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CENTRE FOR SMART ENERGY SYSTEMS

Integration of localised renewable energy into a meat processing site

Michael Walmsley, Elsa Klinac, Shafiq Tito, Martin J. Atkins, Mark Apperley

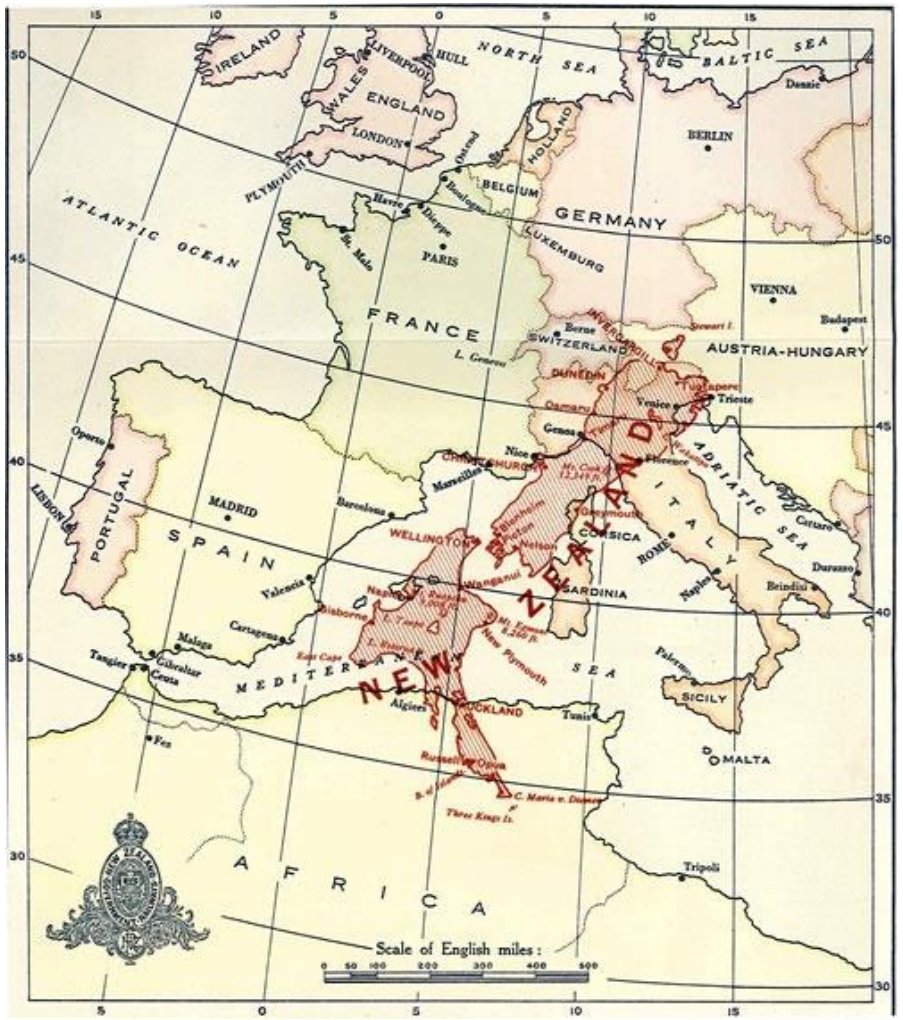
Ahuora – Centre for Smart Energy Systems

The University of Waikato

PRES'23 Conference | 8 - 11th Oct 2023

Overview

1. Industry decarbonisation challenge
2. Decarbonising meat processing
3. Factory centred energy communities
4. NZ meat processing case study
5. Results
6. Further work



If New Zealand were in Europe

Decarbonising process heat in Industry

Three focuses
(1) Reduce demand
(2) New Technology
(3) Fuel switch

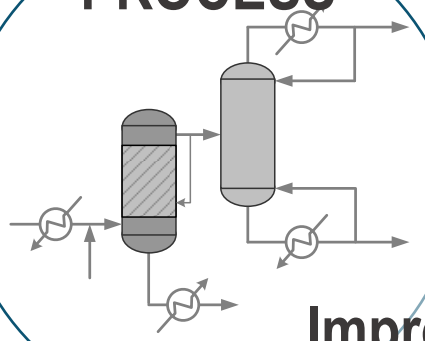
NATIONAL – REGIONAL ENERGY SYSTEMS



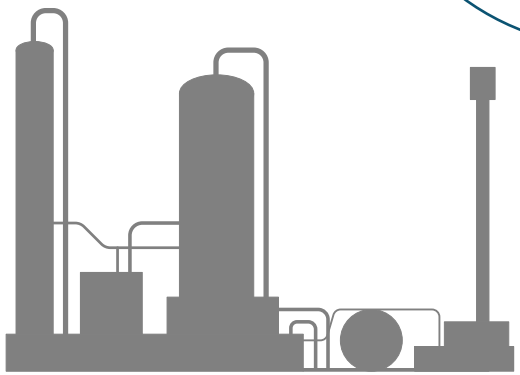


Integrate renewable energy
- Electricity
- Biomass + green H2

PROCESS



Improve process efficiency

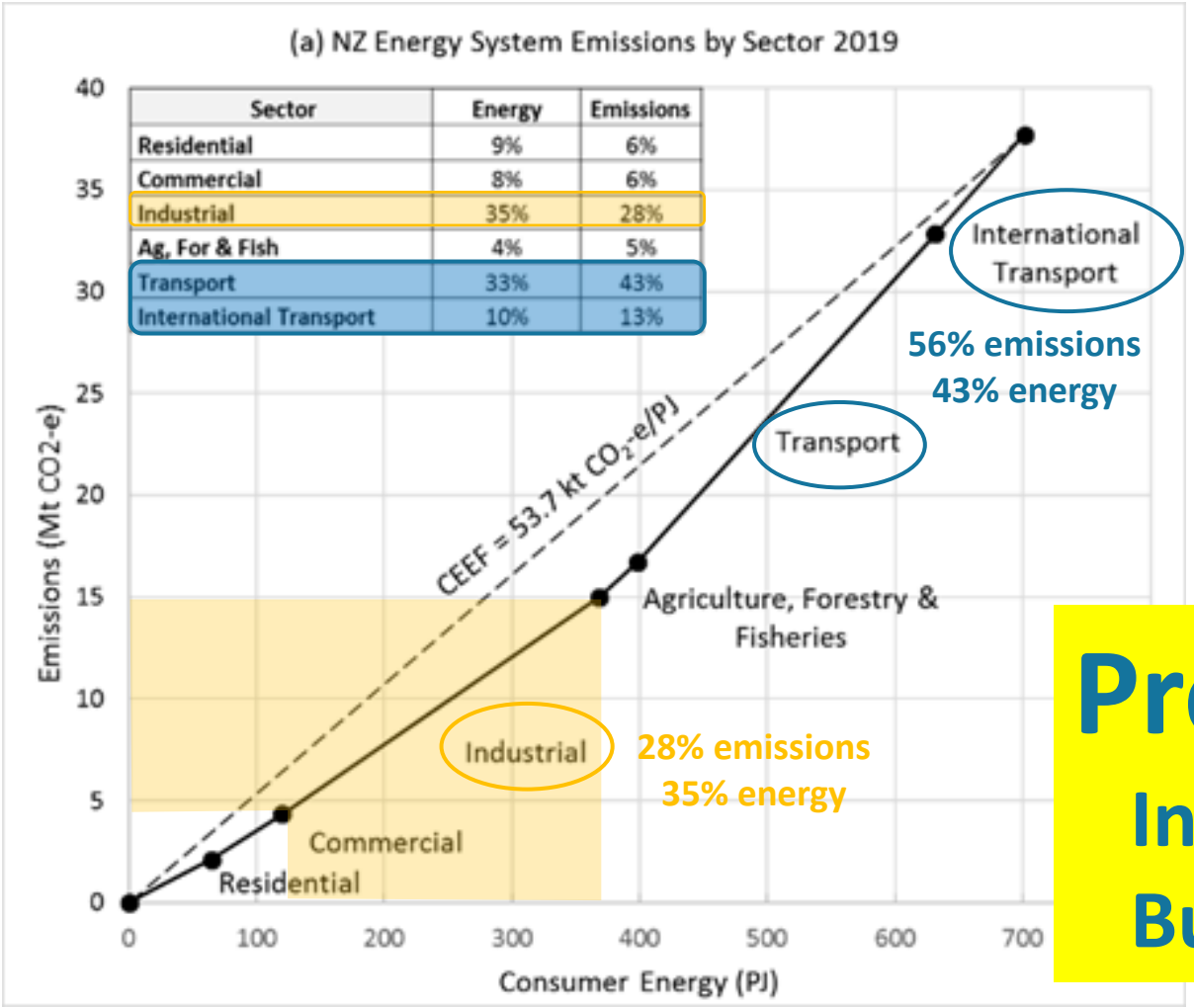


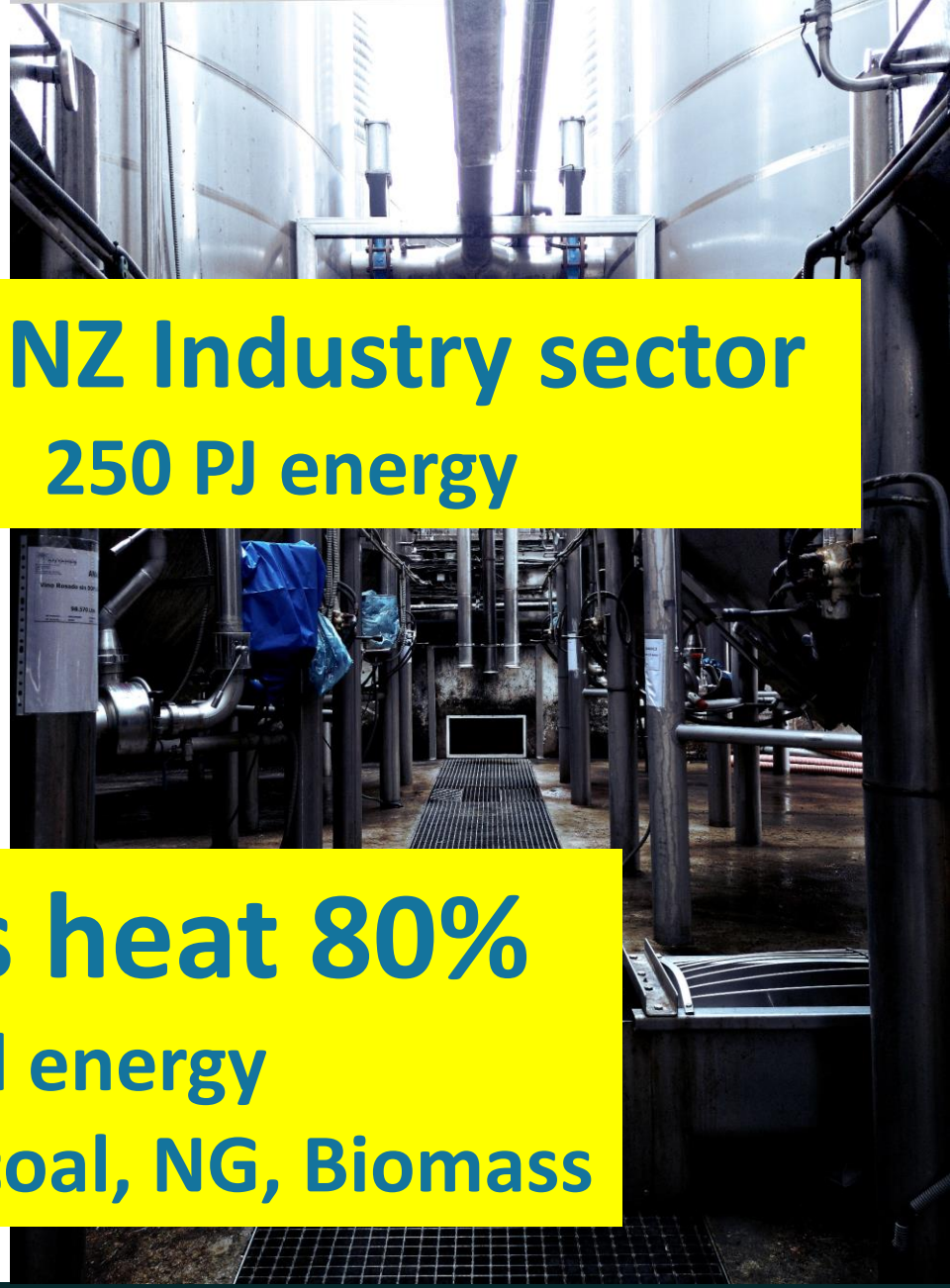
FACTORY SITE

Adopt low emissions heating technology

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Energy consumption in NZ





NZ Industry sector

250 PJ energy

Process heat 80%

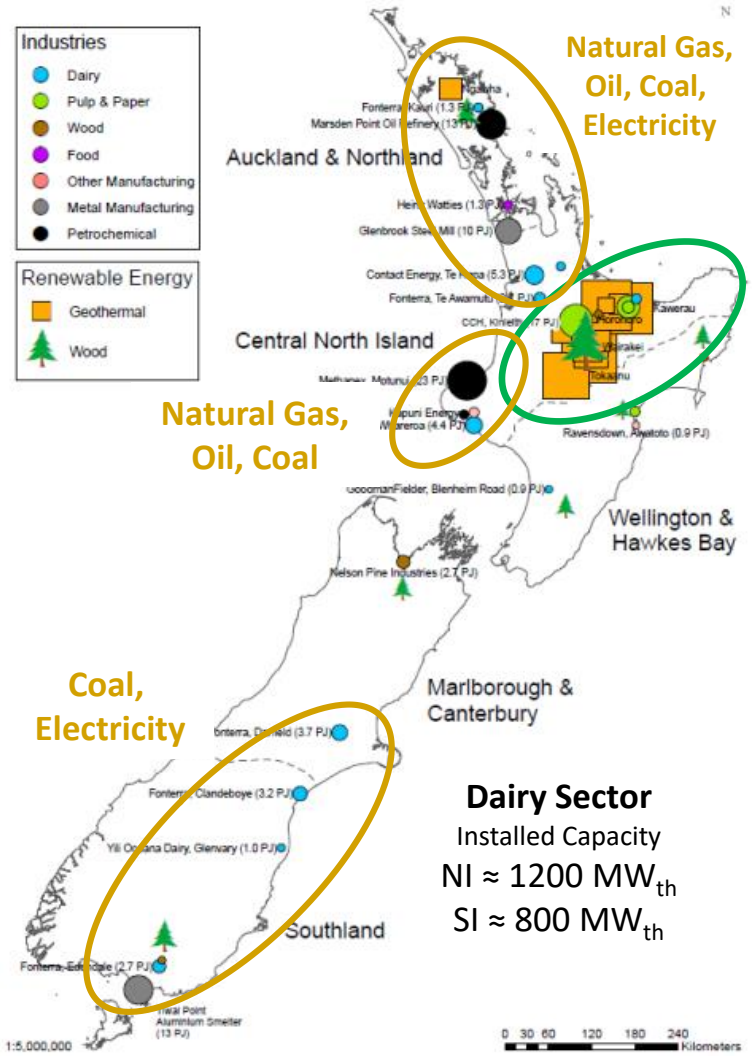
Industrial energy

Burning coal, NG, Biomass

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New Zealand situation 2022

- **Electricity 85% renewable**
  - Hydro 62%
  - Geothermal 16%
  - Wind 6%
  - Biomass 1%
  - **Coal/NG 15% (retire by 2030?)**
- **Process heat 37% renewable**
  - Geothermal 3%
  - Biomass/Black Liquor 28%
  - Electricity 7%
  - **Coal 20%**
  - **NG 34%**
  - **Oil 9%**

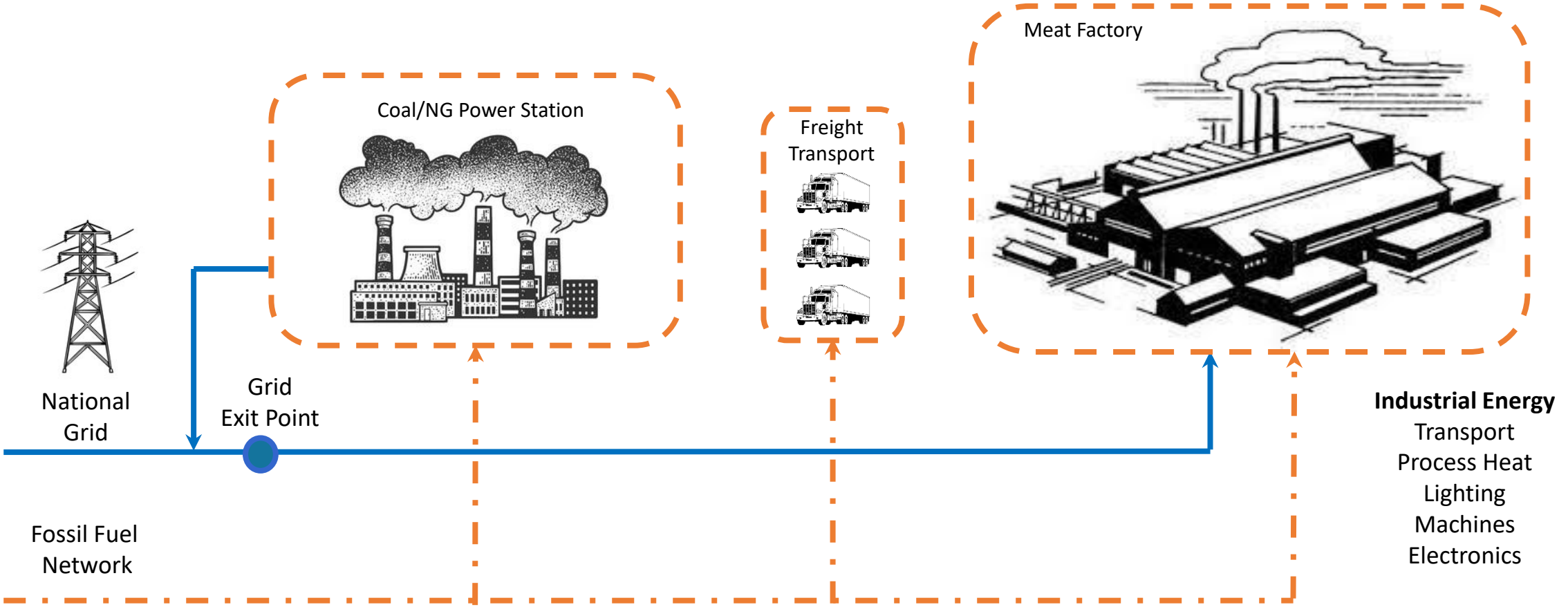


Number of plants by sector (Atkins 2019)

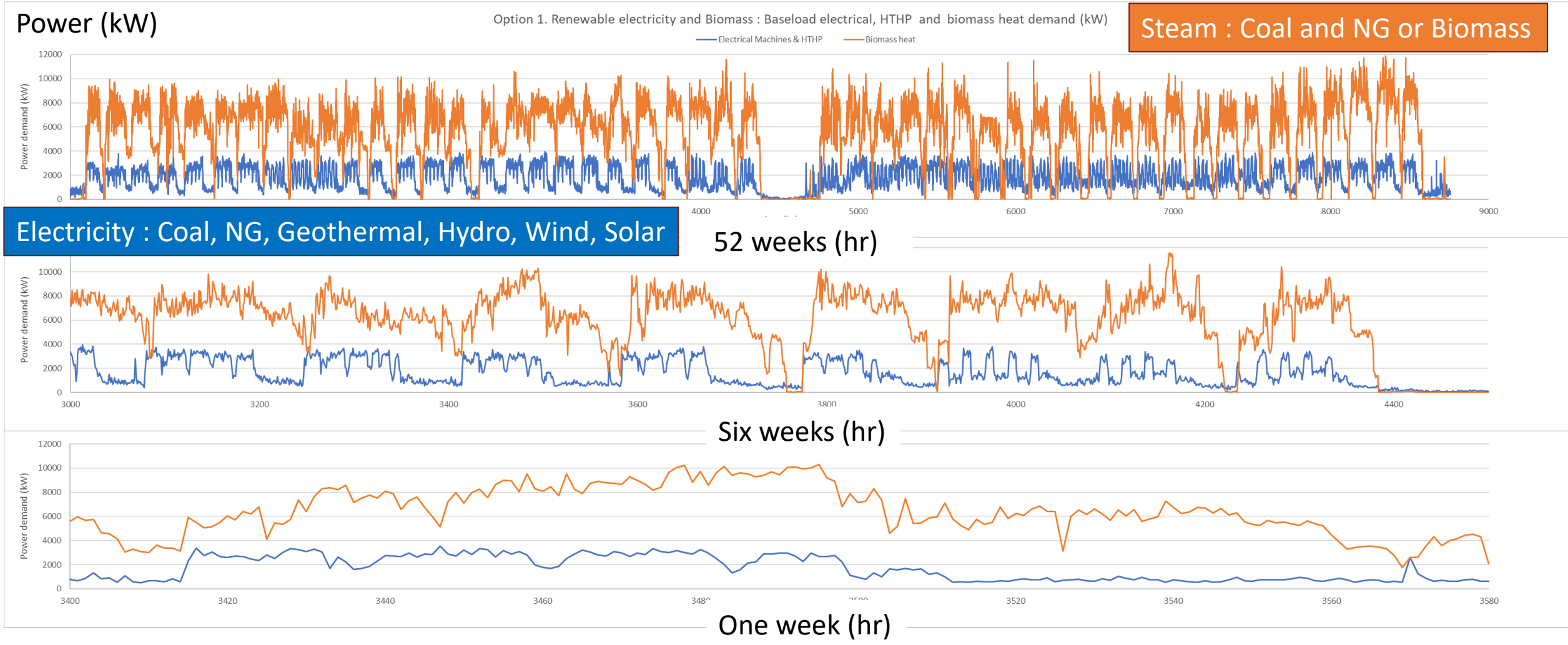
	Sector/process	Number of plants in New Zealand
Boiler plant	Dairy processing *milk powder / other*	≈80 *≈50/30*
	Meat processing	86
	Other food	44
	Wood processing	75
Tightly integrated	Methanol	2
	Urea	1
	Refining	1
	Steel	1
	Aluminium	1
	Cement	1
	Kraft pulp	2

Decarbonising meat processing in NZ

Meat processing example - 2023

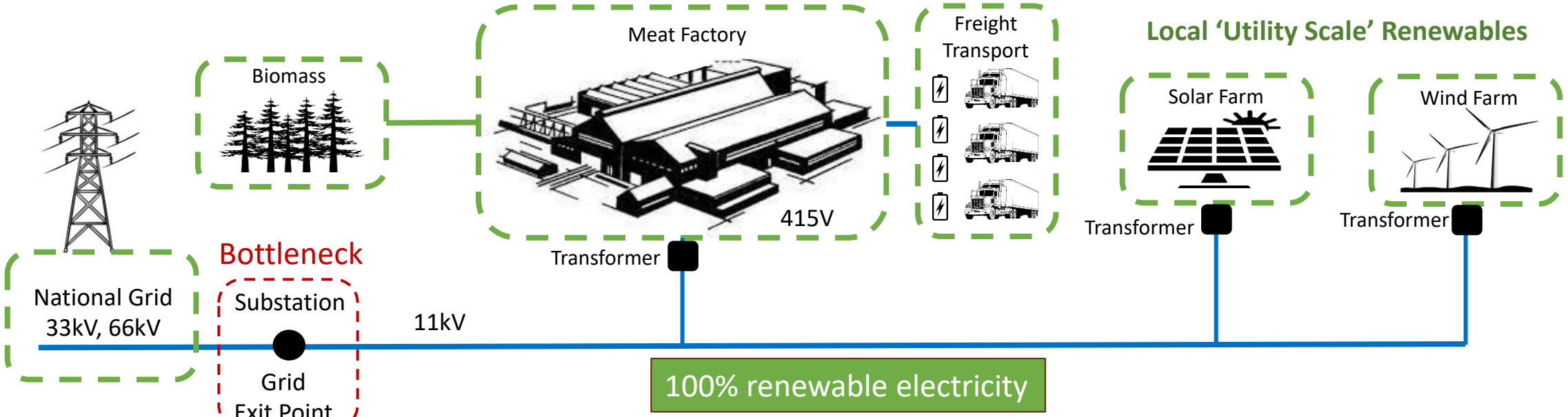


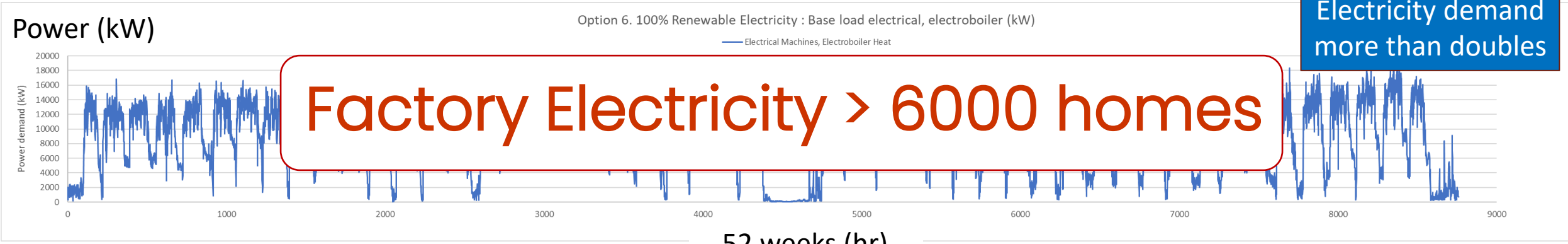
Meat factory energy demand – 2023



What does the future look like?

Decarbonising a meat factory - 2040



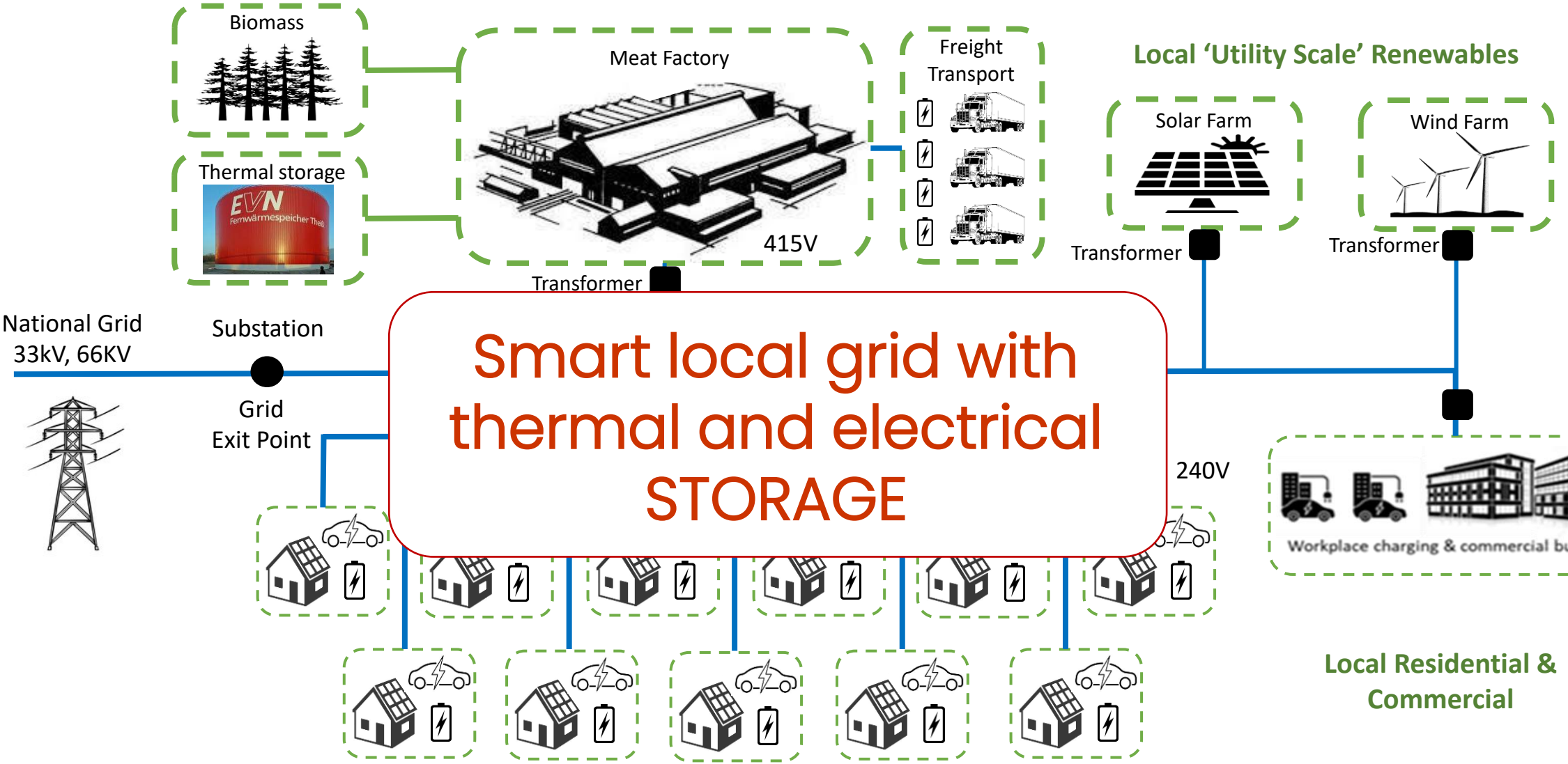


Factory Electricity > 6000 homes

Electricity demand more than doubles

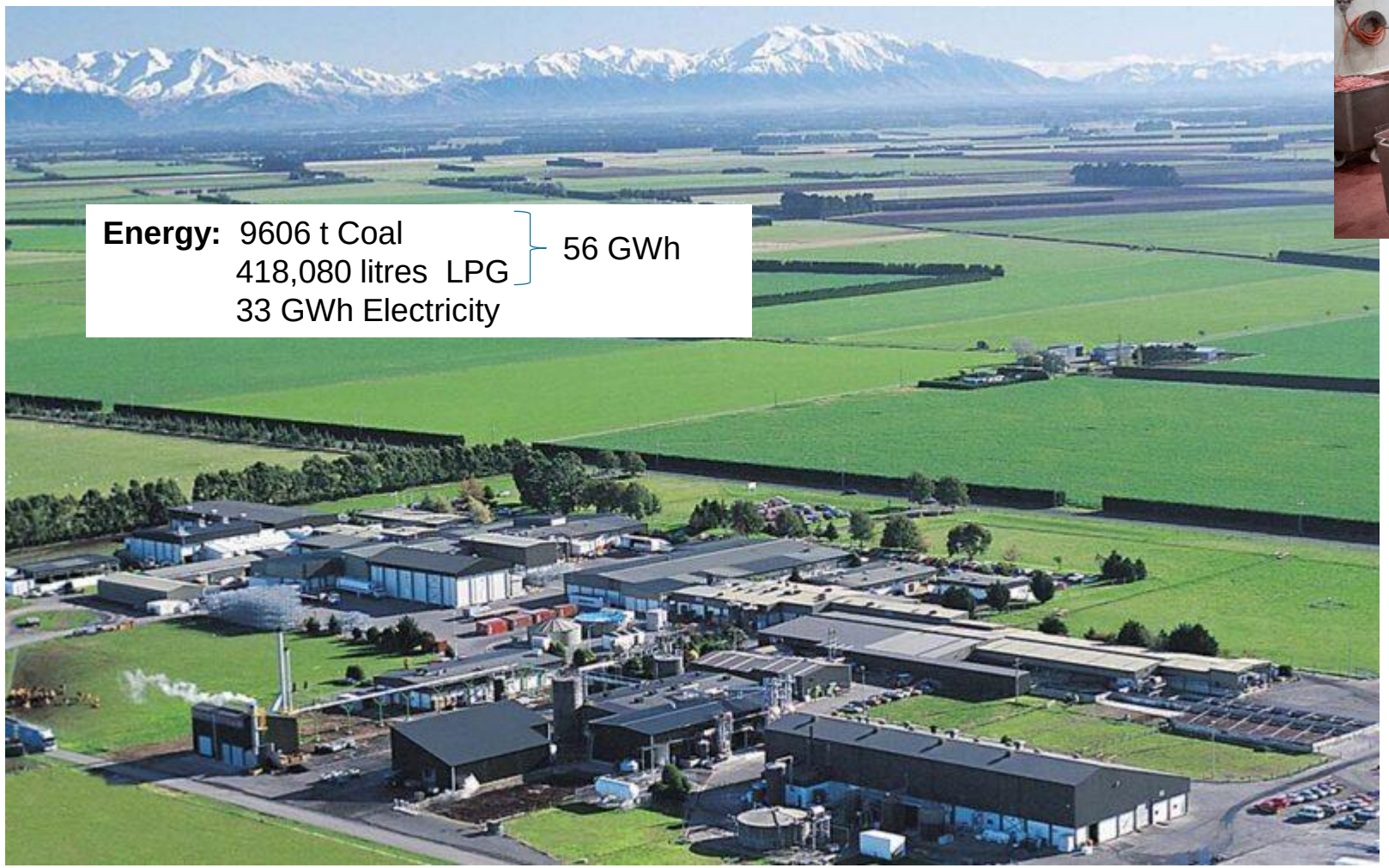
Integrate the factory with the community at the grid edge

Decarbonising a meat factory - 2040



NZ meat processing case study

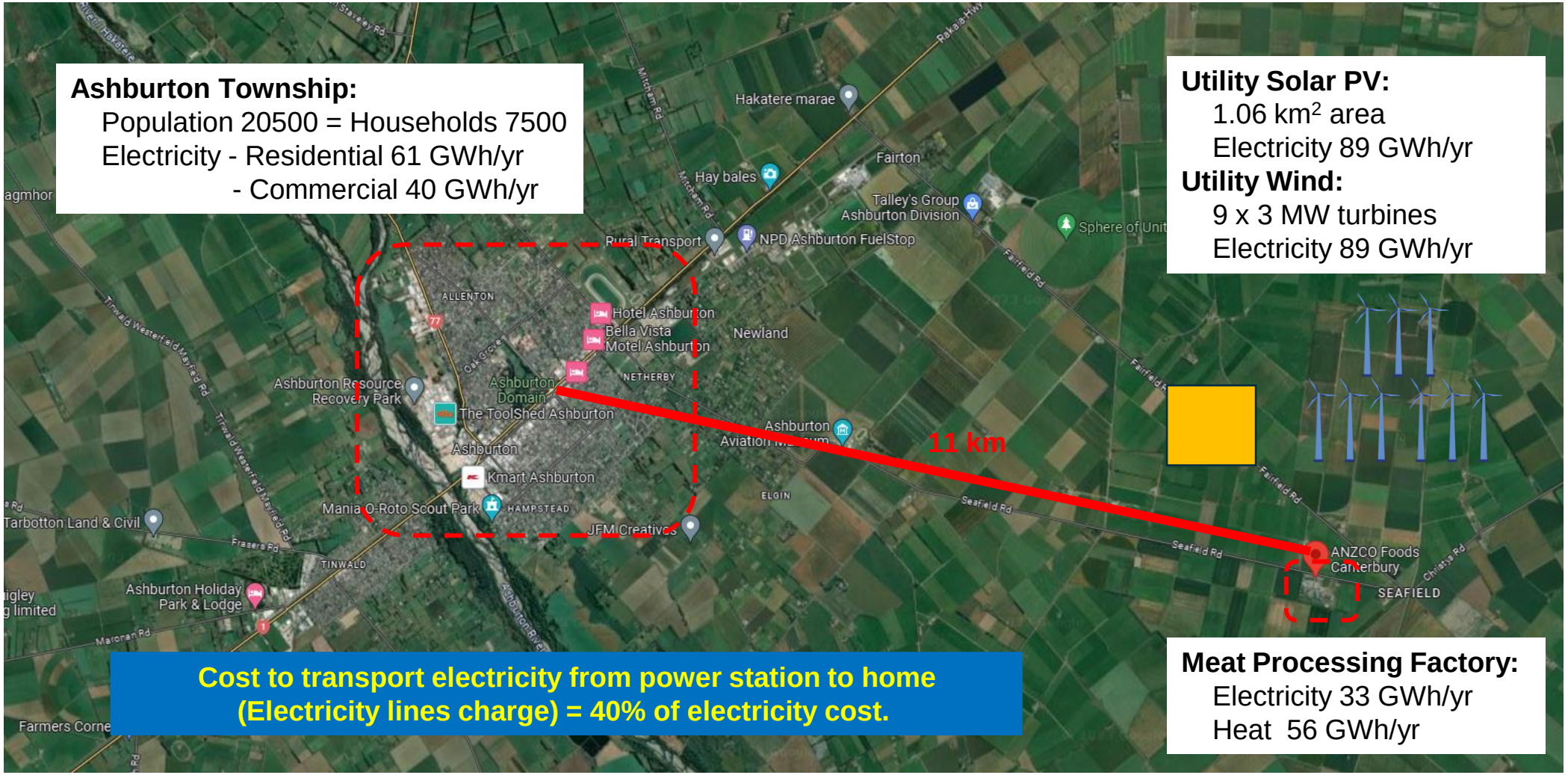
NZ meat processing plant



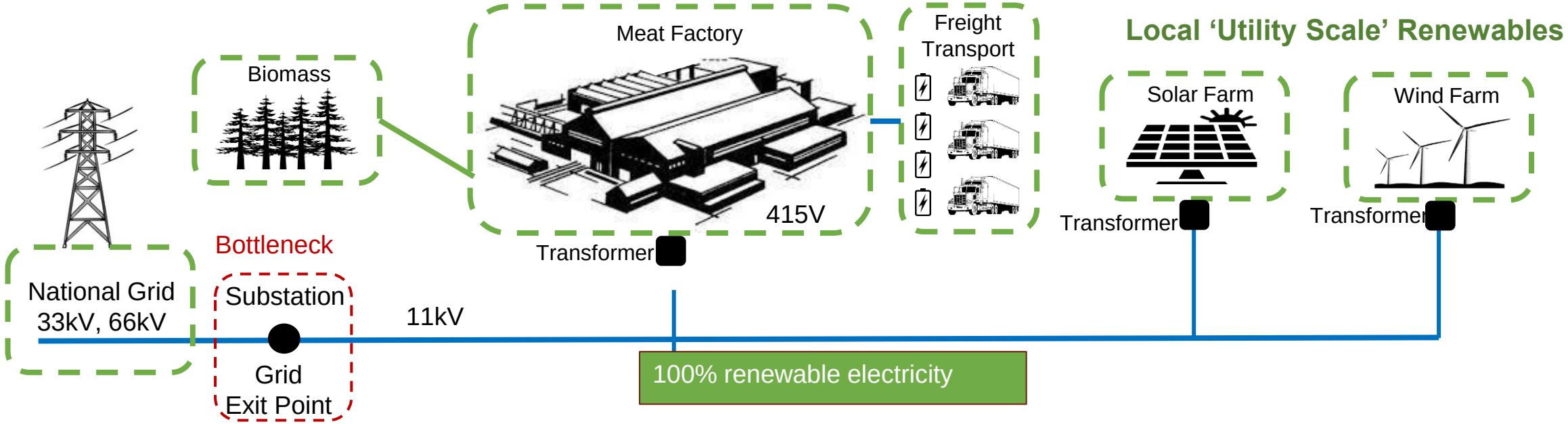


Animal Processing:
1.3 million lambs per year
800,000 beef per year
Meat Processing:
Slaughter house
Boning
Casing
Rendering
Fellmongery

Energy Community and NetZEF



Decarbonising a meat factory - future



Fuel switching options:

1. Biomass
2. Renewable electricity - Electro Boilers
3. Medium Temperature Heat Pumps (< 90°C)
4. High Temperature Heat Pumps (< 150°C)

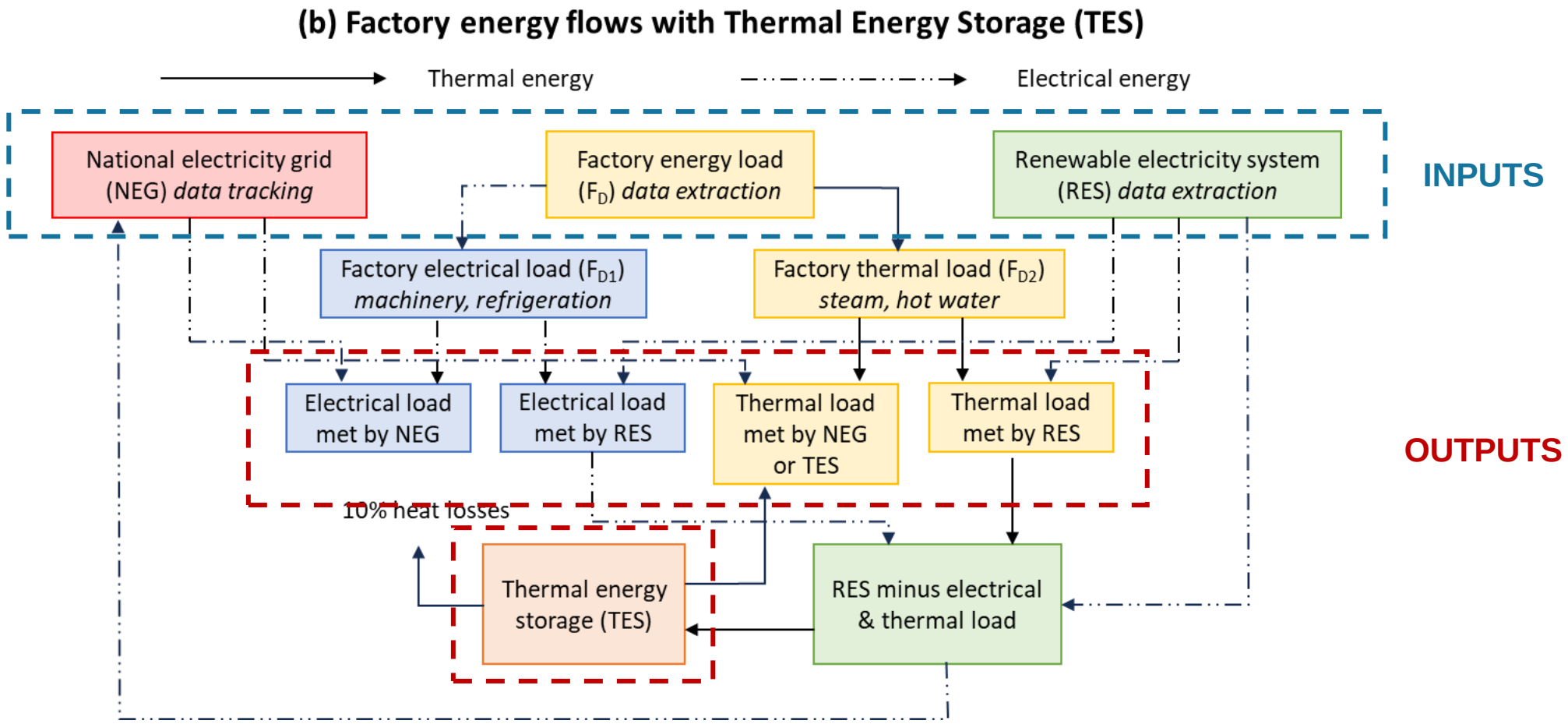
Energy storage:

1. Hot water thermal
2. Battery

Utility scale renewables:

1. Solar PV farm
2. Wind farm

Spreadsheet model

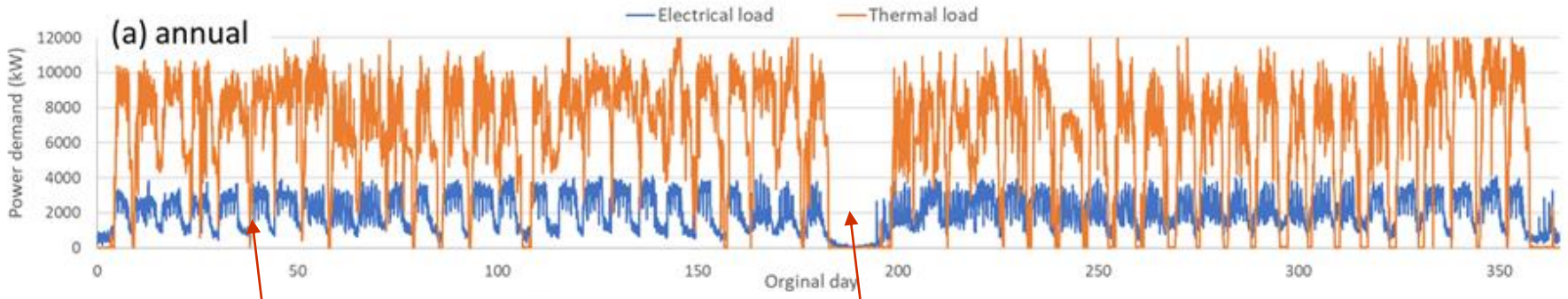


Factory energy load

Meat Factory Energy Loads > 6000 houses

10 MW

3 MW



Weekly Schedule

Annual Plant Shut

10 MW + 3 MW = 13 MW energy peak

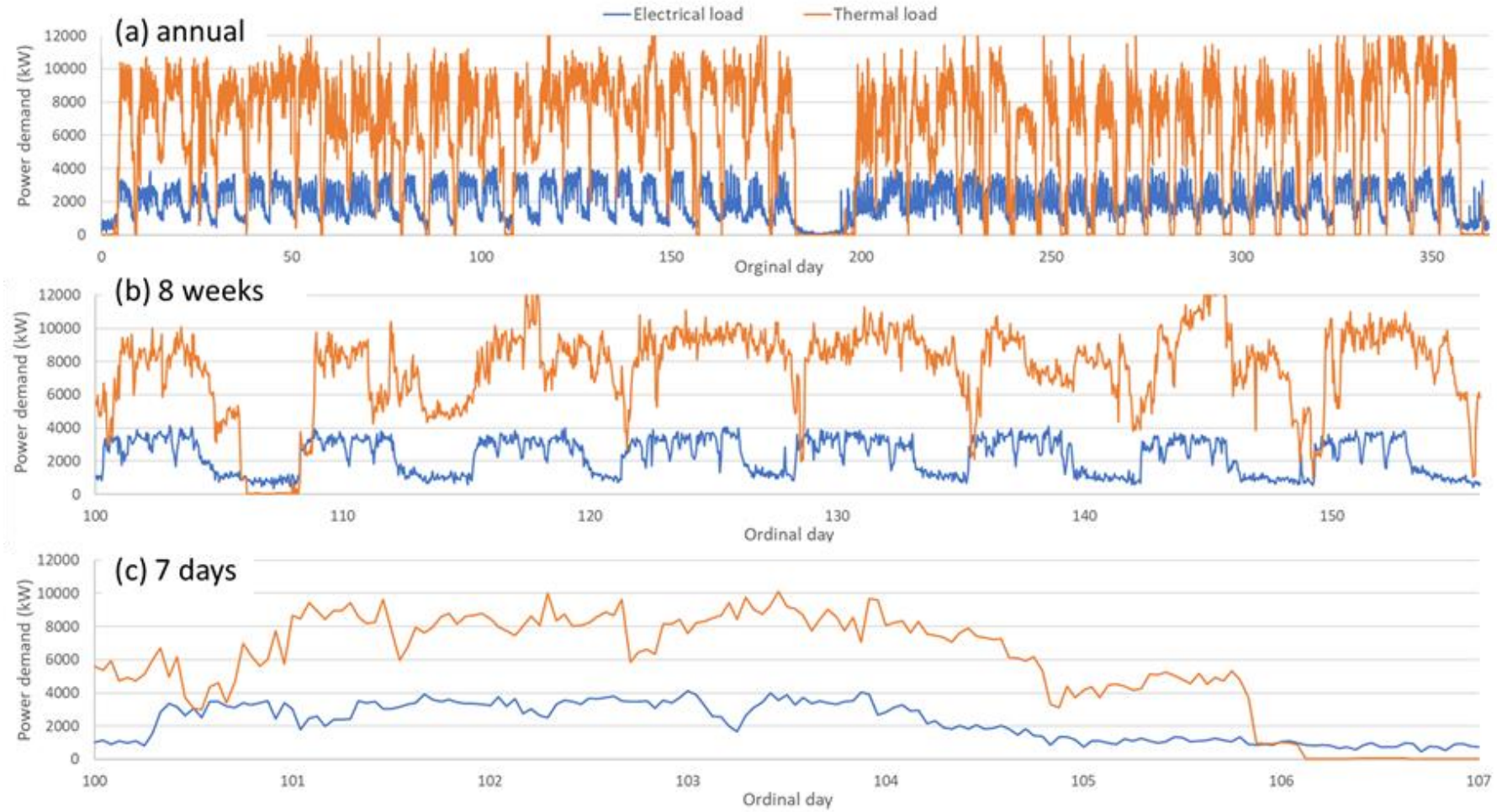
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Factory energy load

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3 MW

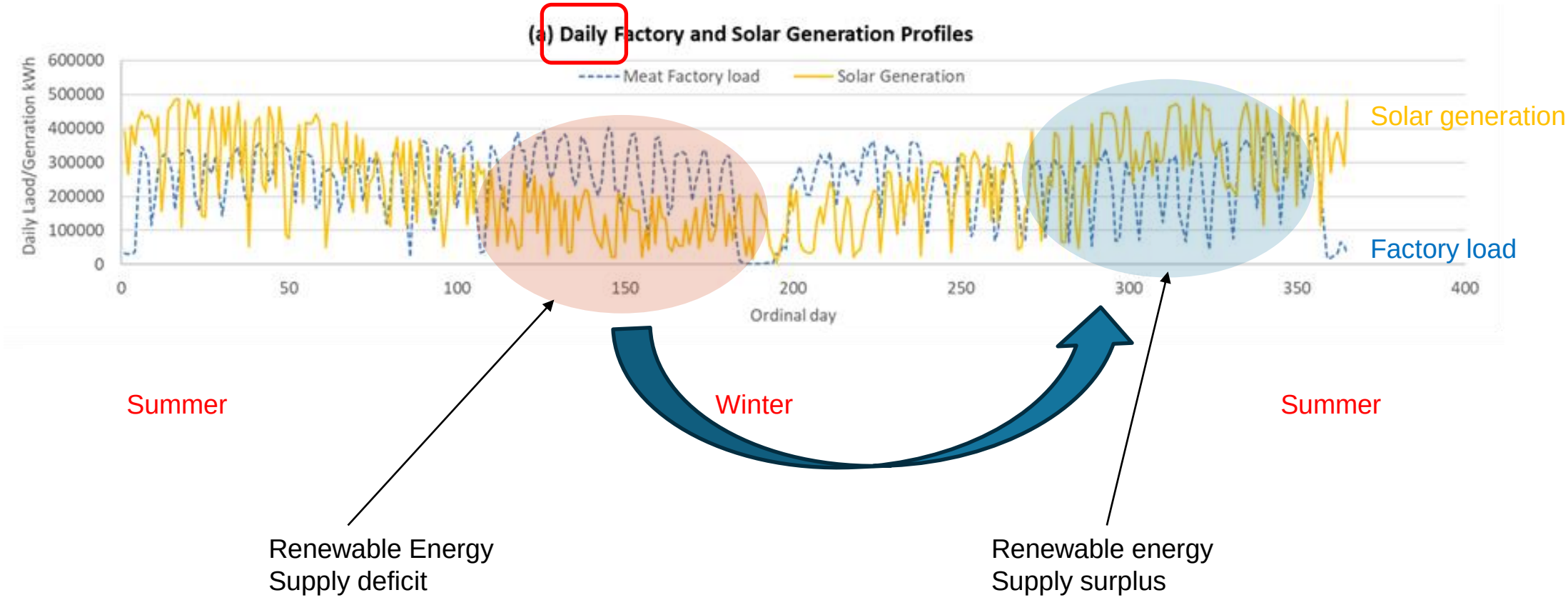


Weekly Schedule

13 MW energy peak

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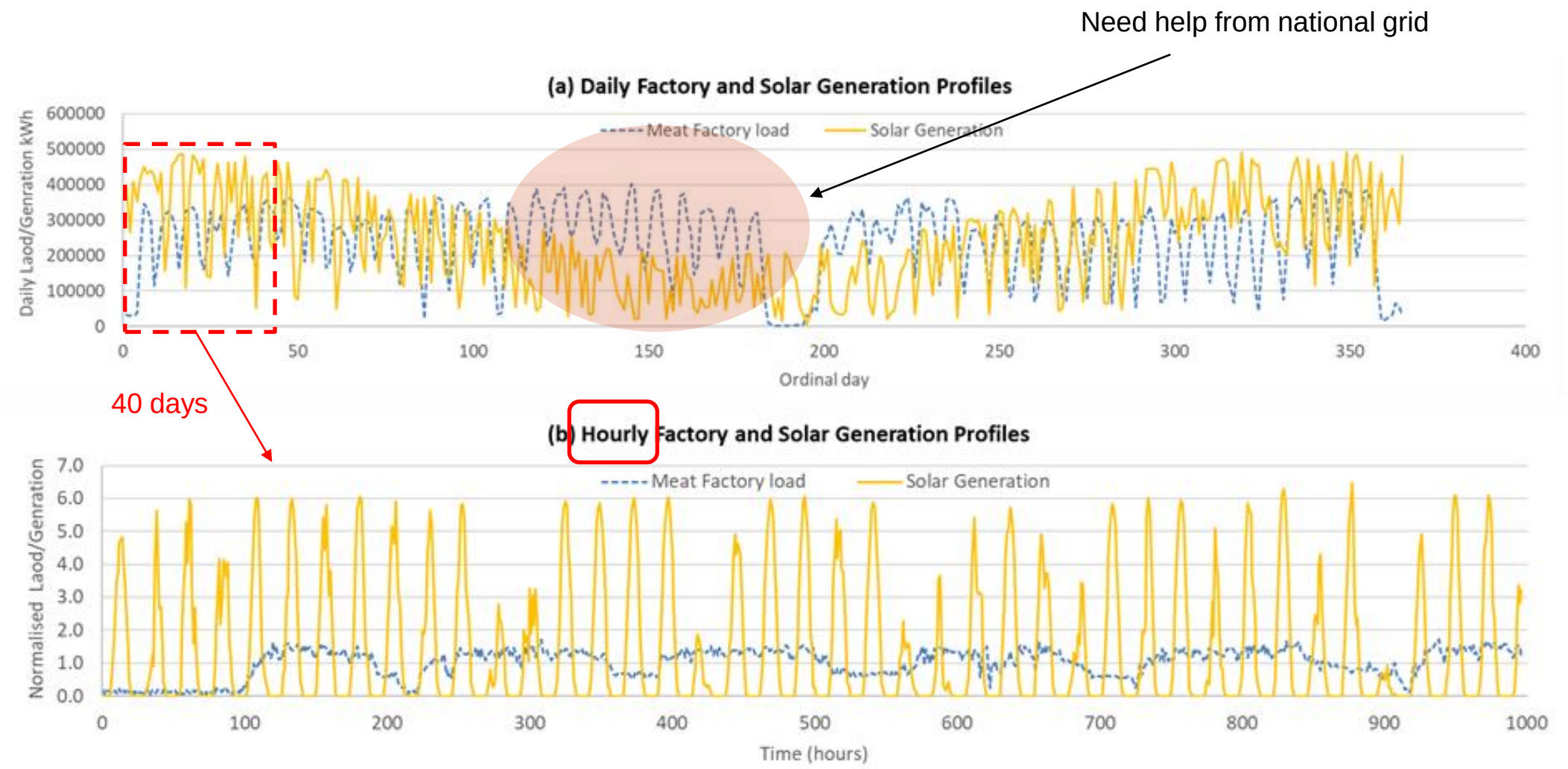
Solar PV electricity supply



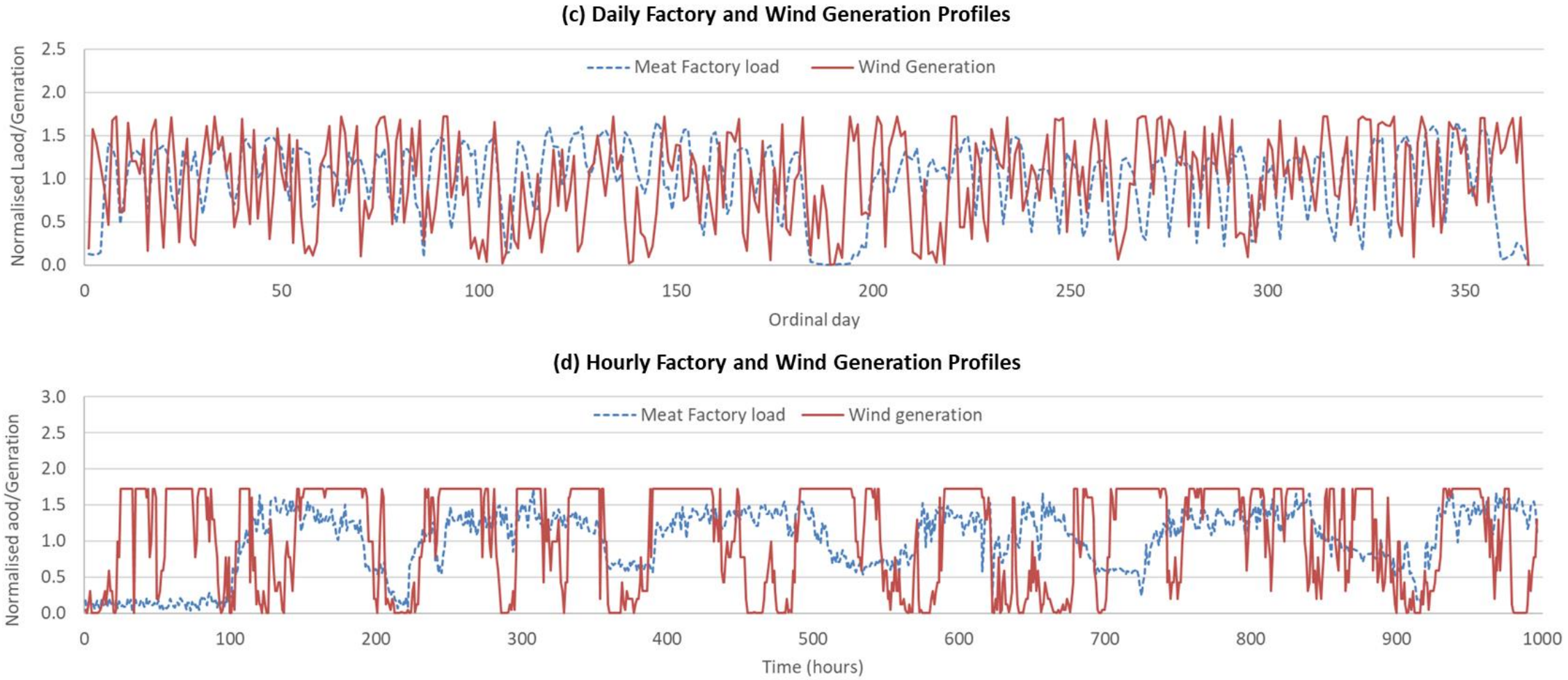
Large energy storage BALANCE seasonal variation

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Solar PV electricity supply

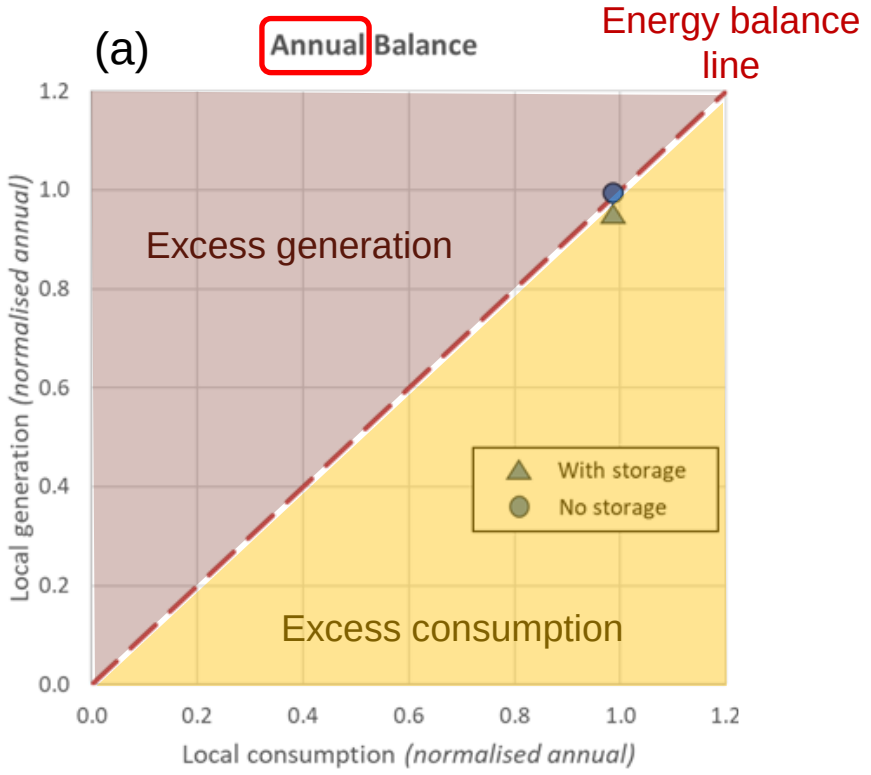


Wind electricity supply



Energy balance – demand and supply

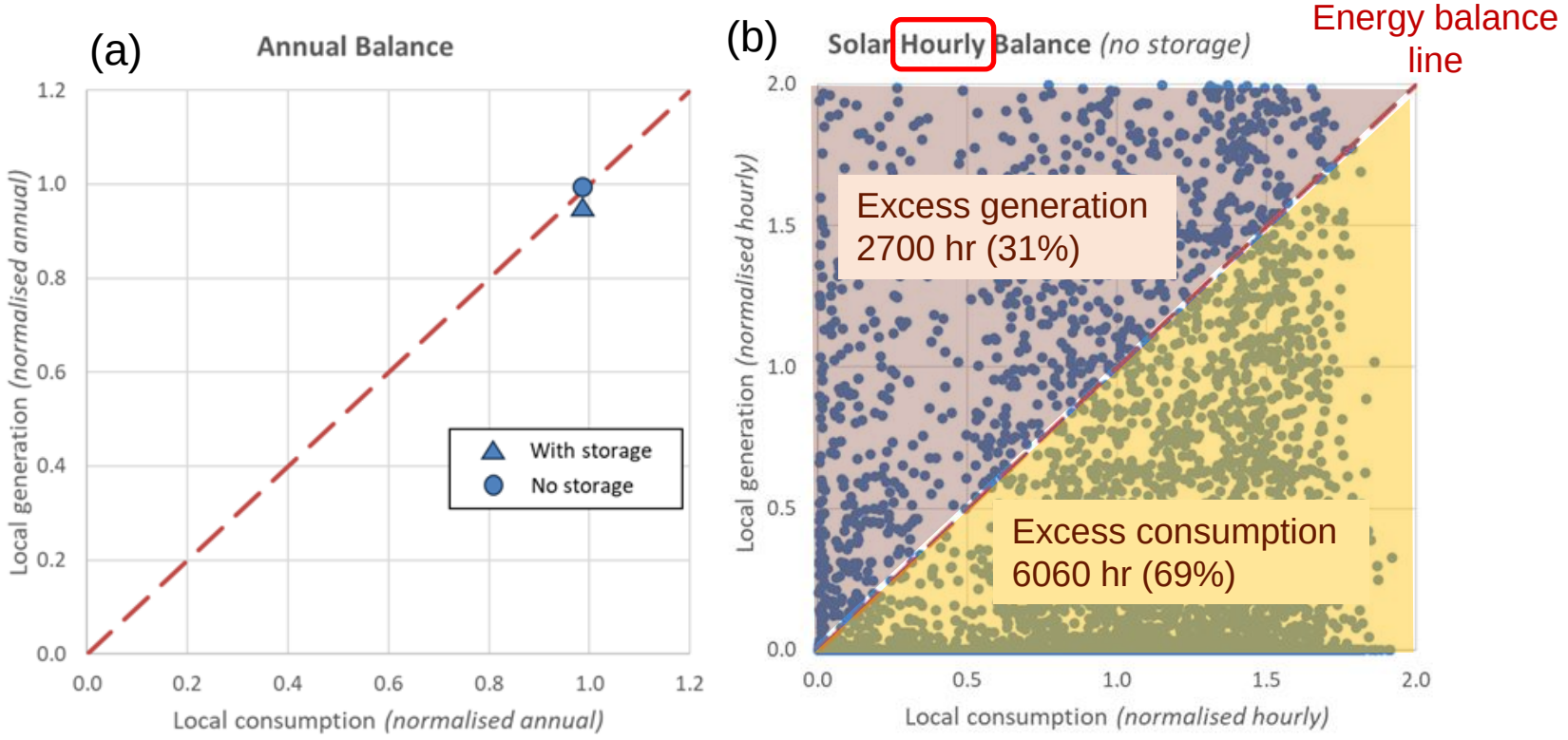
NetZEF (Net Zero Energy Factory)



Net-Zero interval energy balance plots for the example meat factory connected to a utility solar farm; (a) the annual balance with and without storage; (b) hourly balance without storage; (c) hourly balance with storage equivalent to 2 average day's consumption. TES starts 50% full

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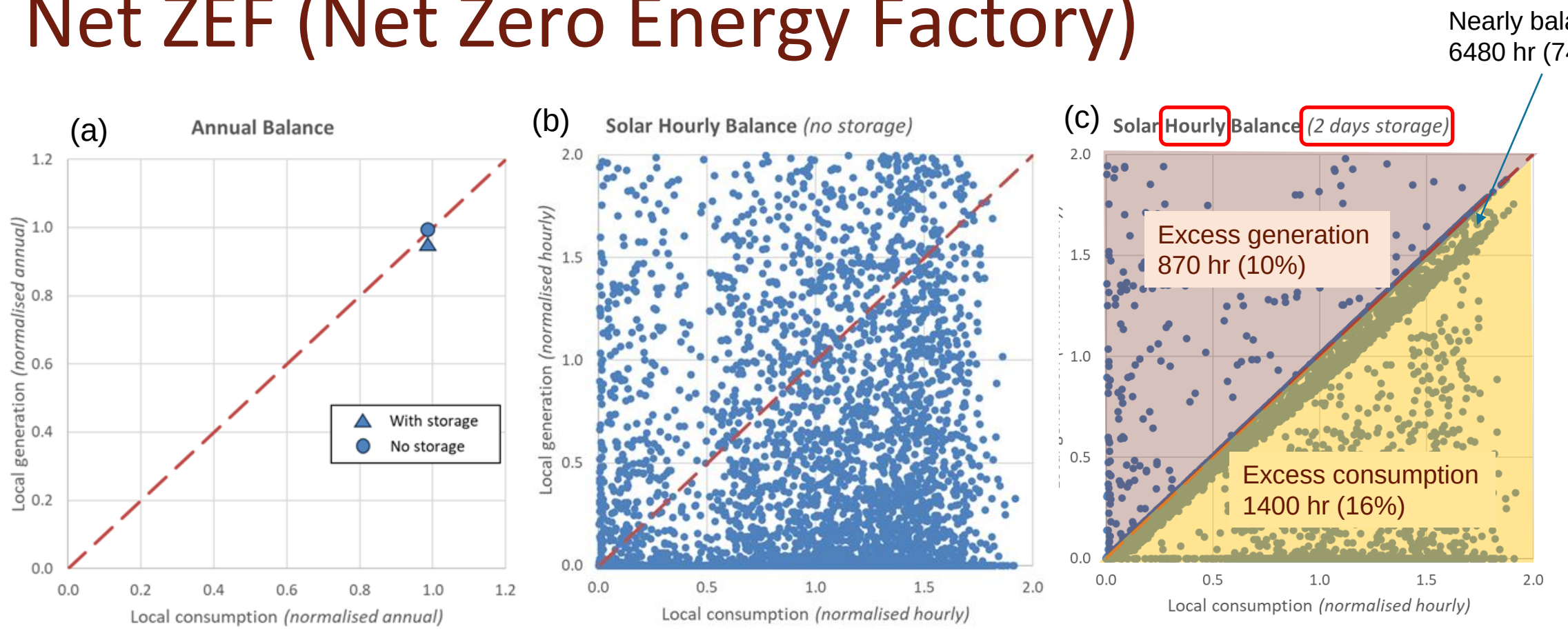
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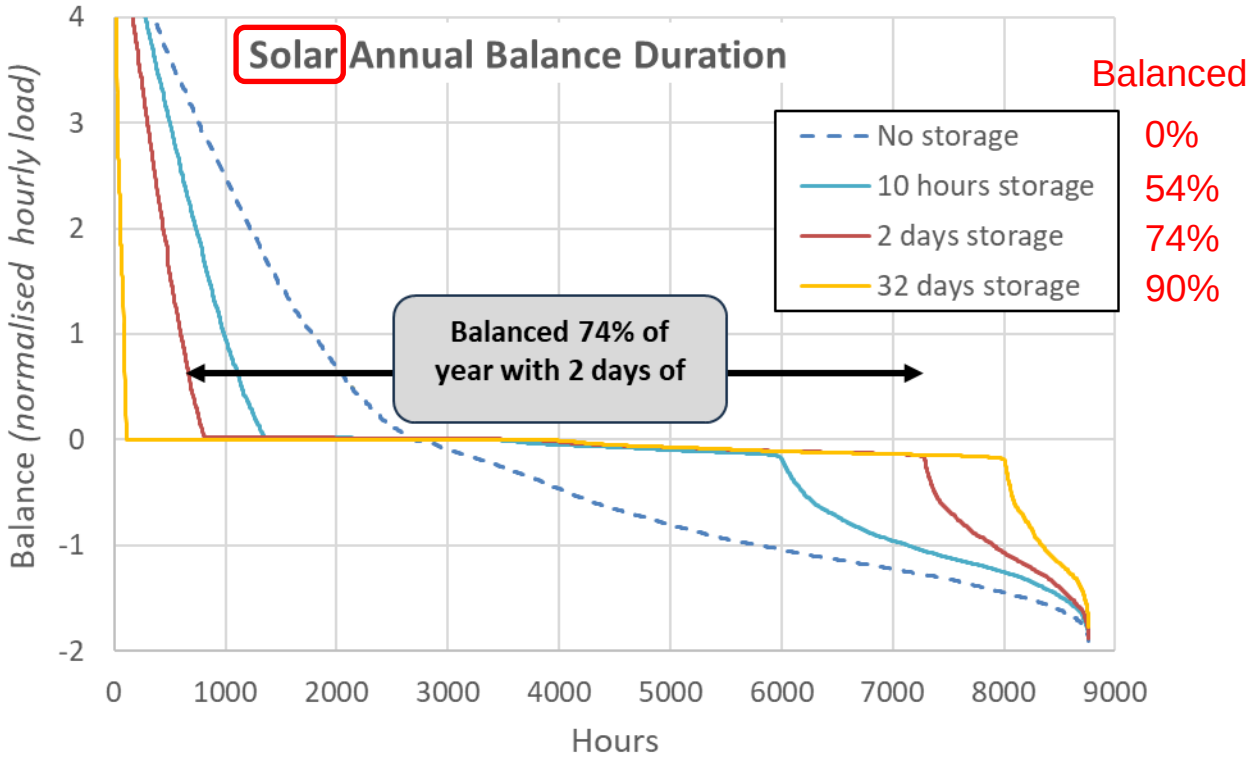
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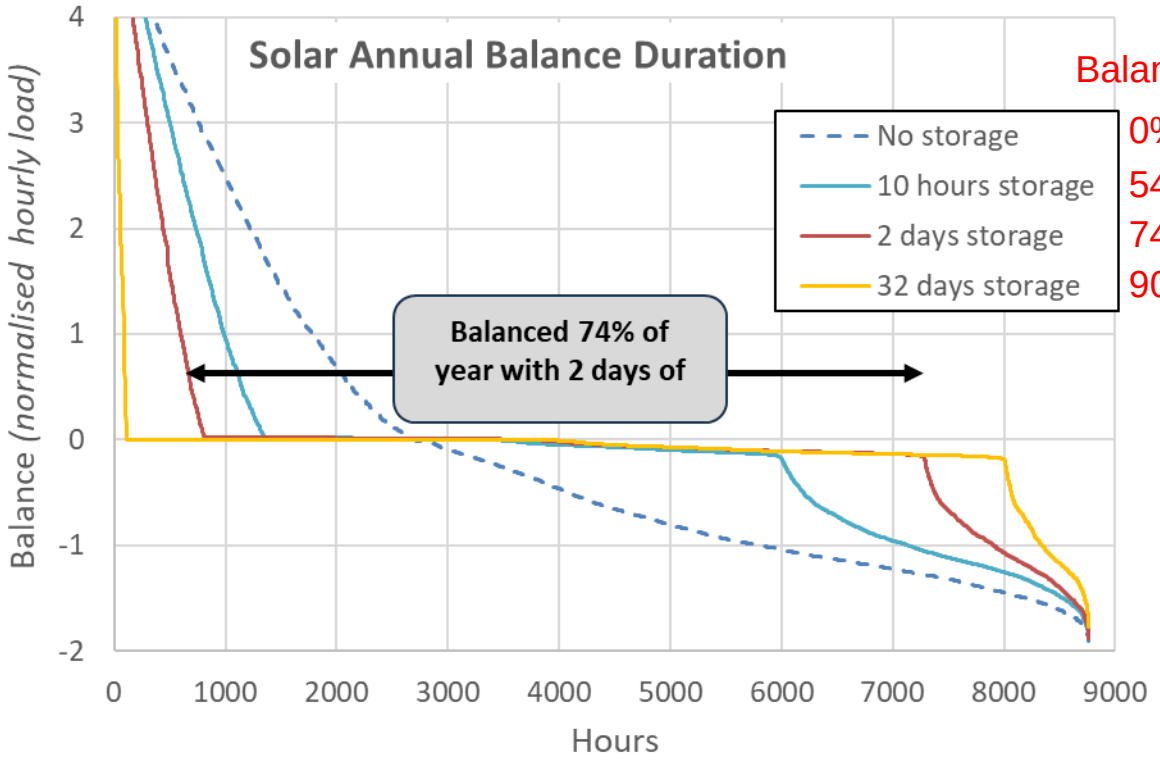
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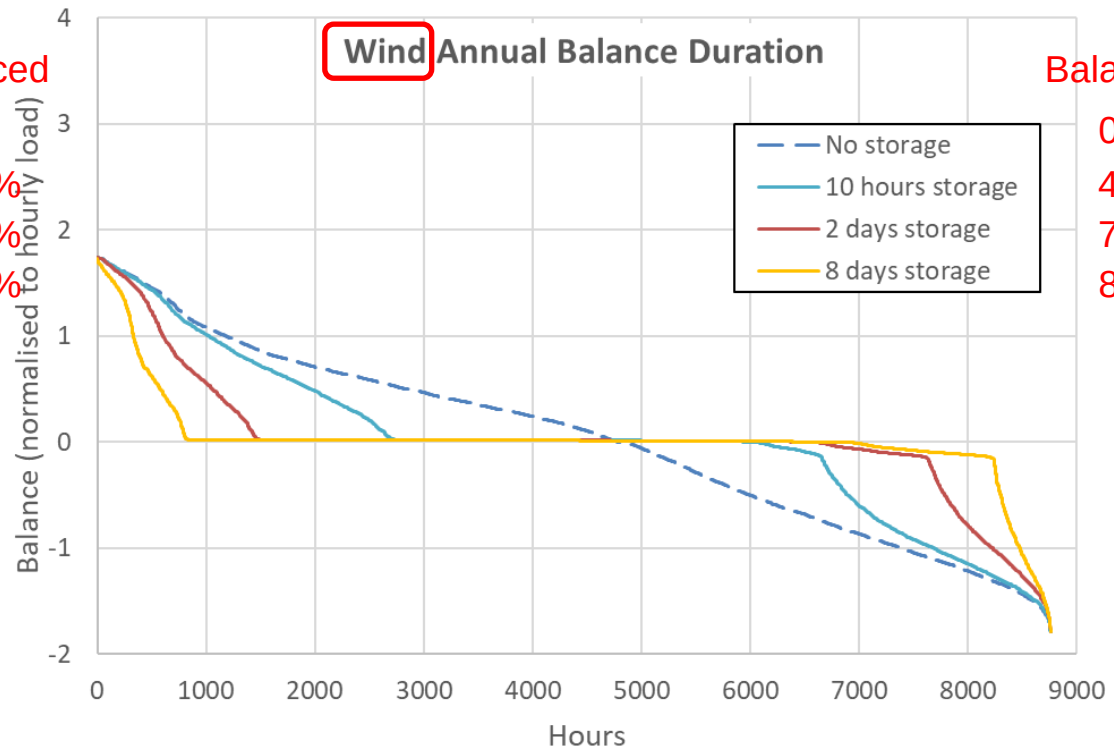
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Solar and wind annual balance

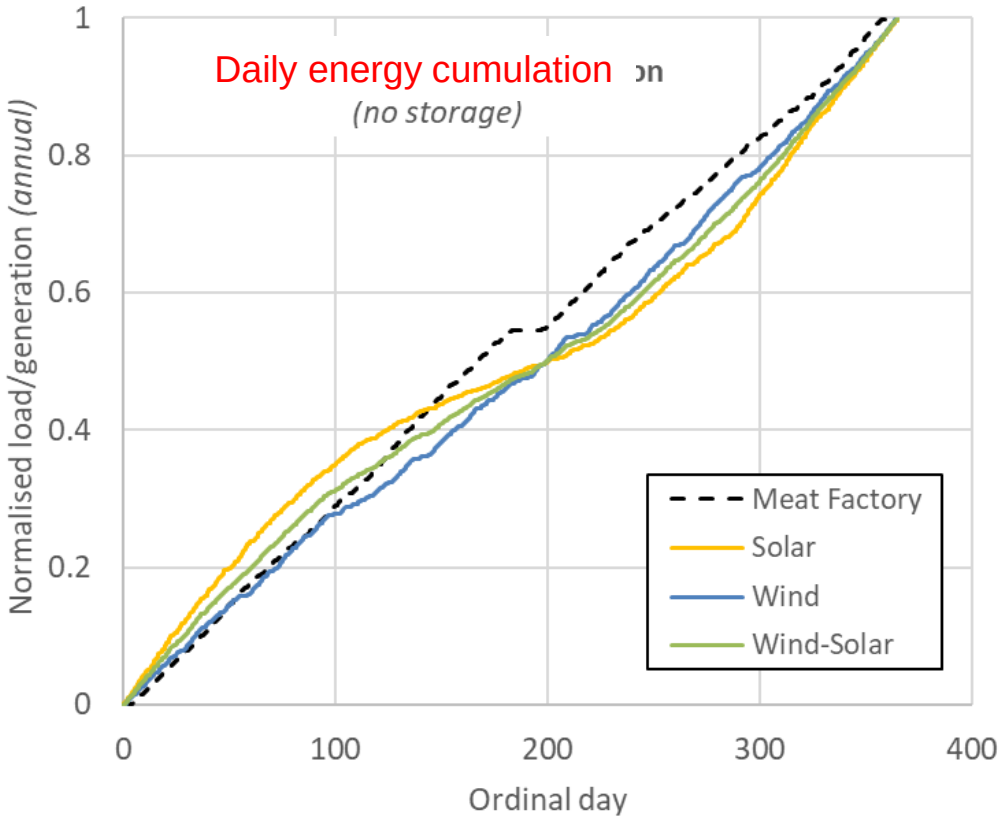


Solar and wind annual balance



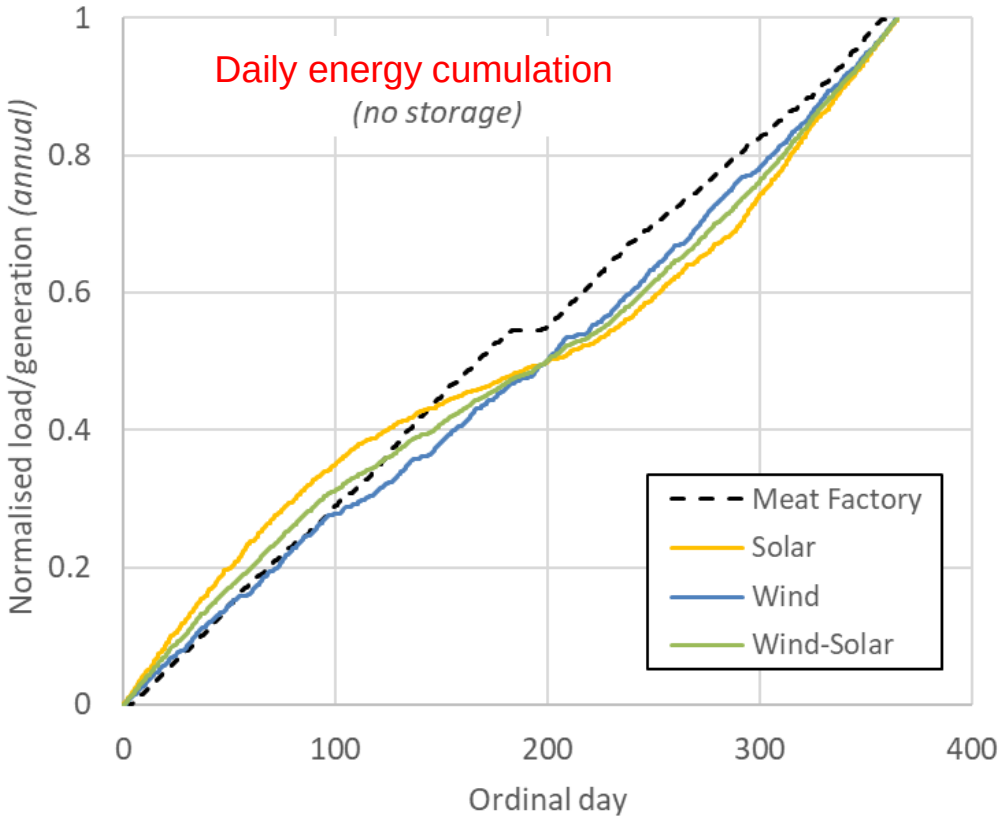


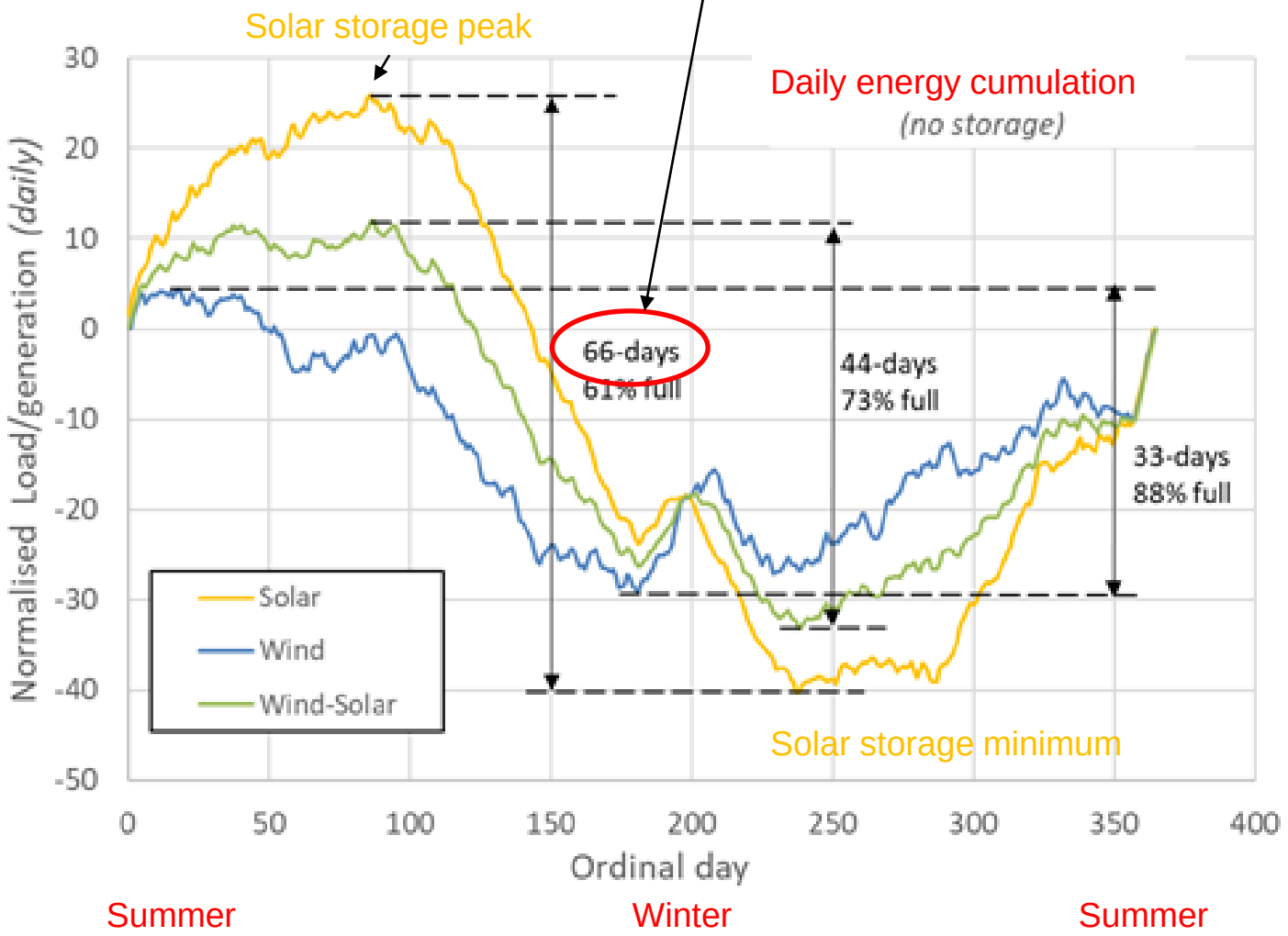
Sizing energy storage capacity



Summer Winter Summer

Sizing energy storage capacity

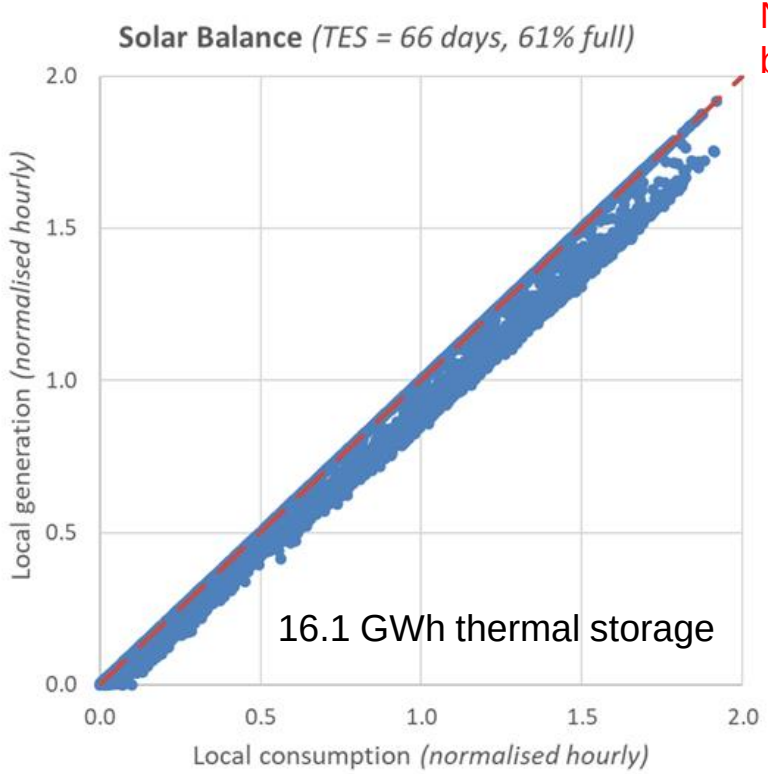




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Sizing energy storage capacity

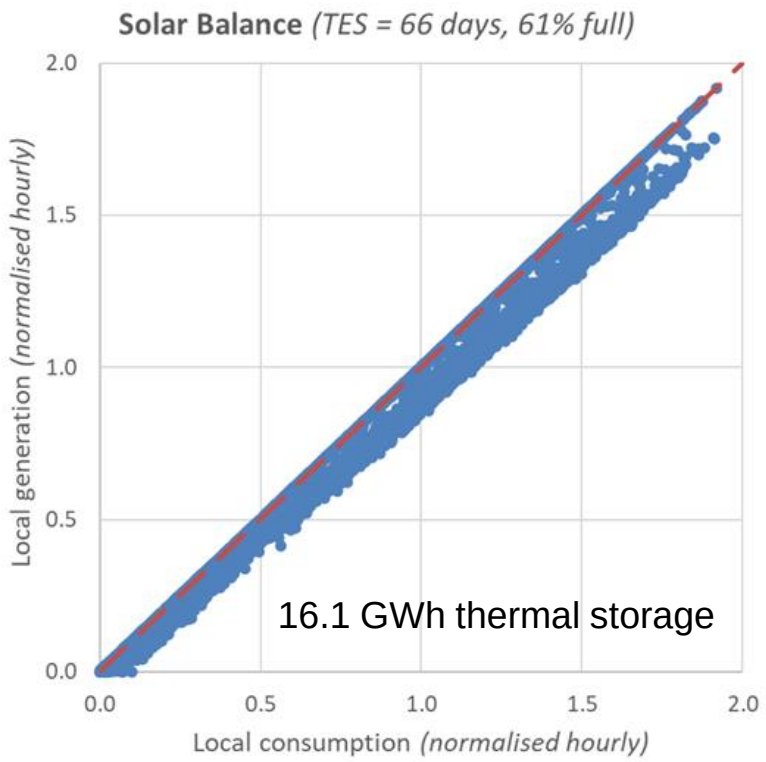
Solar PV



Near 100% balanced

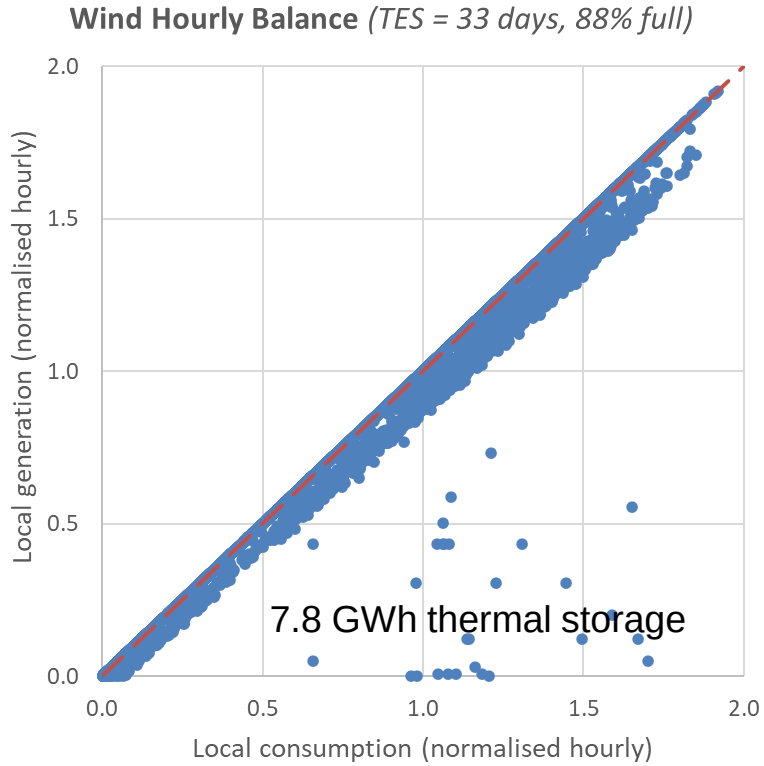
Sizing energy storage capacity

Solar PV



Wind

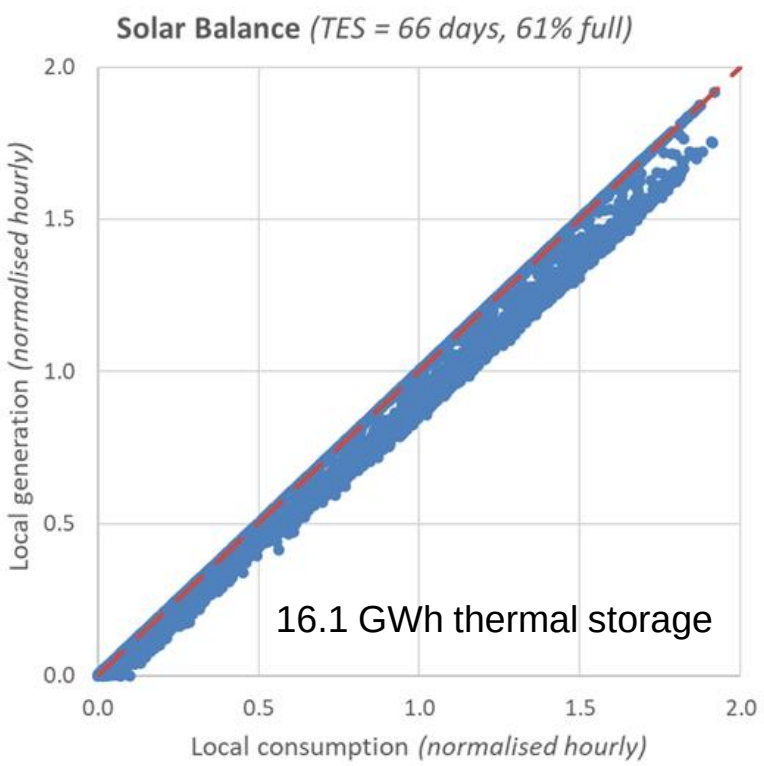
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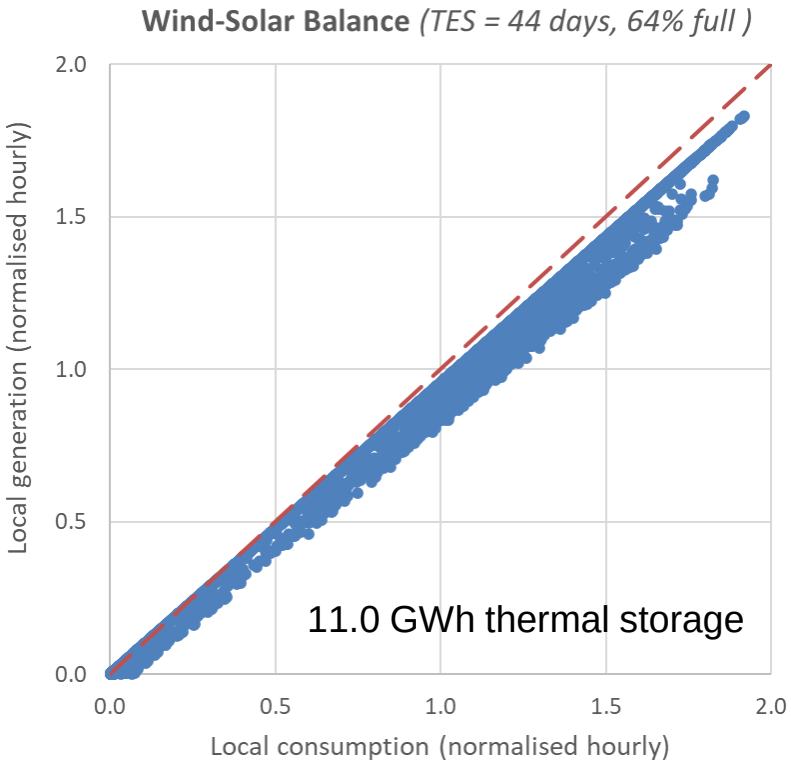
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Sizing energy storage capacity

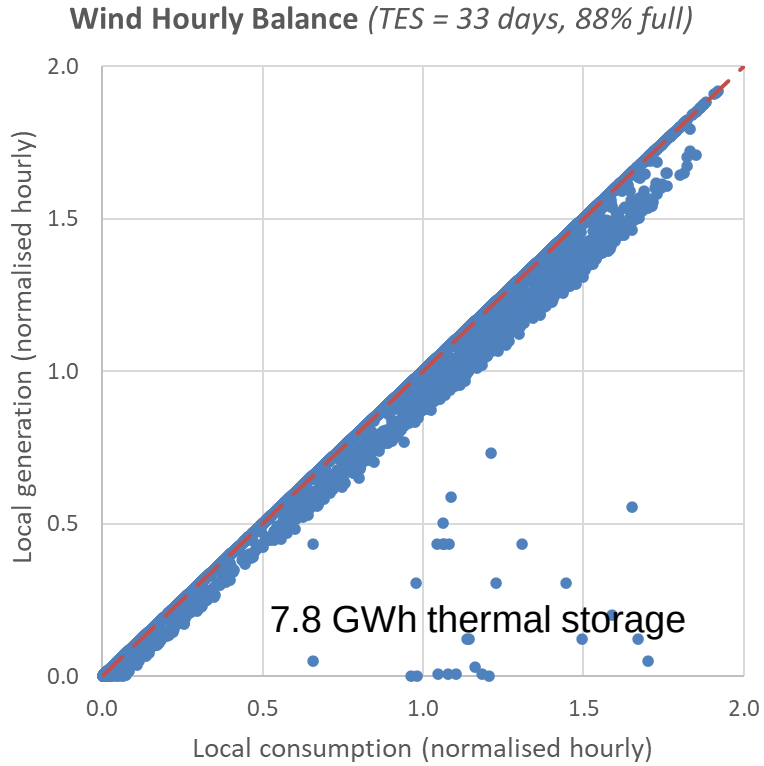
Solar PV



Wind - Solar PV



Wind



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Further work

- Thermal versus battery storage with 2023 grid constraint
- NetZEF Cost optimisation
  - Wind and/or Solar
  - Thermal storage and/or battery storage
  - Grid constraint
- Energy community – smart grid cost optimisation
  - factory and energy storage
  - residential solar
  - commercial solar
  - transport EVs

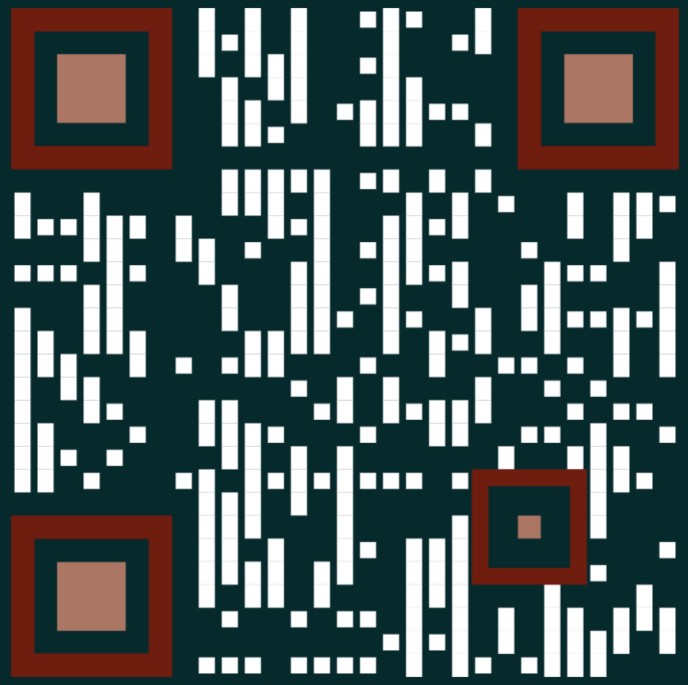
With demand response



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