Annual Energy Report 2021

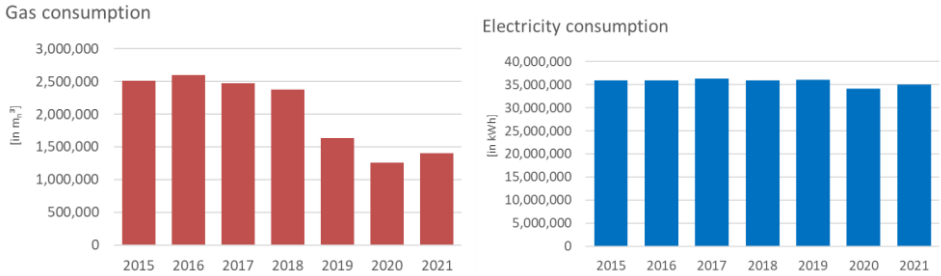
Radboud Universiteit

Contents

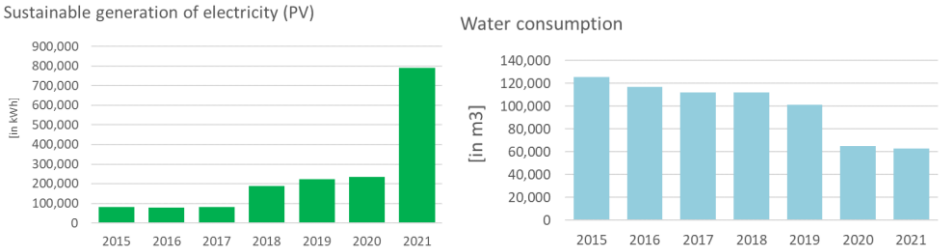
(Cover photo of Dick van Aalst)

Summary

After declining for a number of years, Radboud University's energy consumption rose by 3.4% in 2021. The main reason was that 2021 was a cold year, with the result that boilers and heat pumps consumed more gas and electricity to heat the buildings. The 2021-2024 energy policy plan envisages energy savings of 4.1% annually in absolute terms. This was not achieved in 2021. But the target of cutting energy consumption by 26% by 2024 (by comparison with 2018) definitely remains in view. This is because a great deal will be saved in the 2022-2024 period by means of the projects HEN++, LED's-GO and taking the lecture halls in the Spinoza Building out of use, linked to the construction.



Less gas was used in 2021 than in 2020 after correcting for the outside temperature. Sustainably generated electricity rose by 238% as a result of commissioning the new PV system on the Maria Montessori Building. The share of the electricity consumption that was generated on campus thus rose from 0.7% to 2.3%. CO_2 emissions fell, mainly because less use was made of fossil fuels in the generation of electricity.



Drinking water consumption in 2021 was 3% lower than in the previous year. The continuing low level of consumption was caused largely by low occupancy as a result of COVID.

Introduction

The aim of this Annual Energy Report 2021 is to inform Radboud University management, staff and students on developments concerning energy consumption and the measures taken to save energy and generate sustainable energy in 2021. The Annual Energy Report is published on the intranet and internet, so that everyone can follow developments.

Objectives

The *Radboud University Energy Policy Plan 2021-2024* provides an overview of objectives, basic principles, conditions, requirements and responsibilities in the areas of energy and water consumption. The most important objective is to achieve annual energy savings of 4.1% in absolute terms. This is necessary in order to be energy neutral by 2050. The aim is to attain this as early as 2040, but the feasibility of this still has to be investigated.

Changes in energy consumption and CO_2 emissions

The yardstick for the evolution of energy consumption and implementation of energy policy at Radboud University is the consumption of electricity and gas. *Figure 1* shows changes in gas and electricity consumption.

CO_2 emissions – the consequence of energy consumption – are also shown here. Consumption refers to the buildings and grounds on the Radboud University campus. As well as the energy for the buildings, the energy for ICT and research equipment is taken into account[1].

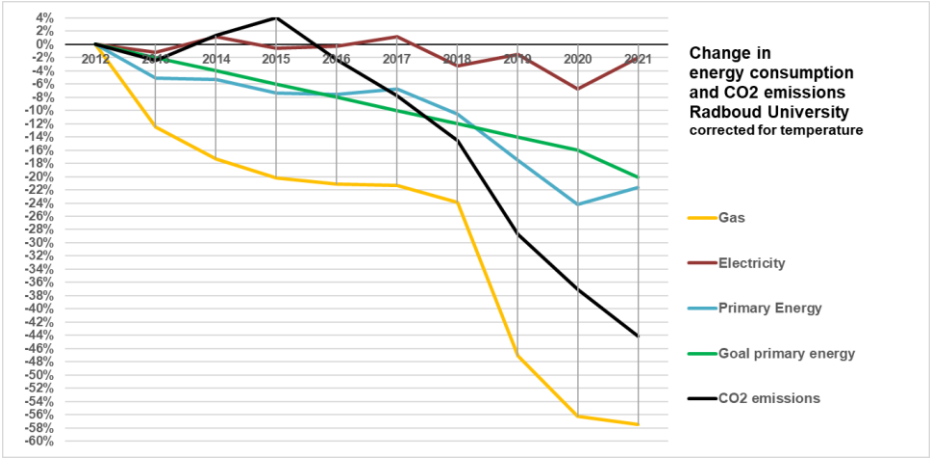


Figure 1 Changes in energy consumption and CO_2 emissions

Natural gas

More than 95% of Radboud University's gas consumption[2] is attributable to heating buildings. The gas consumption has been corrected using degree days, a measure for temperature change. After correcting for an average year with respect to temperature, gas consumption has declined a little. This is shown by the yellow line in *Figure 1.* Gas consumption fell by 3% to 1.38 million m^3 in 2021, by comparison with 2020. This decline may be attributed primarily to optimisation measures implemented on the Hybrid Energy Grid (HEN).

Electricity

At Radboud University, electricity is used primarily for building systems. These are systems for air-conditioning, lighting and ventilation, ICT and research. Approximately 5%[3] of the electricity consumption can be attributed to space cooling. The brown line in Figure 1 shows the change in electricity consumption following correction using the cool days method. Electricity consumption rose by 2.4% in 2021.

[1] The consumption of the HFML (magnet laboratory) with ancillary equipment is not included in these readings, as this is explicitly allocated to the research projects, partly for third parties. The premises of Stichting Studenten Huisvesting Nijmegen (Nijmegen Students Accommodation Foundation) on the campus are also not included, as these are administered by SSH, and Radboud University merely acts as conduit for the energy.

[2] Forum and Huize Heyendael draw heat from the heating network of Radboud university medical center (Radboudumc). This consumption has been converted to natural gas equivalents.

[3] This share is trending downwards as a result of the use of ground-coupled heat exchange (thermal energy storage).

Primary energy
In order to determine the primary energy – the sum of gas consumption and electricity consumption – these are converted to the same unit, i.e. gigajoules. A primary energy factor (PEF) of 1.45 is used for calculating electricity generation. The factor 1.45 is taken from the NTA8800, a Dutch standard for calculating the energy performance of buildings. The share of gas determines primary energy consumption at Radboud University to 20% and the share of electricity to 80%. Over the past year, 3.4% more primary energy was used than in 2020.

CO_2
CO_2 is emitted as a result of the consumption of electricity, gas and diesel. In the case of electricity, it could be contended that, owing to the purchase of 100% green electricity, no emissions at all have occurred. But the reality is that electricity consumption on campus certainly does lead to emissions, as a result of the mismatching between supply and demand. This is because generation and consumption have to occur simultaneously, and sufficient sustainable sources are not always available. For this reason, it has been decided in this report to calculate on the basis of emissions per kWh according to Statistics Netherlands (CBS) (0.29 kg/kWh). The emissions factor declines every year, because less fossil fuel is being used for generating electricity.

Table 1 provides the figures for the change in energy consumption.

		EBP	2017-2020			2021-2024
Energy consumption Radboud University		2017	2018	2019	2020	2021
Natural gas	m3/year	2,476,212	2,378,335	1,633,138	1,258,423	1,404,850
Natural gas correction	m3/year	2,560,127	2,474,004	1,720,055	1,423,013	1,382,585
Electricity	kWh/year	36,236,105	35,703,312	35,909,592	33,972,457	34,250,573
Electricity correction	kWh/year	36,398,491	34,815,580	35,422,580	33,562,479	35,245,889
Gasoil	kg/year	3,657	4,913	8,125	5,831	4,735
Primary energy	GJ/year	267,681	261,855	239,484	217,414	223,454
Primary energy correction	GJ/year	271,184	260,249	239,693	220,484	227,945
CO2-emission factor	0.47	0.45	0.43	0.37	0.35	0.29
CO2-emission	tonnes/year	20,738	19,613	16,227	14,155	12,455
Drinking water usage	172423	112,346	112,232	101,307	65,026	63,145
Building surface	302385	331,371	320,145	313,180	313,422	322,895
Students + employees	number	25,888	27,033	27,908	29,315	30,281

Table 1 Overview of the changes in energy consumption

Cold year

2021 was a relatively cold year. So as to be able to compare energy performances over successive years, we correct for the outside temperature on the basis of the degree day method. With 101.5% of the weighted degree days, 2021 was a little colder than the average over the past 15 years. By contrast, 2020 was really mild, with just 87.8% degree days. So, the fact that more gas was consumed in 2021 than in 2020 is not that surprising. The Royal Dutch Meteorological Institute (KNMI) summarised 2021 as follows: "following three very warm years, 2021 was a normal year when it comes to temperature. The average temperature was 10.4 °C, by comparison with a normal 10.5 °C. The extremely cold spring and hottest June since 1901 were outliers. After a cool August, the last four months of the year were (considerably) warmer than normal." So, while we saw higher gas consumption on the meter, in fact we performed slightly better than in 2020 after correcting for temperature.

CO2 emissions

Figure 2 shows the CO_2 emissions[4] per m^2 of floor area of the buildings and per student / member of staff. Both reveal a linear decline.

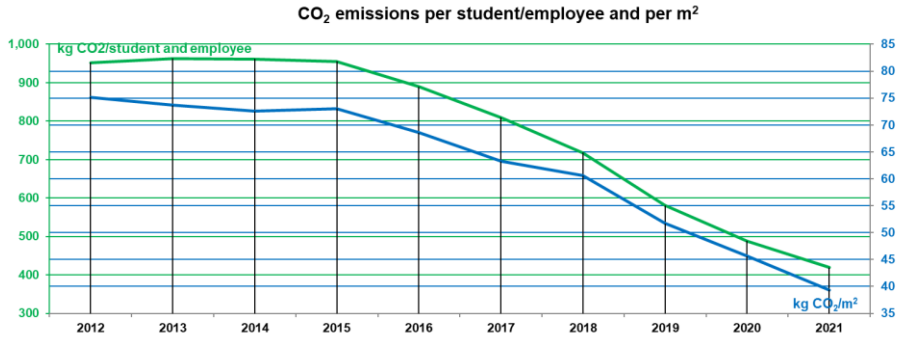


Figure 2 CO_2 emissions per m^2 and student and member of staff

[4] CO_2 emissions: gas = 1.785 kg/m^3; electricity according to Statistics Netherlands; diesel = 74.3 kg/GJ.

Sustainable energy

Ground-coupled heat exchange (thermal energy storage)
The RU has for years been relying increasingly on heating and cooling with the aid of ground-coupled heat exchange (WKO). Really a lot of ground heat was once again used for heating in 2020 and 2021, and this resulted in a sharp reduction in gas consumption. It is noteworthy that over the past two years, more heat was extracted in the winter than returned in the summer (see Figure 3).

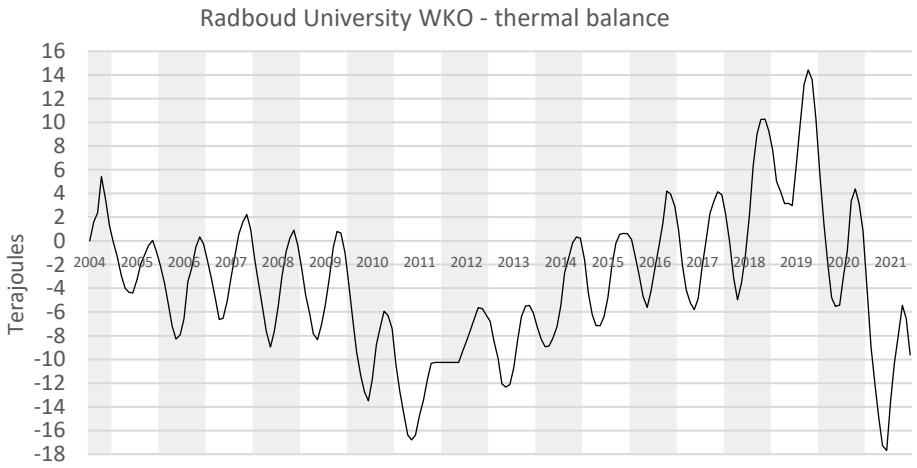


Figure 3 Ground-coupled heat exchange (yield in terajoules)

For the system to function properly and to continue to comply with the requirements in the permit issued on the basis of the Water Act, it is essential to restore the balance. For this reason, the following actions have been implemented immediately, or will be investigated:

- Optimising the heat exchange system control parameters, so that we can store more heat in the ground during the warm period in the summer
- Making use of residual heat from Radboudumc by linking the heat exchange systems, precisely because there is excess heat in the Radboudumc heat exchange system
- Making use of residual heat from the data centres in EOS and Forum.
- Demolition/redevelopment and renovation of obsolescent buildings in order to cut back the need for heat – for this see the campus plan.

Solar power
The share of green electricity generated from solar power on campus rose sharply from 0.7% to 2.3%. This resulted from commissioning the PV system on the roof of the recently completed Maria Montessori Building. This is by far the largest solar panel system on the campus: 670 kWp.

Solar panels	Power	Yield 2021
	kWp	kWh
Forum	11	6,764
Grotius	85	74,664
Gymnasion/Ostrom	42	36,543
University Library	124	97,670
Maria Montessori	670	574,720
Total	**932**	***790,361***

Table 2 PV systems yield

In 2021, 790,361 kWh in solar power was generated on the campus of Radboud University – a record. This corresponds to the annual electricity consumption of 260 households.

The share of green energy from the solar power generated by ourselves remains limited (2.3%), because on-campus electricity consumption is high in relative terms.

Purchase of 100% sustainable electricity

In 2021, Radboud University and Radboudumc bought 100% green electricity for the first time from Geefsweer wind farm in the Province of Groningen.

Radboud University and Radboudumc opted for *additional* green electricity from new sustainable generation capacity in the (European) procurement tender for electricity in 2018. This tender led to a 10-year agreement with Eneco, which has developed a wind farm for the purpose. This long-term agreement and a guaranteed purchase of green certificates was an important condition for being able to implement the wind farm. In 2020, 100% of the consumption could not as yet be made sustainable through the wind farm, because the turbines were not yet ready. But in 2021, this

was the case, and 100% of consumption was in fact covered. With the current contract, Radboud is securing 100% additional green electricity up to 2030.

Energy monitoring

There are more than 400 energy metering points on campus. The meter readings of these gas, electricity and water meters are taken remotely and recorded in the Energy Consumption System (*EnergieConsumptieSysteem* – ECS). The data provide essential information for calculating suggestions for savings and for making energy flows on campus transparent to members of staff and students. They can also be used to highlight and trace excessive energy or water consumption resulting from leaks or incorrect settings. The ECS offers many options for analysis and is able to provide direction in aiming for energy targets. The aim is to accelerate the energy transition on campus in the period ahead by providing users with relevant information based on these data. Maintaining the ECS does, however, demand constant attention. Meters and IT components have to be replaced regularly because they have reached the end of their service life.

Drinking water consumption

The drinking water consumption pattern is shown in *Figure 4*.
Drinking water consumption (green) declined somewhat again in 2021 to more than 63,000 m^3 (35%). The same figure shows drinking water consumption per student and member of staff (blue). This fell to 2.1 m^3 per student and member of staff.

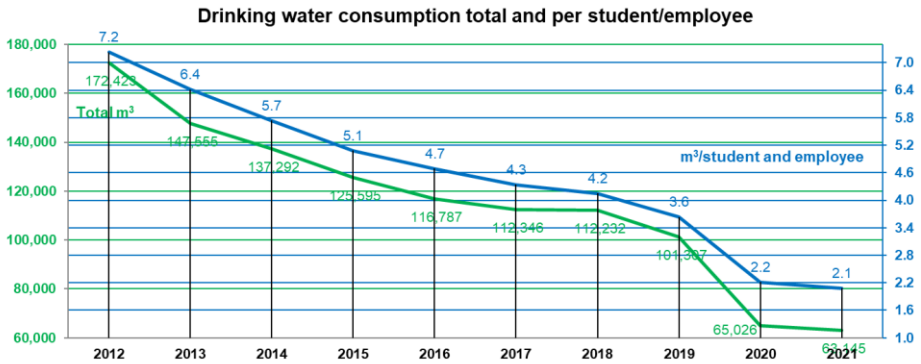


Figure 4 Drinking water consumption from 2012

The drinking water consumption for each building is shown in Appendix 1. Low consumption in 2021 may be attributed primarily to corona measures. Drinking water consumption depends to a greater extent on the occupancy rates of the buildings than does energy consumption.

Energy costs

Radboud University and Radboudumc purchase their electricity and gas jointly. The provider is chosen by means of a joint European procurement tender. A price is then 'locked in' at various points during the year, based on current market prices. This is done in accordance with an agreed strategy based on risk spreading. Prices are set one to three years ahead. This means that the price is always known at least one year ahead. The rate for gas was 40.4 cents per m^3, and for electricity 9.4 cent per kWh, including grid operation and taxes. The rates in 2021 were low, as market prices were also low during the COVID period, and a relatively large amount was locked in at the time. There was, however, a rise in the tax rate in 2021. The reason is that from 1-1-2021 the split with Radboudumc led to Radboud University going through the levels for energy tax (EB) and the sustainable energy levy (ODE) independently for the first time. As a result, the tax rate for electricity rose from 0.5 to 1 cent per kWh, and for gas from 5 to 10 cents per m^3.

Over the course of 2021, we saw large increases in price on the electricity and gas markets, as shown among other things in *Figure 5*. As the price for the university had been fixed rather far in advance, high market prices in 2021 did not yet have an impact on *our* energy prices in 2021 and 2022. These developments will certainly impact our energy prices in 2023, 2024 and 2025. Despite the extremely volatile market, we will continue to pursue the current strategy so as to protect ourselves as much as possible, should the market rise further. At the moment, no reliable forecast can be made of the extent to which high market prices will work through into our energy prices, given that market uncertainty largely depends on the crisis in Ukraine and the relationship between the EU and Russia. Prices are not expected to return to levels seen before the COVID pandemic.

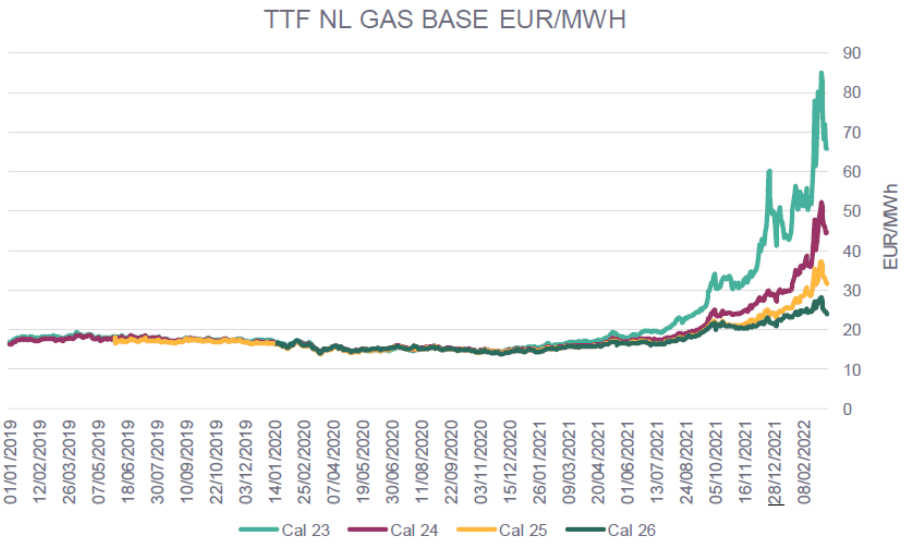


Figure 5 Sharp price rises on the futures markets

Energy programme 2021-2024

A decision was taken in the 2021-2024 energy policy plan in favour of an ambitious package of measures for greater energy savings and sustainable generation, with the aim of achieving an average 4.1% in energy savings in absolute terms. These plans were implemented in projects in 2021. This energy programme led to measurable savings in 2021 in a limited way. The implementation stages of the projects are planned for 2022, 2023 and 2024. For example, extension of the Hybrid Energy Grid (HEN++) is well underway at the moment. The Mercator 1 and 2 buildings, the Proeftuin (Experimental Garden), the Child Day Care, Forum and the Berchmanianum will be connected to the heat exchange grid. Various other projects have been launched in addition. In the project 'LED's-Go', a project plan and tendering strategy have been worked out for replacing conventional lighting with LED lighting in the Huygens, Elinor Ostrom/Gymnasion, Grotius and University Library buildings. Solar panels will be installed on the roof of the HFML in 2022, and another project will investigate which other roofs are suitable for this. This is being done in the context of the objective to fit as many suitable roofs with solar panels as possible. Other projects and initiatives are in various stages of preparation. Among the ideas are LED lighting in the greenhouses (Proeftuin), LED sports field lighting, waste heat recovery, optimising (heat) pumps and ventilation, heat pumps with a higher COP (yield), up to structural measures, such as outer wall insulation and installing insulated glazing in the University Library. These projects are being checked for their payback time. They must also line up with the campus plan as far as possible.

Staff change

Toon Buiting has announced that he will cease to work as Energy Policy Coordinator in 2022. Over the past 10 years, Toon has been responsible for energy policy and previous energy reports. Among other aspects, by developing the Hybrid Energy Grid he has contributed to the decrease in gas consumption on campus. His duties will be taken over by Tom van Onna. Tom has been working as manager of energy & energy transition at the Campus & Facilities division since 1 October 2021. Before this he worked at the Alliander grid operator for more than 10 years.

Figure 4 Tom van Onna (left) and Toon Buiting (right) on the roof of the Maria Montessori Building.

Appendix 1 Building energy labels and consumption

A great deal of attention has been paid to energy labels in the past year. Energy labels have not yet been drawn up for all buildings. New legislation makes energy label C mandatory for all office buildings from 2023. This obligation applies once the floor area used for office work takes up 50% or more of the total surface area of that office building and the floor area for office work exceeds 100 m^2. There are various buildings with an office function on our campus. While other buildings do have to have a label, the label's level is not of concern here. There are a number of exceptions, including for monuments and buildings used for teaching. An investigation has been conducted into which building needs to have which label and when that needs to be done. In consequence, instructions have been issued to have a new energy label drawn up for the Mercator I, Mercator II, Mercator III, Sports Pavilion, Child Day Care Centre, Gele vlieger, Transitorium, UBC and Maria Montessori buildings. The labels will be available in 2022.

2021 (with COVID)	**Consumption**			**Energy**	
	gas	**electricity**	**primary**	**label**	**water**
Buildings	m3	kWh	kWh/m2 NVOtot		m3
Aula	35,413	203,729	318	D	283
Comenius A+B (Adm. building)	65,328	204,469	199	G	335
Berchmanianum	109,883	349,704	221		-
Erasmus building/Refter	132,685	3,032,737	HEN *	E	3,385
University Library	22,120	554,099	*	C	1,470
CC / Thomas van Aquino building	at Erasmus	182,830	*	E	418
Th. v. Aquinostr. 1	at Erasmus	186,841	*	G	232
Maria Montessori Building	at Erasmus	414,708	*		500
Spinoza Building	at Erasmus	622,464	*	G	981
Huize Heyendael (heat > gas)	57,921	102,200	375	n.v.t.	635
Oud Heyendaal	5,537	8,726	164	n.v.t.	49
Forum (heat > gas)	36,602	109,990	161	n.v.t.	148
Forum servers + installations		*1,748,397*			
Trigon	90,589	2,021,204	646	C	2,555
Werf GWT	11,045	25,234	244	A	142
Pavillion and Student Church	25,488	112,287	279	n.v.t.	145
Grotius	7,369	1,140,971	119	A+++	1,936
Gymnasion / Elinor Ostrom	40,699	2,589,544	134	A	5,473
Gymnasion servers + installations		*790,014*			
Transitorium	40,598	142,050	179	A	31
A1 Building (incl. Vibration-free lab)	at Huygens	231,751	312	n.v.t	1,185
NMR	at Huygens	538,006	1,282	n.v.t	at HFML
Logistics Centre	6,000	75,887	351	n.v.t	at A1
Linnaeus Building	78,117	561,748	292	n.v.t	343
Huygens Building	119,490	10,199,396	463	D	22,764
HFML (Magnet Laboratory) excl 50kV	38,226	1,421,469	701	n.v.t	3,356
HFML ancillary equipment					
FEL Building	16,571	1,433,466	1,390	n.v.t	165
Nano Laboratory	11,758	189,532	1,244	n.v.t	243
Experimental Garden & Greenhouses	69,041	1,125,652	1,131	n.v.t	7,195
Events and Greenery					3,298
Total without third parties	**1,020,479**	**30,319,105**	**256**		**57,268**
Gele Vlieger (formerly KDV I)	14,151	29,665	202	D	551
Child Day Care (II)	32,967	74,916	273	A	200
Mercator 1	76,126	439,248	326	F	653
Mercator 2	63,044	826,206	415	C	1,326
Mercator 3	128,625	1,218,786	339	B/C	3,669
UBC (Valkenburg)	58,690	85,778	375		131
Total	**1,394,083**	**32,993,703**	**263**		**63,797**

Campus & Facilities
Campus Development
tom.vanonna@ru.nl