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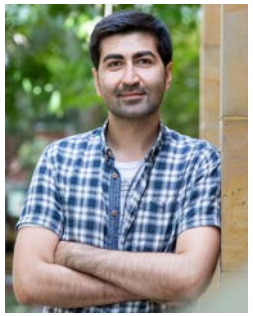
#SESAAU2020

Towards net-zero emission and energy resilient communities: a multi-dimensional approach to energy master planning

Saeid Charani Shandiz, Dr Behzad Rismanchi, Prof Greg Foliente



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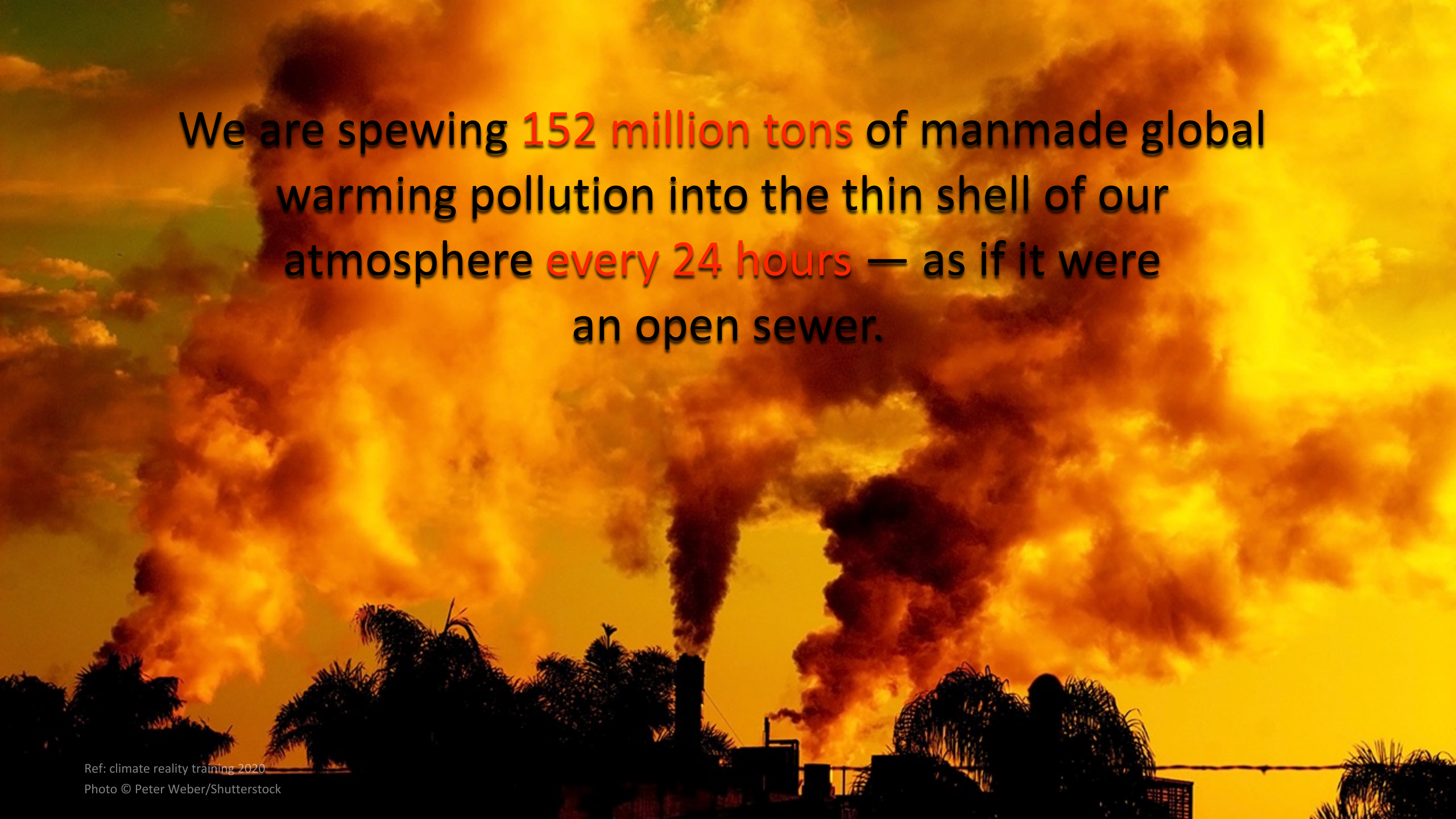
We are developing a computer tool which offers a multi-dimensional approach to the planning, design and assessment of resilient net-zero emission communities



Ref: climate reality training 2020

Canberra, Australia

January 5, 2020

Canberra set a new, all-time high temperature record of 44° C on January 4.

Ref: climate reality training 2020

Resilient net-zero emission communities are needed

A multi-dimensional approach to energy master planning of net-zero emission communities is required, especially focusing on the energy resilience of community level energy systems

What is Energy Master Planning?

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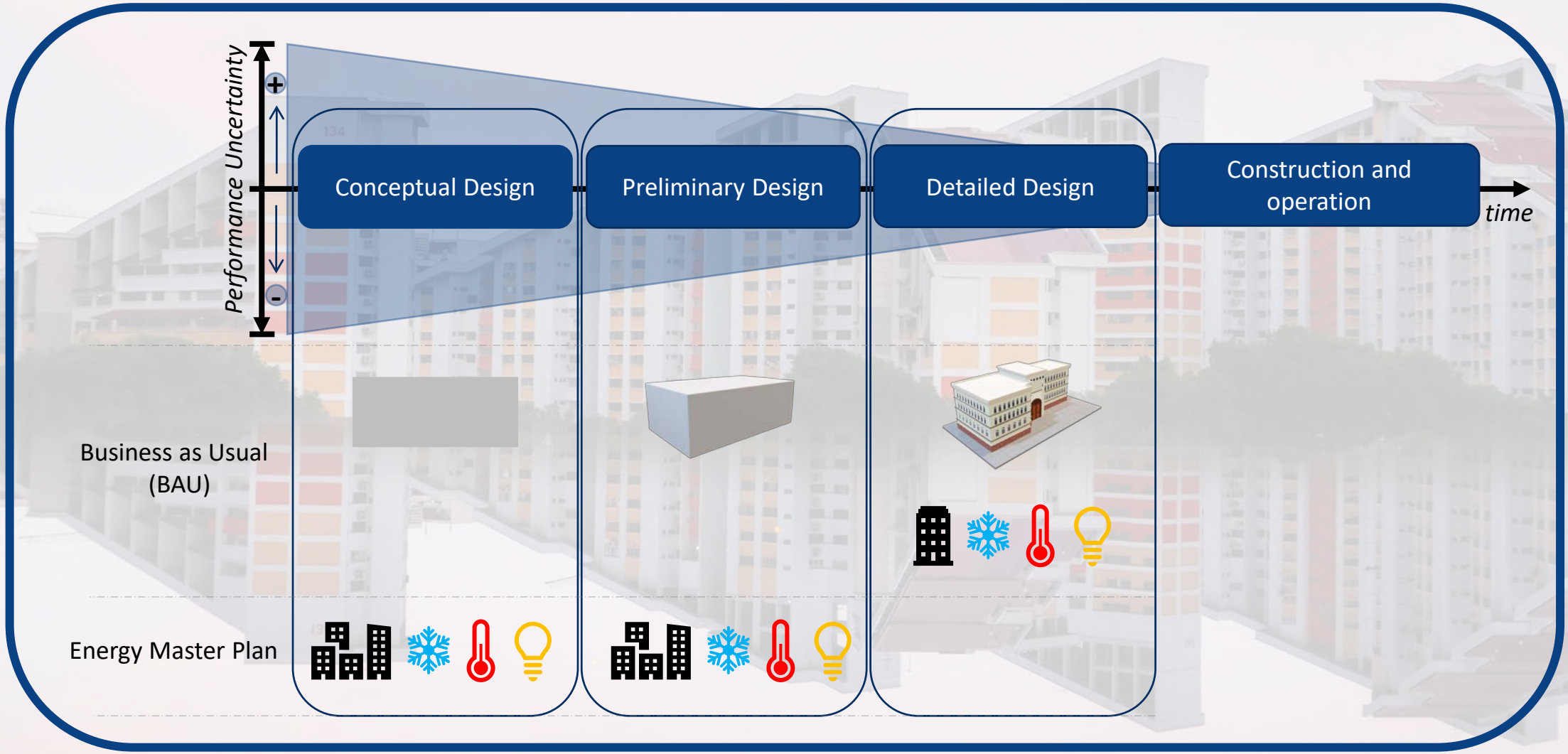
Energy Master Planning



Ref: Charani Shandiz S, Rismanchi B, Foliente G. Energy master planning for net-zero emission communities: state of the art and research challenges. Renew Sust Energ Rev. 2020. (Under review)

What is a community level energy system?

- Co-located buildings that own generation units and connected to energy networks
- Mixed-use (both electrical and thermal energy)
- Single owner/organisation for making decision and investments
- A variety of technology options available

- Examples are university campuses, school campuses, social housing clusters, group of office buildings, commercial centres, airport buildings, military camps, large hospitals, isolated communities in a remote area and more.

Photo by Chuttersnap on Unsplash

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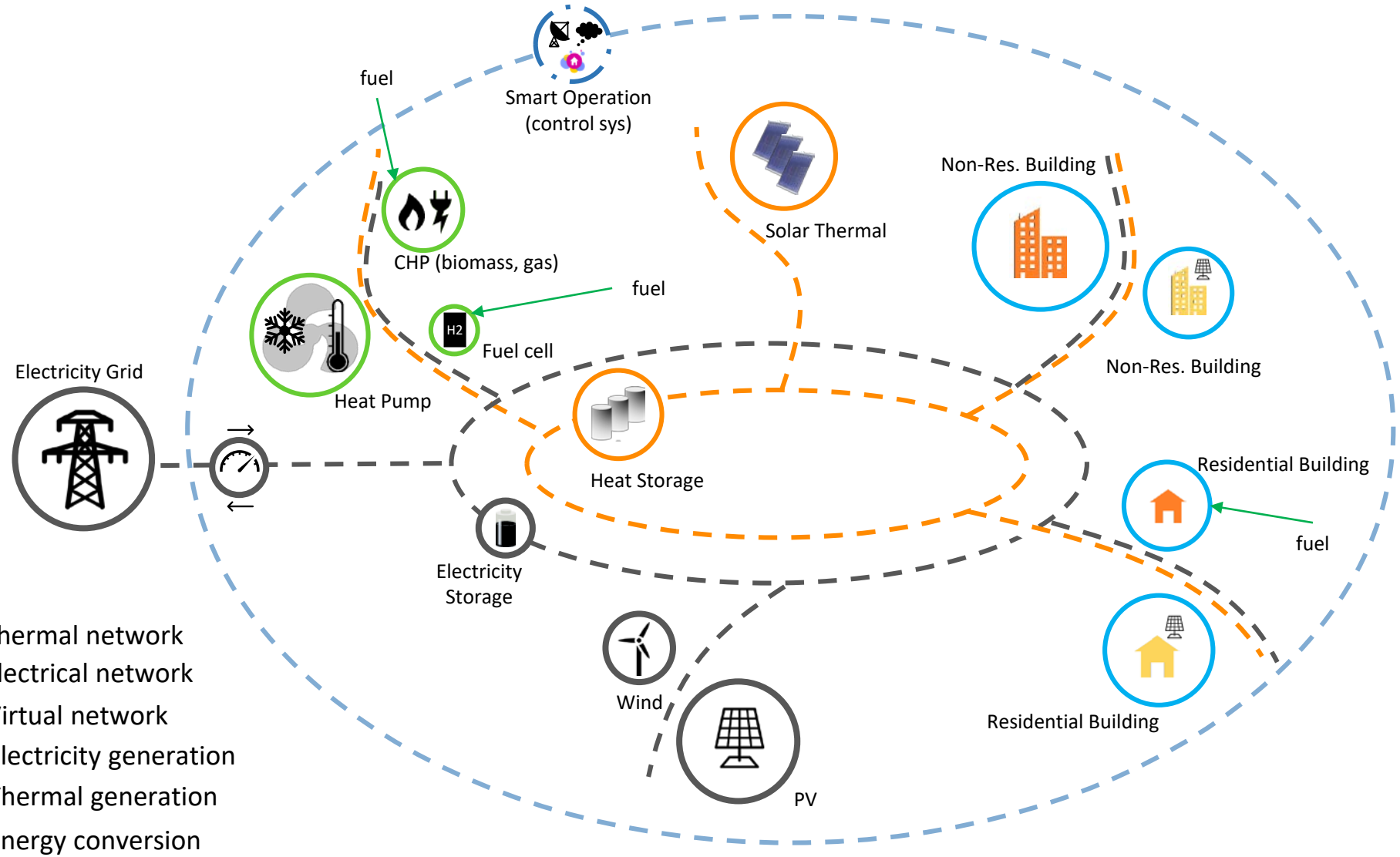
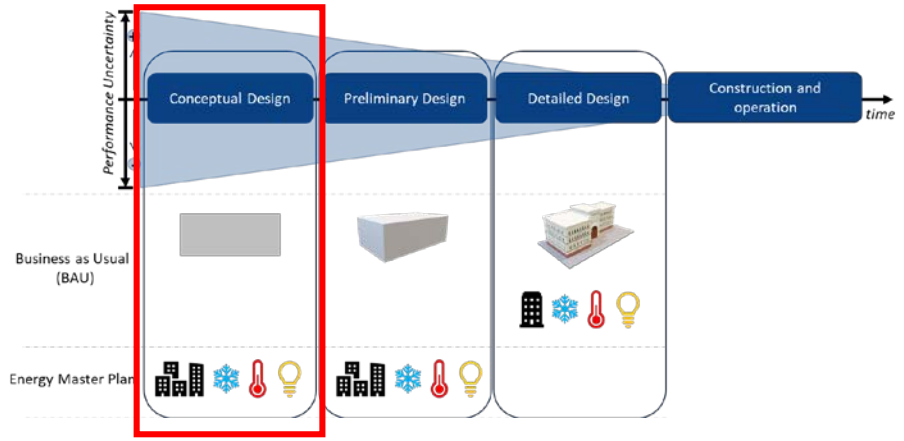
Community level system and technologies



Legend

- Thermal network
- Electrical network
- Virtual network
- Electricity generation
- Thermal generation
- Energy conversion
- Buildings energy demand

Methodology
Conceptual design stage



start

Inputs:
- Client requirements/objectives
- Site data and constraints
- Energy demand (load)-typical days
- Technology alternatives

python™

High level sizing and operation formulations

Outputs:
- System sizing (capacity)
- Operational lifecycle performance (high-level)
- Multi-dimensional analysis
- Ranking/filtering

Energy resilience framework

Resilience is ability to prepare for, withstand, and recover from disruptions caused by major accidents, attacks, or natural disasters.

"Bounce-back-ability"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Resilience framework and metrics for energy master planning of communities

Saeid Charani Shandiz [a], Greg Foliente [a], Behzad Rismanchi [a, *], Amanda Wachtel [b], Robert F. Jeffers [b]

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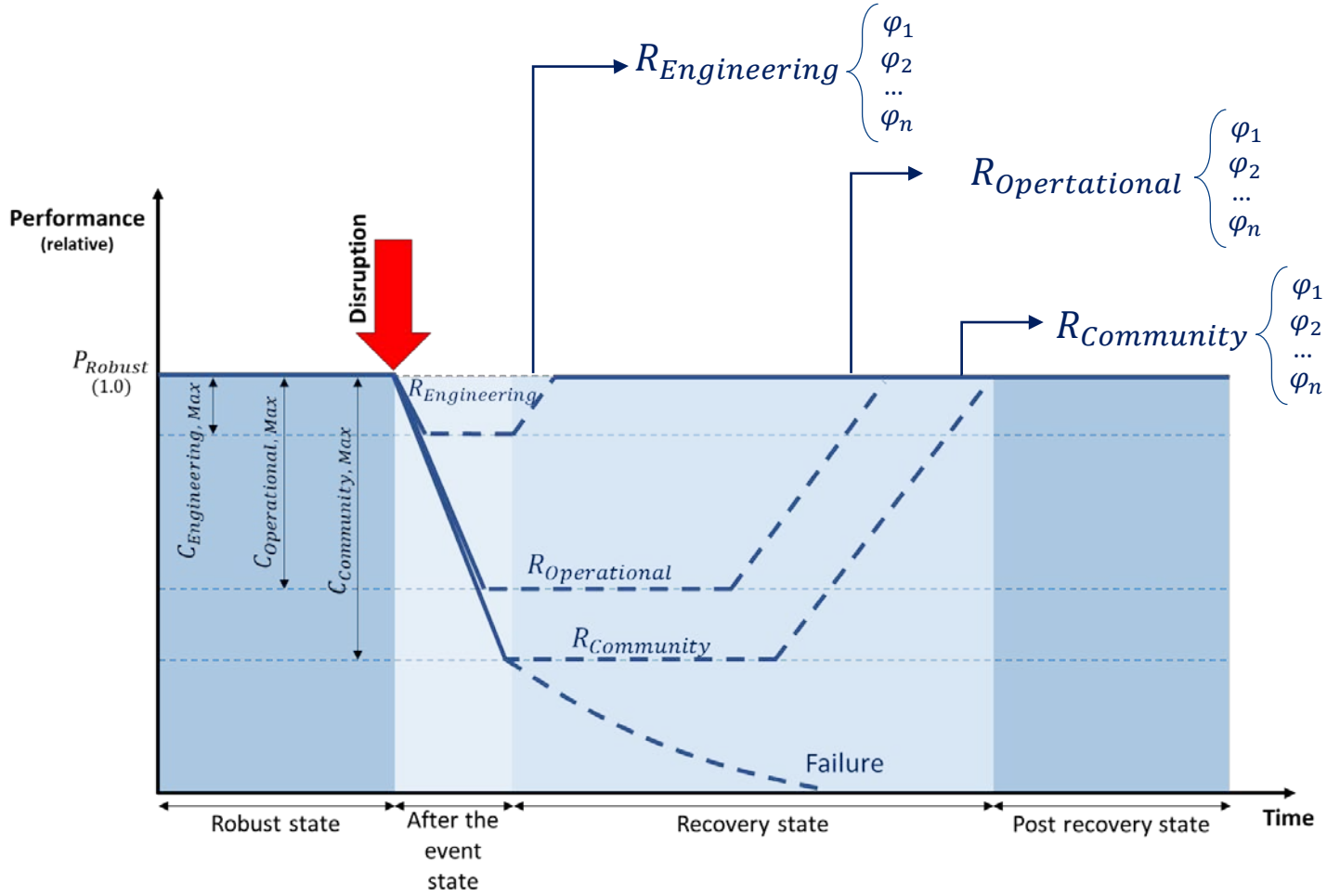
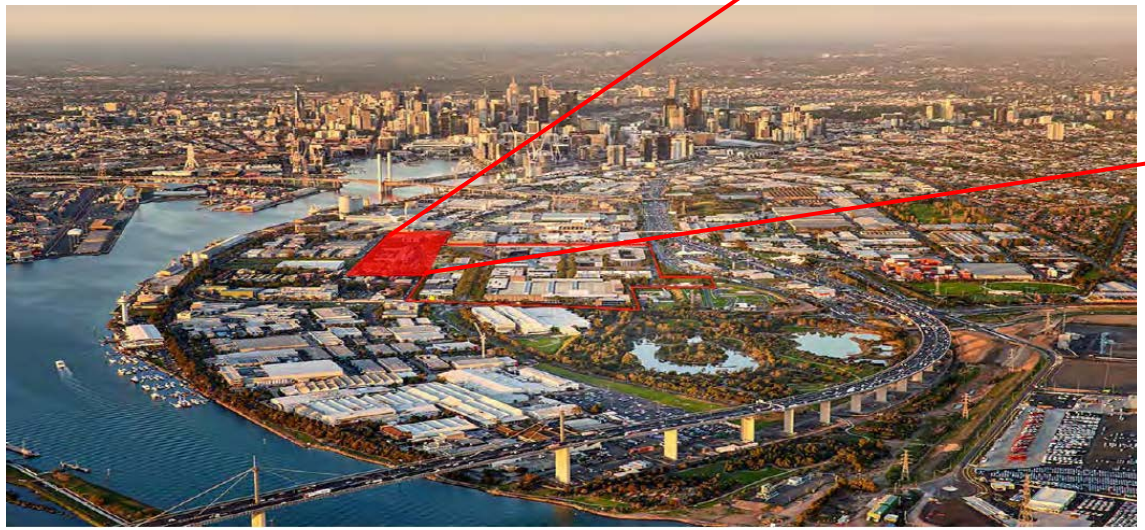


Conceptual multi-phase energy resilience trapezoid

Case study description

The University of Melbourne new campus

- Net zero emission by 2050
- Sustainable and resilient design
- Highest Green Star rating



Fishermans Bend, Melbourne, Australia

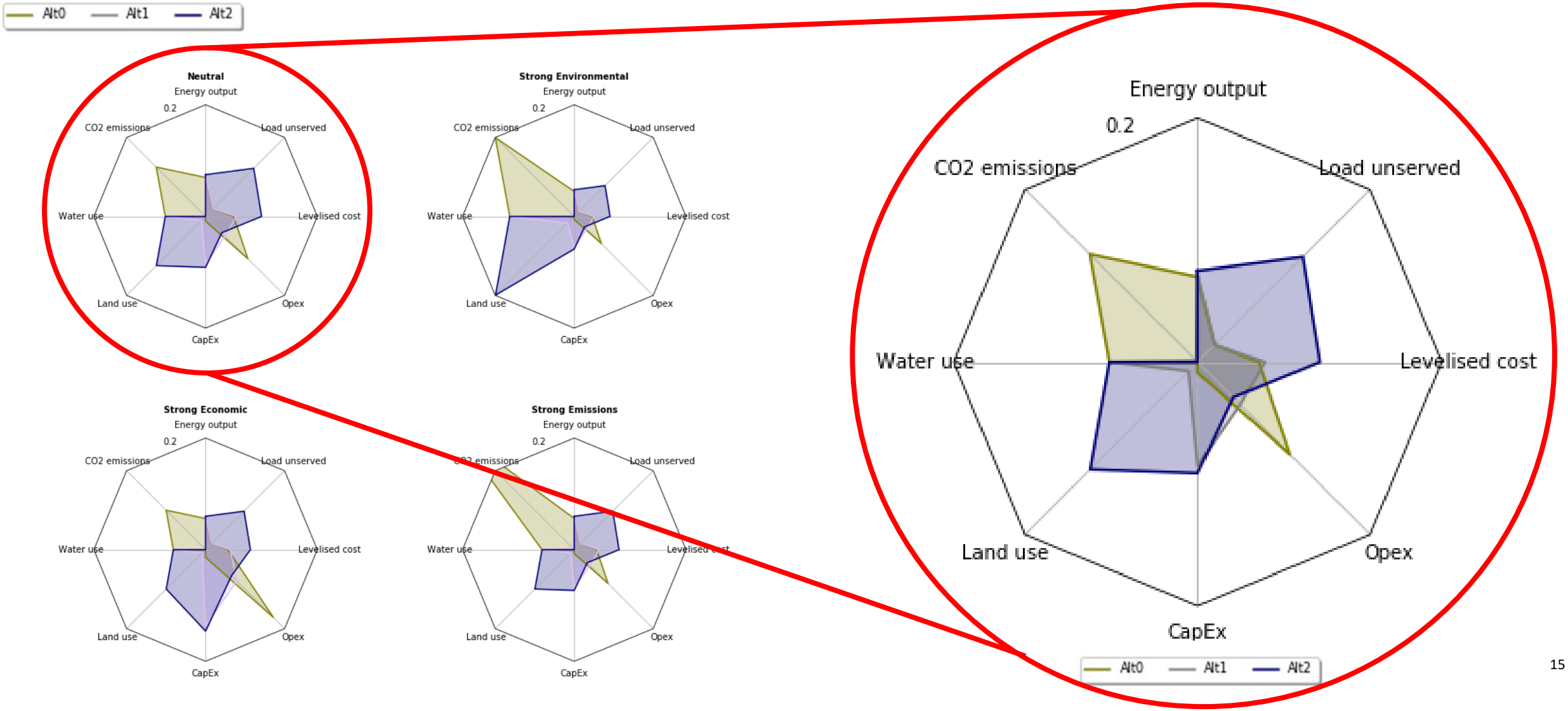
Source: https://ourcampus.unimelb.edu.au/fishermans-bend

Stage 1 of the campus development	
Total land area	~7 ha
Gross Floor area	54 987 m^2
Peak electricity demand	956 kW
Peak cooling demand	1 327 kW
Peak heating demand	665 kW

Alternatives	Electricity gen tech	Cooling gen tech	Heating gen tech
Alt0	Grid	Heat pump	Boiler (gas)
Alt1	Wind turbine	Heat pump	Boiler (gas)
Alt2	PV	Heat pump	Solar thermal

Preliminary results

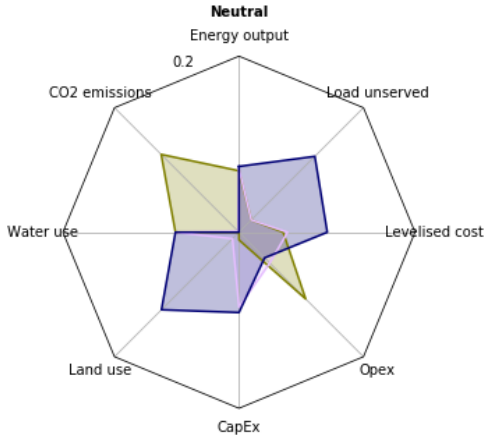
multi-dimensional performance assessment of design alternatives

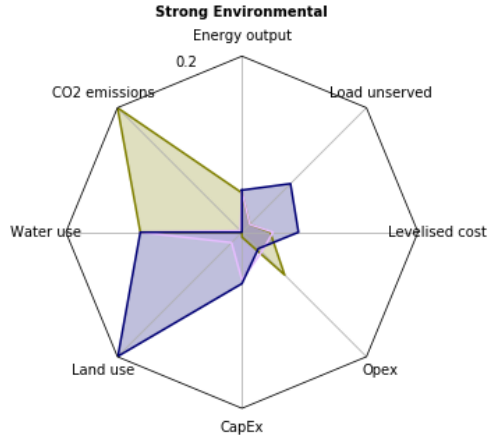


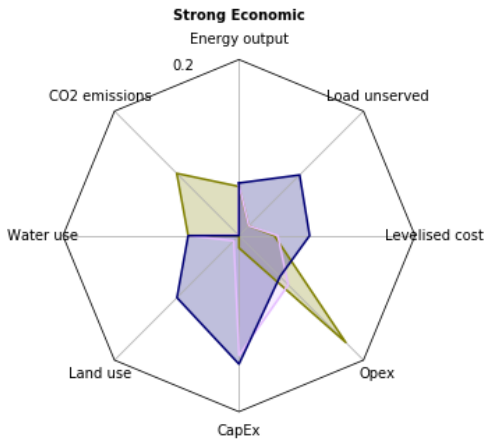
Preliminary results

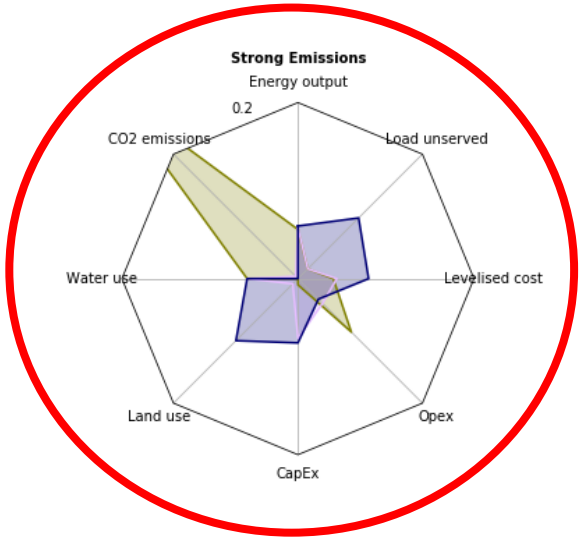
Multi-dimensional performance assessment of design alternatives

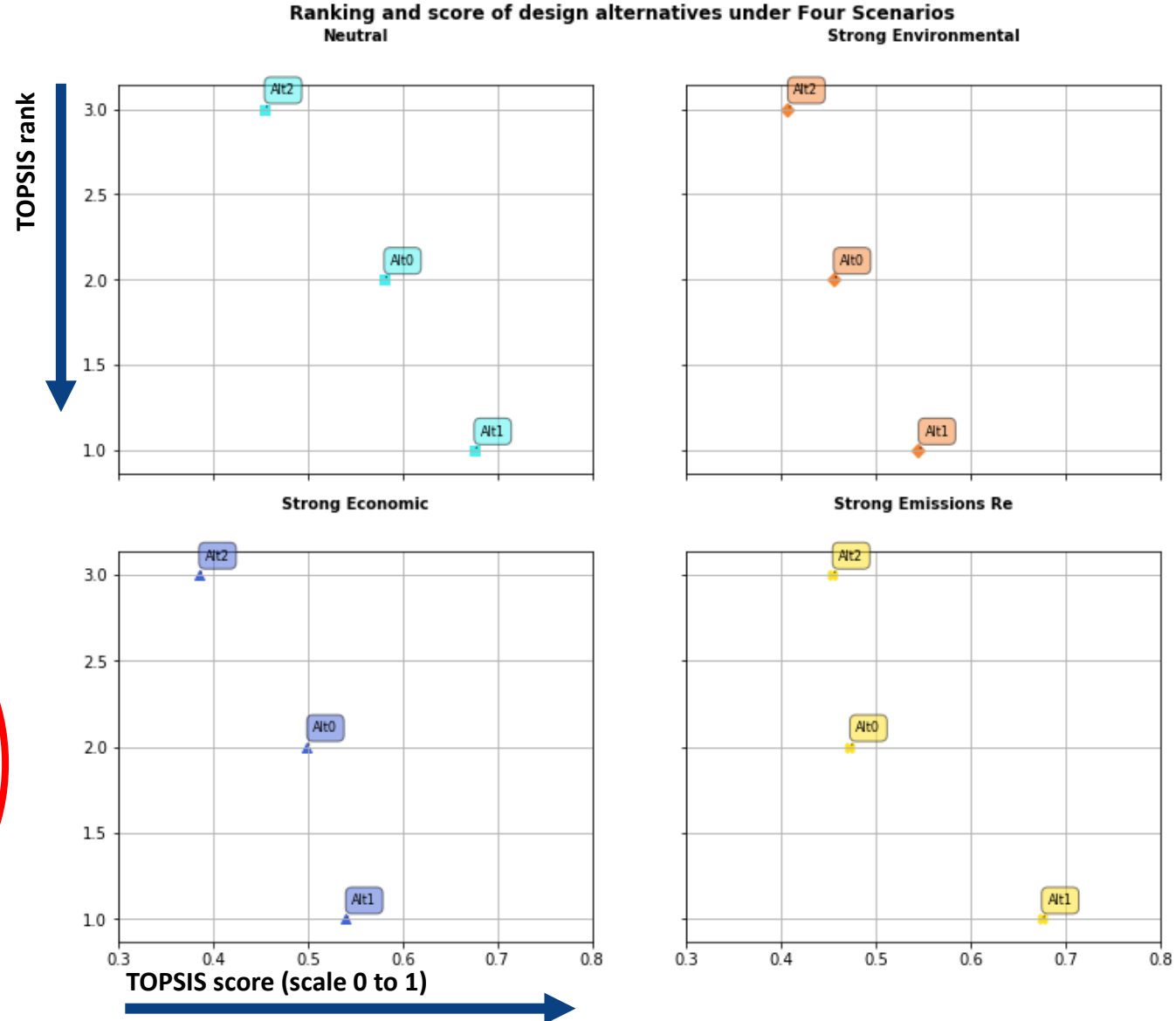
Alternatives	Electricity gen tech	Cooling gen tech	Heating gen tech
Alt0	Grid	Heat pump	Boiler (gas)
Alt1	Wind turbine	Heat pump	Boiler (gas)
Alt2	PV	Heat pump	Solar thermal





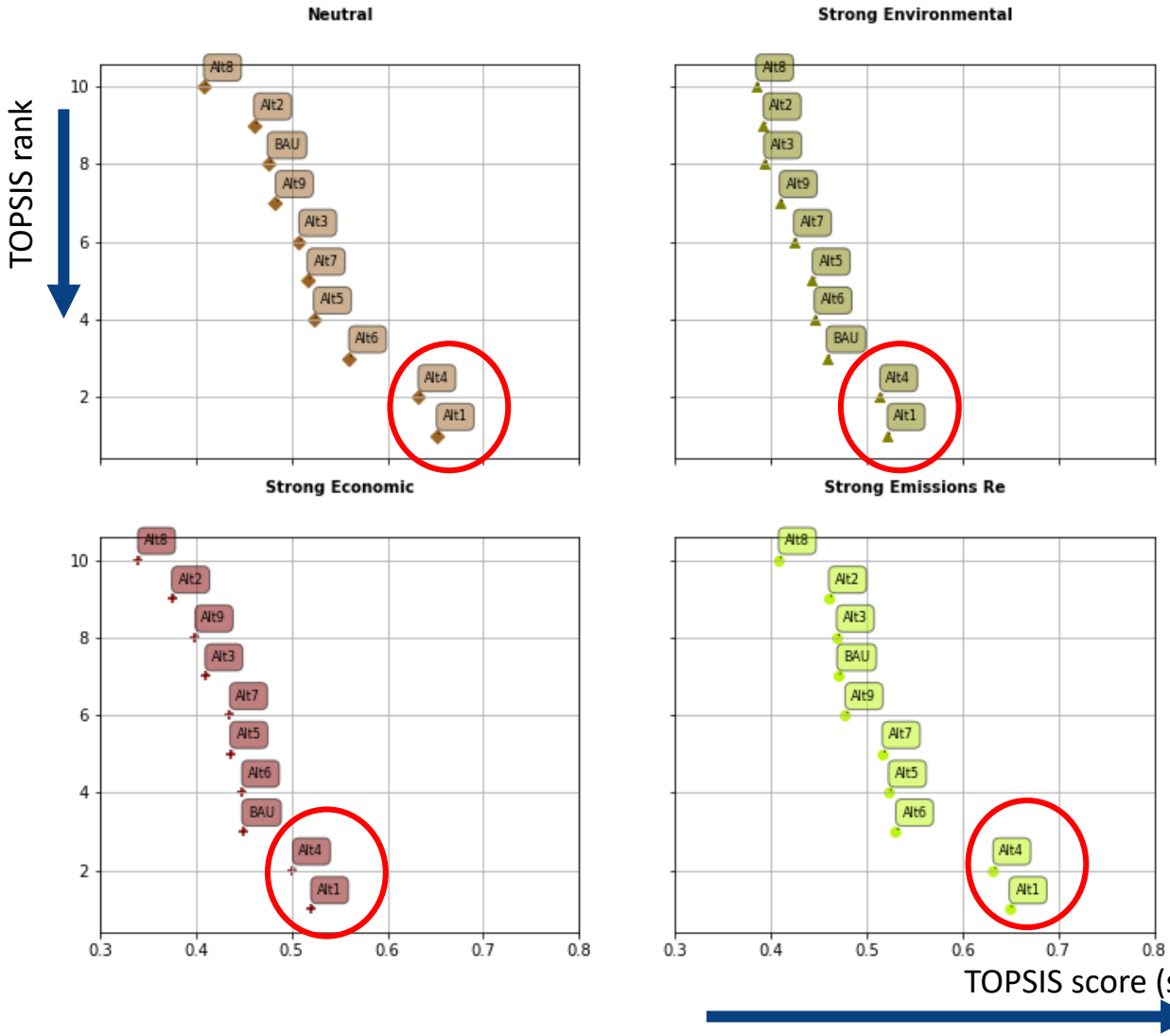






Preliminary results

Multiple alternatives TOPSIS ranking and scores

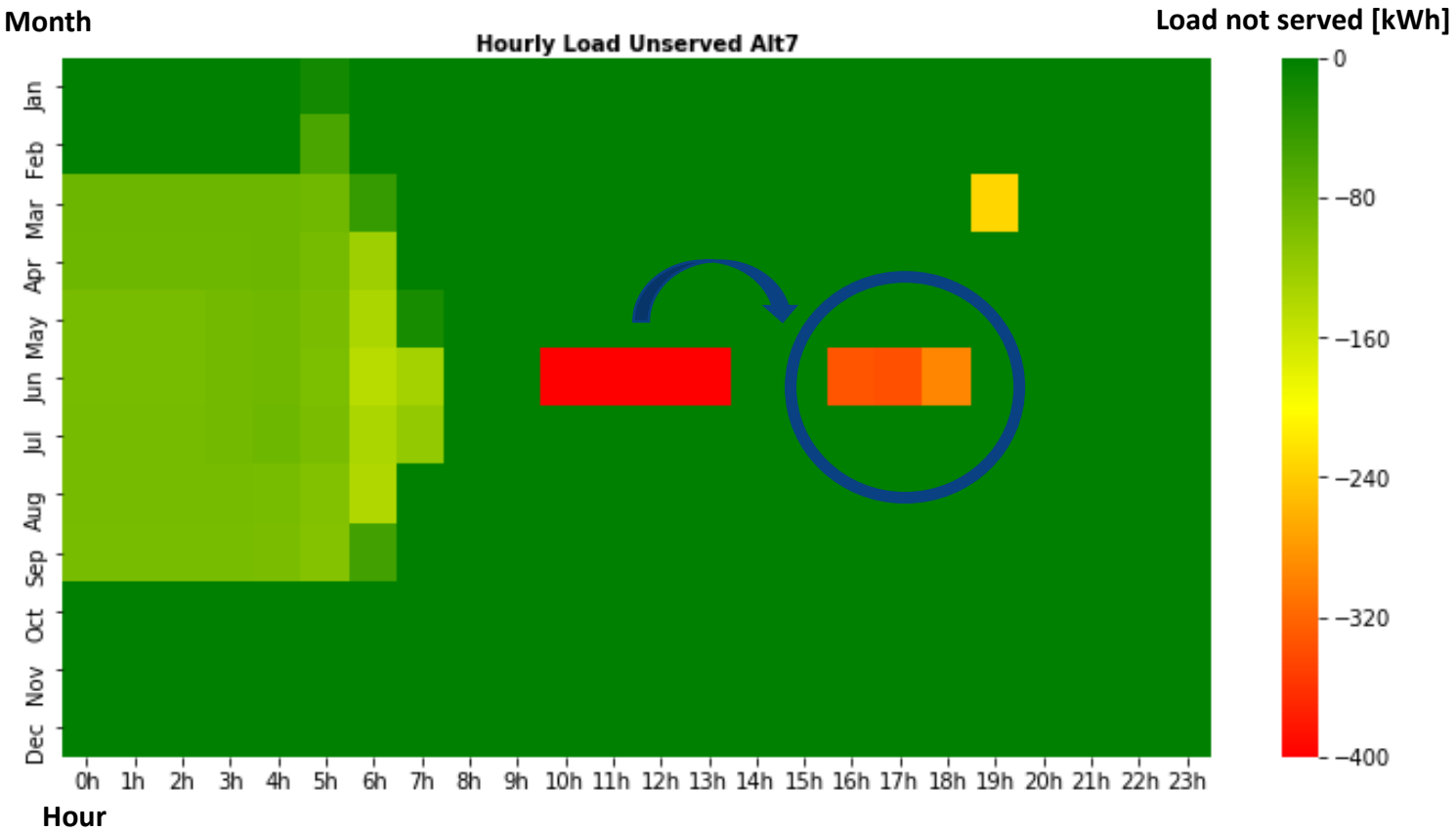


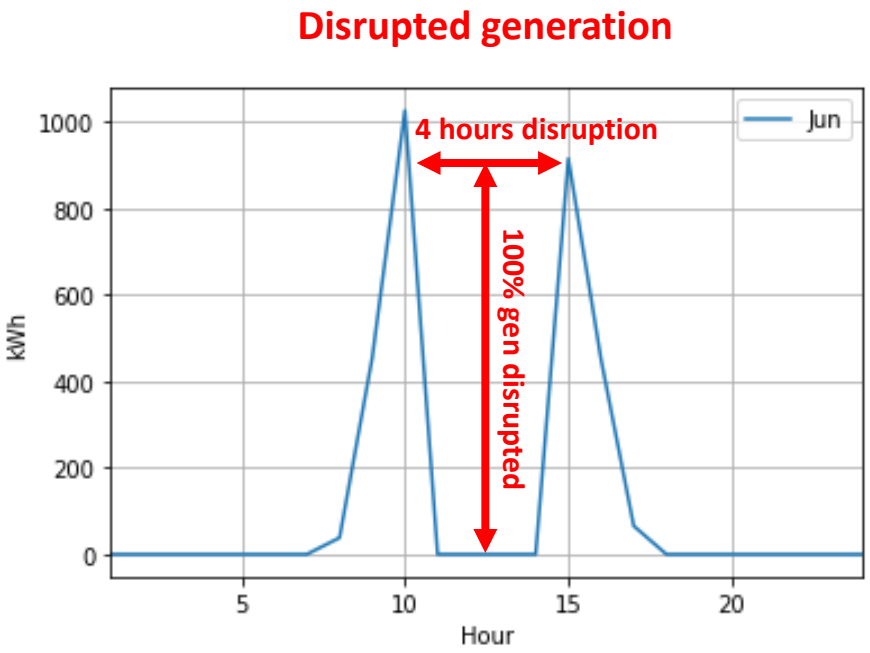
Design alternatives

Alternatives	Electricity gen tech	Cooling gen tech	Heating gen tech
BAU	Grid	Heat pump	Boiler (gas)
Alt1	Wind turbine	Heat pump	Boiler (gas)
Alt2	PV	Heat pump	Solar thermal
Alt3	PV	Heat pump	Boiler (electric)
Alt4	Wind turbine	Heat pump	Boiler (electric)
Alt5	Wind turbine	Heat pump	Solar thermal
Alt6	Wind turbine	Heat pump	Boiler (electric)
Alt7	PV	Heat pump	Heat pump
Alt8	PV	Heat pump	Boiler (biomass)
Alt9	PV	Heat pump	Boiler (gas)

Preliminary results
Energy resilience evaluation

Alternatives	Electricity gen tech	Cooling gen tech	Heating gen tech
Alt7	PV	Heat pump	Heat pump





Concluding remarks and research implications

- The multi-dimensional approach to energy master planning can facilitate the transition to resilient net-zero emission communities.

- Can be of benefit to various stakeholders such as utility providers, energy planners, researchers, facility managers, designers, investors and owners.

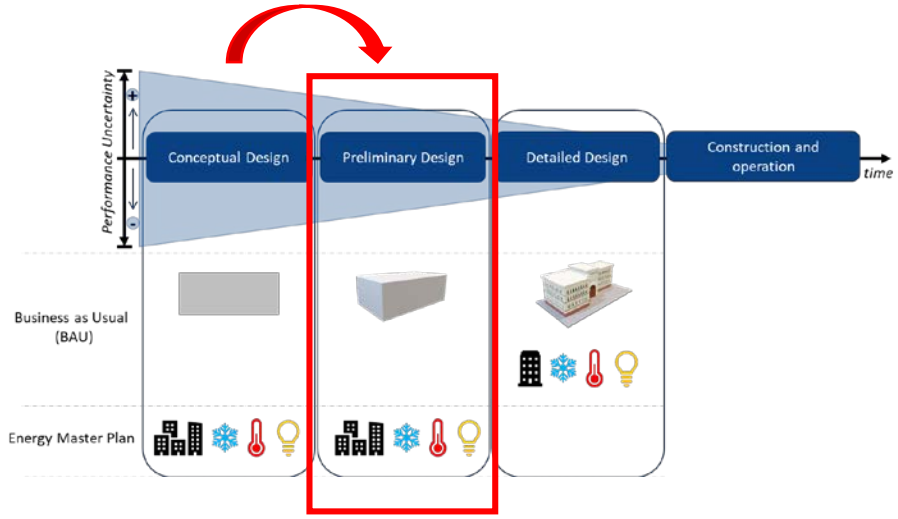
- Can provide a multi-dimensional evaluation of design alternatives in a timely manner and in the early stages of energy master planning process.

- Can help uncover investment opportunities and contribute towards more effective sustainable policies.

- Can help assess economic and technical implications of design options for the urban energy grids and wider community, especially in terms of evaluation of primary energy saving, CO_2 emission reduction, flexibility, energy demand management and decreased (power) system vulnerability.

Future work direction

- Developing the preliminary design stage modelling feature in the tool.
- Assessment of energy resilience with a higher resolution.
- Exploring the tool in global case studies.



Relevant references

- Charani Shandiz S, Rismanchi B, Foliente G. Energy master planning for net-zero emission communities: state of the art and research challenges. Renew Sust Energ Rev. 2020. (Under review)
- Charani Shandiz S, Foliente G, Rismanchi B, Wachtel A, Jeffers RF. Resilience framework and metrics for energy master planning of communities. Energy. 2020;203:117856.
- Erba S, Pagliano L, Charani Shandiz S, Pietrobon M. Energy consumption, thermal comfort and load match: study of a monitored nearly Zero Energy Building in Mediterranean climate. IOP Conference Series: Materials Science and Engineering. 2019;609:062026.
- Charani Shandiz, S., Denarie, A., Cassetti, G., Calderoni, M., Frein, A., & Motta, M. (2019). A simplified methodology for existing tertiary buildings' cooling energy need estimation at district level: A feasibility study of a district cooling system in Marrakech. Energies, 12(5).
- L. Wells, B. Rismanchi, and L. Aye, A review of Net Zero Energy Buildings with reflections on the Australian context. Energy and Buildings, 2018. 158: p. 616-628.
- B. Rismanchi, District energy network (DEN), current global status and future development. Renewable & Sustainable Energy Reviews, 2017. 75: p. 571-579.
- Foliente G, Kearns A, Maheepala S, Bai X, Barnett G. Beyond Triple Bottom Line – Sustainable Cities RD&D at CSIRO. Procs State of Australian Cities National Conference (SOAC2007), 28-30 November 2007. 2007(November):28-30.

Thank you

Please email me your feedback

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