



Depotbygget på Haakonsvern

Nullenergibygget med 8 grep

Byggherre og PL: Forsvarsbygg

PRL: Stema Rådgivning

ARK: LINK Arkitektur

RIV, RIE og RIB: Multiconsult

Spesialrådgiver energi: ZEB

Av Inger Andresen, RIM

LINK ARKITEKTUR

 **Forsvarsbygg**

Målsetninger



ca. 2000 m² BRA
97 arbeidsplasser

Kontorbygg, med noen
spesialfunksjoner

”Normal” arkitektur

Kostnadseffektivt

Robust og brukervennlig

Energiklasse A

Passivhus

Nullenergibygg

Pilotprosjekt ZEB

(www.zeb.no)

Prosess

Integrert energidesign

skisseprosjekt

forprosjekt

des
2011

mai
2012

okt
2012



Målsetning: Bygget skal regnes som nullenergi for energipostene oppvarming, varmtvann, vifter, pumper, belysning og kjøling.

4 alternative konsept



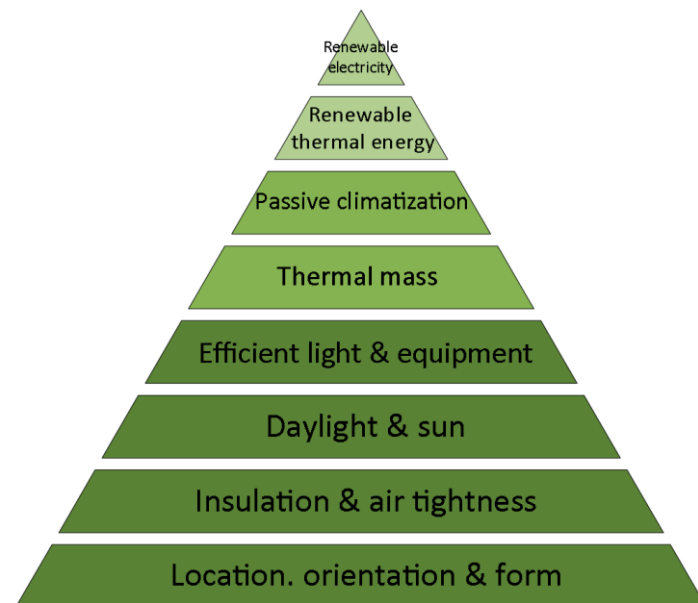
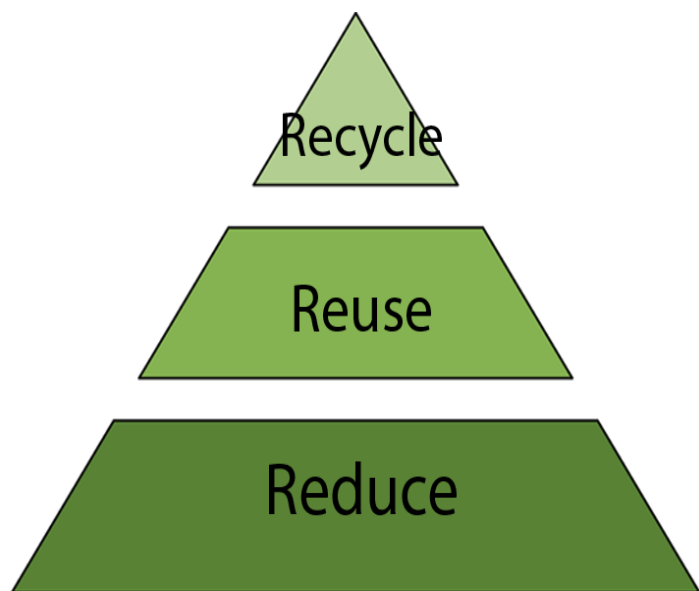
Prosess

Integrert energidesign



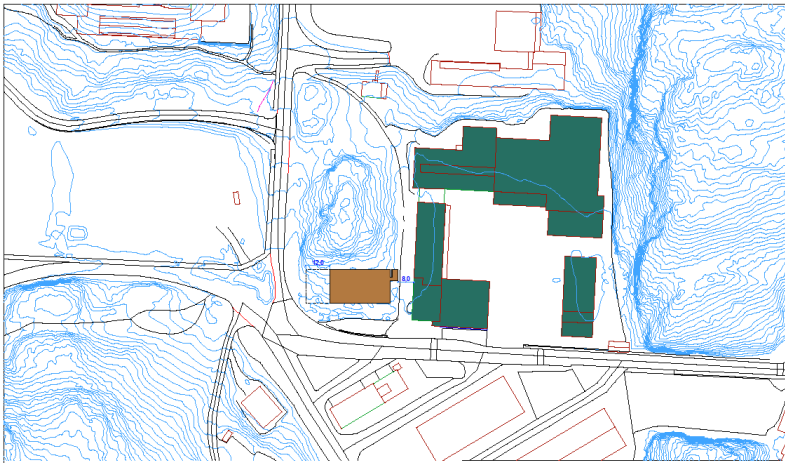
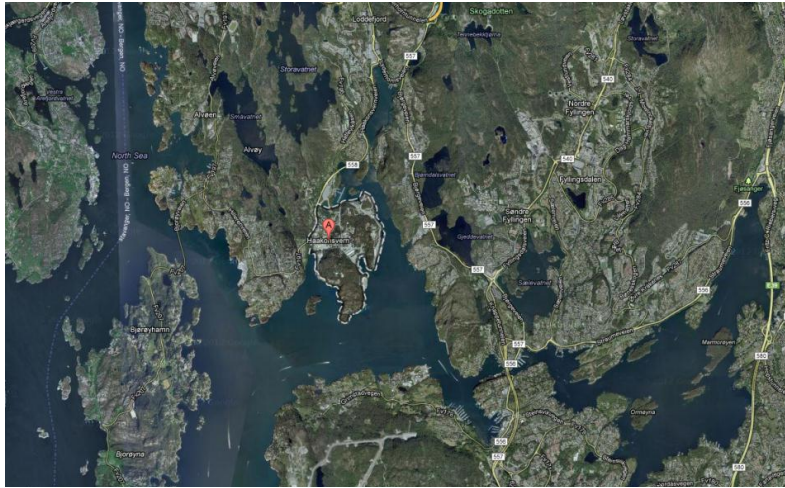
Strategi

8 steg mot nullenergi



Steg 1

Plassering, orientering og form



Situasjonsplan

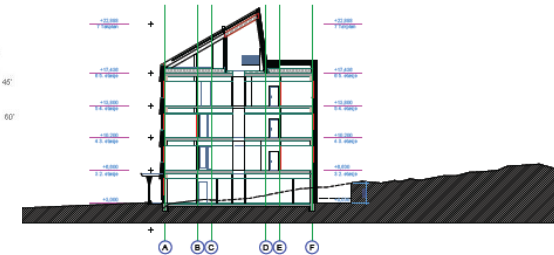
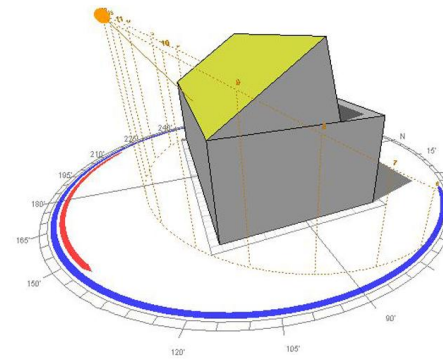
Depotbygg

A.01

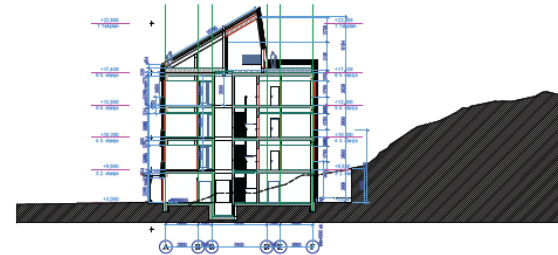
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P.O. 4121 Dreggen
5025 Bergen

Telefon: +47 55 52 34 00
Telefax: +47 55 57 34 01
E-post: bergend@linkarkitektur.no

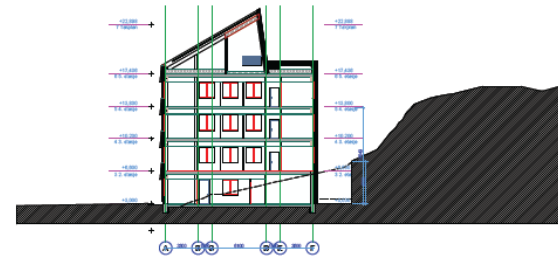
Skala: 1:100 Dato: 24.01.2012 Team: UTM_Konstr.10 Oppdr.: 10 Akse: 04 Rev: 0/01



A Tverrsnitt 1:200



B Tverrsnitt 1:200



C Tverrsnitt 1:200

Steg 1

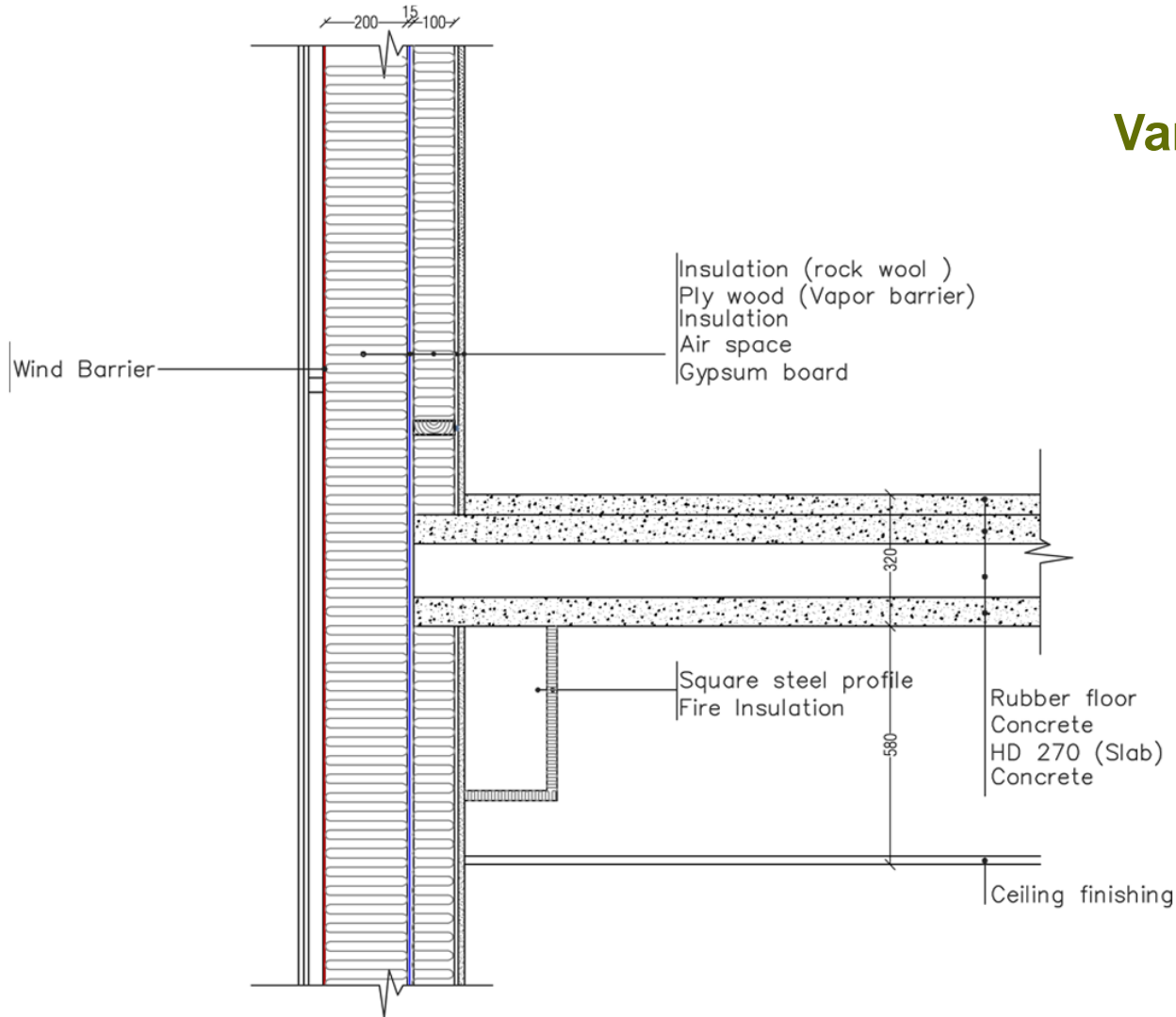
Plassering, orientering og form

Beregnet årlig levert energi, kWh/m² BRA



Steg 2

Varmeisolering og tetting



Yttervegg:

U-verdi 0,13

100 + 200 mm isolasjon

Kontinuerlig, intrukket dampsperre

Kontinuerlig vindtetting

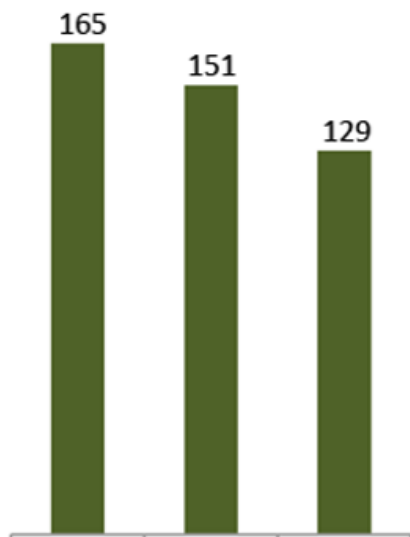
Bæring innenfor klimaveggen

Minimalt med kuldebroer

Steg 2

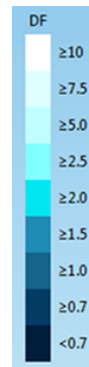
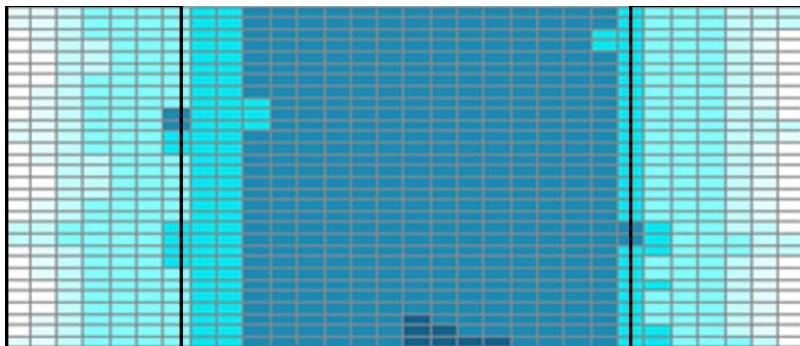
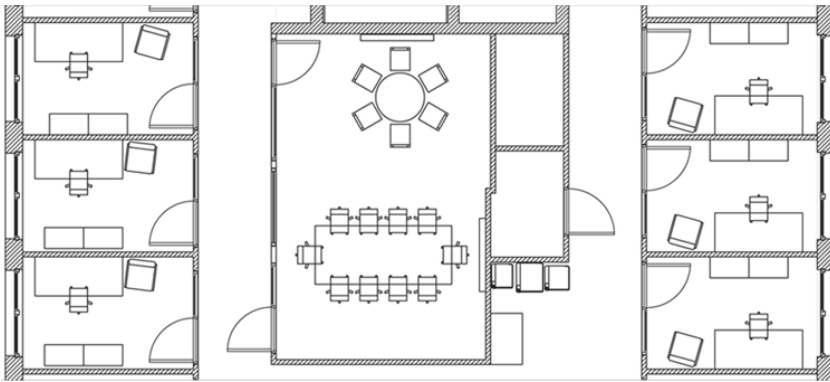
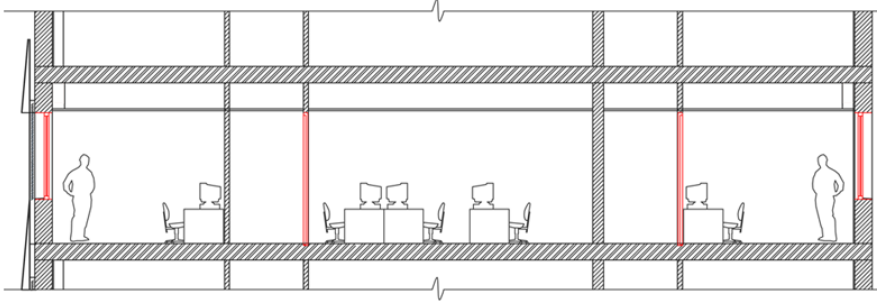
Varmeisolering og tetting

Beregnet årlig levert energi, kWh/m² BRA



Steg 3

Dagslys og sol

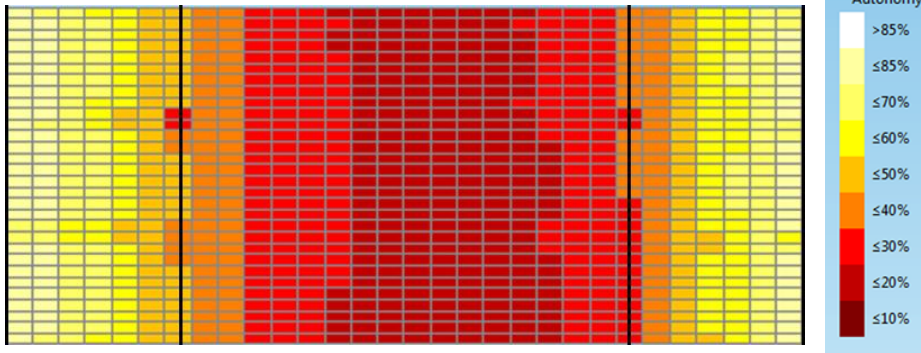
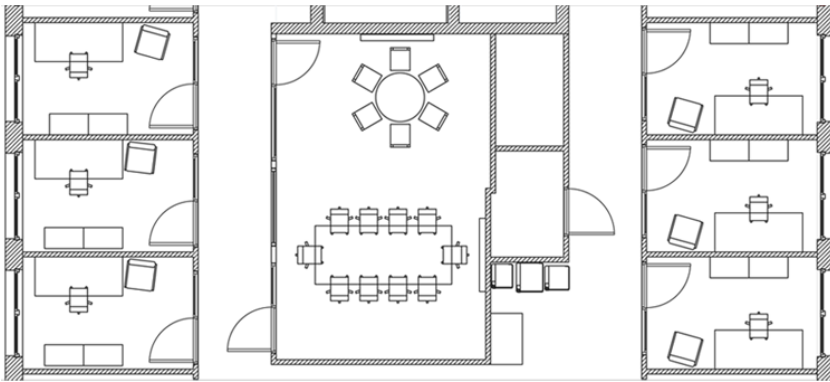
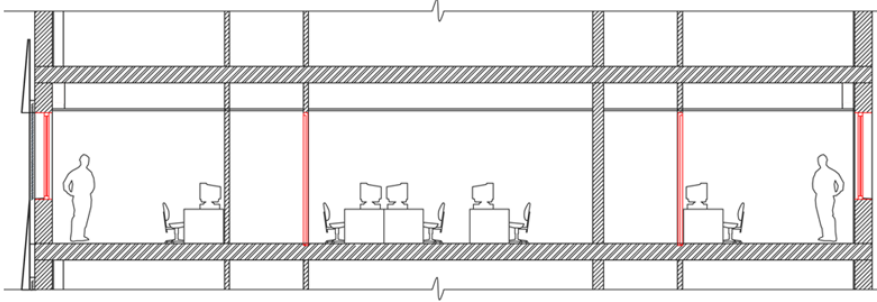


Dagslysfaktor $> 5\%$ i oppholdsrom

Beregnet med programmet DIAL+Lighting

Steg 3

Dagslys og sol



Dagslys-autonomi:
Antall timer i året som dagslys alene
gir tilstrekkelig belysning

-% av arbeidstid

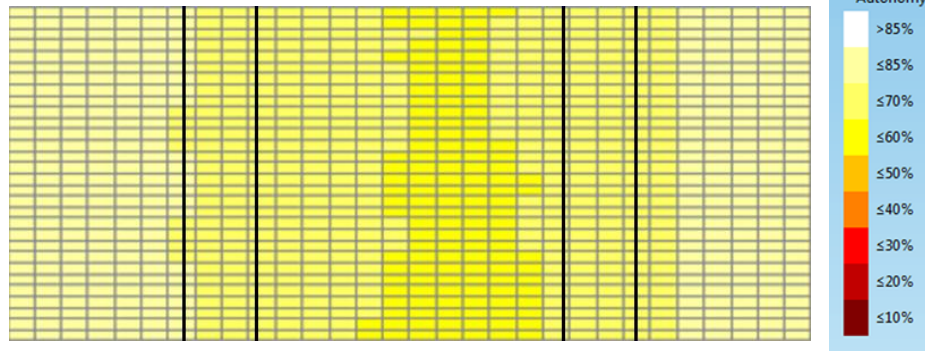
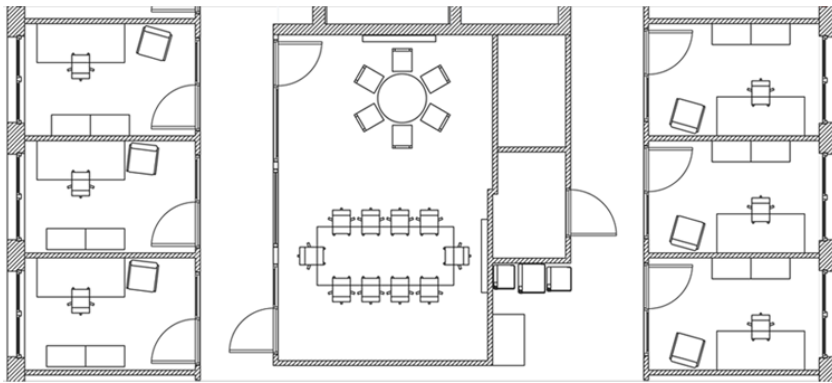
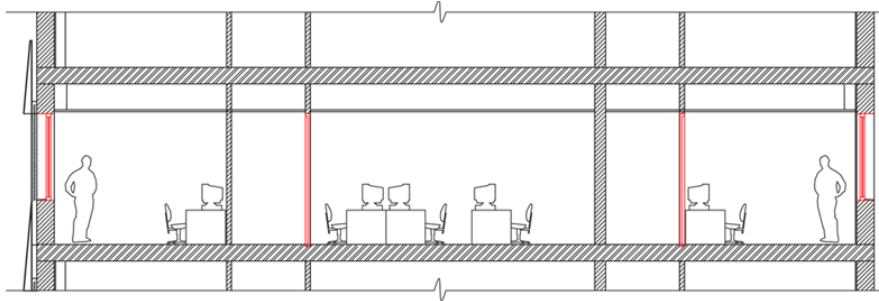
- kun overskyede dager

- kravnivå kontorer: **500 lux**

Beregnet med programmet DIAL+Lighting basert på
statistiske værdata for Bergen

Steg 3

Dagslys og sol



Dagslys-autonomi:
Antall timer i året som dagslys alene
gir tilstrekkelig belysning

-% av arbeidstid

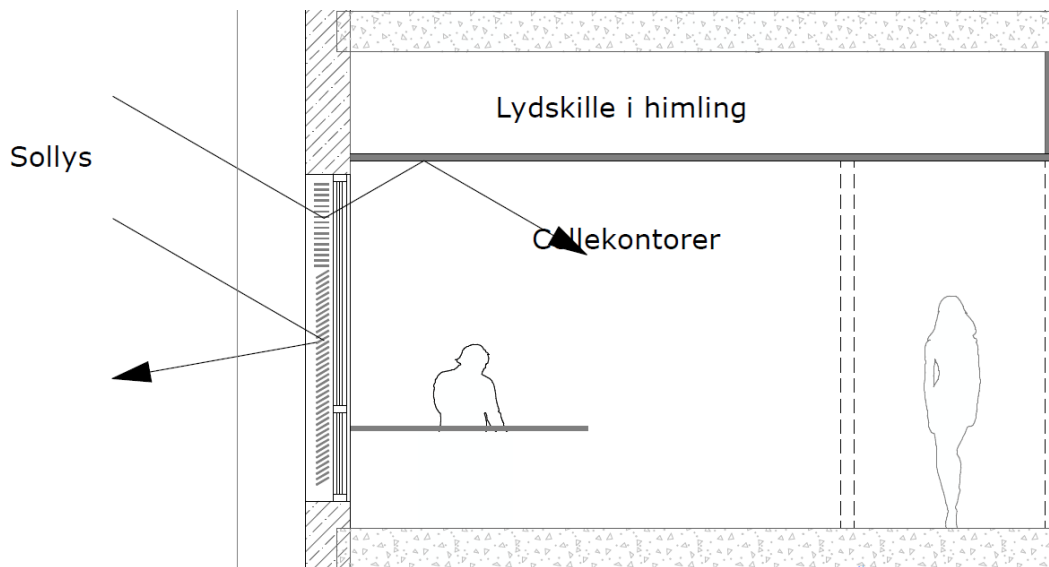
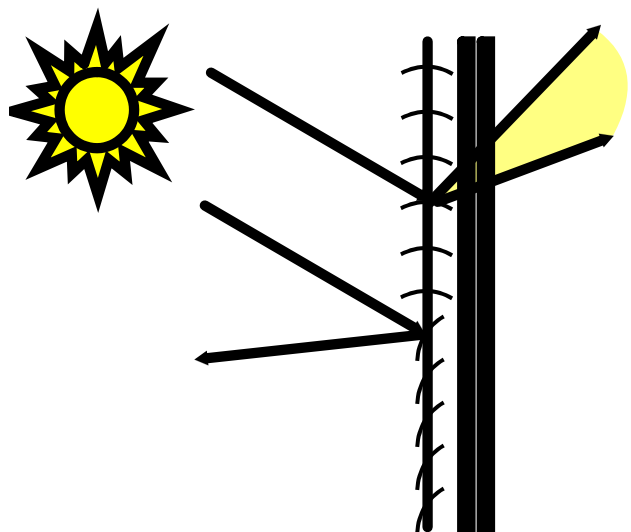
- kun overskyede dager

- kravnivå korridorer: **150 lux**

Beregnet med programmet DIAL+Lighting basert på
statistiske værdata for Bergen

Steg 3

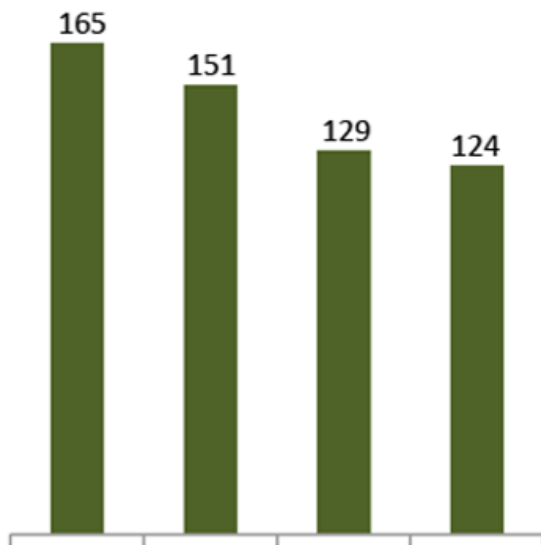
Dagslys og sol



Steg 3

Dagslys og sol

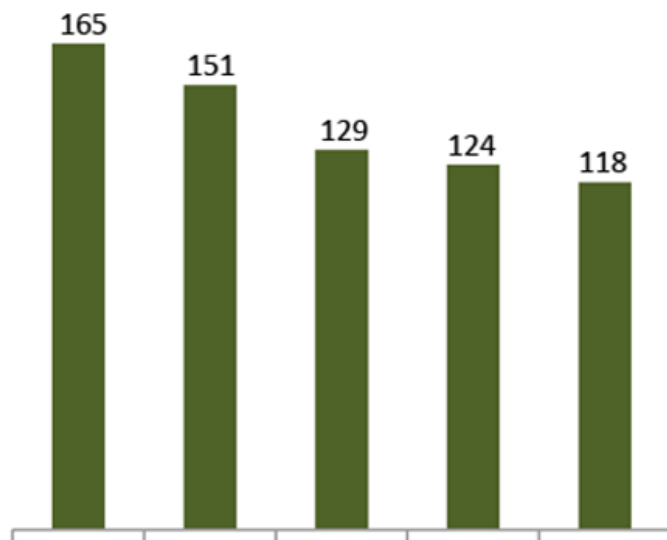
Beregnet årlig levert energi, kWh/m² BRA



Steg 4

Effektivt lys og utstyr

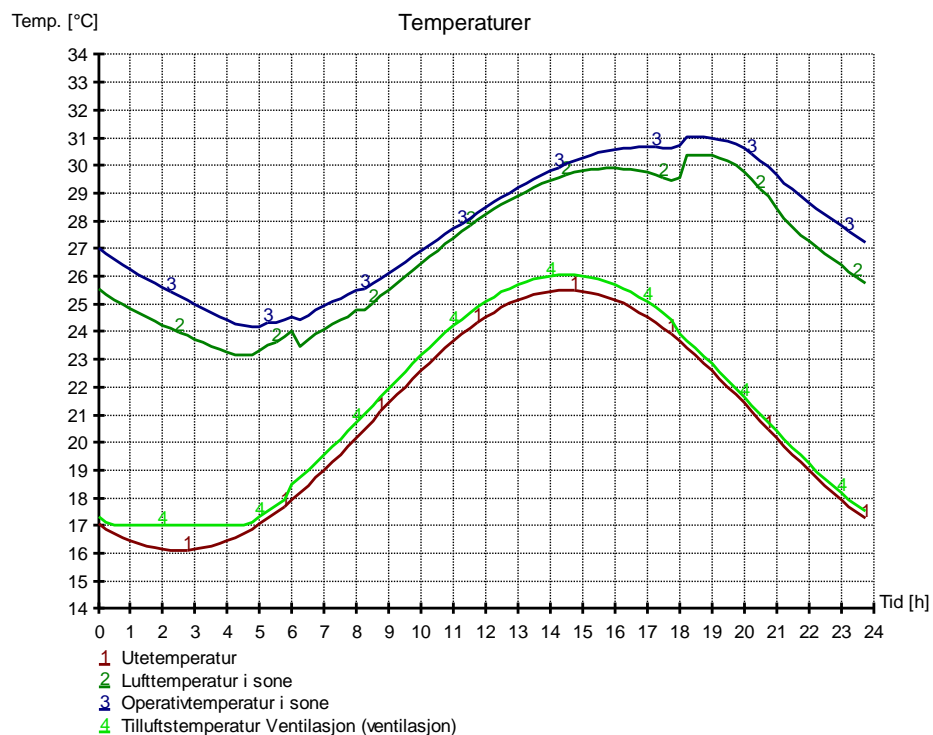
Beregnet årlig levert energi, kWh/m² BRA



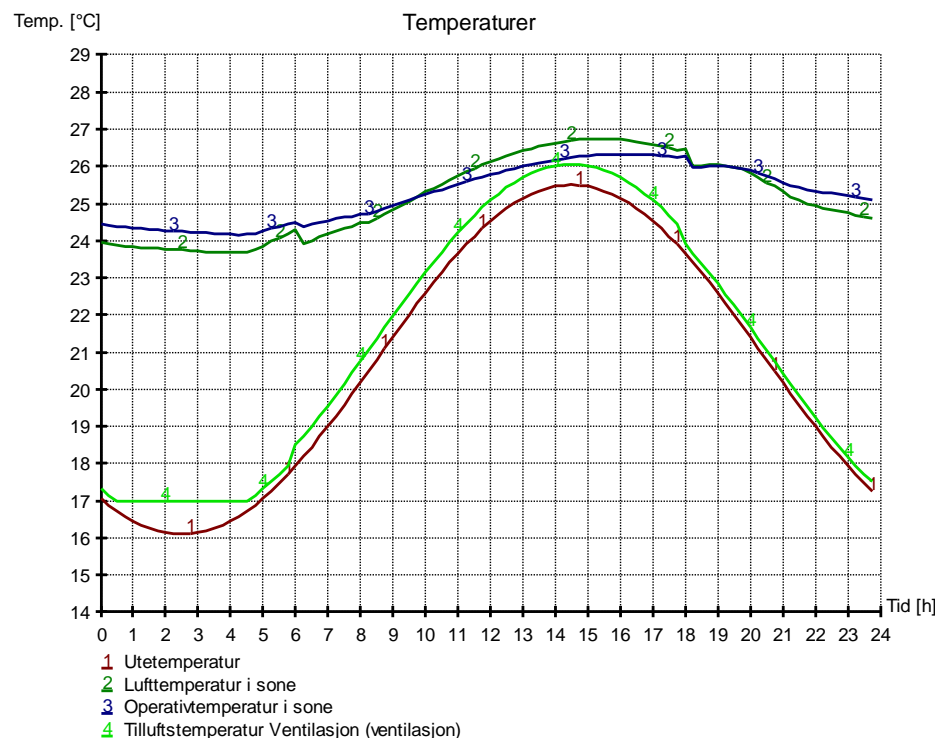
Steg 5

Termisk masse

Lett bygg



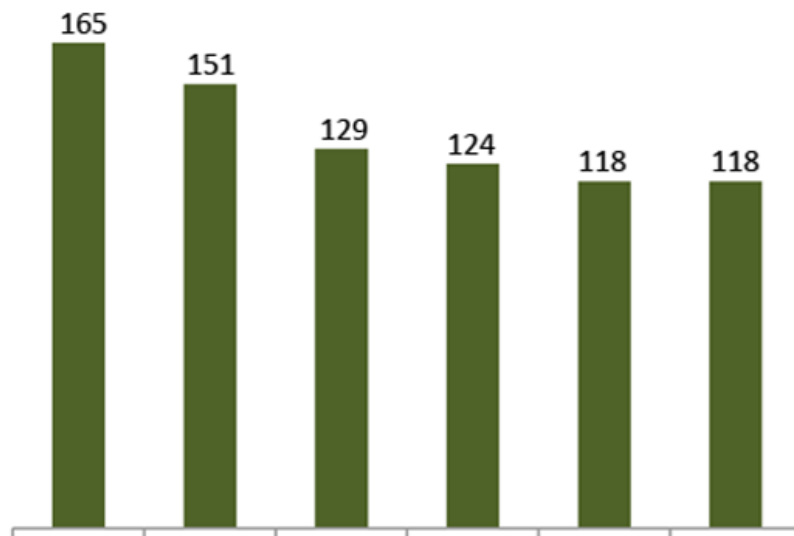
Tungt bygg



Steg 5

Termisk masse

Beregnet årlig levert energi, kWh/m² BRA



Foreløpig resultat.
Må kombineres med
andre strategier for å
gi god effekt

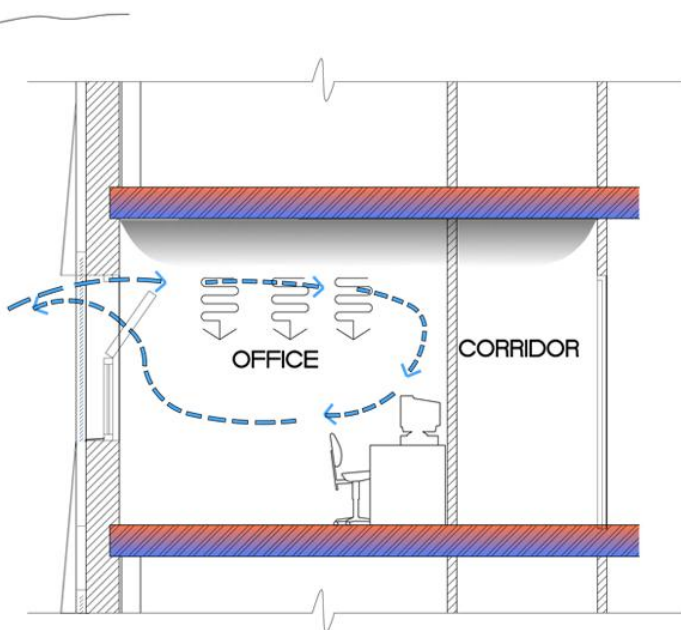


Steg 6

Passiv klimatisering

Sommer:

Nattkjøling via vinduer eller ventilasjonsanlegg



$$q = C_d \cdot \frac{W}{3} \cdot (8gH^3 \rho' \Delta\rho)^{0.5} \text{ [Allard 1998]}$$

hvor:

q: luftmengde i (m³/s)

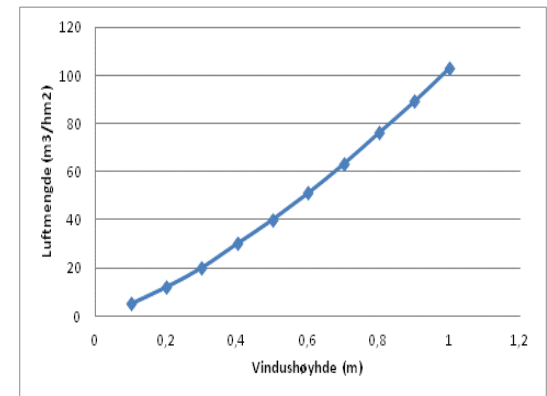
C_d: trykkstapskoeffisient

W: Vindusbredde (m)

H: Vindushøyde (m)

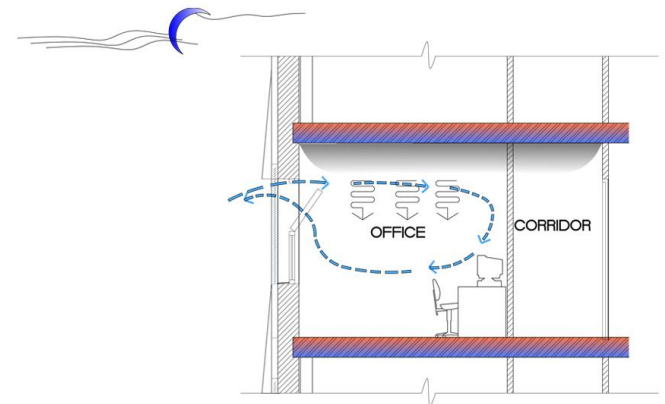
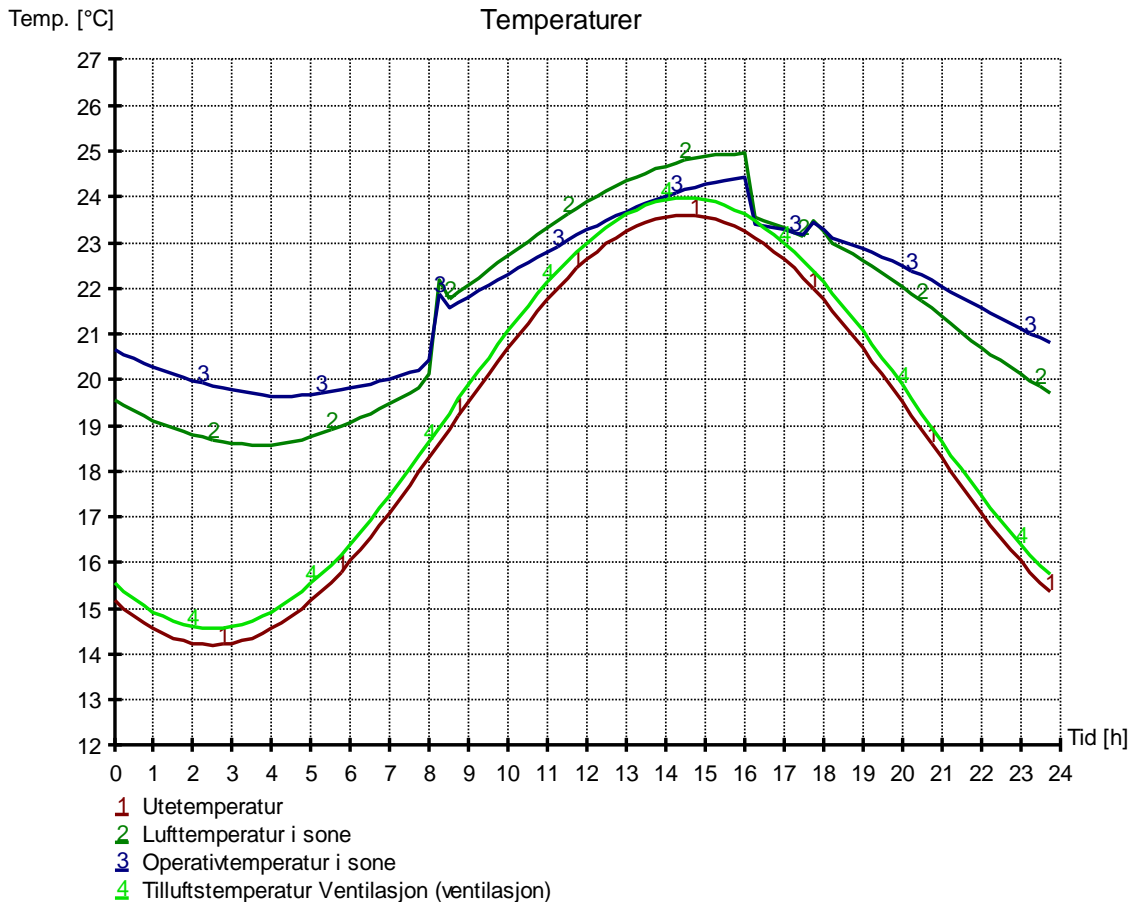
$$\rho' = \frac{\rho_i}{[1 + (\frac{\rho_i}{\rho_o})^{0.33}]^3}$$

$$\Delta\rho = (\rho_o - \rho_i)$$



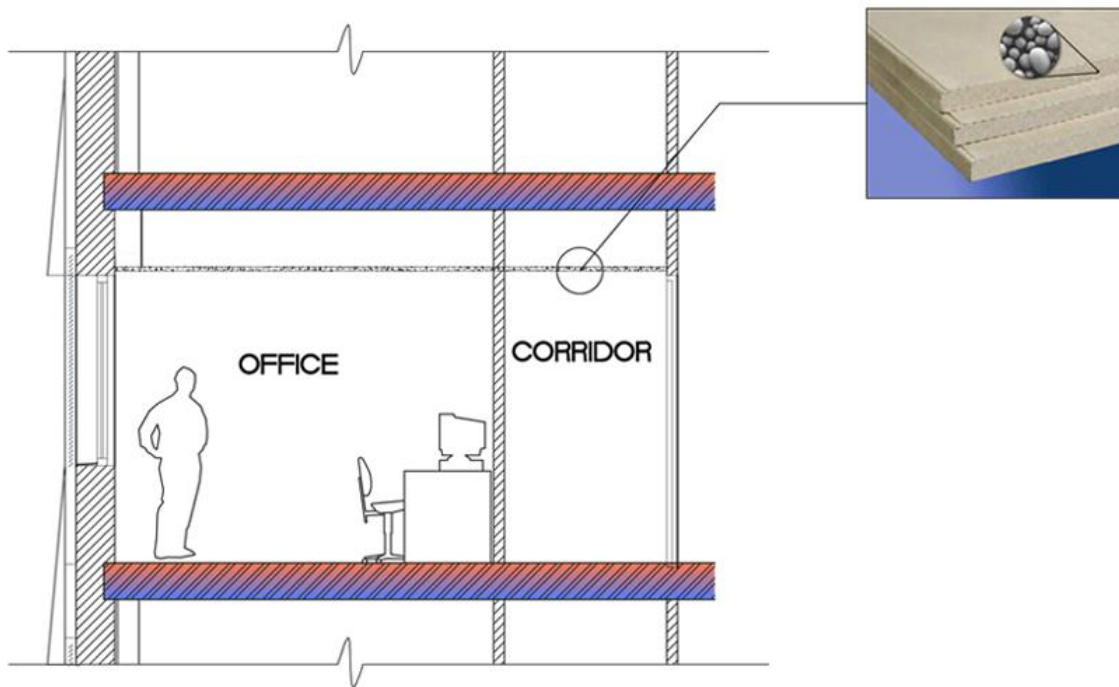
Steg 6

Passiv klimatisering



Steg 6

Passiv klimatisering



Faseforandringsmaterialer (PCM)

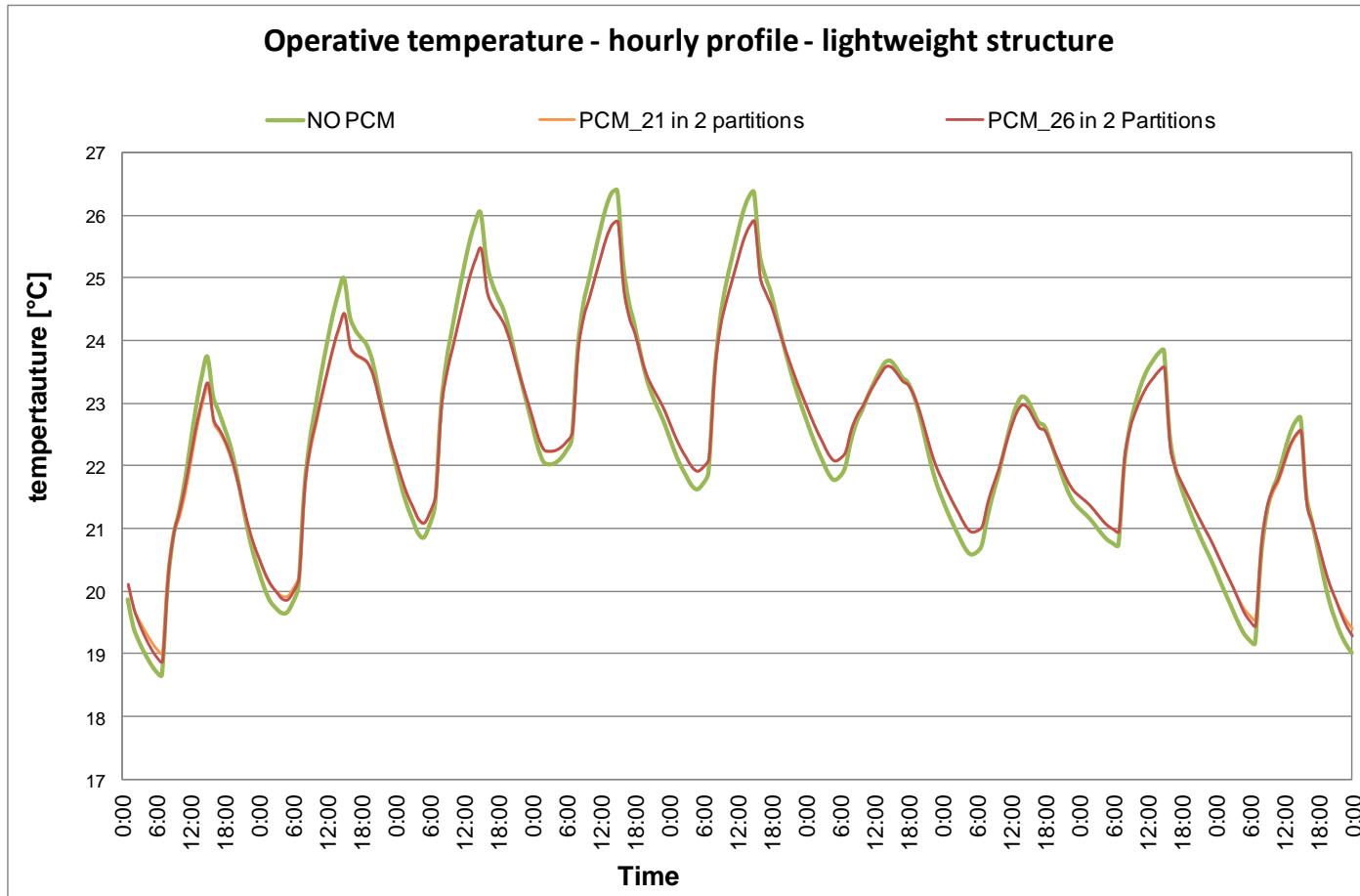
Har potensiale til å gi samme effekt som eksponerte tunge materialer

Lab-målinger viste effekt på ca 2°

Beregninger viste liten effekt

Steg 6

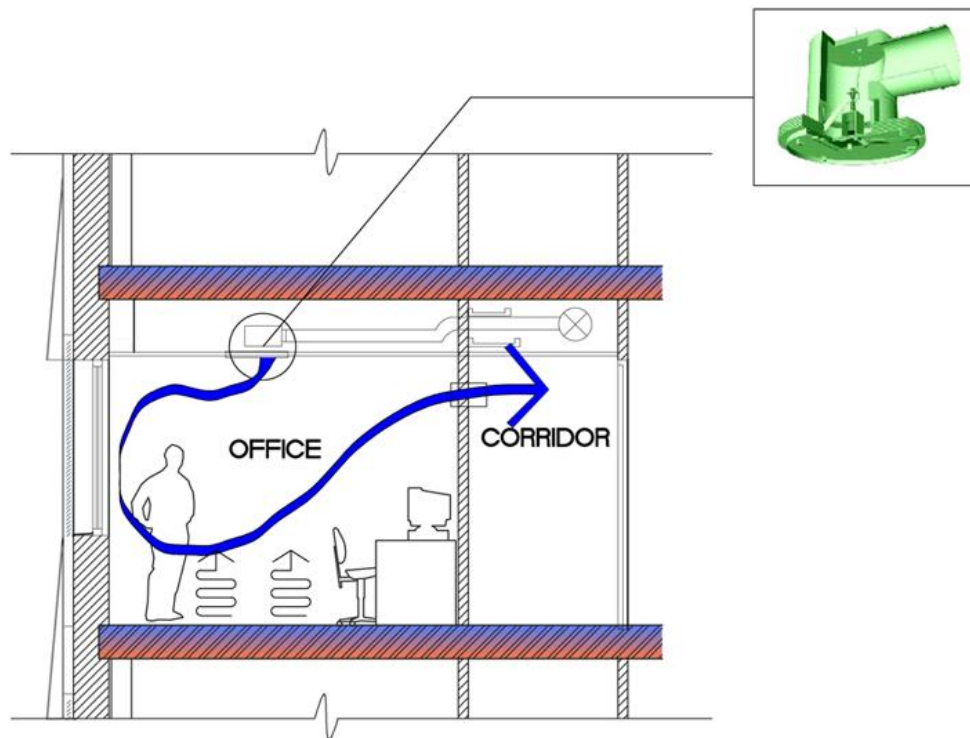
Passiv klimatisering



Calculated with Energy Plus for a warm week in August

Steg 6

Passiv klimatisering



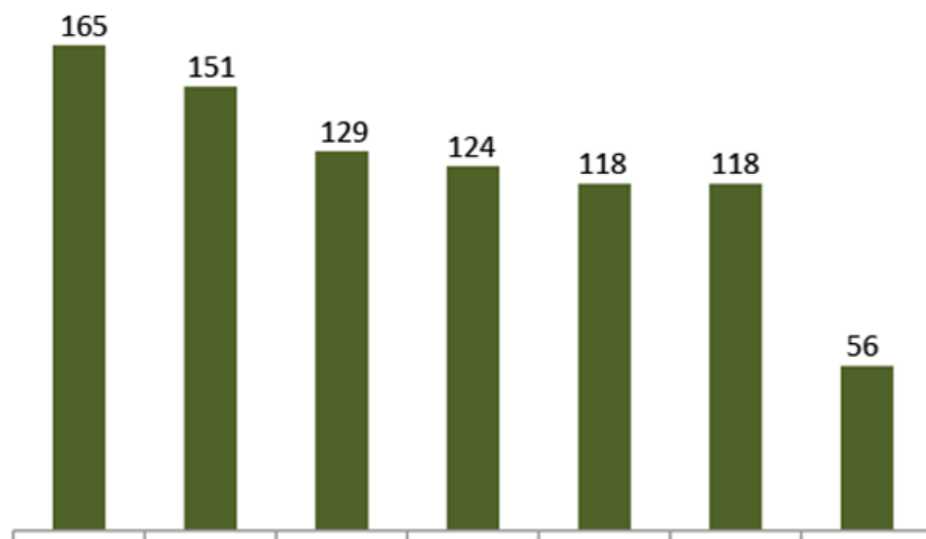
Aktive tilluftsventiler

- gir svært god behovsstyring av luftmengder og tilluftsstemperatur
- gir lav gjennomsnittlig SFP
- gir mulighet for å sløyfe radiatorer i superisolerte kontorer

Steg 6

Passiv klimatisering

Beregnet årlig levert energi, kWh/m² BRA

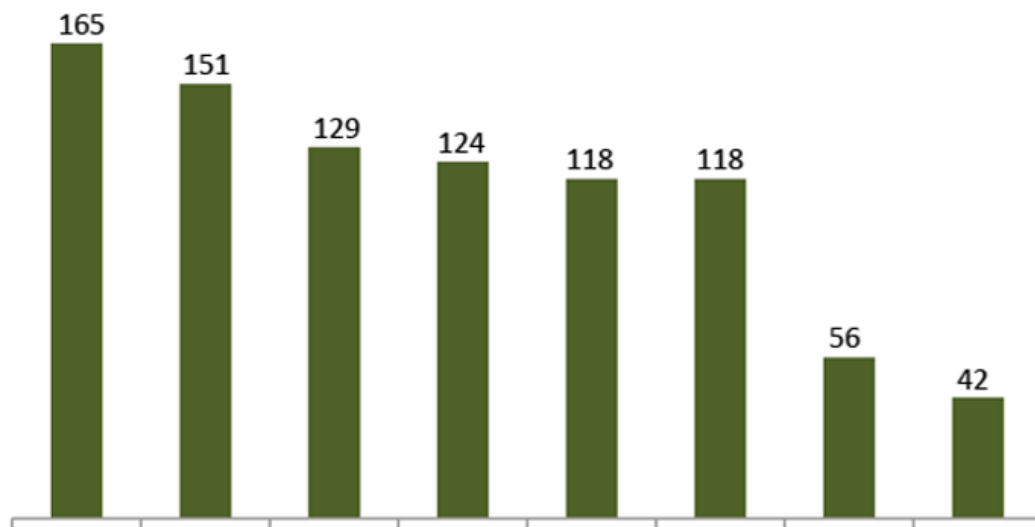


Steg 7

Lokal fornybar varme og

kjøling

Beregnet årlig levert energi, kWh/m² BRA



Sjøvannsbasert varmepumpe

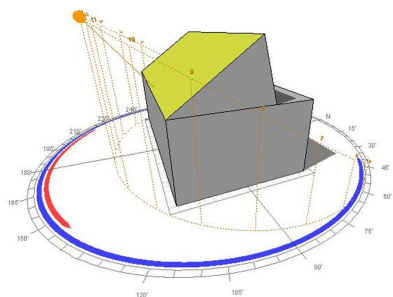
COPvarme = 3.0

COPkjøling = 10.0

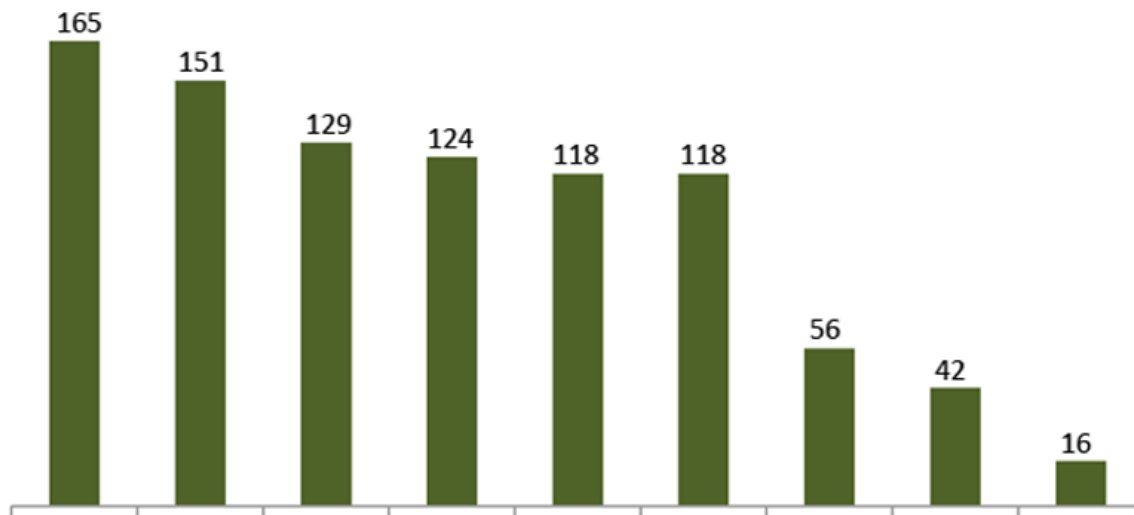


Steg 8

Lokal fornybar elektrisitet



Beregnet årlig levert energi, kWh/m² BRA

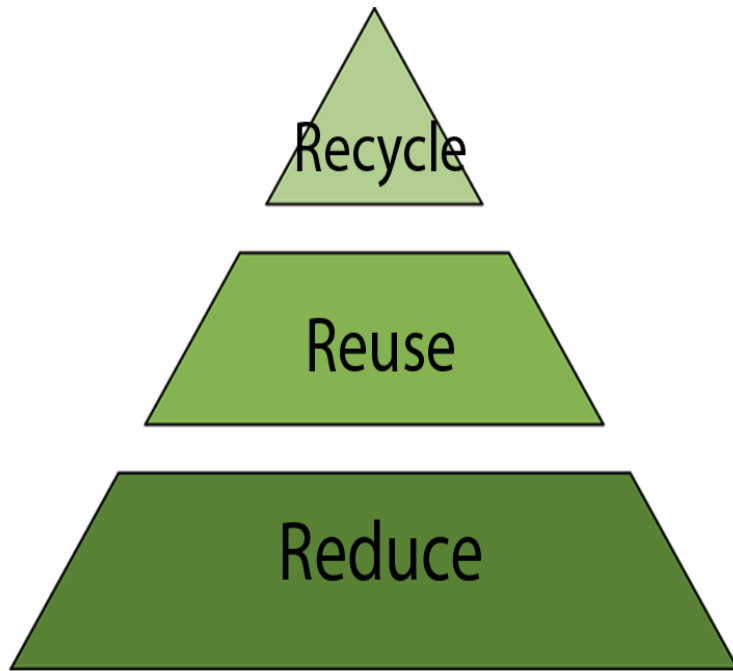


310 m² solcellemoduler,
17% systemvirkningsgrad
ca. 50.000 kWh/år i statistisk normalår



Oppsummering

(nesten) Null på 1-2-3

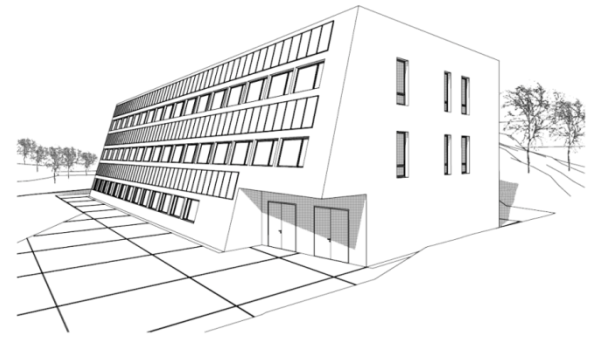
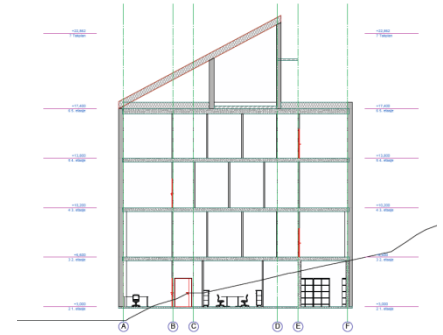


16 kWh



165 kWh





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