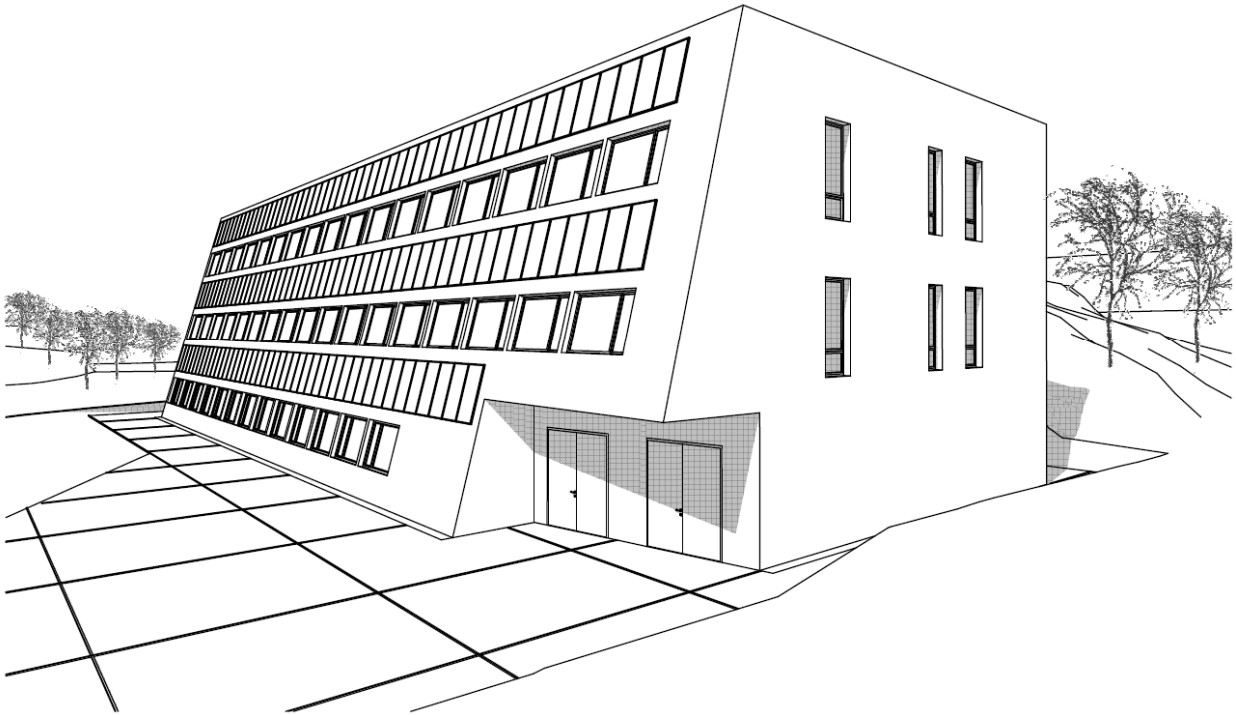
Depotbygget på Haakonsvern

- Nullenergi i det enkle



Byggherre og PL: Forsvarsbygg

PRL: Stema Rådgivning

ARK: LINK Arkitekter

RIV, RIE og RIB: Multiconsult

Spesialrådgiver energi: ZEB

Av Inger Andresen, RIM

LINK ARKITEKTUR

Prosess

- Integrert energidesign

skisseprosjekt

forprosjekt

des 2011

mai 2012

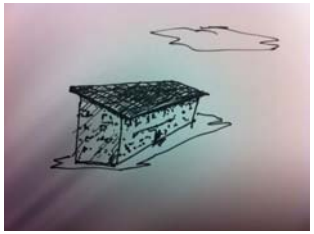
juni 2012

ZEB workshop no 1:

Konsept

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

4 alternative konsept



LINK ARKITEKTUR

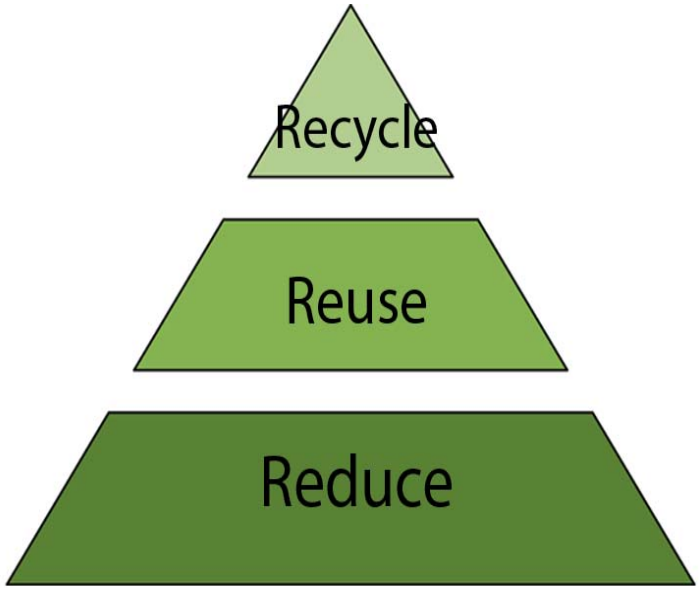
Prosess

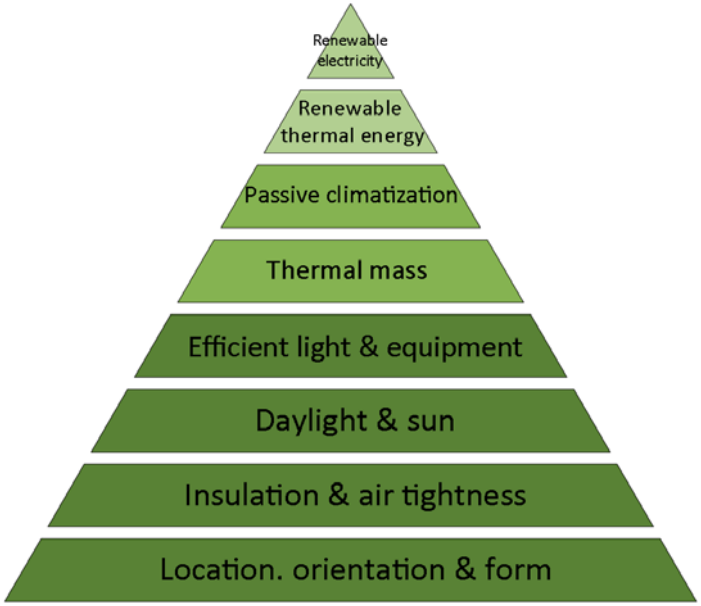
- Integrert energidesign

LINK ARKITEKTUR

Strategi

- 8 grep mot nullenergi

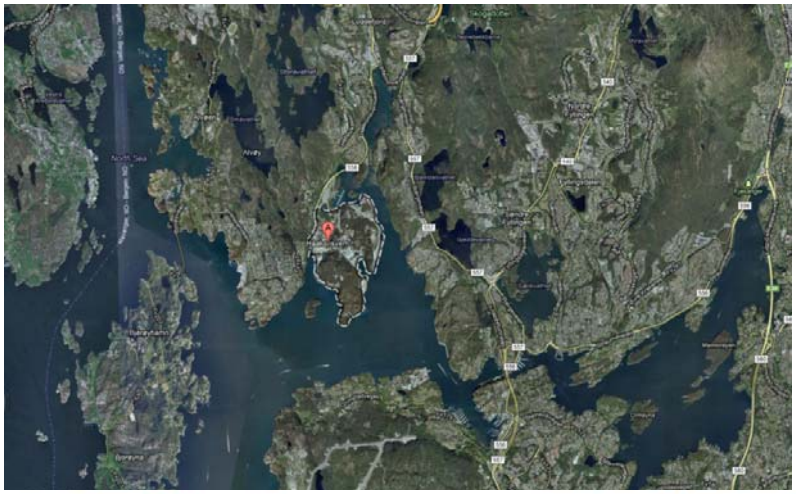


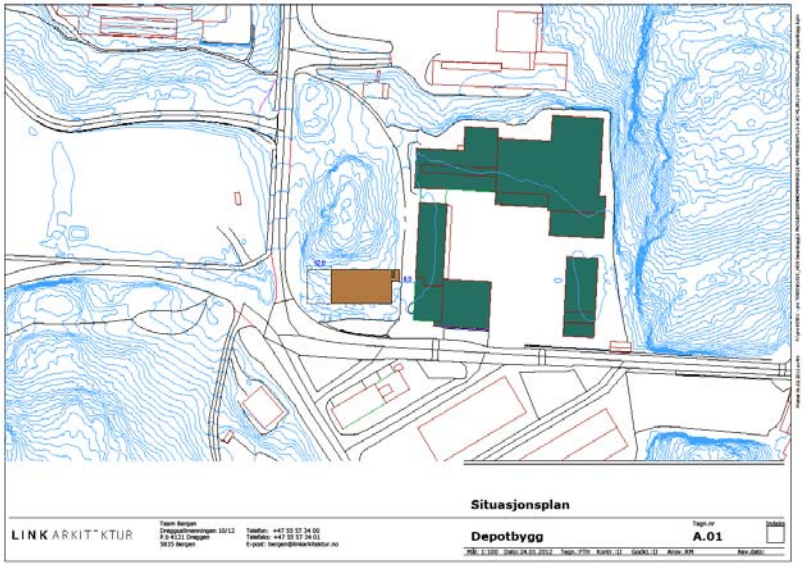


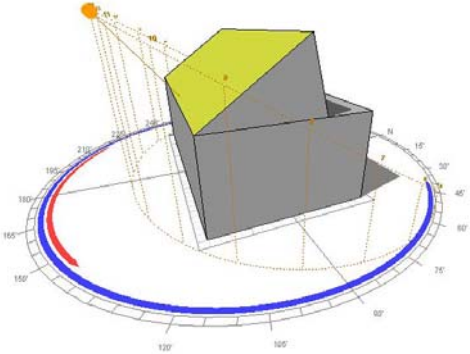
LINK ARKITEKTUR

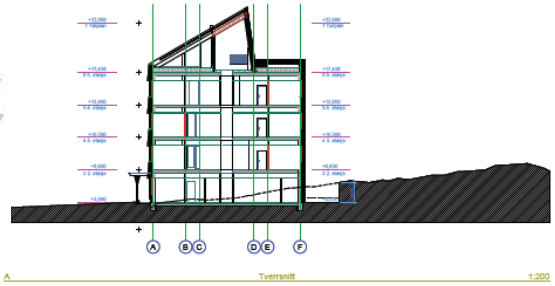
Strategi

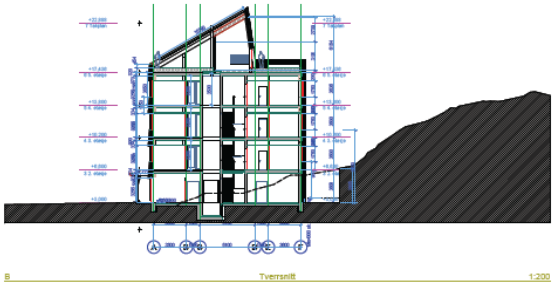
1: Plassering, orientering og form

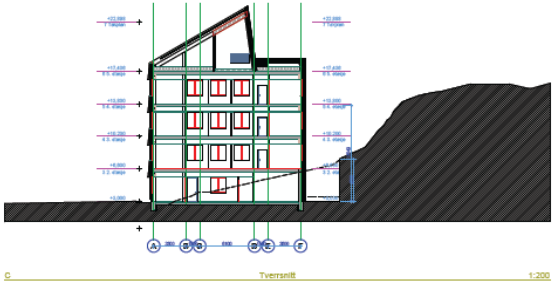












LINK ARKITEKTUR

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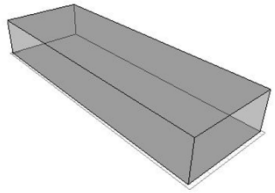
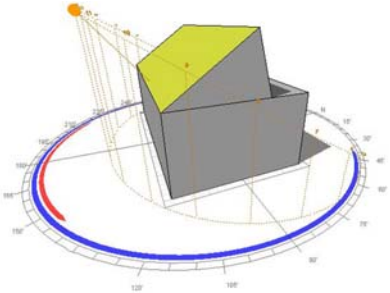
Strategi

1: Plassering, orientering og form

Beregnet årlig levert energi, kWh/m^2 BRA



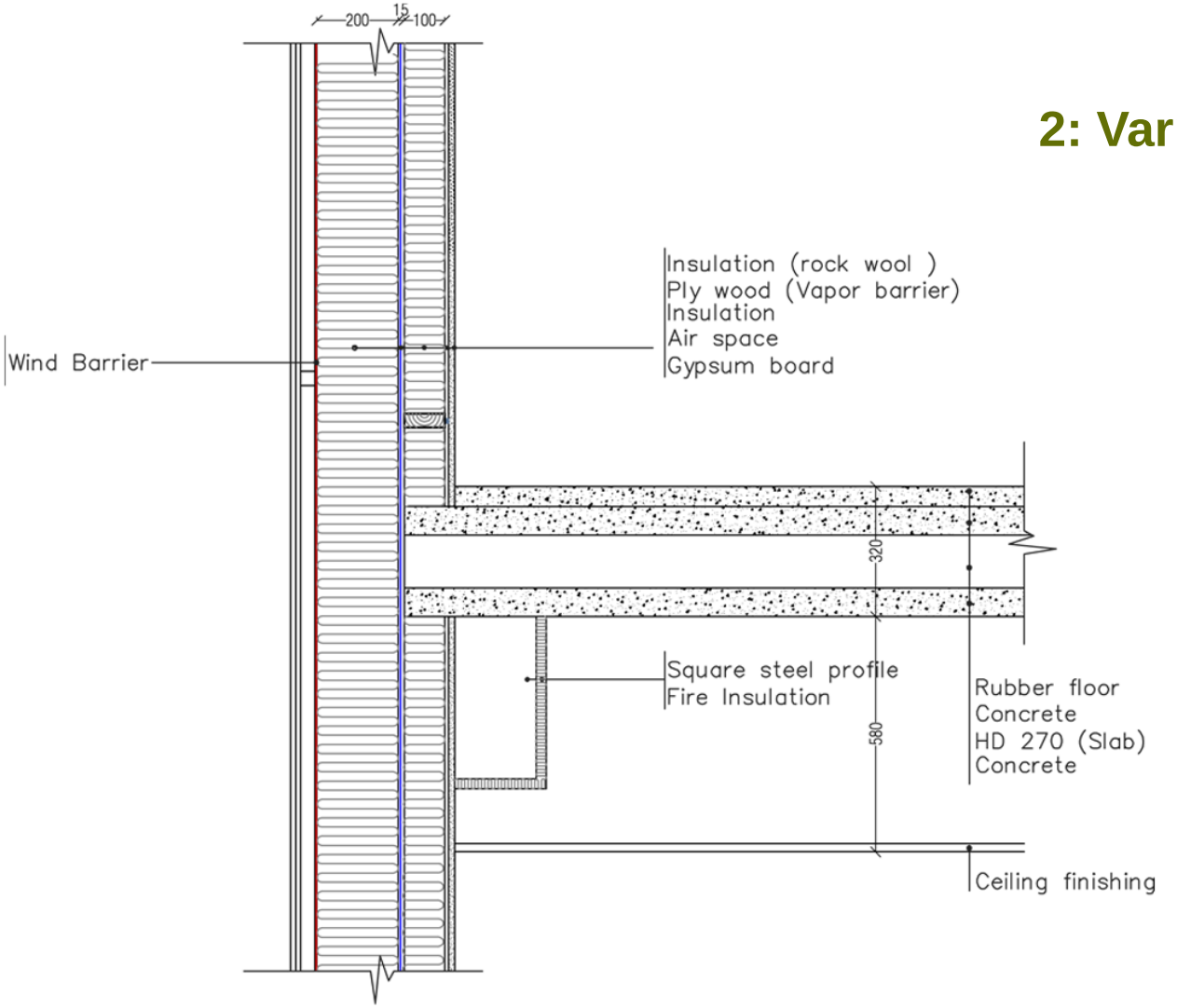


LINK ARKITEKTUR

Inger Andresen / 2012-09-05

Strategi

2: Varmeisolering og tetting



Yttervegg:

U-verdi 0,13

100 + 200 mm isolasjon

Kontinuerlig, inntrukket dampsperre

Kontinuerlig vindtetting

Bæring innenfor klimaveggen

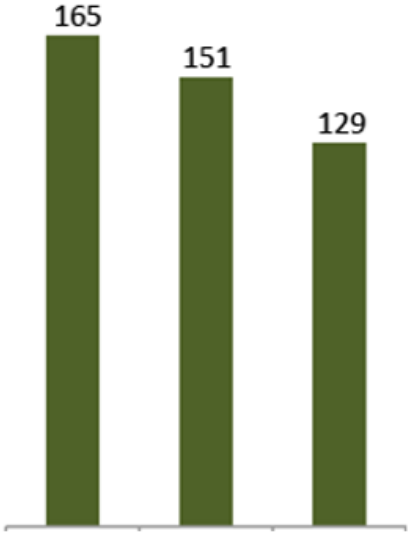
Minimalt med kuldebroer

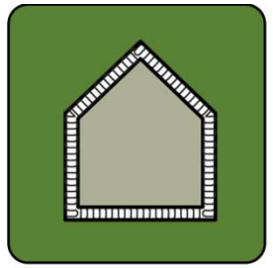
LINK ARKITEKTUR

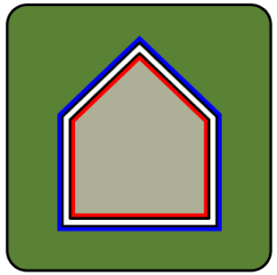
Strategi

2: Varmeisolering og tetting

Beregnet årlig levert energi, kWh/m^2 BRA







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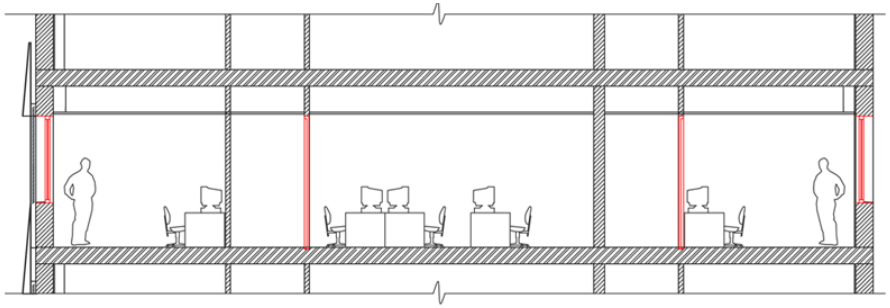
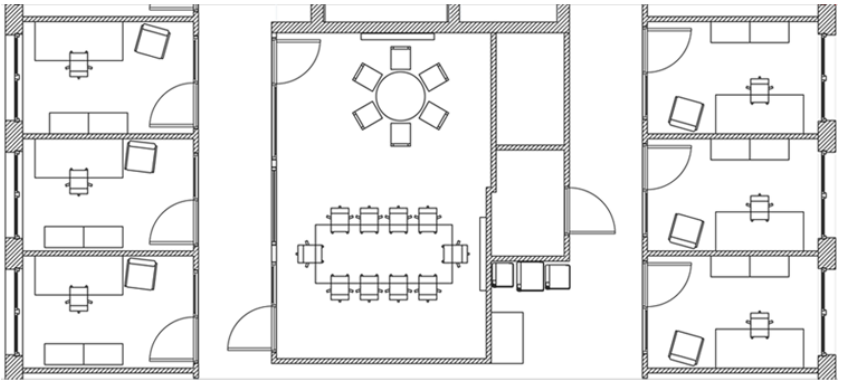
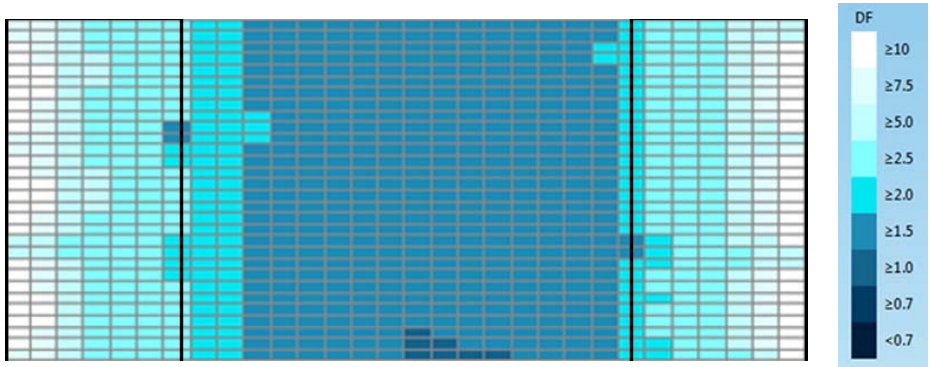
Strategi

3: Dagslys og sol







Dagslysfaktor > 5% i oppholdsrom

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

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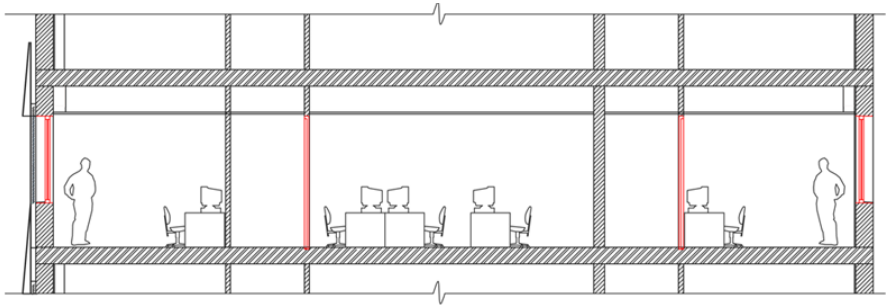
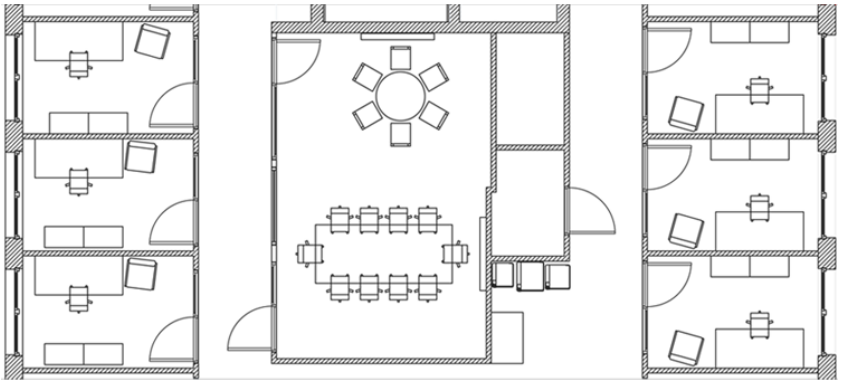
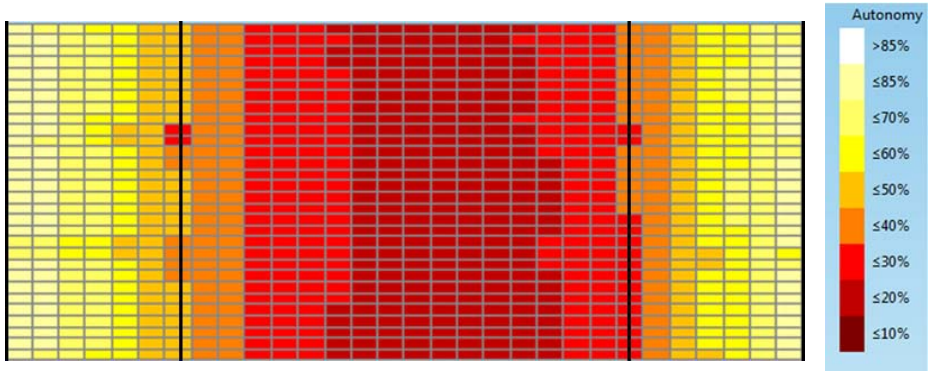
Strategi

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

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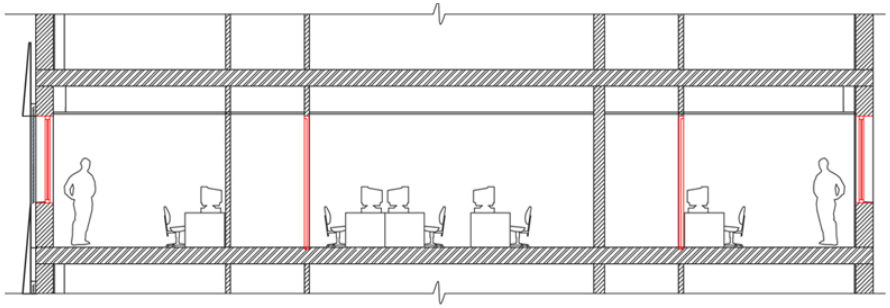
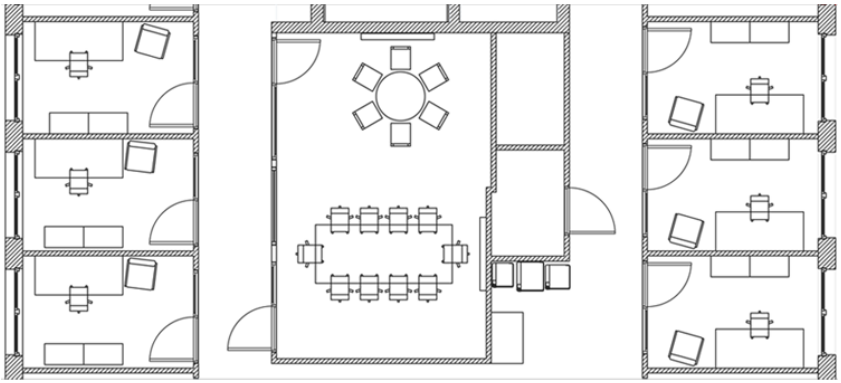
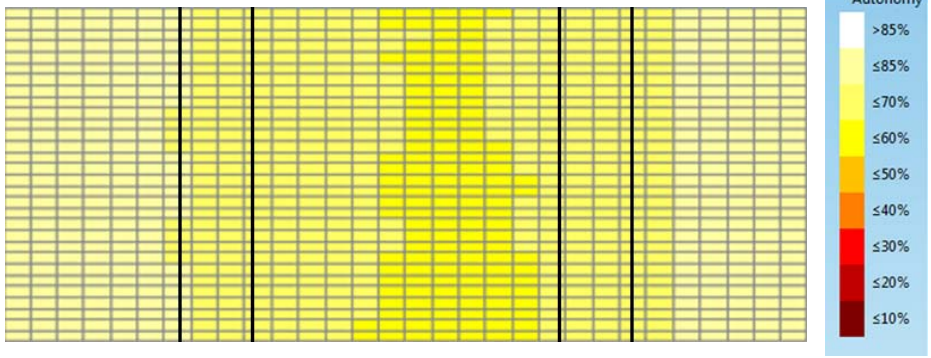
Strategi

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**

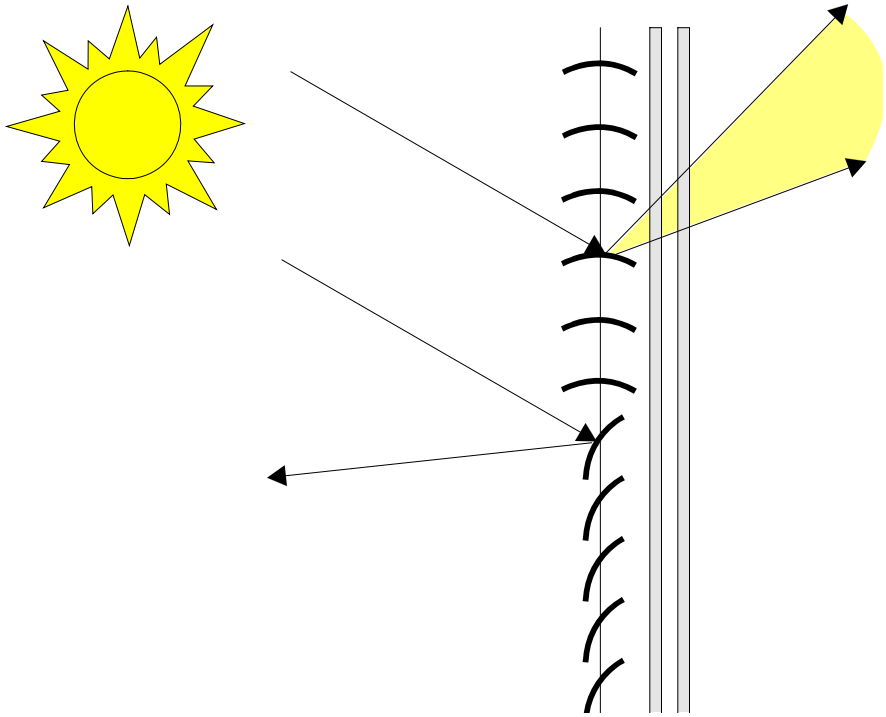
Beregnet med programmet DIAL+Lighting basert på statistiske værdata for Bergen

LINK ARKITEKTUR

Inger Andresen / 2012-09-05

Strategi

3: Dagslys og sol



LINK ARKITEKTUR

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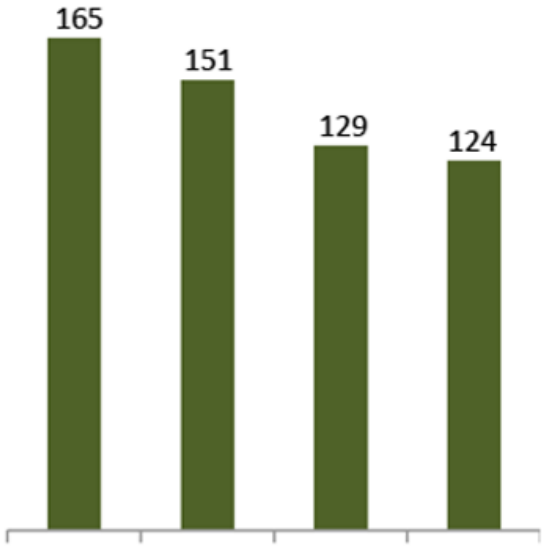
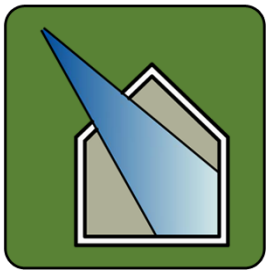
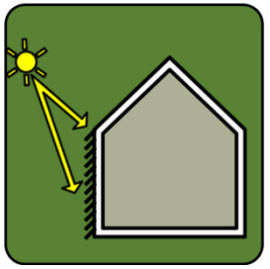
Strategi

3: Dagslys og sol

Beregnet årlig levert energi, kWh/m^2 BRA







LINK ARKITEKTUR

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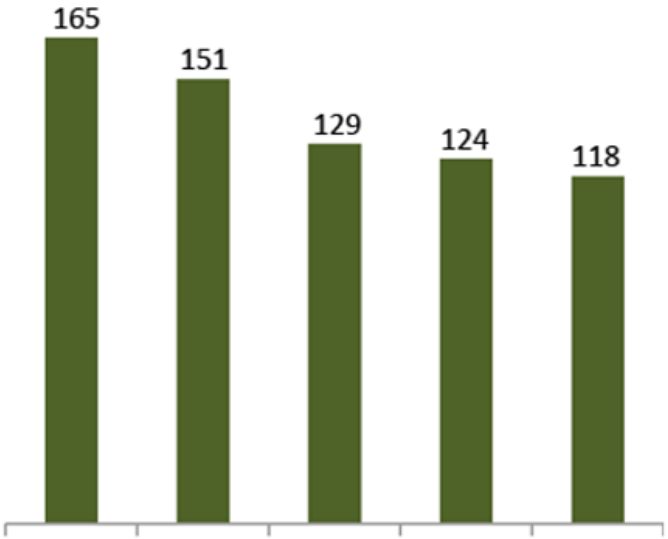
Strategi

4: Effektivt lys og utstyr

Beregnet årlig levert energi, kWh/m^2 BRA



LINK ARKITEKTUR

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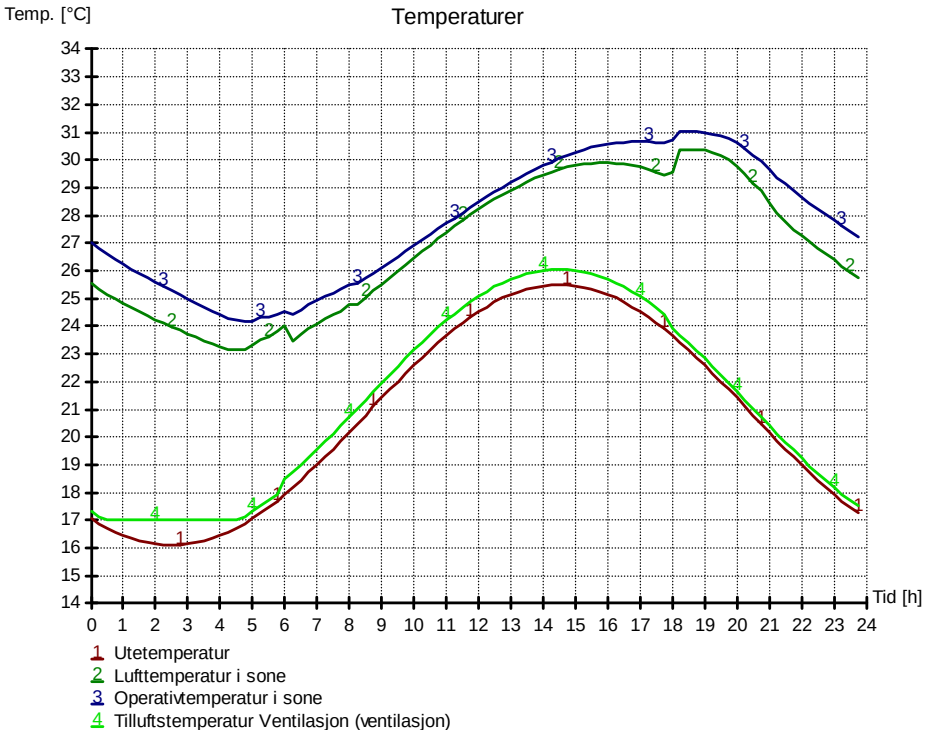
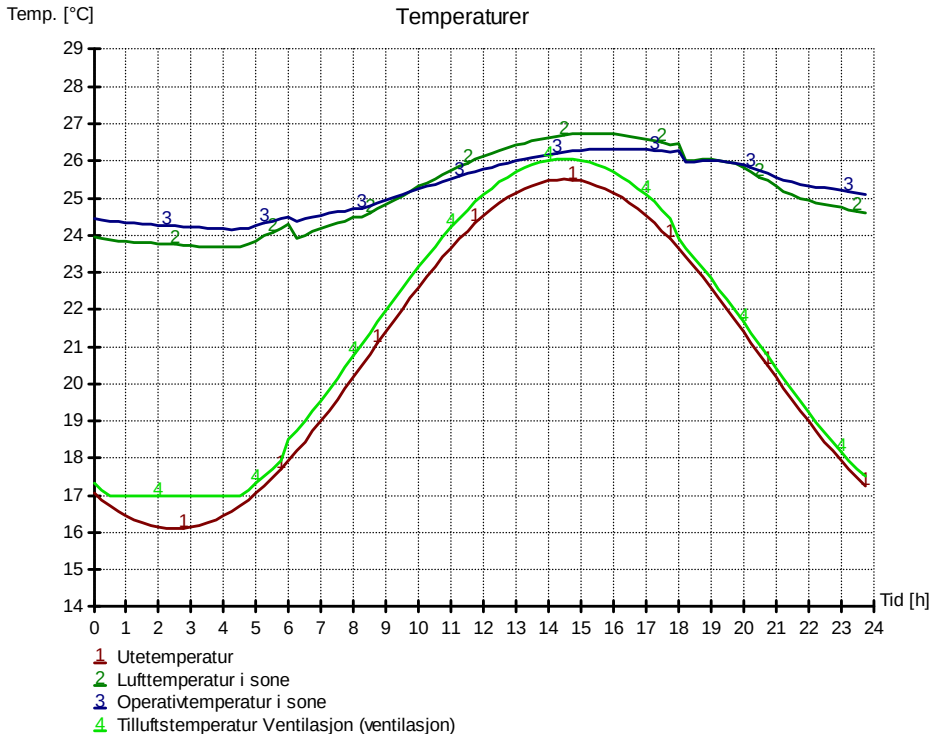
Strategi

5: Termisk masse

Lett bygg



Tungt bygg



LINK ARKITEKTUR

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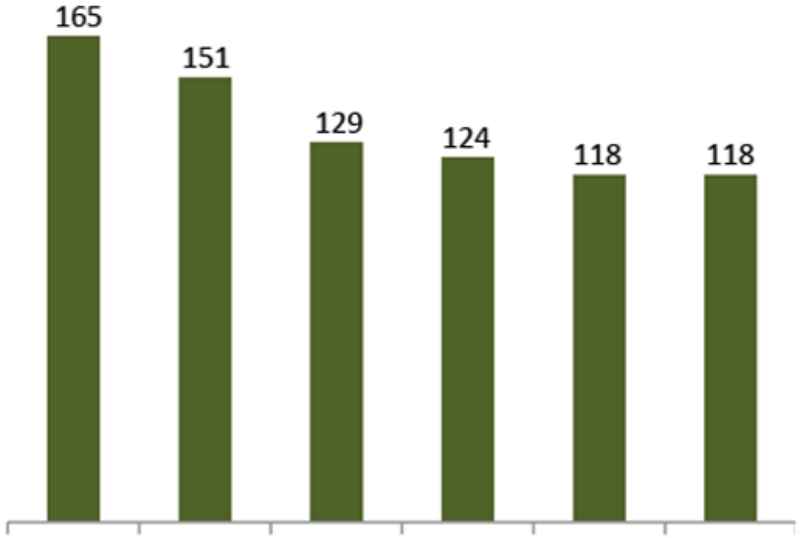
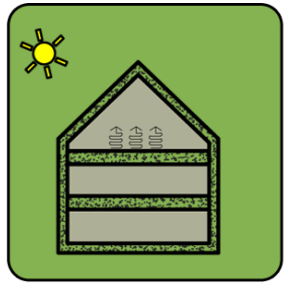
Strategi

5: Termisk masse

Beregnet årlig levert energi, kWh/m^2 BRA





LINK ARKITEKTUR

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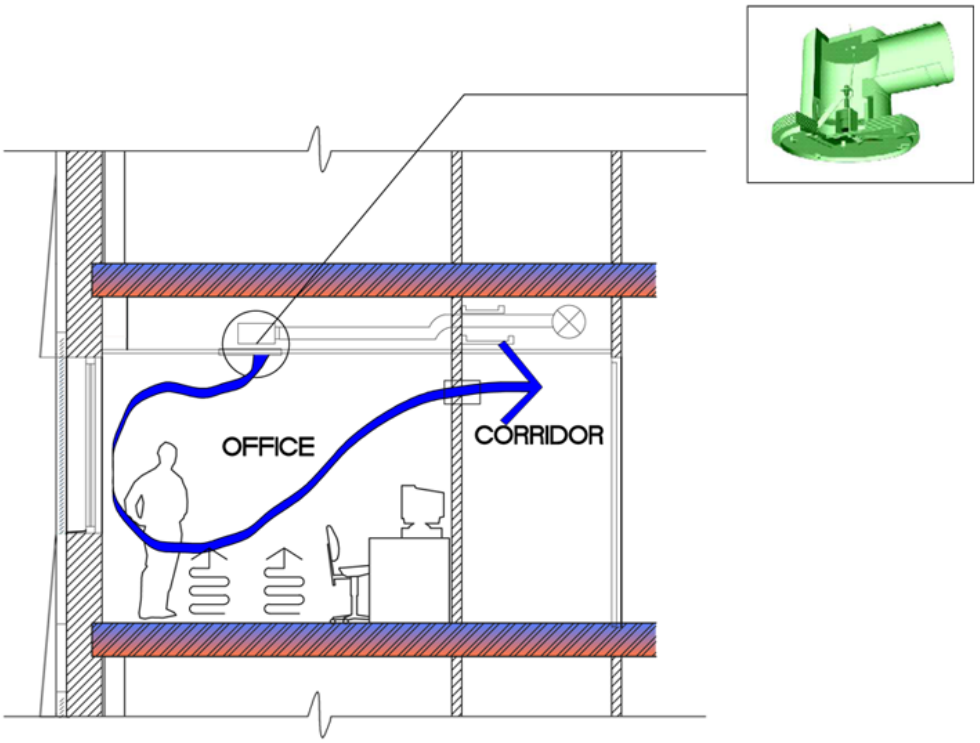
Strategi

6: Passiv klimatisering



Aktive tilluftsventiler

- gir svært god behovsstyring av luftmengder og tilluftsstemperatur

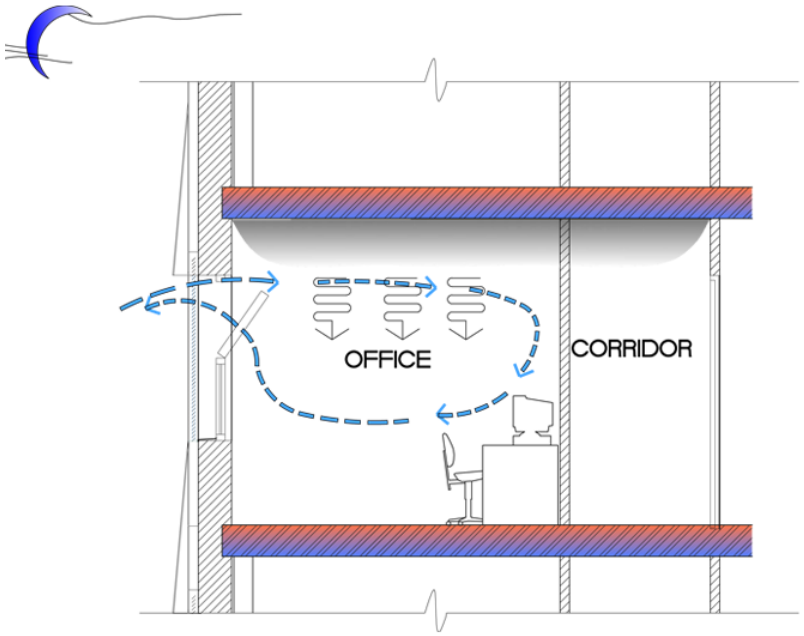
- gir lav gjennomsnittlig SFP

- gir mulighet for å sløyfe radiatorer i superisolerte kontorer

LINK ARKITEKTUR

Strategi

6: Passiv klimatisering



Sommer:

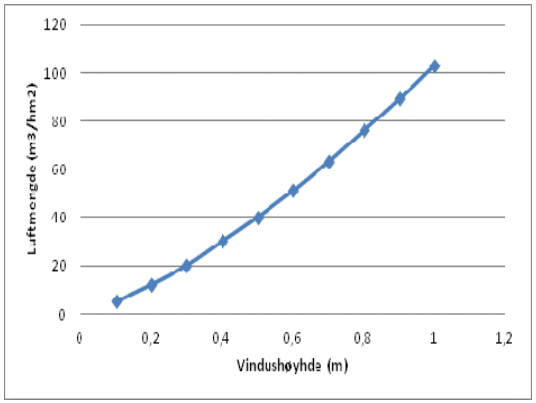
Nattkjøling via vinduer eller ventilasjonsanlegg

$$q = C_d \cdot \frac{W}{3} \cdot (8gH^3 \rho' \Delta\rho)^{0,5}$$ [Allard 1998]

hvor:
q: luftmengde i (m^3/s)
C_d: trykkstapskoeffisient
W: Vindusbredde (m)
H: Vindushøyde (m)

$$\rho' = \frac{\rho_i}{[1 + (\frac{\rho_i}{\rho_o})^{0,33}]^3}$$

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

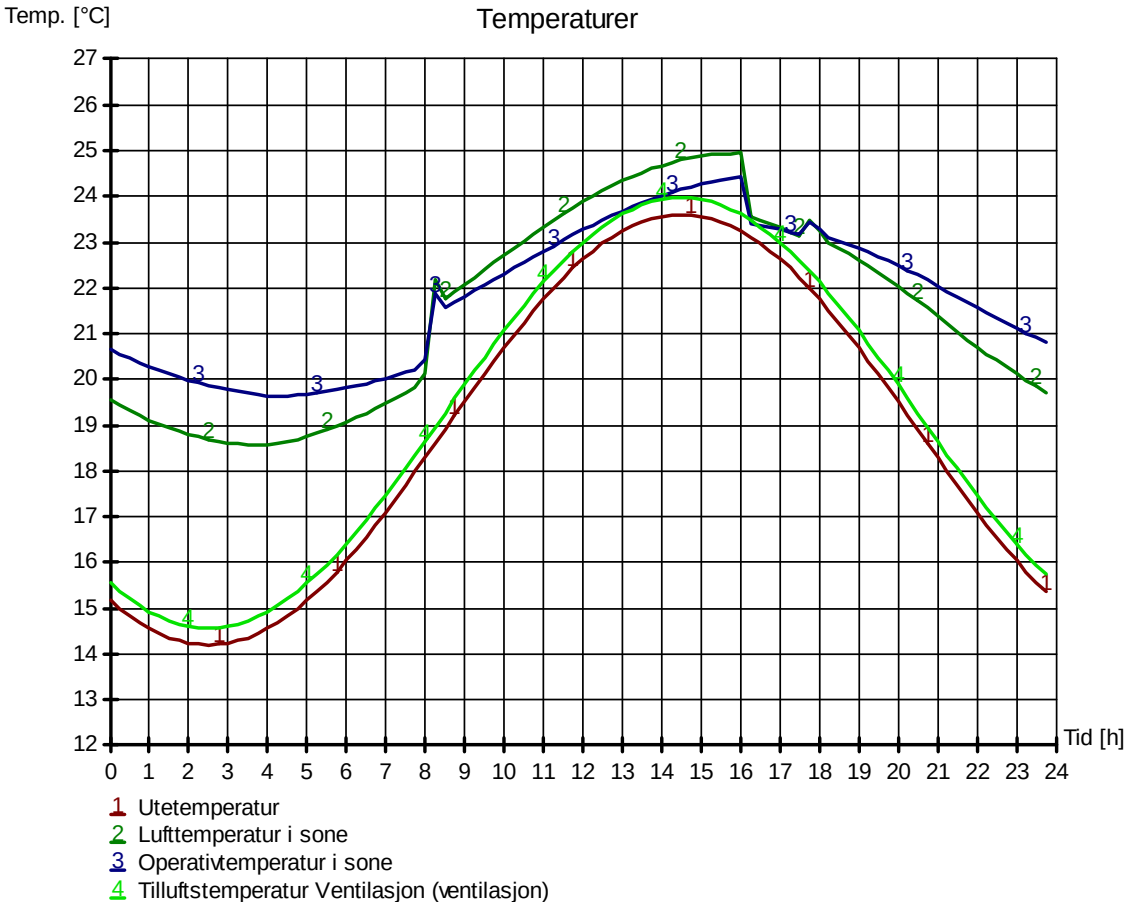


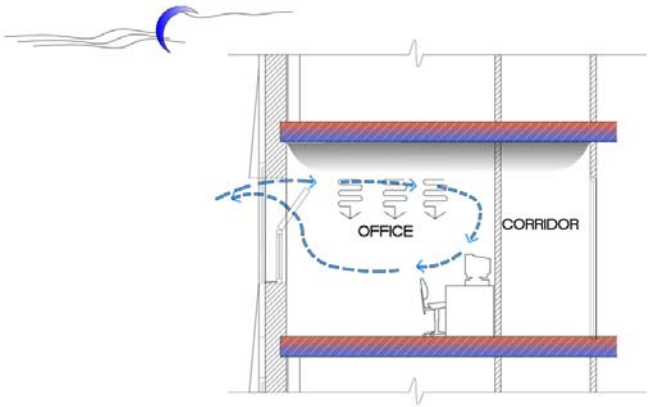
LINK ARKITEKTUR

Inger Andresen / 2012-09-05

Strategi

6: Passiv klimatisering





LINK ARKITEKTUR

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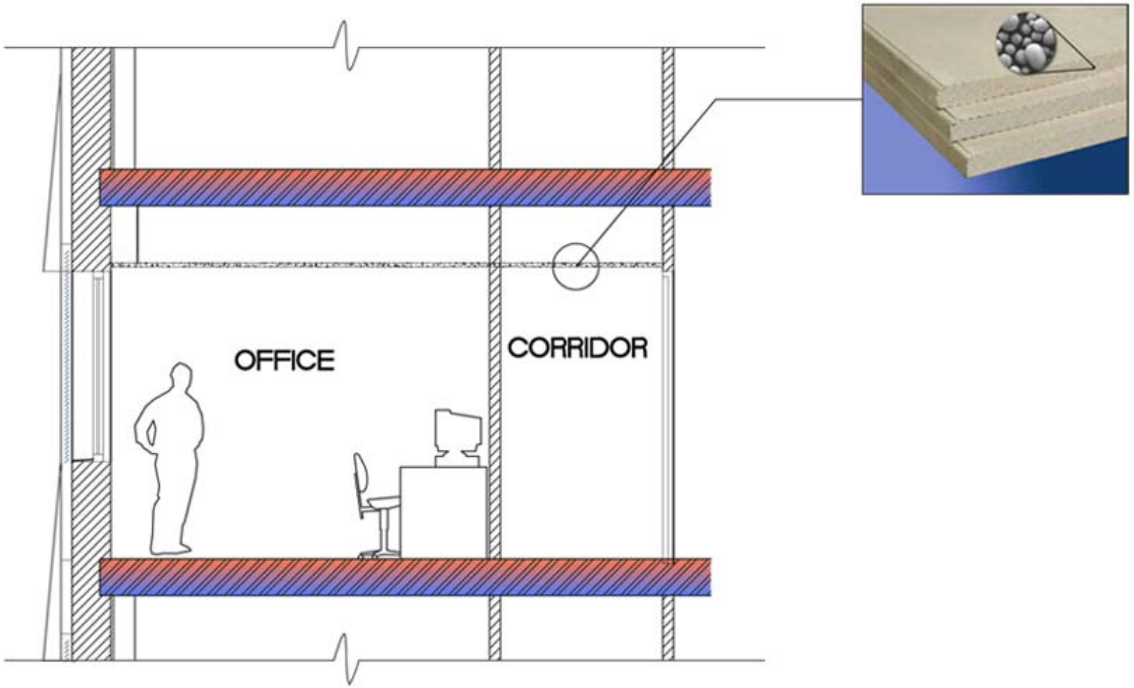
Strategi

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

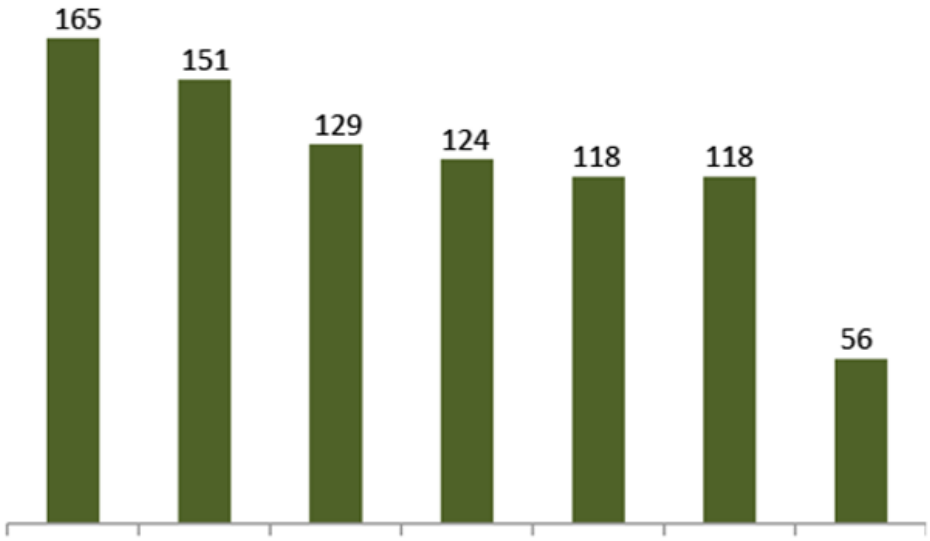
LINK ARKITEKTUR

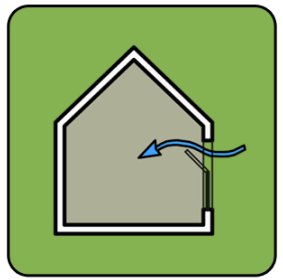
Inger Andresen / 2012-09-05

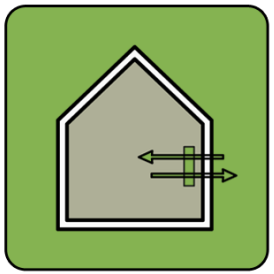
Strategi

6: Passiv klimatisering

Beregnet årlig levert energi, kWh/m^2 BRA







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Strategi

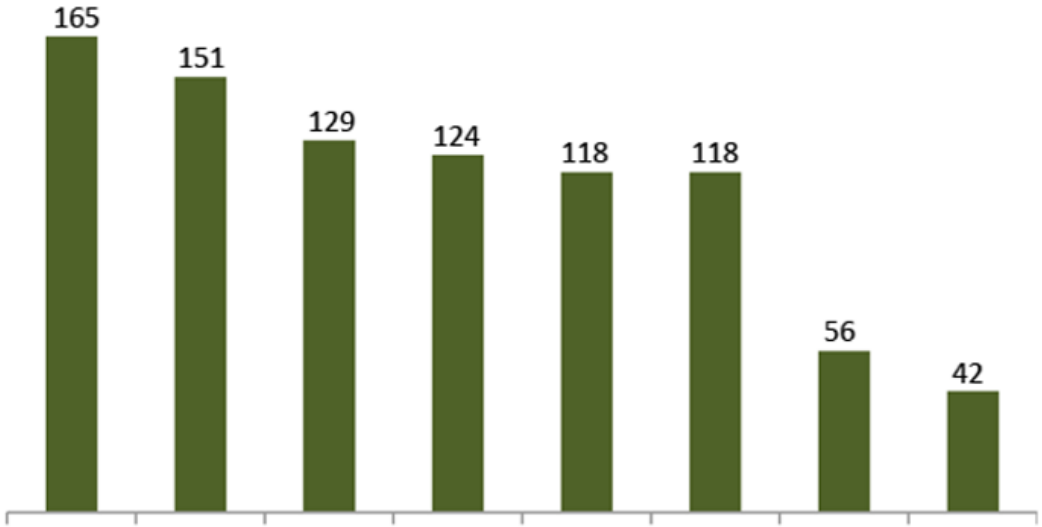
7: Lokal fornybar varme og kjøling

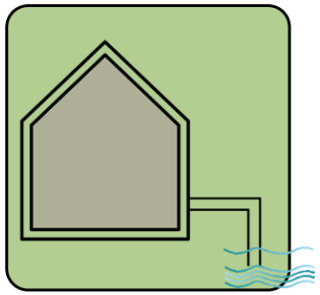
Sjøvannsbasert varmepumpe

COPvarme = 3.0

COPkjøling = 10.0

Beregnet årlig levert energi, kWh/m^2 BRA





LINK ARKITEKTUR

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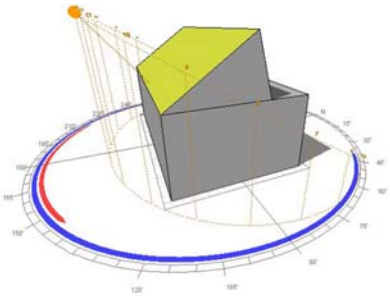
Strategi

8: Lokal fornybar elektrisitet

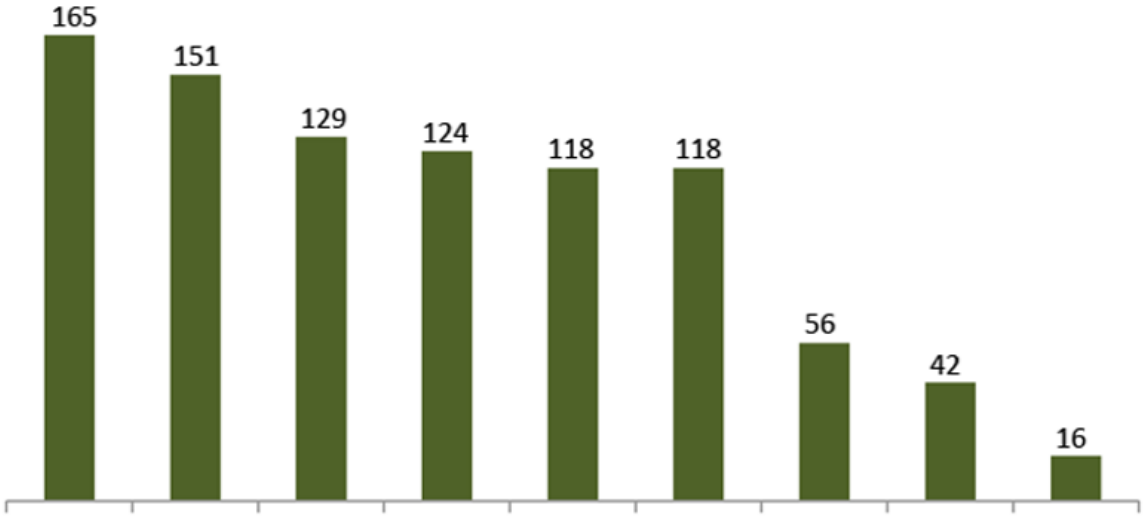


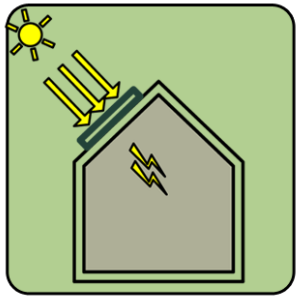
Solcelleanlegg:

310 m^2 solcellemoduler, 17% virkningsgrad gir

ca. 30.000 kWh/år i statistisk normalår

Beregnet årlig levert energi, kWh/m^2 BRA





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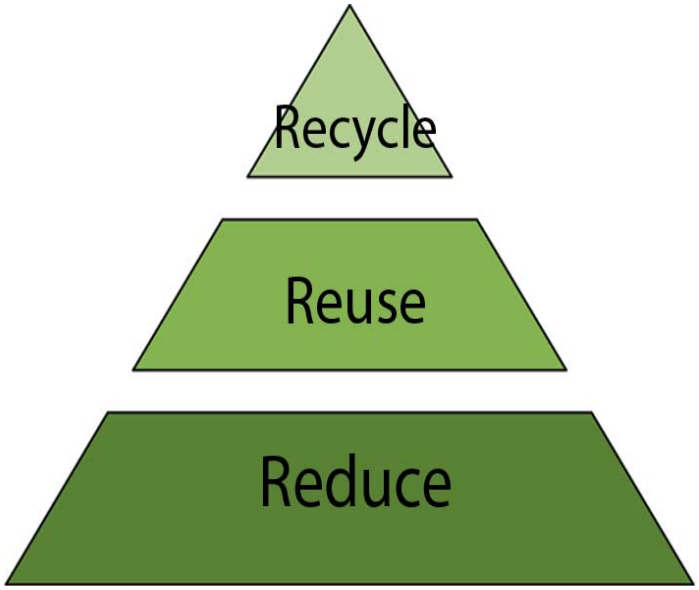
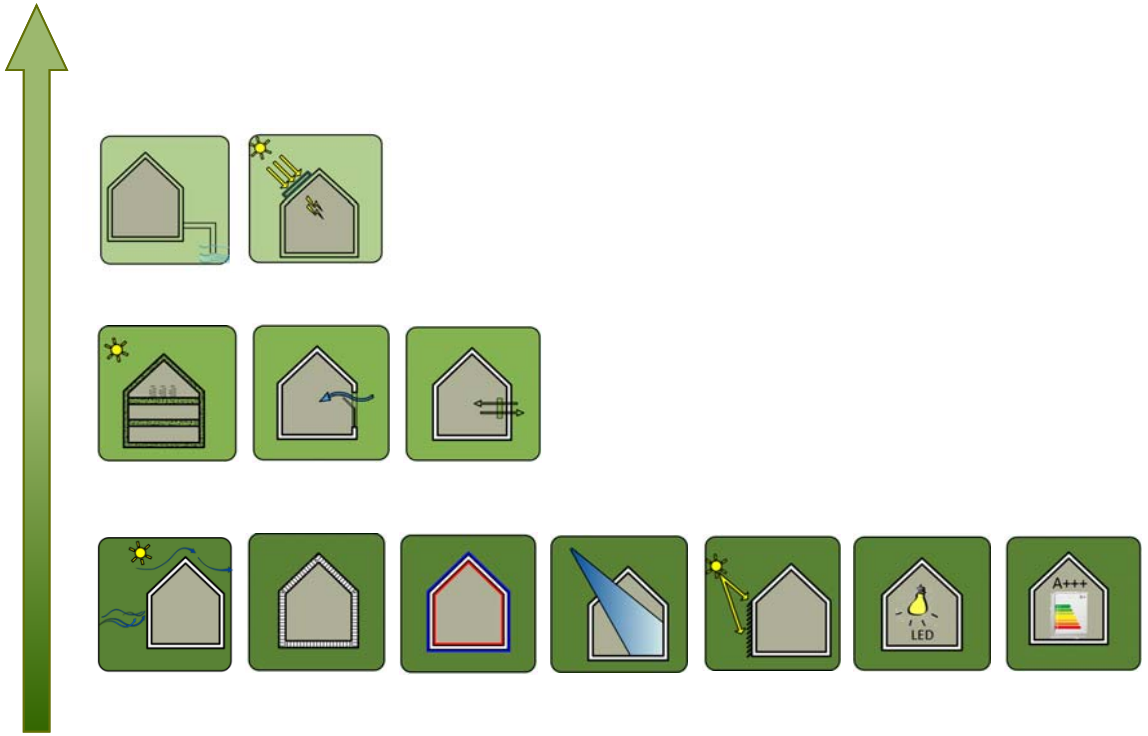
Oppsummering

16 kWh

(nesten) **Null på 1-2-3**





165 kWh

LINK ARKITEKTUR