

# 5 ZERO ENERGY DWELLINGS AT SKARPNES, ARENDAL

Steinar Grynning, Åse L. Sørensen, Judith  
Thomsen, Lars Gullbrekken

# Summary

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- The *zero energy* buildings at Skårpnes
- Inhabitants
- Indoor climate
- Energy
- Conclusions



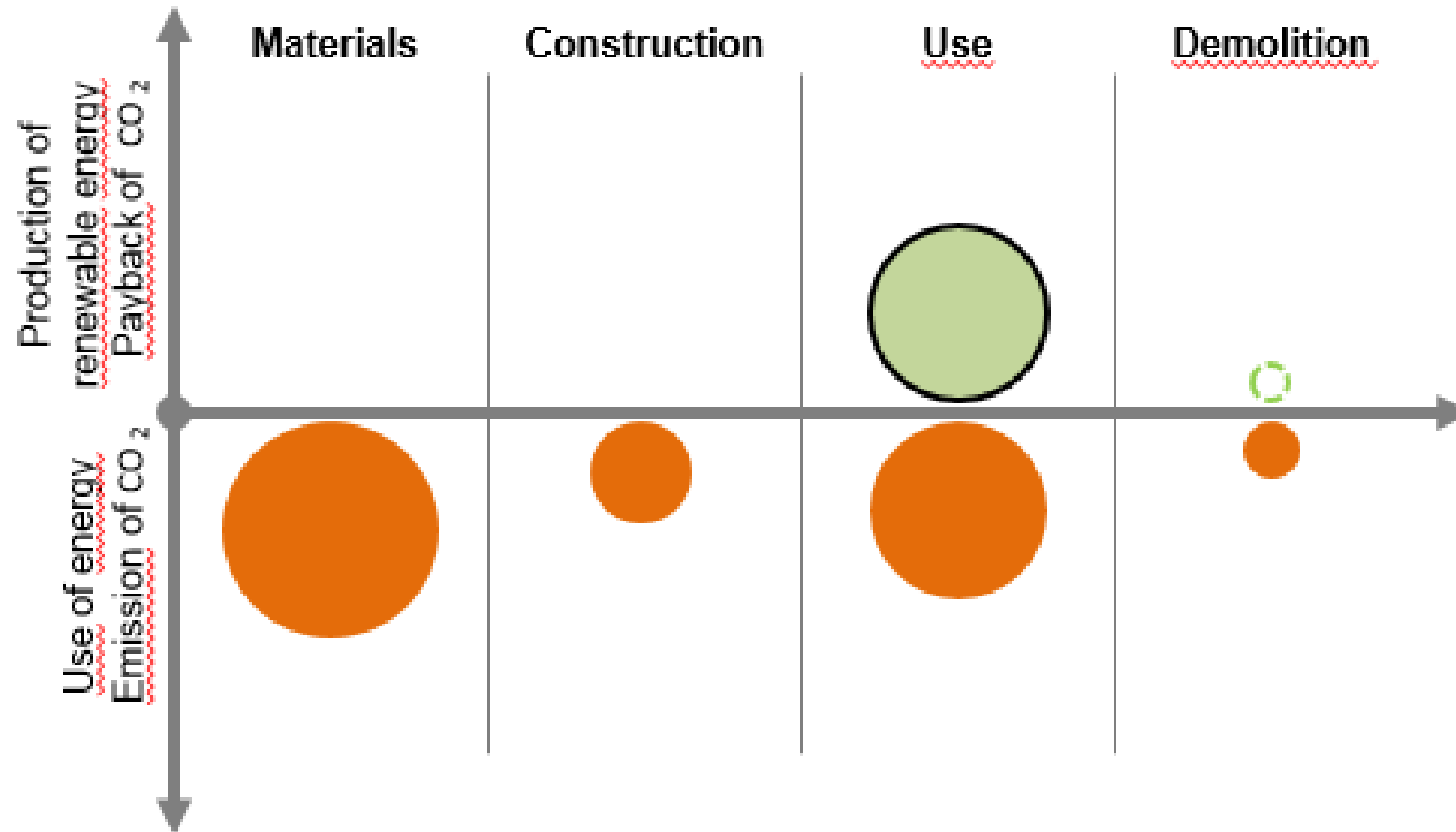
# The first zero energy dwellings in Norway

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- *Located:* Skarpnes, Arendal
- *Type:* Single family dwellings
- *Size:* 156 m<sup>2</sup> pr dwelling / 5 dwelling
- *Entrepreneur:* Skanska
- *Consultants:* Øivind B. Berntsen AS, VVS teknikk. The research centre on Zero Emission Buildings
- *Architect:* Rambøll Arendal
- *Built:* 2014/15
- *Ambition:* ZEB-O



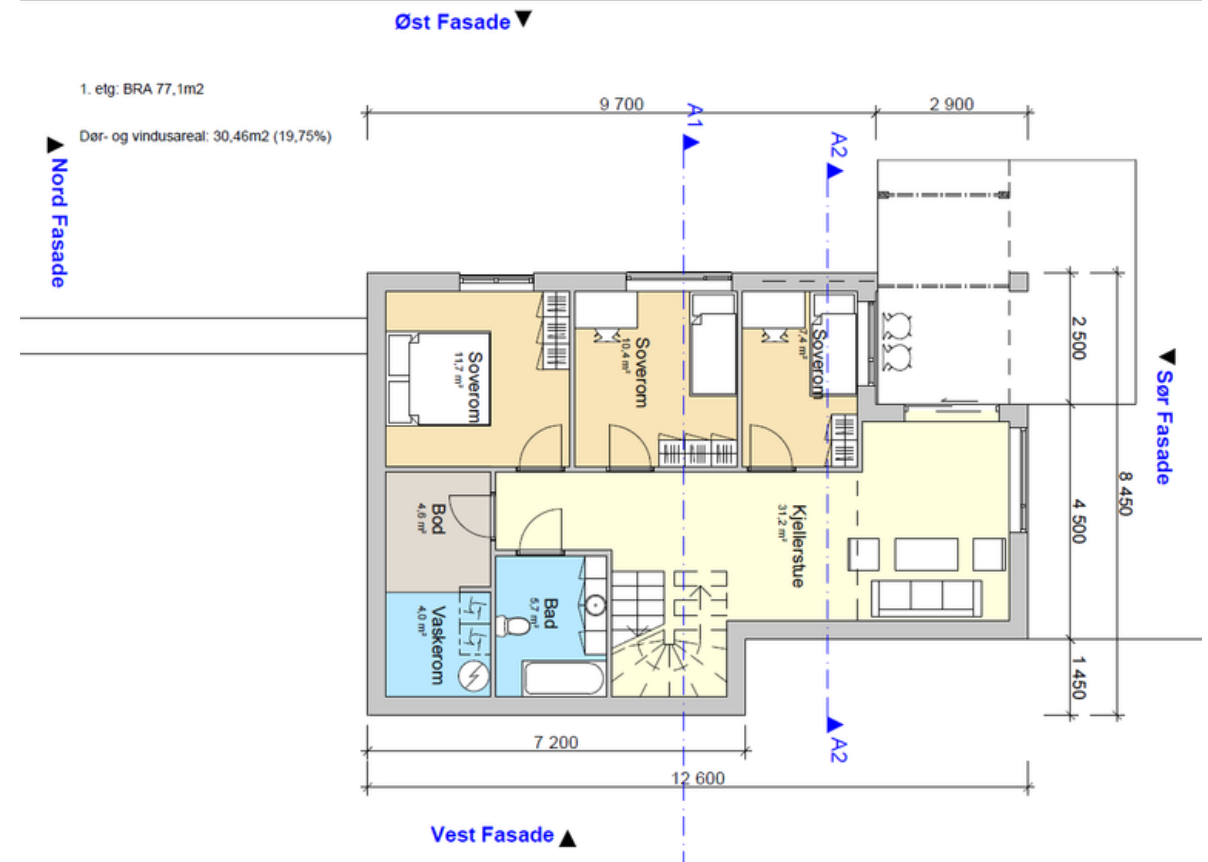
# Zero Energy = ZEB-O



# Areas and floor plan



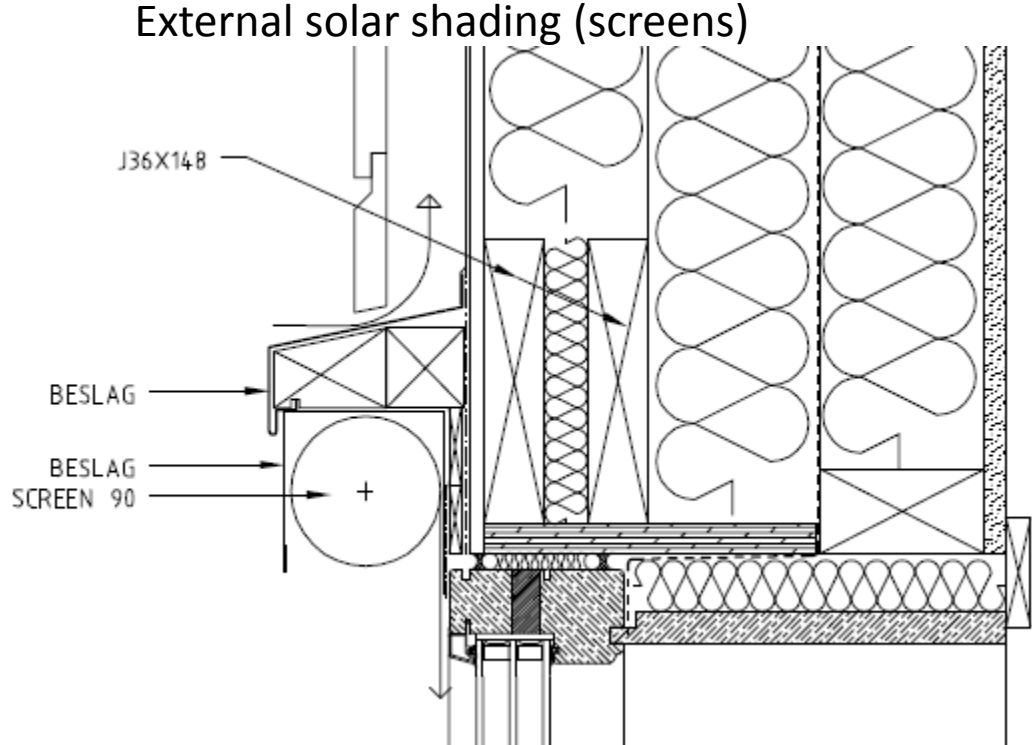
- Heated floor area 77.1 m<sup>2</sup> for each floor, total 154.2 m<sup>2</sup>.
- Four bedrooms total, three in the first floor and one on the second floor.
- The building is built after the Passive house level (NS 3700)



# Building characteristics



| Construction part                       | Value                            |
|---|----------------------------------|
| U-value External wall                   | 0.12 [W/m <sup>2</sup> K]        |
| U-value Roof                            | 0.08 [W/m <sup>2</sup> K]        |
| U-value Floor on ground                 | 0.09 [W/m <sup>2</sup> K]        |
| U-value Windows and doors               | Less than 0.8...                 |
| U-value Normalized thermal bridge value | 0.03                             |
| Air tightness                           | 0.6 air changes per hour (@50Pa) |
| Specific Fan Power                      | 1.5 kW/m <sup>3</sup> /s         |

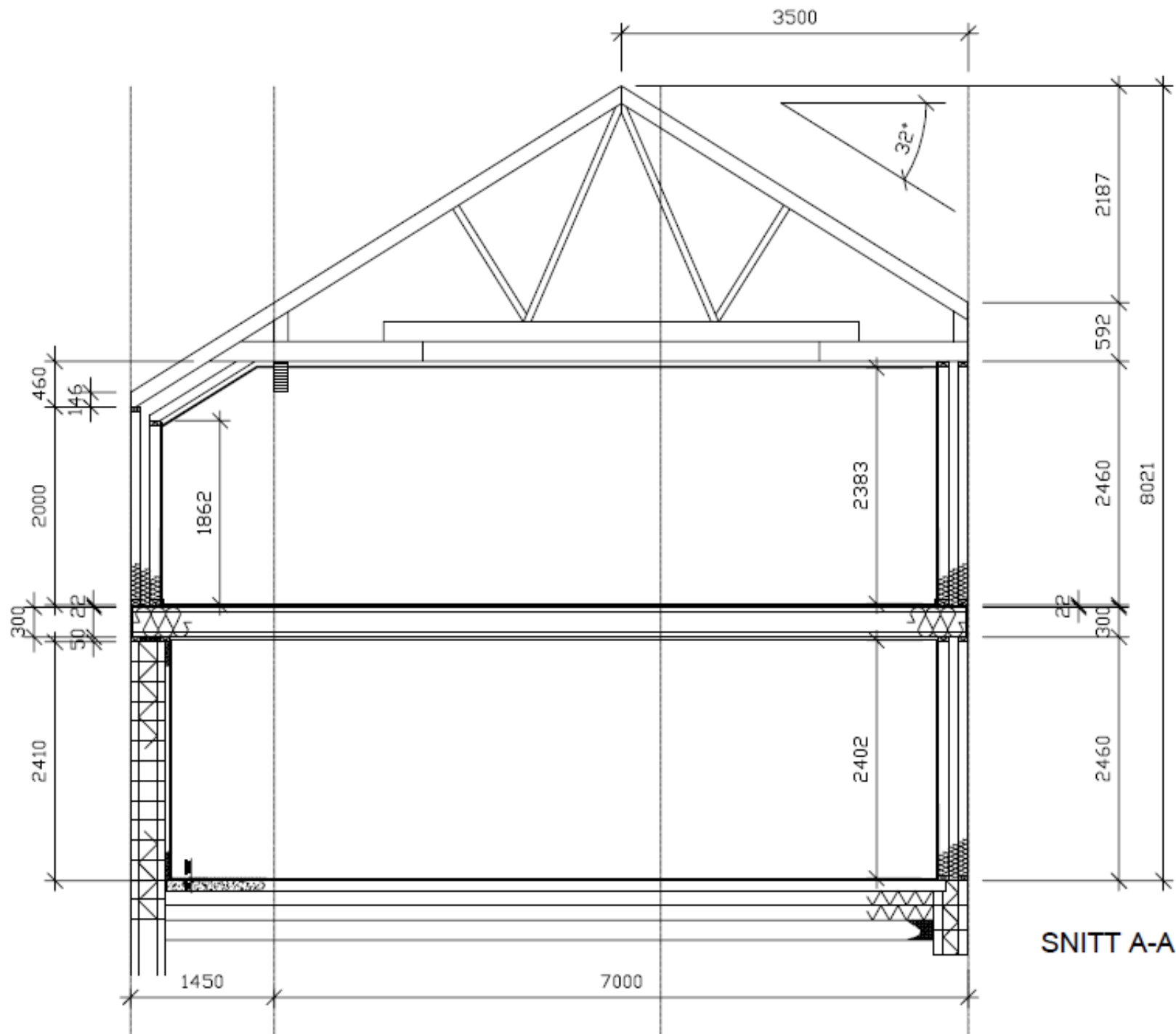


# Form follow function (and cost...)

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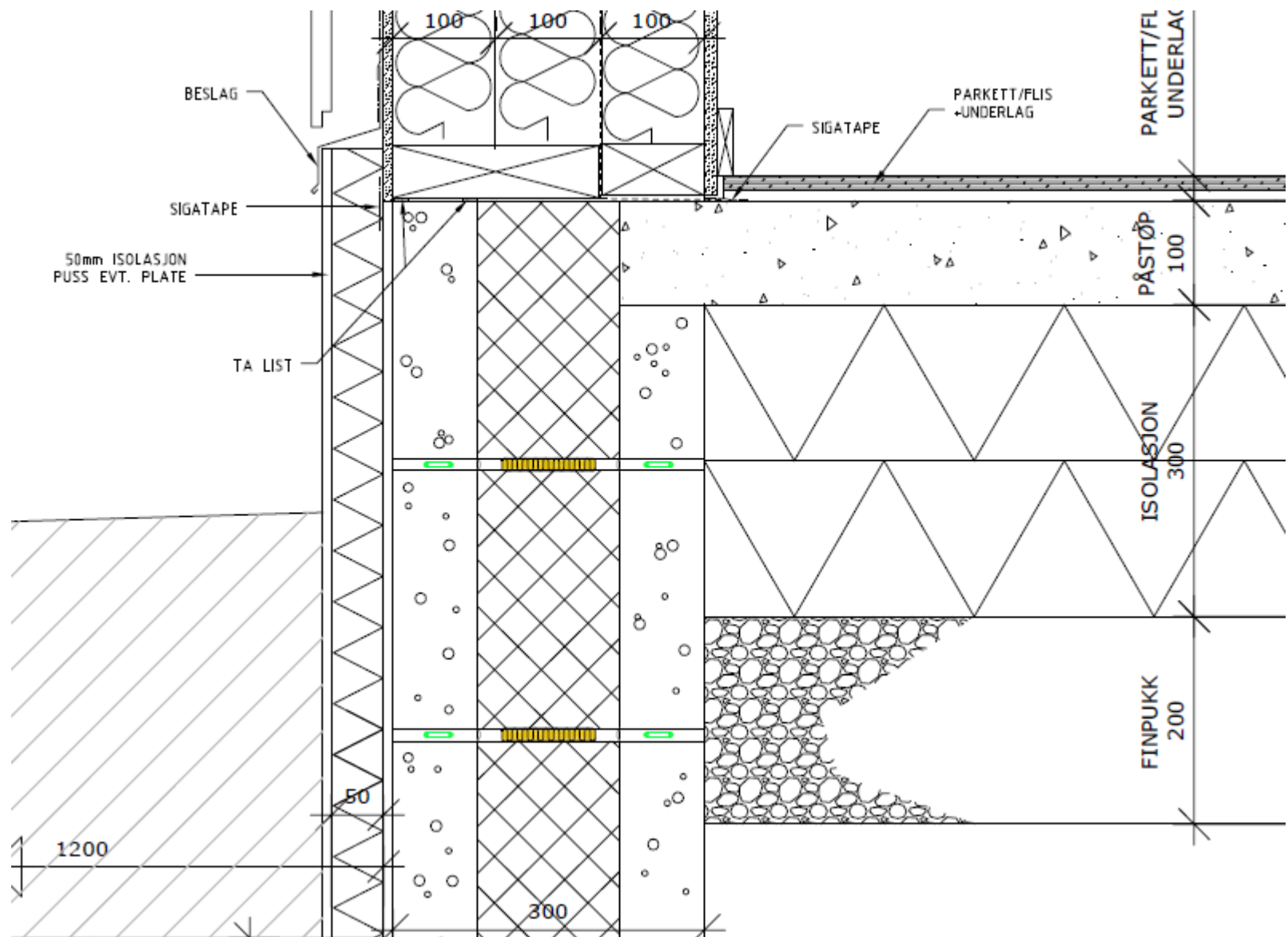
*"I wonder if the houses would have looked different if the architect had been involved at an earlier stage?"*

- Roof slope and orientation chosen to maximize solar harvesting
- Downsized area for cost-optimal solar harvesting solution
- Original plan of vertically mounted solar collectors abandoned
  - Large opaque areas in the facade

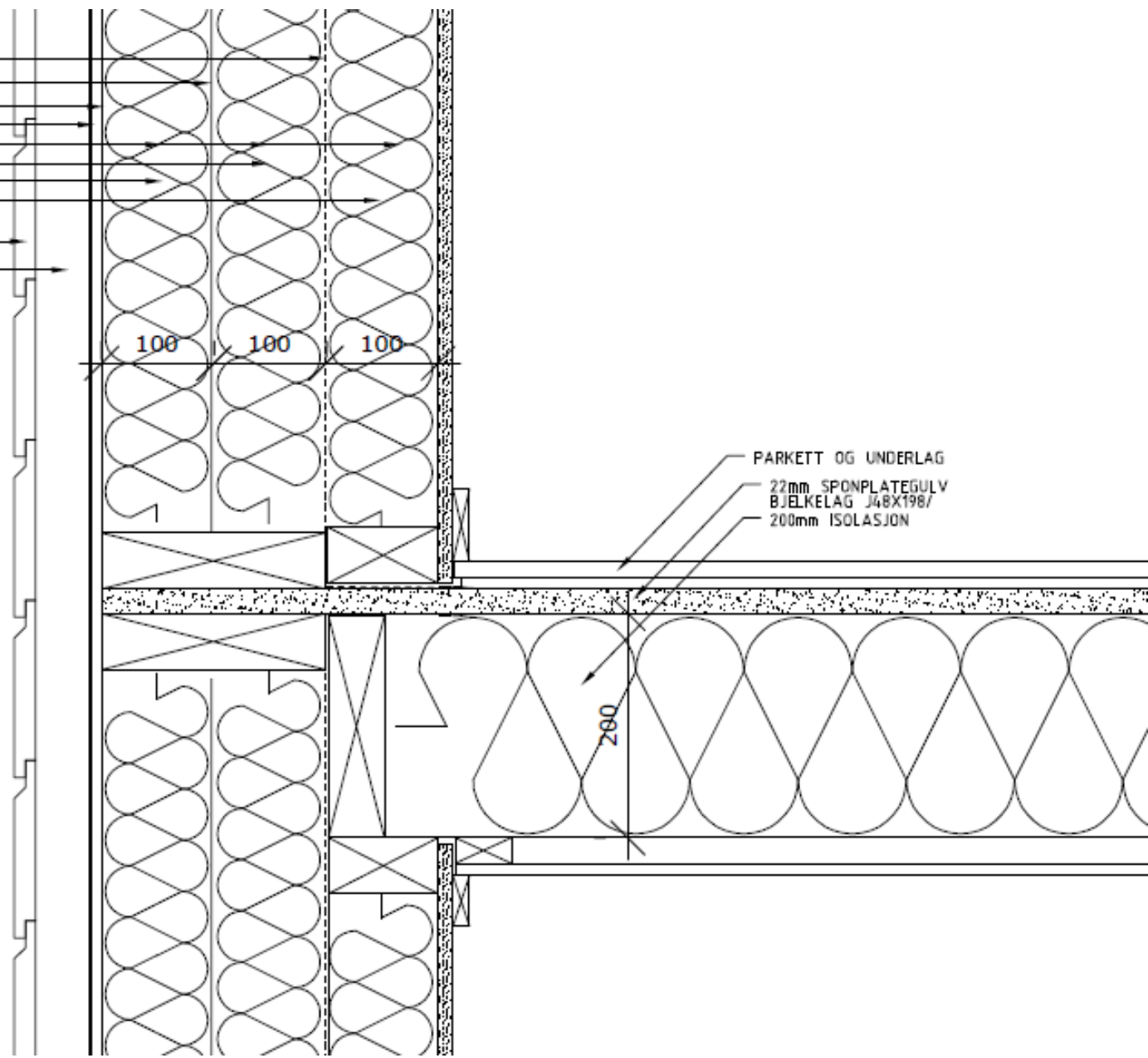


SNITT A-A



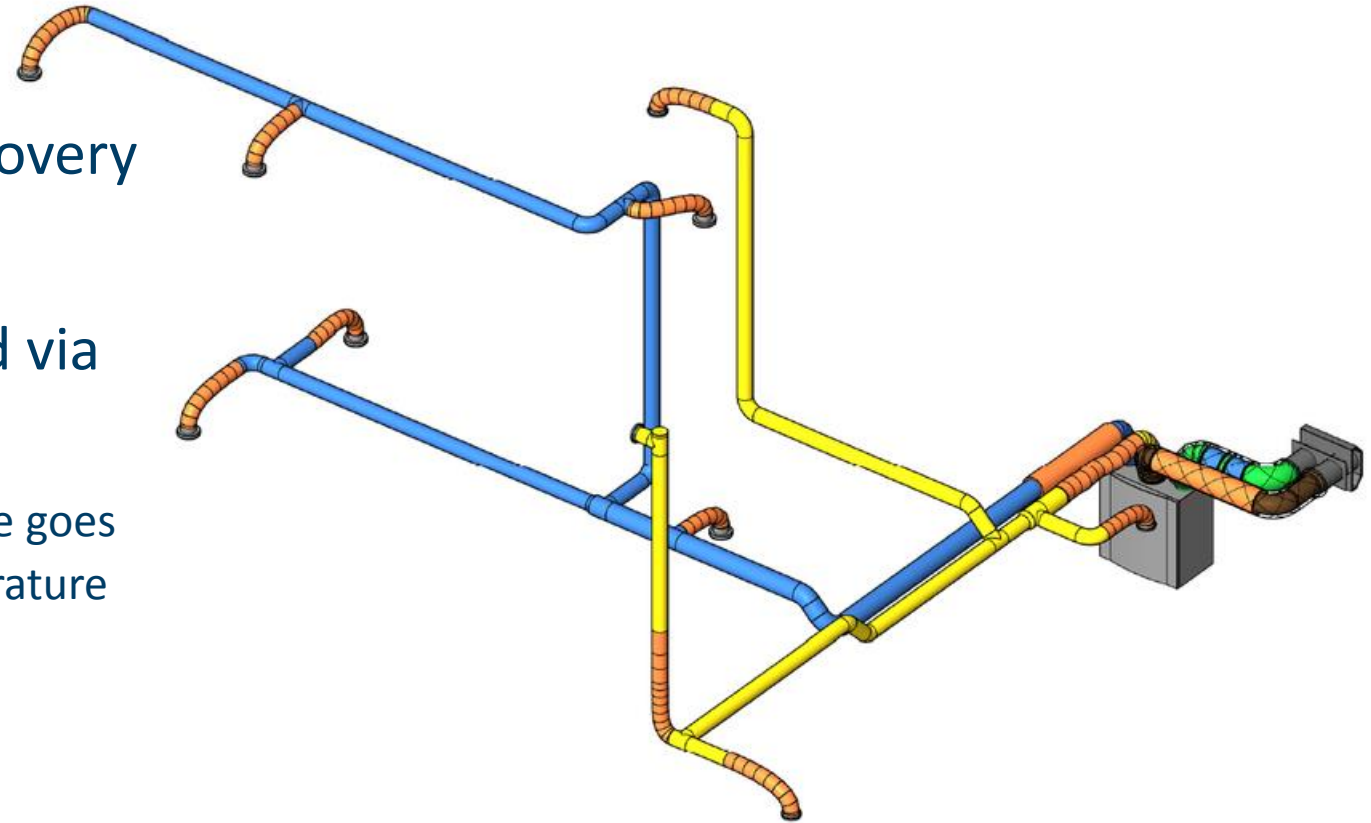


0,15mm FOLIE, KLEMMES OG  
 TAPES I SVILL OPPE OG NEDE  
 PAPIRSJKT  
 12mm ASF.PL  
 TYVEK  
 3x 100mm X33GLAVA ISO  
 IKKE BINDINGSVERK  
 BINDINGSVERK J48X98  
 BINDINGSVERK J36X98  
 19x148mm KLEDNING  
 J48x48mm



# Ventilation system

- Mechanical ventilation w/heat recovery ( $\eta = 86\%$ )
- Supply air preheated or pre-cooled via the geothermal wells.
- It is preheated if the outside air temperature goes below  $-5\text{ C}^\circ$  and it is pre-cooled if the temperature goes above  $17\text{ C}^\circ$



|  |               |                                       |            |            |   |   |       |          |   |
|--|---------------|---------------------------------------|------------|------------|---|---|-------|----------|---|
| Tekniske Entrepriser AS  | Prosjekt nr.: | Prosjekt navn:                        |            |            |   |   | Rev.: | Dato:    | Stasjon:  |
|  | Prosjekt nr.: | Enebolig type C Petter Lindaas Tomt 7 | Målestokk: | Dato:      |   |   | 1     | 29.09.14 | Flybet aggregat til yttervegg + tatt hensyn til ståldrager over kjølerstue. |
| Prosjekt nr.:  | 3D            | Oppdragsleder:                        | H. Wikene  | 29.09.2014 | 2 |   |       |          |   |
| Prosjekt nr.:  | TypeC Tomt7   | Oppdragsnr.:                          |            | TEK-10     | 3 |   |       |          |   |
| <small>                 NB! Se monteringsveiledning på regningsprogramet, samt vedlagt detaljer monteringsanvisning.<br/>                 (Finnes også i plattform på ventilasjonsaggregatet)             </small> |               |                                       |            |            |   | <small>                 Våre ventilasjonsanvisninger må ikke brukes eller kopieres uten tillatelse fra Systemair AS.             </small> |       |          |   |

# Heating system

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- Water based floor heating system in the bathrooms, the entrance and ground floor living room.
- The heat source is the ground source heat pump (cop 4,2-4,5).
- One convector installed in each floor.
- The heating system is a low temperature floor heating system with operating temperatures around 26-30 degrees

# Domestic Hot water

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- The domestic hot water is heated primarily with the heat pump, and has an operating temperature of 55 C°. To avoid legionella problems, the tank is heated to 70 C° once a week during the night. The controlling system takes care of this automatically. The buffer energy for the hot water comes from direct electricity, however in normal operation the hot water tank is supplied primarily from the heat pump.



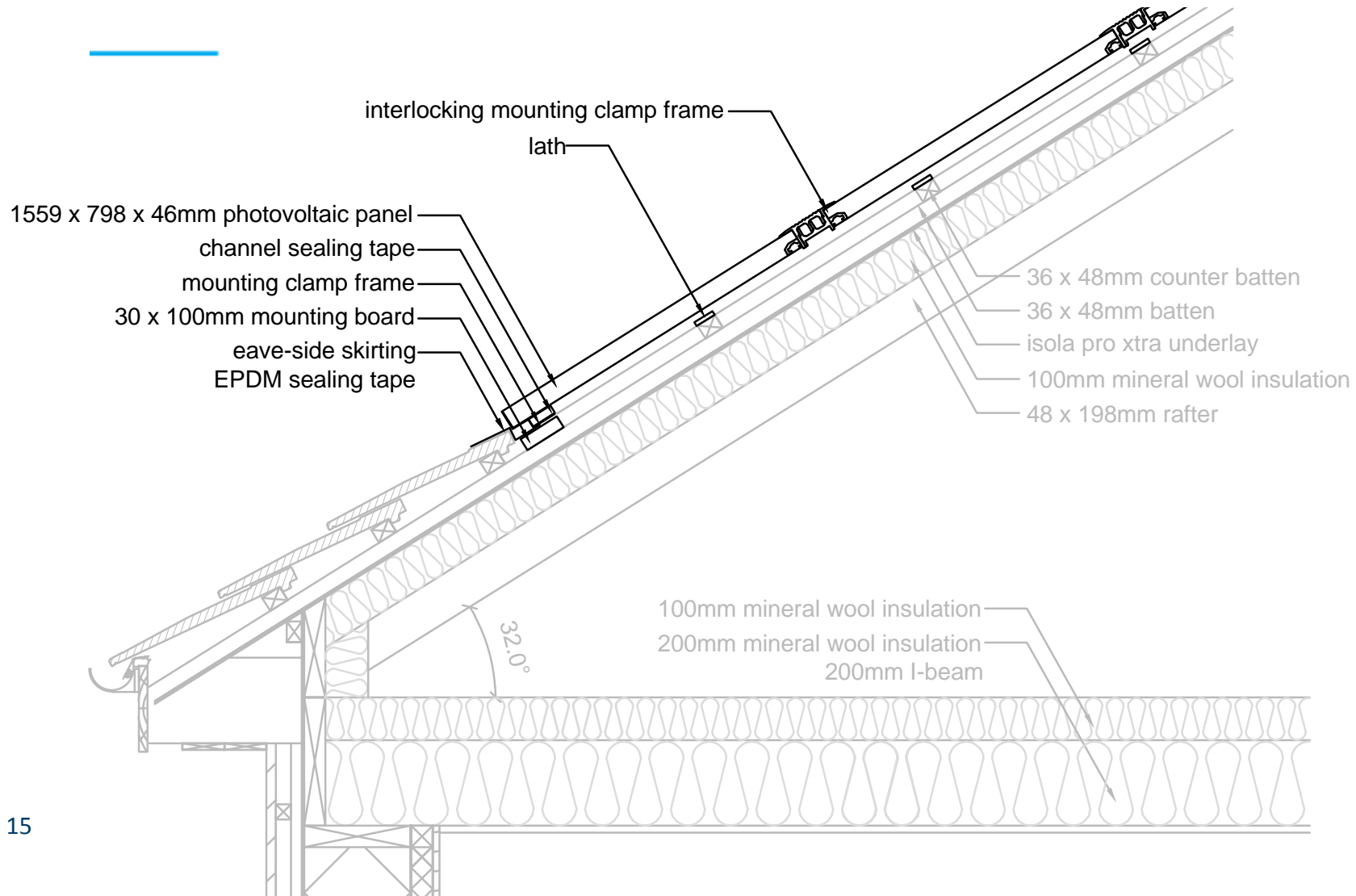
# PV system

- 32 high efficient modules from SunPower.
  - four rows on the south-facing part of the pitched roof.
  - There are no shading objects in the immediate surroundings of the building
- BiPV: does not cover the full area of the roof, but is integrated in the upper part of the south facing side.



| Description                        | Unit           | B – Skarpnes                  |
|------------------------------------|----------------|-------------------------------|
| Manufacturer                       | -              | Sunpower                      |
| Type of module                     | -              | SPR-230NE-BLK-D               |
| Country of PV module production    |                | The Philippines               |
| Cell technology                    | -              | Mono-Si (back-contacted)      |
| Rated power per module             | Wp             | 230                           |
| Efficiency at STC*                 | %              | 18.5                          |
| Module size                        | m <sup>2</sup> | 1.24 (1.559 x 0.798)          |
| Weight                             | kg             | 15                            |
| Number of modules                  | -              | 32                            |
| Total module area                  | m <sup>2</sup> | 40                            |
| Total rated power                  | kWp            | 7.36                          |
| Total weight of modules            | kg             | 480                           |
| Inverter                           |                | 1 x SMA Sunny Tripower 7000TL |
| Number of strings                  |                | 2                             |
| PV/inverter power ratio            |                | 1.05                          |
| Type of mounting system            |                | BIPV                          |
| Mounting system manufacturer       |                | Schweizer/ Schweizer          |
| Place of mounting frame production |                | Chemnitz, Germany             |
| Battery storage                    |                | No storage                    |

# BiPV



# The first Norwegian zero energy inhabitants

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*"We don't consider us being particularly interested in saving energy"*

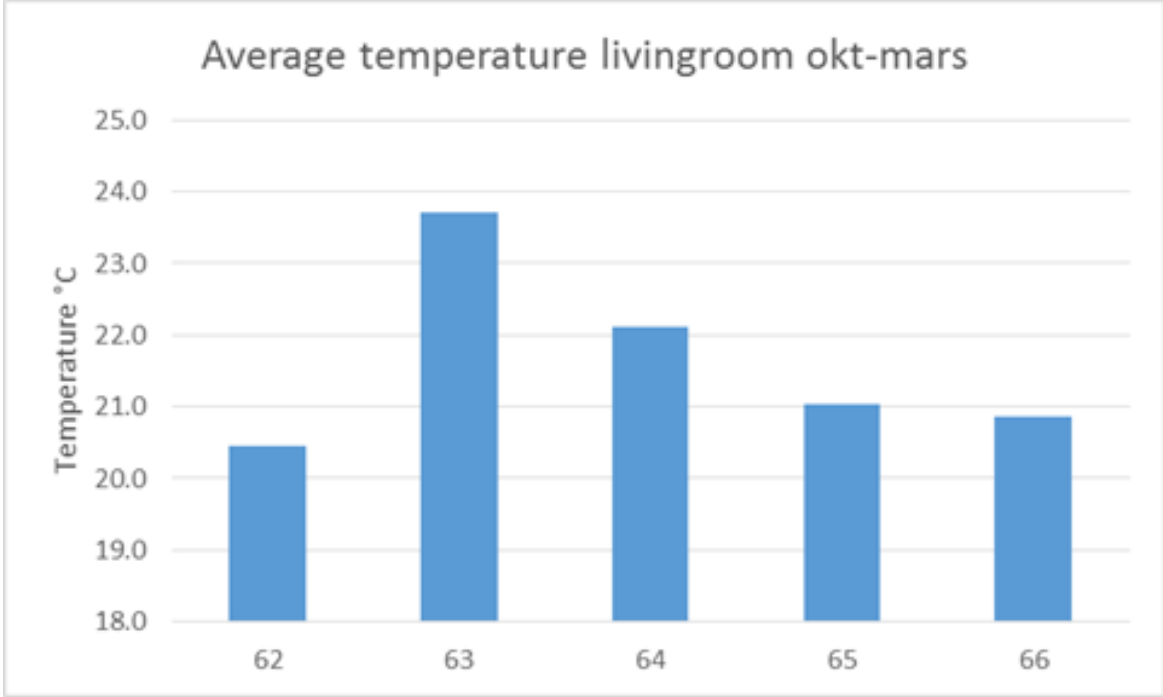
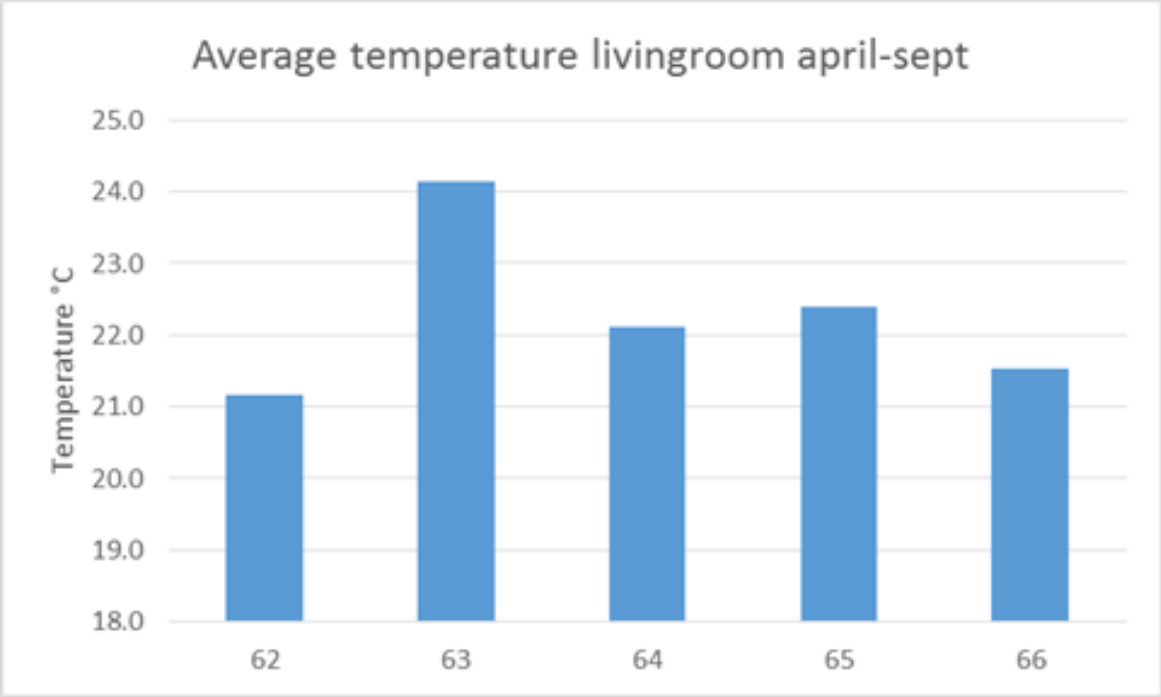
- Why buy a ZeroE-house?

- *Better value than in Oslo (inhabitants from Oslo...)*
- *Positive towards zero energy*
- ***Location, design** and the fact that it's a **new house** is important arguments for buying*

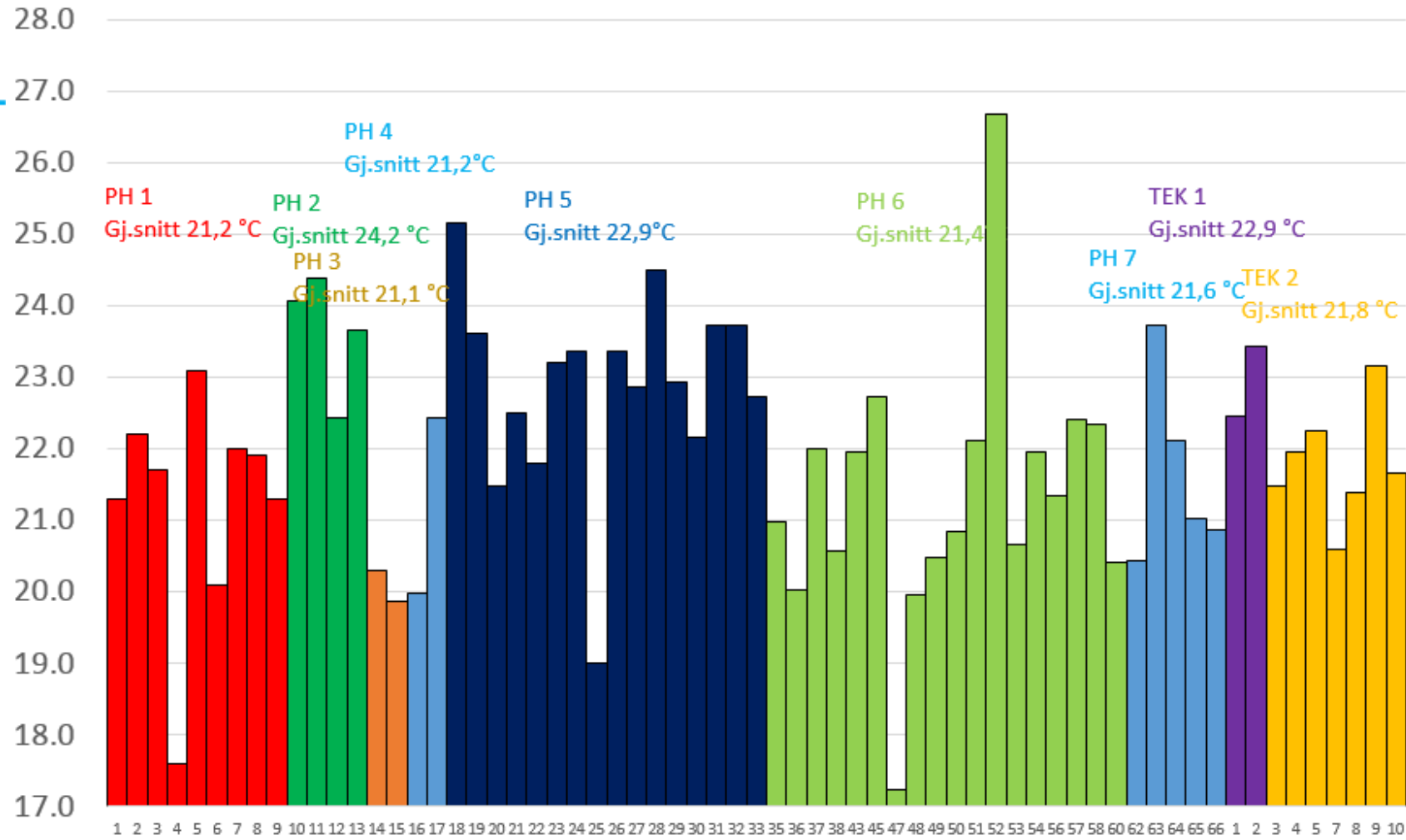
- How's life in a ZeroE-house?

- *Happy with interior temperature*
- *Adjustment possibilities og T is good through;*
  - *Thermostat, Window opening, Solar shading, Ventilation air*
- *We want to have it warm during winter and the summer isn't perceived as too warm*
- *Good air-quality (less bothered by pollen)*
- *We open bedroom windows during the night*
  
- *We would have liked to get more tailored information. There is a lot of new technical systemske løsninger*
- *There was some issues breaking the house in, but it has gotten better*

# Interior climate

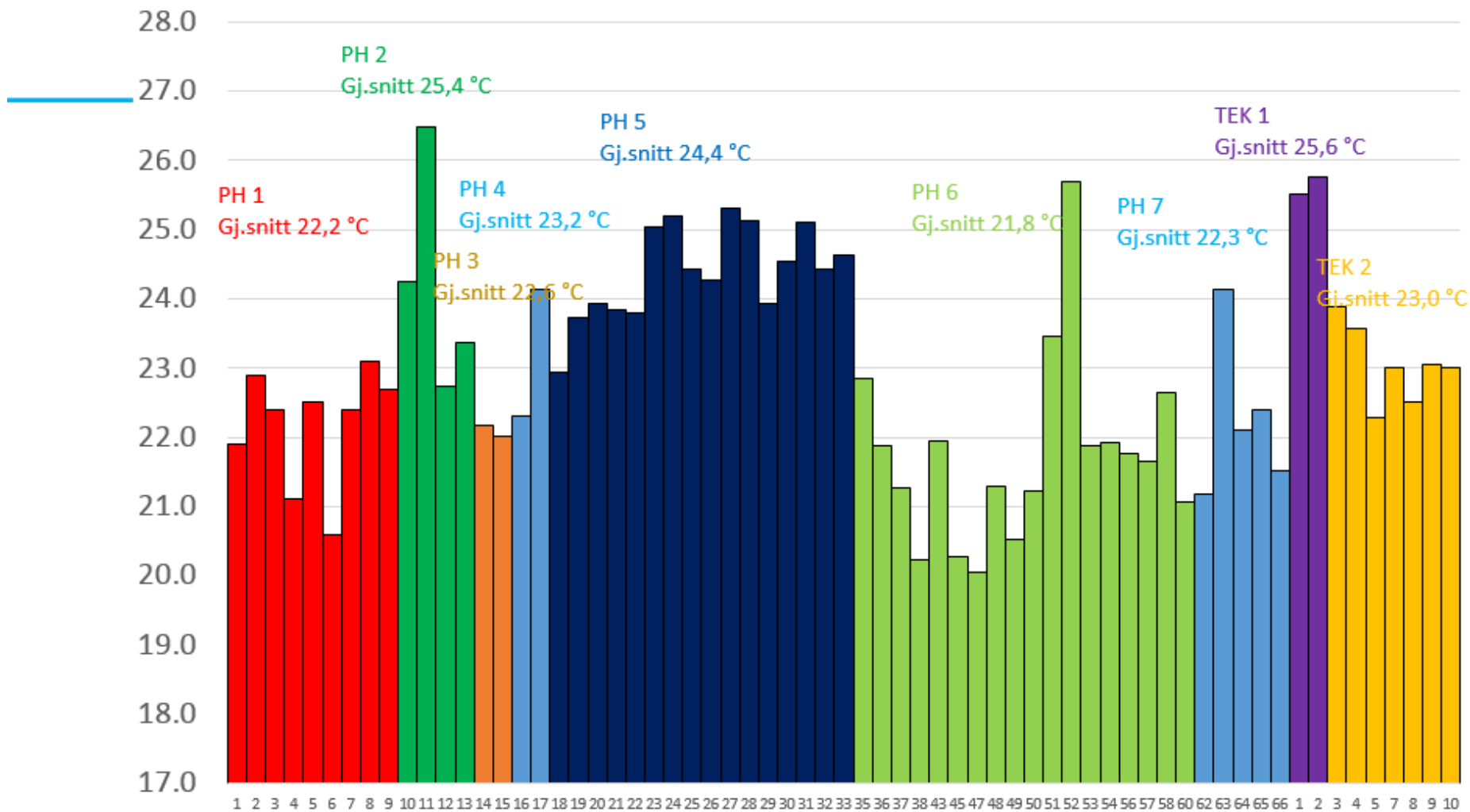


°C Målt gj.snittstemperatur på stua i vinterhalvåret (okt.-mars)

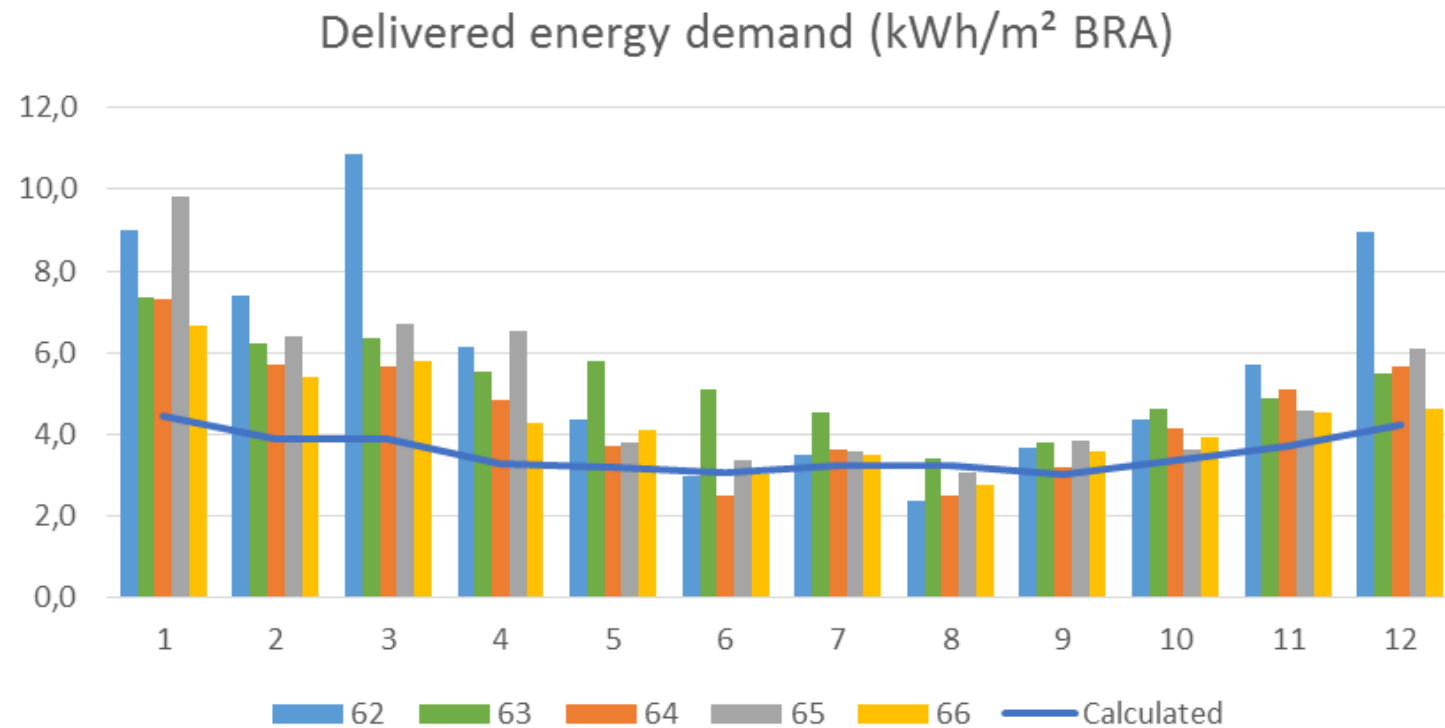




## °C Målt gj.snittstemperatur på stua i sommerhalvåret (april-sept.)

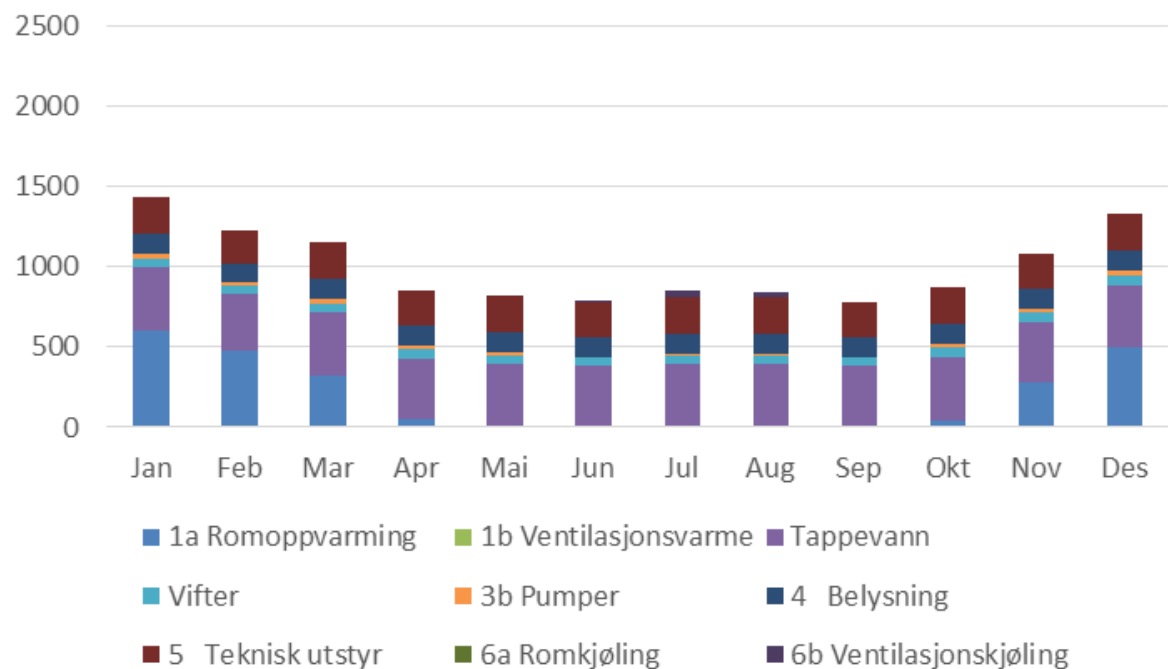


# Energy use

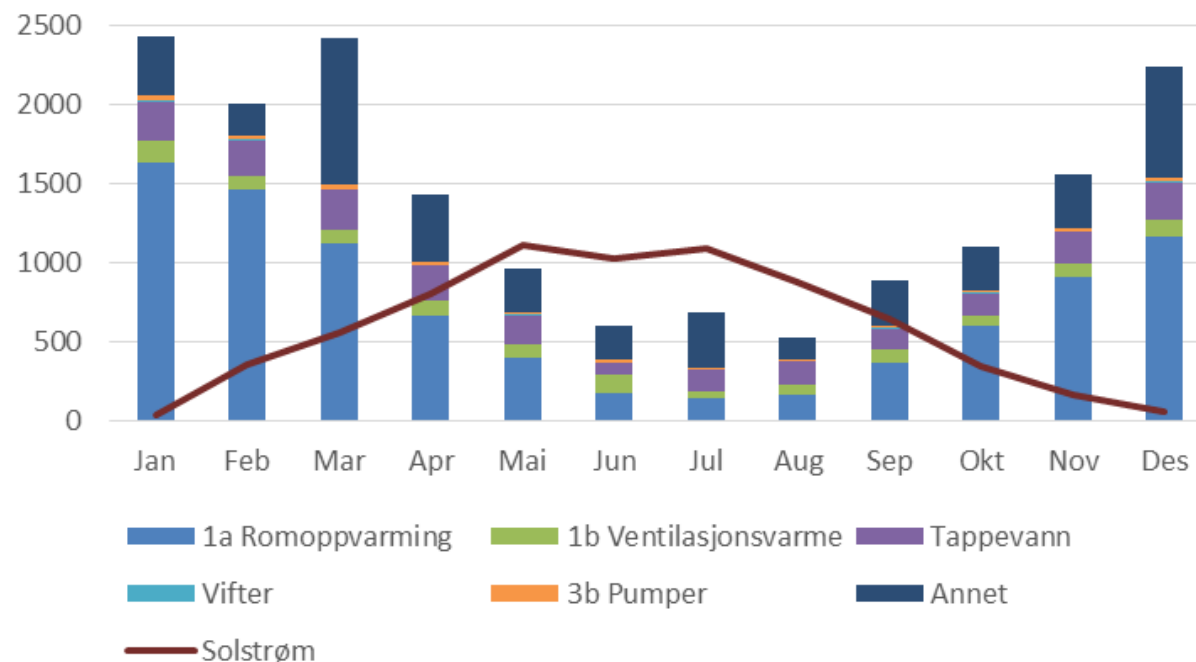


# Measurements vs. calculations

Calculated energy demand average Skarpnes (kWh)



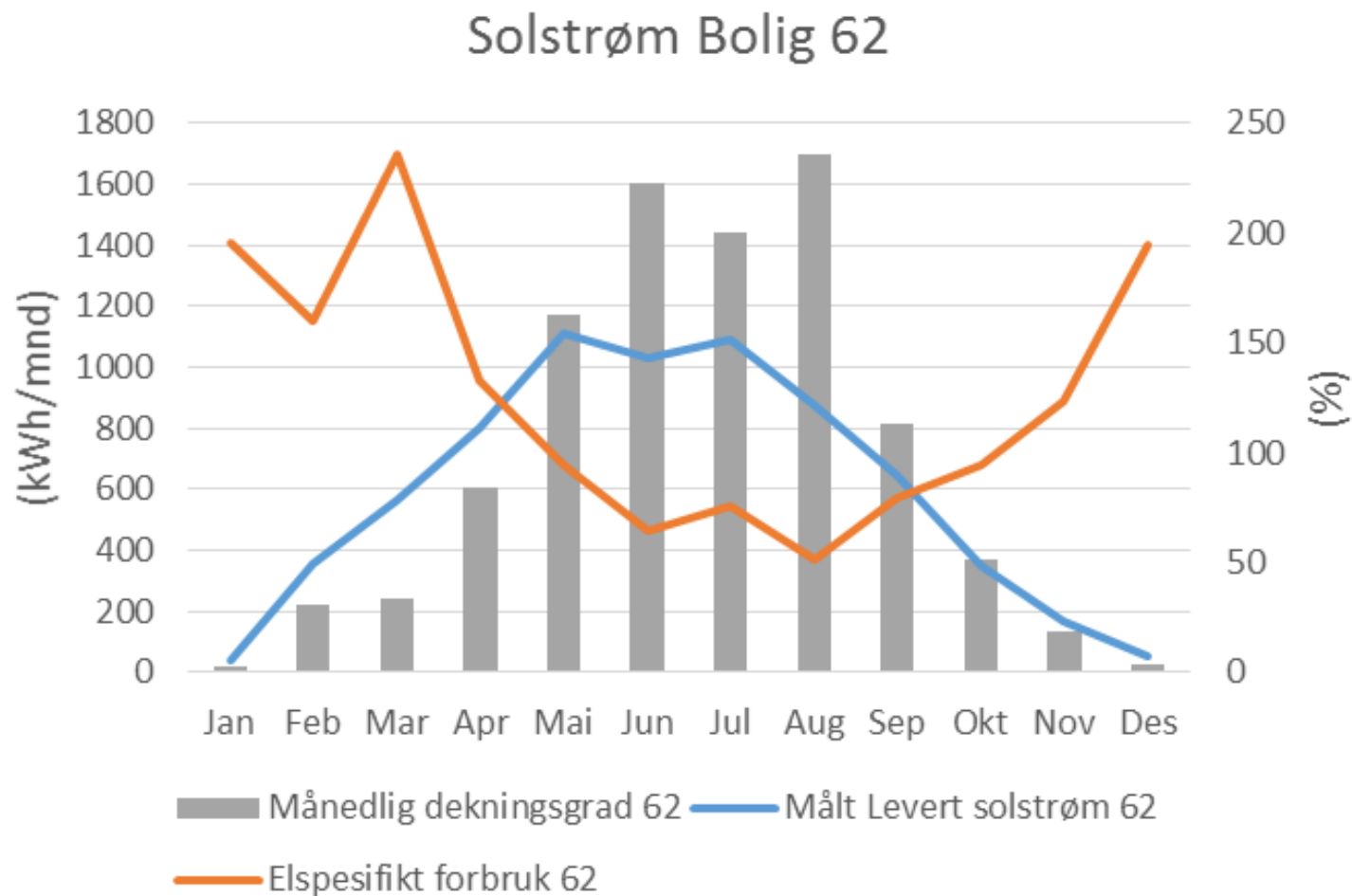
Measured energy demand Skarpnes #62 (kWh)



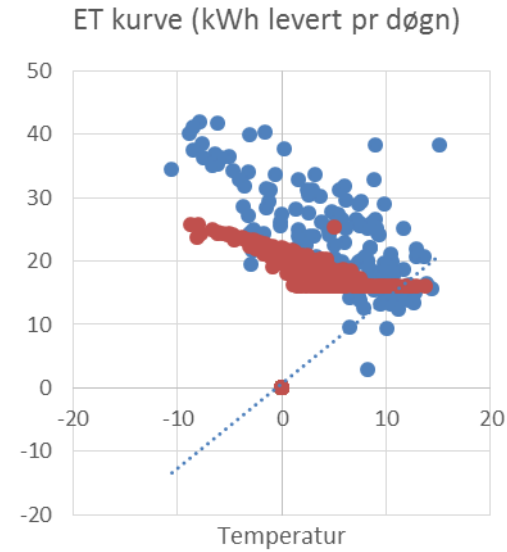
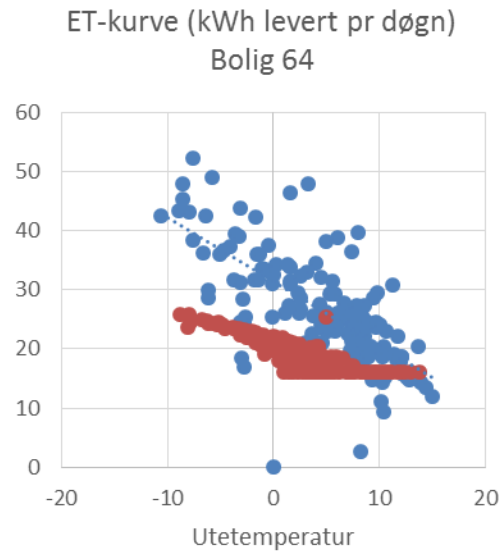
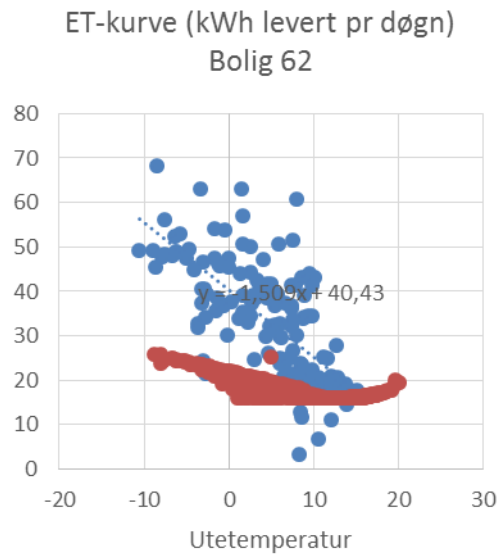
# PV production



Assumptions in calculations:

- PV cover; 50% of hot water and 10% of space heating



# Underestimation of heating demand?



 dots = calculated  
 dots = measured



# Conclusions

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- Measured energy demand is averaegely 35 % higher than calculated
  - 62 %, 35 %, 8 %, 30 % and 43 % for the five individual houses
- PV-production is higher in reality than calculated
- Heating demand is likely to have been underestimated in design phase
- Inhabitants in the buildings are in general quite happy with their Zero-Energy homes
- Too high temperatures is not *that big of a problem...*



Teknologi for et bedre samfunn