

# Photovoltaics on green roofs in Scandinavia



Helen Johansson



SCANDINAVIAN  
GREEN ROOF  
INSTITUTE



Berlin  
27. - 29.06.2023

Weltkongress Gebäudegrün

World Green  
Infrastructure Congress  
WGIC 2023

[www.bugg-congress2023.com](http://www.bugg-congress2023.com)



# Scandinavian Green Infrastructure Association (SGIA)



<https://greenroof.se/sgia>

# Photovoltaics on green roofs

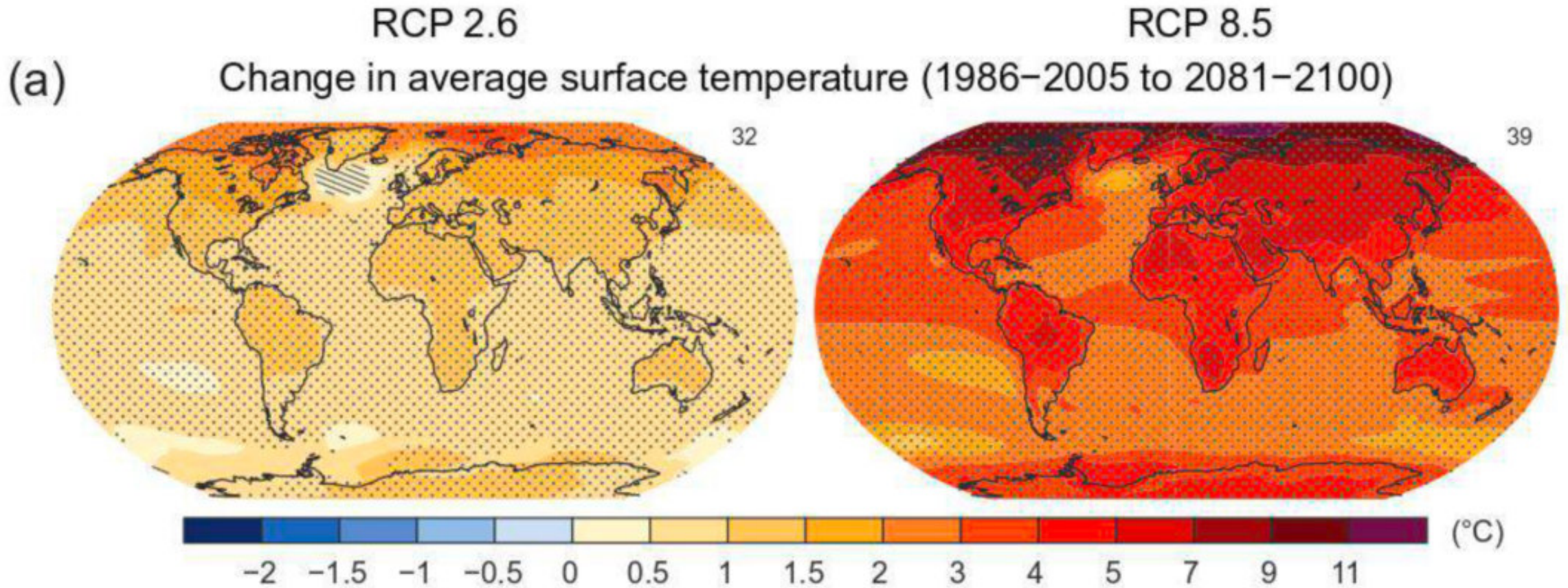


Photo credit: Scandinavian Green Roof Institute



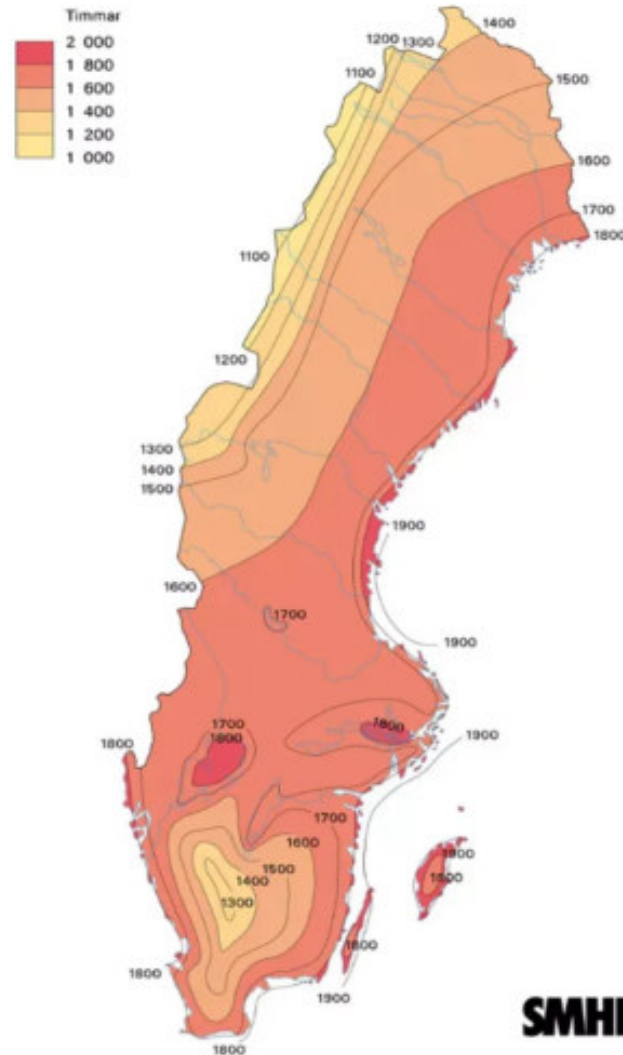
Photo credit: Sander Crombach on Unsplash

# What about the future?



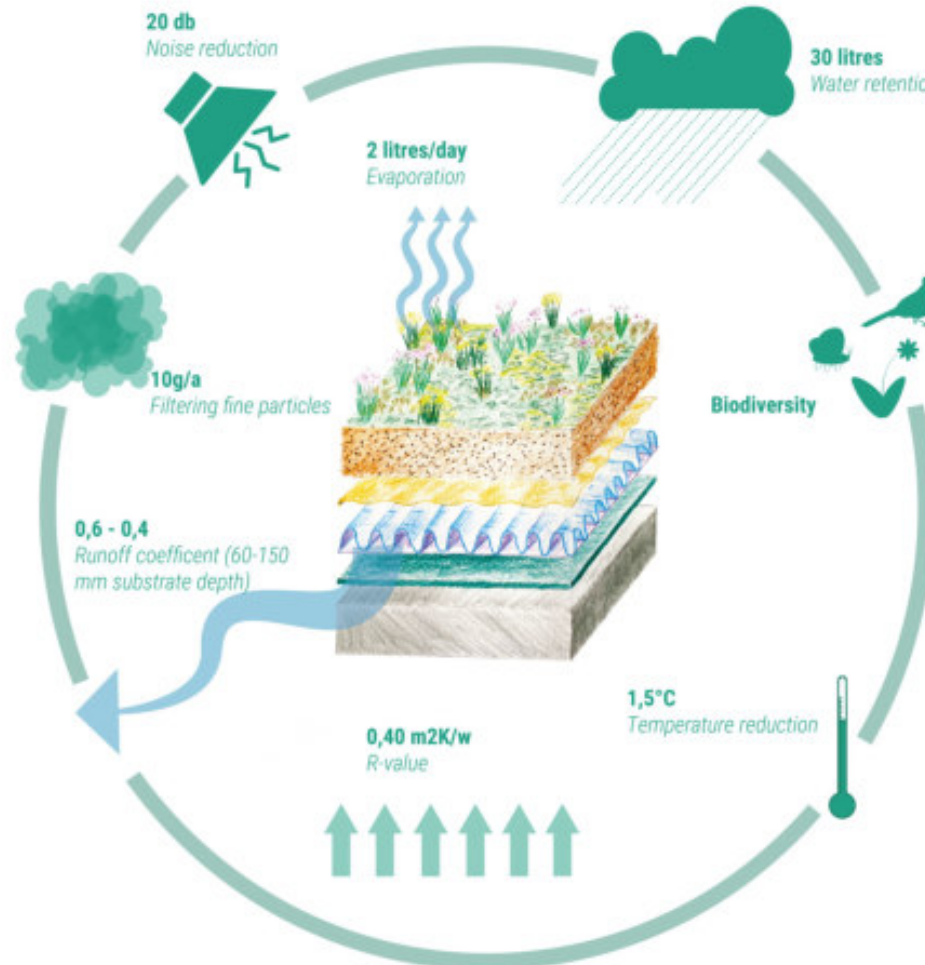
IPCC, 2013

# Number of hours of sunshine in Sweden



# Benefits from green roofs

## Performance of 1m2 extensive green roof



# Photovoltaics on green roofs



Photo credit: Scandinavian Green Roof Institute



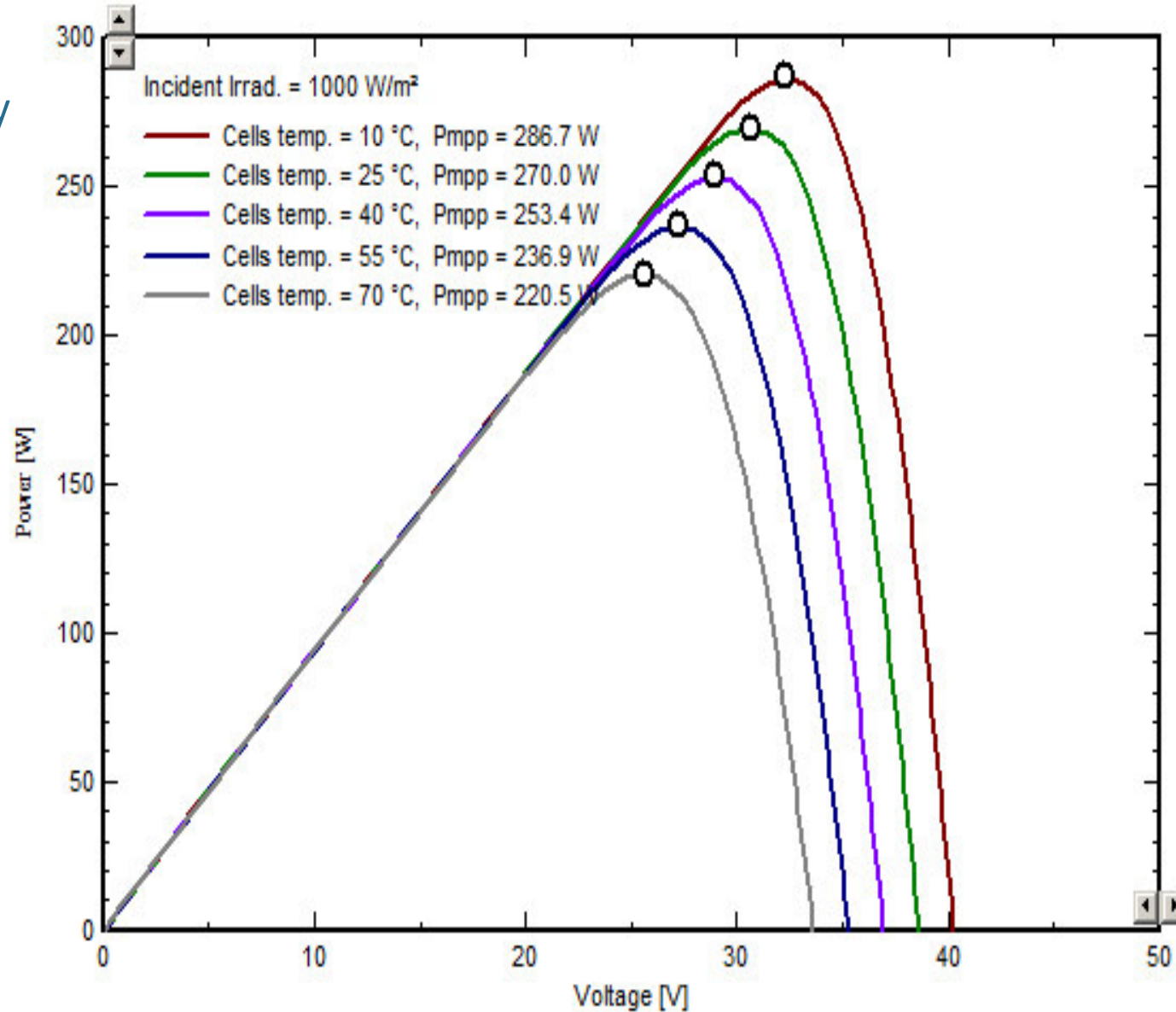
# Photovoltaics on green roofs



Photo credit: Scandinavian Green Roof Institute

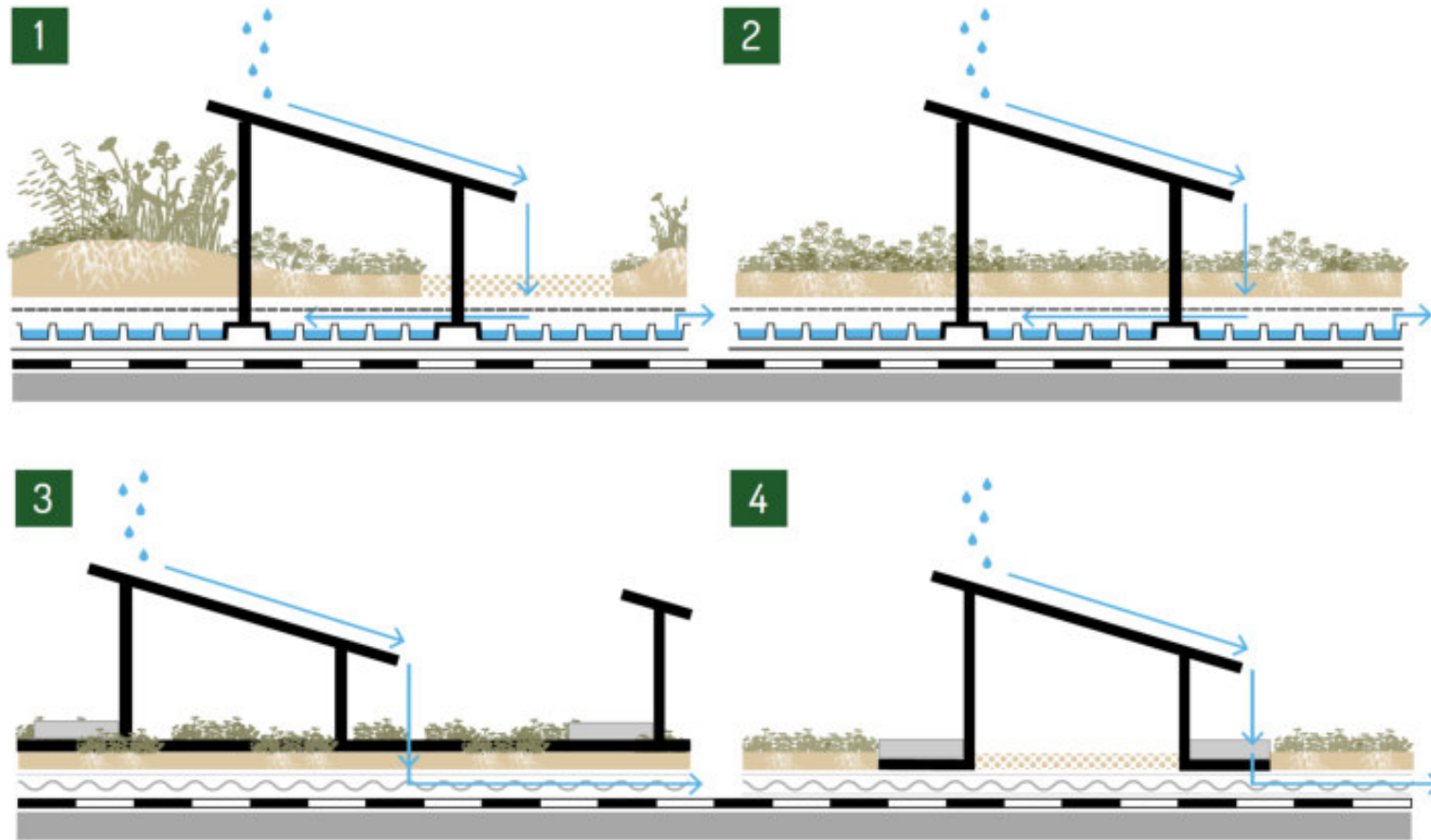
# The effect of temperature on the efficiency of solar cells

Efficiency



1000 W/m<sup>2</sup>  
Different temperatures

# Different solutions, conventional systems



System example	1	2	3	4
<b>Vegetation system under/close to panel</b>	Sedum-herb, meadow	Sedum or sedum-herb	Sedum or sedum-herb	Sedum
<b>System weight /m<sup>2</sup></b>	> 150 kgs	> 120 kgs	> 100 kgs	> 100 kgs
<b>Anchoring</b>	Plant bed as ballast	Plant bed as ballast	Stand and ballast on top of plant bed	Concrete as ballast
<b>Recommended substrate depth</b>	Varying over the roof surface 60 - 150 mm	> 80 mm	> 60 mm	> 30 mm

# Vertical solar panels



Photo credit: Over Easy Solar A/S

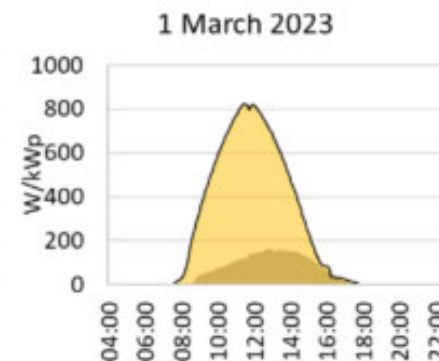
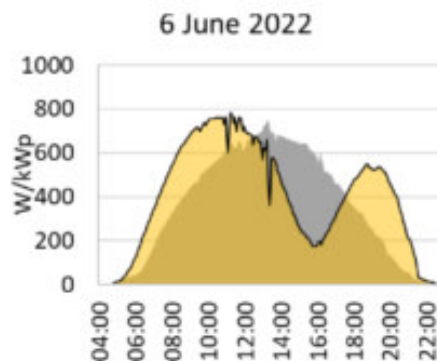
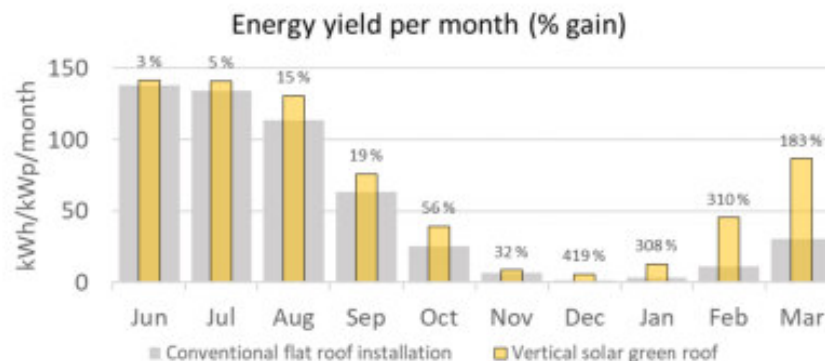
# Vertical solar panels



## Observations: Energy performance

- Pilot 2022
  - 5 kWp solar power
  - Orientation SE/NW
  - 90% bifaciality
  - 10 cm clearance
  - 25 cm solar panel height
- 31% higher energy yield in the period Jun'22-Mar'23
- Annual yield 2022, simulated: 1050 kWh/kWp
- No shading from sedum plants or weeds

\*data from until 12 March 2023



# Problems



# What to consider



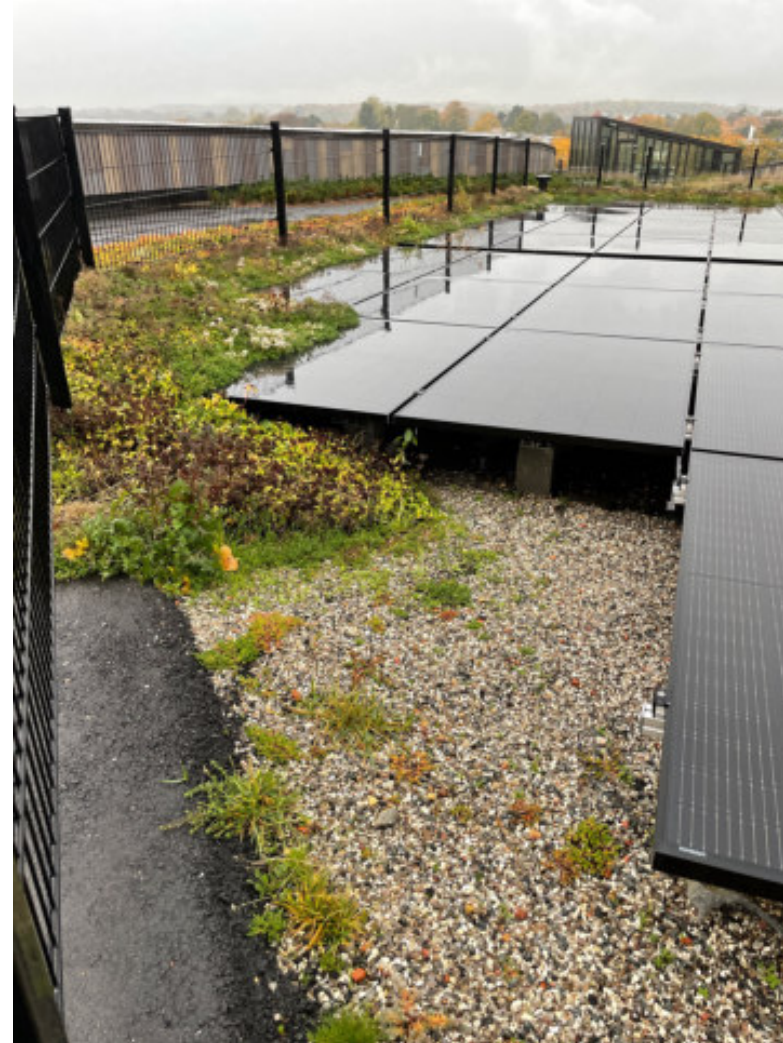
# New building techniques and lack of regulation



Photo credit: Scandinavian Green Roof Institute



# Basecamp, Skovbrynet Kongens Lyngby

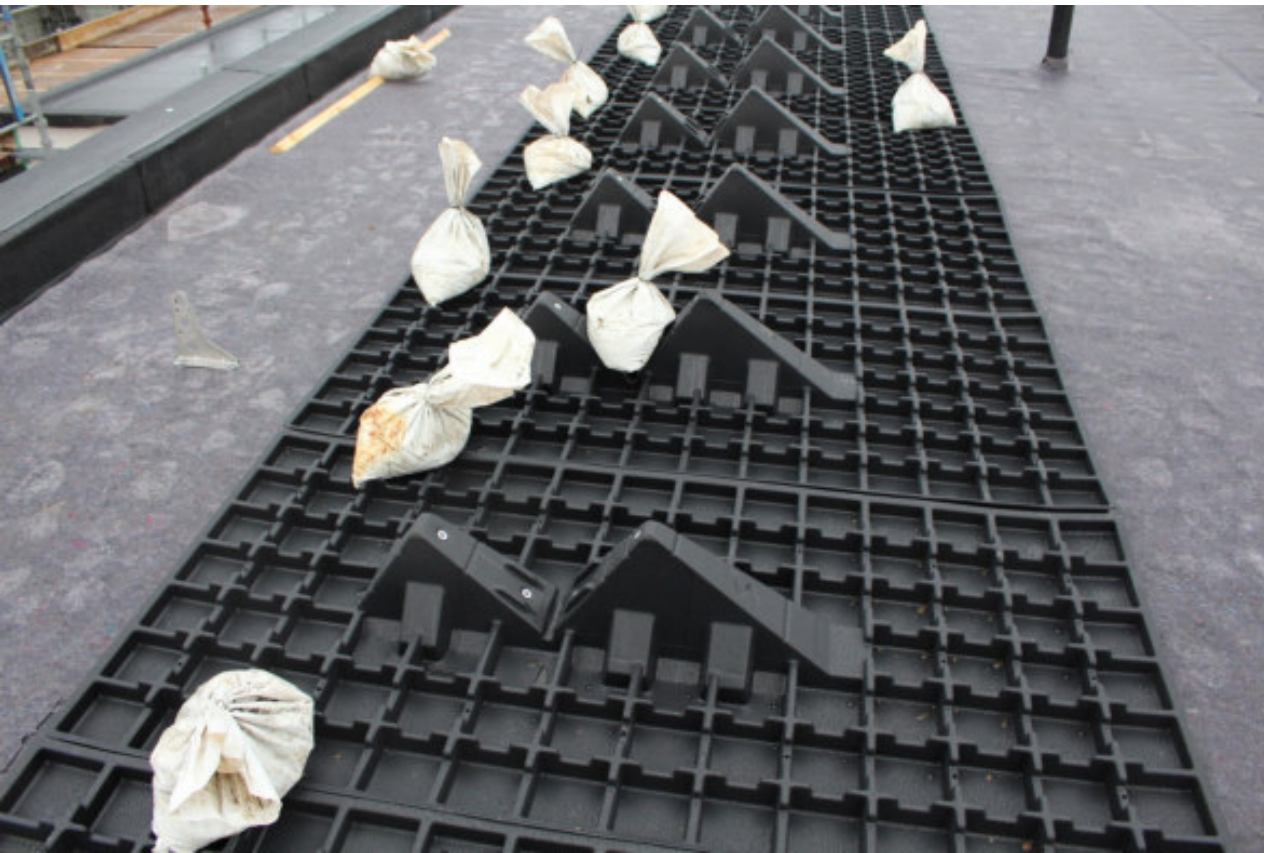


# Sofia, Malmö



Photo credit: Scandinavian Green Roof Institute

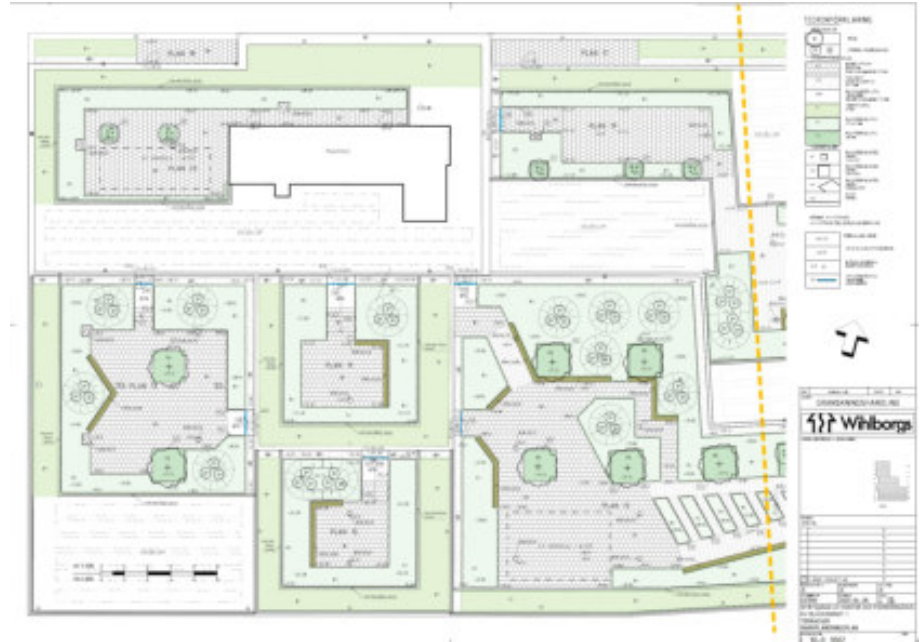
# Sofia, Malmö



# Poolen, Solna



# Vista, Malmö



Credit: Wihlborgs Fastigheter AB

# Substrate depth determines type of vegetation



<b>Plant shapes</b>	<b>Sedum species, mosses</b>	<b>Sedum species, herbs, few grasses</b>	<b>Grasses and herbs</b>	<b>Grasses and herbs</b>
<b>Layer thickness</b>	From 30 mm	From 100 mm	From 120 mm	From 150 mm

Achievable growth depending on the thickness of the vegetation support layer for extensive green roofs



# Thank you!

Helen Johansson

[www.greenroof.se](http://www.greenroof.se)

[helen@greenroof.se](mailto:helen@greenroof.se)

+46 723 00 66 68

