

# Green roof and photovoltaik comparative research in Sydney

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Our mission of Today for Tomorrow!  
Climate Adaption, Quality of Life,  
City of the Future

A man with dark hair and a beard, wearing a light blue surgical mask and a blue lab coat, stands in a laboratory. He is gesturing with his hands as if speaking. The lab coat has "UTS SCIENCE" printed on the chest. In the background, another person in a blue lab coat is visible, and there are various pieces of laboratory equipment and a metal shelving unit.

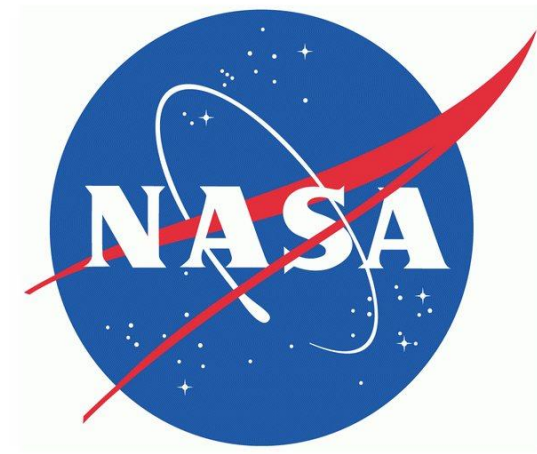
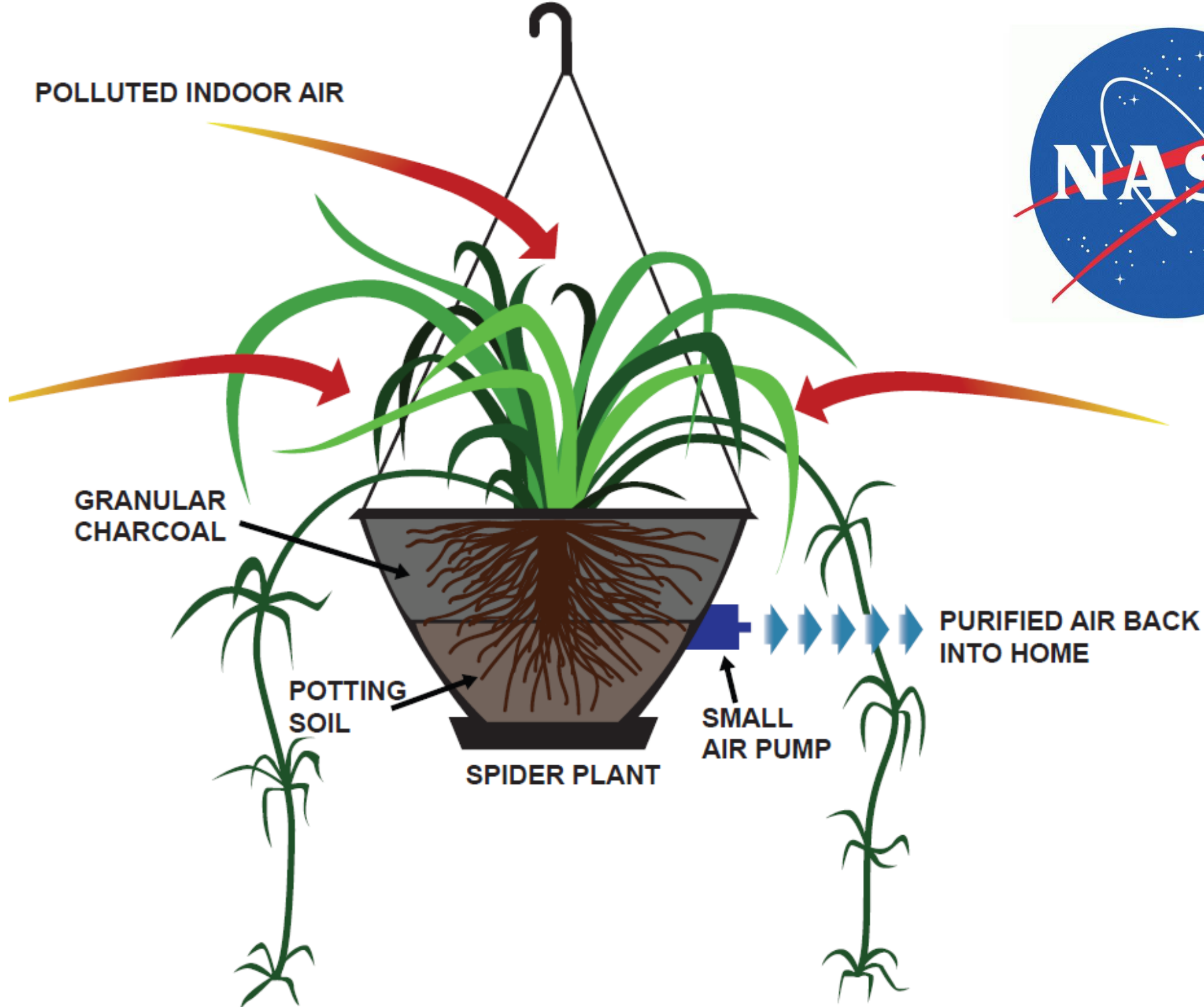
**Dr Peter Irga**  
**Senior Lecturer**  
**Australian Research Council Fellow**  
**University of Technology Sydney, Australia**

**Research expertise:**  
**Air quality,**  
**Phytoremediation,**  
**Green Infrastructure,**  
**Green Wall, Green Roof**

# University of Technology Sydney and Central Park One







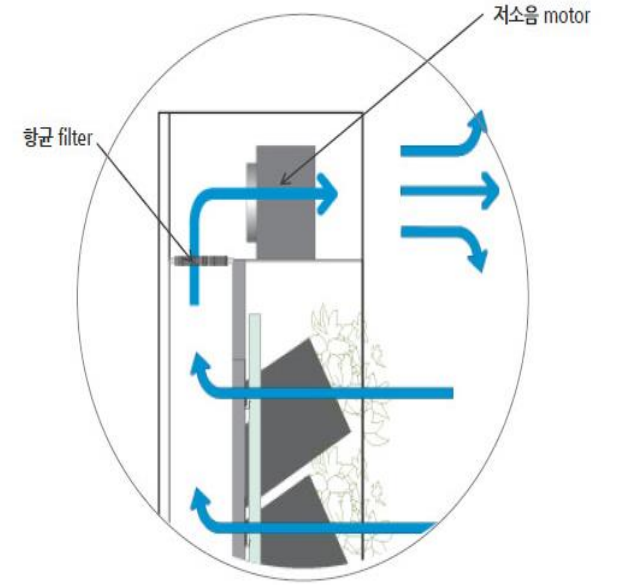
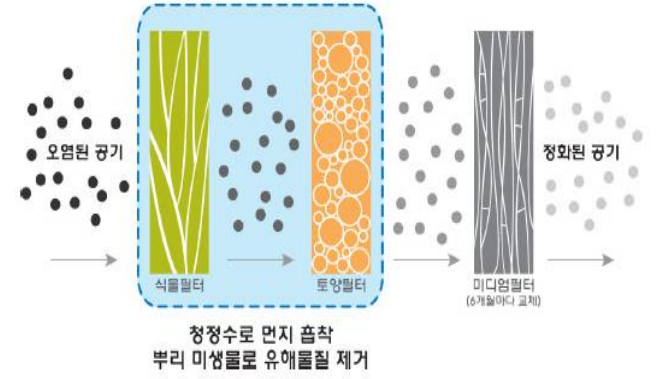
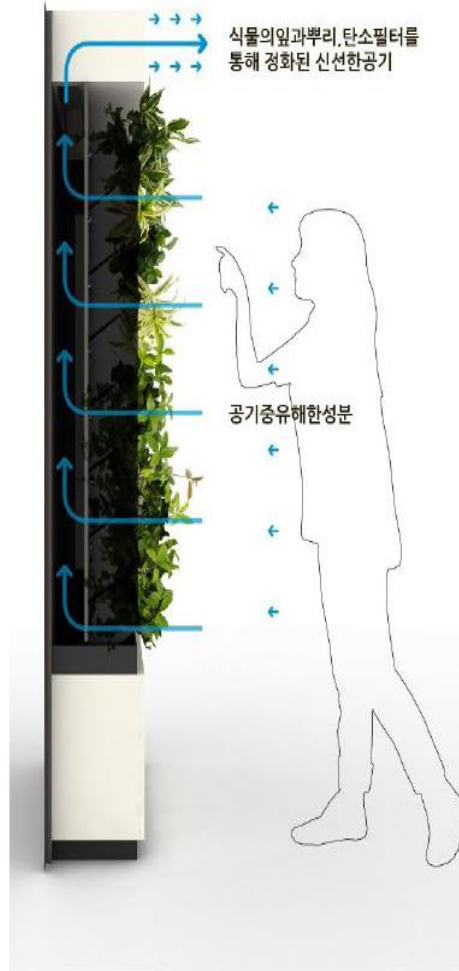
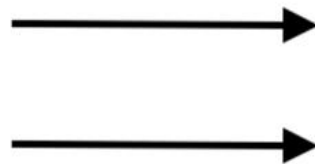


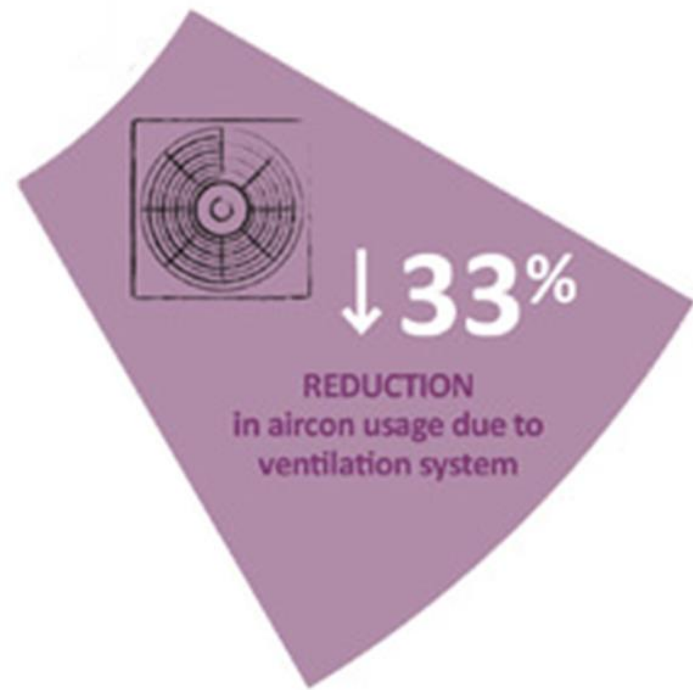
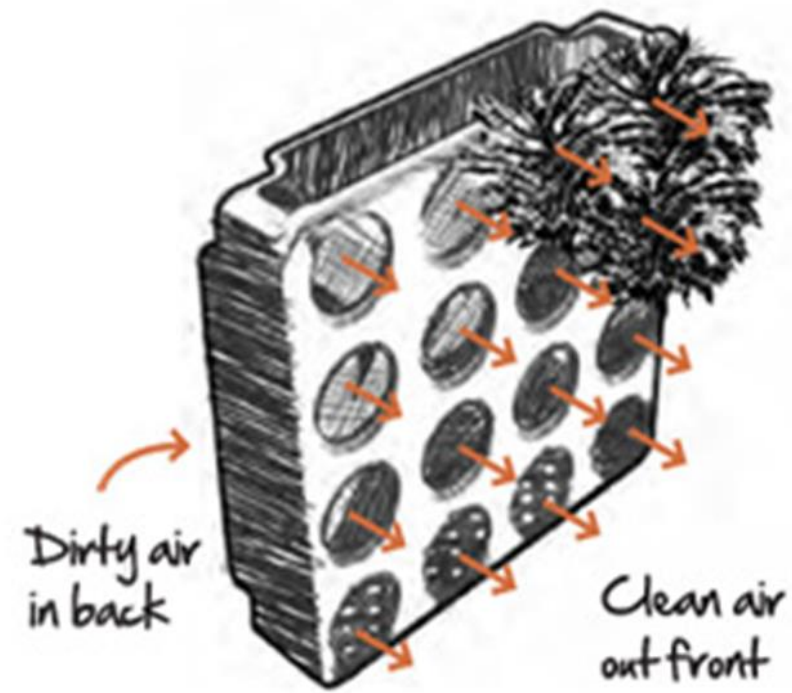
Passive diffusion



VOCs

PM

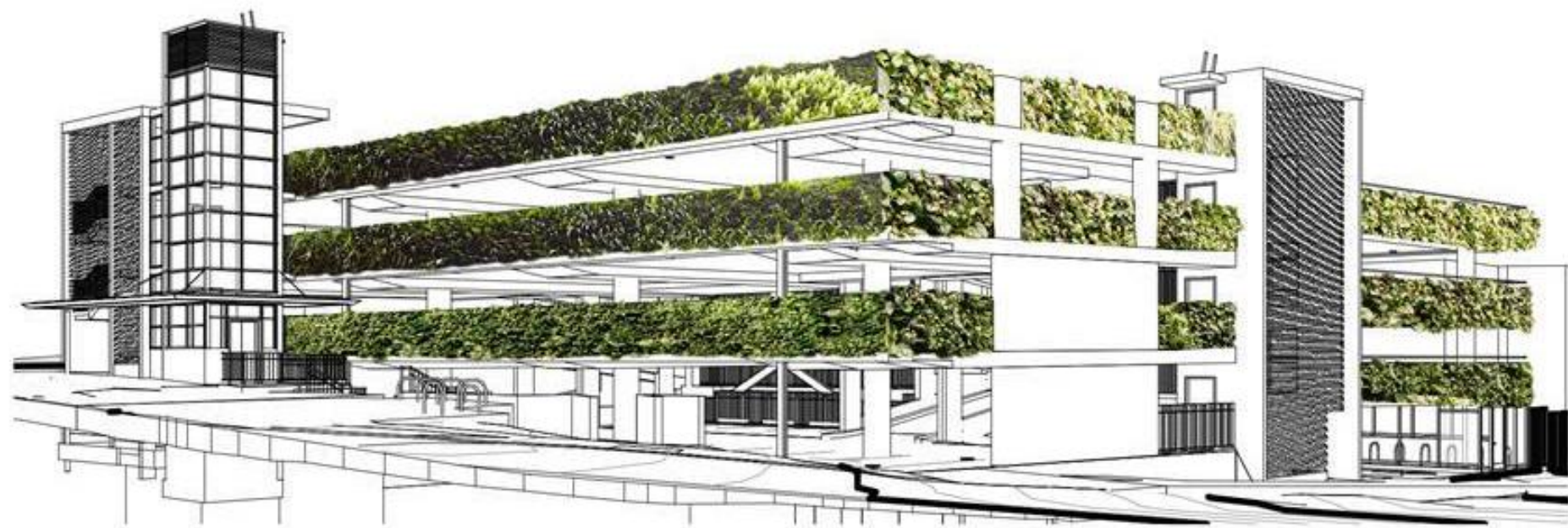


















📷 St Leonards is looking forward to a new green space. Picture: Supplied

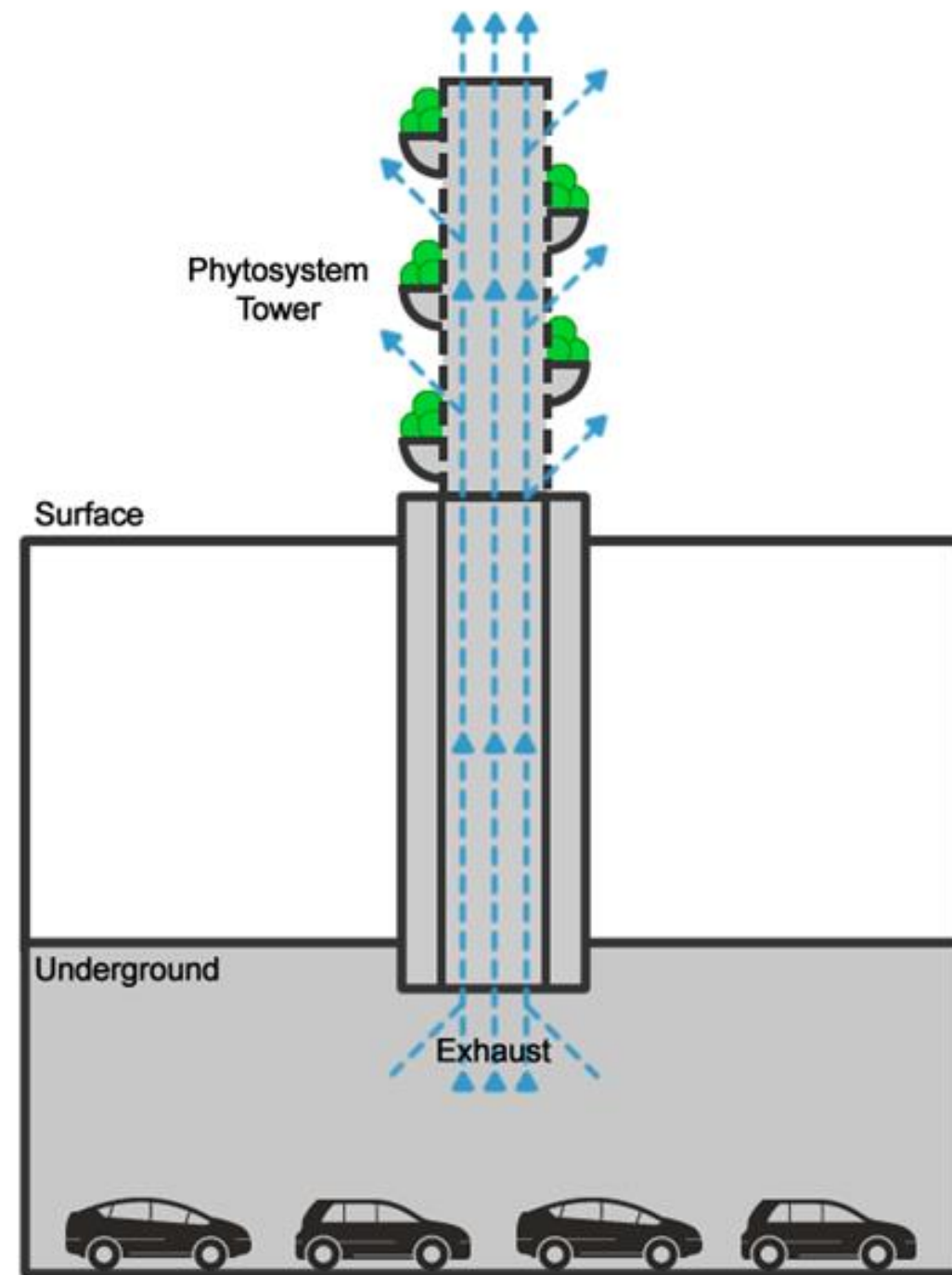
## MOSMAN

# North Sydney Council creating new park in St Leonards



# Infrastructure projects





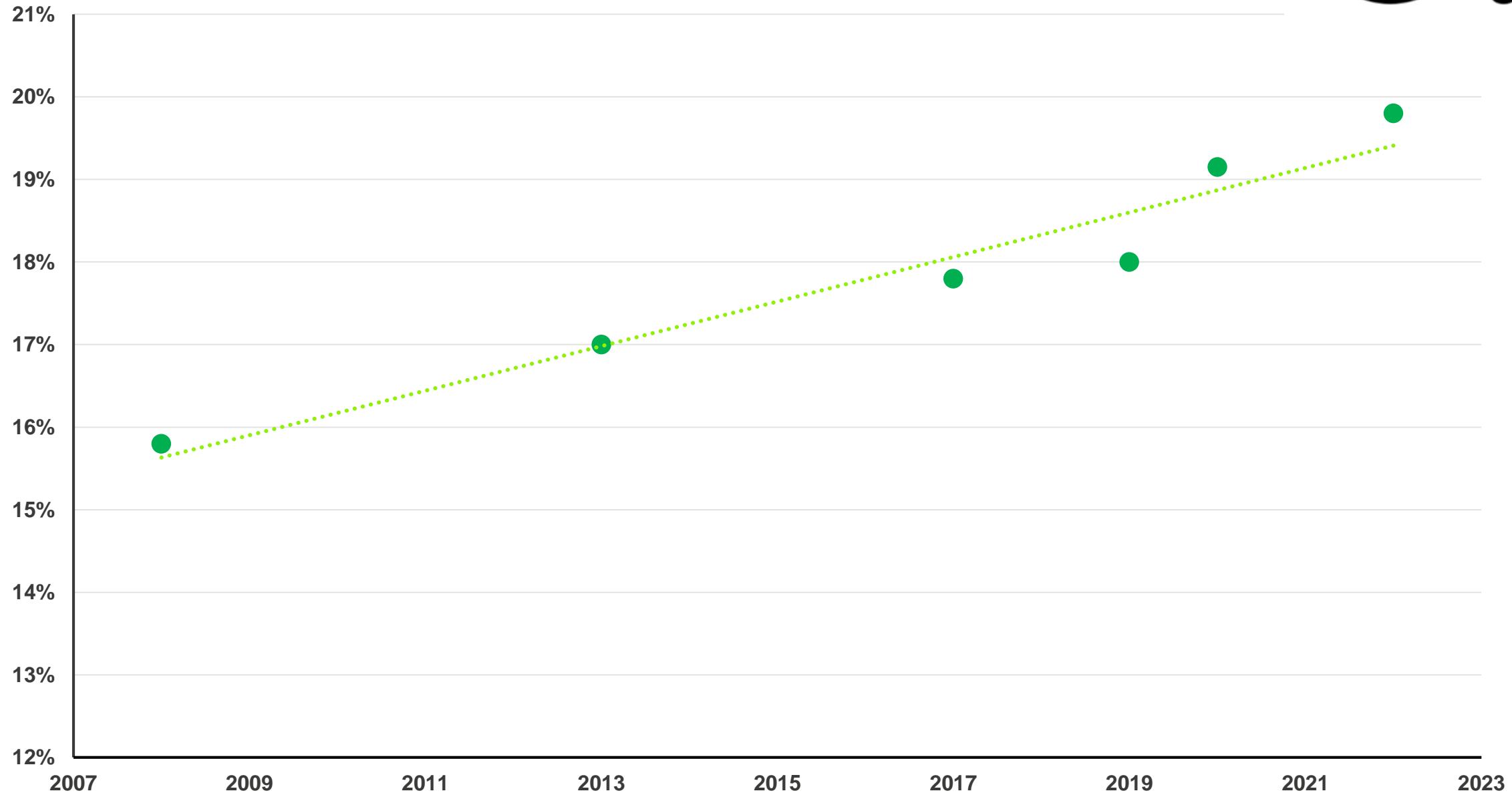






**CITY OF  
SYDNEY**

## Total canopy cover City of Sydney





# CITY OF SYDNEY

## Green Roofs and Walls Policy and Implementation Plan

### Local research gaps identified

1. Providing leadership in supporting the development of green roofs and walls;
2. Addressing barriers to the adoption of green roof and wall technology;
3. Supporting sustainable design through research, education, guidelines and standards;
4. Collaborating with community, industry and other stakeholders;
5. Informing and educating the community about green roofs and walls;
6. Supporting local, practical research;
7. Supporting the recognition of green roofs and walls in existing planning systems and rating tools;
8. Installing green roofs and walls on Council properties; and
9. Monitoring, evaluating and reporting on progress.

# Green Roof research Opportunity



Daramu House,  
Sussex Street,  
Barangaroo

International House,  
Sussex Street,  
Barangaroo



wework

# Green Roof metrics

**Biodiversity**

**Stormwater**

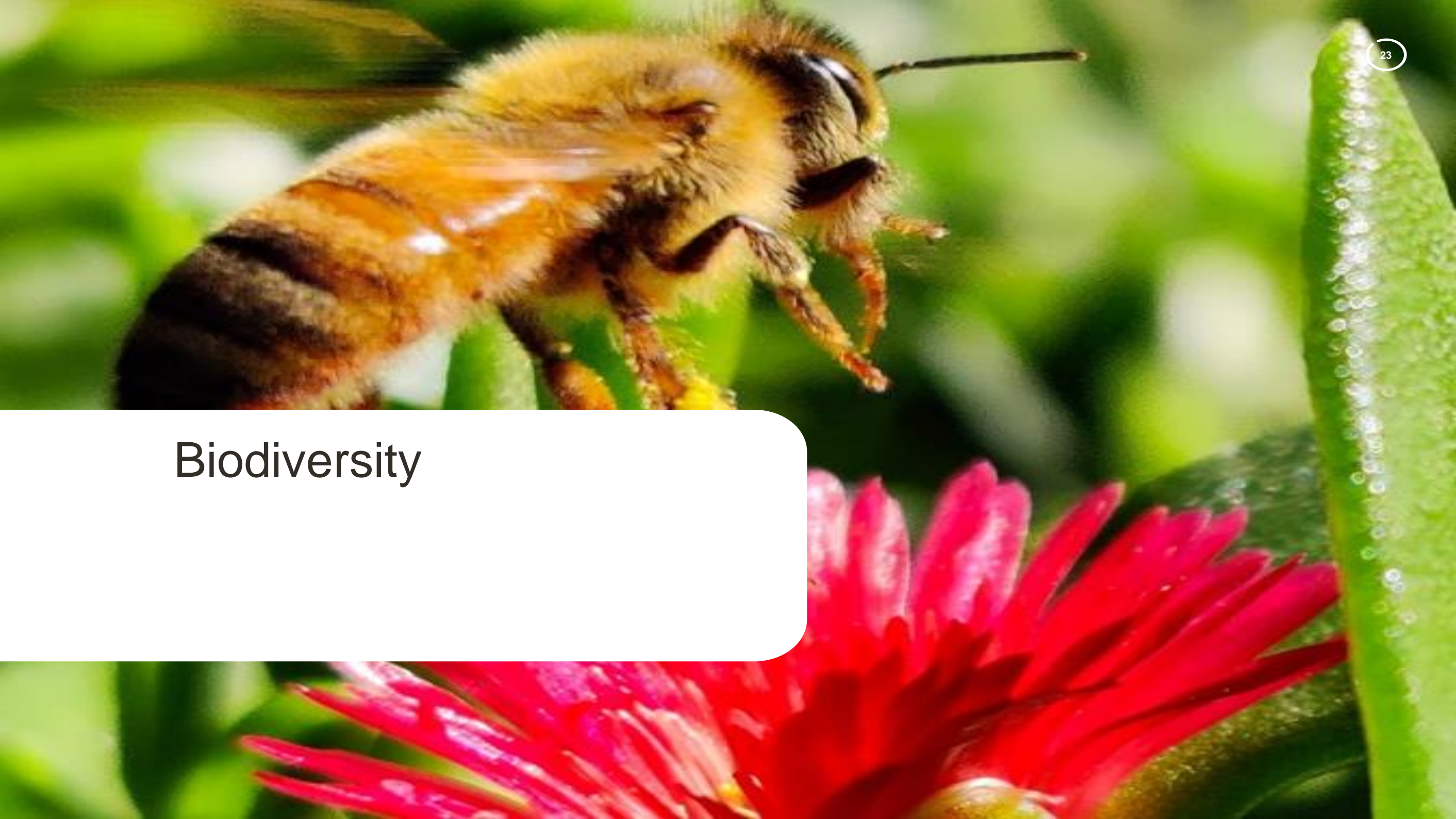
Detention & Quality

**Energy efficiency**

Thermal performance

PV energy conversion





# Biodiversity

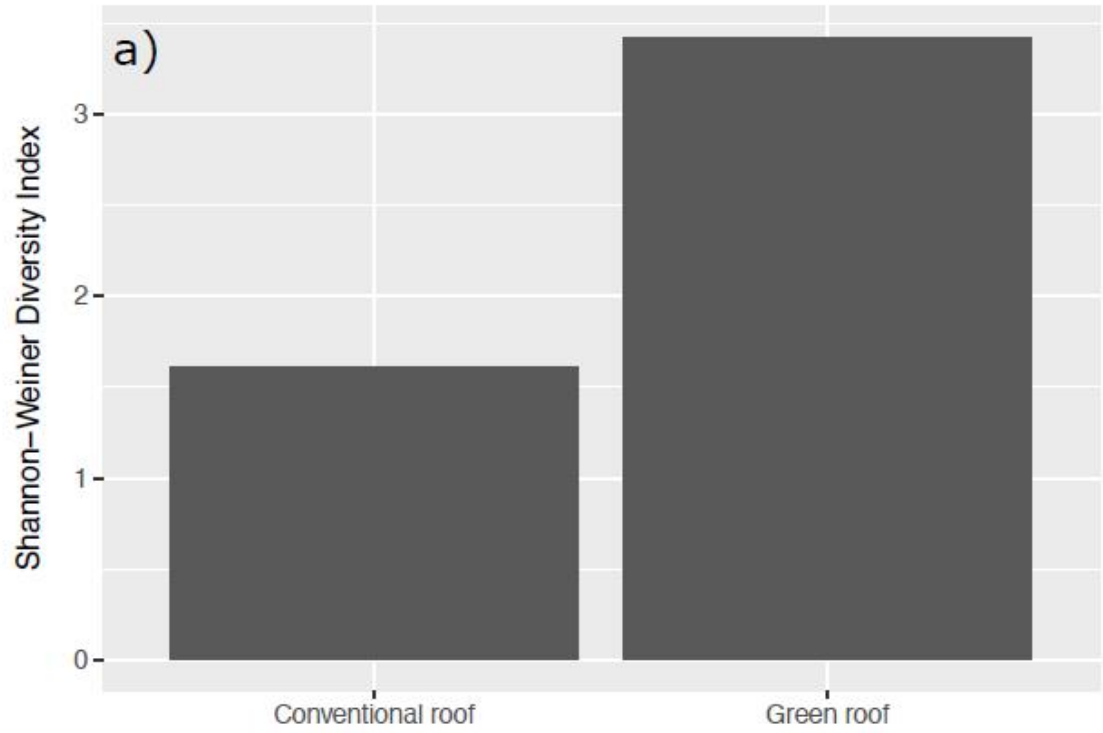
Plants selected to drive biodiversity –mix of local plants

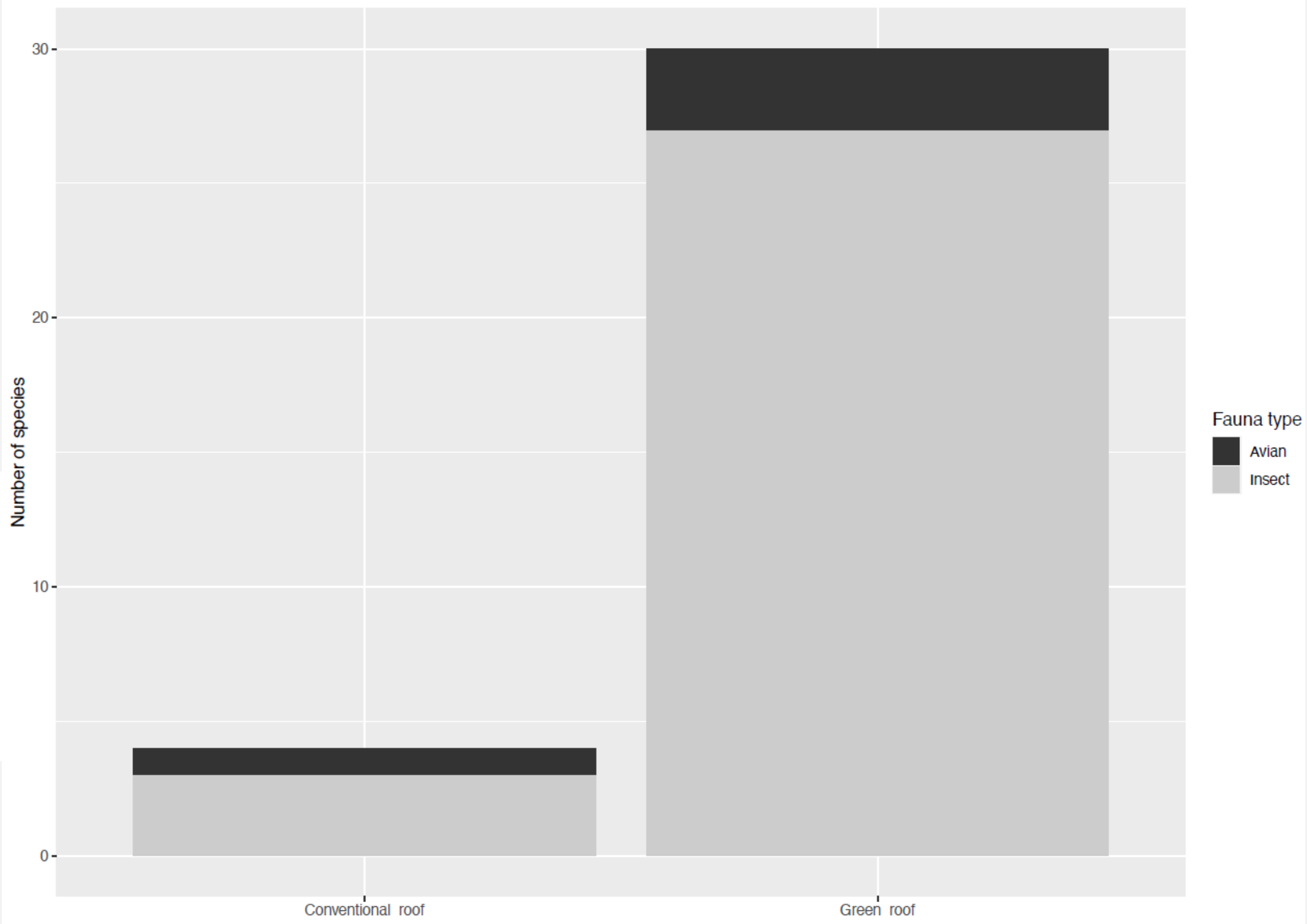




# Flowering plants all year round, to encourage pollinators







Australian Blue Banded Bee (*Amegilla sp.*)

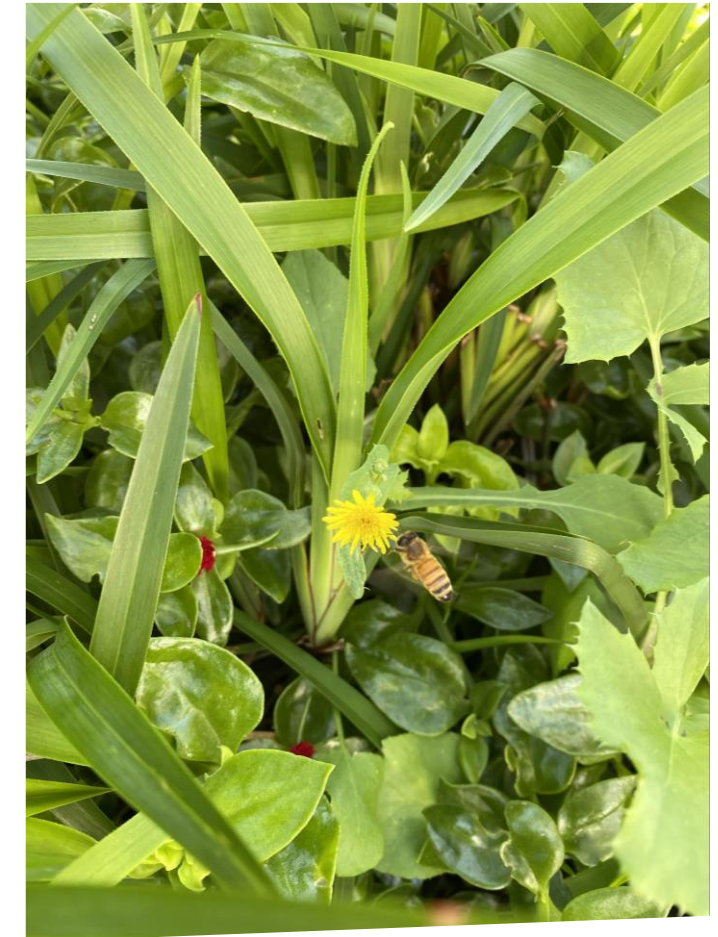


Lychee metallic shield bug (*Scutiphora pedicellate*)







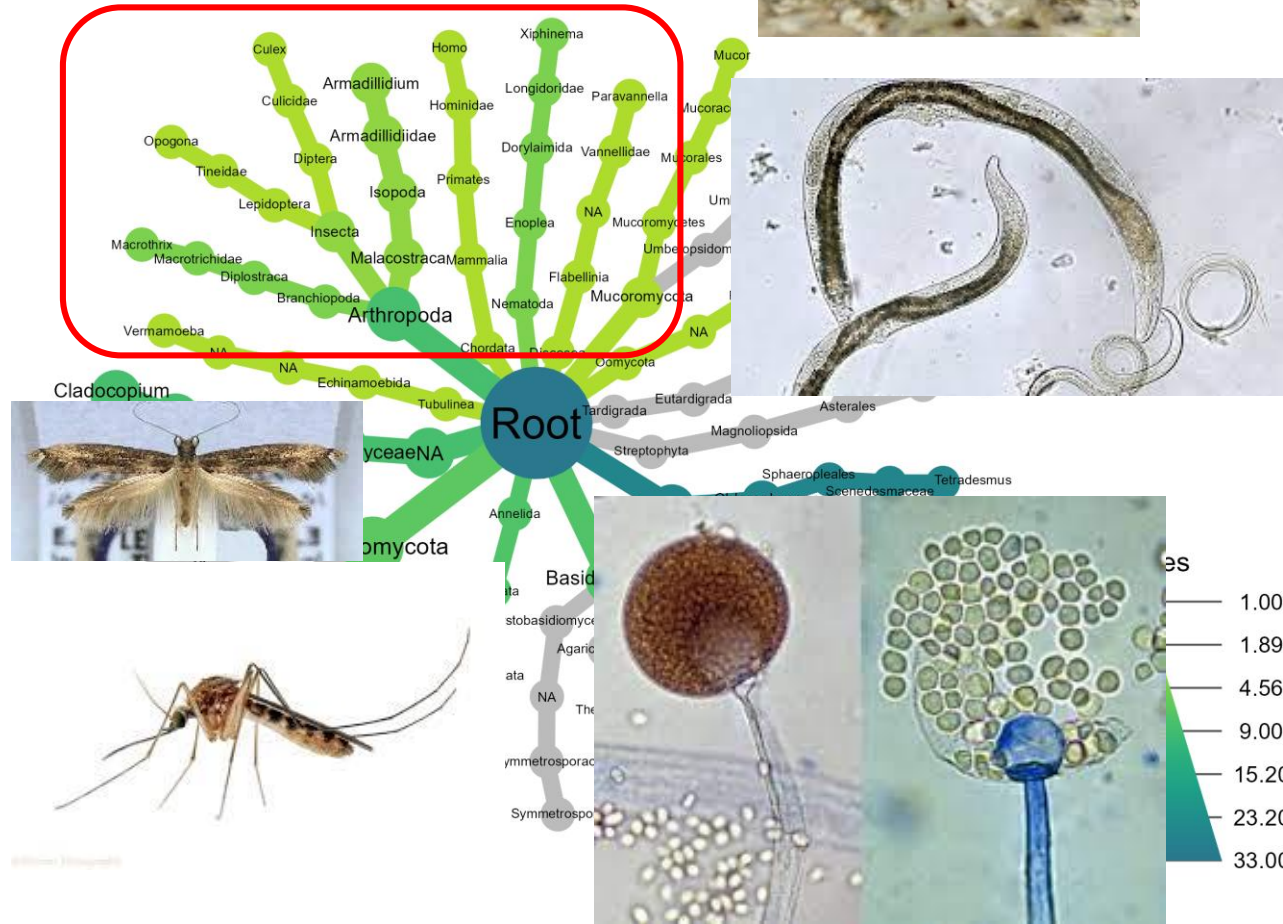


## eDNA Sample collection

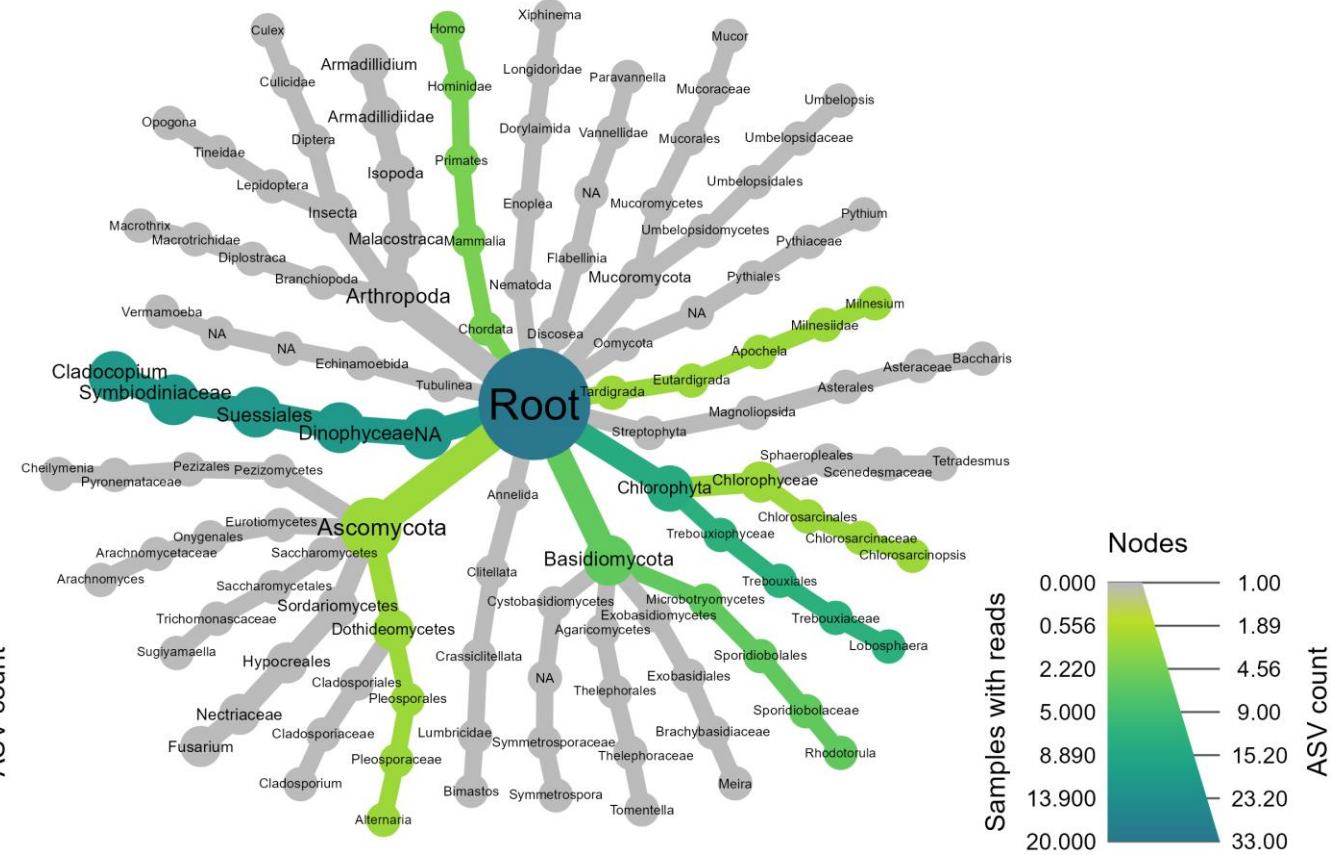
- Filtered on site using Smith-Root self preserving filter papers (5uM)
  - Utilise irrigation
  - Processed samples by syringing/sponging into a collection container
- Collected 72 samples across 5 months:
- 41 on green roof (seven sampling occasions)
  - 31 on conventional roof (six sampling occasions)

# eDNA Results

## Green

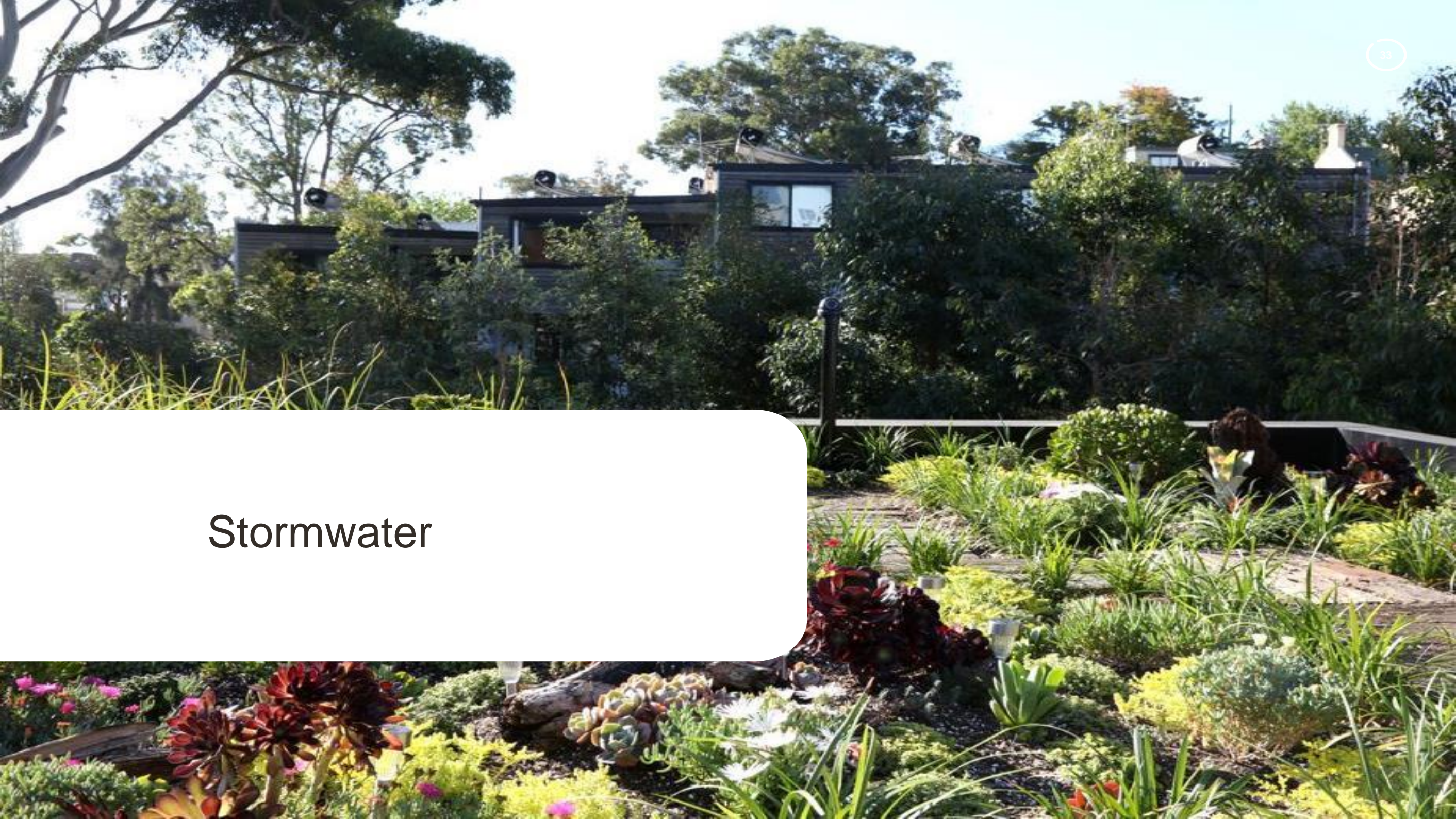


## Conventional



Figures showing eukaryotic eDNA detected on the green and conventional roots throughout the sampling period.



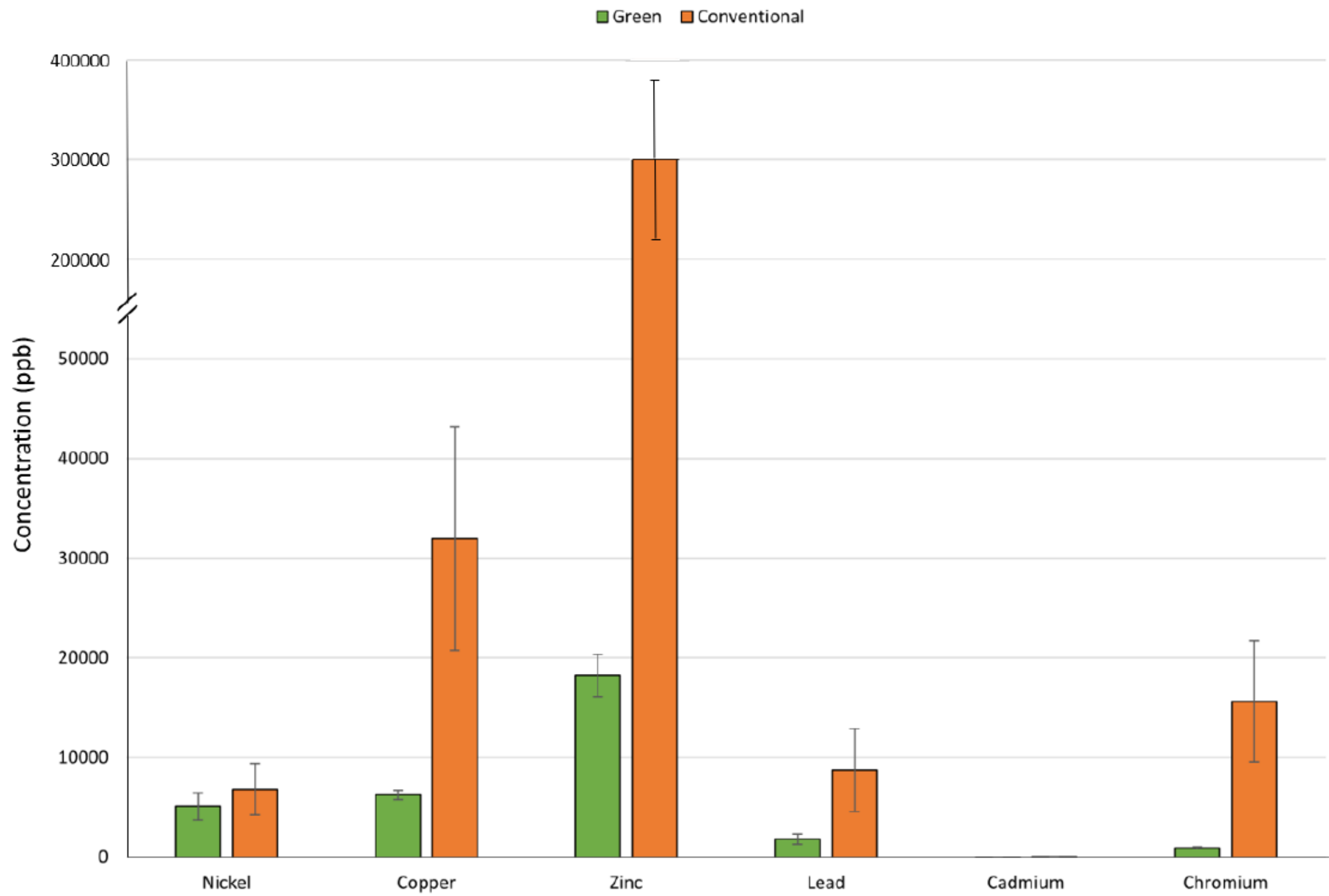


Stormwater

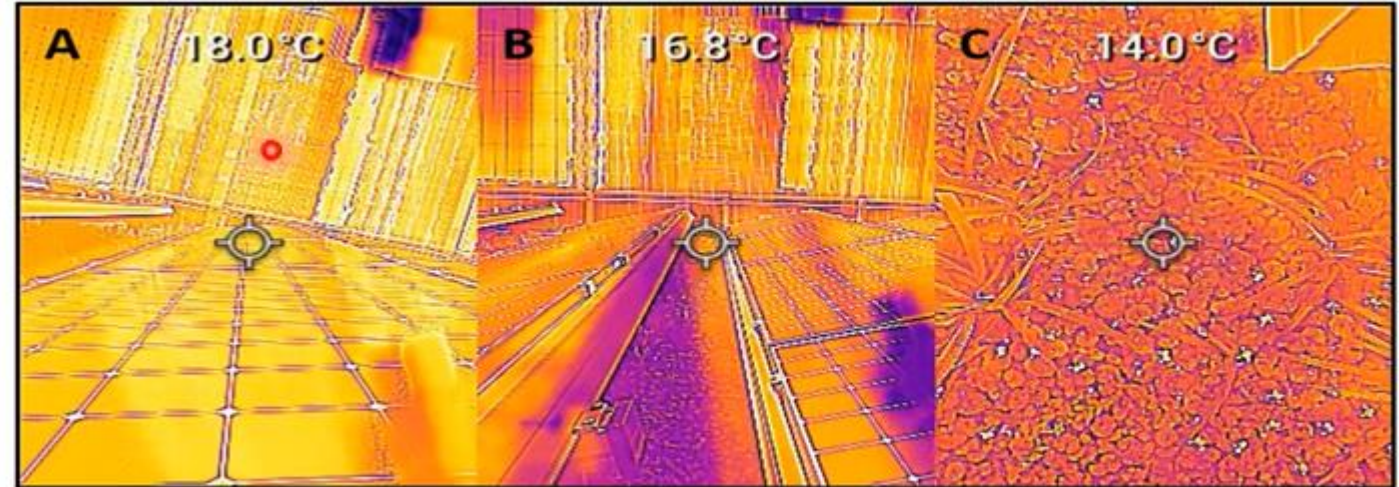
# Stormwater Flood Mitigation

20% Annual Exceedance Probability (AEP) -  
Once in a 5 year storm event

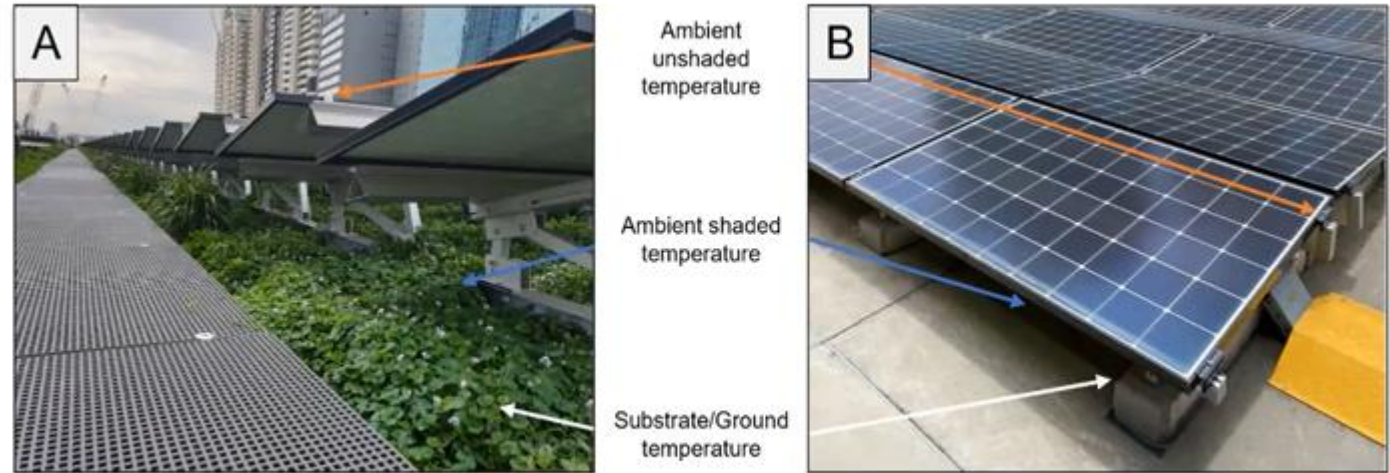
1. 0L/s in overflow
2. Outlet flow from green roof site is 7L/s compared to the control of 634L/s from conventional roofs, indicating reduction



- Surface temperature assessment using a thermal camera



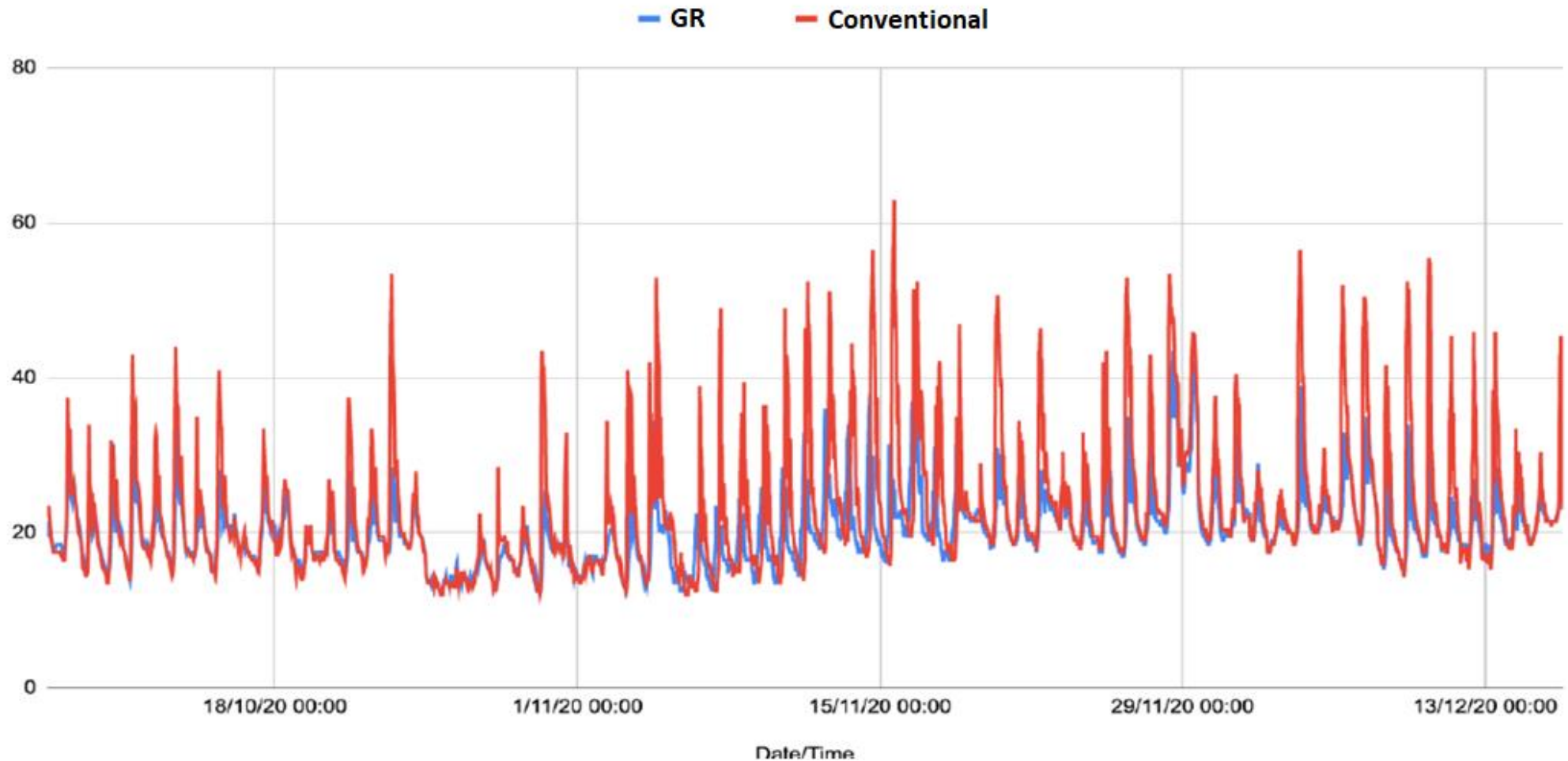
- Temperature gradient assessment using temperature sensors



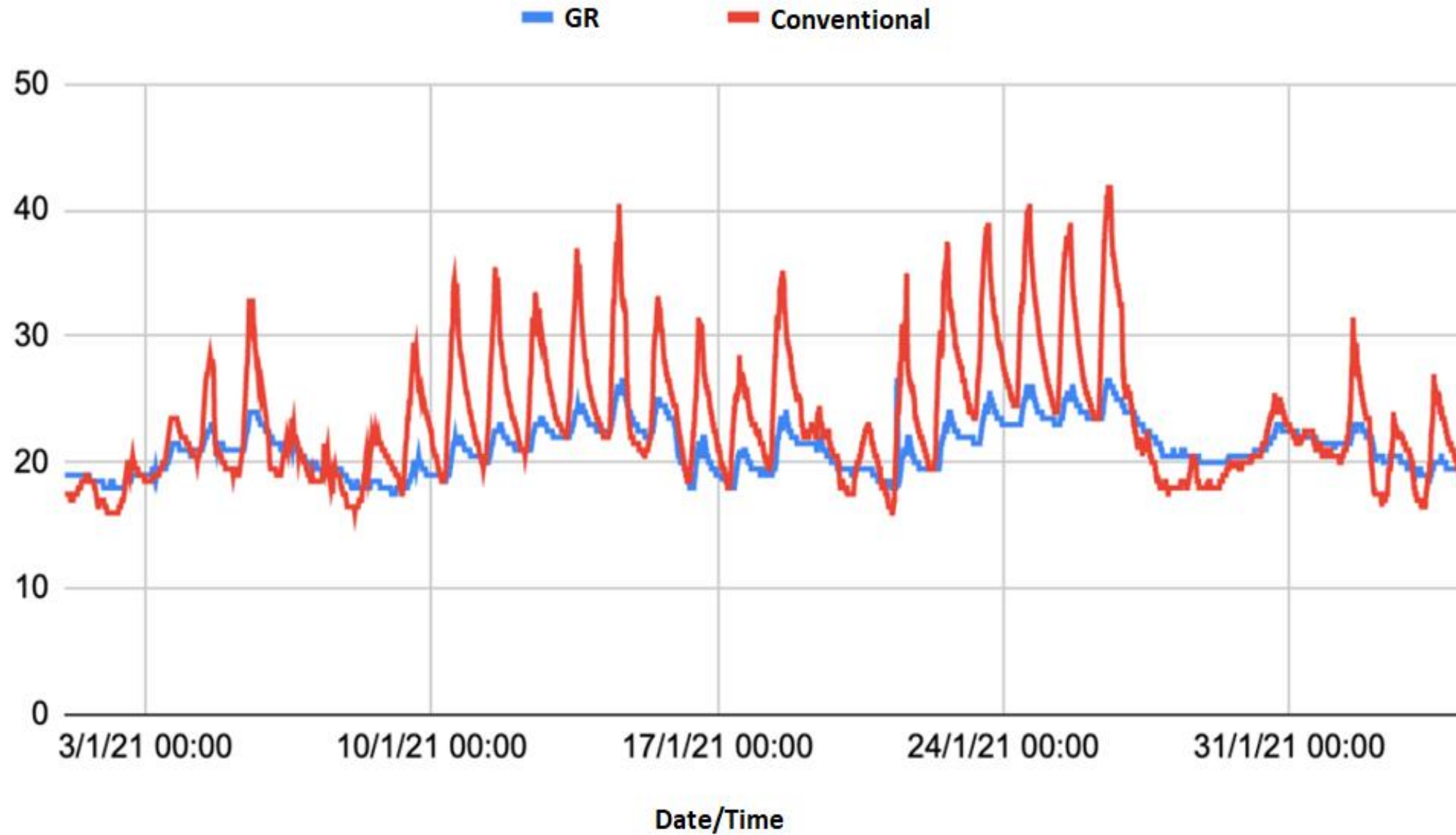
# Radiant heat below solar panels (shaded areas)

Current data demonstrates thermal buffering potential of green roof substrate vs standard concrete

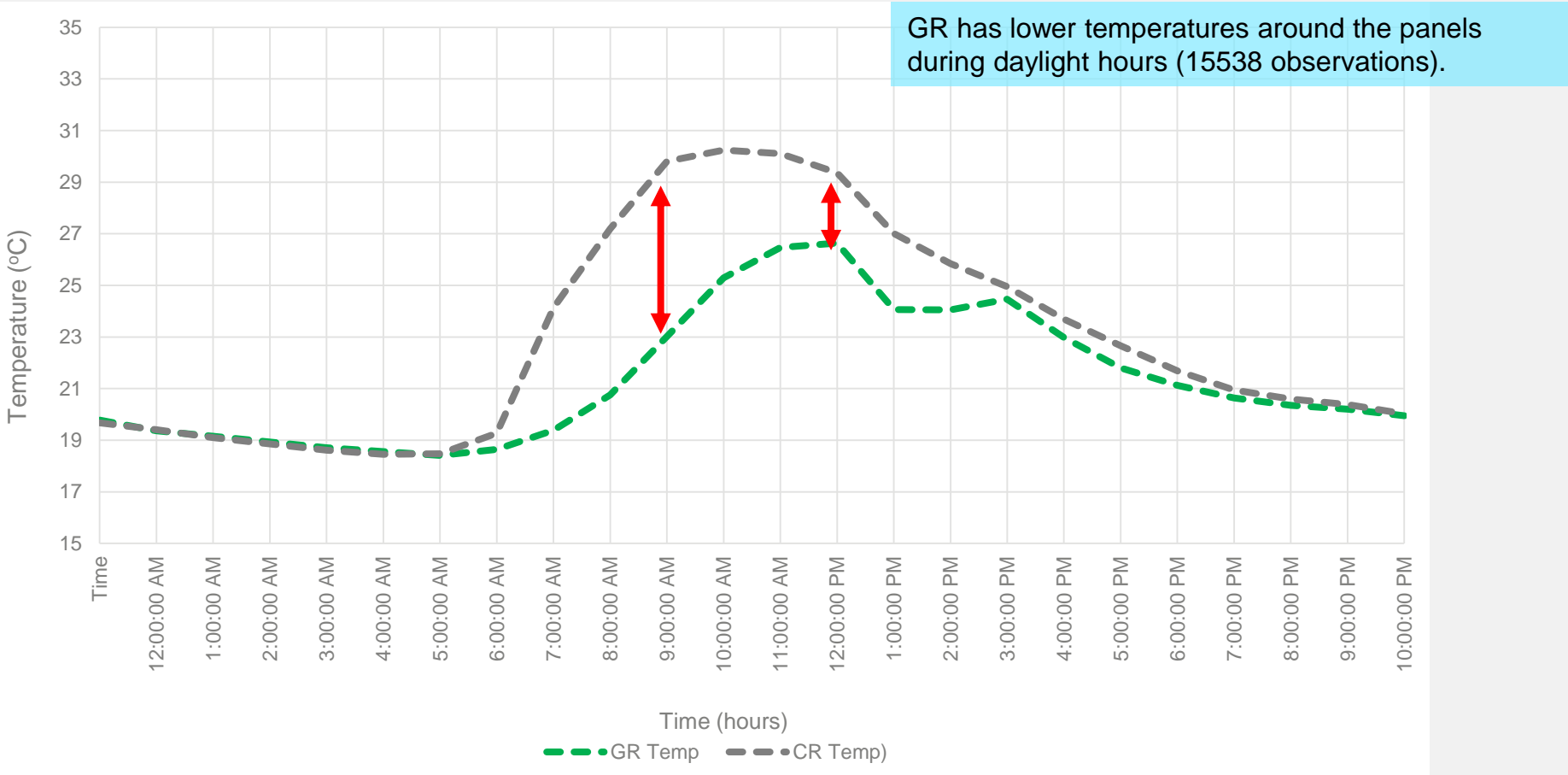
Green roof below panel radiant heat consistently lower than conventional roof



# Surface temperature of rooftop surfaces during Summer



# RESULTS – Temperature



# Photovoltaic energy

## **Heat Affects Solar Panel Efficiency**

Solar panels optimal temperature for performance is approximately 25°C and are rated to perform at peak efficiency between 15°C and 35°C.

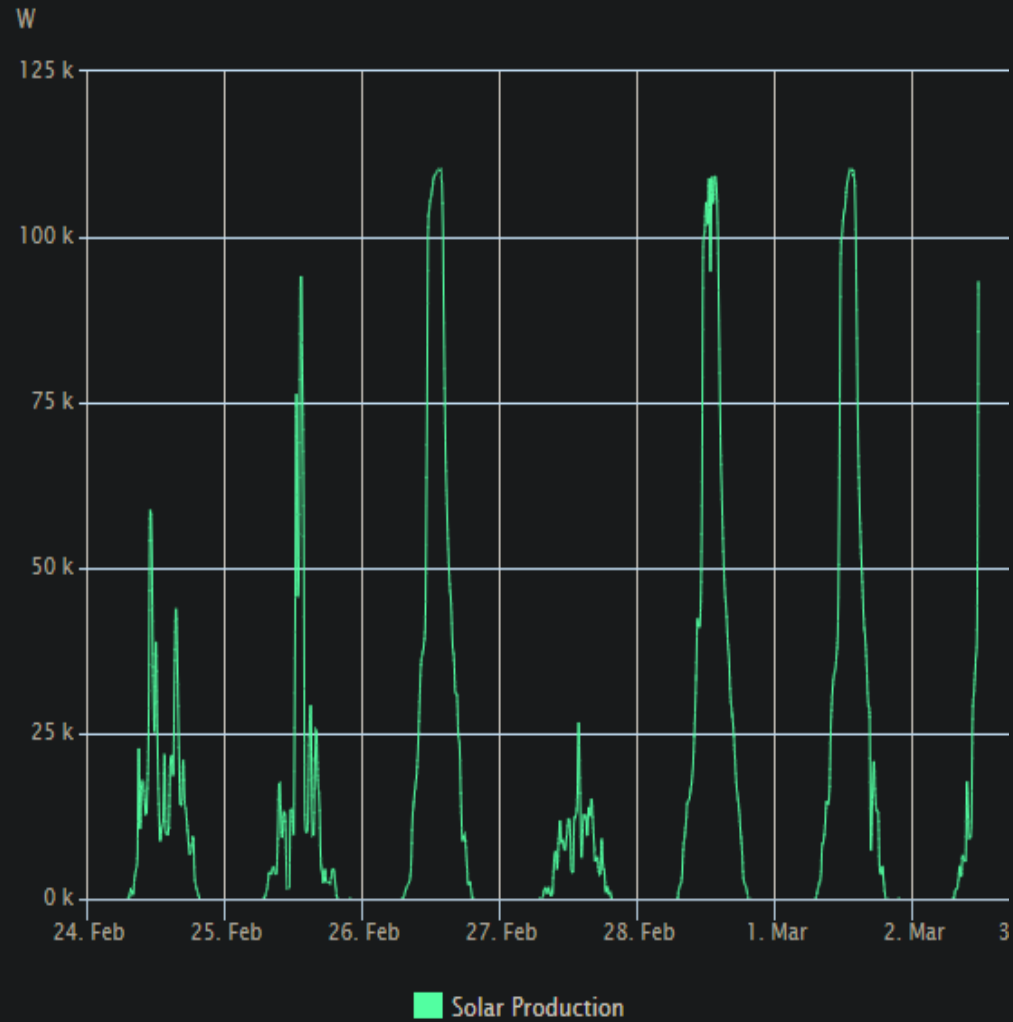
Solar panels may get as hot as 65°C during the summer, reducing efficiency.

## **Green roof can cool the solar panels**

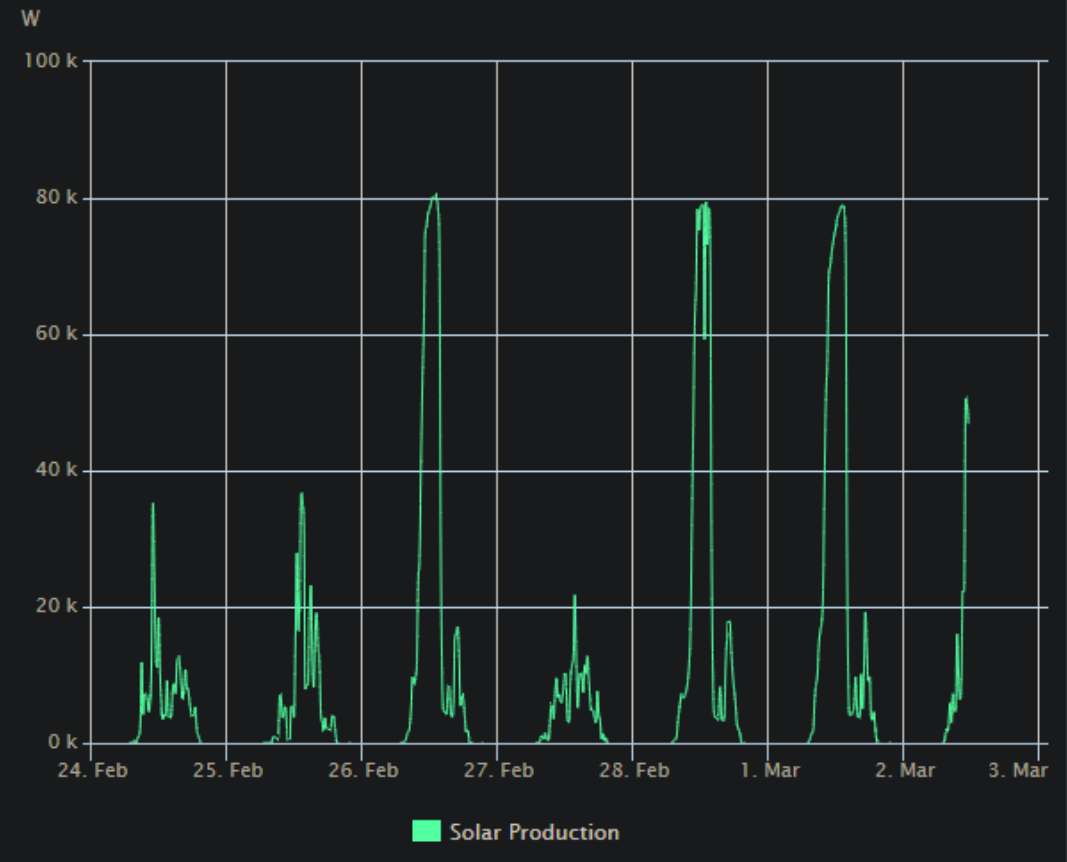
Pilot/small scale experiments indicate green roofs can cool underside of solar panels improving PV performance. Results range between 1-6% improvement.



# Green Roof

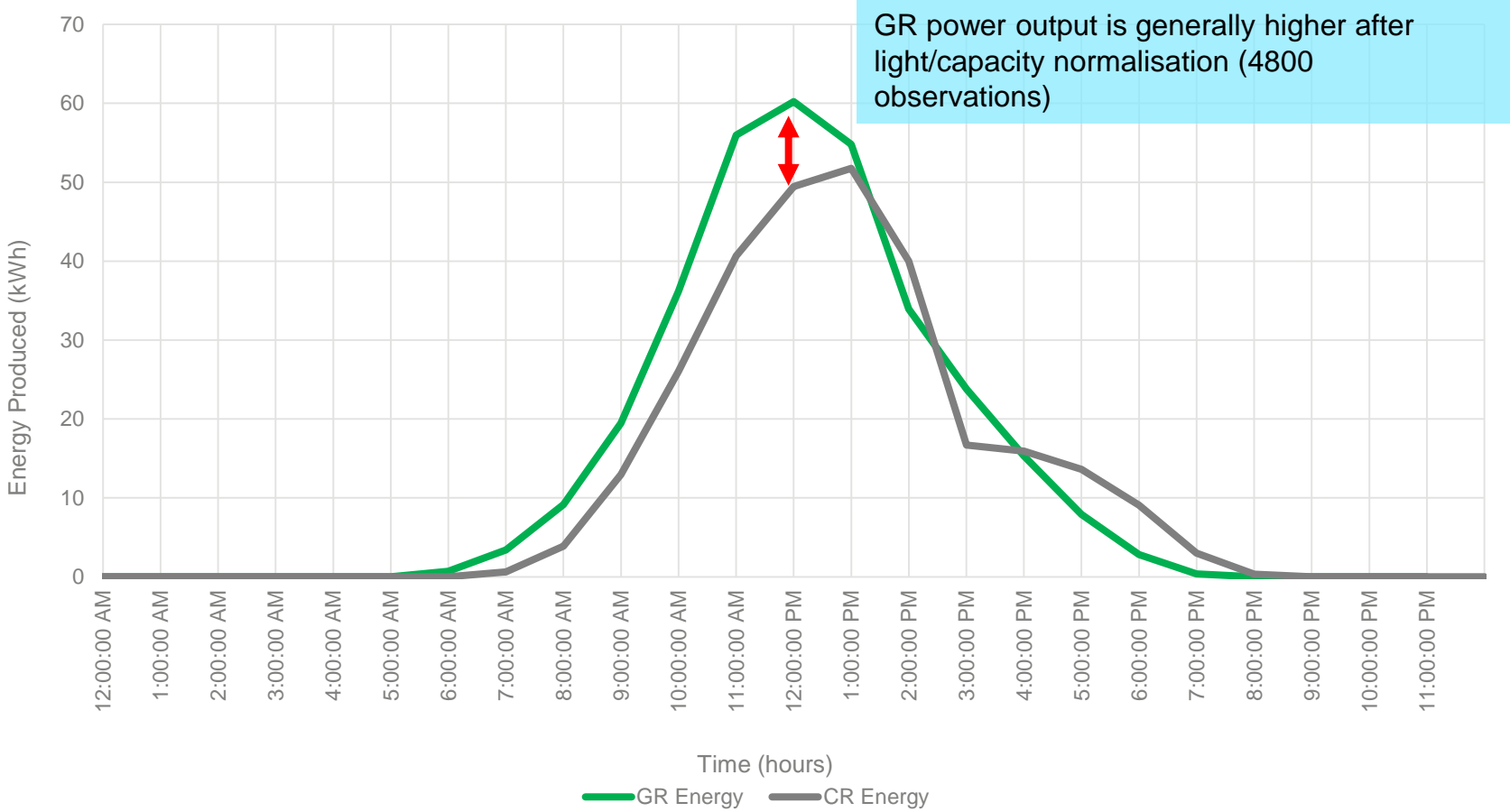


# Conventional

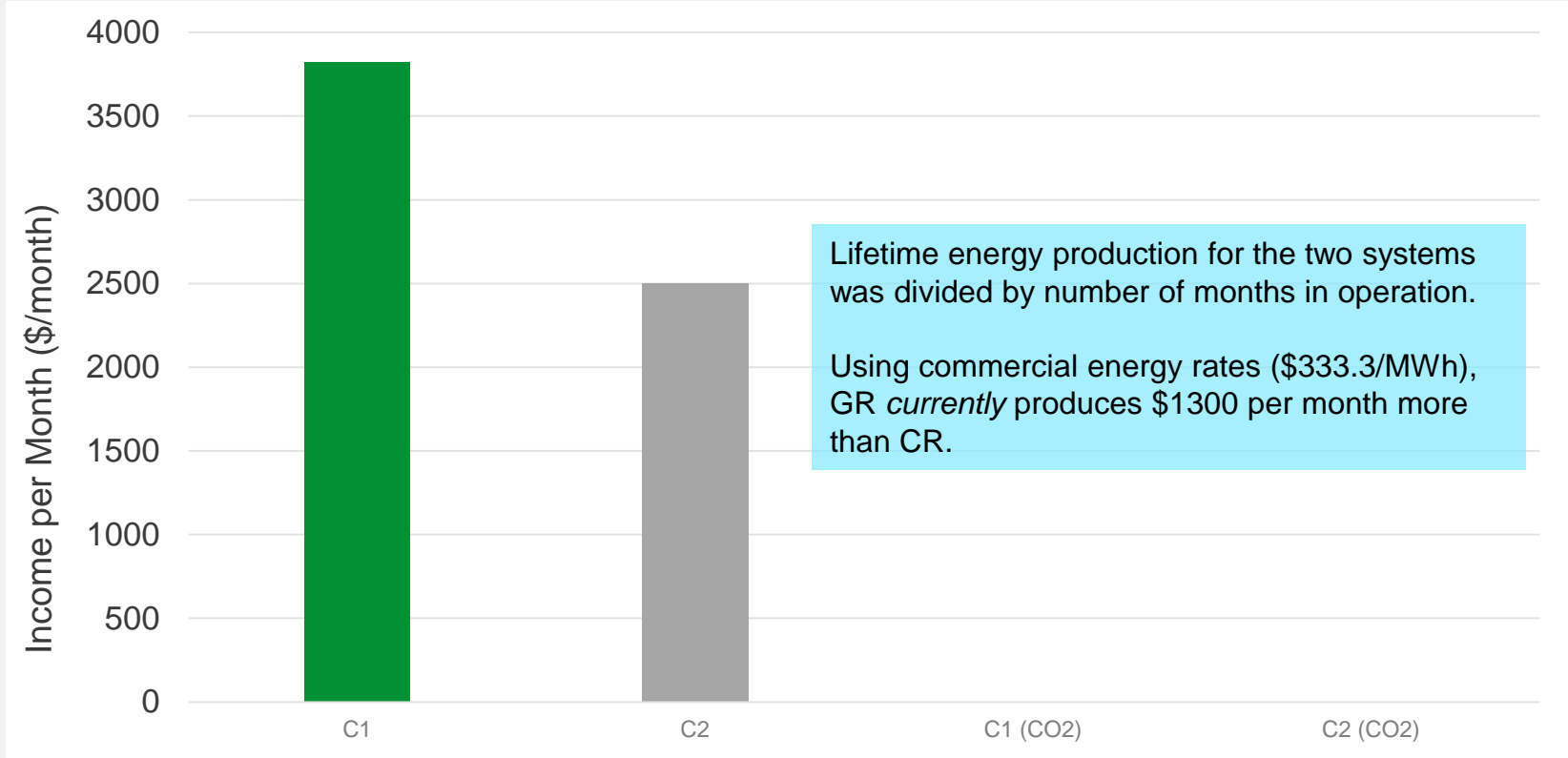


Data indicates the energy output of **Green Roof is ~15-25% greater** at peak times than that of the Conventional Roof.

# RESULTS – Energy production



# RESULTS – Revenue potential

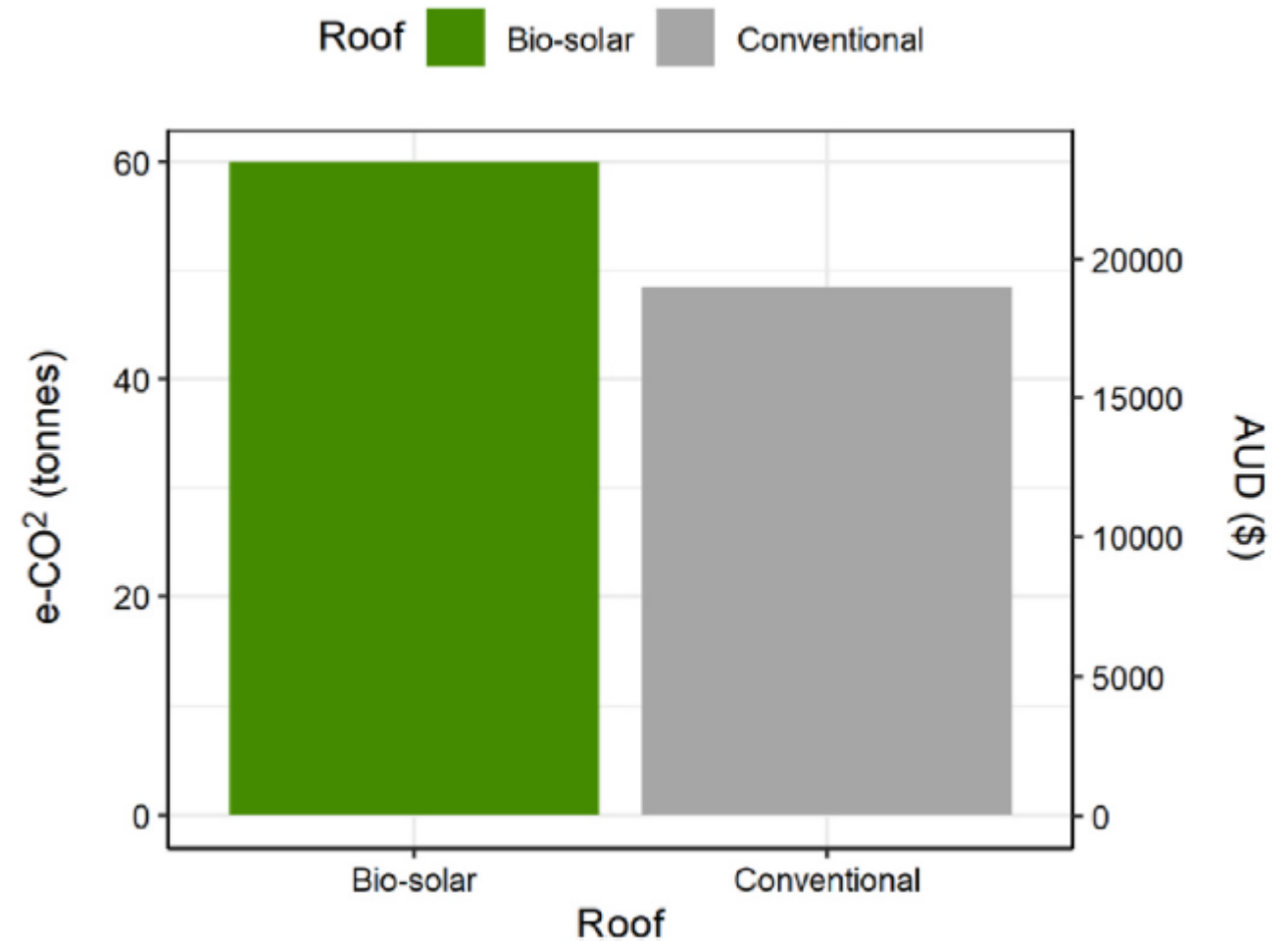


# RESULTS – CO<sub>2</sub> abatement potential

Green roof to mitigate 11.55T MORE  
E-co<sub>2</sub> ghg emission

Equivalent of 192 urban trees

Green roof increases economic  
benefit of PV by 23.84%



# Urban development

Global move to define and account for nature

Building Sustainability rating tools

Investor and community driven focus





Transport  
for NSW

CITY OF SYDNEY 

Transurban



BUGG®

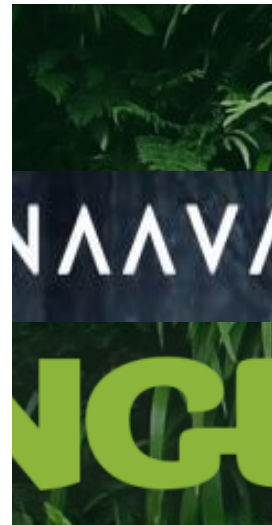
Bundesverband GebäudeGrün e. V.

Dach-, Fassaden- und Innenra

bre



GREENER CITIES  
IN EUROPE



# References

## **Active Green Wall research:**

- Irga, P. J., et al. "The phytoremediation of indoor air pollution: a review on the technology development from the potted plant through to functional green wall biofilters." *Reviews in Environmental Science and Bio/Technology* 17 (2018): 395-415.
- Pettit, T., et al. "Do the plants in functional green walls contribute to their ability to filter particulate matter?." *Building and Environment* 125 (2017): 299-307.
- Irga, P. J., et al. "The distribution of green walls and green roofs throughout Australia: Do policy instruments influence the frequency of projects?." *Urban Forestry & Urban Greening* 24 (2017): 164-174.
- Ilgan, Reina, and Peter Irga. "Are green wall technologies suitable for major transport infrastructure construction projects?." *Urban Forestry & Urban Greening* 65 (2021): 127313.
- Pettit, T., et al. "Effective reduction of roadside air pollution with botanical biofiltration." *Journal of Hazardous Materials* 414 (2021): 125566.
- Morgan, A L., et al. "The botanical biofiltration of volatile organic compounds and particulate matter derived from cigarette smoke." *Chemosphere* 295 (2022): 133942.

## **Green Roof Photovoltaic research:**

- Fleck, R., et al. "Bio-solar green roofs increase solar energy output: The sunny side of integrating sustainable technologies." *Building and Environment* 226 (2022): 109703.
- Irga, P.J., et al. "Green Roof & Solar Array–Comparative Research Project Final Report July 2021." (2021).
- Irga, P.J., et al. "Rewilding our cities: Green roofs for green targets." *AQ-Australian Quarterly* 94.2 (2023): 23-27.
- Fleck, R., et al. "Urban green roofs to manage rooftop microclimates: A case study from Sydney, Australia." *Building and Environment* 209 (2022): 108673.
- Fleck, R., et al. "The hydrological performance of a green roof in Sydney, Australia: A tale of two towers." *Building and Environment* 221 (2022): 109274.