

# Solar energy in Bergen-lessons learnt

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# Multiconsult

- Founded 1908
- Employees 2.450
- Employees in Bergen >250

## Subsidiaries

- Norway
- Poland
- Singapore
- UK
- Sweden
- Denmark
- Tanzania
- Uganda

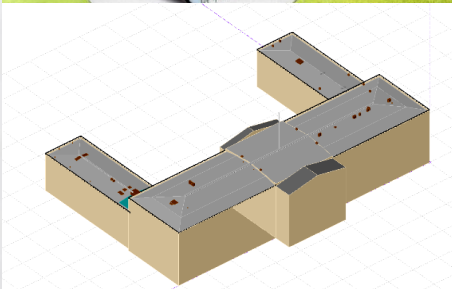


# Solar energy in Multiconsult



## Haakonsvern, Bergen

Assistance in design. Yield assessment and optimization.



## The Royal Palace of Norway, Oslo

Feasibility study. Focus on technical and aesthetic solutions.



## GET FiT Uganda

Assistance in contract negotiations, technical support (quality control and commissioning) as well as environment and social monitoring.



## DNV Marineholmen, Bergen

Technical specifications, tender documents



## AdO Arena Bergen

Feasibility study, yield assessments, power engineering, building physics, cost estimations and assessment of the profitability.

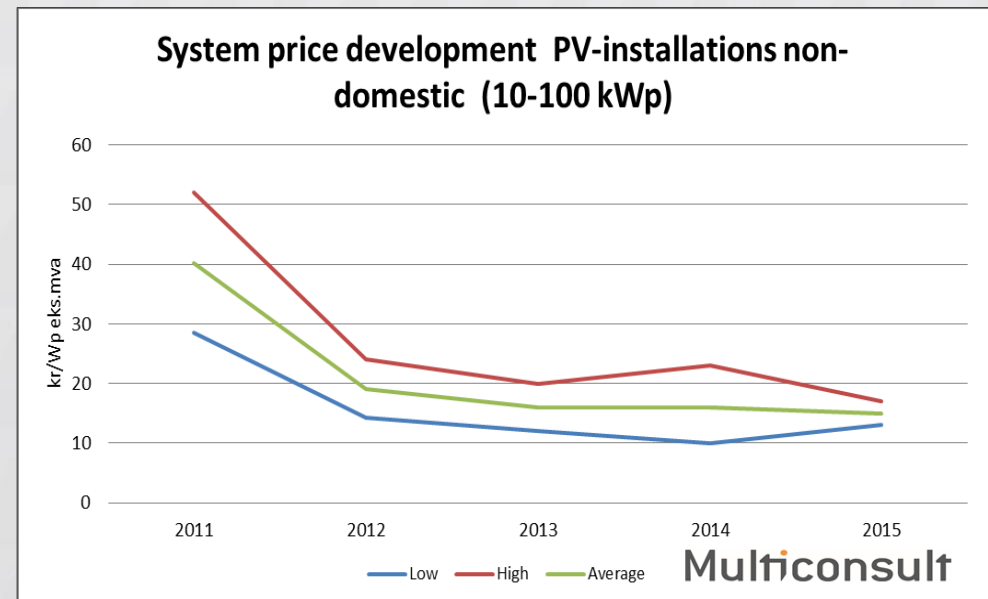
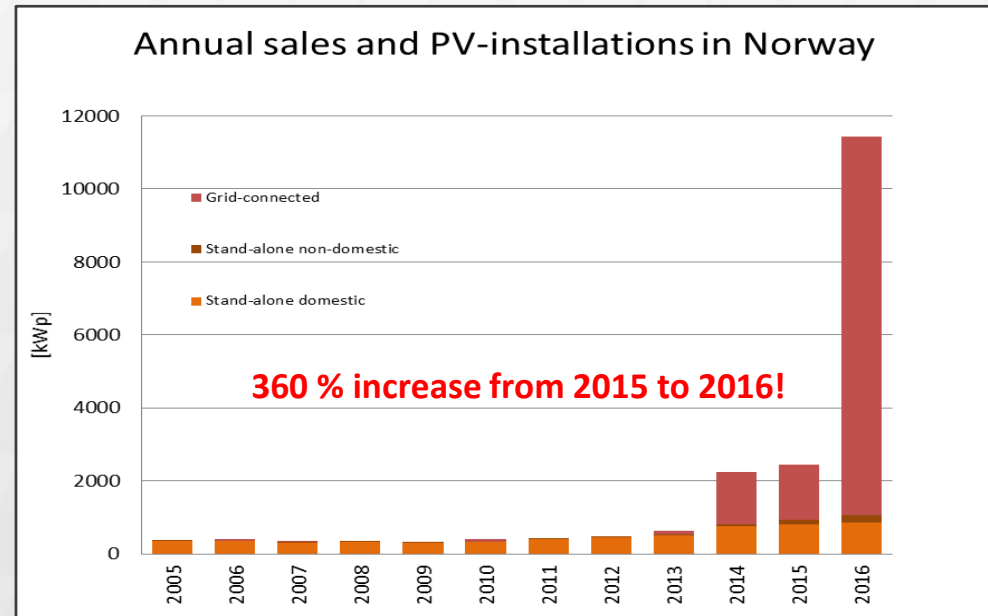


## Troll Green Station, Antarctica

Preliminary study. Integration of Solar Power in combination with diesel aggregates and batteries

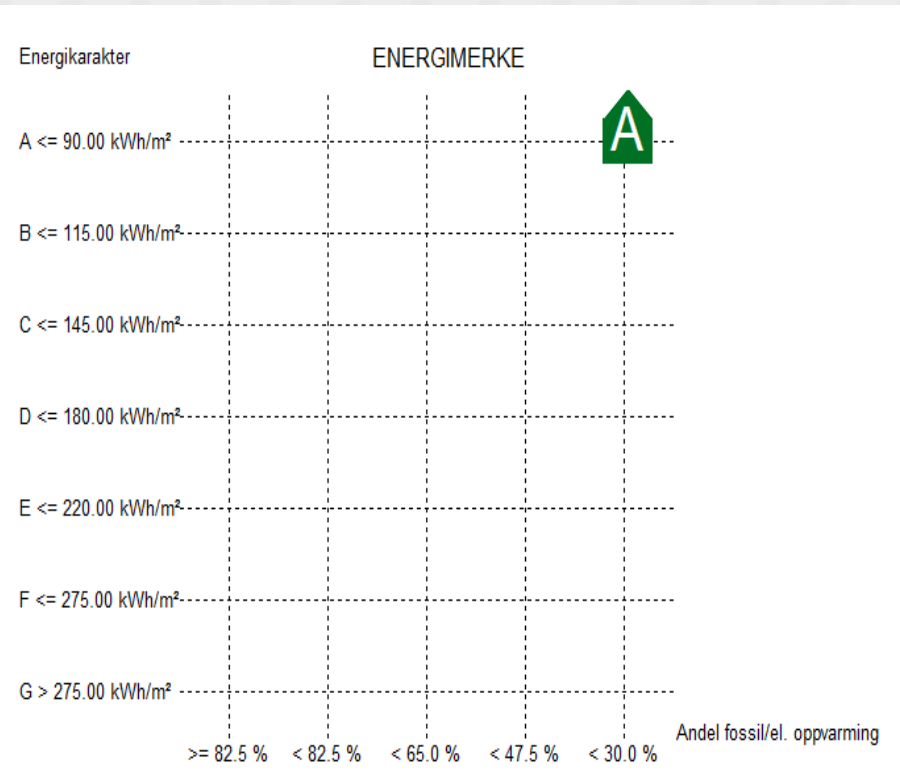
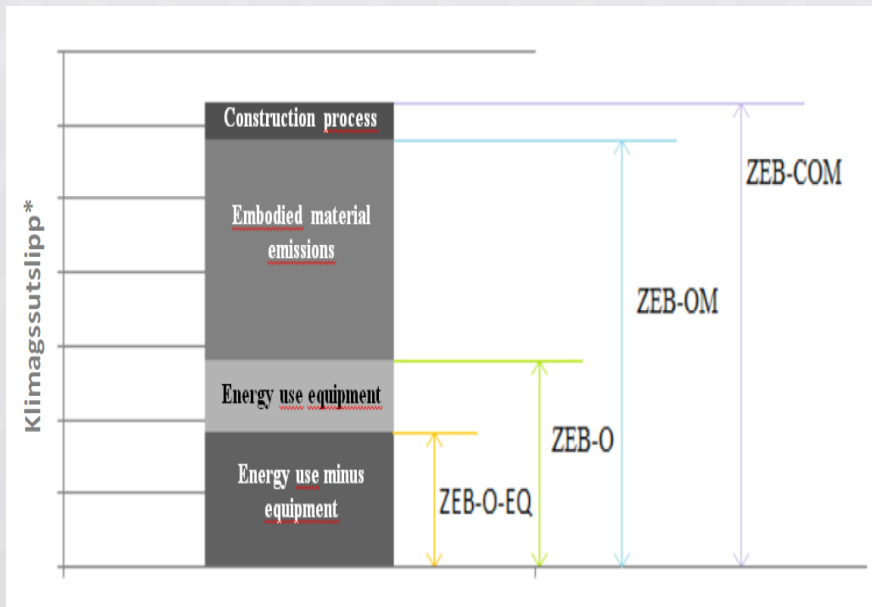
# Market

- Increased interest in solar energy
- Decreasing prices
- The city council in Bergen are positive to solar energy
- The city council have asked the city government to consider producing solar energy on suitable roofs owned by the municipal



# Biggest driver

- Increased focus on the use of energy, especially in buildings
  - Energy label
  - BREEAM
  - Zero Emission buildings
  - Zero energy buildings

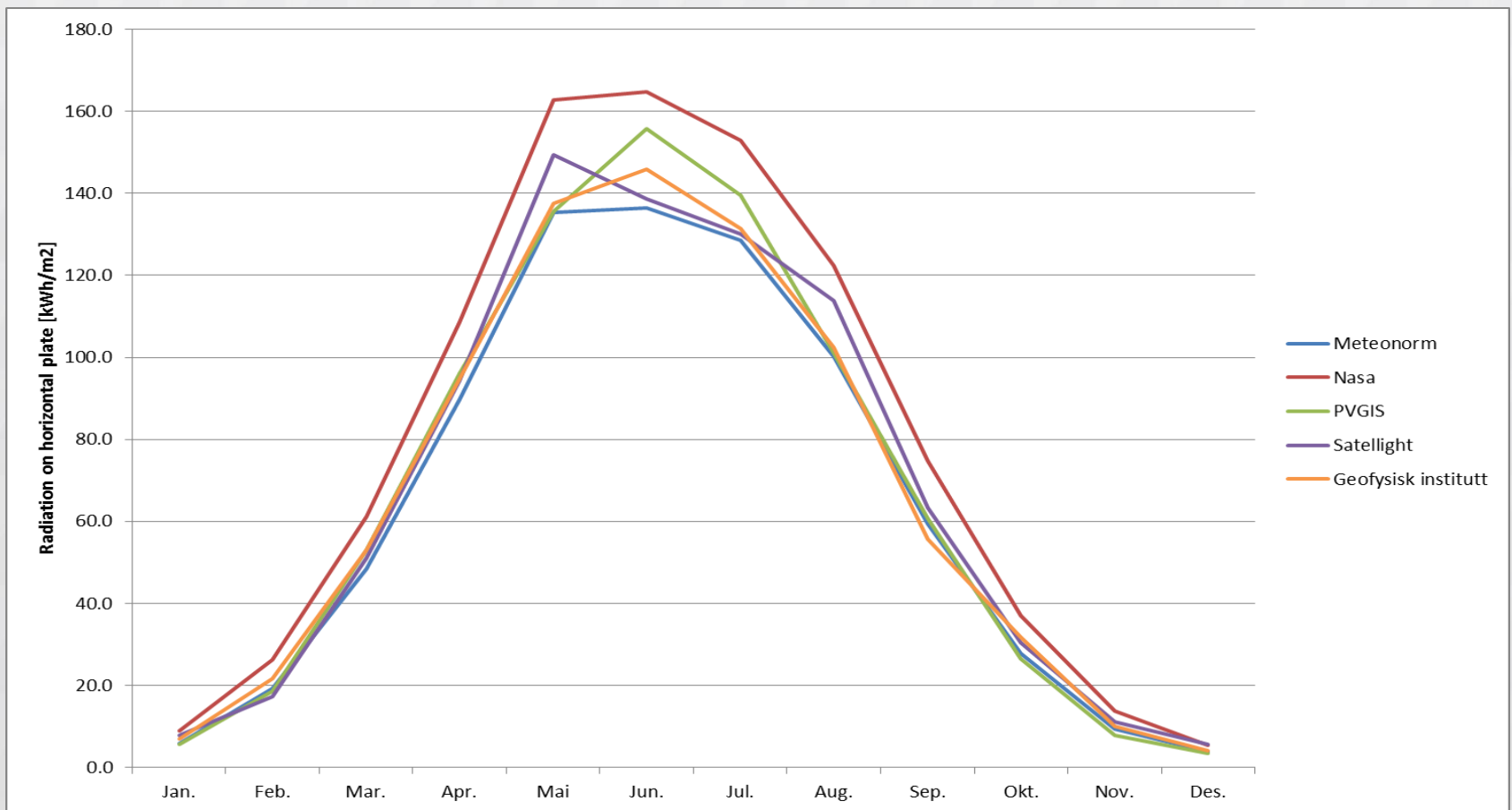


## The main issue in Bergen....

- Lack of reliable climate data
- Meteonorm interpolates with measuring station in Scotland
- Other sources use satellite images which are unaccurate at high latitudes and with snow, water, clouds and mountains....
- 10 % difference in global radiation between Florida and Flesland

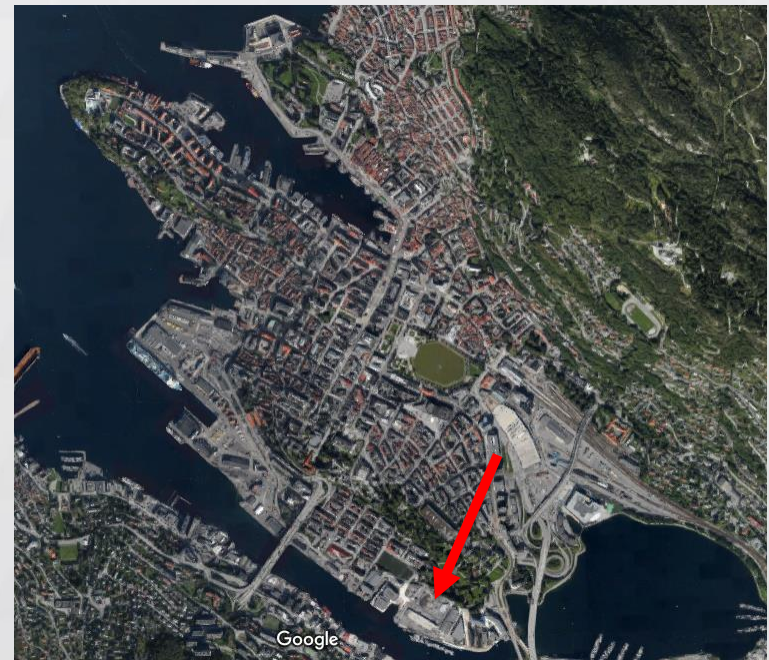
# The main issue in Bergen....

Radiation in bergen from different sources:



# DNV Marineholmen

- Developer: GC Rieber
- Office building
- BREEAM Excellent
- Aim: produce 80 000 kWh/yr
- 735 m<sup>2</sup> solar cells, 131 kWp,  $\eta \approx 18\%$
- East-west orientation

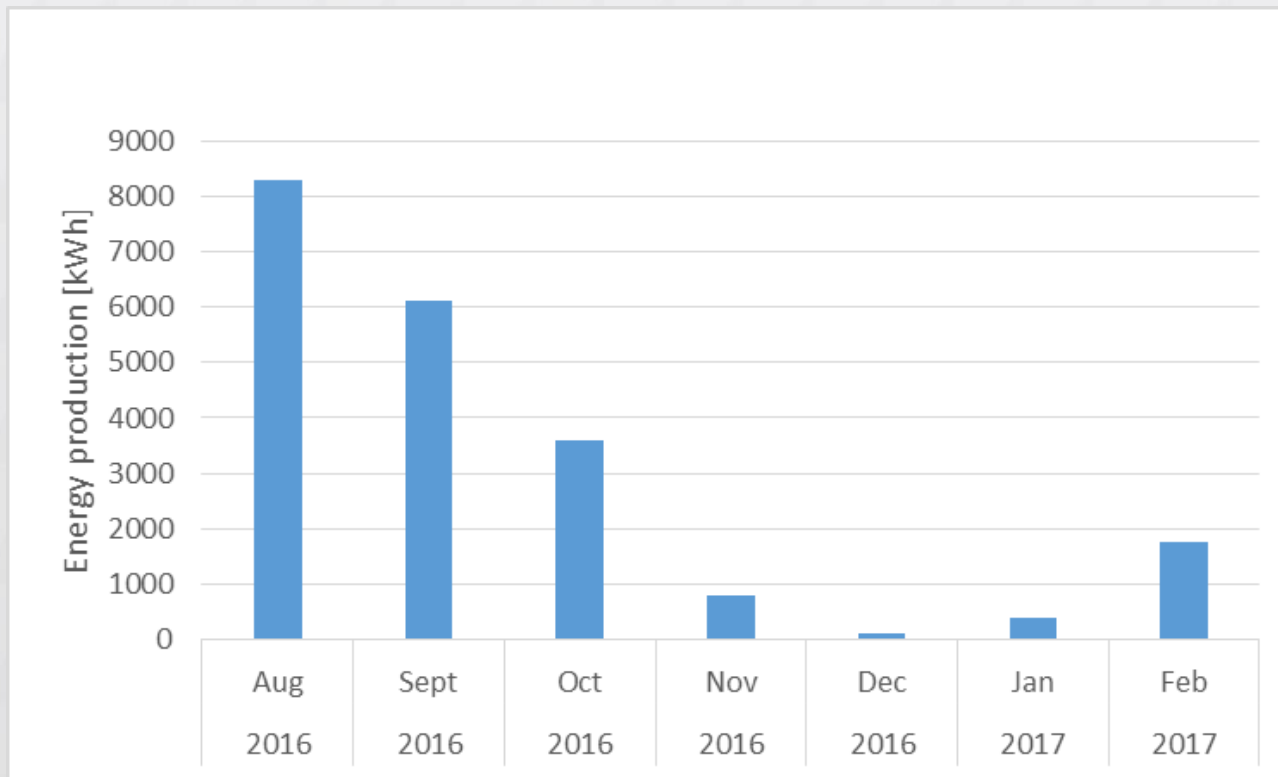


Source: GC Rieber



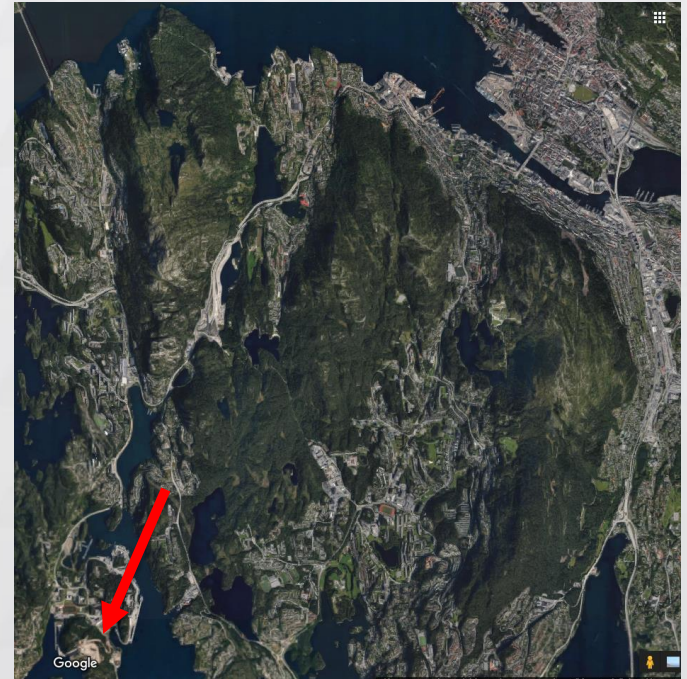
# DNV Marineholmen

- Total production since commissioning: 31 000 kWh



# FLO Haakonsvern

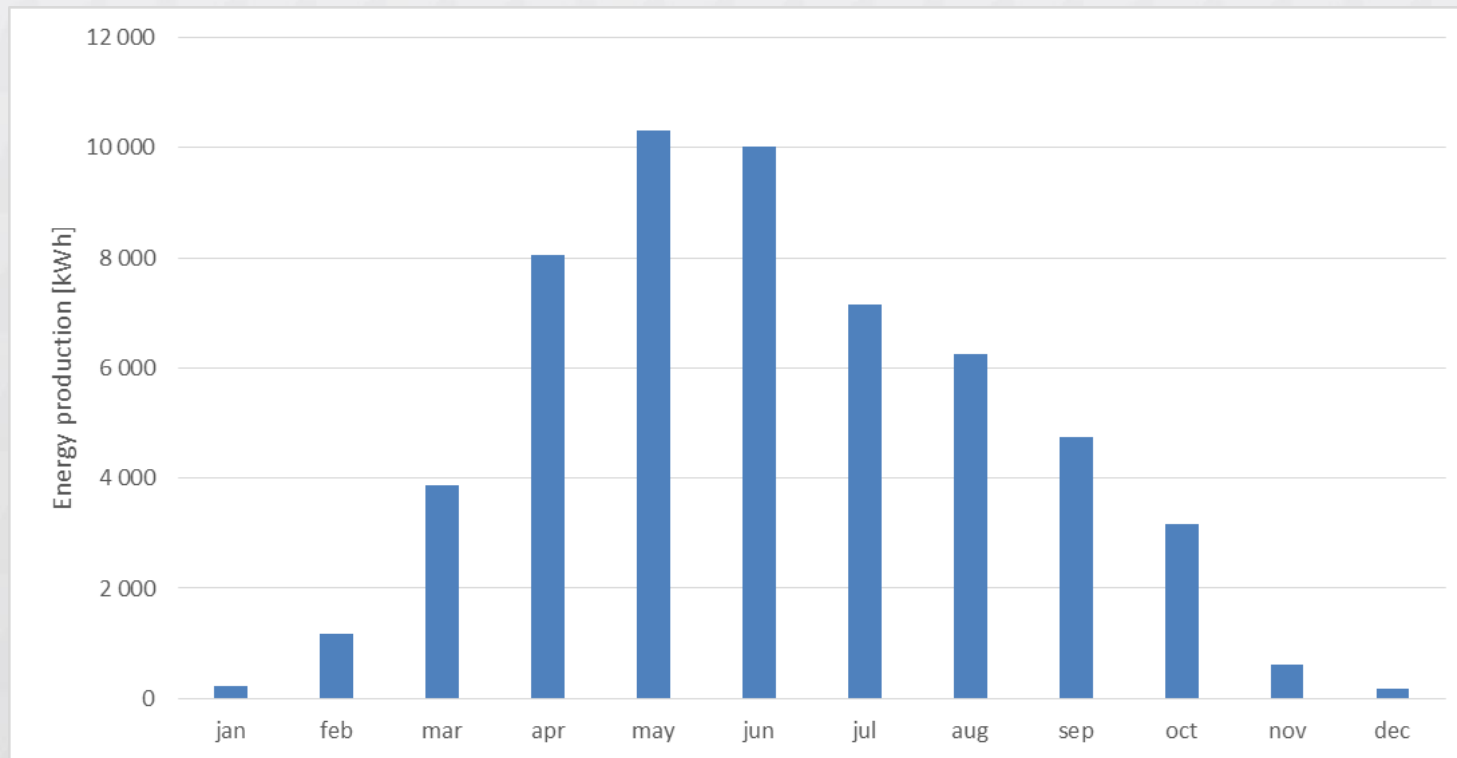
- Office building
- Zero energy building
- Aim: produce 53 000 kWh/yr
- 381 m<sup>2</sup> solar cells, 85 kWp,  $\eta \approx 20\%$
- East-West orientation



Source: Veidekke

# FLO Haakonsvern

- Total production in 2016: 56 000 kWh



Source: Veidekke

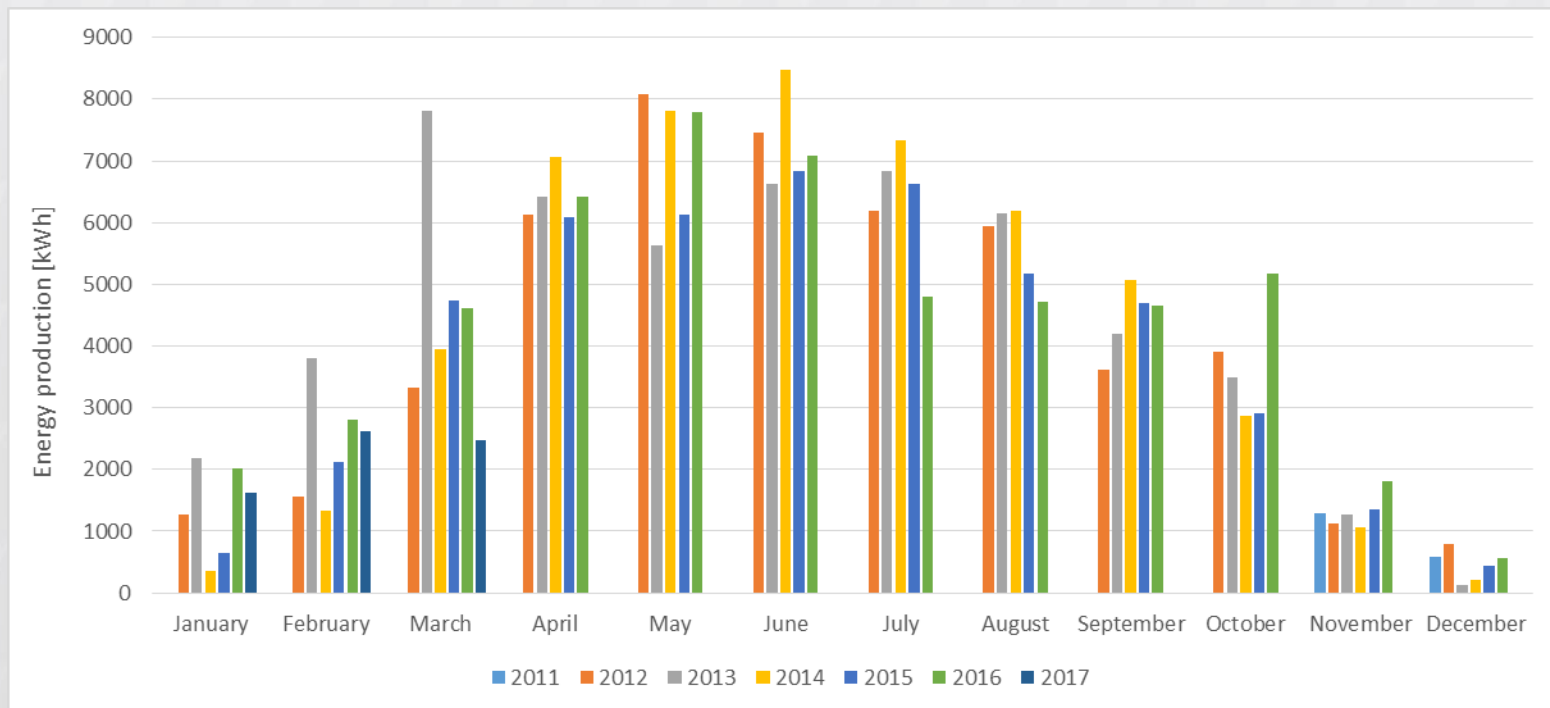
# Oseana

- Cultural building
- 400 m<sup>2</sup> solar cells, 63 kWp,  $\eta \approx 14\%$
- Facade integrated towards south
- Increased energy production due to reflection from the ocean



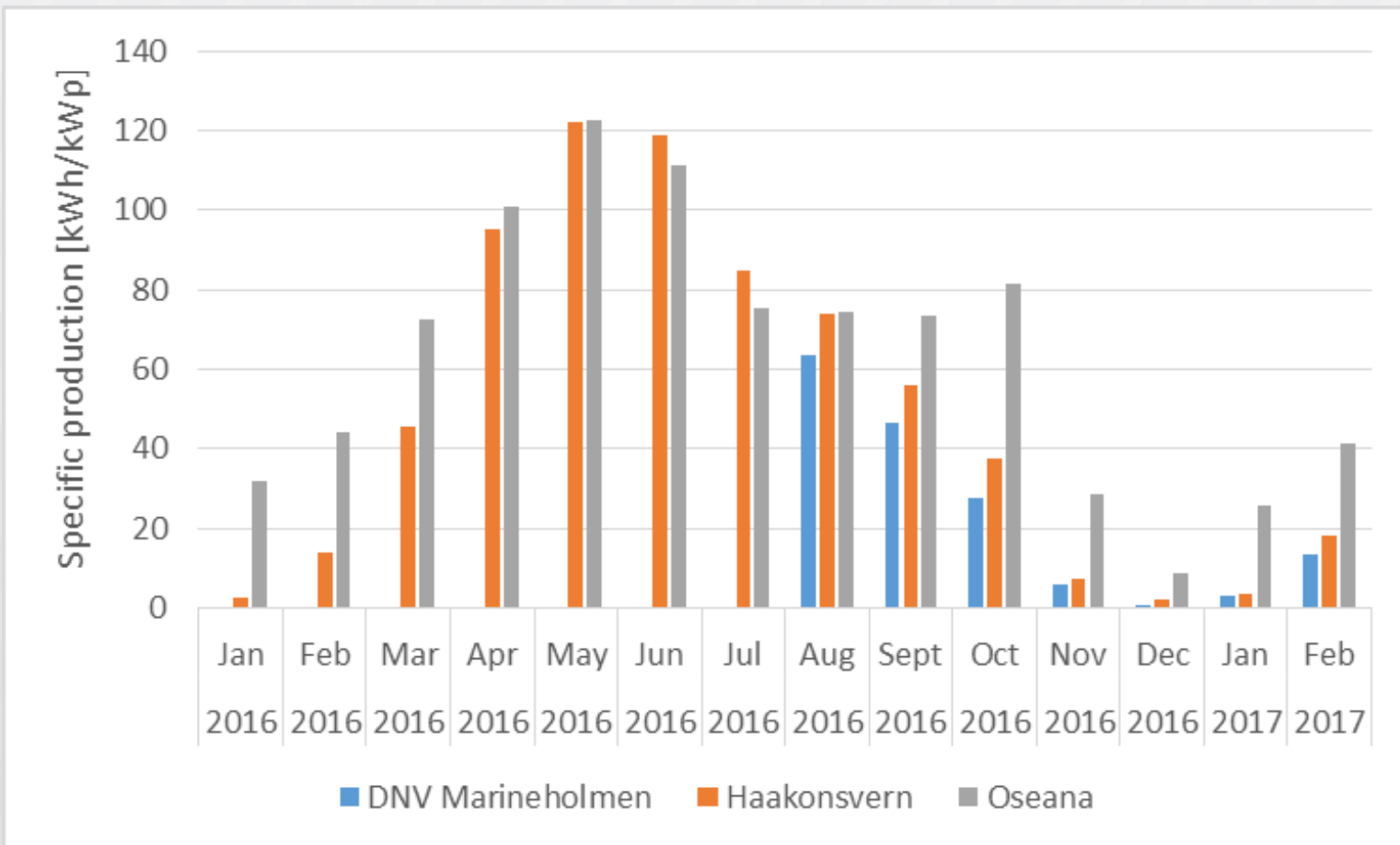
# Oseana

- Yearly production: 48 000-52 000 kWh



Source: Oseana kunst og kultursenter

# Comparisons



25 % higher specific production in 2016 for Oseana compared to Haakonsvern

# Lessons learnt

- Lack of reliable climate data complicates the design process i Bergen
- Ulriken and Løvstakken influences solar radiation
- Lower radiation compared to E.g Oslo means higher demands for optimal design
- Late planning often influences energy production