Norwegian Tax Authority - Oslo Norway

Arne Førland-Larsen

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Vienna 5th of September 2012

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Environmental goals

Initially energy label B

Goals were increases to Energy label A and:

- Meeting passive house criteria
- Meeting Future Built criteria
- Meeting criteria to be granted by ENOVA
- Fulfilling criteria BREEAM – “Very Good”

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Overcoming user skeptical to passive house

Will it be hot during summertimes ?
Will it be cold during wintertime ?

Indoor temperature summer before and after

	Existing	Refurbish	
Temperatur above 26 °C [h]	14	0	Hours
Temperatur over 25 °C [h]	274	0	Timer
Temperatur over 24 °C [h]	670	159	Timer
Temperatur over 23 °C [h]	1042	831	Timer
Temperatur over 22 °C [h]	2505	2470	Timer
Temperatur over 21 °C [h]	2895	2920	Timer
Temperatur over 20 °C [h]	2920	2920	Timer
Maks sommer temperatur	26,5	24,5	°C

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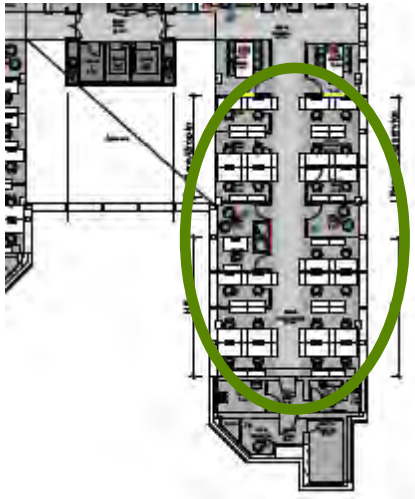
Glazing area in proportion to internal area of outerwall increases from ~25 % to ca. ~45%

Daylight factor of 2 (from facade)
New ~ 3 – 3,5 m
Existing ~ 2 – 2,5 m

Mean daylight factor
New ~2,5
Existing ~2,0 m



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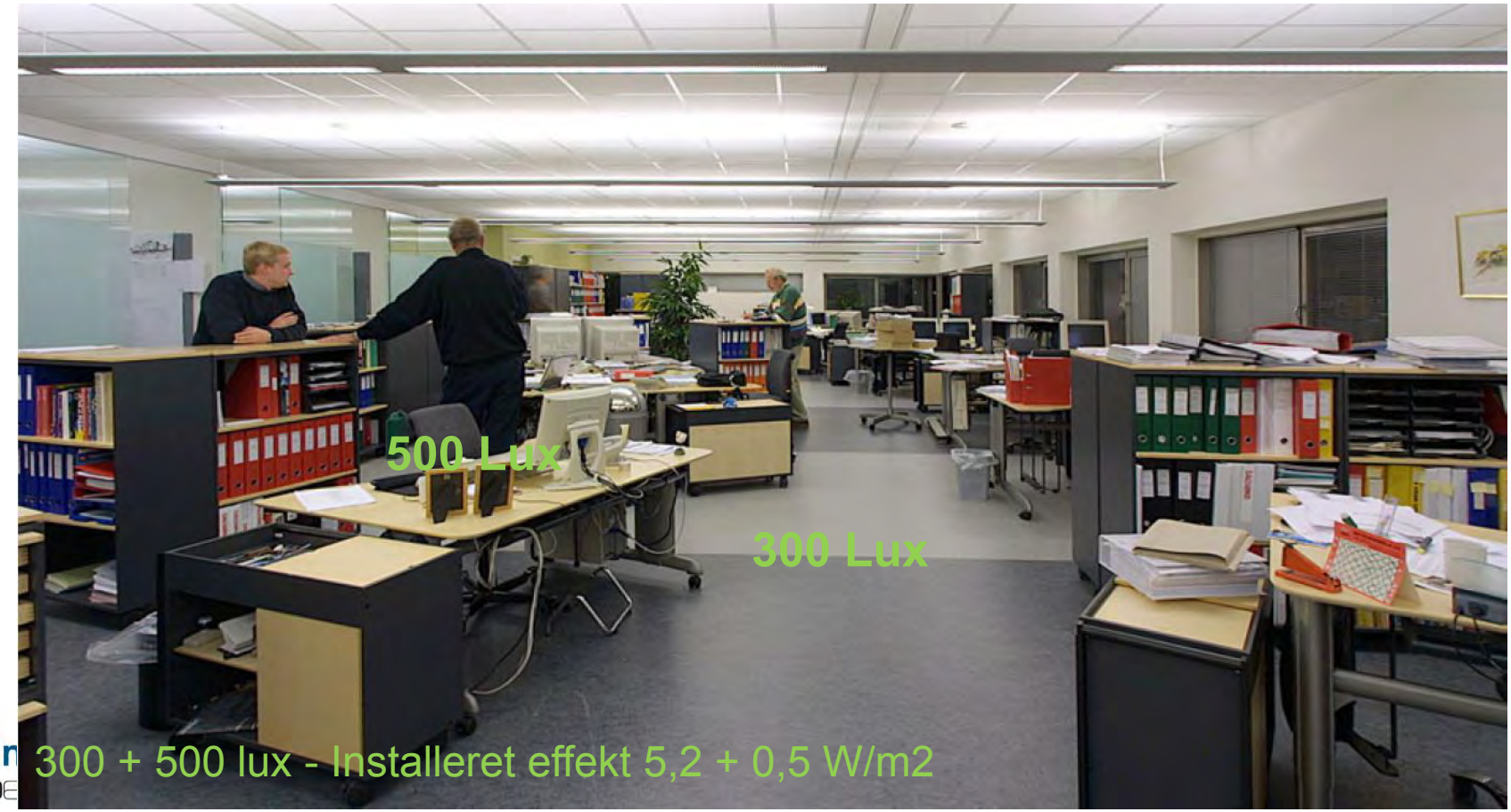
Adjusting client brief

- Demand for 500 LUX in all areas – **7 W/m2**
- Alerted to 300 lux general light level, and 500 lux on workplace – **5 W/m2**



Adjusting internal loads equipment

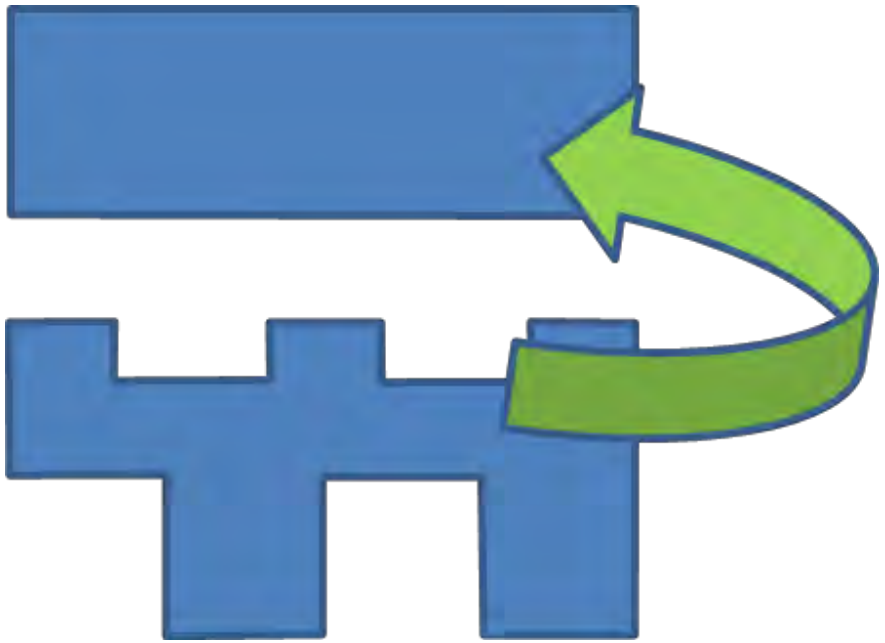
- Internal load computers where measured
- Present % where discussed / adjusted
- Working hours discussed / adjusted

Reversed internal premises in brief

- PC ”Thin Clients” 120 W pr. pc – 100% load
- Person 80 % present percentage during working hours
- Working hours 8.00 – 16.00

OVERALL DESIGN STRATEGY

- Optimizing the building envelope
- Optimizing technical system
- Utilization / recovery of energy from data facility in the building

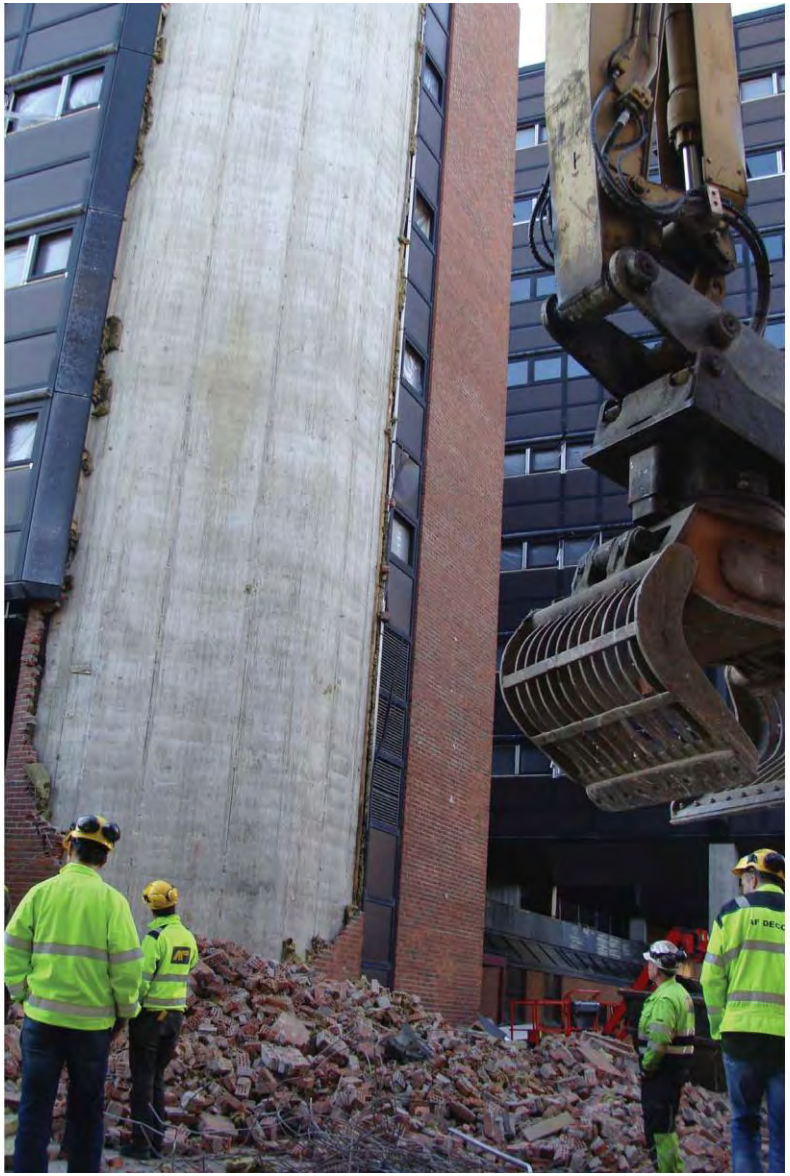


Reduced envelope to volume ratio and avoid “cooling fingers”

Optimizing glazing

Optimizing the building envelope

- Roof construction: U-value: < 0,13 W/m^{2}K (average)
- Wall construction : U-value: < 0,14 W/m^2 K (average above ground)
  U-value: < 0,47 W/m^2 K (average below ground)
- Windows: : U-value: < 0,72 W/m^2 K (average)
- Thermal bridge avoidance, wood facade construction with few thermal bridges., and 200 mm insulation in front of slabs.
- Overall demand to thermal bridges are: < 0,02 W/m^2 K
- Airtightness n50-value < 0,6 h^{-1}



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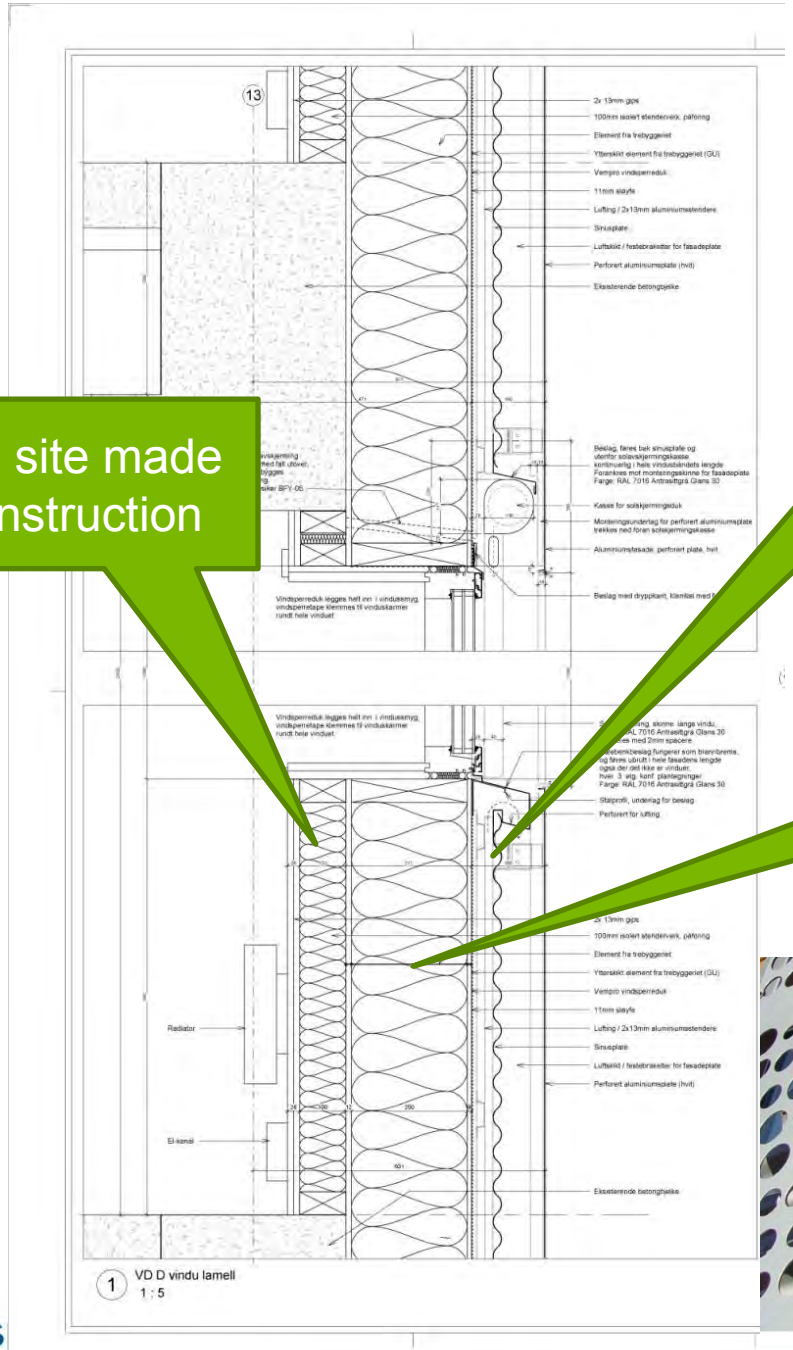
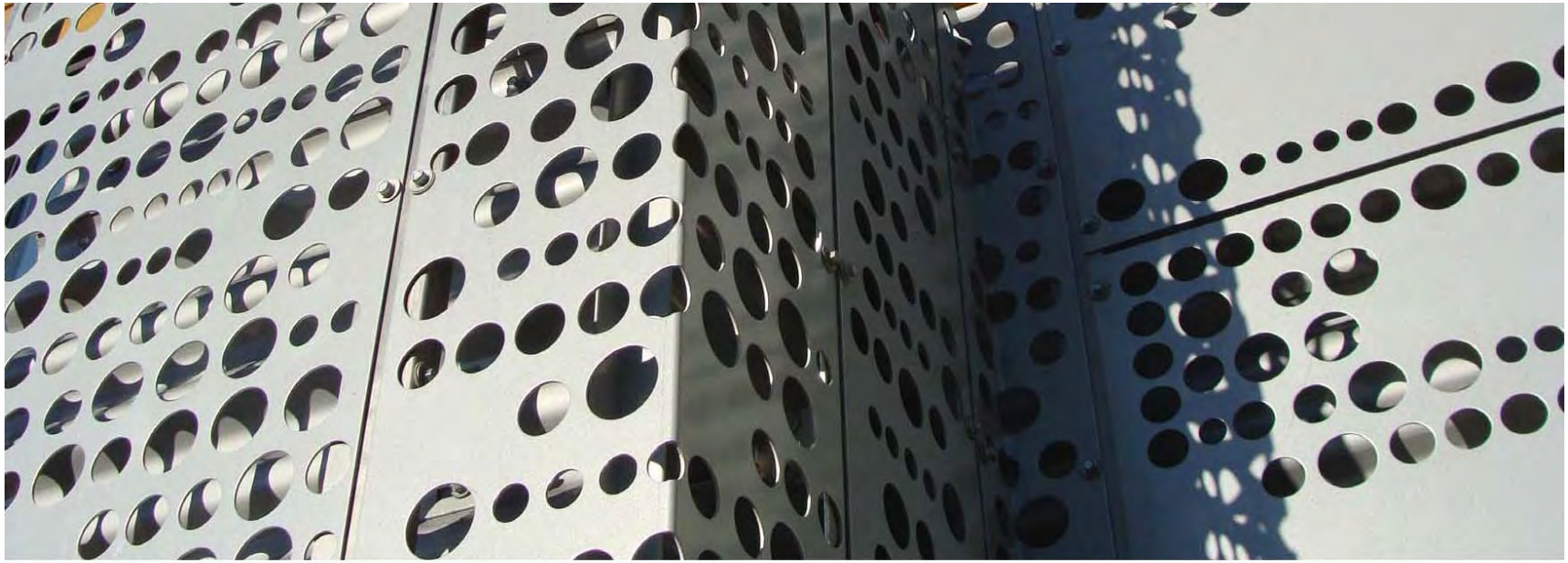


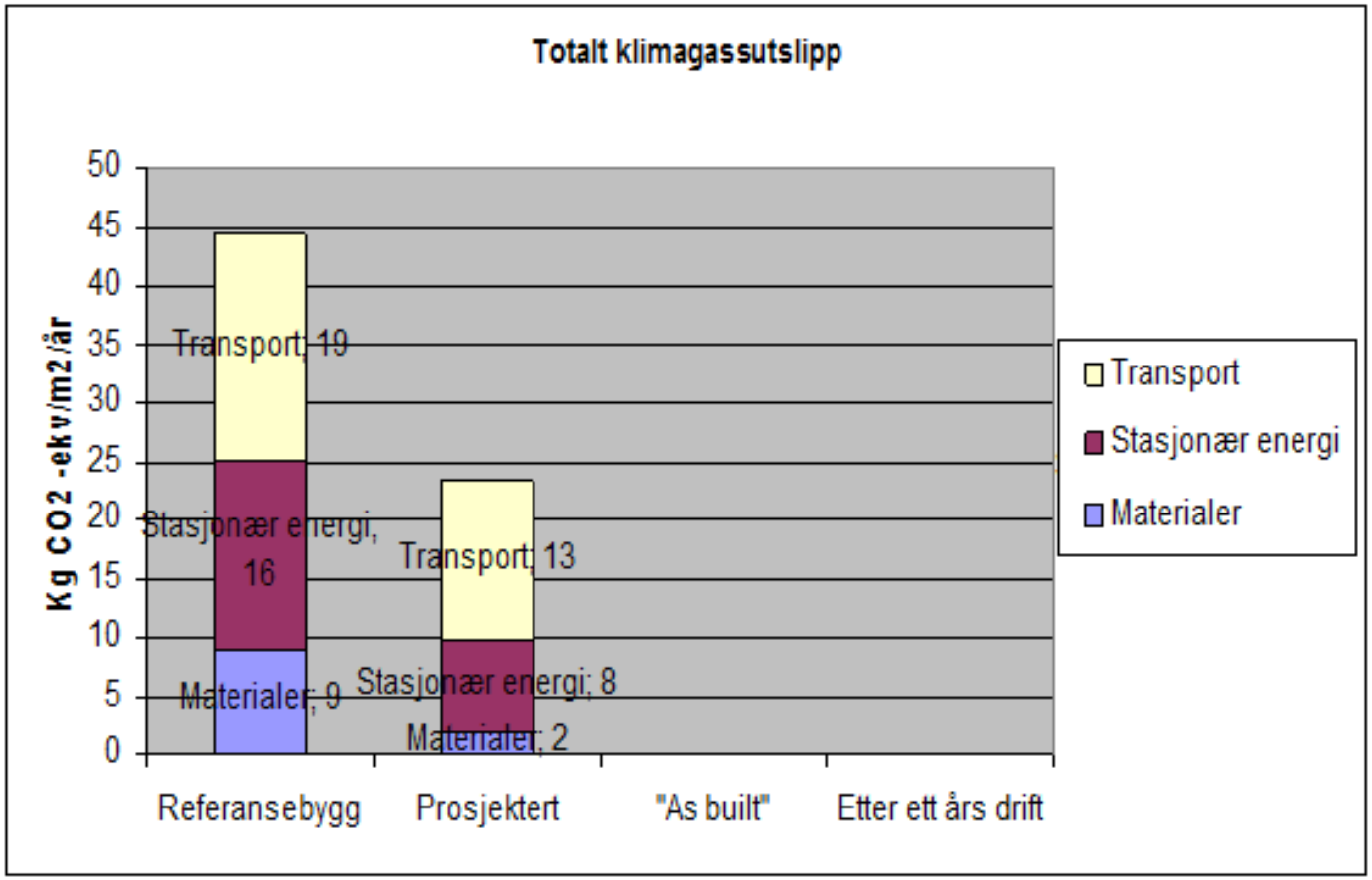
On site made construction

On site made construction

Prefabricated construction



Embodied Energy – CO_2 reduction

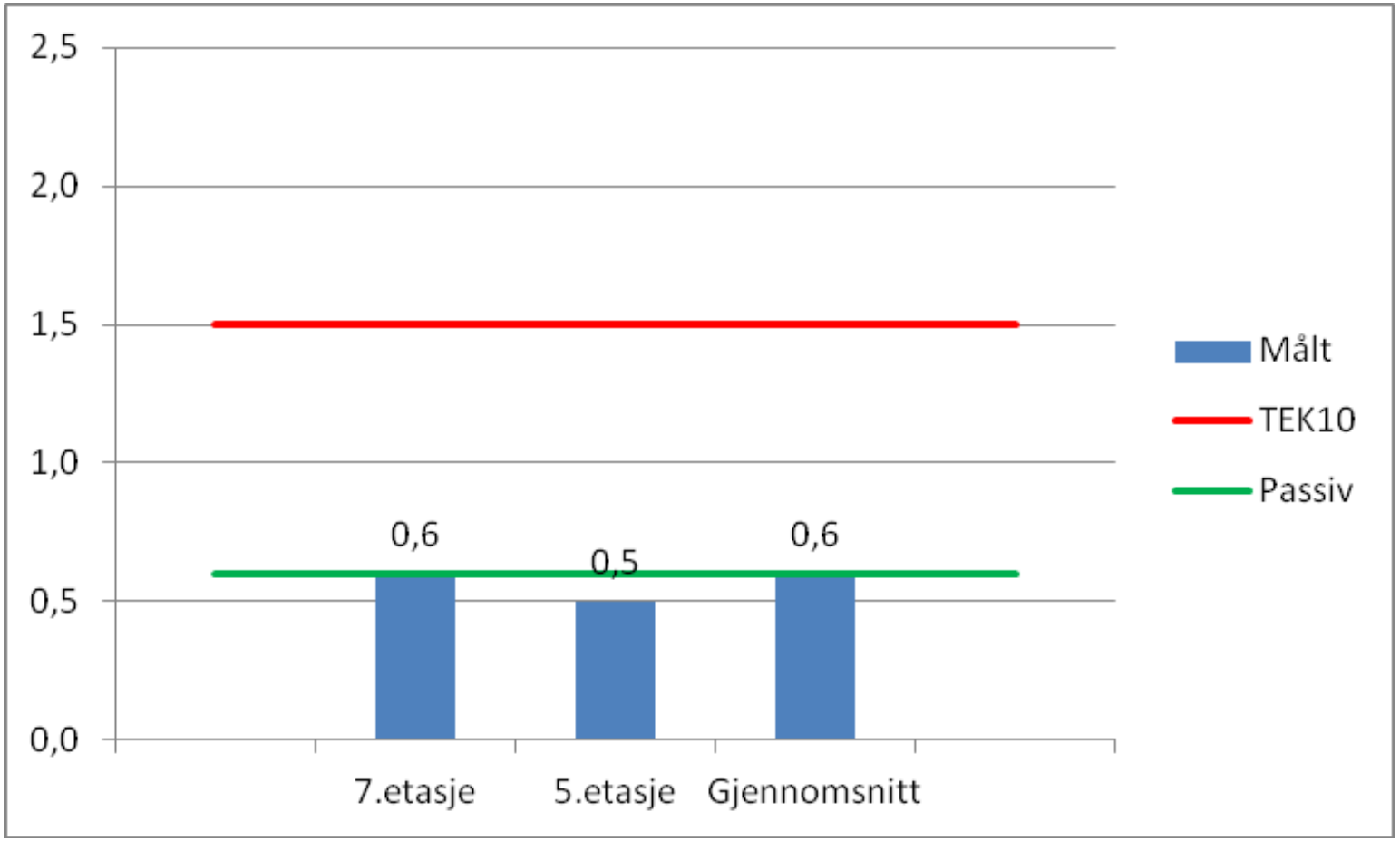


The basement – optimal solution ?

Heated areas Unheated areas

Economical payback time	~ 45 year
CO_2 payback time	~ 6 year

Air tightness measurement – 5 test



Technical solutions

LIGHTING SYSTEM

- LENI number ~15 kWh/m2 year

HEATING SYSTEM

- Water based heating systems, based on heat recovery from data facilities in basement

COOLING

- Reduced cooling demand

VENTILATION Efficient ventilations system

- VAV mechanical ventilation
- Efficient heat recovery – 85 % in average
- Low SFP < 1,5 kW/ m3 /s

Estimate for reel budget – Further improvements / reductions – focus on el consumption !

Energy budget		**Existing building**		**Energy refurbished building**						**Energy reduction**
Frederik Selmersvei		**Electircity**		**Electricity**		**Heating**		**Total**		
		kWh/ m² år		**kWh/ m² år**		**kWh/ m² år**		**kWh/ m² år**		**kWh/ m² år**
Space Heating		57	2)	3	3)	5	5)	7	3)	50
Mech. Vent. Heating		23	2)	1	3)	2	5)	3	3)	20
Domestic hot water		5	2)	1	3)	2	5)	3	3)	2
Mech. Vent fans		15	2)	12				12		3
Pumps		1	2)	2				2		-1
Lighting		32	2)	16				16		16
Technical equipment, PC, data		40	2)	40				40		0
Cooling, beams and vetilation		4	2)	6				6		-3
Kitchen - process		8	2)	8	2)			8		0
Elevators		2	2)	2	2)			2		0
Outsite light		1	2)	1	2)			1		0
El power other tech. Systems		3	2)	3	2)			3		0
Total energi consumption		**190**	1)	**95**		**8**		**103**	4)	**87**

Electricity consumption ~ 90 %

Heat consumption ~ 10 %

Measure	Describtion	Amount	Unit	Extra investment	Energy saving	Energy saving saving	Energy saving	Payback time
				[Euro]	[kWh/ year]	[kWh/ m2 year]	[euro/ year]	[year]
Building envelope:								
Walls above ground	U- value improved from 0,3 in average	14 500	m^2	1 680 000	249 375	7,1	31 172	54
	to 0,15 W/m2 K							
Walls belove ground	U-value improved from 0,47 in average	1 500	m^2	80 000	13 125	0,4	1 641	49
	to 0,37 W/m2 K (basement are 4,5 m							
	belove ground level in average)							
Roof	U- value improve from 0,22 in average	4 480	m^2	110 000	61 250	1,7	7 656	14
	to 0,13 W/m2 K							
Roof basement	Roof in basement belove ground level	2 800	m^2	130 000	476 875	13,6	59 609	2
	(facing ground), from 1,0 to 0,15 W/m2 K							
Air tight building	Air tightness improve from 1,5 to	132 000	m^3	125 000	271 250	7,7	33 906	4
	0,6 h^{-1} (n_{50} value)	(volume building)						
Passive house windows	U-value improved from 1,2 i average	3 500	m^2	350 000	118 125	3,4	14 766	24
	to 0,8 W/m2 K							
Cold bridges	Improved from 0,15 to 0,03 W/m2 K	35 000	m^2	50 000	91 875	12,6	11 484	4
Floor facing outside	U- value improved from 0,22 in average	450	m^2	70 000	7 000	0,2	875	80
above the ground	to 0,13 W/m2 K							
Technical system and energy supply								
Heat recovery and	Heat recovery on mechanical ventilation	240 000	m^3/h	240 000	843 500	24,1	105 438	2
VAV mechanical vent.	improved from 70% to 85% in average, and							
	demand controlled VAV mechanical							
	ventilation.							
SFP	Specific fanpower reduced from 2,0	240 000	m^3/h	120 000	122 500	3,5	15 313	8
	to 1,5 kW/ m3/s in average							
Efficient lighting	Efficiency of lighting system improved	35 000	m^2	840 000	420 000	12,0	52 500	12
	from LENI 25 to 12,4 kWh/m2 year							
Energy supply	System for heatrecovery from data	35 000	m^2	100 000	560 000	16,0	70 000	1
	facility in basement (water based heat-							
	ing system not included)							
Process planing quality ensurance								
Extra project planning cost, quality planning etc., course		35 000	m^2	170 000	-	-	-	-
workers on site.								
Overall budget investments cost				**4 065 000**	**3 234 875**	**102**	**404 359**	**10**
Subsidized				**2 400 000**				
Pay back time with subsidizing				**1 665 000**				**4,1**

Building envelope – long pay back time

Technical systems – “short” pay back tim

Average – “short” pay back tim

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Summing up - Conclusion

- Pay back time for measures on building envelope are in general long
- Pay back time for technical measures are in general “reasonable” / short
- Refurbishment to passive house level is possible with a “reasonable” pay back time for the entire solution
- Improving of existing basements is a challenge
- Measures for reduction of power consumption has in general large potentials
- The design and technical solutions are in general well know technology.
- Daylight has to be emphasized in the design process
- Discuss demands in client brief

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