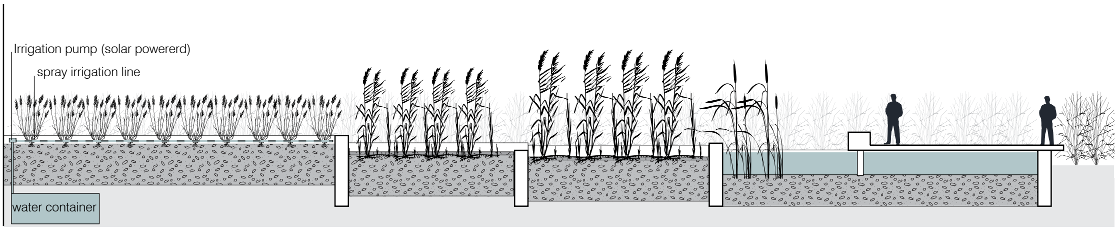
Fig.171. Pipeline viaduct to elevated walkway. Section Sc1:100

Fig.172. The constructed surface flow wetland

Alopecurus pratensis
Meadow Foxtail Grass

Phragmites australis
Phragmites

Typha latifolia
Cattail



phytoirrigation
rhizodegradation

phytohidraulics

phytohidraulics

174

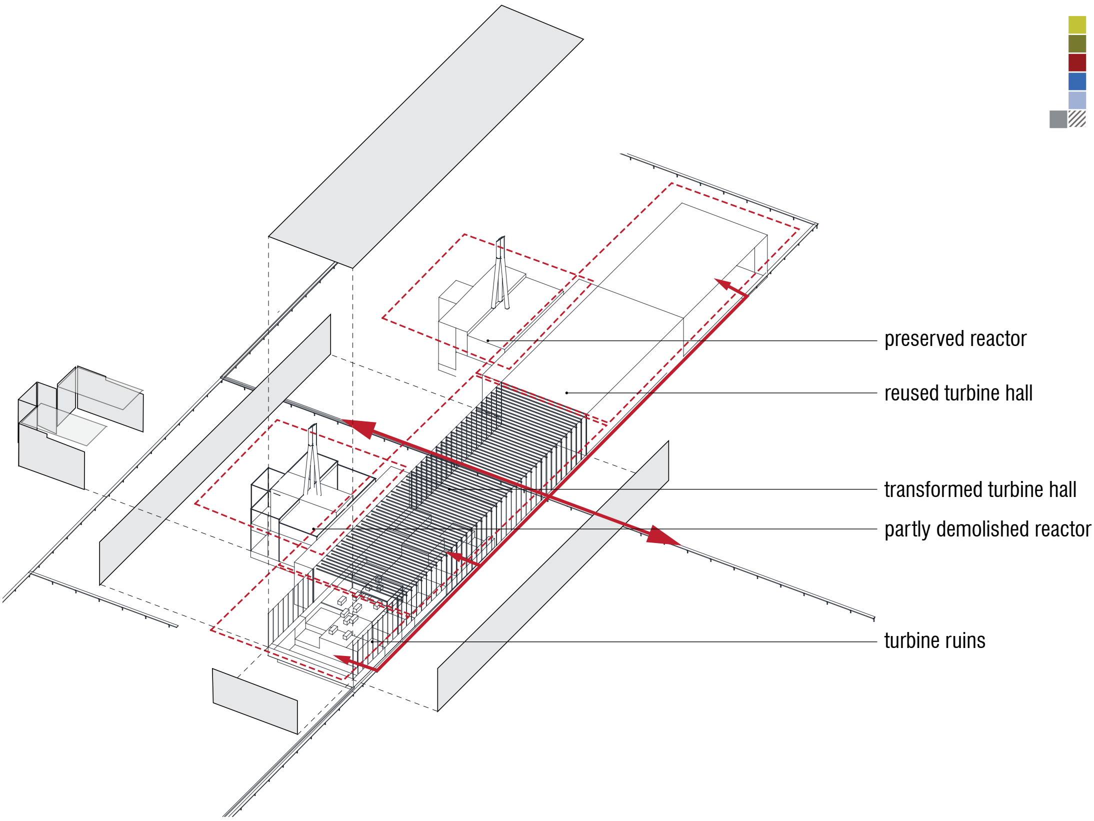
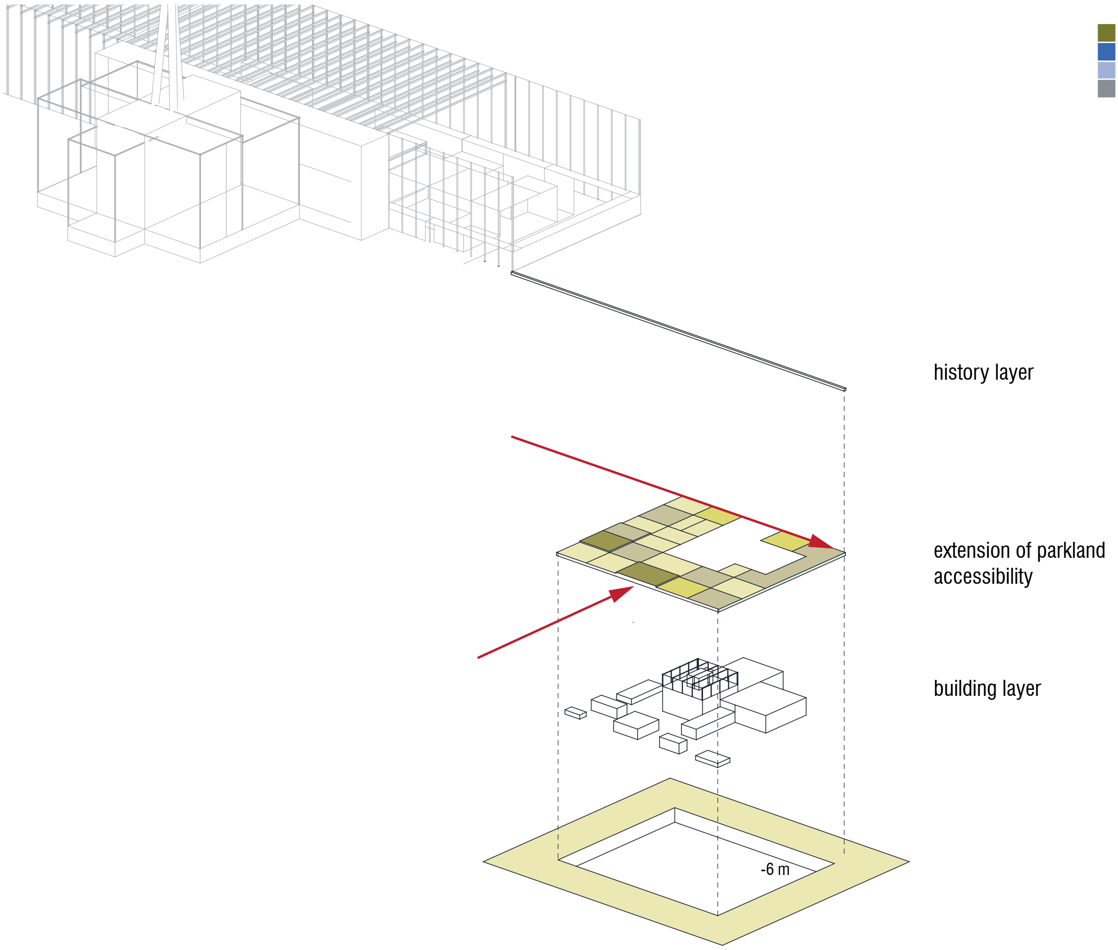


Fig.173. Transformations of nuclear reactors and turbine halls

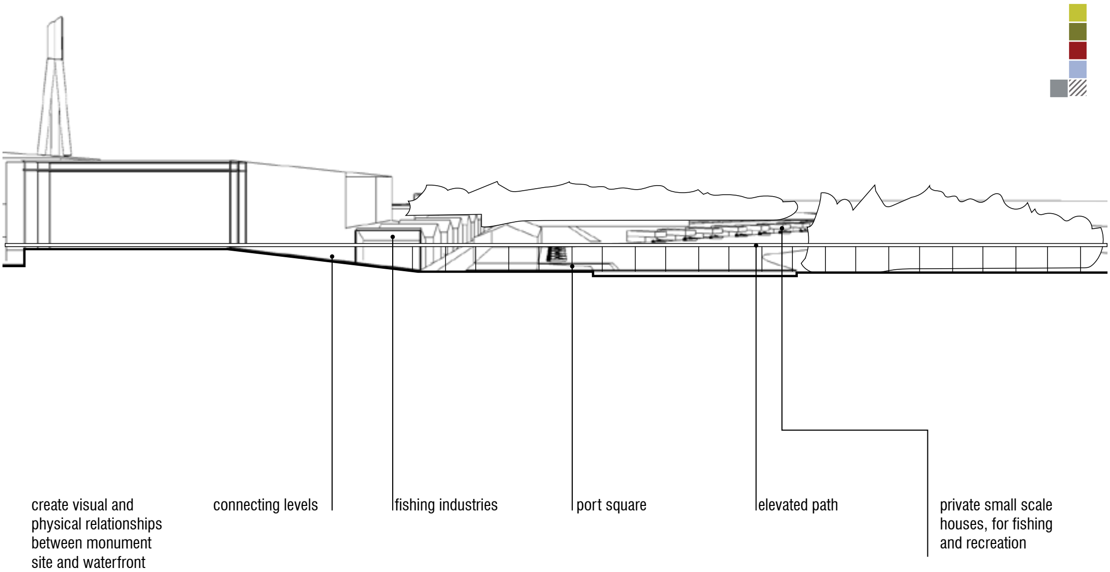
Fig.174. The new nuclear fusion power plant


history layer
extension of parkland accessibility
building layer
-6 m

Waterfront is a former place for inlet and outlet canals of Ignalina nuclear power plant. These canals are reused for quay and fishing functions. Waterfront becomes a node where land and water paths intersect. Ships connect this node to the settlements around the lake.

The waterfront has several typologies, space for fish farms, quay, recreational fishing village. The further you go from the power plant, the stronger the relationship with the water is.

Fig.175. The section through the waterfront space


create visual and physical relationships between monument site and waterfront
connecting levels
fishing industries
port square
elevated path
private small scale houses, for fishing and recreation

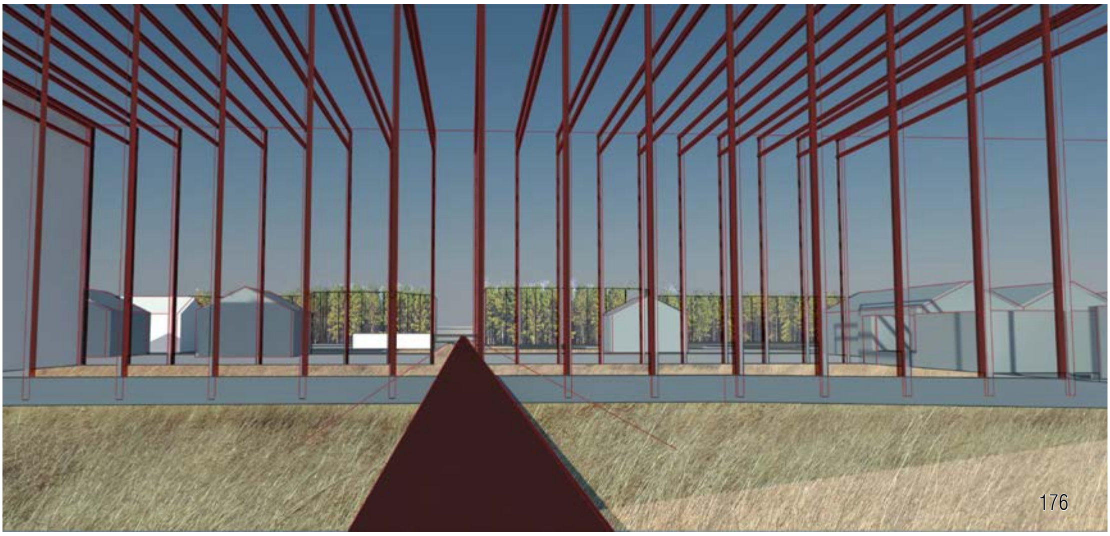
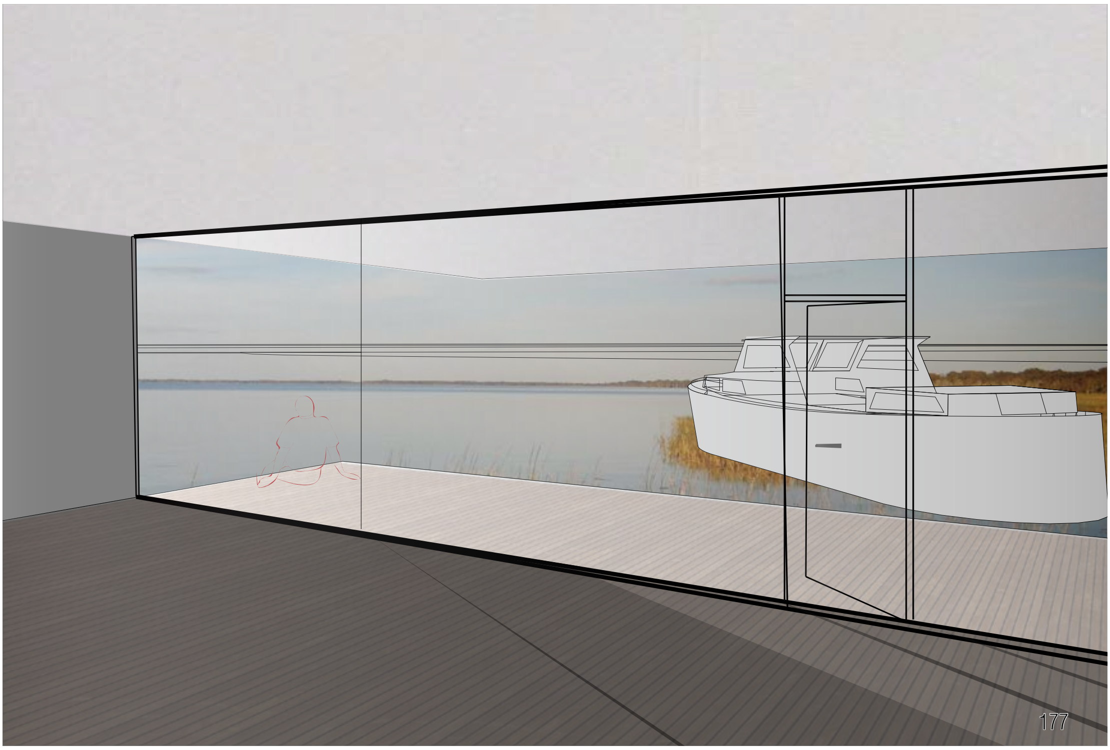


Fig.176. The transformations of turbine hall.
A connection to waterfront

Fig.177. The view from fishermen house


177

“The Walk of Giant” is a conversion of former energy transmission corridors. They are turned into a biodiversity corridors with artistic and functional transformations of electricity pylons.

This is part of the monument, it is the first glimpse to it while approaching INPP site, characterizing the immense scale of nuclear power plant. The place that tells the story about relationship between nature and industry, the overwhelming dominance of the latter.

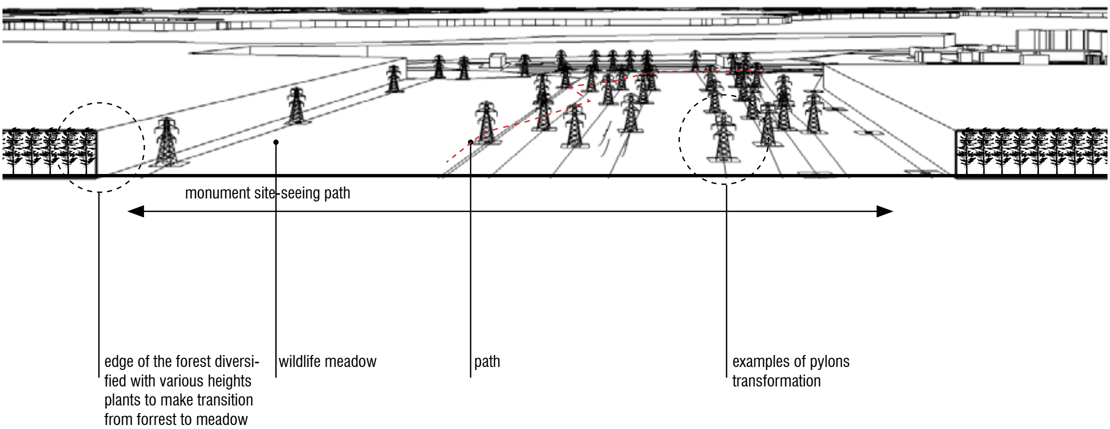
“The Walk of Giants” is a framework project, enabling collective design that emerges through time.

Rules for growth:

-no permanent residency, scale and size of structures <80 m2

-land-use - 95 percent nature, 5 percent is for leisure, agricultural uses.

Fig.178. The electricity transmission corridors



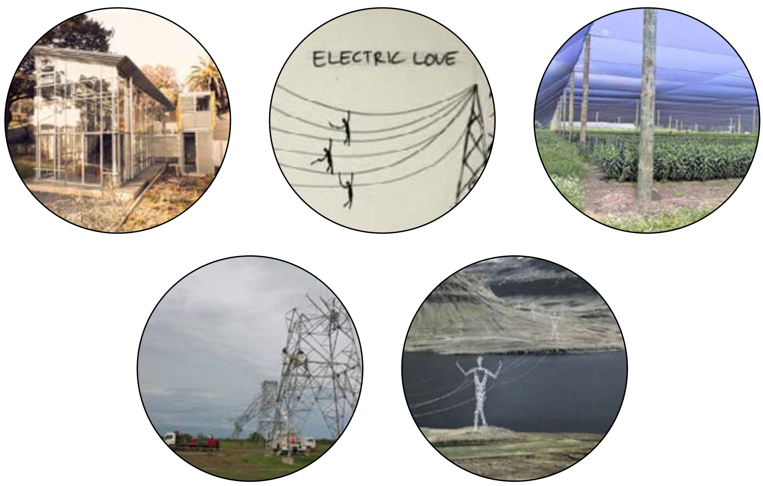
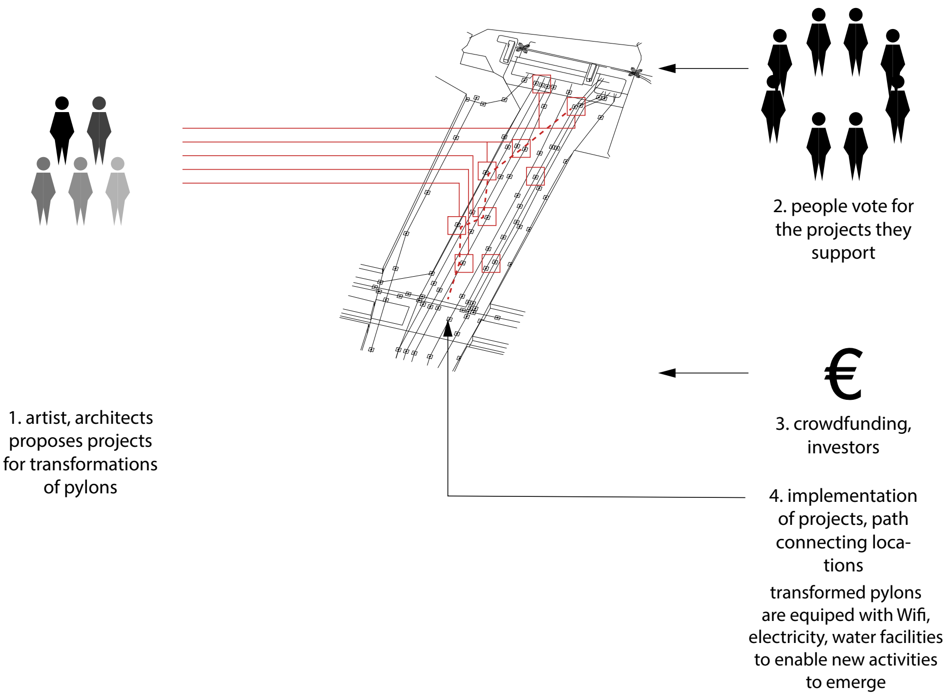


Fig.179. The section through "Walk of Giants"

Fig.180. The framework for the project


1. artist, architects proposes projects for transformations of pylons
2. people vote for the projects they support
€
3. crowdfunding, investors
4. implementation of projects, path connecting loca-tions
transformed pylons are equiped with Wifi, electricity, water facilities to enable new activities to emerge

5.2.
LINK BETWEEN INPP AND THE TOWN

The link between nuclear power plant and Visaginas is a complex element that consists of new wildlife corridors, public spaces in the landscape, stops that acts also as shelters for cyclists and inter-modality points for shared cars and bicycles; a new morphological element - a square, bicycle and car paths.

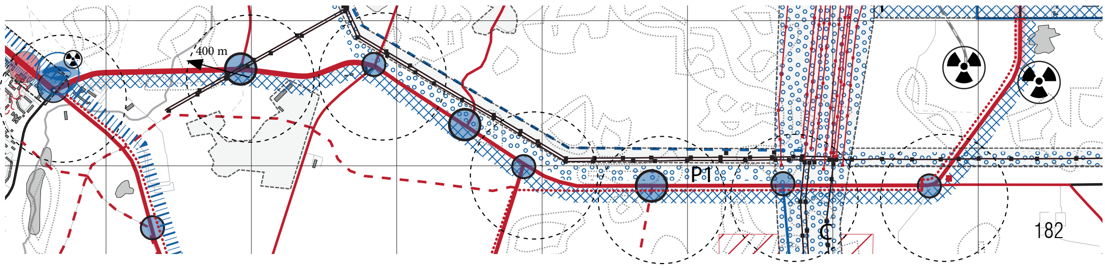
These paths are placed in separate spatial corridors which are designed according the mode of transportation. Due to the difference of speeds of movement, perception of the space and its detail level differs. The nature plays an architectural role in shaping the space.

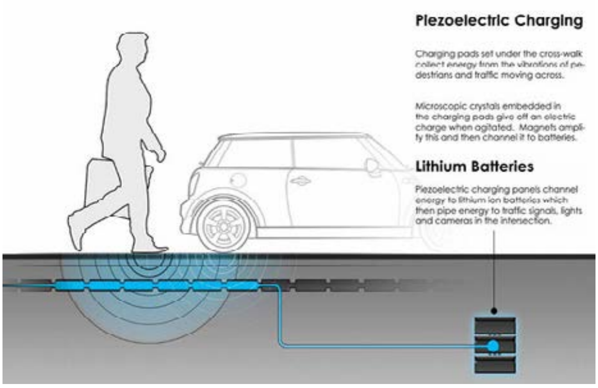
Industrial and architectural elements (heat pipe and squares) are guiding elements along the path.

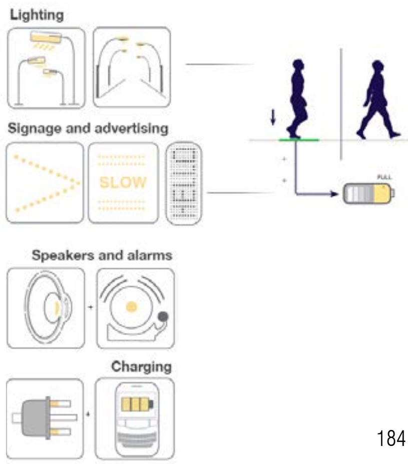
Fig.181. The link between INPP and the city. Existing situation

Fig.182. The link between INPP and the city. The framework


181


400 m
P1
C
182



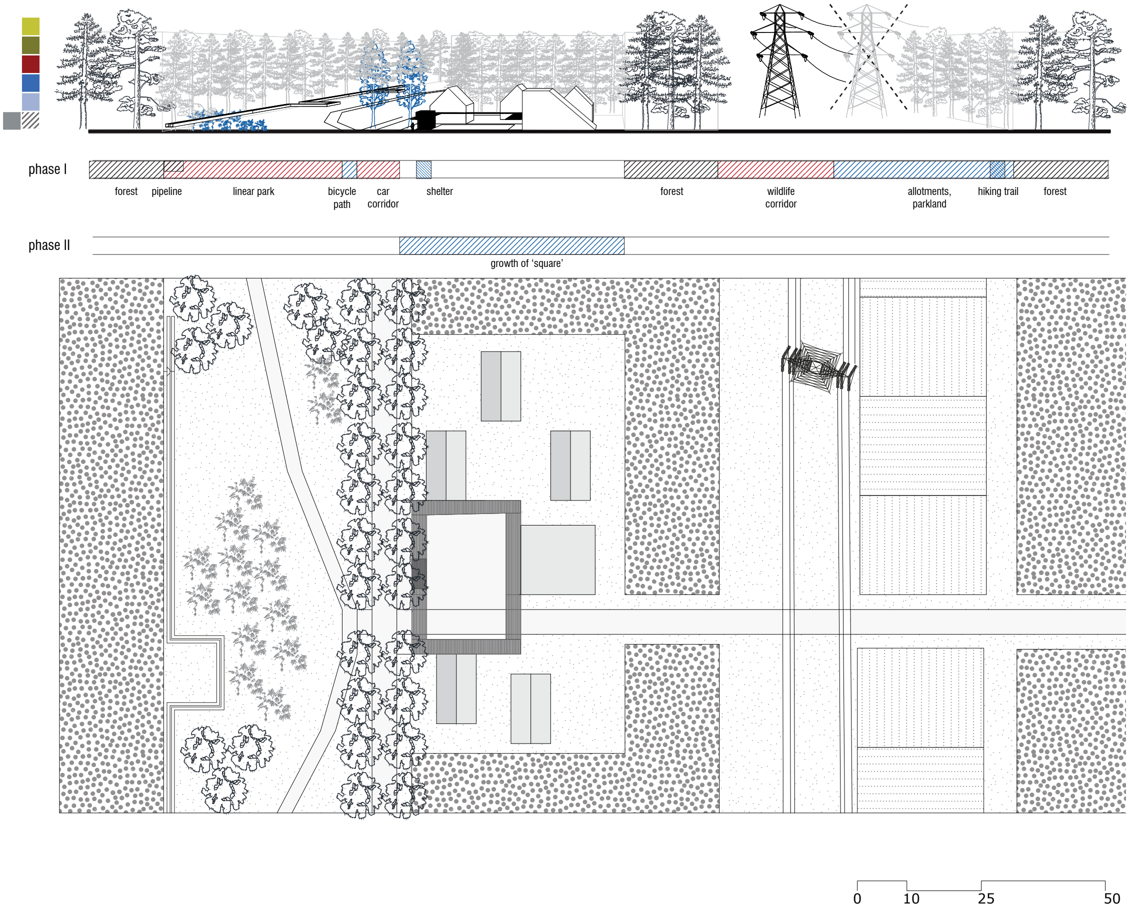


184

Fig.183. The existing situation of the road between INPP and the city

Fig.184. Piezoelectric technologies

Fig.185. The section and the plan



pipeline as barrier and as a guide

new bicycle/ pedestrian path with piezoelectric technology

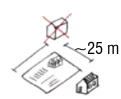
downgraded road. Piezoelecric technology

trees shapes the corridors, diminish the impact of infrastructure

hedges regulate wildlife passages

underpass

“squares” every 800 m (more information under the chapter “Nodes”)



allotments

5.3.
NODES

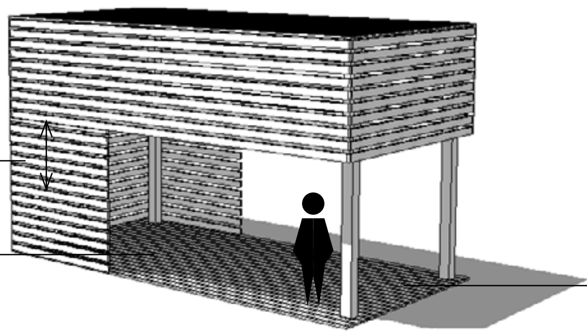
The reference for the nodes comes from spatial-economic element "Karcema". It is an inn in Eastern Europe that emerged due to the trade relationships between West and East followed by long traveling distances of merchants. Karcema was a building for accommodation, catering services and horse stable.

Considering changes in modality system, new bicycle routes in the region connecting areas on daily use, stops would serve as shelters from rain, landmarks marking the entrances to public spaces in the landscape and market places to sell the production grown in allotment gardens in former transmission corridors.

These squares with pavilions might grow in the future to form an urban square. The further expansion is not restricted.

Fig.186. Karciama plan and view

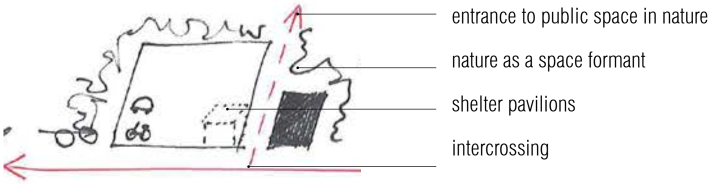
186

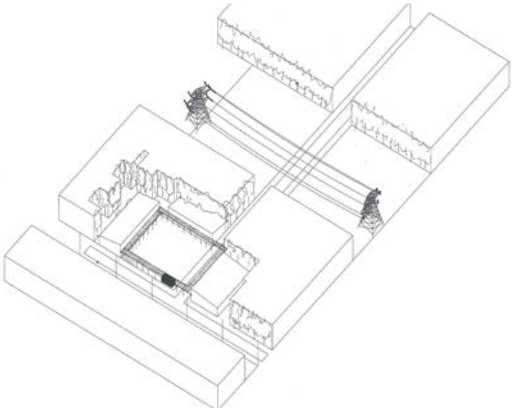


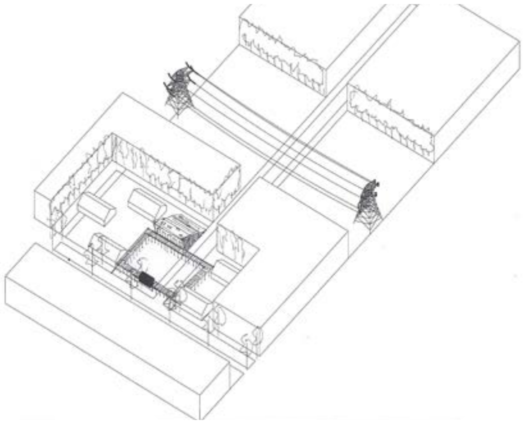
187

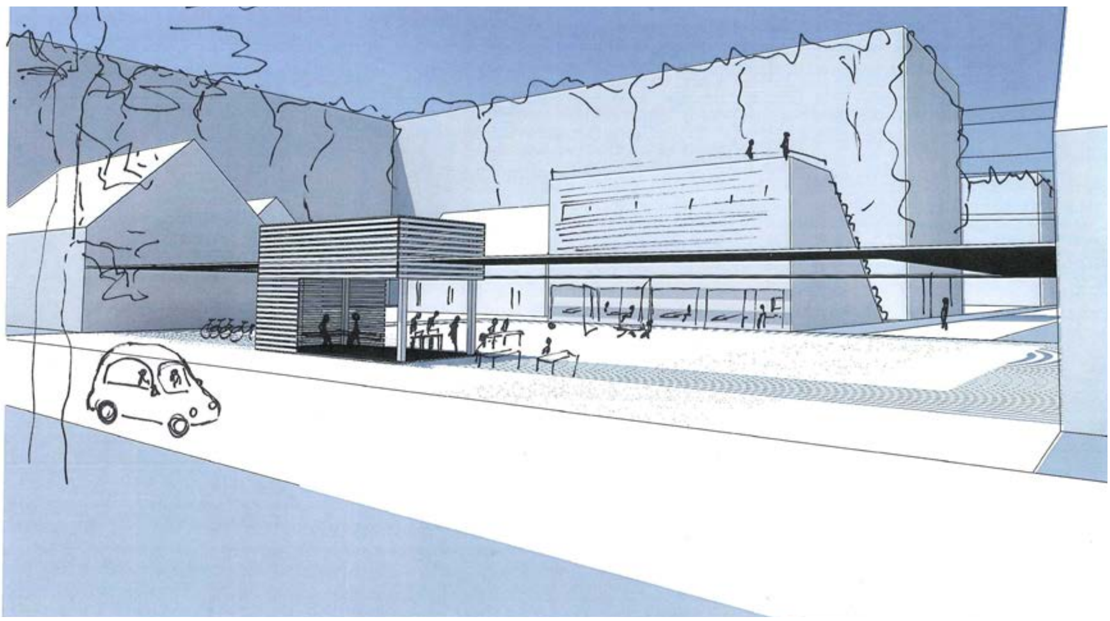
Fig.187. The multi-functional pavilion

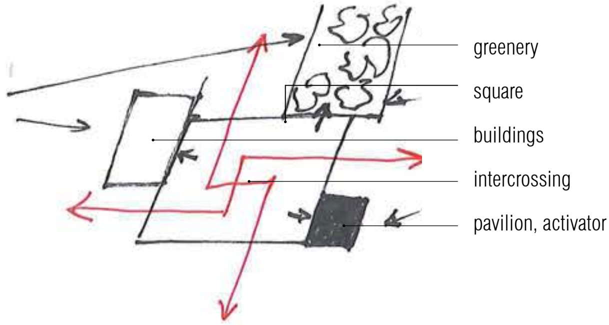
Fig.188. Typologies of squares near the link between INPP and the city

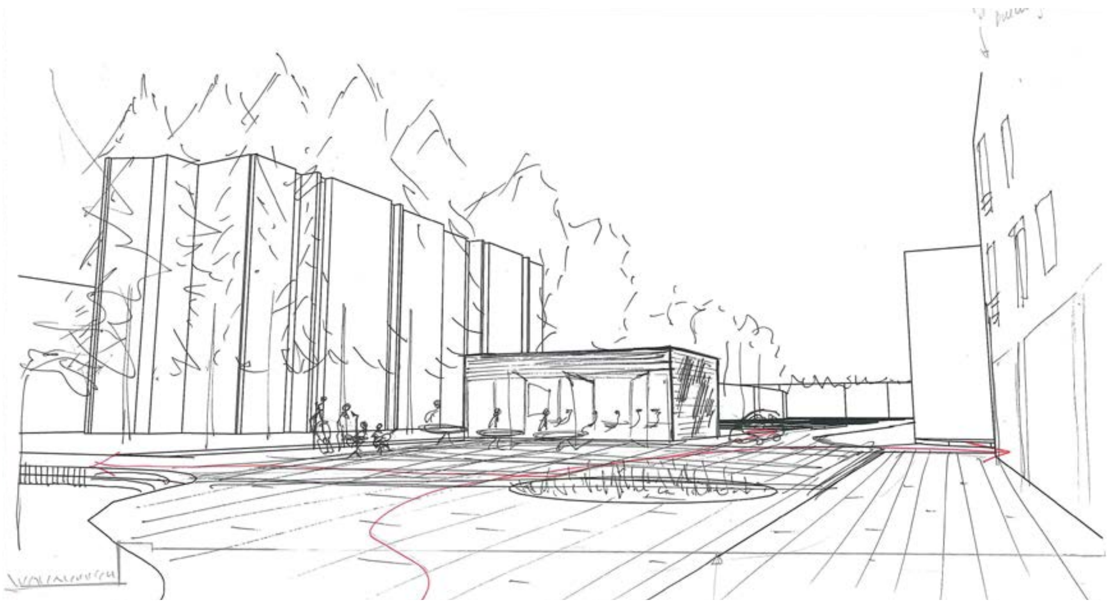

entrance to public space in nature
nature as a space formant
shelter pavilions
intercrossing











189

Fig.189. The example of square in the city

5.4.
PATHS IN THE CITY

The town of Visaginas from a “sleeping district” for nuclear power plant workers becomes a multi-functional unit, work comes back in the shape of small scale high tech industries and research facilities. Transformations of existing buildings, activation of public spaces is followed by bringing wilderness to the city to strengthen its identity and spatial quality.

The town of Visaginas has three intervention zones - main street, secondary street and the pedestrian alleys, named accordingly “gates to forest”, wilderness corridors and a“winter garden”.

The new research institute acts as activator of economic activities in the city and spatial transformations.

There are regulations for land-use applied to the main city paths:

- 25 % commerce

- 25 % services

- 50 % industries

Regulations can be influenced by people living in those streets.

Residents of Visaginas build the city with their own hands and now feel much more attached to the place and even if forced to leave, they still come back at least for holidays. Learning from the history, new buildings would be build involving the inhabitants form the very early design stage, using baugruppe principle.

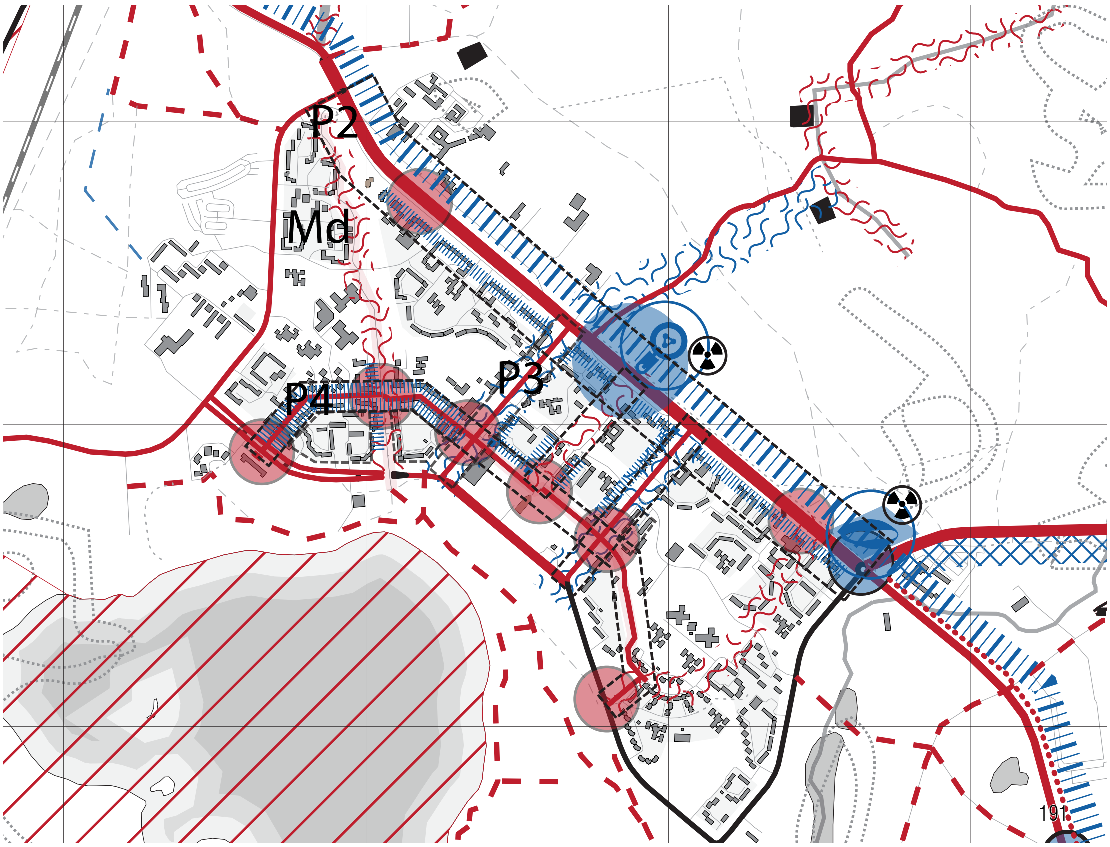
Fig.190. Visaginas, The existing situation

Fig.191. Visaginas. The framework

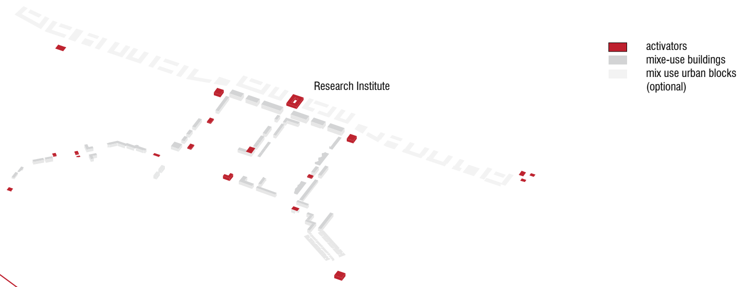
Fig.192. The composition

Fig.193. The axo

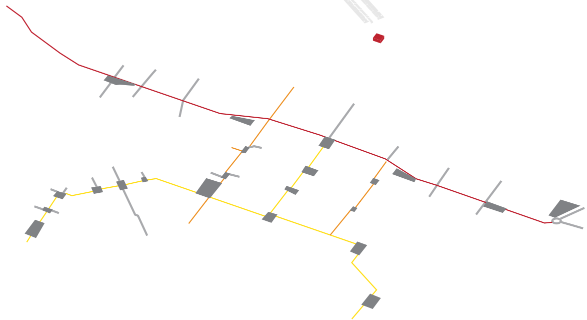

190


P2
Md
P3
P4
191

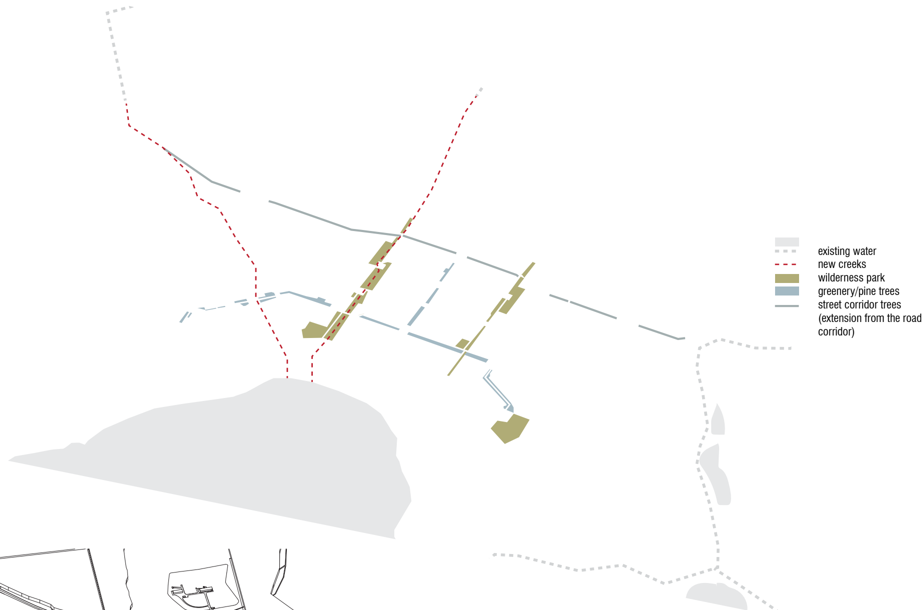
BUILDINGS



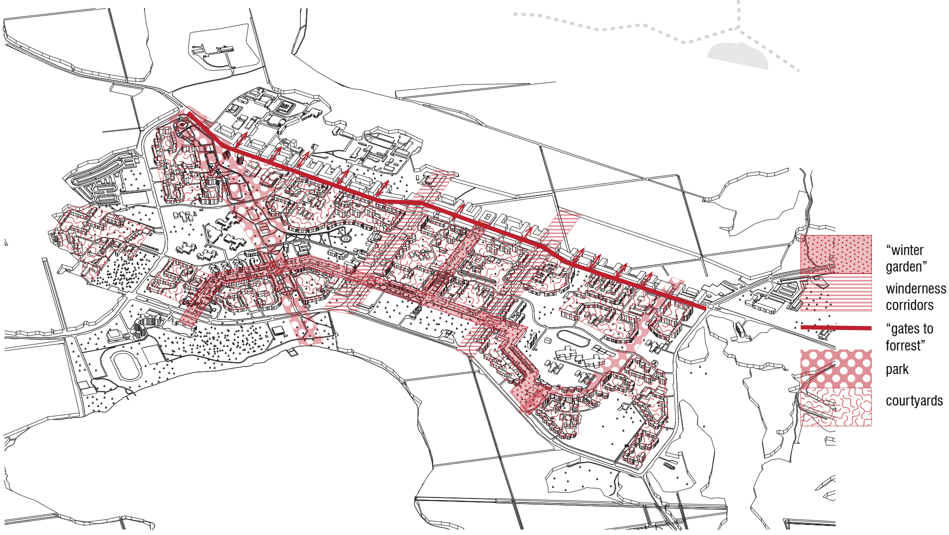
PATHS



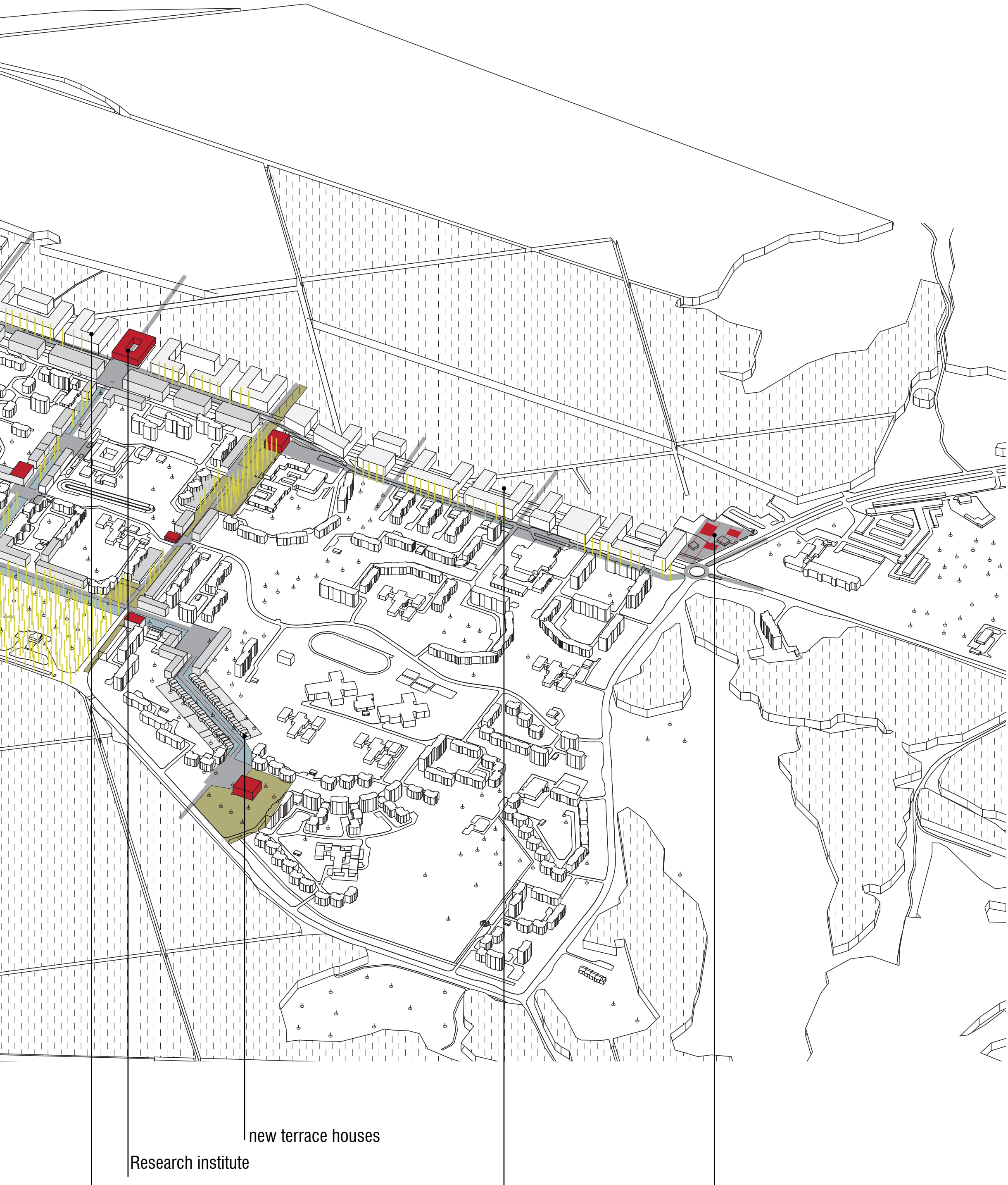
WATER AND NATURE



COMPOSITION




biodiversity corridors
green pedestrian al-ley with with active urban front (small scale industries, retail, services)
Activators: labs, libraries, cultural centres, cafés, etc.
new mix-use houses


new terrace houses
Research institute
main city street with trans-
formed existing apartment
blocks and new urban blocks,
green corridor continuing
outside the city
mix- use urban
blocks (optional)
new nuclear fusion
power plant

The city structure is based on socialist city principles: hierarchy of streets with public facilities next to them depending on the frequency of usage, micro-districts that provide residential space and daily facilities. The micro-district element in the city functions quite well providing safe and walkable, family friendly neighborhoods, while main arteries of the city with extensive car infrastructure are no longer fulfilling the changed lifestyles. There is a need for interaction spaces rather than purely transition in empty car corridors that, due to their disproportional character, strengthens the image of vacancy in the city.

The main paths holds a potential to become vibrant spaces showing the new face of the city, accommodating small scale high tech industries, services, public spaces, places for socializing and interaction, urban elements together with wild nature.

There three typologies selected:

- Pedestrian street

- Secondary street

- Main street

that due to their morphological and functional differences, require particular design.

Pedestrian street turns into 'winter garden' seeking to convert a conflict of densification and greening into opportunity where wilderness and urban environment coexists attracting attention to the details - the change of heights, play of geometrical and organic surfaces, the light, wind and humidity interacts to give impression of the forest while being in urban environment.

The secondary street turns into wilderness corridor extending nature to the city and creating the corridor for species to move towards the lake. The hidden creek is recovered and goes along the shared mobility path. Level differences helps to avoid clashes.

Fig.194. The existing situation of the pedestrian alley

Fig.195. The reference. Winter-garden

Fig.196. The existing situation of secondary street

Fig.197. The existing situation of the main street


194


195


196


197

The shared mobility path is build on the previous road, by downgrading it and making slight turns to slow down the traffic and shorten the vistas which concentrates driver's attention on the edges of the road. The new path fits in the borders of the former road. Urban fronts are activated and connected to the linear wildlife park.

The main street could become gates to the surroundings. Instead of being a border, it becomes a connector. This street contains extensive car infrastructure that was meant for the city, two times larger than existing one (the second half of the city was never built). By downgrading the road, the space is opened for new developments. New mix-use urban blocks are proposed, including larger scale industries that doesn't fit in the pedestrian or secondary streets.

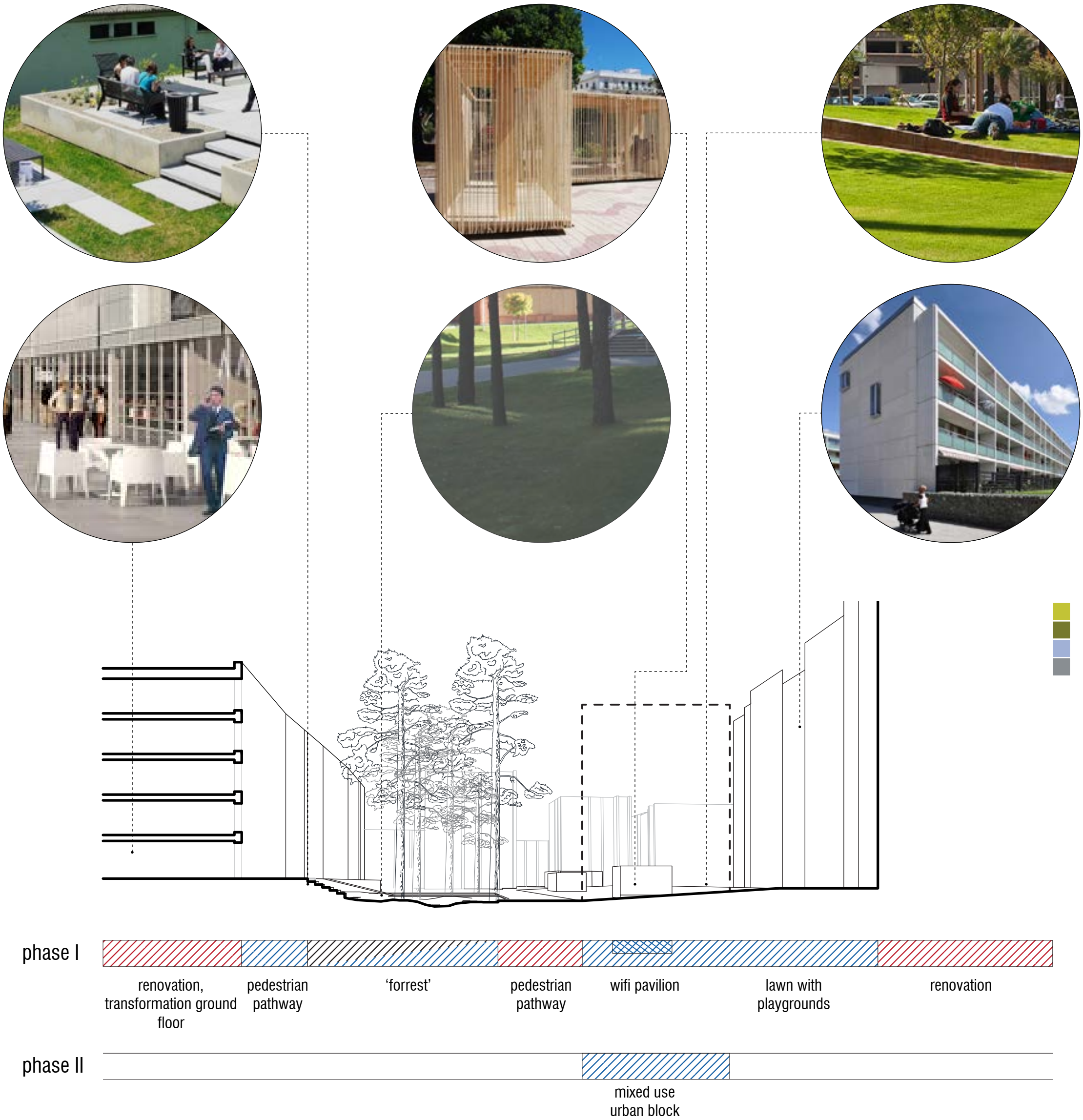
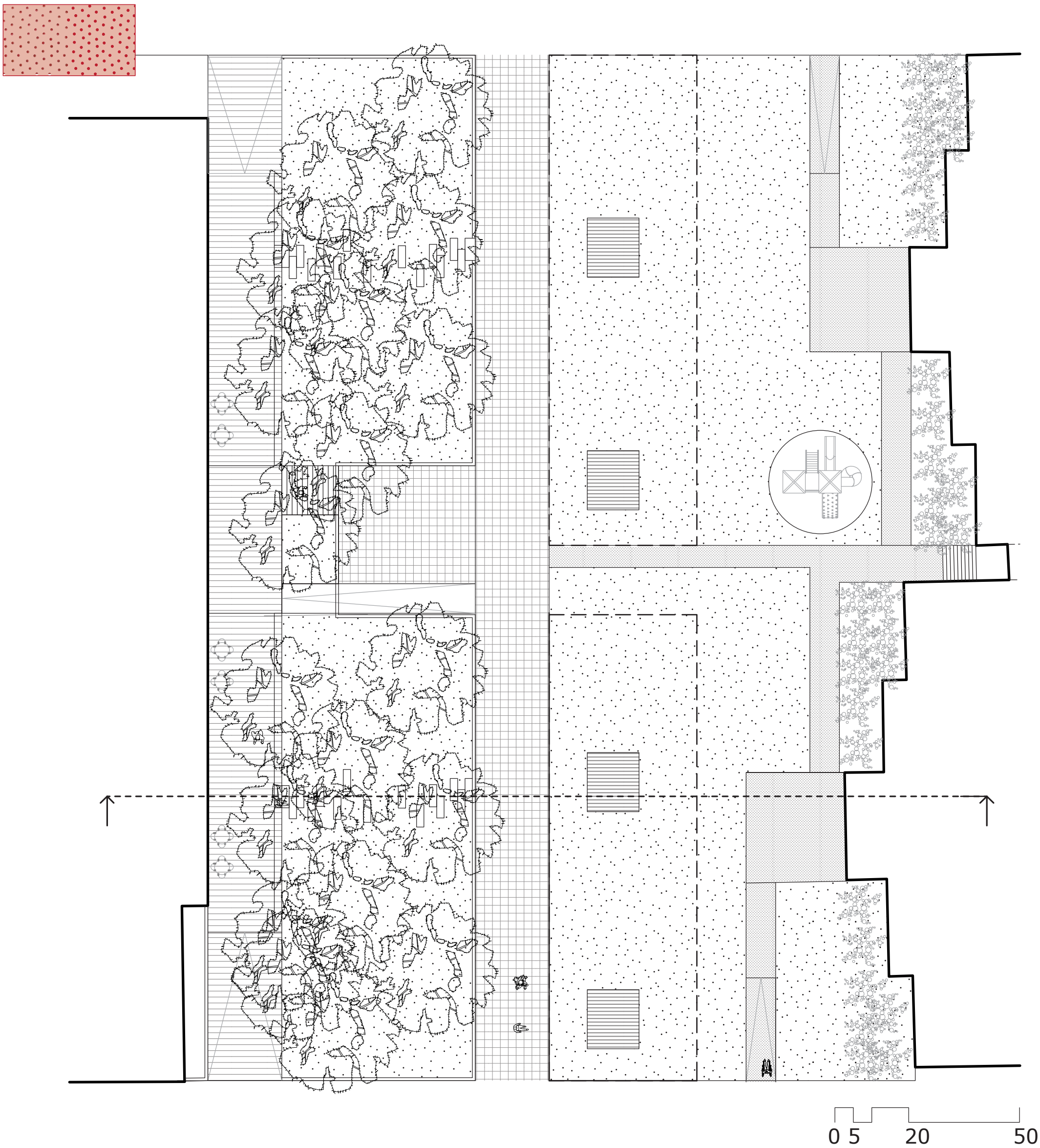


Fig.198. The section and the plan of pedestrian street design



205

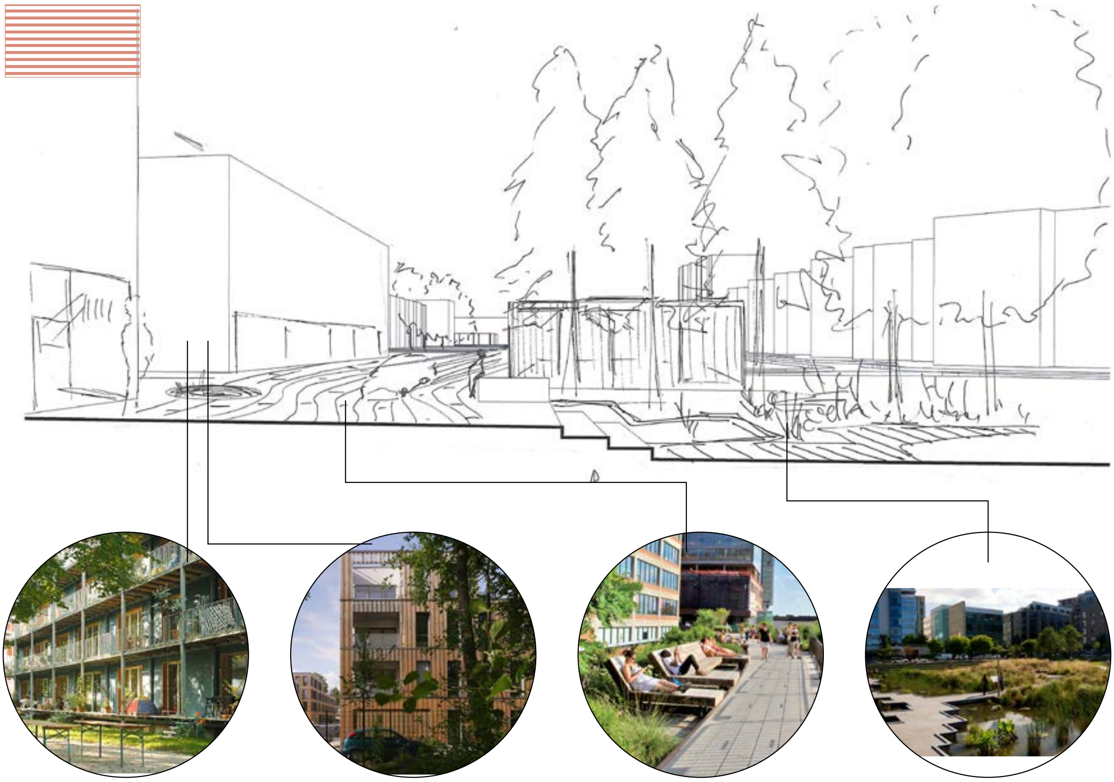
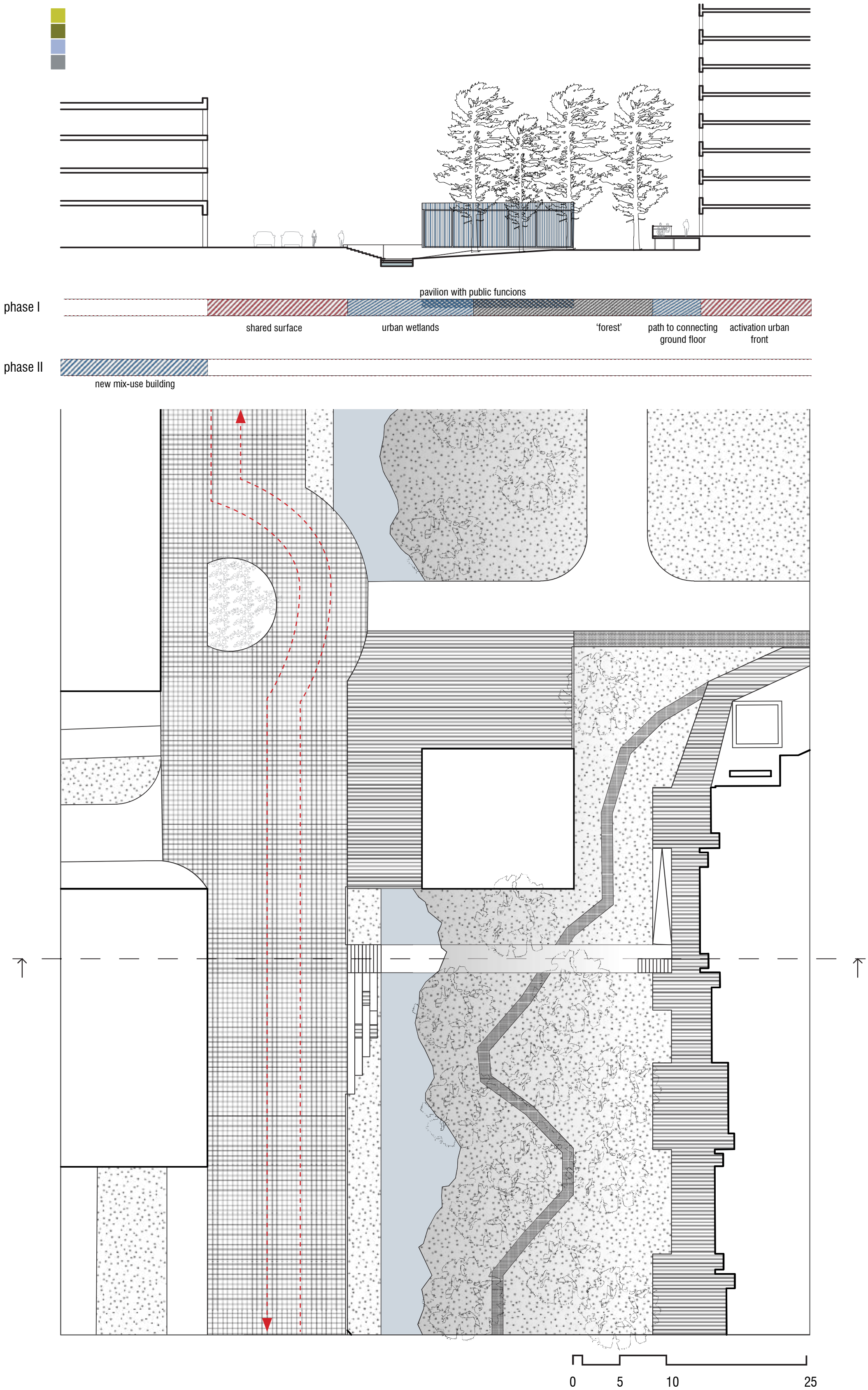


Fig.199. The section and the plan of secondary street design


pavilion with public funcions
phase I
shared surface
urban wetlands
'forest'
path to connecting ground floor
activation urban front
phase II
new mix-use building
0
5
10
25

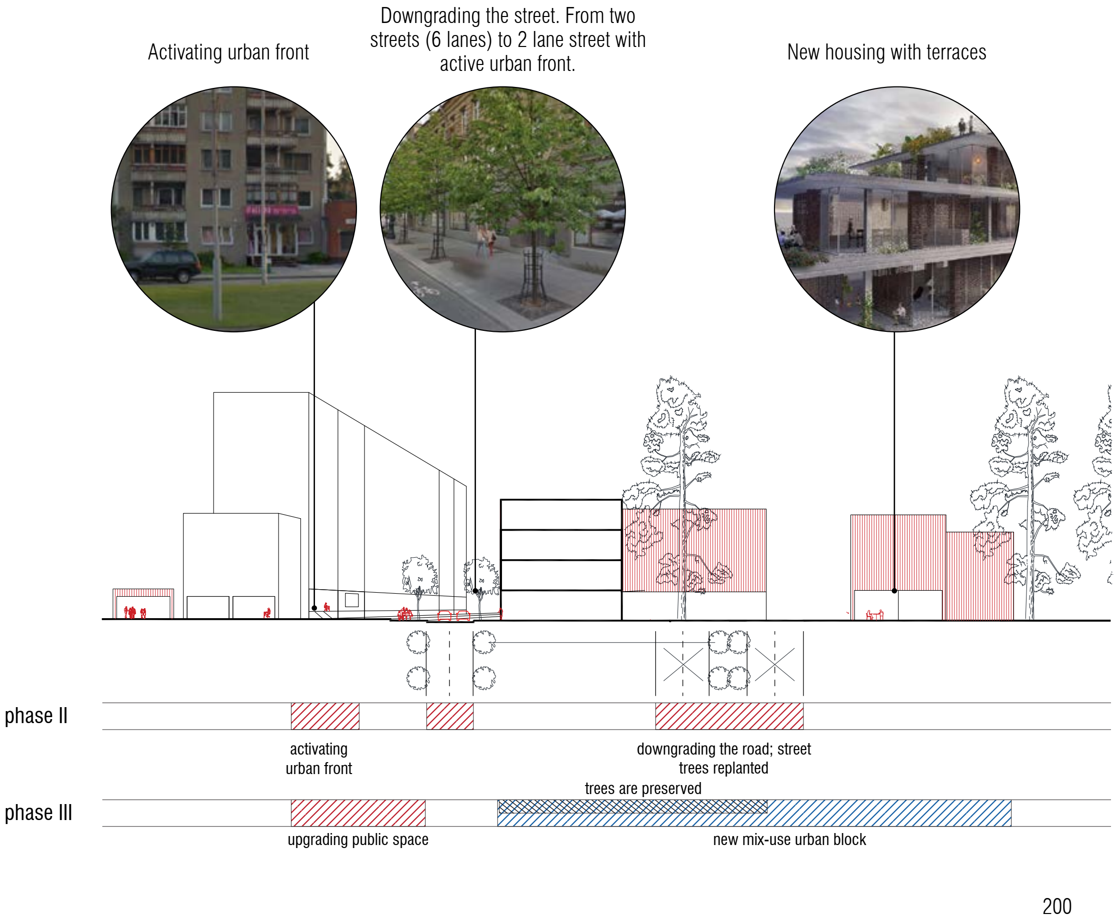


Fig.200. The section of the main street design

CONCLUSION

6.1. CONCLUSION

The project **shows the way how nuclear power plant regions** with their landscape and distinct populations discarded after decommissioning of their nuclear facility **could revive using the resources** both spatial and social that already exist in the region. It upcycles structures and the society created by nuclear power plant, strengthens the nature and uses the potentials of industrial heritage.

The project reconsiders relationship between urbanized parts and the environment. The city is not just placed in the forest, it is **part of the wild nature** and gives people opportunity to experience it. The project contributes to the **biophilic cities** movement designing an urban environment that gives emotional and psychological benefits and economic value of the ecological services provided by natural systems.

Interactions with nature on daily basis increases appreciation and awareness about **nature preservation.** The education, urban environment, nature related activities (biodiverse farming, allotments) become tools for passive preservation and strengthening of the international nature framework followed by active methods of remediation.

Deindustrialized sites becomes **places for coalescence** rather than segregation. Various activities (energy generation, farming, industry, culture and arts, sports) and structures (urban and nature, energy, heritage) come together and make synergistic relationships.

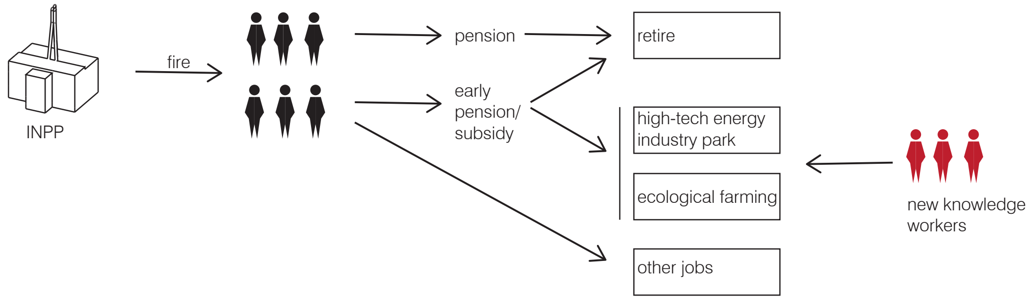
The project offers **an alternative process of decommissioning** that is applied to the whole region rather than just the power plant area. It involves people rather than excluding them and allows residents to contribute to the image of the city.

The project looks at decommission-

Fig.201. The employment scheme

Fig.202. The independence from political decisions on international level scheme

Fig.203. Cultural heritage scheme



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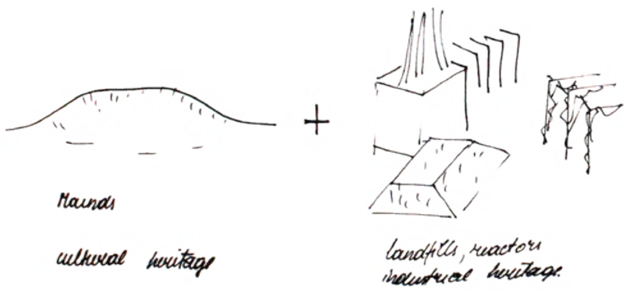

203

213

ing as a "**window of opportunity**" rather than a threat, as a development step rather than the end point. It connects to transformability theories and strengthens transformability attributes in the region.

The project stops shrinkage of the city and enables residents to stay and contribute to the building a new future for the city. The **new workplaces** are provided in the diversified economy that adds energy research, high tech industries, energy generation, remediation, farming, environmental research, culture (museums, galleries, libraries), tourism related jobs to the existing job market. Jobs connected with remediation of industrial sites are work types where the boundary between relaxation and the work melts, built on the culture patterns in the region.

The further **radioactive contamination is prevented** due to sensing technologies that give people control over their safety. Handled radiation and the handling process itself distinguish the region from other high tech industry towns.

The energy transition is another exceptional feature that connect to the history of the place by using nuclear fusion reactors. The drop in scale and change in safety of technology enables the region to **be free from political decisions** made on national or international levels.

New power plants and research institute reuses the **knowledge** that is accumulated in the city and bridges it with the **innovations**.

The city, the landscape, the former industrial sites incorporate work, live and leisure, architecture and nature on different quantities resulting in **variety of living and working environments** for the existing residents and the newcomers with diverse lifestyles to choose from.

The region builds up stronger relationships among its components and integrates contrasts of history and the future, urban and natural, obtrusive and hidden, threat and safety in the new step of Atomgrad's existence - Atompark.

6.1. SOCIETAL AND SCIENTIFIC RELEVANCE. ETHICAL RESPONSIBILITY

The graduation project contributes to the topic of Design as Politics studio Let's work – industry, architecture and the city by exploring specific type of industry – nuclear energy industry and its relation to built environment and job market. Decommissioning of nuclear power plant, causes unemployment and increases precariat class - a class of workers without contracts and all sorts of insecurities. Decommissioning results in spatial changes due to demolitions in nuclear power plant site and the city. In the course of transformation, there is an opportunity to reconsider the structure of the city which has been created according First Nuclear Age utopias and adapt it to upcoming tendencies of work styles and workplaces.

Societal relevance

The societal challenges in the project are related with unemployment of both highly educated people and workers with low education level, aging, population decline caused by decommissioning of nuclear power plant. INPP workers are forced to escape from the First Atomic age dream and face the uncertainty of their future which is even increased current tendencies of job market - raising precariat class. Controversial opinions about nuclear energy influenced by Chernobyl disaster and lack of decisions on political level keep the development of nuclear energy as an open question. INPP workers once was exemplary part of society, now are unwanted. Solutions showed in the project are relevant or will be relevant to other nuclear power plant cities in Eastern Europe and America.

In more general sense, nuclear power plant cities with decommissioned facilities show the end of utopia created by the First Nuclear Age and encourages us to think about the possible impacts of upcoming new utopia - the Second Nuclear age. Would it succeed to fulfill promises of Atoms of Peace and revolutionize our lifestyles, or become another failure to be solved for future generations? Thinking about the broader context, project becomes relevant to the global society as well.

Scientific relevance

Master thesis contributes to existing state of knowledge on new towns created to house nuclear power plant workers and nuclear energy (works of Kate Brown, Veronica Wendland, ect.), trying to answer questions, how to achieve sustainable economic transitions of cities that have lost their economical pillar, how to deal with the shrinkage and people emigration, safety and radioactive pollution.

In addition to this, project adds to the knowledge of transformability theories describing features that helps nuclear facility new towns, from a first glance contradicting transformable city image, to overcome successful transformation.

The presence of radioactivity in our environments are much more broad than just areas around the nuclear power plants. Landfills of waste leaks tritiated water, regions in Europe still suffers from higher radioactivity levels due to fallout caused by the accidents in Chernobyl power plant. The strategies for cleaning the landscape and strengthening ecological frameworks could be applied to those regions as well.

Ethical responsibility

Nuclear power plants are large and complex engineering objects. The activities in the surroundings are influenced by restrictions of sanitary protective and observation zones. Urban designer needs to take into consideration these spatial limitations, risks created by nuclear power plant, political decisions and propaganda spread on national or international levels and be responsible for the safety of the residents and environment while working with development plans of the city.

In addition to this, there are few conventions which obliges people working with the topic of nuclear power plants to keep some aspects opaque. Nuclear power plants are considered as strategic objects, therefore the structure of the power plant and its premises can't be documented without the permission. The decommissioning process is the time when these conventions should be negotiated.

The project process involved among others interviews with vulnerable groups. The information provided by them that could affect their property or work is not documented.

GLOSSARY OF TERMS

Biodynamic agriculture – a form of alternative agriculture very similar to organic farming, but which includes various esoteric concepts drawn from the ideas of Rudolf Steiner. It treats soil fertility, plant growth, and livestock care as ecologically interrelated tasks.

Bioremediation - The use of naturally-occurring micro-organisms or genetically engineered microbes to sequester toxic and radioactive compounds or transform them into less harmful forms.

Decommission- to remove nuclear power plant from service

Ecology – the branch of biology that deals with the relations of organisms to one another and to their physical surroundings. Traditional term of ecology follows the understanding it as purely non-human science. In my project I use the modern term of ecology where human being is considered as one of organisms, within the complex relationships to other organisms and their environment.

Framework – A basic system underlying urban design issues.

Healing landscape – therapeutic landscape

Ionizing radiation – radiation consisting of particles, X-rays, or gamma rays with sufficient energy to cause ionization in the medium through which it passes.

Phytotechnologies – use plants to extract, degrade,-contain, or immobilize pollutants in soil, groundwater, surface water, and other contaminated media.

Radiation – the emission or transmission of energy in the form of waves or particles through space or through a material medium

Remediation – the action of remedying something, in particular of reversing or stopping environmental damage.

Resource – place of opportunity for future development.

Sanitary protection zone – a special territory or a site of radioactive contamination where the irradiation level may exceed the prescribed norms under normal operational conditions of a nuclear facility.

Scenario – Coherent, internally consistent and plausible descriptions of future states of the world, used to inform future trends, potential decisions or consequences. (UK Climate Impacts Programme (UKCIP), 2001, p4)

Strategy – a systematic plan of action. (Cowan, 2005)

Transformability – the capacity to cross thresholds into new development trajectories.

(Economic) transition – the process or a period of changing from one state or condition to another:

Vision – desired state, common objective.

Acronyms

INPP – Ignalina nuclear power plant

EBRD – European Bank for Reconstruction and Development

Euratom – European Atomic Energy Community

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ANNEX

Nuclear Facility New Towns: Decay or Endurance?

Transformability attributes in nuclear facility cities

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Abstract – Nuclear facility New Towns are urban-technological phenomenon emerged in 1960s and 70s, in so called Atomic Age. Huge residential areas were built as parts of existing cities or as completely new towns in order to house highly educated nuclear power plant workers. The latter is mainly the case in the Western part of the former Soviet Union and America. Nuclear power plant cities have a specific term – atomgrads. Due to political decisions, accidents or the end of operation time approximately 150 of nuclear facilities in the world are decommissioned or facing decommissioning, which makes the future of satellite settlements uncertain. This paper would explore the ability of such, at a first glance, mono-functional urban formations in America and Eastern Europe to overcome socio-economic transformation and the attributes that determine their transformability, such as novelty, diversity, and organization of human capital trust, power and diversity in institutions, fast and abundant cross-scale communication within systems. More specifically it is illustrated in the successful transformation of one of the first atomgrads - Richland.

Key words – nuclear facility New Towns, atomgrad, transformability, resilience, closed city

1. Introduction

Nuclear facility New Town phenomenon emerged in 1960-1970s during, so called, first Atomic Age as a consequence of a construction of a large industry – nuclear facility. Such centrally planned New Towns were built as part of existing cities or as completely new towns, which is mostly the case in Eastern Europe and America. However, due to political decisions, accidents or the end of operation time approximately 150 of nuclear facilities ("Nuclear Decommissioning: Decommission nuclear facilities," 2016)
in the world are decommissioned or facing decommissioning, which poses the question of the future development and transformability opportunities of such cities.

Atomgrads could be seen as a part of postindustrial new town transformation studies, but nuclear industry have different urban form and social capital. Moreover the specifics of nuclear industry creates different precondition for transformability.
The main features of nuclear facility New Towns, such as being a centrally planned mono-functional unit, isolation spatially and/or by regulations, contradict the basic principles of transformability: **diversity** in natural and built capital, variety in institutions, actors, networks. This paper takes a deeper look to this urban-technological phenomenon in search for ability of such towns to transform in socio-economic terms. The attributes of transformability theory is analyzed in the context of nuclear facility New Towns with a more specific case of Richland.

2. Definition of the nuclear facility New Town

Nuclear facility New Town falls in the context of other industrial New Towns; however, the specifics of the nuclear industry (power plants, uranium mines, plutonium extraction plants) determine differences in development patterns, spatial form and social capital. Nuclear facilities, differently from other industries, have certain inertia. The operation can't be easily stopped and the proper decommissioning takes around 30 years ("Nuclear Decommissioning: Decommission nuclear facilities," 2016), which defines the time frame for strengthening the capacity for transformability.

Nuclear facility New Towns are small industrial cities, between 30 000 – 80 000 inhabitants (Wendland, n.d.), usually located in sparsely lived areas. The spatial form of such towns is determined by sanitary protection zones, therefore towns become territorial urban units, scattered in the landscape. Their location is also determined by the allocation of resources (e.g. uranium mines), sinks of energy (large industrial sites) or infrastructure (industrial railway, high voltage grids). The city is isolated from main roads and passenger train lines. In cases of closed cities, the entrance to the city could be restricted.

Nuclear power plant cities has a specific term – Atomgrad or atomograd (Russian "atom city") (Wendland, n.d.).

The other term found in literature is defined by Kate Brown (2013) - "cities made by plutonium" - closed and secret military nuclear facility cities in U.S. and former Soviet Union.

They both served for political propaganda either showing the exemplary models of "nuclear age" society or demonstrating the military power of the country. These cities have similarities in the spatial formation and development patterns and now are facing the need for socio-spatial transformation in the context of decommissioning of their main economic pillar - nuclear facility.

Specific spatial organization defined by nuclear facility location, resources, political propaganda and distinct population created the "nuclear age" phenomenon - nuclear city, that is facing the transition caused by changing socioeconomic situation.

3. Transformability theory

Transformability term is used in **resilience thinking** which address the characteristics and development of social - ecological systems (SES) – integrated system of ecosystem and society with reciprocity and interdependence between them (Folke et al., n.d.). The transformability is one of the key aspects of resilience thinking together with resilience and adaptability. All three are interrelated on different scales and share several common attributes (Folke et al., n.d.). Transformability in this paper is analyzed on the city – region scale.

The term transformability means the capacity to shift to new development paths. It was defined in Walker et al. (2004):

> Transformability – the capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable.

Other two terms of resilience thinking - resilience and adaptability, are interrelated with transformability. Resilience is defined as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker et al., 2004). Adaptability captures the capacity to learn, combine knowledge and experience, adjust structures according changing situation and develop within the current path (Berkes et al., 2003). Transformability, differently from resilience and adaptability, involves a change in development direction.

In case of atomgrads which are strongly dependent on their nuclear facilities, untenable situation is usually created by political powers that once initiated the foundation of the city now are influencing the closure of their nuclear facilities. Transformations in these cities are **forced** on them by changing socioeconomic, economic, environmental, political conditions rather than occur according **deliberate model** (Folke et al., n.d.) which would be initiated by the residents.

The **attributes** of transformability have a lot of in common with general resilience and adaptability theories. All of them **share high levels of all forms of natural and built capital, variety in landscapes and waterbodies, institutions, actors, networks, rich learning platforms, presence of collective action, support from higher governance levels.** (Folke et al., n.d.)

The specific transformability attributes are related with **novelty** as one of the most important features, **diversity and organization of human capital** (education system, expertise, variety of occupations), **trust, power and diversity in institutions, fast and abundant cross-scale communication within systems.** (Walker et al., 2004)

However there are slower variables that could restrict transformability such as identity, core values and lifestyles that residents would like to keep and resist to changes. Political and power relations could complicate the decision making for the future development of the city. Ethics is a relevant question in atomgrads as well. Decision makers should take a position whether they continue to operate the nuclear facility or close it. On the one hand, they would stop polluting natural and built environment, but on the other hand would put the economy of the nuclear facility town in uncertainty.

Transformability being part of resilience thinking seeks for building the capacity for city to shift to new development directions by defining and evaluating in time and in terms of opportunities resources of the city. Transformability looks at thresholds, crisis as "windows of opportunity for novelty and innovation" (Folke et al., n.d.), recombination of sources of capital, know-how and knowledge to direct the successful socio-economic transition.

4. Features of nuclear facility city and transformability

Nuclear facility cities share common features in terms of location, spatial organization and population. Some of characteristics become a prerequisite for transformability capacity of such cities.

Nuclear facility cities are situated in sparsely populated areas, usually forested, marshy or agriculture lands in the proximity of waterbodies – a huge lake, river or a sea. Such location is predefined by the technical aspects of nuclear facility and sanitary protection zones that range from 3 to 16 km depending on the site specifics, geographical location and demographics ("NRC: Emergency Planning Zones," 2014). Technical aspects require nuclear facility to be located on a stable soil far from seismic belts and in the close proximity to huge waterbodies due to the need of using water for cooling of reactors. There are certain restrictions for residential and agricultural land use inside sanitary protection zones, therefore during the operation of nuclear facilities, **such zones has less interference of human activities and have potential to become nature reserves - sites rich with diverse flora and fauna habitats valuable not only on regional but also on national and international levels.**

Nuclear facility New Towns characterized by very well developed industrial infrastructure (railway, high voltage grids) that connects them with national and international networks. This infrastructure could be potentially reused for new production industries after the decommissioning of nuclear facility.

Nuclear facility New Town consists of several mono-functional different morphology parts that are scattered in the landscape and are very well connected with each other. The **connectivity** is one of the four structural variables that define the resilience of urban form (Alberti, 1999). In the context of transformability such principles of city formation, not the urban shape are crucial for building the capacity to overcome a disruptive change. Even the dispersed urban form could be transformable if it contains strong relationships between its elements and abundant cross-scale communication between systems.

In terms of institutional organization, nuclear facilities New Towns are based on one large commercial – nuclear facility. There are other auxiliary functions that serve the nuclear facility and its workers. Abundance of cultural and sports institutions are created due to special attention to the health of residents. In the course of time, these institutions grow and develop vast interstate/international networks in fields of their expertise. However, the functioning of nuclear facility, especially nuclear power plant is relatively temporal (30 – 60 years) and the decommissioning causes negative impact to related companies. For example, in case of Visaginas, New town in Lithuania, former Soviet Union, 75 per cent of companies are directly or indirectly dependent on nuclear power plant, during its operation. Cities in Eastern Europe are extremely vulnerable to changes in nuclear facility. The auxiliary companies of nuclear facility are under the roof of the same organization, while in Western Europe such functions are outsourced to private companies decreasing their dependency on the nuclear facility. Transformation of nuclear facility institutional structure increases the stability of economic situation of the city.

The distinct feature of nuclear facility New Towns is the population. Cities functioned as ethnic islands, containing multinational/multicultural population that came all over the country (in case of the U.S. – from different states, the former Soviet Union – from different countries), purely white-skinned and most of them highly educated (Brown, 2013). High education levels and a lifelong learning, which is required by nuclear facility, create preconditions for the novelty.

In addition to this, the population of nuclear facility New Towns is also characterized by active and strong communities, which usually have the support from higher government levels (Brown, 2013). Good relationship with the government emerges from the concept of atomic age utopia, in which nuclear facility workers plays an important role as an exemplary society. This privileged position allows the residents to influence the development of the city.

The **strong communities of highly educated people, vast institutional networks on national and international levels, the seek for novelty, functional diversity that emerges during the time, rich landscapes and waterscapes are the main features that drive nuclear facility New Towns to be capable to transform after disturbance**. The expected and unexpected resources emerge during the development of the city which later could become a fertile ground for a new economy and the change of spatial organization of the city.

5. Case study - Richland

Richland is located in United States and is one of the first nuclear facility New Towns in the World that had already passed the transformation.

Richland was a small (around 300 people) farmers' village before government decided to build a city to house workers for Manhattan project Hanford site in 1943. Farmers' property was condemned and compensated by federal court. Construction works for 16 000 – resident bedroom community started instantly at brisk pace following the trends and standards of middle class living environment of that time (fig.1) ("HistoryLink.org- the Free Online Encyclopedia of Washington State History," n.d.) City spread thought the landscape with thousands of single family homes, duplexes, apartments, dormitories and immense numbers of cultural and educational institutions. City was a green spot in a dusty, dry and treeless landscape, enclave of upper middle class inhabitants in sparsely lived countryside.

Fig. 1 *Richland village in 1950s*

Fig. 2 *Changes in Richland: construction of the Riverside Inn (bottom right corner, along the river), hospital, library, federal building, new housing area in the Richland North. (1973)*

Richland was higly dependent on Hanford Site, project of plutonium production for nuclear bombs. Every time the government cut the spending for plutonium production, it resulted in unemployment and emigration of young educated workers in search for the job. Even though the government imposed their agenda on Hanford, citizens put the effort to retain it. They fear less the impact of radiation to their health rather than losing their main economy driver and privileged status. When Atomic Energy Commission shut down eight of nine Hanford reactors during 1964-197, Richland inhabitants came in action. Using political channels, they persuaded the Atomic Energy Commission to support the construction of new reactor, which was able to produce not only weapons-grade plutonium, but also provided the power for the region; negotiated better deal for privatization of homes and businesses and gained access to part of buffer land near Hanford site (Findlay and Hevly, 2011). The city expanded, following with construction of new roads, existing houses were remodeled and enlarged, services upgraded – citizens improved the town and put it in the new agenda (see fig. 2). The transition was made to more peaceful use of nuclear facilities – **from plutonium production for nuclear bombs, to energy generation, nuclear waste management and site cleanup.** Even if the city still was highly dependent on the one company, transition gave a new hope for the city and **attracted high technology industries**, which grew up and surpassed the Hanford works in 1970s. Some of the buildings during the decommissioning procedure were maintained, like B reactor - the first industrial-scale nuclear reactor in the world ("BRMA home," n.d.). It was opened for occasional guided tours. The Hanford buffer zone due to establishment of the Hanford Nuclear Reservation were not affected by urbanization or agricultural activities since 1943 and become **valuable site of national wildlife which was turned into the Hanford Reach National Monument** in 2000(fig.3)("Cultural Resources - Hanford Reach - U.S. Fish and Wildlife Service," n.d.). These are prerequisites for the development of **tourism** in the region. Existing services grew as well and contributed to diversification of the economy of Richland to technology, medicine, education and transportation.

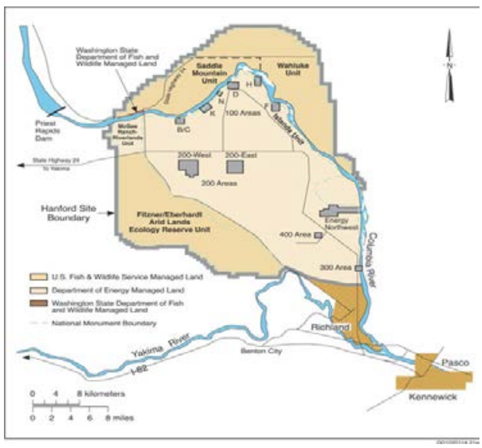

Fig. 3. *The Hanford Reach National Monument, Tri-Cities.*

Another reason for the success of Richland transformation is related with the regional setting. Before Hanford project, region was dominated by cities of Kennewick and Pasco, which were based on agriculture (orchards and vineyards) and trade respectively. They kept developing independently even though their demographics were affected by Hanford project. In 1950s, **Richland, Pasco and Kennewick formed Tri-Cities**, an unofficial alliance of metropolitan region, which helped to strengthen their position and have more effective marketing. (fig.3) ("HistoryLink.org- the Free Online Encyclopedia of Washington State History," n.d.)

Richland is an example of successful transformation that was determined primarily by social structure. Active and privileged community of Richland took the responsibility the city's future and initiated transition to energy and high technologies economy. Their knowledge and skills become a fertile ground for new companies to settle. The spatial organization – agglomeration of three cities, increased the accessibility and connectivity. Natural treasure that developed through time in the sanitary protection zone, nowadays contributes to city's economy and wellbeing of its residents. In general, a path dependency is visible in the case of Richland transformation – in the context of disruptive change, city uses its social and spatial capital, transforms its urban form and develops as a nuclear science and high technology city.

6. Conclusion

The nuclear facility New Towns, from a first glance, representing contradicting cases to transformability theories, shows the ability to develop the transformability attributes through time and successfully pass the socio-economic transition, except for the cases of nuclear disasters. Nuclear facility cities share the set of the most common transformability features, such as strong communities of workers, highly educated people, diverse learning platforms, spatial transformations of the restricted sites near the nuclear facility. The knowledge about transformability attributes could diminish the shock caused by decommissioning of nuclear facility and strengthened transformability capacity of other nuclear facility cities in order to facilitate transformative change. **The research and constant update of the knowledge about city's resources is the precondition that helps in urban planning to know if, when, and how to conduct a transformative change to avoid seriously undesirable situations,**

7. Questions for further research

The further research is needed in translation of transformability theories into practice, more precisely, about urban planning tools that could help to acknowledge the transformability attributes, foster and use them in order to conduct a transformative change.

8. Glossary of terms

Sanitary protection zone – a special territory or a site of radioactive contamination where the irradiation level may exceed the prescribed norms under the normal operational conditions of a nuclear facility. (Seimas of the Republic of Lithuania, 1996)

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List of illustrations

Figure 1. *Richland village in 1950s* . At: https://www.washington.edu/uwired/outreach/cspn/Website/Classroom%20Materials/Pacific%20Northwest%20History/Lessons/Lesson%2020/20.html (Accessed on 15.12.2015)

Figure 2. *Changes in Richland: construction of the Riverside Inn (bottom right corner, along the river),hospital, library, federal building, new housing area in the Richland lorth.* (1973). At: http://www.tri-cityherald.com/news/special-reports/article31730502.html (Accessed on 05.12.2015)

Figure 3. *The Hanford Reach National Monument, Tri-Cities.* At: http://hanford-site.pnnl.gov/envreport/2001/sumoverview.stm (Accessed on 05.12.2015)

Nuclear power and the city

At the beginning of the 20th century, new forms of energy were discovered which attracted scientists' attention like no scientific discovery ever had before. Nuclear fission was expected to revolutionise the energy sector. Initial applications of nuclear technologies came into practice with the detonation of the nuclear bomb in 1945. The first nuclear age had started. The military aspect of nuclear innovations was later covered with the veil of peace and promoted for it's energy potential by U.S. president Eisenhower (Eisenhower, 1953). Nuclear energy was a symbol of progress and modernity that could solve most of the energy issues. The 1960s-1970s was the period when large scale nuclear power plants were constructed all around the world.

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Nowadays, due to political decisions, accidents or as facilities come to the end of their operational time, approximately 150 of such nuclear facilities have been decommissioned. This presents a critical period of transition for these nuclear landscapes, calling us to reconsider the relationship between nuclear power and a built environment, as well as the social, spatial and environmental impact of decommissioning.

Network of a nuclear power plant

Large scale nuclear power plants, being part of a centralised energy network, create a huge amount of infrastructure; city sized industrial sites and complexes for facilities. Entirely new energy landscapes (Fig. 1) are created, characterized by high voltage energy transmission lines, spent nuclear fuel landfills and safety zones with restricted land use activities. Life in the region with such nuclear power plants is associated with a constant threat of radioactive pollution due to accidents or even a meltdown of reactors. Utilisation of spent nuclear fuel is another question under debate in nuclear countries attracting the attention of the broader society. For instance, sculptor James Acord tried to raise awareness about long lasting nuclear waste by making sculptures out of uranium. Furthermore, nuclear power plants are part of the larger nuclear network that consists of uranium mining industries, milling, conversion, enrichment, fabrication plants, spent fuel reprocessing plants and storage facilities. Uranium mining pollutes the environment and causes cancer in people working and living in its proximity. In this way, nuclear power plants affect our lives directly or indirectly, by transforming our environments and leaving structures behind for the centuries to come.

Emergence and decline of atomgrads

Large scale nuclear power plants also created new settlements as part of existing towns or completely new towns. The latter one has a specific term – atomgrad (Fig. 2). This is a small industrial city, between 30.000 – 80.000 inhabitants, built to house nuclear power plant workers. There are several dozen of such cities around the world, mainly in the former Soviet Union and America. Such cities have a distinct urban shape. The spatial form of such towns is determined by the sanitary protection zone (3 to 16 km), resulting in territorial urban units, scattered in the landscape. Nuclear facility cities are situated in sparsely populated areas, usually forested, marshy or agricultural lands in the proximity of large waterbodies to cool down reactors. There are certain restrictions for residential and agricultural land use inside sanitary protection zones. Therefore during the operation of nuclear facilities, such zones have become nature reserves - sites rich with diverse flora and fauna habitats valuable not only on regional but also on national and international levels, for example Hanford national monument in the U.S. (Fig. 3)

Atomgrads house a very distinct type of population. The cities function as isolated islands of non-local populations, which are almost exclusively white and mostly highly educated[1]. Residents form strong and privileged communities, which usually have support from higher government levels as being the showcase of exemplary society in nuclear age propaganda (Brown, 2013). They fear less the impact of radiation than the shutdown of their nuclear facility – the main economic pillar. The specific knowledge of such workers and language barrier becomes an issue in finding work after the decommissioning, causing unemployment and a shrinking population in the atomgrads.

The impact of decommissioning

The decommissioning of large scale nuclear facilities is not only an economic issue but also a threat to the identity of atomgrads. All the decommissioning options defined by the International Atomic Energy Agency involve dismantling the nuclear power plant. Therefore the nuclear facility disappears both functionally and physically.

2

3

Reconsidering decommissioning

The process of dismantling causes a huge amount of waste and the loss of valuable structures. The heritage question of nuclear power plants is controversial. There are very good examples of nuclear power plants that functioned without any accident, even with a positive impact on the natural environment and population, for example providing oxygen to flora and fauna of a frozen lake, creating well-paid jobs and sustaining nuclear science. On the regional scale they can be seen as an achievement, however, they still support the radioactive uranium mines by creating demand for nuclear fuel. The heritage questions of nuclear power plant site are even more complicated in former Soviet Union countries, where such nuclear power plants were seen as invaders built by foreigners. Decommissioning could be a time when the value of nuclear power plant structures is reconsidered; compromises between conflicting opinions are made.

The phenomenon of nuclear power plants affects us directly or indirectly, creating physical and mental imprints: infrastructures, wastes and brownfields, cities, populations, memories and knowledge. Decommissioning tries to eliminate the danger of radioactivity from our environment, however, it takes away more than that. As designers, we should question structures under demolition, whether or not they have cultural value, how they could be adapted to future uses, how the relationship between isolated industrial sites and the surrounding environment, city and the region should change. We should think about the knowledge value of former nuclear power plant workers and ways to reuse it; and finally envision development possibilities of nuclear power plants settlements and the interventions required. A more integral plan of decommissioning is needed to build the future of nuclear power plant sites and cities on the relics of the First Nuclear Age. •

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1. Ignalina Nuclear Power Plant in Visaginas, Lithuania ©Andrius Pavelko
2. Skyline of Kuznetsovsk ©Dyakov Vladimir Leonidovich
3. Hanford Reach National Monument, Washington, United States © www.handsontheland.org

Note

1. For example 85% of Visaginas' population, an atomgrad in Lithuania, came from across the whole former Soviet Union.