Appendix

Autonomous Oosterwold

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Faculty of Architecture and the Built Environment
Master Track: Urbanism
Studio: Urban Metabolism

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1. Interviews and surveys

1.1 Interview Yolanda Sikking (area team)

06.12.18

Yolanda Sikking is part of the area team who represent the government in Oosterwold. In this case the government means Gemeente Almere, the Water board and the Province of Flevoland. The team is responsible for informing new inhabitants, organizing the purchasing of plots, introducing residents to each other and ensuring the principles are maintained. Yolanda is responsible for all external communication.

1.1 Freedom is the most important principle

This interview was conducted to develop a further understanding of the role of the government in Oosterwold. As Yolanda explained, that role is as small as possible to respect the first principle of Oosterwold: people design Oosterwold. Until today this remains the most important principle in Oosterwold even when this process is sometimes met with setbacks, such as utility companies (e.g. Alliander) who do not communicate with private individuals, only with government. Now, luckily, this obstacle has been dealt with by the area team, but it shows the amount of energy and change necessary to be able to comply as much as possible to this first rule. The freedom in developing and designing your own household is also one of the main reasons many people come to Oosterwold. "They often have a specific philosophy on life they want to pursue and share with others" according to Yolanda. This has already led to interesting communities where people share the care for their children or live together with several generations within one family.

1.2 Quota on food production

Even though the area team is always working towards maximum freedom, they are currently thinking about enforcing restrictions or quota on the envisioned food production that is supposed to take place on people's plot. As Yolanda explained, food production is the most important element within Oosterwold with around 50% of the land dedicated for farming. To remain true to this vision it is important that inhabitants participate. At the moment not all inhabitants are fully participating. In some cases, food production is merely solved with a single fruit tree or flock of chickens which is not sufficient enough to create the agricultural area Oosterwold is supposed to be. It has also led to some discussion within the area since some inhabitants are actively participating in producing food. The area team is now trying to inspire the inhabitants that are not participating through events and workshops alongside discussing possible restrictions and quota. Other than that the area team has decided to inflict different rules when property is developed by a project developer. The area team has seen that often in these type of developments inhabitants were not properly informed about the specific principles in Oosterwold leading towards these kind of problems. Therefore, the area team has decided to view the inhabitant as their main interlocutor. This means inhabitants are obligated to

come to an informative presentation and it means project developers have to find inhabitants before they are able to develop a plot.

1.3 Communal essential services are stimulated

Apart from challenges within food production, there are also some challenges considering the wastewater treatment that is done per plot or community using IBA's or helophyte filters. Oosterwold needs strict rules since eventually 15.000 households will be connected to decentralized systems. To ensure these rules are met the water quality is measured twice every year and previous measurements have shown that the water quality is not sufficient. At the moment an external agency is conducting research into how these systems can be optimized to ensure a high water quality, now and in the future. It has already been concluded that IBA's or helophyte filters work better when wastewater of several households is combined. Combining these systems with several households is therefore stimulated by the area team, and this is similar for energy production or food production. "Communal energy production, food production and specifically wastewater treatment is definitely stimulated" according to Yolanda.

There were of few other interesting remarks Yolanda made. First about the specific phasing of the area, secondly how self-sufficiency is more important than sustainability but not in the case of electricity, thirdly how archaeological investigations have been taken back by the municipality and lastly how it was calculated that Oosterwold takes up the same amount of space as regular city expansions.

1.4 Phasing

The development of the area is split in two phases: Oosterwold-Almere and Oosterwold-Zeewolde. Right now the first 1/3 of the area is being developed on the Almere side and the other 2/3 of the area is developed after 2022 (also depending on how fast the development goes) in collaboration with the municipality Zeewolde.

1.5 Self-sufficiency and electricity

When designs are made essential service solutions are not necessarily evaluated for their sustainable impact. The emphasis is more on the self-sufficiency of essential service systems. Inhabitants are mostly stimulated to develop as much self-sufficiency as possible. With energy this is different because inhabitants can also choose to connect to the (national) electricity grid.

1.6 Archeology

After a few disputes with inhabitants who bought a plot but eventually could not built a house on a large part of that plot due to archaeological discoveries, the municipality decided to regain responsibility over the archaeological research that is was previously the responsibility of inhabitants. This is to create a more candid overview of the different plots and their possibilities.

1.7 City expansion

On first sight is seems like Oosterwold is granted more land surface per inhabitant than usual.

However, essential services and for example public greenery is now organized within the neighbourhood opposed to a normal situation where it is organized outside of a neighbourhood. When this is also taken into account the neighbourhood has about the same dimensions as a normal city expansion.

To conclude, freedom for designing or a way of life is the essential principle of Oosterwold. On the other hand, the area team is looking for ways to assess whether people stay true to the other principles of Oosterwold such as food production and water quality and how to improve these factors. The area team also stimulates the formation or development of communities who share essential service systems since it has been noticed in the case of wastewater treatment this results in a better working of the system.

1.2 Interview inhabitant of Oosterwold

07.12.18

This interview was conducted to develop a further understanding of the ambitions and motives for developing a house in Oosterwold as well as the essential service systems with inhabitants. In this case an inhabitant was interviewed (his name is not mentioned due to privacy reasons) who is currently in the process of becoming an inhabitant of Oosterwold. He has bought a standard plot and is now planning to move into a mobile home on the plot in March 2019. He is in the process of building his house and hopes to finish in July 2019. He (52) is employed in the municipality Almere and is moving there together with his partner (45) and adolescent son and daughter. They are building independently and have chosen to design and built their own essential service systems.

2.1 The choice for Oosterwold and development of their plot

The inhabitant and his partner came into contact with Oosterwold quite early in the process since he works at the municipality. This also means that he knew more beforehand than the average inhabitant of Oosterwold. As he explained their main reason for choosing to live in Oosterwold was due to the possibility to live off-grid and independent, away from the busy city life and in a calm and natural environment. They were first drawn to standardized plans but eventually decided to build their own house due to a possible reduction in costs and an incidental available piece of land. This means he and his partner did not design their own plot. The main challenges during the development so far have been the archaeological discoveries on their plot which has slowed the process down by a year. This has also resulted in an extra strain on the road discussion (which was already a cause for high dispute since private interest sometimes dominate the discussion) since he and his family are now one of the few who still have to develop their plot and are obstructing the actual building of the road. Since amenities such as electricity are part of the road neighbours have grown impatient. Even though this has led to discussions, he still has more and better contact with his neighbours than he has in his current neighbourhood. He is especially inspired by some who seem to have an infinite amount of enthusiasm.

2.2 Essential Services

During the built there was the possibility of joining forces with neighbours and creating a combined wastewater treatment plan. If they would combine their wastewater in one system (for example a helophyte system) it would reduce the cost of construction and lead to a better water quality. In the end they didn't choose this combined system because of the insecurity that other (future) neighbours might possibly pollute the system. He said that this is the difference between developing on your own or developing with a group of people you trust such as a family or food and energy are also done individually. He stipulates that there are still people using chloride as their main cleaning product resulting in polluted waters. The inhabitant would not be surprised if in the end some households need to be reconnected to the sewage system. In the case of energy, the house will have a combined pvc/pvt system attached to a heat pump. The electricity is transferred to the electricity grid with the help

of Liander. In total 100 m2 of the area will be directed to food production of which a part will be in greenhouses to be able to produce ‘exotic’ food.

2.3 Contact with the area team

The inhabitant strongly believes that the municipality should interfere as little as possible. Rather they should take upon the role as advisor or informant. Although they currently have the obligation to inform inhabitants according to him this could be done better. New initiators within Oosterwold are often not connected to their neighbours but this is essential to be able to start conversations on for example the road. This can slow down the development process. Also, things like telling him and his neighbours corners of 90 degrees in the road are not possible or the probability of finding things of archaeological importance. Apart from that he believes the area would benefit from a small team between the government and inhabitants who are experts on the way of living in Oosterwold and can advise as well as act as mediator.

1.3 Survey conducted by 5 inhabitants

10.12.18

Nummer Respondent	Uit hoeveel personen bestaat uw huishouden?	Wat voor type kavel heeft u?	Hoe is uw kavel ontwikkeld?	Waarvoor gebruikt u uw kavel?
1	2	Normale kavel	Individueel	Wonen, Stadslandbouw
2	4	Normale kavel	Individueel	Wonen
3	2	Normale kavel	Individueel	Wonen
4	3	Normale kavel	Individueel	Wonen
5	4	Normale kavel	Gezamenlijk met andere huishoudens	Wonen

1. Question one of the survey

Nummer Respondent	Hoe hoog is uw elektriciteit (kilo Watt uur) verbruik per jaar voor het gehele huishouden	Hoe hoog is uw warmtevraag (Giga Joule) per jaar voor het gehele huishouden?	Wat is uw jaarlijkse waterverbruik (per 100 liter) voor het gehele huishouden?	Heeft uw huishouden een aangepast dieet?
Nummer Respondent	Uit hoeveel personen bestaat uw huishouden?	Wat voor type kavel heeft u?	Hoe is uw kavel ontwikkeld?	Waarvoor gebruikt u uw kavel?
1	2	Normale kavel	Individueel	Wonen, Stadslandbouw
2	4	Normale kavel	Individueel	Wonen
3	2	Normale kavel	Individueel	Wonen
4	3	Normale kavel	Individueel	Wonen
5	4	Normale kavel	Gezamenlijk met andere huishoudens	Wonen

2. Question two of the survey

Nummer Respondent	Bent u aangesloten op het elektriciteitsnet?	Wekt u (een deel van) uw eigen elektriciteit op?	Waarmee wekt u uw elektriciteit op?	Wekt u uw elektriciteit gezamenlijk (met meerdere huishoudens) op?	Gebruikt u elektriciteit opslag?
1	Ja	Ja, maar te kort om percentage te weten	PVT panelen (zonnepanelen)	Nee, individueel	Nee, Nee, maar we zijn dit in de toekomst wel van plan
2	Ja	Ja, volledig	PVT panelen (zonnepanelen)	Nee, individueel	Nee, maar we zijn dit in de toekomst wel van plan
3	Ja	Ja, 20 - 40 % van het totale verbruik	PVT panelen (zonnepanelen)	Nee, individueel	Nee
4	Ja	Ja, > 20 % van het totale verbruik	PVT panelen (zonnepanelen)	Nee, individueel	Nee, maar we zijn dit in de toekomst wel van plan
5	Ja	Ja, volledig	PVT panelen (zonnepanelen)	Nee, individueel	Nee, maar we zijn dit in de toekomst wel van plan

3. Question three of the survey

Nummer Respondent	Hoe verwarmt u uw huis?	Wekt u uw warmte gezamenlijk (met meerdere huishoudens) op?
1	Lucht warmte-pomp	Nee, individueel
2	Lucht warmte-pomp	Nee, individueel
3	Lucht warmte-pomp	Nee, individueel
4	Lucht warmte-pomp, Houtskachel	Nee, individueel
5	Lucht warmte-pomp, Thermische panelen (zonnecellen), Houtskachel	Nee, individueel

4. Question four of the survey

Nummer Respondent	Waar komt uw water vandaan?	Maakt u gebruik van gescheiden afvalwater inzameling?	Hoe verwerkt u uw afvalwater?	Verwerkt u uw afvalwater gezamenlijk (met meerdere huishoudens)?
1	Waternetwerk / leidingen	Nee	Helofytenfilter, Septische put	Nee, individueel
2	Waternetwerk / leidingen	Nee	Helofytenfilter	Nee, individueel
3	Waternetwerk / leidingen	Nee	Helofytenfilter	Nee, individueel
4	Waternetwerk / leidingen	Nee	Helofytenfilter	Nee, individueel
5	Waternetwerk / leidingen	Nee	Helofytenfilter	Ja

5. Question five of the survey

Nummer Respondent	Waarvoor gebruikt u landbouw?	Op welke manier vult u uw landbouwgrond in?	Hoe verwerkt u uw voedsel afval?
1	Voedsel	Moestuin, Fruitbomen, Schapen	Composthoop
2	Voedsel	Moestuin, Fruitbomen, Veeteelt (kippen, varkens, koeien)	Composthoop
3	Voedsel	Moestuin,	Dit wordt

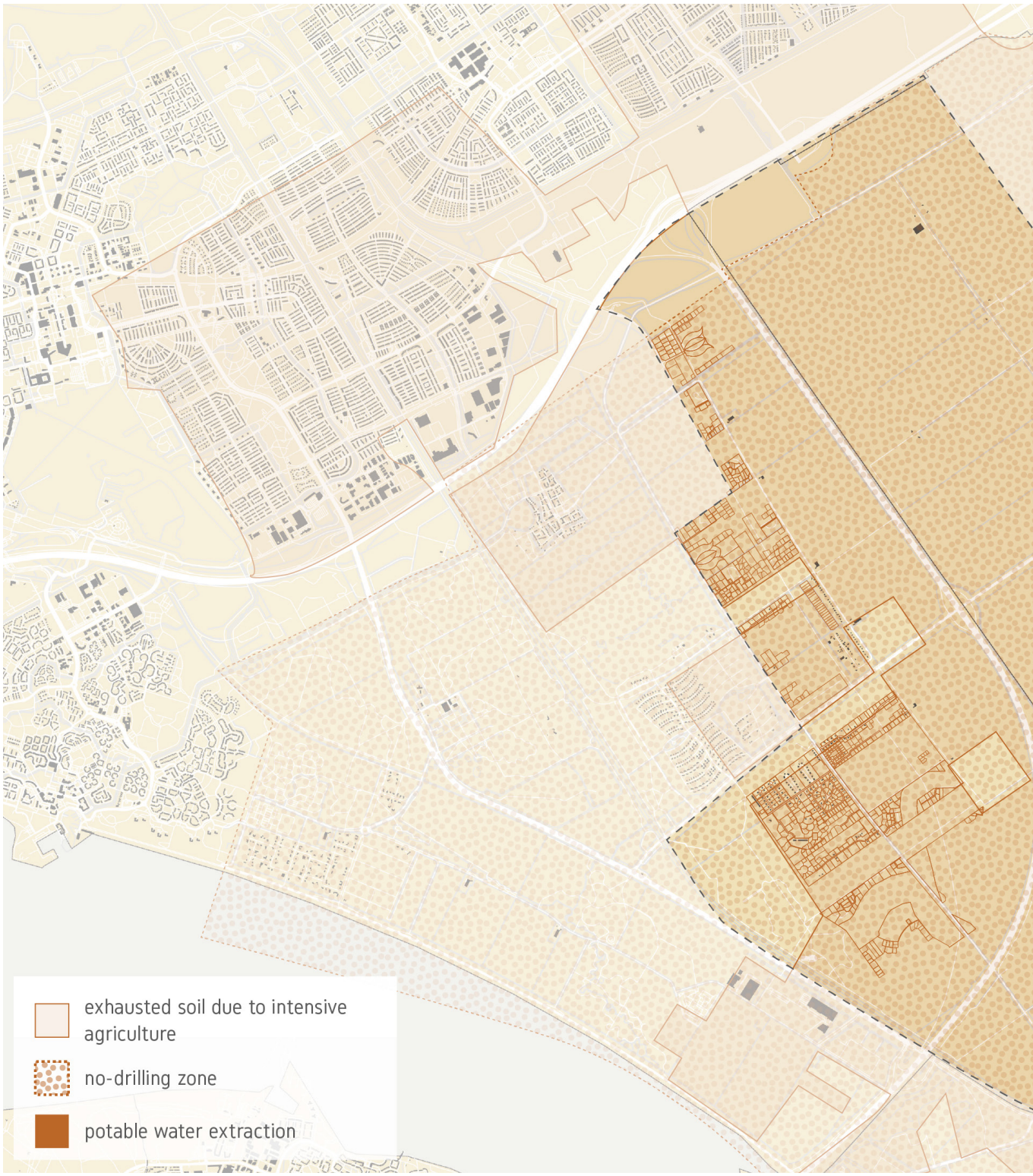
Nummer Respondent	Uit hoeveel personen bestaat uw huishouden?	Wat voor type kavel heeft u?	Hoe is uw kavel ontwikkeld?	Waarvoor gebruikt u uw kavel?
1	2	Normale kavel	Individueel	Wonen, Stadslandbouw
2	4	Normale kavel	Individueel	Wonen
3	2	Normale kavel	Individueel	Wonen
4	3	Normale kavel	Individueel	Wonen
5	4	Normale kavel	Gezamenlijk met andere huishoudens	Wonen

6. Question six of the survey

Nummer Respondent	Heeft u nog suggesties, verbeteringen of opmerkingen over energie, water en voedsel systemen in Oosterwold?
1	
2	
3	
4	Misschien meer gezamenlijke opvang van water dmv van een vooraf aangelegd grachten/sloten systeem. Zo weet je zeker dat de verplichte waterberging ook daadwerkelijk plaatsvindt (en niet alleen op papier)
5	samen werken aan waterzuivering wordt niet gestimuleerd, de regelgeving ontmoedigt dit zelfs (niet als doe maar als bijeffect) maar gezamenlijke zuivering blijkt wel beter. verder wordt samenwerking op gebied van berging ook onbedoeld ontmoedigt.

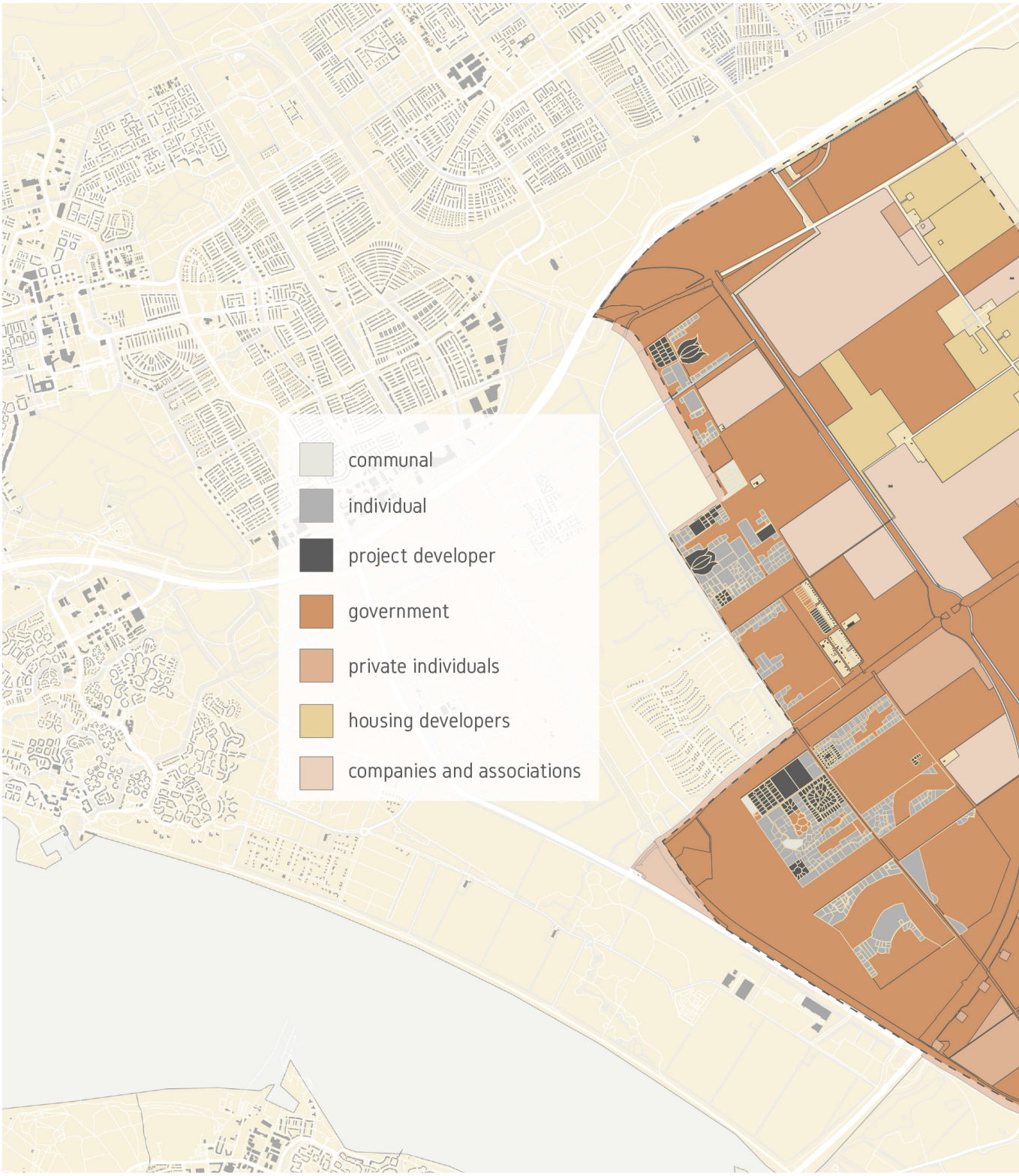
7. Question seven of the survey

2. Additional maps

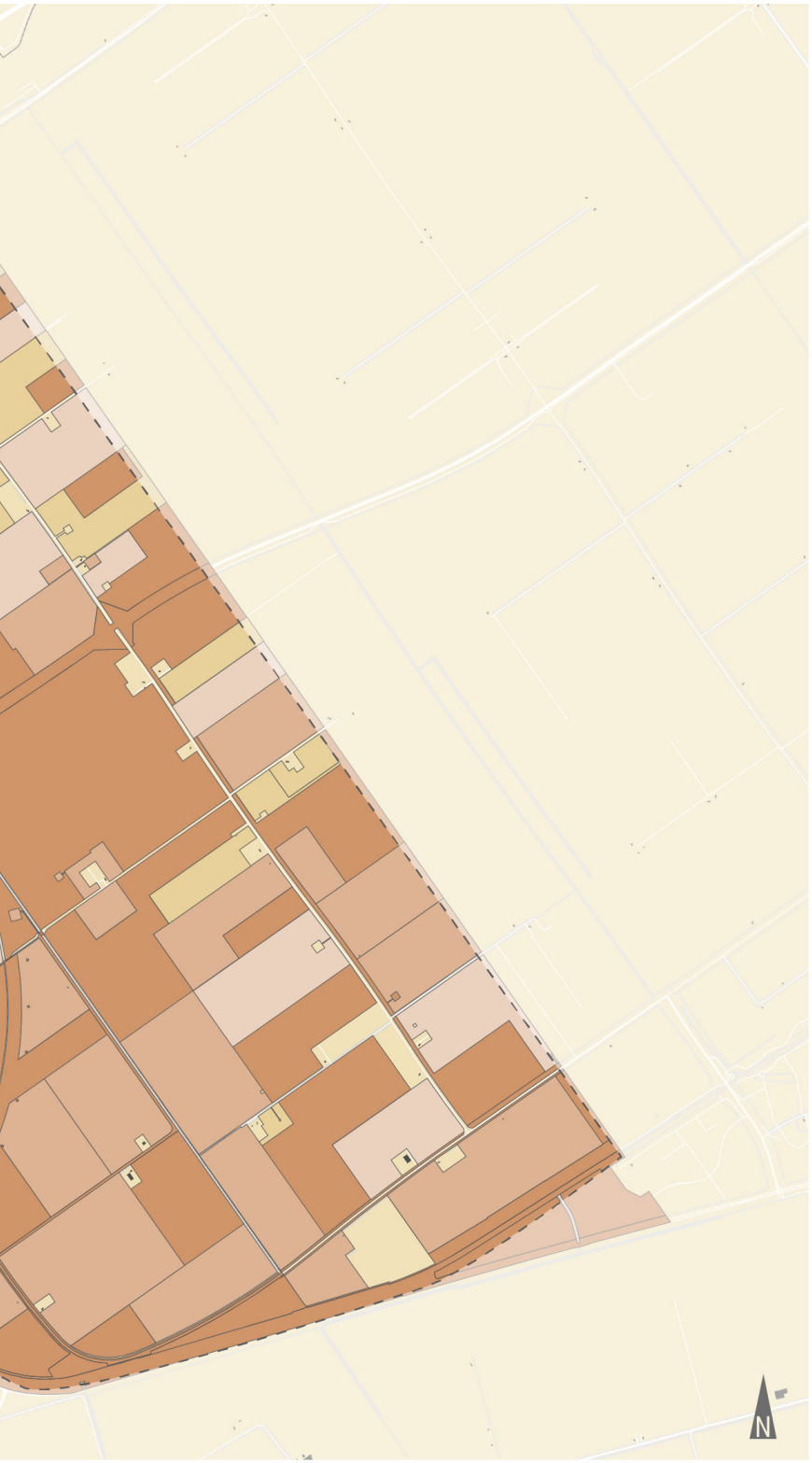


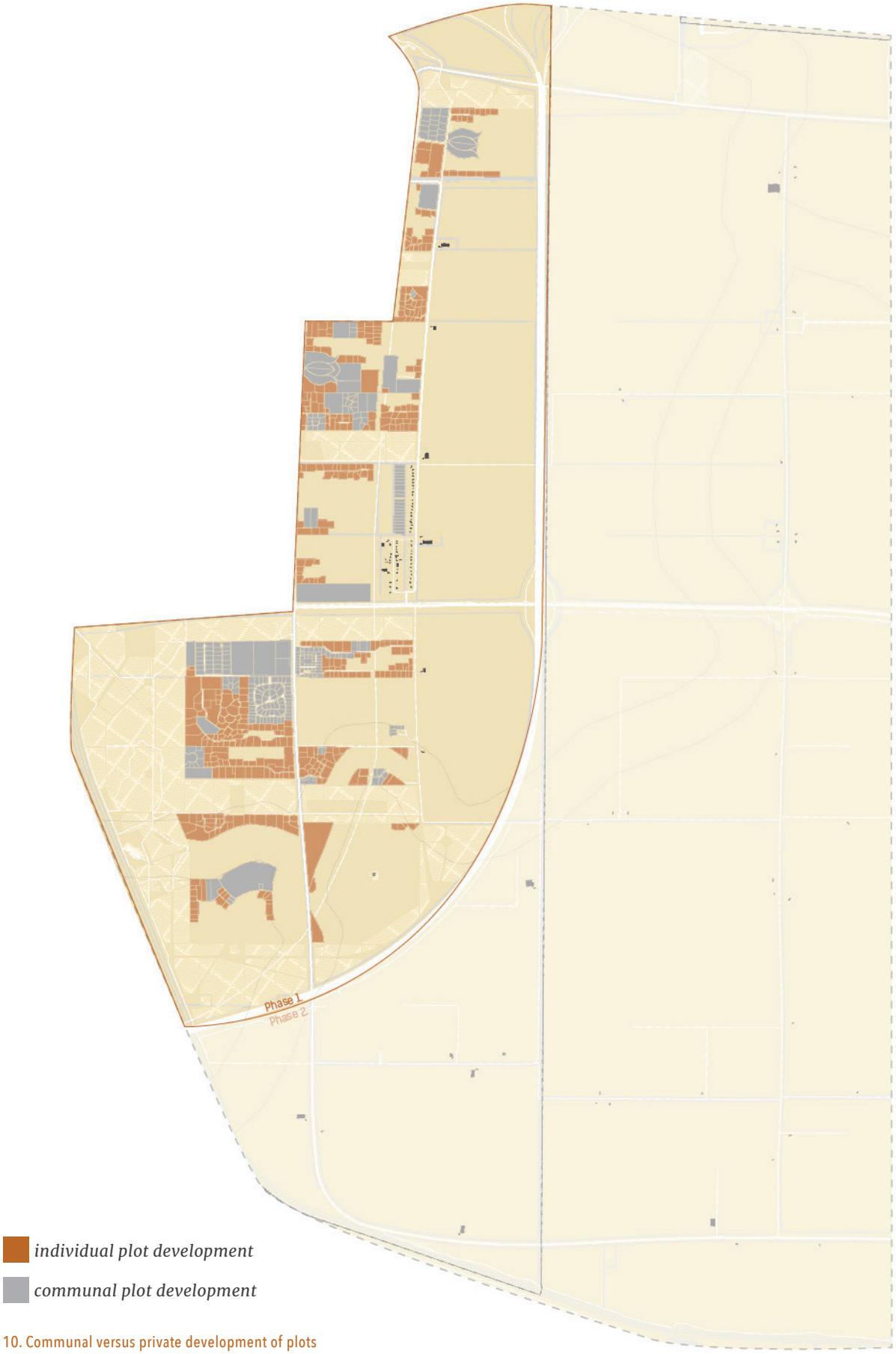
8. No-drilling zone due to potable wwater abstraction


Municipality Zeewolde
Municipality Almere
Oosterwold
N

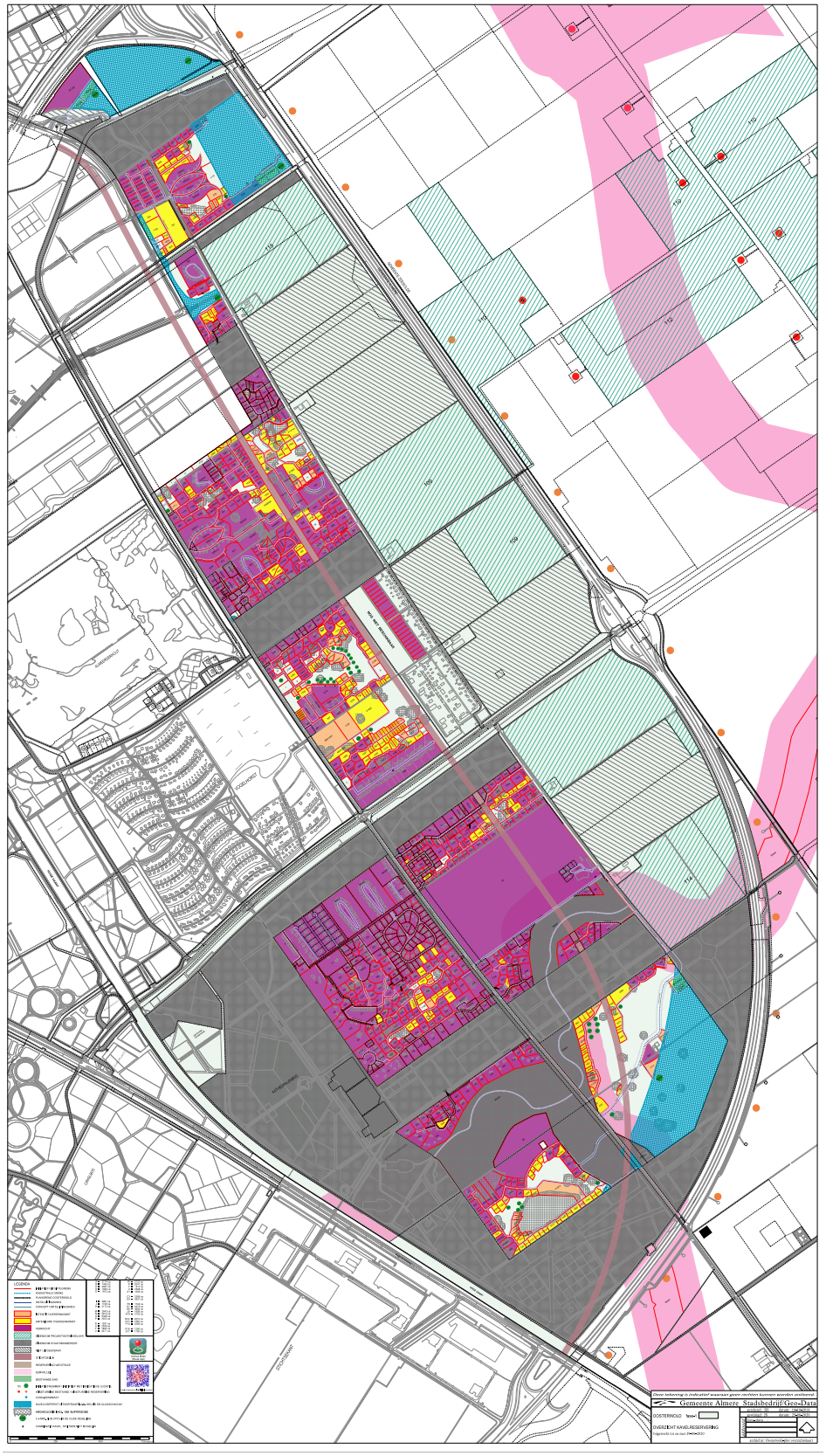


9. Land-ownership in Oosterwold


N



10. Communal versus private development of plots



11. Most recent map of Oosterwold

3. Calculations

3.1 Spatial division based on the scenarios

	Household	Street 20 households	Neighbourhood 500 households
Function	**m²**	**m²**	**m²**
Housing (red)	400	8.000	200.000
Agriculture (light-green)	800	16.000	400.000
Nature (green)	192	3.840	96.000
Roads (grey)	167	3.340	83.500
Water (blue)	32	640	16.000
Total	**1.591**	**31.820**	**795.500**

12. Spatial division based on the scnearios

3.2 Consumption pattern base on the scenarios

The monthly pattern of energy and wastewater treatment demand is based on the average Dutch household and the typologies and sizes found in Oosterwold. The average Dutch household is around 2,1 persons but since Oosterwold does not attract many single households, the average is likely to be higher. In documents regarding the quality of wastewater of households in Oosterwold the average of 50 households is around 2,5 which is also adopted in this research (source). The average size of a household is based upon the average square meters per person in the region of Almere. This is around 57 m2 per person which is around 143 m2 per household in the case of 2,5 people. This is rounded to a house of 12 by 12 meters, 144 m2. Based on this data the total volume of wastewater and energy demand for one household are calculated.

2.1 Demand for wastewater treatment

The total volume of wastewater for one household is based upon the average water consumption of one person multiplied by 2,5 persons. This amounts to the following wastewater volume:

	Household	Street 20 households	Neighbourhood 500 households
Wastewater type	**Volume (m^3 per year)**	**Volume (m^3 per year)**	**Volume (m^3 per year)**
Grey water	72,1	1.442	36.050
Bath	1,7	34	850
Shower	44,9	898	22.450
Sink	4,7	94	2.350
Washing machine	14,1	282	7.050
Dishwasher	5,6	112	2.800
Food preparation	1,1	22	550
Black water	36	720	18.000
Flush water	31,6	632	15.800
TOTAL	**103,7**	**2.074**	**51.850**
TOTAL	**8,6**	**173**	**4.325**

13. Wastewater influent volume

Black water also has the following (possible) additions which can be quantified:

	Household	Street 20 households	Neighbourhood 500 households
Additions to blackwater	**Volume (m^3 per year)**	**Volume (m^3 per year)**	**Volume (m^3 per year)**
Urine	1,4	28	700
Faeces	0,1	2	50
(Food waste)	0,5	10	250

14. Black water volume contents

There are no large monthly variations when it comes to wastewater. Variations are only noticeable on a weekly or daily basis depending on the presence of inhabitants and shower times which is usually during morning and evenings.

2.2 Energy demand

The energy demand is split into a heating demand and an electricity demand. The electricity demand is based upon the average consumption of household sized around 2 persons and between 100 - 150 m2 in surface area. Rounded, this is around 3000 kWh (source) on a yearly basis. There is little monthly variation in electricity consumption since the largest variations can be found on a daily presence depending on the presence of inhabitants which is usually during mornings and evenings. The heating demand can be calculated using the size of one home and the BENG regulations which will officially be introduced in 2021. According to these regulations a household with a total of 144 m2 surface area and 288 m2 of area through which heat is lost (facade and roofing) can have a maximum demand of 70 kWh per m2 of surface area (source). This amounts to a total of 10080 kWh per year. The heating demand is based on the varying outside temperate. This means the total amount of kWh is roughly divided among the months according to the difference between the outside temperature and the preferable 20 degrees of interior temperature. Cooling is not taken into account. On top of that comes the hot water demand based on the hot water consumption which needs to be a temperature of at least 65 degrees.

Month	Household	Street 20 households	Neighbourhood 500 households
January	1.438	28.751	718.785
February	1.421	28.411	710.278
March	1.174	23.477	586.937
April	919	18.374	459.342
May	587	11.739	293.468
June	374	7.486	187.139
July	179	3.573	89.316
August	213	4.253	106.329
September	468	9.357	233.924
Oktober	791	15.822	395.544
November	1.131	22.627	565.671
December	1.387	27.731	393.266
TOTAL	**10.080**	**201.600**	**5.040.000**

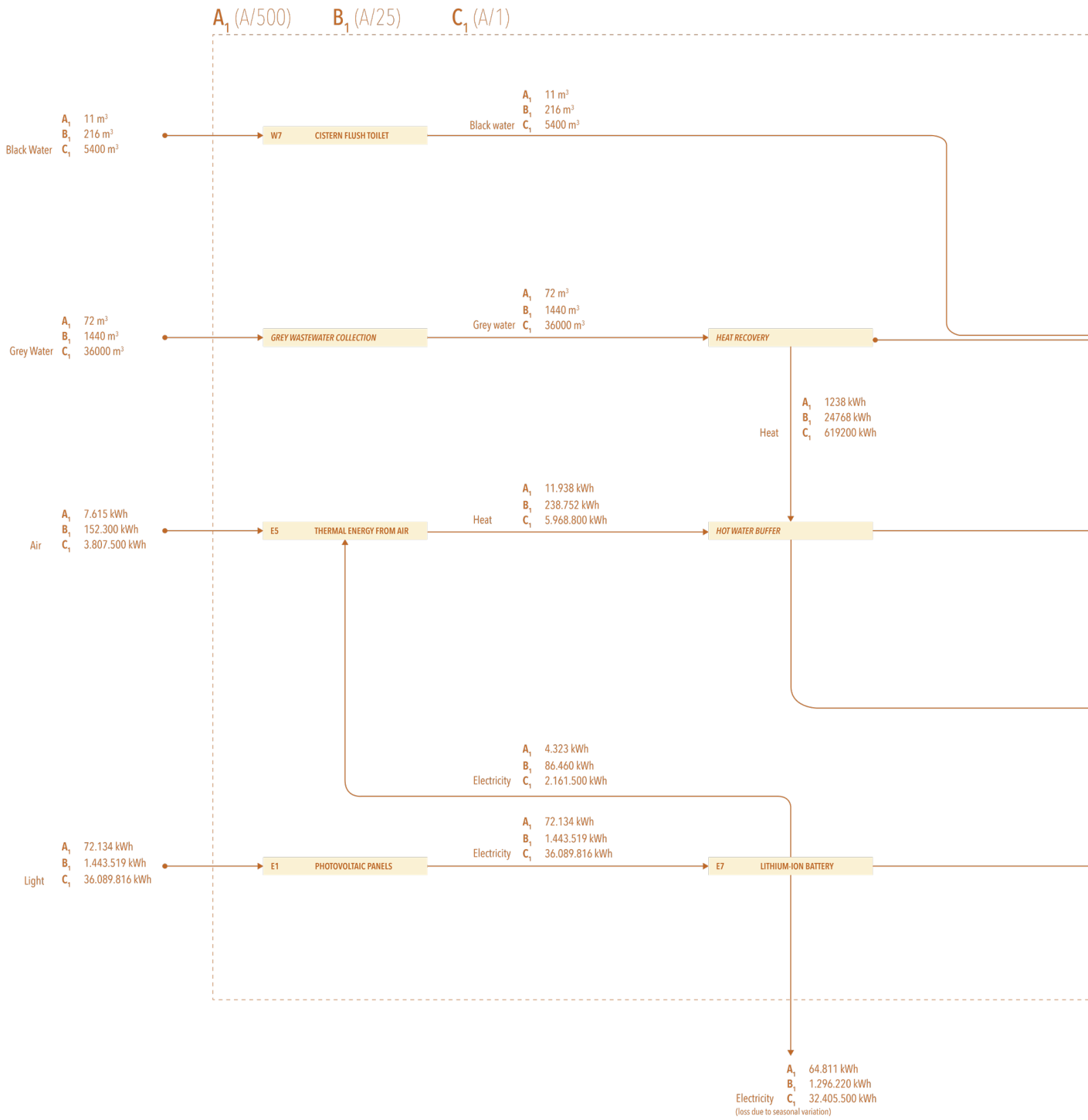
15. Energy consumption (kWh) for heating based on the Dutch BENG policies

Month	Household	Street 20 households	Neighbourhood 500 households
January	250	5.000	125.000
February	250	5.000	125.000
March	250	5.000	125.000
April	250	5.000	125.000
May	250	5.000	125.000
June	250	5.000	125.000
July	250	5.000	125.000
August	250	5.000	125.000
September	250	5.000	125.000
Oktober	250	5.000	125.000
November	250	5.000	125.000
December	250	5.000	125.000
TOTAL	**3.000**	**60.000**	**1.500.000**

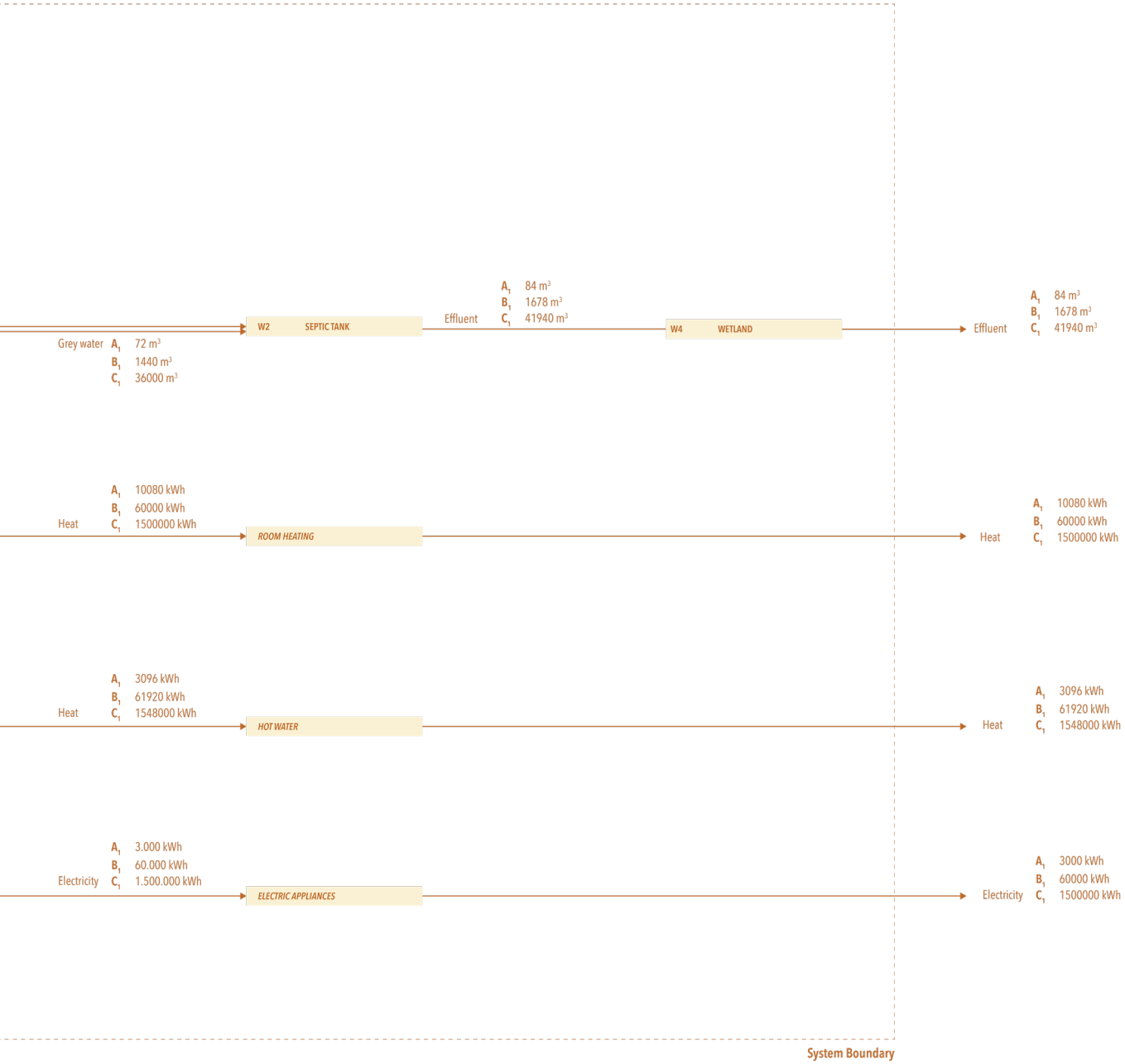
16. Energy consumption (kWh) for electricity based on an average household of 2,5 persons

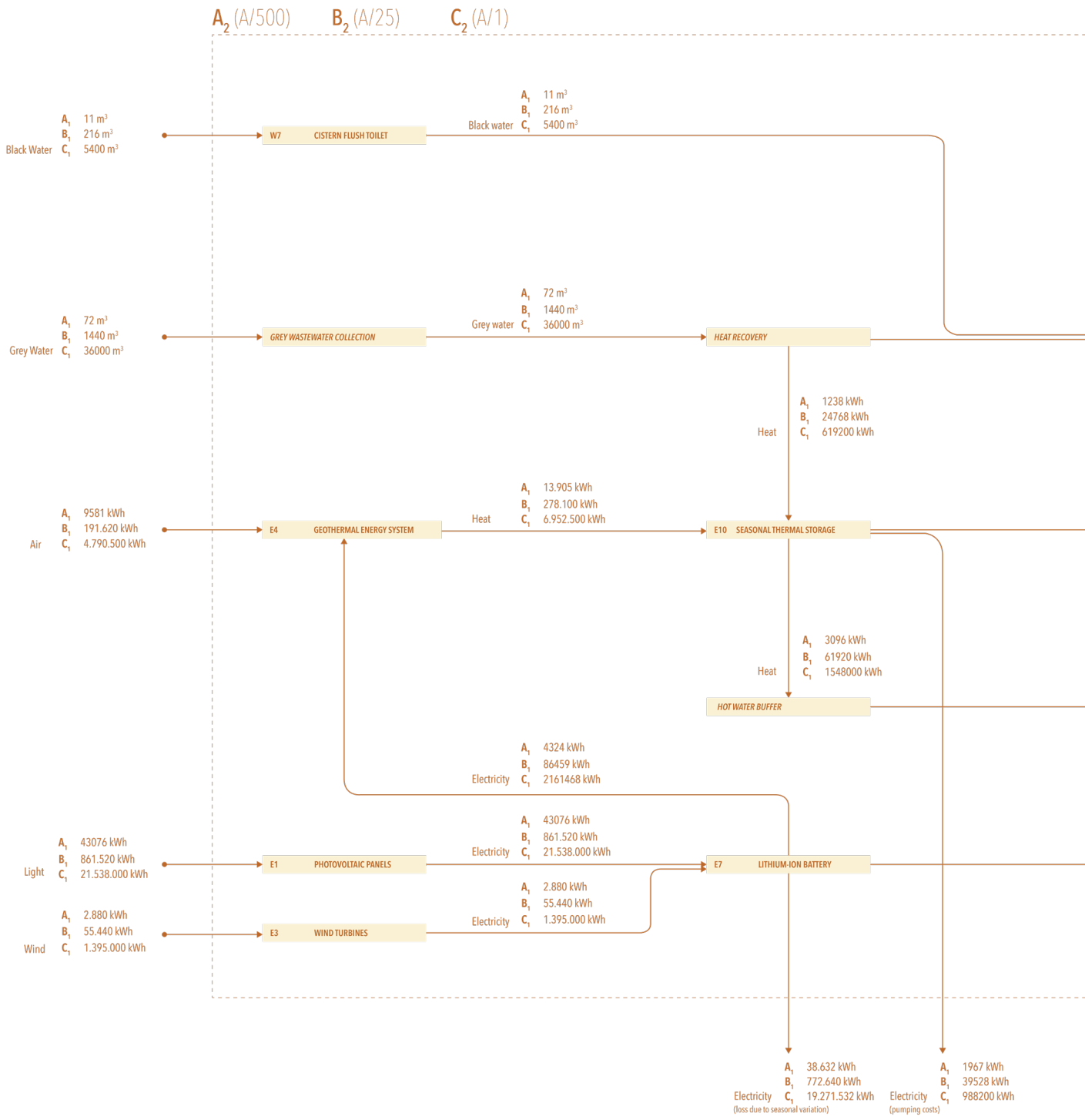
Month	Household	Street 20 households	Neighbourhood 500 households
January	258	5.160	129.000
February	258	5.160	129.000
March	258	5.160	129.000
April	258	5.160	129.000
May	258	5.160	129.000
June	258	5.160	129.000
July	258	5.160	129.000
August	258	5.160	129.000
September	258	5.160	129.000
Oktober	258	5.160	129.000
November	258	5.160	129.000
December	258	5.160	129.000
TOTAL	**3.096**	**61.920**	**1.548.000**

17. Energy consumption (kWh) based on hot water consumption

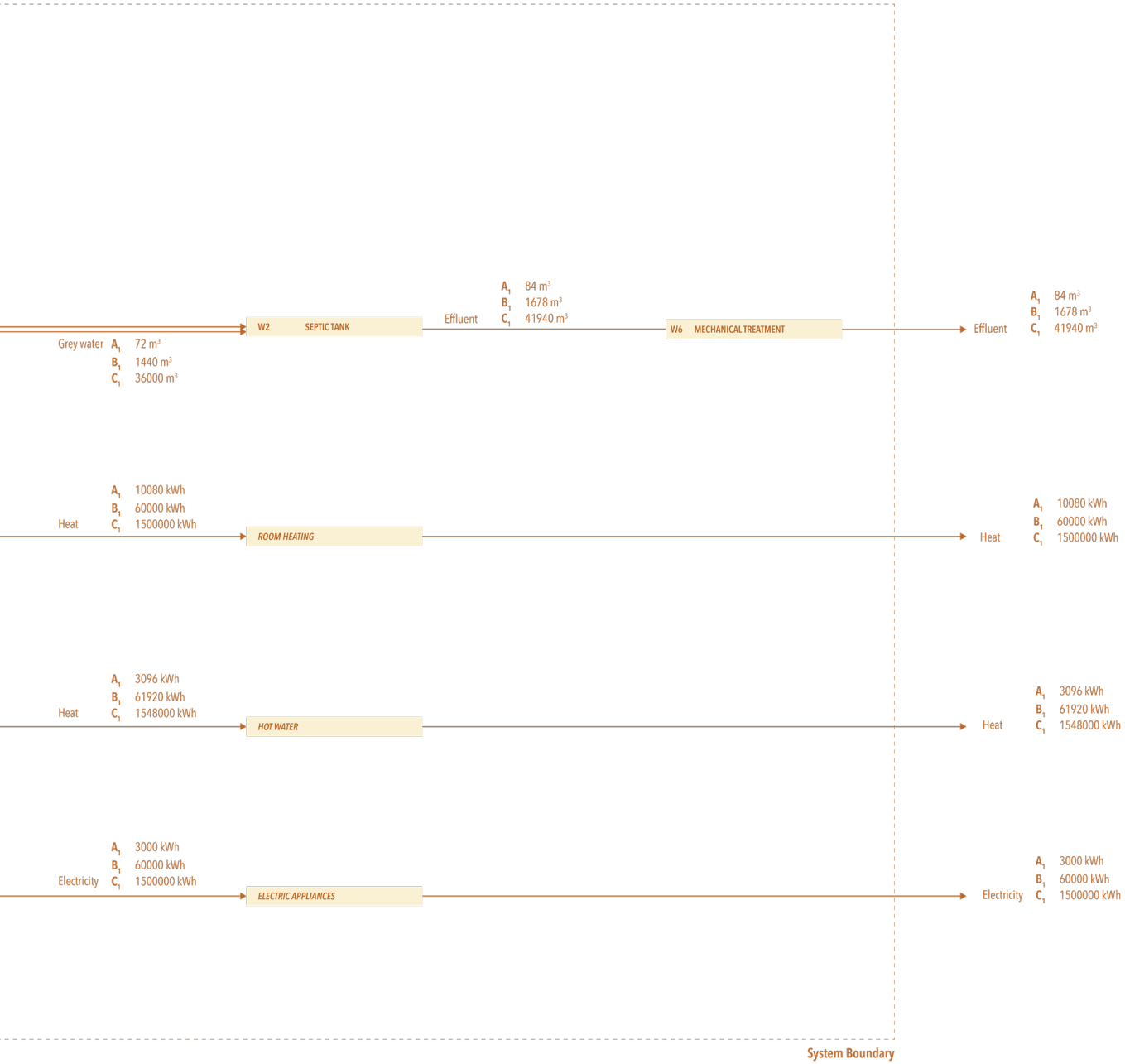


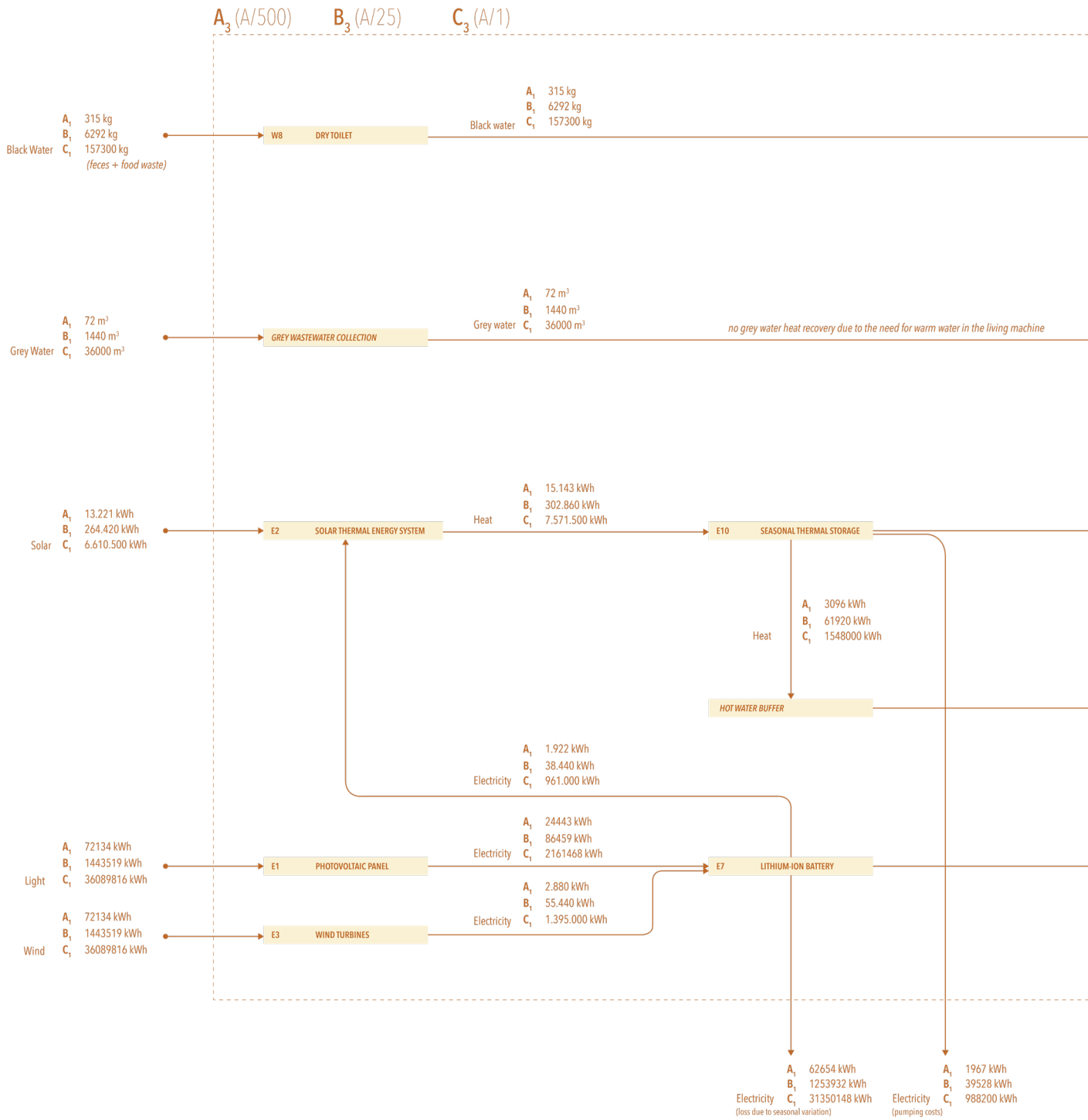
18. Overview of the calculations for the first set of maximizations (1.)


W2 SEPTIC TANK
Effluent
A1 84 m3
B1 1678 m3
C1 41940 m3
W4 WETLAND
Effluent
A1 84 m3
B1 1678 m3
C1 41940 m3
Grey water
A1 72 m3
B1 1440 m3
C1 36000 m3
A1 10080 kWh
B1 60000 kWh
Heat
C1 1500000 kWh
ROOM HEATING
Heat
A1 10080 kWh
B1 60000 kWh
C1 1500000 kWh
A1 3096 kWh
B1 61920 kWh
Heat
C1 1548000 kWh
HOT WATER
Heat
A1 3096 kWh
B1 61920 kWh
C1 1548000 kWh
A1 3.000 kWh
B1 60.000 kWh
Electricity
C1 1.500.000 kWh
ELECTRIC APPLIANCES
Electricity
A1 3000 kWh
B1 60000 kWh
C1 1500000 kWh
System Boundary

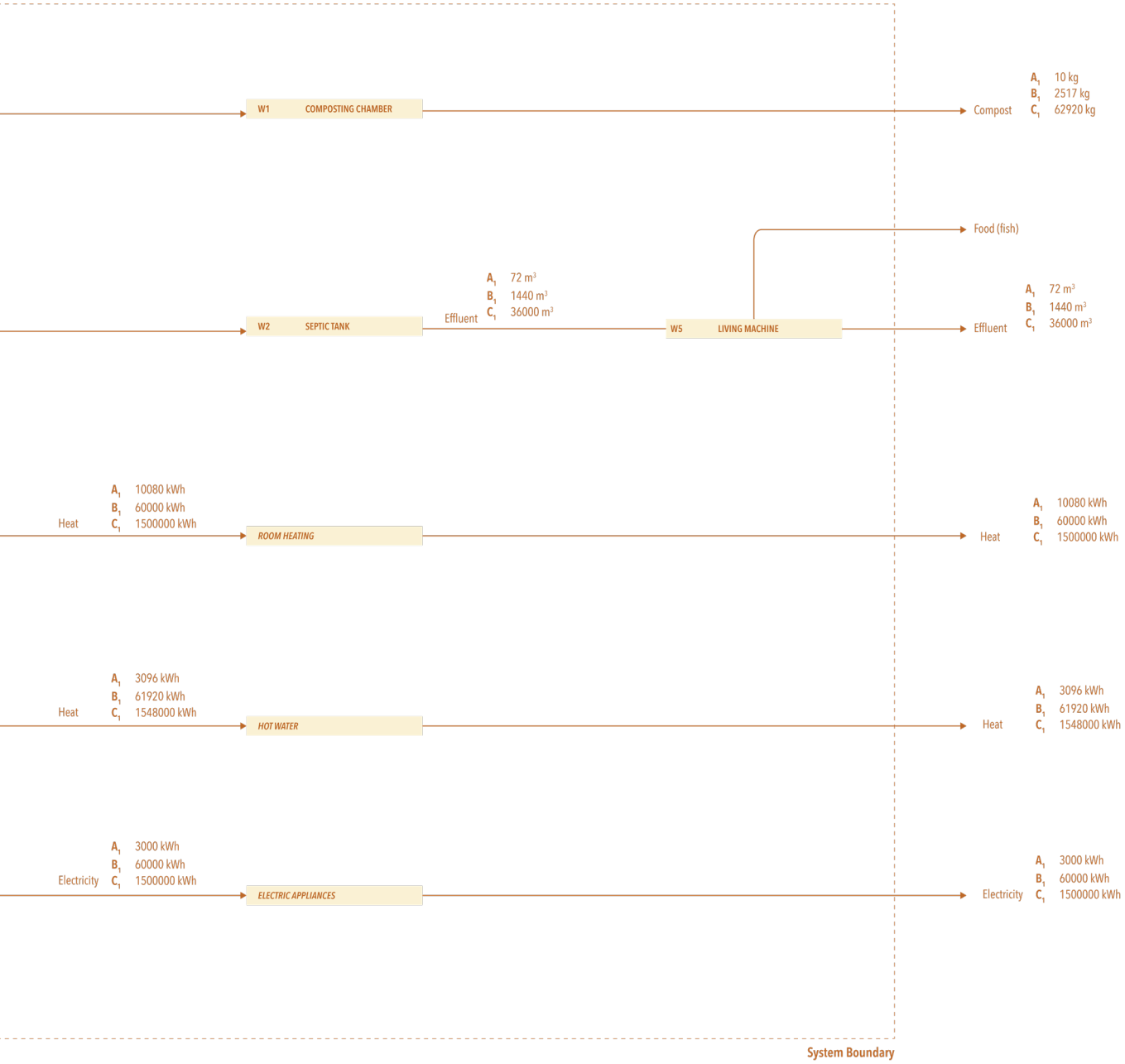


19. Overview of the calculations for the second set of maximizations (2.)


Grey water
A1 72 m3
B1 1440 m3
C1 36000 m3
W2 SEPTIC TANK
Effluent
A1 84 m3
B1 1678 m3
C1 41940 m3
W6 MECHANICAL TREATMENT
Effluent
A1 84 m3
B1 1678 m3
C1 41940 m3
Heat
A1 10080 kWh
B1 60000 kWh
C1 1500000 kWh
ROOM HEATING
Heat
A1 10080 kWh
B1 60000 kWh
C1 1500000 kWh
Heat
A1 3096 kWh
B1 61920 kWh
C1 1548000 kWh
HOT WATER
Heat
A1 3096 kWh
B1 61920 kWh
C1 1548000 kWh
Electricity
A1 3000 kWh
B1 60000 kWh
C1 1500000 kWh
ELECTRIC APPLIANCES
Electricity
A1 3000 kWh
B1 60000 kWh
C1 1500000 kWh
System Boundary



20. Overview of the calculations for the third set of maximizations (3.)


W1 COMPOSTING CHAMBER
Compost
A1 10 kg
B1 2517 kg
C1 62920 kg
Food (fish)
W2 SEPTIC TANK
Effluent
A1 72 m3
B1 1440 m3
C1 36000 m3
W5 LIVING MACHINE
Effluent
A1 72 m3
B1 1440 m3
C1 36000 m3
Heat
A1 10080 kWh
B1 60000 kWh
C1 1500000 kWh
ROOM HEATING
Heat
A1 10080 kWh
B1 60000 kWh
C1 1500000 kWh
Heat
A1 3096 kWh
B1 61920 kWh
C1 1548000 kWh
HOT WATER
Heat
A1 3096 kWh
B1 61920 kWh
C1 1548000 kWh
Electricity
A1 3000 kWh
B1 60000 kWh
C1 1500000 kWh
ELECTRIC APPLIANCES
Electricity
A1 3000 kWh
B1 60000 kWh
C1 1500000 kWh
System Boundary

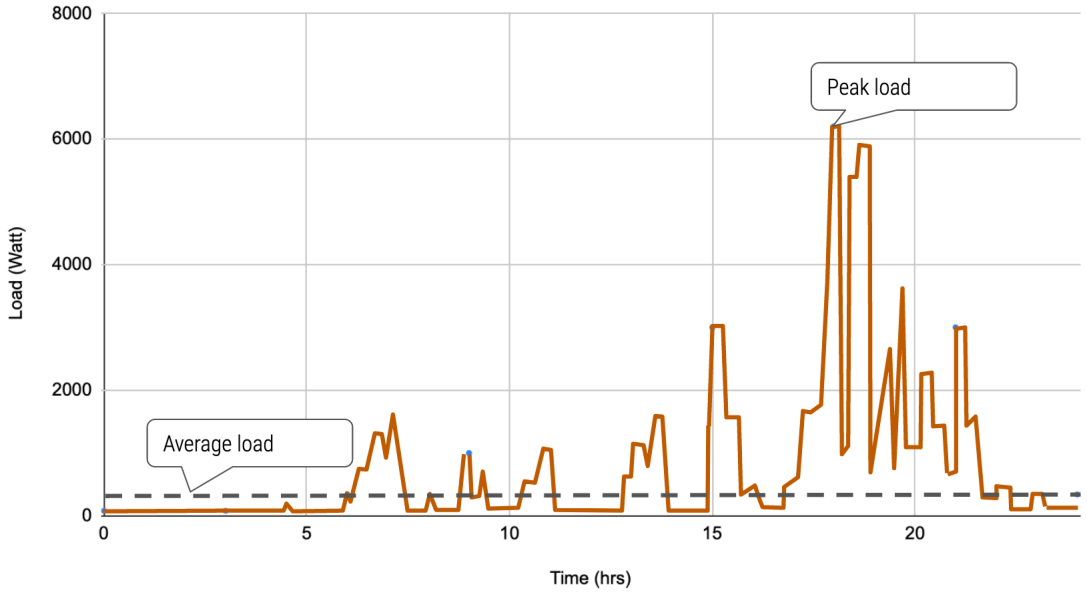
3.3 Estimation of electricity storage peek and the advantage of communal storage

The following paragraphs provided a detailed description of the calculations for storage capacity and the advantage of communal storage. Eventually these were left out of the research and calculations due to their level of detail but are still included as they might provide relevant for future research looking at individual versus communal electricity storage.

3.1 Storage capacity as a function of daily fluctuations in demand and supply

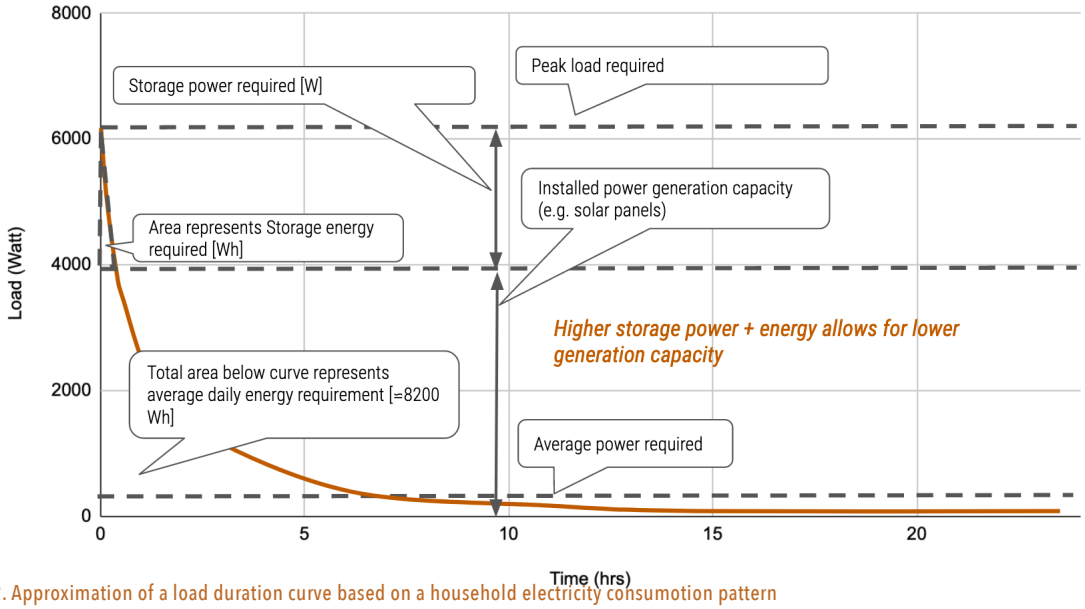
Planning domestic storage requirements requires a deeper understanding of daily demand and supply fluctuations. There is a close relationship between power generation requirements, and available storage capacity. If, in the extreme case no storage is installed, this will lead to an excessive power requirement to cater for peaks in demand, and low availability. This paragraph will concentrate on understanding fluctuations in demand.

We can distinguish between base load tools (appliances that are switched on nearly all of the time), and variable use (cooking, lights, PC, stereo, TV etc.). All of the domestic electricity use can then be represented by a so-called Load Duration Curve, showing the relationship between a particular power requirement, and the number of hours such requirement occurs during any given year. The area under the Load duration curve should then correspond to the total electricity consumption of approximately 4000 kWh for a typical 2.5 person family as assumed for Oosterwold, at an average power requirement 500 W. It should be noted that limited data around this is available on the web, so the load duration curve has been built up based on typical consumer data.



21. Approximation of a household electricity demand during the day

The curve indicates that nearly all electricity consumption is discretionary, with only a small baseload between 50 and 150 kW (refrigerator + freezer + floor heating). The curve does not comprise electric vehicle loading or the effect of heat pumps, which will significantly distort the curve creating an even sharper peakload of in total 10-15 KW as compared to the peak of 6kW in the picture. All area above the average consumption could be optionally stored, such that the power supply could be dimensioned at a continuous 500 Watt. The minimum daily storage capacity should then be between 6 and 12 kWh (= the average daily consumption), with a minimum power of 5.5 kW to cater for the daily peak. In reality there are significant variations in supply as well, particularly for renewables, such that a larger storage is desirable. The curve also indicates the significant potential for pooling with various households, which will reduce the aggregate peak due to statistical spreading. Having a smart net will further reduce peak load given that it will drive behaviour. It is expected that the compound impact of pooling and a smart net will reduce the aggregate peak by more than 25%, though this should be subject to a detailed statistical analysis.



22. Approximation of a load duration curve based on a household electricity consumotion pattern