Future City Design under extreme weather conditions

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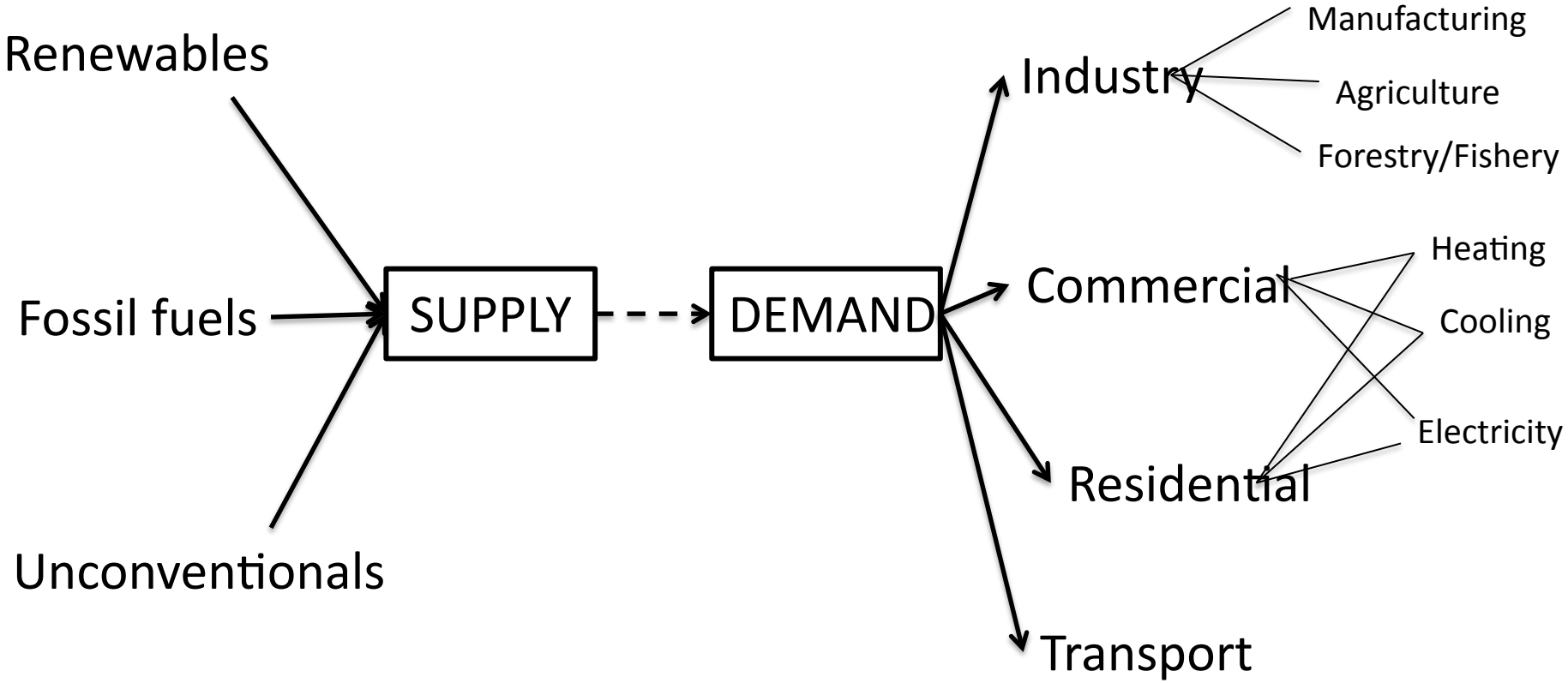
Introduction

- Extreme climatic conditions resulting in heavy winters and hot summers are becoming more prominent due to climate change and global warming.
- Cities pressured by these extreme weather conditions
- Increasingly constrained in meeting their energy demands and form a challenging environment to create a sustainable city in all sectors.

Energy balance system



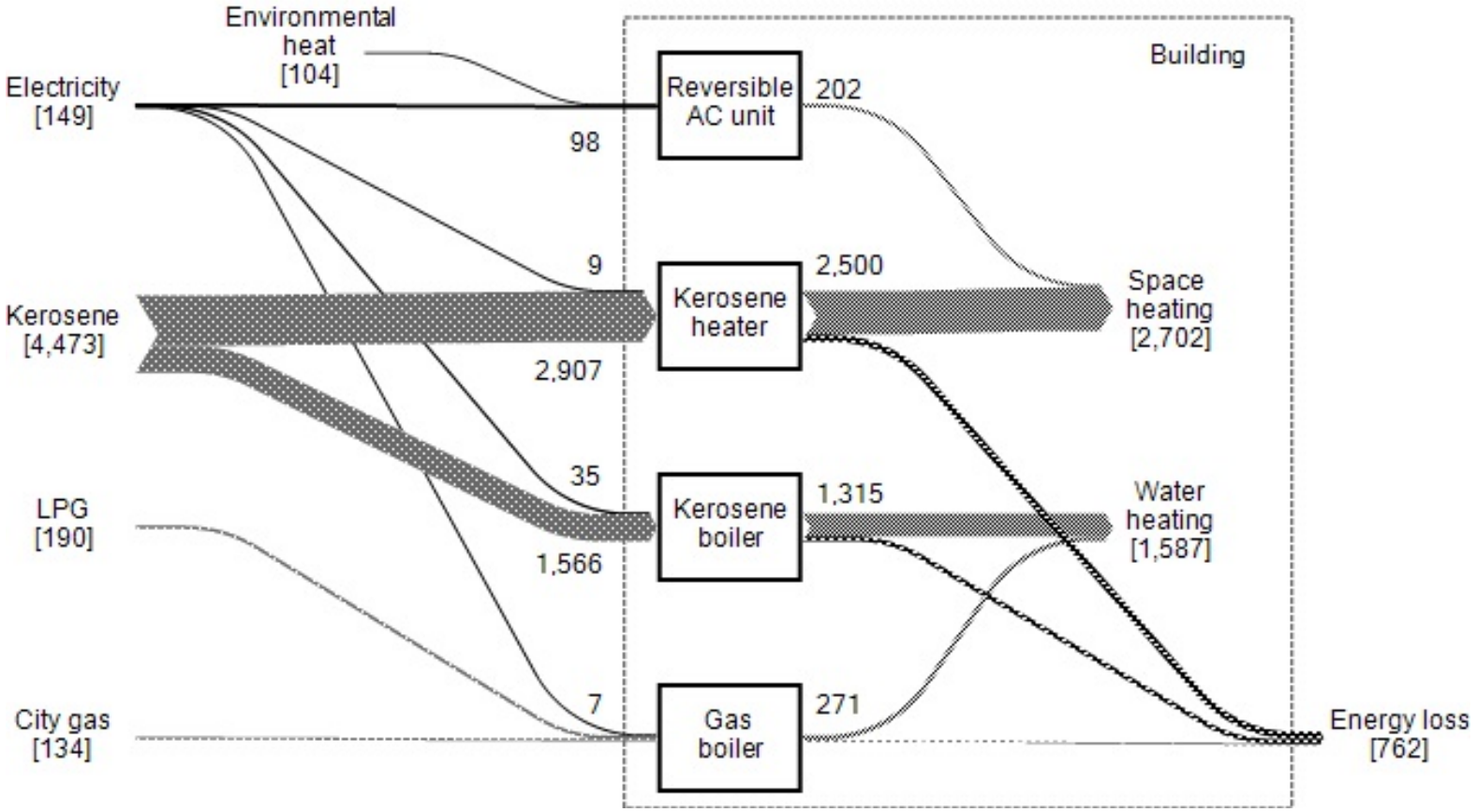
Objective

- To create a *sustainable* and *resilient* future energy system of a city bound
- Take into account extreme climatological conditions.
- Exploit as much as possible the locally available (renewable) energy resources and the local environmental features.

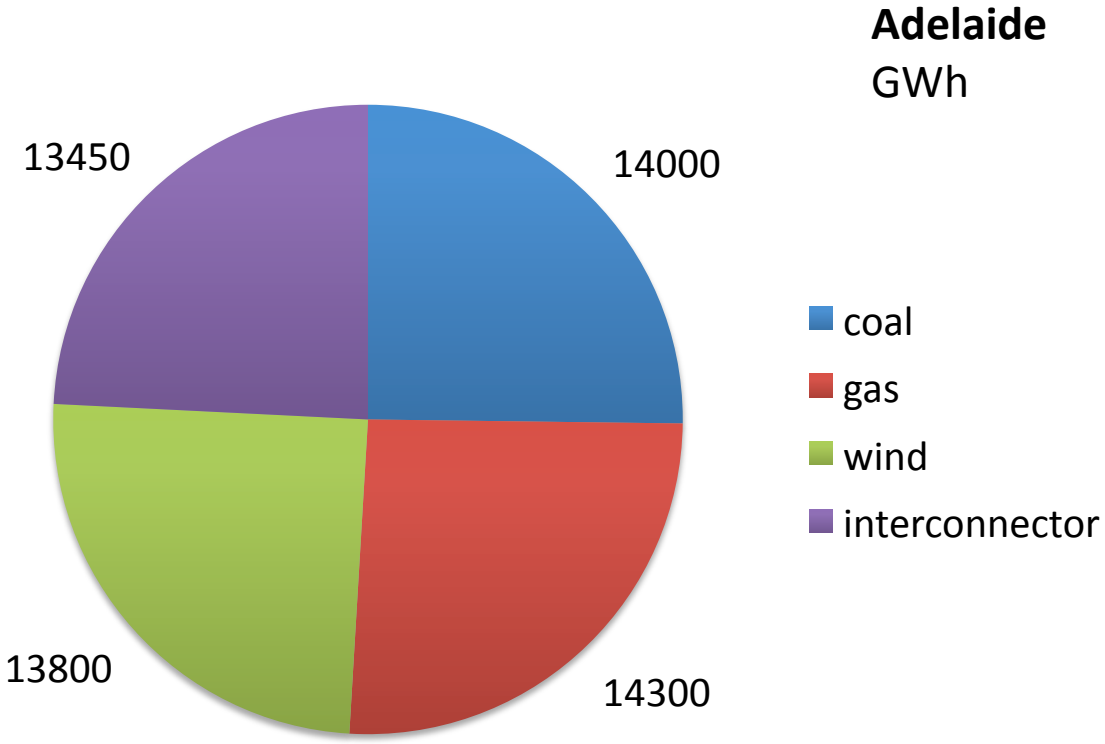
Methodology

- Transition theory

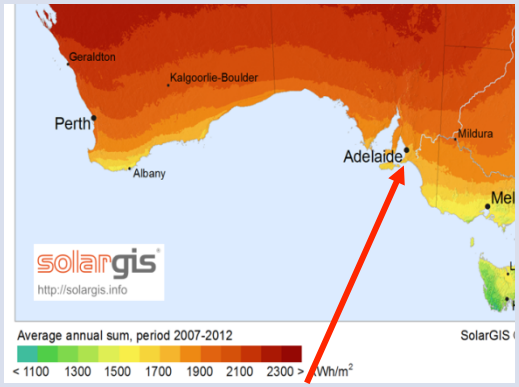
Energy system (heat) of Hirosaki



Current electricity sources



City profiles

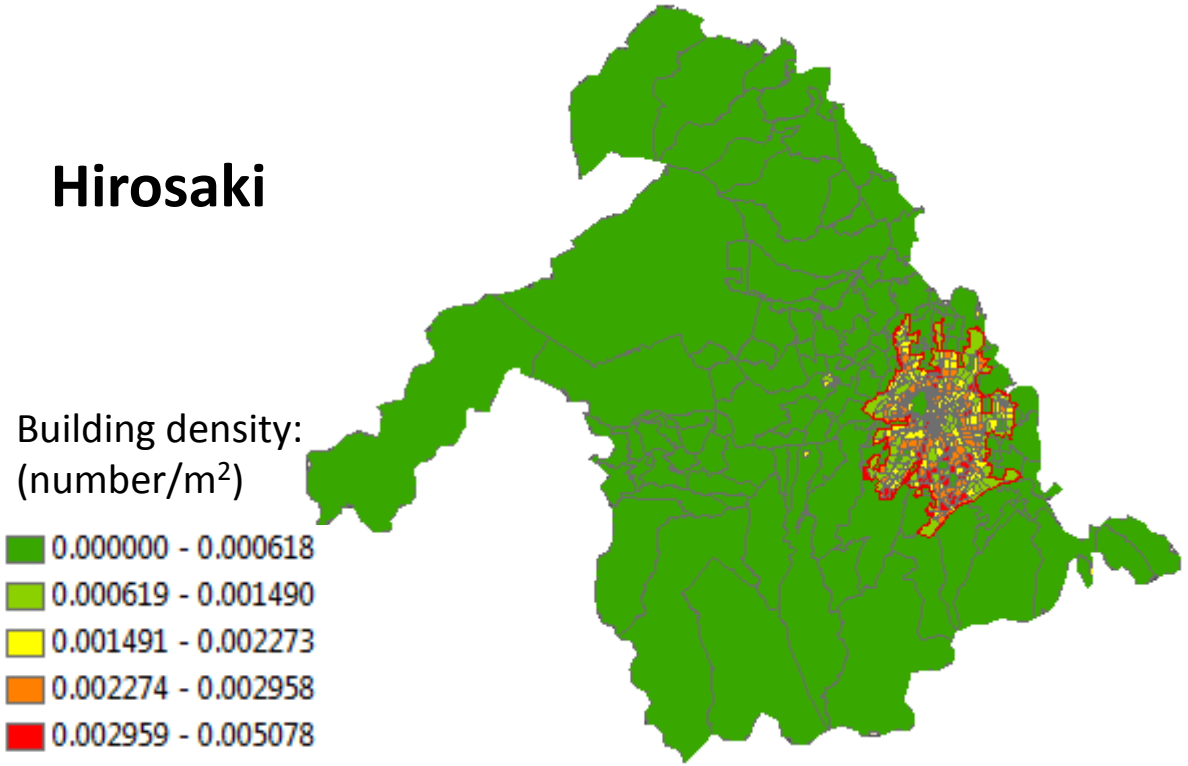
City	Adelaide	Hirosaki
Average yearly solar irradiation		
Max avg Temp. Min avg Temp.	29-30 degrees 7-8 degrees	15 degrees 5 degrees
RES	Solar – Wind - Biomass	Wind – Geothermal - Biomass
Population	1,203,200	183,473
Climate	Hot Mediterranean climate - mild winters with moderate rainfall and hot, dry summers	Mild humid summer and cold winters with heavy snowfall

City profiles

City	Adelaide	Hirosaki
Characteristics	- summer heat waves: >10 consecutive days >35 degrees - water usage restrictions - low household insulation standard - Stand-alone 1 floor houses – spread out living - car culture – barely public transport - peak cooling demand - Only major city in the state - 75% of population - access to the sea	- heavy accumulated snowfall winter: 2.4 m - low household insulation standard - compact residential living - peak heating demand - second biggest city in the region - land locked

Understand the city - Hirosaki

The city centre occupies 6% in area, but accommodates 60% of the buildings.

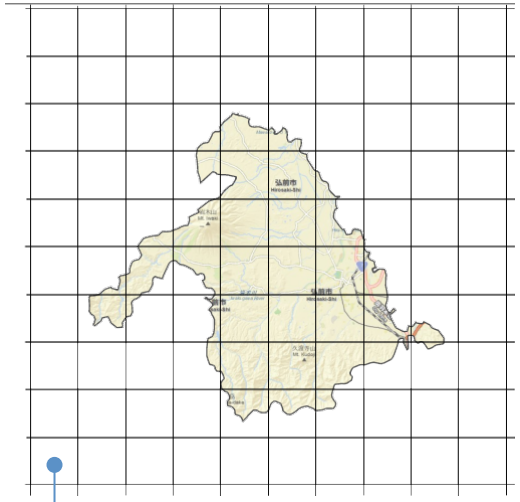


Source: Public map database of Japan

Meshed network

Hirosaki

523 km^2

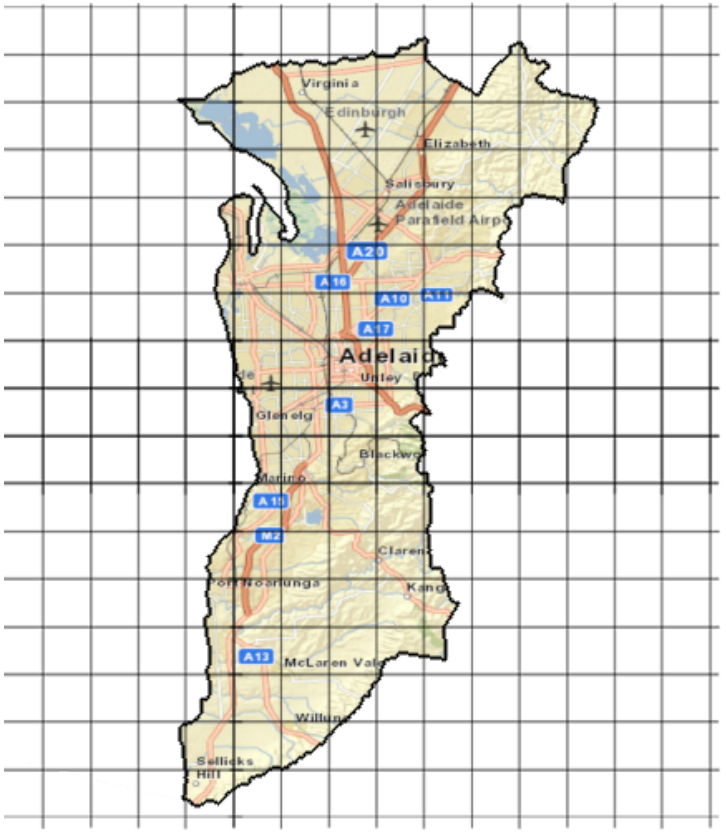


5

5 *(km)*

Adelaide

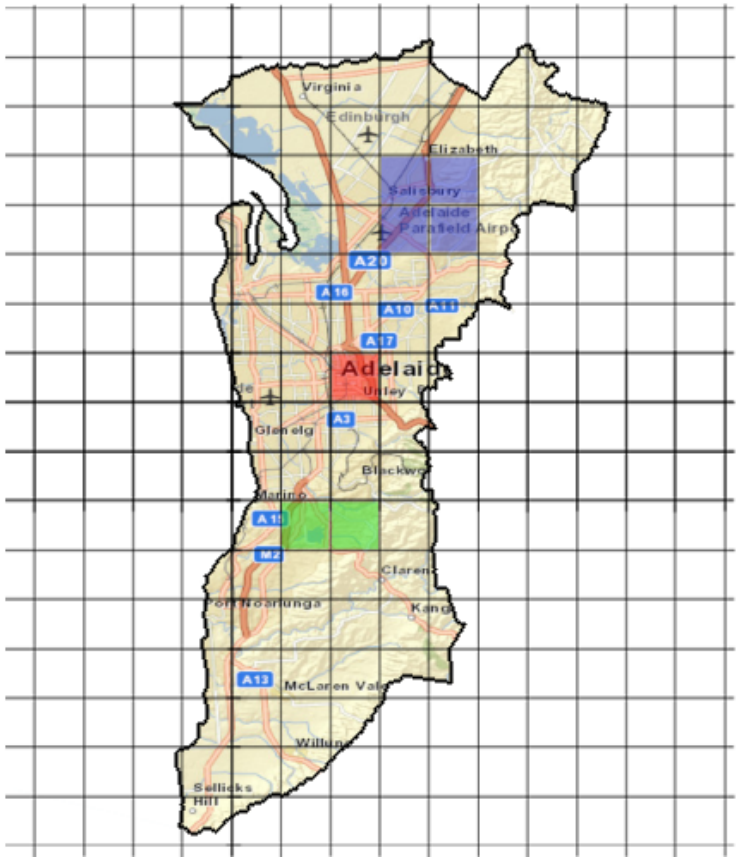
1,827 km^2



Understand the city

Use geo-divided grids to break down cities to areas.

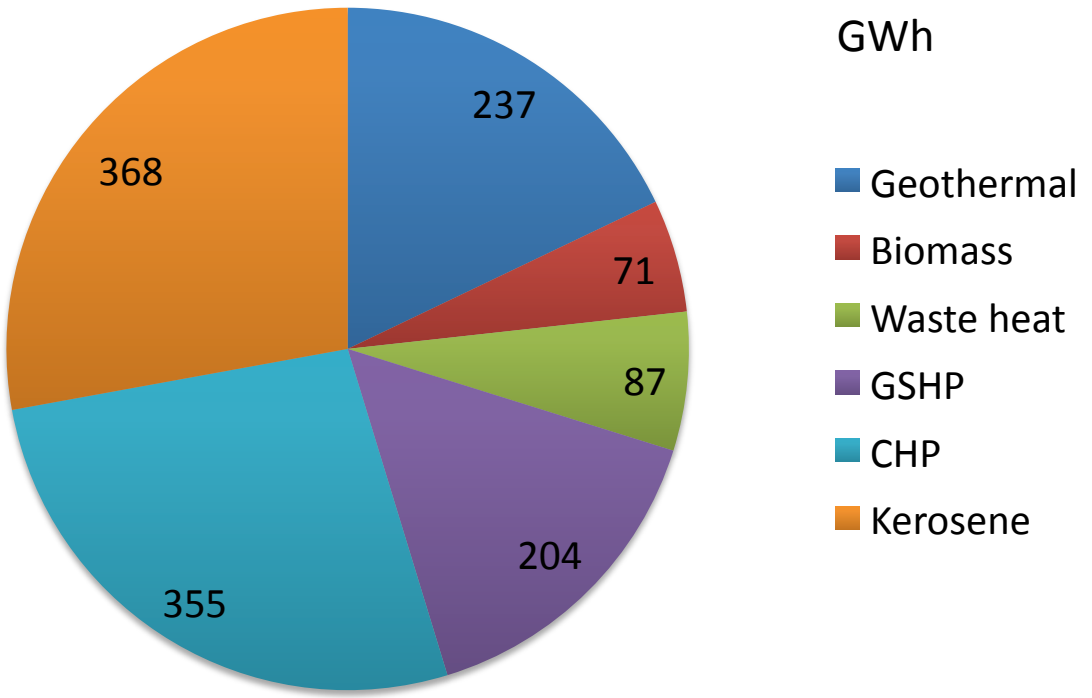
Adelaide



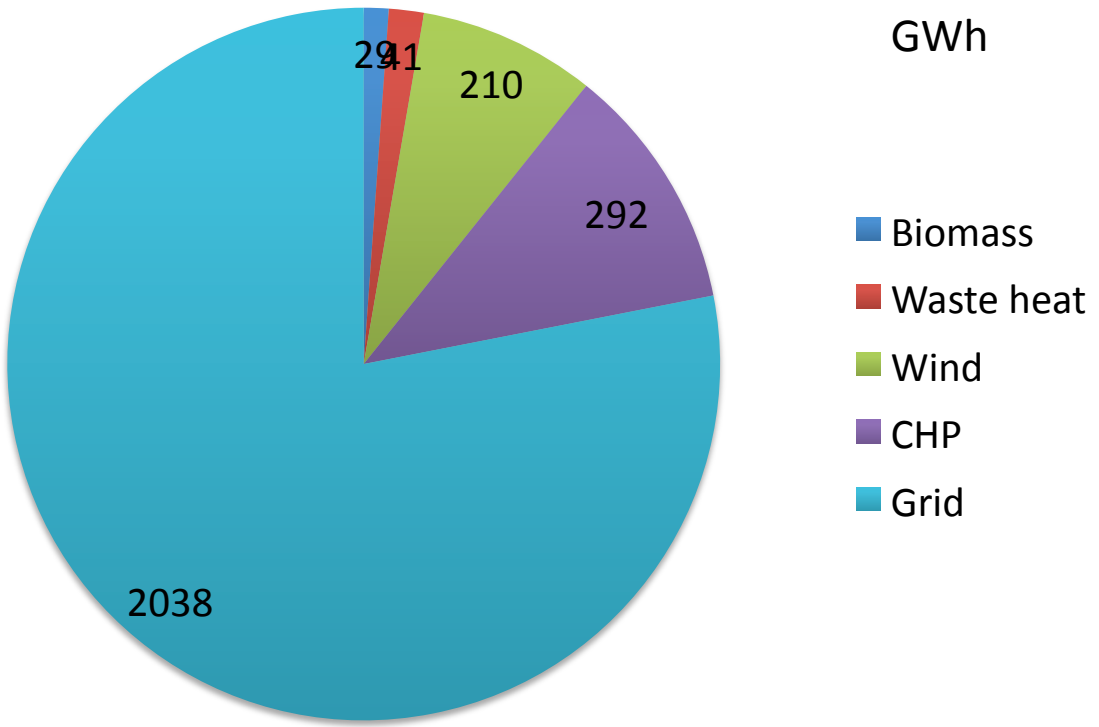
Future city design

Adelaide	Hirosaki
- smart energy grid meshed network with demand side management - house insulation - small scale CHP with absorption chillers CHPC in each zone - district cooling system - CHPC for industrial players and hospitals connected to the network - roof top PV and solar hot water exploiting large surface areas - waste incineration and biomass for cogeneration of heat to cooling an electricity -installation of large scale solar desalination plant and rain water storage tanks in each building to elevate water restrictions - hydrolysis plant for hydrogen generation - installation of central wind farm park outside city to feed in on central network	- smart energy grid meshed network with demand side management - house insulation - small scale CHP in each zone - district heating system also for road heating - CHP for industrial players and hospitals connected to the network - low exergy heat source through geothermal generation outside city center to feed in on district heating network - waste incineration and biomass for cogeneration of heat to cooling an electricity - installation of central wind farm park outside city to feed in on central network - hydrolysis plant for hydrogen generation

Potential heat supply of Hirosaki



Potential electricity supply of Hirosaki



Transition pathway

- The current situation of both cities is analysed and their future design is envisioned.
- Transition pathways and timeline to achieve the change have to be checked.
- The proposed pathway is to make distribution and transmission system operators in each city area key for the implementation and roll out of the smart energy network since they will provide the energy as well as own the local CHP generation units.
- The district thermal systems together with the electricity network will be owned and operated by them.
- The local government will be supporting the roll out through incentives under the form of tax reductions, subsidies for building insulation and local generation and feed-in tariffs for consumers as well as subsidies to roll out the smart network to the DSO and TSOs.

Conclusion

- The cities considered are constraint in terms of their future design through climatic extremities.
- Nevertheless, a general meshed zone approach can be used to create a future smart and resilient network with different resources using transition theory.
- In terms of **sustainability**, the future city designs increase efficient use of locally available energy resources such as wind and geothermal as well as cogeneration. The energy demand is decreased through building insulation and smart network demand side management.
- In terms of **resilience**, the meshed network structure with multiple sources provides flexibility and smart usage of the generation sources.