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Flexibility in thermal grids
– a review of short-term storage in distribution networks

Jay Hennessy – Industry PhD Student

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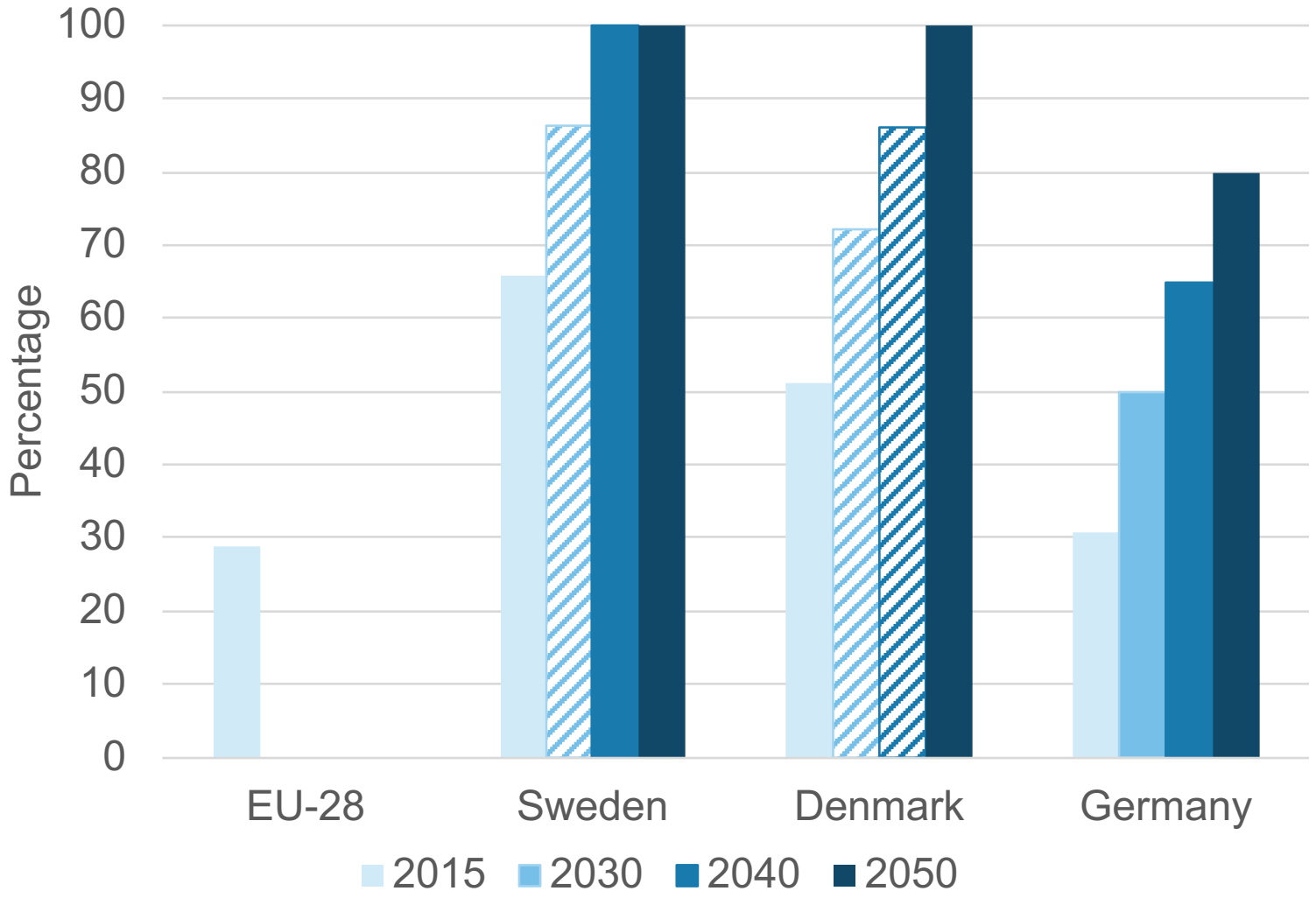
Review

- Flexibility in thermal grids
- Review scope: district heating distribution networks
- Results, pros/cons, knowledge gaps
- Conclusions

- Short-term storage

Electricity



- Renewables % of electricity consumption

(German Federal Ministry of Economics and Technology, 2010; Government Offices of Sweden,2016; Fraende and Reuters, 2011)

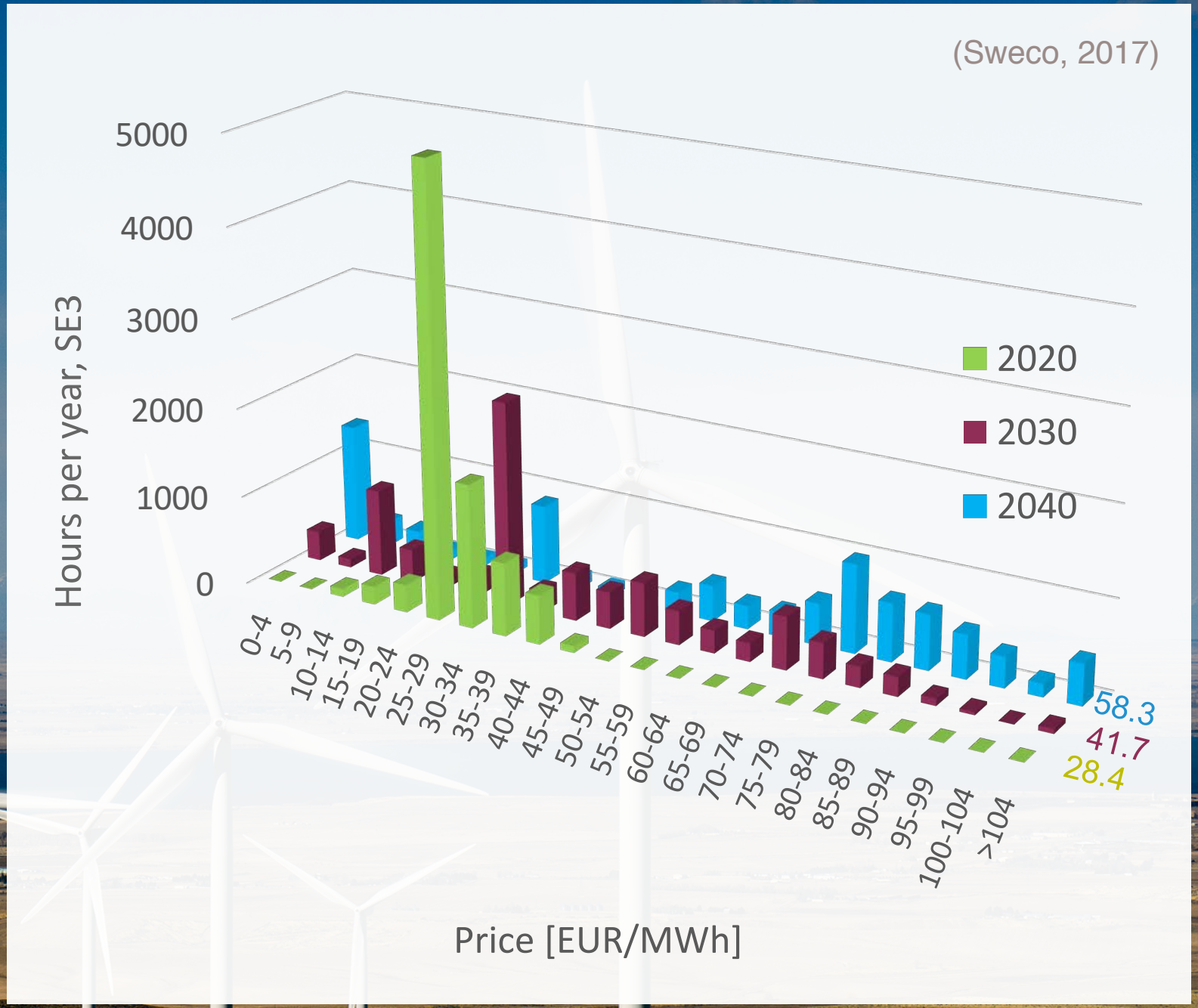
China

2015

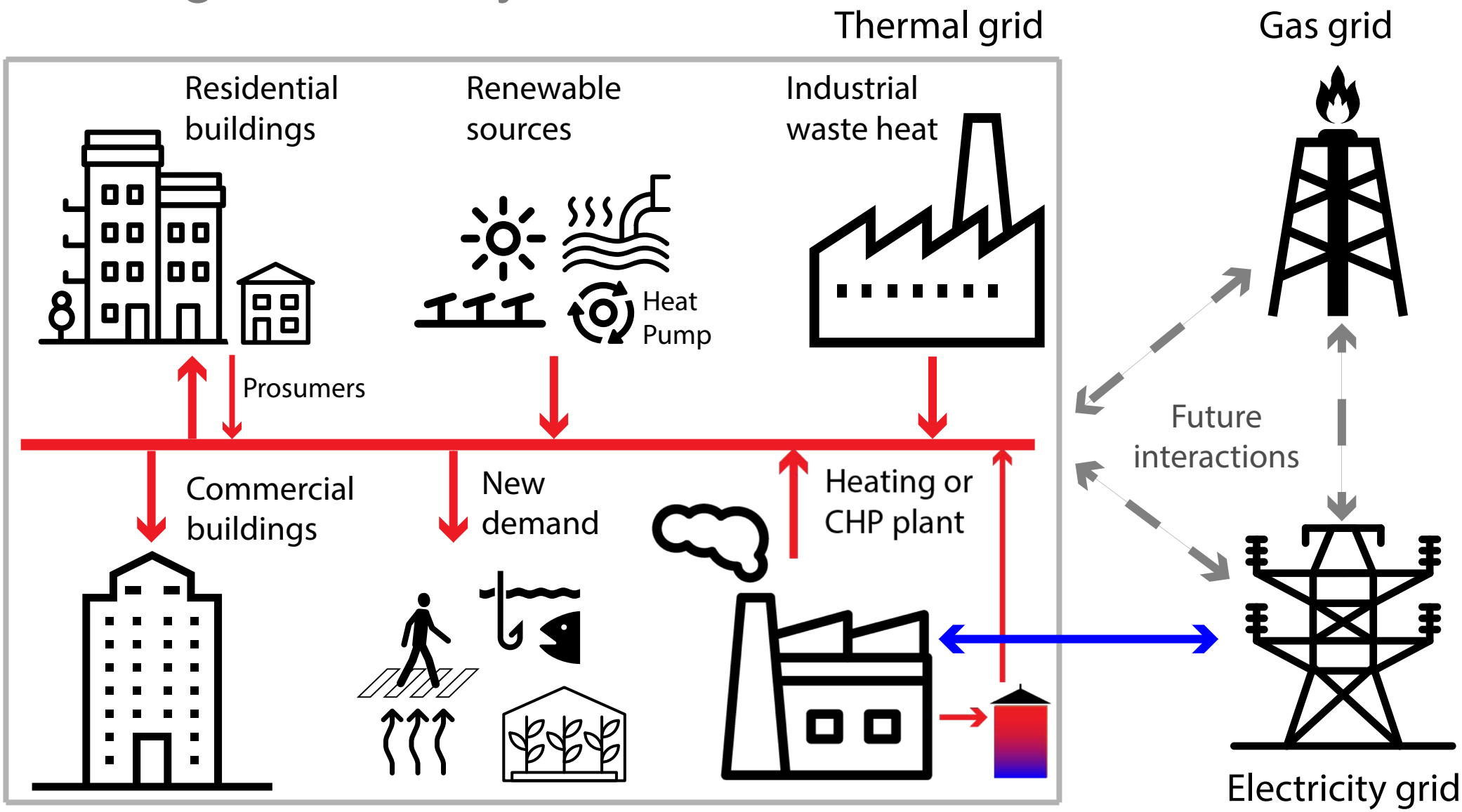
27% of global wind capacity

20% curtailed power (Chen et al., 2015)

Sweden
2020–2040



Thermal grid flexibility



Review scope

- Short-term storage
- Thermal grid distribution networks
  - Centralised sensible storage tanks
  - Network storage (pipeline contents)
- Excluded
  - Distributed storage tanks
  - Network-connected building inertia

Centralised storage tanks

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Results

- Nearly all combined heat and power plants have storage (EU)
- Size: 0.1% of annual heat demand e.g. in Sweden 42 GWh vs 156 GWh
- Cost is 500–2000 EUR/MWh (electricity 50–100 times more)
- Case: Sweden
  - 62% of district heating have storage
  - **64% of this available for flexibility**

Advantages/disadvantages

✓Often already exist

✓Low cost

✓Decreases system operating cost

✓Extends into medium-term storage

✗Payback period may exceed 10 yrs

✗Not all systems have storage tanks

(Hennessy et al., n.d.)

RI. SE

Network storage

Results

- Pre-loading heat is used for peak shaving of heat load
- Heat storage allows increased renewable energy integration
- Storage capacity for Denmark estimated to be 10% of tanks
  - Case Helsinki, Finland: 1.2 GWh
- Different temperature increases used: 10 K, 15 K, 20 K
- Increased cycling causes fatigue

Advantages/disadvantages

✓Minimum investment needed

✓Some amount available in all systems

✕Increased fatigue on components

✕Decreased efficiency (but…)

Growing interest

- Europe
  - Finland, Belgium, Croatia
- China
  - Jilin Province, Heilongjiang Province

(Hennessy et al., n.d.)

Knowledge gaps

Centralised storage tanks

- Designed capacity and current uses are unclear
  - spare capacity hard to estimate at national scale

Network storage (pipeline contents)

- Storage capacity is not standardized
- Modelling does not account for component fatigue
- No estimation of threshold size of network for storage
- No studies look at scaling in detail

(Hennessy et al., n.d.)

Conclusions

- Scope: centralised and network storage
- Strong potential for storage to increase flexibility
- Implementations of network storage are rare…
- Accurate calculation of national flexibility potentials prevented by:
  - Impacts on physical components not considered
  - Capacity limitations unclear
  - Standardised methods needed accounting for supply temperature, fatigue, and effect of return temperature

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Questions?

Jay Hennessy

jay.hennessy@ri.se

+46 73 810 6005

@jayjhennessy

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