

## **VEDLEGG V**

**1 OMPROSJEKTERING PASSIVHUS**

**2 OMPROSJEKTERING NULLENERGIBYGG**

**3 OMPROSJEKTERING PLUSSHUS**

# **1 – OMPROSJEKTERING PASSIVHUS**

**1.1** Passivhus PER Oslo

**1.2** Passivhus PER Trondheim

## Primary Energy Renewable PER

Passive House with PHPP Version 9.6a

Dråpen moderne / Climate: Oslo / TFA: 140 m² / Heating: 22.8 kWh/(m²a) / Freq. overheating: 1 % / PER: 74 kWh/(m²a)

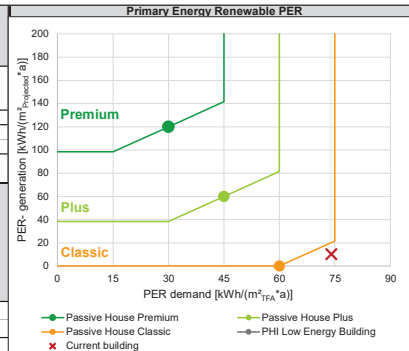
Selection of heat generation system(s)		Contribution margin (useful energy)		Addl. input in following worksheets	Heating demand incl. distribution & hydr. frost protection	Building type:	
Primary heat generation type		Heating	DHW			Treated floor area A <sub>TFA</sub> :	
5-Direct electricity		100 %	100 %			140	m²
Secondary heat generation type (optional & different)						Projected building footprint A <sub>Projected</sub> :	
		0 %	0 %			22,75	m²
						Cooling energy dem. incl. dehumidification	
						DHW demand including distribution:	25,12 kWh/(m²a)

Energy demand Reference: Treated floor area	Efficiency		Final energy		PER			PE		CO <sub>2</sub>	
	Calculati on	User defined value	Contribution (final energy)	Final energy demand	PER factor	Effective PER factor (including biomass)	PER specific value	PE factor	PE value	CO <sub>2</sub> emissions factor (CO <sub>2</sub> -eq) kg/kWh	CO <sub>2</sub> eq emissions kg/(m²a)
	-	-		kWh/(m²a)	kWh/kWh	kWh/kWh	kWh/(m²a)	kWh/kWh	kWh/(m²a)		
							74,05		137,75		28,9
Heating			100 %			1,35	33,93				
Electricity (HP compact unit)					1,45			2,60	65,4	0,532	13,4
Electricity (heat pump)					1,45			2,60		0,532	
District heating: 1-None					2,8 4,5 3,3					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / RE methanol					2,30			1,10		0,320	
Solar thermal system								0,00		0,045	
Electricity (direct)	1,00		100 %	22,753	1,45	1,34	30,45	2,60	59,2	0,532	12,1
Vedovn med vannkappe		1,00			1,10						
Aux. electricity (heating, wintertime ventilation)				2,403	1,45	1,45	3,48	2,60	6,2	0,532	1,3
Cooling and dehumidification					1,00		1,79		4,7		1,0
Electricity cooling (heat pump)					1,00			2,60		0,532	
Auxiliary electricity cooling, ventilation summer				1,790	1,00		1,79	2,60	4,7	0,532	1,0
Electricity dehumidification (heat pump)					1,00			2,60		0,532	
Auxiliary electricity (dehumidification)					1,00			2,60		0,532	
DHW generation			100 %			0,75	19,21	1,03	26,3		6,1
Electricity (HP compact unit)					1,20			2,60		0,532	
Electricity (heat pump)					1,20			2,60		0,532	
District heating: 1-None					2,8 4,5 3,3					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / Methanol					2,30			1,10		0,320	
Solar thermal system			62 %	15,501	0,46	0,46	7,08	0,00	0,0	0,045	0,698
Electricity (direct)	1,00		38 %	9,618	1,20	1,20	11,54	2,60	25,0	0,532	5,1
Vedovn med vannkappe		1,00			1,10						
Aux. electricity (DHW + solar DHW)				0,489	1,20	1,20	0,59	2,60	1,3	0,532	0,3
Household electricity				15,9		1,20	19,11		41,4		8,5
Electricity (household or non-residential lighting, etc.)				15,9	1,20	1,20	19,11	2,60	41,4	0,532	8,5
Auxiliary electricity (other)					1,20			2,60		0,532	
Gas / RE gas dry/cook				0,0	1,75		0,00	2,60	0,0	0,270	0,0

Energy generation Reference: Projected building footprint area	Final energy		PER		PE		CO <sub>2</sub>	
	Final energy generation kWh/a	Final energy generation kWh/(m²A <sub>Projected</sub> ) <sup>a</sup>	PER factor kWh/kWh	PER specific value kWh/(m²A <sub>Projected</sub> ) <sup>b</sup>	PE factor kWh/kWh	PE Value kWh/(m²a)	Emission factor (CO <sub>2</sub> -eq) kg/kWh	CO <sub>2</sub> eq emissions kg/a
				10,2		27,3		97,6
PV electricity	0	0,0	1,00	0,0	-		-	
Solar thermal system	2169	22,3	0,46	10,2	1,22	27,3	0,045	97,6
		0,0						

PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]	120	Current building reaches following class	138	Requirement met?	no
--	-----	--	-----	------------------	----

Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)	Useful energy, performance				Airtightness n <sub>50</sub>	Primary Energy Renewable PER
	Annual heat. dem Treated floor area kWh/(m²a)	Heating load Treated floor area W/m²	Useful cool. energy Treated floor area kWh/(m²a)	Cooling load Treated floor area W/m²		
Requirement Passive House Premium					1/h	
Requirement Passive House Plus	15	10	-	-	0,60	
Requirement Passive House Classic						
Requirement PHI Low Energy Building	30		-		1,00	
Current building reaches following class for aspi	23	16	-	-	0,6	
	PHI Low Energy Building		Premium		Premium	
Summary	Final energy MWh/a	PER specific value MWh/a	PE value MWh/a	CO <sub>2</sub> eq emissions kg/a	CO <sub>2</sub> eq substitution balance kg/a	
Though, from the scientific point of view, not entirely correct, different energy carriers will be added together here. This is done to meet the criteria of other energy standards.	9,580	10,4	19,27	4041	4041	
Demand	-2,168589	-1,0	-2,65	98	-451	
Generation						
Demand, cumulative generation (annual balance)	7,41185	9,37	16,62	4138	3590	
Demand w/o household electricity	7,4	7,7	13,48	2855	2855	
Demand w/o household electricity, cum. generation	5,18	6,69	10,83	2953	2404	



		Building type:		
		Treated floor area A <sub>TFA</sub> :		140 m²
		Projected building footprint A <sub>Projected</sub> :		97 m²
Selection of heat generation system(s)		Contributed margin (useful energy)		
Primary heat generation type		Addl. input in following worksheets		
5-Direct electricity		Heating 100 %	DHW 100 %	
Secondary heat generation type (optional & different)		Heating demand incl. distribution & hydr. frost protection		21,22 kWh/(m²a)
		Cooling energy dem. incl. dehumidification		
		DHW demand including distribution:		25,12 kWh/(m²a)
		0 %	0 %	

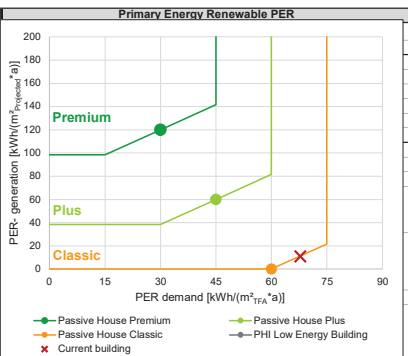
Energy demand		Efficiency		Final energy		PER		PE		CO <sub>2</sub>						
Reference: Treated floor area		Calculation	User defined value	Contribution (final energy)	Final energy demand	PER factor	Effective PER factor (including biomass)	PER specific value	PE factor	PE value	CO <sub>2</sub> emissions factor (CO <sub>2</sub> -eq) kg/kWh	CO <sub>2</sub> -eq emissions kg/(m <sup>2</sup> a)				
		-	-		kWh/(m <sup>2</sup> a)	kWh/kWh	kWh/kWh	kWh/(m <sup>2</sup> a)	kWh/kWh	kWh/(m <sup>2</sup> a)						
									1-PE factors (non-renewable) PHI Certification		1-CO2 factors GEMIS (Germany)					
									67,82		130,07		27,3			
Heating				100 %		1,27		30,09		2,60		61,4		12,6		
Electricity (HP compact unit)						1,35			2,60				0,532			
Electricity (heat pump)						1,35			2,60				0,532			
District heating: 1-None						2,8[4,5]3,3							0,000			
Wood and other biomass						1,10			-				-			
Natural gas / RE gas						1,75			1,10				0,250			
Heating oil / RE methanol						2,30			1,10				0,320			
Solar thermal system									0,00				0,045			
Electricity (direct)		1,00		100 %	21,219	1,35		1,26	26,83	2,60	55,2		0,532	11,3		
Vedovn med vannkappe			1,00			1,10										
Aux. electricity (heating, wintertime ventilation)					2,414	1,35		1,35	3,26	2,60	6,3		0,532	1,3		
Cooling and dehumidification						1,00		1,11				2,9		0,6		
Electricity cooling (heat pump)						1,00				2,60				0,532		
Auxiliary electricity cooling, ventilation summer					1,110	1,00			1,11	2,60		2,9		0,6		
Electricity dehumidification (heat pump)						1,00				2,60				0,532		
Auxiliary electricity (dehumidification)						1,00				2,60				0,532		
DHW generation				100 %		0,71		18,31		0,95		24,3		5,7		
Electricity (HP compact unit)						1,15				2,60				0,532		
Electricity (heat pump)						1,15				2,60				0,532		
District heating: 1-None						2,8[4,5]3,3								0,000		
Wood and other biomass						1,10				-				-		
Natural gas / RE gas						1,75				1,10				0,250		
Heating oil / Methanol						2,30				1,10				0,320		
Solar thermal system				65 %	16,248	0,46		0,46	7,54	0,00		0,0	0,045	0,731		
Electricity (direct)		1,00		35 %	8,869	1,15		1,15	10,20	2,60		23,1	0,532	4,7		
Vedovn med vannkappe			1,00			1,10										
Aux. electricity (DHW + solar DHW)					0,489	1,15		1,15	0,56	2,60		1,3	0,532	0,3		
Household electricity					15,9		1,15		18,32		41,4				8,5	
Electricity (household or non-residential lighting, etc.)						15,9		1,15	1,15	2,60		41,4	0,532	8,5		
Auxiliary electricity (other)						1,15				2,60			0,532			
Gas / RE gas dry/cook					0,0		1,75		0,00		2,60		0,0		0,0	

Energy generation		Final energy		PER		PE		CO <sub>2</sub>	
Reference: Projected building footprint area		Final energy generation	Final energy generation	PER factor	PER specific value	PE factor	PE Value	Emission factor (CO <sub>2</sub> -eq)	CO <sub>2</sub> -eq emissions
		kWh/a	kWh/(m <sup>2</sup> a) <sub>Projected</sub>	kWh/kWh	kWh/(m <sup>2</sup> a) <sub>Projected</sub>	kWh/kWh	kWh/(m <sup>2</sup> a)	kg/kWh	kg/a
					10,9		28,6		102,3
PV electricity		0	0,0	1,00	0,0	-		-	
Solar thermal system	2273	23,4		0,46	10,9	1,22	28,6	0,045	102,3
		0,0							

PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]	120	Current building reaches following class	130	Requirement met?	no
--	-----	--	-----	------------------	----

Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)	Useful energy performance				Airtightness	Primary Energy Renewable PER  [kWh/(m² <sub>EP,renov</sub> ·a)]
	Annual heat. dem	Heating load	Useful cool. energy	Cooling load	n <sub>50</sub>	
	Treated floor area kWh/(m²·a)	Treated floor area W/m²	Treated floor area kWh/(m²·a)	Treated floor area W/m²		
Requirement Passive House Premium					1/h	
Requirement Passive House Plus	15	10	-	-	0.60	
Requirement Passive House Classic						
Requirement PHI Low Energy Building	30		-		1.00	
Current building reaches following class for aspr	21		-		0.6	
	#VERDII	#VERDII	Premium		Premium	

Summary	Final energy	PER specific value	PE value	CO2eq emissions	CO2eq substitution balance
Though, from the scientific point of view, not entirely correct, different energy carriers will be added together here. This is done to meet the criteria of other energy standards.			1-PE factors (non-renewable) PHI Certification	1-CO2 factors GEMIS (Germany)	1-CO2 factors GEMIS (Germany)
	MWh/a	MWh/a	MWh/a	kg/a	kg/a
Demand	9,272	9,5	18,20	3826	3826
Generation	-2,273075	-1,1	-2,78	102	-473
Demand, cumulative generation (annual balance)	6,99899	8,43	15,42	3928	3353
Demand w/o household electricity	7,0	6,9	12,40	2640	2640
Demand w/o household electricity, cum. generation	4,77	5,87	9,63	2743	2168



## **2 – OMPROSJEKTERING**

### **NULLENERGIBYGG**

**2.1** Nullenergibbygg PER Oslo

**2.2** Nullenergibbygg PER Trondheim

Dråpen moderne / Climate: Oslo / TFA: 140 m² / Heating: 22.8 kWh/(m²a) / Freq. overheating: 1 % / PER: 67 kWh/(m²a)

Selection of heat generation system(s)

Primary heat generation type

5-Direct electricity

Secondary heat generation type (optional & different)

Contribution margin (useful energy)

Heating

100 %

DHW

100 %

Addl. input in following worksheets

Building type:

Treated floor area A<sub>TFA</sub>:

Projected building footprint A<sub>Projected</sub>:

Heating demand incl. distribution & hydr. frost protection

Cooling energy dem. incl. dehumidification

DHW demand including distribution:

140

m²

97

m²

22,75

kWh/(m²a)

kWh/(m²a)

25,12

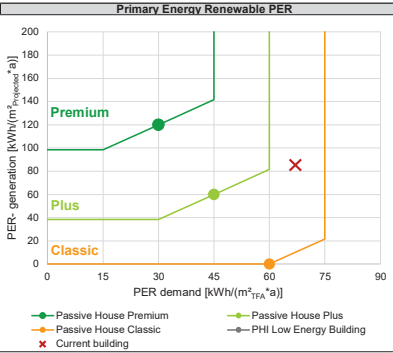
kWh/(m²a)

Energy demand	Efficiency		Final energy		PER			PE		CO <sub>2</sub>	
	Calculation	User defined value	Contribution (final energy)	Final energy demand	PER factor	Effective PER factor (including biomass)	PER specific value	PE factor	PE value	CO <sub>2</sub> emissions factor (CO <sub>2</sub> -eq) kg/kWh	CO <sub>2</sub> eq emissions kg/(m²a)
Reference: Treated floor area	-	-		kWh/(m²a)	kWh/kWh	kWh/kWh	kWh/(m²a)	kWh/kWh	kWh/(m²a)		
							67,00		121,85		25,9
Heating			100 %			1,10	27,70	2,01	50,7		10,6
Electricity (HP compact unit)					1,45			2,60		0,532	
Electricity (heat pump)					1,45			2,60		0,532	
District heating: 1-None					2,8 4,5 3,3					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / RE methanol					2,30			1,10		0,320	
Solar thermal system			25 %	5,674	0,35	0,35	2,00	0,00	0,0	0,045	0,2554
Electricity (direct)	1,00		75 %	17,078	1,45	1,30	22,22	2,60	44,4	0,532	9,1
Vedovn med vannkappe		1,00			1,10						
Aux. electricity (heating, wintertime ventilation)				2,403	1,45	1,45	3,48	2,60	6,2	0,532	1,3
Cooling and dehumidification					1,00		1,79		4,7		1,0
Electricity cooling (heat pump)					1,00			2,60		0,532	
Auxiliary electricity cooling, ventilation summer				1,790	1,00		1,79	2,60	4,7	0,532	1,0
Electricity dehumidification (heat pump)					1,00			2,60		0,532	
Auxiliary electricity (dehumidification)					1,00			2,60		0,532	
DHW generation			100 %			0,72	18,39	0,98	25,1		5,9
Electricity (HP compact unit)					1,20			2,60		0,532	
Electricity (heat pump)					1,20			2,60		0,532	
District heating: 1-None					2,8 4,5 3,3					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / Methanol					2,30			1,10		0,320	
Solar thermal system			63 %	15,940	0,43	0,43	6,79	0,00	0,0	0,045	0,717
Electricity (direct)	1,00		37 %	9,178	1,20	1,20	11,01	2,60	23,9	0,532	4,9
Vedovn med vannkappe		1,00			1,10						
Aux. electricity (DHW + solar DHW)				0,489	1,20	1,20	0,59	2,60	1,3	0,532	0,3
Household electricity				15,9		1,20	19,11		41,4		8,5
Electricity (household or non-residential lighting, etc.)				15,9	1,20	1,20	19,11	2,60	41,4	0,532	8,5
Auxiliary electricity (other)					1,20			2,60		0,532	
Gas / RE gas dry/cook				0,0	1,75		0,00	2,60	0,0	0,270	0,0

Energy generation	Final energy		PER		PE		CO <sub>2</sub>	
	Final energy generation	Final energy generation	PER factor	PER specific value	PE factor	PE Value	Emission factor (CO <sub>2</sub> -eq) kg/kWh	CO <sub>2</sub> eq emissions kg/a
Reference: Projected building footprint area	kWh/a	kWh/(m²A <sub>Projected</sub> ) <sup>a</sup>	kWh/kWh	kWh/(m²A <sub>Projected</sub> ) <sup>b</sup>	kWh/kWh	kWh/(m²a)		
				85,3		38,1		1053,7
PV electricity	7059	72,7	1,00	72,7	0,00	0,0	0,130	917,6
Solar thermal system	3024	31,1	0,40	12,6	1,22	38,1	0,045	136,1
		0,0						

PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]	120	Current building reaches following class	122	Requirement met?	no
--	-----	--	-----	------------------	----

Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)	Useful energy, performance				Airtightness
	Annual heat. dem Treated floor area kWh/(m²a)	Heating load Treated floor area W/m²	Useful cool. energy Treated floor area kWh/(m²a)	Cooling load Treated floor area W/m²	n <sub>50</sub> 1/h
Requirement Passive House Premium		10		-	0,60
Requirement Passive House Plus	15		-		
Requirement Passive House Classic					1,00
Requirement PHI Low Energy Building	30		-		0,6
Current building reaches following class for aspi	23	16	-	-	Premium
	PHI Low Energy Building		Premium		Premium
Summary	Final energy	PER specific value	PE value	CO <sub>2</sub> eq emissions	CO <sub>2</sub> eq substitution balance
	MWh/a	MWh/a	1-PE factors (non-renewable) PHI Certification MWh/a	1-CO <sub>2</sub> factors GEMIS (Germany) kg/a	1-CO <sub>2</sub> factors GEMIS (Germany) kg/a
Demand	9,5804	9,4	17,05	3624	3624
Generation	-10,0827	-8,3	-3,70	1054	-3467
Demand, cumulative generation (annual balance)	-0,5023	1,09	13,35	4678	158
Demand w/o household electricity	7,4	6,7	11,25	2439	2439
Demand w/o household electricity, cum. generation	-2,73	-1,58	7,56	3492	-1028



Dråpen moderne / Climate: Trondheim / TFA: 140 m<sup>2</sup> / Heating: 21,2 kWh/(m<sup>2</sup>a) / Freq. overheating: 0 % / PER: 65,4 kWh/(m<sup>2</sup>a)

		Building type:			
		Treated floor area A <sub>TFA</sub> :		140	m²
Selection of heat generation system(s)		Projected building footprint A <sub>Projected</sub> :		97	m²
Primary heat generation type		Heating demand incl. distribution & hydr. frost protection		21,22	kWh/(m²a)
5-Direct electricity		Cooling energy dem. incl. dehumidification			kWh/(m²a)
Secondary heat generation type (optional & different)		DHW demand including distribution:		25,12	kWh/(m²a)
-					

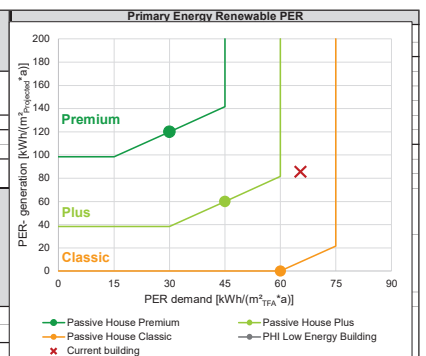
Energy demand	Efficiency		Final energy		PER			PE		CO <sub>2</sub>	
Reference: Treated floor area	Calculation	User defined value	Contribution (final energy)	Final energy demand	PER factor	Effective PER factor (including biomass)	PER specific value	PE factor	PE value	CO <sub>2</sub> emissions factor (CO <sub>2</sub> -eq)	CO <sub>2</sub> eq emissions
	-	-		kWh/(m²a)	kWh/kWh	kWh/kWh	kWh/(m²a)	kWh/kWh	kWh/(m²a)	kg/kWh	kg/(m²a)
							65,43	120,79		25,6	
							1-PE factors (non-renewable) PHI Certification		1-CO2 factors GEMIS (Germany)		
Heating			100 %			1,10	25,91	2,09	49,3		10,3
Electricity (HP compact unit)					1,35			2,60		0,532	
Electricity (heat pump)					1,35			2,60		0,532	
District heating: 1-None					2,8 4,5 3,3					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / RE methanol					2,30			1,10		0,320	
Solar thermal system			22 %	4,663	0,45	0,45	2,12	0,00	0,0	0,045	0,2099
Electricity (direct)	1,00		78 %	16,556	1,35	1,24	20,53	2,60	43,0	0,532	8,8
Vedovn med vannkappe				1,00			1,10				
Aux. electricity (heating, winterime ventilation)				2,414	1,35	1,35	3,26	2,60	6,3	0,532	1,3
Cooling and dehumidification					1,00		1,11		2,9		0,6
Electricity cooling (heat pump)					1,00			2,60		0,532	
Auxiliary electricity cooling, ventilation summer				1,110	1,00		1,11	2,60	2,9	0,532	0,6
Electricity dehumidification (heat pump)					1,00			2,60		0,532	
Auxiliary electricity (dehumidification)					1,00			2,60		0,532	
DHW generation			100 %			0,78	20,10	1,06	27,2		6,2
Electricity (HP compact unit)					1,15			2,60		0,532	
Electricity (heat pump)					1,15			2,60		0,532	
District heating: 1-None					2,8 4,5 3,3					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / Methanol					2,30			1,10		0,320	
Solar thermal system			60 %	15,154	0,53	0,53	8,08	0,00	0,0	0,045	0,682
Electricity (direct)	1,00		40 %	9,963	1,15	1,15	11,46	2,60	25,9	0,532	5,3
Vedovn med vannkappe				1,00			1,10				
Aux. electricity (DHW + solar DHW)				0,489	1,15	1,15	0,56	2,60	1,3	0,532	0,3
Household electricity				15,9		1,15	18,32		41,4		8,5
Electricity (household or non-residential lighting, etc.)				15,9	1,15	1,15	18,32	2,60	41,4	0,532	8,5
Auxiliary electricity (other)					1,15			2,60		0,532	
Gas / RE gas dry/cook				0,0	1,75		0,00	2,60	0,0	0,270	0,0

Energy generation		Final energy		PER		PE		CO <sub>2</sub>	
Reference: Projected building footprint area		Final energy generation	Final energy generation	PER factor	PER specific value	PE factor	PE Value	Emission factor (CO <sub>2</sub> -eq)	CO <sub>2</sub> eq emissions
		kWh/a	kWh/(m <sup>2</sup> a) <sub>Projected</sub> <sup>a</sup>	kWh/kWh	kWh/(m <sup>2</sup> a) <sub>Projected</sub> <sup>b</sup>	kWh/kWh	kWh/(m <sup>2</sup> a)	kg/kWh	kg/a
					85,6		34,9		1020,2
PV electricity		6888	70,9	1,00	70,9	0,00	0,0	0,130	895,5
Solar thermal system		2772	28,6	0,51	14,6	1,22	34,9	0,045	124,8
			0,0						

PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]	120	Current building reaches following class	121	Requirement met?	no
--	-----	--	-----	------------------	----

Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)	Useful energy, performance				Airtightness	Primary Energy Renewable PER  [kWh/(m² <sub>gross</sub> ·a)]
	Annual heat. dem	Heating load	Useful cool. energy	Cooling load	n <sub>50</sub>	
	Treated floor area kW/h(m²·a)	Treated floor area W/m²	Treated floor area kWh/(m²·a)	Treated floor area W/m²	1/h	
Requirement Passive House Premium					0,60	
Requirement Passive House Plus	15	10	-	-	1,00	
Requirement Passive House Classic					0,6	
Requirement PHI Low Energy Building	30	#VERD!!	-	-	Premium	
Current building reaches following class for aspi	21				Premium	

Summary	Final energy	PER specific value	PE value	CO2eq emissions	CO2eq substitution balance
Though, from the scientific point of view, not entirely correct, different energy carriers will be added together here. This is done to meet the criteria of other energy standards.	MWh/a	MWh/a	1-PE factors (non-renewable) PHI Certification MWh/a	1-CO2 factors GEMIS (Germany) kg/a	1-CO2 factors GEMIS (Germany) kg/a
<b>Demand</b>	<b>9,2721</b>	<b>9,2</b>	16,90	3583	3583
<b>Generation</b>	<b>-9,6608</b>	<b>-9,3</b>	-3,39	1020	-3346
<b>Demand, cumulative generation (annual balance)</b>	-0,3888	0,85	13,51	4603	237
<b>Demand w/o household electricity</b>	<b>7,0</b>	<b>6,6</b>	11,11	2397	2397
<b>Demand w/o household electricity, cum. generation</b>	-2,62	-1,72	7,72	3417	-949



## **3 – OMPROSJEKTERING PLUSSHUS**

- 3.1** Plusshus PER Oslo
- 3.2** Plusshus HP Oslo
- 3.3** Plusshus PER Trondheim
- 3.4** Plusshus HP Trondheim



## Primary Energy Renewable PER

Passive House with PHPP Version 9.6a

Dråpen moderne / Climate: Oslo / TFA: 140 m² / Heating: 22.8 kWh/(m²a) / Freq. overheating: 1 % / PER: 46.7 kWh/(m²a)

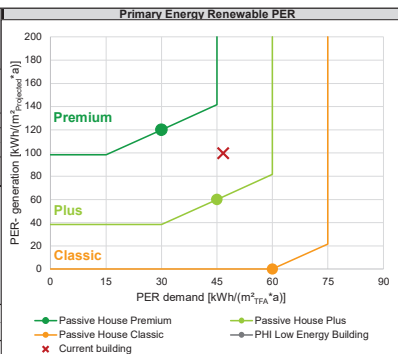
Selection of heat generation system(s)		Contribution margin (useful energy)		Add. input in following worksheets	Heating demand incl. distribution & hydr. frost protection	Cooling energy dem. incl. dehumidification	DHW demand including distribution:	Building type:	
Primary heat generation type		Heating	DHW					Treated floor area A <sub>TFA</sub> :	
2-Heat pump(s)		100 %	100 %					140	m²
Secondary heat generation type (optional & different)								Projected building footprint A <sub>Projected</sub> :	
-		0 %	0 %					22,75	m²
									kWh/(m²a)
									kWh/(m²a)
								25,12	kWh/(m²a)

Energy demand	Efficiency		Final energy		PER			PE		CO <sub>2</sub>	
	Calculation	User defined value	Contribution (final energy)	Final energy demand	PER factor	Effective PER factor (including biomass)	PER specific value	PE factor	PE value	CO <sub>2</sub> emissions factor (CO <sub>2</sub> -eq) kg/kWh	CO <sub>2</sub> eq emissions kg/(m²a)
Reference: Treated floor area	-	-		kWh/(m²a)	kWh/kWh	kWh/kWh	kWh/(m²a)	kWh/kWh	kWh/(m²a)		
							46,70	1-PE factors (non-renewable) PHI Certification		1-CO2 factors GEMIS (Germany)	
									82,30		17,8
Heating			100 %		0,93		15,82	1,73	29,3		6,3
Electricity (HP compact unit)								2,60		0,532	
Electricity (heat pump)	1,92		75 %	8,882	1,45	1,16	10,33	2,60	23,1	0,532	4,7
District heating: 1-None					2,8 4,5 3,3					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / RE methanol					2,30			1,10		0,320	
Solar thermal system			25 %	5,674	0,35	0,35	2,00	0,00	0,0	0,045	0,2554
Electricity (direct)					1,45			2,60		0,532	
Vedovn med vannkappe		1,00			1,10						
Aux. electricity (heating, wintertime ventilation)				2,403	1,45	1,45	3,48	2,60	6,2	0,532	1,3
Cooling and dehumidification					1,00		1,79		4,7		1,0
Electricity cooling (heat pump)					1,00			2,60		0,532	
Auxiliary electricity cooling, ventilation summer				1,790	1,00		1,79	2,60	4,7	0,532	1,0
Electricity dehumidification (heat pump)					1,00			2,60		0,532	
Auxiliary electricity (dehumidification)					1,00			2,60		0,532	
DHW generation			100 %		0,54		9,98	0,37	6,9		2,1
Electricity (HP compact unit)					1,20			2,60		0,532	
Electricity (heat pump)	4,24		37 %	2,164	1,20	1,20	2,60	2,60	5,6	0,532	1,2
District heating: 1-None					2,8 4,5 3,3					0,000	
Wood and other biomass					1,10			-		-	
Natural gas / RE gas					1,75			1,10		0,250	
Heating oil / Methanol					2,30			1,10		0,320	
Solar thermal system			63 %	15,940	0,43	0,43	6,79	0,00	0,0	0,045	0,717
Electricity (direct)					1,20			2,60		0,532	
Vedovn med vannkappe		1,00			1,10						
Aux. electricity (DHW + solar DHW)				0,489	1,20	1,20	0,59	2,60	1,3	0,532	0,3
Household electricity				15,9		1,20	19,11		41,4		8,5
Electricity (household or non-residential lighting, etc.)				15,9	1,20	1,20	19,11	2,60	41,4	0,532	8,5
Auxiliary electricity (other)					1,20			2,60		0,532	
Gas / RE gas dry/cook				0,0	1,75		0,00	2,60	0,0	0,270	0,0

Energy generation	Final energy		PER		PE		CO <sub>2</sub>	
	Final energy generation kWh/a	Final energy generation kWh/(m²A <sub>Projected</sub> ) <sup>a</sup>	PER factor kWh/kWh	PER specific value kWh/(m²A <sub>Projected</sub> ) <sup>b</sup>	PE factor kWh/kWh	PE Value kWh/(m²a)	Emission factor (CO <sub>2</sub> -eq) kg/kWh	CO <sub>2</sub> eq emissions kg/a
Reference: Projected building footprint area								
						38,1		1237,3
PV electricity	8471	87,2	1,00	87,2	0,00	0,0	0,130	1101,2
Solar thermal system	3024	31,1	0,40	12,6	1,22	38,1	0,045	136,1
		0,0						

PE demand requirement in case of verification through PE (non-renewable) [kWh/(m²a)]	120	Current building reaches following class	82	Requirement met?	yes
--	-----	--	----	------------------	-----

Achievable energy standard through the verification of renewable primary energy (assessment of individual aspects)	Useful energy, performance				Airtightness	Primary Energy Renewable PER
	Annual heat. dem Treated floor area kWh/(m²a)	Heating load Treated floor area W/m²	Useful cool. energy Treated floor area kWh/(m²a)	Cooling load Treated floor area W/m²		
Requirement Passive House Premium					1/h	
Requirement Passive House Plus	15	10	-	-	0,60	
Requirement Passive House Classic						
Requirement PHI Low Energy Building	30		-		1,00	
Current building reaches following class for aspi	23	16	-	-	0,6	
	PHI Low Energy Building		Premium		Premium	
Summary	Final energy MWh/a	PER specific value MWh/a	PE value MWh/a	CO <sub>2</sub> eq emissions kg/a	CO <sub>2</sub> eq substitution balance kg/a	
Though, from the scientific point of view, not entirely correct, different energy carriers will be added together here. This is done to meet the criteria of other energy standards.	7,4524	6,5	11,51	2492	2492	
Demand	-11,4945	-9,7	-3,70	1237	-4034	
Generation						
Demand, cumulative generation (annual balance)	-4,0420	-3,16	7,82	3729	-1542	
Demand w/o household electricity	5,2	3,9	5,72	1307	1307	
Demand w/o household electricity, cum. generation	-6,27	-5,83	2,02	2544	-2728	



Heat pump

Passive House with PHPP Version 9.6a

Dråpen moderne / Climate: Oslo / TFA: 140 m² / Heating: 22,8 kWh/(m²a) / Freq. overheating: 1 % / PER: 46,7 kWh/(m²a)

		Building type:		
		Treated floor area A <sub>TFA</sub> :	140	m²
Covered fraction of space heating demand	(PER worksheet)		75 %	
Space heating demand + distribution losses	Q <sub>H</sub> +Q <sub>HL</sub> : (DHW+Distribution)		3183	kWh/a
Solar fraction for space heat	η <sub>Solar, H</sub> (SolarDHW worksheet)		25 %	
Effective annual heating demand	Q <sub>H,WI</sub> =Q <sub>H</sub> *(1-η <sub>Solar, H</sub> )		2389	kWh/a
Covered fraction of DHW demand	(PER worksheet)		37 %	
Total heating demand of DHW system	Q <sub>gDHW</sub> (DHW+Distribution)		3514	kWh/a
Solar fraction for DHW	η <sub>Solar, DHW</sub> (SolarDHW worksheet)		63 %	
Effective DHW demand	Q <sub>DHW, WI</sub> =Q <sub>DHW</sub> *(1-η <sub>Solar, DHW</sub> )		1284	kWh/a
Number of heat pumps in the system			1	
Functionality			Heating & DHW	
Heating				
Selection of HP:	1-Standard air/water heat pump	Heat source:	1-Outdoor air	
Selection of distribution system			1-Underfloor heating	
Design distribution temperature		θ <sub>design</sub> (DHW+Distribution)	35,00	°C
Nominal power of distribution system		P <sub>nom</sub>	1,73	kW
Distribution system (to be completed by experienced users only)				
Nominal power of distribution system		P <sub>nom</sub>		kW
Radiator exponent		n		
Heat storage tank (buffer storage tank 'DHW+Distribution' worksheet)			0-No	
Specific heat losses storage	U * A <sub>Storage</sub>			W/K
Storage location in thermal envelope			1-Inside	
Room temperature (storage location: outside of thermal envelope)	(DHW+Distribution)			°C
Sink temperature of heat pump for heating	θ <sub>sink</sub>		61,50	°C
Entries in relation to the domestic hot water system				
Selection of HP:	0-None	Heat source:		
DHW temperature		(DHW+Distribution)	60,00	°C
Orientation of DHW storage tank ('storage 1' in 'DHW+Distribution' worksheet)			1-Inside	
Specific heat losses storage	U * A <sub>Storage</sub>		0,7	W/K
Room temperature (storage location: outside of thermal envelope)	(DHW+Distribution)		20,00	°C
Type of backup heater			1-Elec. Immersion heater	
Δθ of electric continuous flow water heater				K
Additional options in case of one heat pump for both functions: Heating & DHW				
Same heat pump's sink temperature for Heating and for DHW			1-Yes	
Heat pump priority	(Manufacturer, tech. data)		1-DHW-priority	
Control strategy				
Heat pump control strategy			1-On/Off	
Heating				
Depth ground water / Ground collector / Ground probe	z			m
Power of pump for ground heat exchanger	P <sub>pump</sub>			kW

Heating

Heat pump: Standard air/water heat pump

Source: 1-Outdoor air

	$\theta_{\text{source}}$ °C	$\theta_{\text{sink}}$ °C	Heating capacity kW	COP
Test point 1	-7,0	35,0	2,2	2,7
Test point 2	2,0	35,0	2,6	3,1
Test point 3	7,0	35,0	3,1	3,7
Test point 4	15,0	35,0	3,8	4,3
Test point 5	20,0	35,0	4,1	4,9
Test point 6	-7,0	50,0	2,0	2,0
Test point 7	2,0	50,0	2,5	2,3
Test point 8	7,0	50,0	3,0	2,8
Test point 9	15,0	50,0	3,7	3,3
Test point 10	20,0	50,0	3,9	3,5
Test point 11				
Test point 12				
Test point 13				
Test point 14				
Test point 15				

Temperature difference in sink $\Delta\theta_{\text{Sink}}$ 5,0K

DHW

Heat pump: Standard air/water heat pump

Source: 1-Outdoor air

	$\theta_{\text{source}}$ °C	$\theta_{\text{sink}}$ °C	Heating capacity kW	COP
Test point 1	-7,0	35,0	2,2	2,7
Test point 2	2,0	35,0	2,6	3,1
Test point 3	7,0	35,0	3,1	3,7
Test point 4	15,0	35,0	3,8	4,3
Test point 5	20,0	35,0	4,1	4,9
Test point 6	-7,0	50,0	2,0	2,0
Test point 7	2,0	50,0	2,5	2,3
Test point 8	7,0	50,0	3,0	2,8
Test point 9	15,0	50,0	3,7	3,3
Test point 10	20,0	50,0	3,9	3,5
Test point 11				
Test point 12				
Test point 13				
Test point 14				
Test point 15				

Temperature difference in sink $\Delta\theta_{\text{Sink}}$ 5,0K

Electr. energy consumption pump (grnd. water / ground)

Energy by direct electricity

Space heat supplied by HP

Winter DHW supplied by HP

Summer DHW supplied by HP

Space heating supplied by HP without storage losses

Winter DHW supplied by HP without storage losses

Summer DHW supplied by HP without storage losses

Electrical consumption of HP

$Q_{\text{EL,Pump}}$

$Q_{\text{EL,dir}}$

$Q_{\text{HP,Heating}}$

$Q_{\text{HP,DHW,Winter}}$

$Q_{\text{HP,DHW,Summer}}$

$Q_{\text{HP,Heating}}$

$Q_{\text{HP,DHW,Winter}}$

$Q_{\text{HP,DHW,Summer}}$

$Q_{\text{el,HP}}$

0

60

1713

402

67

1734

375

8

1486

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

Seasonal performance factor of heat pump

Final electrical energy demand heat generation

Annual primary energy demand

Annual CO<sub>2</sub>-equivalent emissions

$\text{SPF}_{\text{H-1}}$

$Q_{\text{final}}$

1. HP: Heating or heating & DHW

2. HP: Domestic hot

1,47

1545

4018

kg/a

822

11,0

28,7

kg/(m²a)

5,9

Dråpen moderne / Climate: Trondheim / TFA: 140 m<sup>2</sup> / Heating: 21,2 kWh/(m<sup>2</sup>a) / Freq. overheating: 0 % / PER: 46,6 kWh/(m<sup>2</sup>a)

PHPP PLUSSHUS MAX

## Heat pump

Passive House with PHPP Version 9.6a

Dräpen moderne / Climate: Trondheim / TFA: 140 m² / Heating: 21,2 kWh/(m²a) / Freq. overheating: 0 % / PER: 46,6 kWh/(m²a)

		Building type:	
		Treated floor area A <sub>TFA</sub> :	140 m²
Covered fraction of space heating demand	(PER worksheet)		78 %
Space heating demand + distribution losses	Q <sub>H</sub> +Q <sub>HL</sub> : (DHW+Distribution)		2969 kWh/a
Solar fraction for space heat	η <sub>Solar, H</sub> (SolarDHW worksheet)		22 %
Effective annual heating demand	Q <sub>H,WI</sub> =Q <sub>H</sub> *(1-η <sub>Solar, H</sub> )		2316 kWh/a
Covered fraction of DHW demand	(PER worksheet)		40 %
Total heating demand of DHW system	Q <sub>gDHW</sub> (DHW+Distribution)		3514 kWh/a
Solar fraction for DHW	η <sub>Solar, DHW</sub> (SolarDHW worksheet)		60 %
Effective DHW demand	Q <sub>DHW, WI</sub> =Q <sub>DHW</sub> *(1-η <sub>Solar, DHW</sub> )		1394 kWh/a
Number of heat pumps in the system			1
Functionality			Heating & DHW
<b>Heating</b>			
Selection of HP:	1-Standard air/water heat pump	Heat source:	1-Outdoor air
Selection of distribution system			1-Underfloor heating
Design distribution temperature	θ <sub>design</sub> (DHW+Distribution)		35,00 °C
Nominal power of distribution system	P <sub>nom</sub>		1,75 kW
<b>Distribution system (to be completed by experienced users only)</b>			
Nominal power of distribution system	P <sub>nom</sub>		
Radiator exponent	n		
Heat storage tank (buffer storage tank 'DHW+Distribution' worksheet)			0-No
Specific heat losses storage	U * A <sub>Storage</sub>		
Storage location in thermal envelope			1-Inside
Room temperature (storage location: outside of thermal envelope)	(DHW+Distribution)		
Sink temperature of heat pump for heating	θ <sub>sink</sub>		61,50 °C
<b>Entries in relation to the domestic hot water system</b>			
Selection of HP:	0-None	Heat source:	
DHW temperature		(DHW+Distribution)	60,00 °C
Orientation of DHW storage tank ('storage 1' in 'DHW+Distribution' worksheet)			1-Inside
Specific heat losses storage	U * A <sub>Storage</sub>		0,7 W/K
Room temperature (storage location: outside of thermal envelope)	(DHW+Distribution)		20,00 °C
Type of backup heater			1-Elec. Immersion heater
Δθ of electric continuous flow water heater			
<b>Additional options in case of one heat pump for both functions: Heating &amp; DHW</b>			
Same heat pump's sink temperature for Heating and for DHW			1-Yes
Heat pump priority	(Manufacturer, tech. data)		1-DHW-priority
<b>Control strategy</b>			
Heat pump control strategy			1-On/Off
<b>Heating</b>			
Depth ground water / Ground collector / Ground probe	z		
Power of pump for ground heat exchanger	P <sub>pump</sub>		

3.4

Heating

Heat pump: Standard air/water heat pump

Source: 1-Outdoor air

	$\theta_{source}$ °C	$\theta_{sink}$ °C	Heating capacity kW	COP
Test point 1	-7,0	35,0	2,2	2,7
Test point 2	2,0	35,0	2,6	3,1
Test point 3	7,0	35,0	3,1	3,7
Test point 4	15,0	35,0	3,8	4,3
Test point 5	20,0	35,0	4,1	4,9
Test point 6	-7,0	50,0	2,0	2,0
Test point 7	2,0	50,0	2,5	2,3
Test point 8	7,0	50,0	3,0	2,8
Test point 9	15,0	50,0	3,7	3,3
Test point 10	20,0	50,0	3,9	3,5
Test point 11				
Test point 12				
Test point 13				
Test point 14				
Test point 15				

Temperature difference in sink  $\Delta\theta_{Sink}$  5,0 K

DHW

Heat pump: Standard air/water heat pump

Source: 1-Outdoor air

	$\theta_{source}$ °C	$\theta_{sink}$ °C	Heating capacity kW	COP
Test point 1	-7,0	35,0	2,2	2,7
Test point 2	2,0	35,0	2,6	3,1
Test point 3	7,0	35,0	3,1	3,7
Test point 4	15,0	35,0	3,8	4,3
Test point 5	20,0	35,0	4,1	4,9
Test point 6	-7,0	50,0	2,0	2,0
Test point 7	2,0	50,0	2,5	2,3
Test point 8	7,0	50,0	3,0	2,8
Test point 9	15,0	50,0	3,7	3,3
Test point 10	20,0	50,0	3,9	3,5
Test point 11				
Test point 12				
Test point 13				
Test point 14				
Test point 15				

Temperature difference in sink  $\Delta\theta_{Sink}$  5,0 K

Electr. energy consumption pump (grnd. water / ground)

Energy by direct electricity

Space heat supplied by HP

Winter DHW supplied by HP

Summer DHW supplied by HP

Space heating supplied by HP without storage losses

Winter DHW supplied by HP without storage losses

Summer DHW supplied by HP without storage losses

Electrical consumption of HP

$Q_{EL,Pump}$

$Q_{EL,direct}$

$Q_{HP,Heating}$

$Q_{HP,DHW,Winter}$

$Q_{HP,DHW,Summer}$

$Q_{HP,Heating}$

$Q_{HP,DHW,Winter}$

$Q_{HP,DHW,Summer}$

$Q_{EL,HP}$

0

86

1699

421

132

1721

392

66

1515

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

kWh/a

Seasonal performance factor of heat pump

Final electrical energy demand heat generation

Annual primary energy demand

Annual CO<sub>2</sub>-equivalent emissions

$SPF_{H-1}$

$Q_{final}$

1. HP: Heating or heating & DHW

2. HP: Domestic hot

1,49

1601

4162

kg/a

852

11,4

29,8

kg/(m²a)

6,1

PHPP, HP

PHPP PLUSSHUS\_MAX