6th International Conference on Smart Energy Systems
6-7 October 2020
#SESAAU2020

ASSESSMENT OF RENEWABLE AND WASTE HEAT RECOVERY IN DH THROUGH GIS MAPPING: THE NATIONAL POTENTIAL IN ITALY

Dénarié A., Fattori F., Macchi S., Cirillo V.F., Spirito G., Motta M., Energy Department
Politecnico di Milano

Persson U., School of Business, Engineering and Science, Halmstad

POLITECNICO
MILANO 1863

HALMSTAD UNIVERSITY

Powered by

AALBORG UNIVERSITY
DENMARK

energy CLUSTER DENMARK

sEEnergies

Innovation Fund Denmark

reINVEST

midt regionmidtjylland

DEN EUROPÆISKE UNION
Den Europæiske Fond for Regionaludvikling
Vi investerer i din fremtid

GRØN ENERGI

kamstrup

LOGSTOR

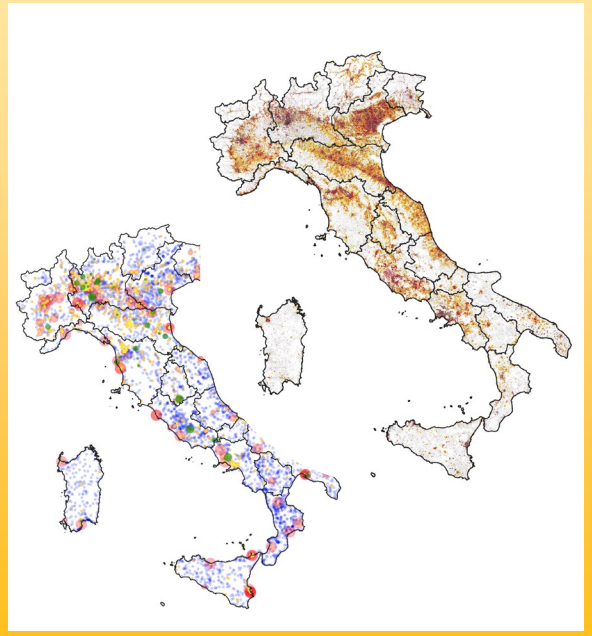
Ørsted

Aalborg Forsyning

6th International Conference on Smart Energy Systems
6-7 October 2020
#SESAAU2020

FRAMEWORK

Assessing the potential diffusion of renewable based district heating in Italy through energy mapping



AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Structure of the work

HEAT DEMAND

Estimation and spatial distribution in the residential and tertiary sector

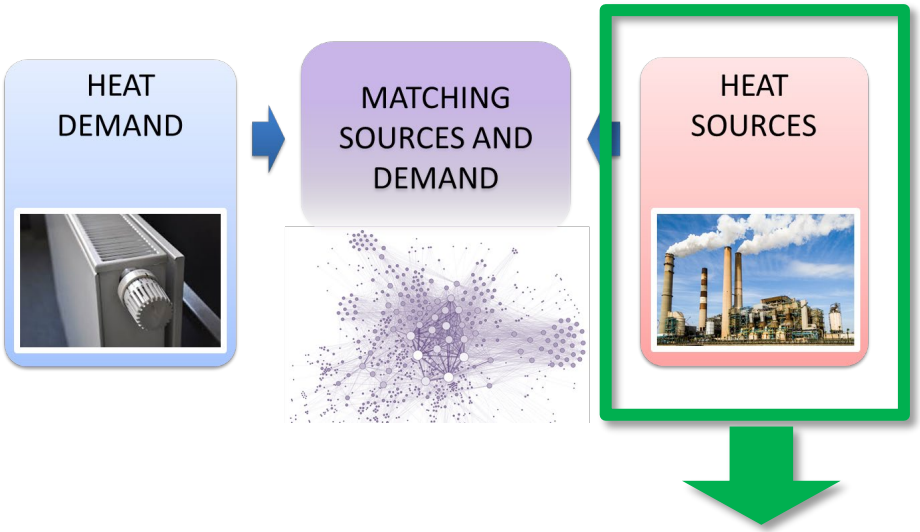
MATCHING SOURCES AND DEMAND

Spatial allocation of heat sources and spatial distribution of DH in comparison with individual solutions

HEAT SOURCES

Estimation and spatial distribution of heat sources and current individual solutions

AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning



Mapping heat sources and renewable exploitation potential for DH – GIS environment

- Position – distance from heat demand
- Waste heat availability – *theoretical potential*
- Recoverable heat – *technical potential*
- Matching with heat demand profile

AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Industrial processes
Power Plants
Waste to Energy plants
Waste water treatment plants

WASTE HEAT SOURCES

Geothermal
Shallow geothermal – HP
Biomass
Solar thermal

RENEWABLE HEAT SOURCES

AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Heat recovery

Input Data
CO_2 emissions

EPRTR tCO2

ISPRA

Energy input
Primary energy

fCO_2 emission factors [1]

eurostat

Waste heat
Theoretical potential

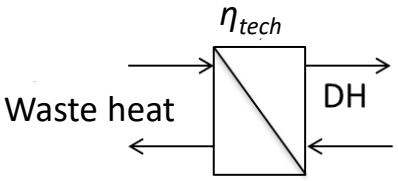
η_{heat} waste heat [2]

HOTMAPS

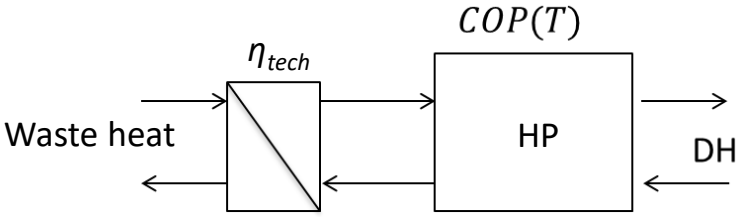
Heat recovery
Technical potential

η_{tech} recovery efficency [2-3]

High Temperature



Low Temperature



AALBORG UNIVERSITY DENMARK

energy CLUSTER DENMARK

sEEnergies

Innovation Fund Denmark

reINVEST

midt regionmidtjylland

DEN EUROPÆISKE UNION
Den Europæiske Fond for Regionaludvikling
Vi investerer i din fremtid

GRØN ENERGI

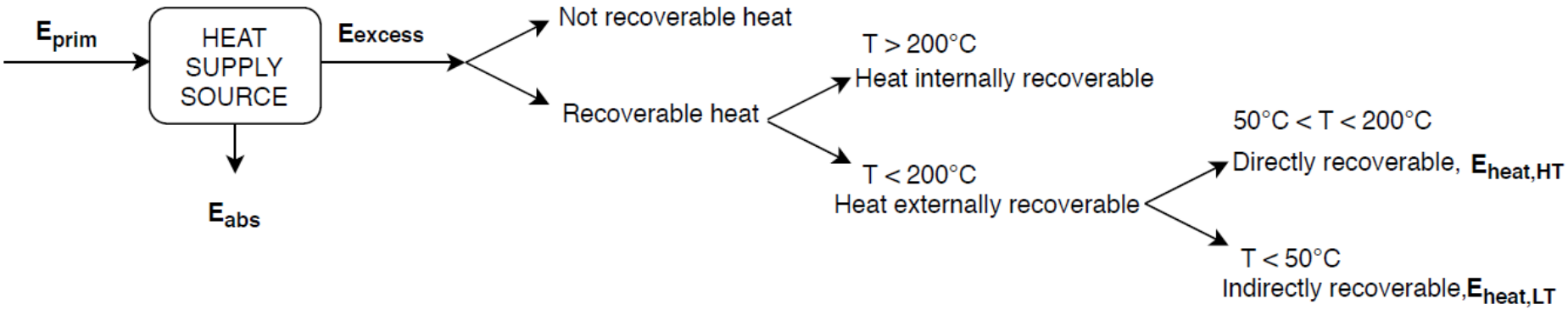
kamstrup

LOGSTOR

Ørsted

Aalborg Forsyning

Heat recovery

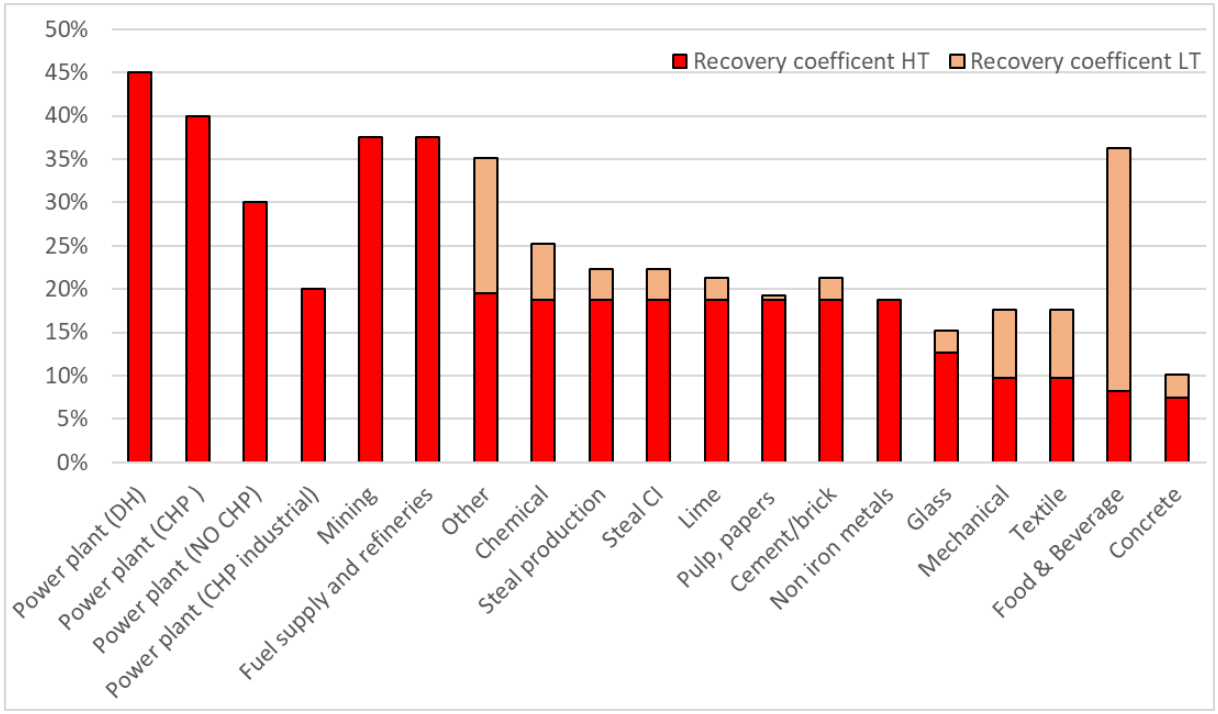


High Temperature

Low Temperature

AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

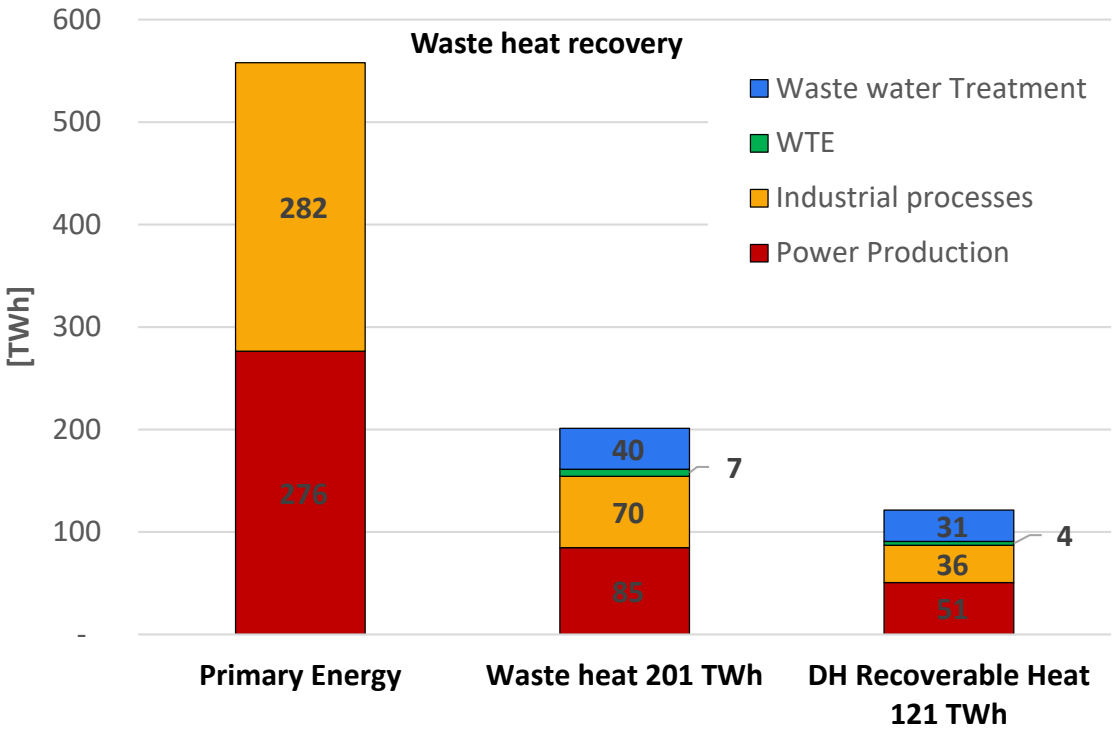
Heat recovery

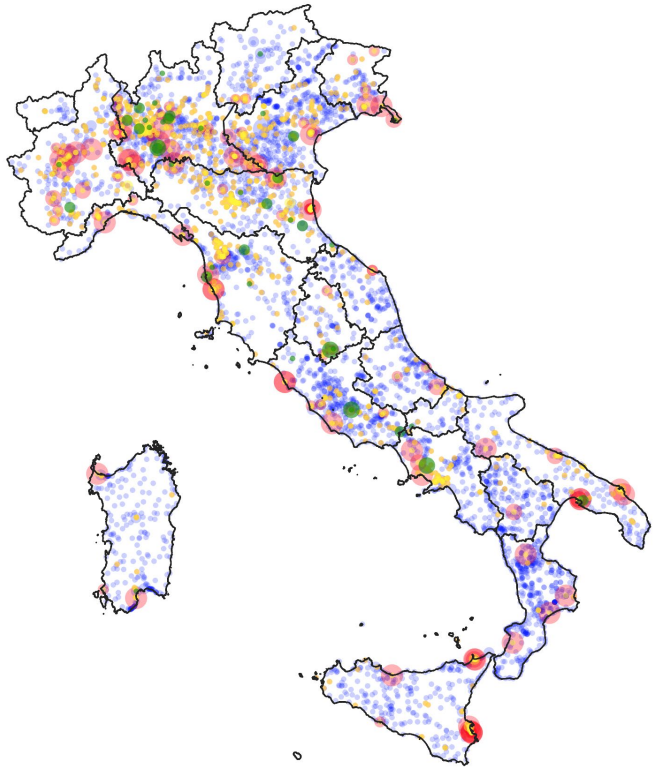


- ***Heat Pump COP***
  (Temperature)
- ***Matching time profile***
  - *DH base load - 3500 hh*
  - *industrial load - 7000 hh*
  - *WWTP load - 4500 hh*

AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Heat recovery





AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Industrial processes
Power Plants
Waste to Energy plants
Waste water treatment plants

WASTE HEAT SOURCES

Geothermal
Shallow geothermal – HP
Biomass
Solar thermal

RENEWABLE HEAT SOURCES

AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Renewables

Biomass
Biomass availability

Heat recovery from CHP

Stratego
ENHANCED HEATING & COOLING PLANS

Geothermal energy
Map of underground T

Direct, indirect, shallow

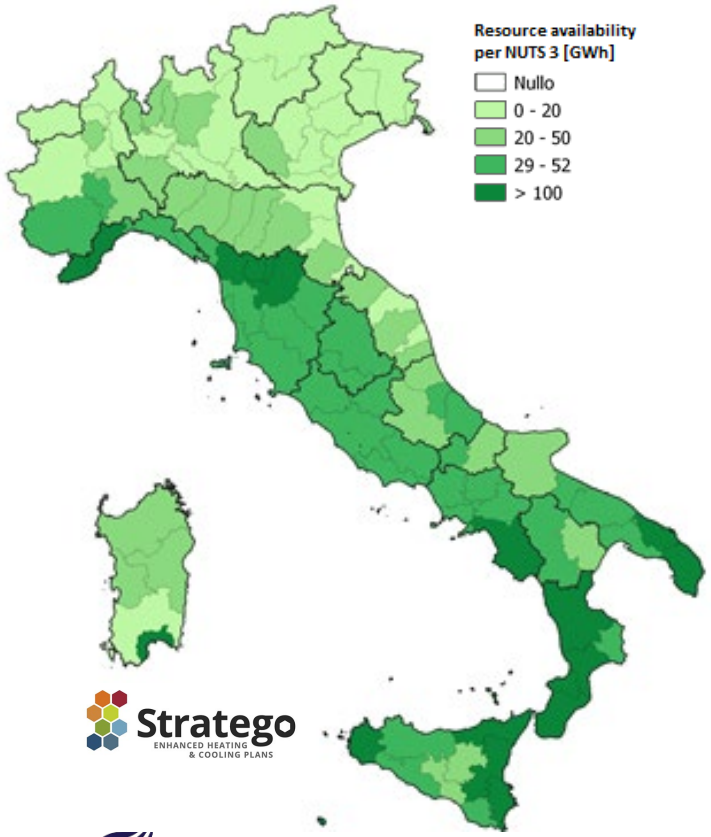
Stratego
ENHANCED HEATING & COOLING PLANS

Solar thermal
Integration

Percentage of demand - wip

AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Renewables



Hypothesis on biomass use in future national energy system

- 1/3 Transports
- 1/3 Buildings heating
- 1/3 Power production

Heat recovery of 3.4 TWh

Stratego ENHANCED HEATING & COOLING PLANS
AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Renewables

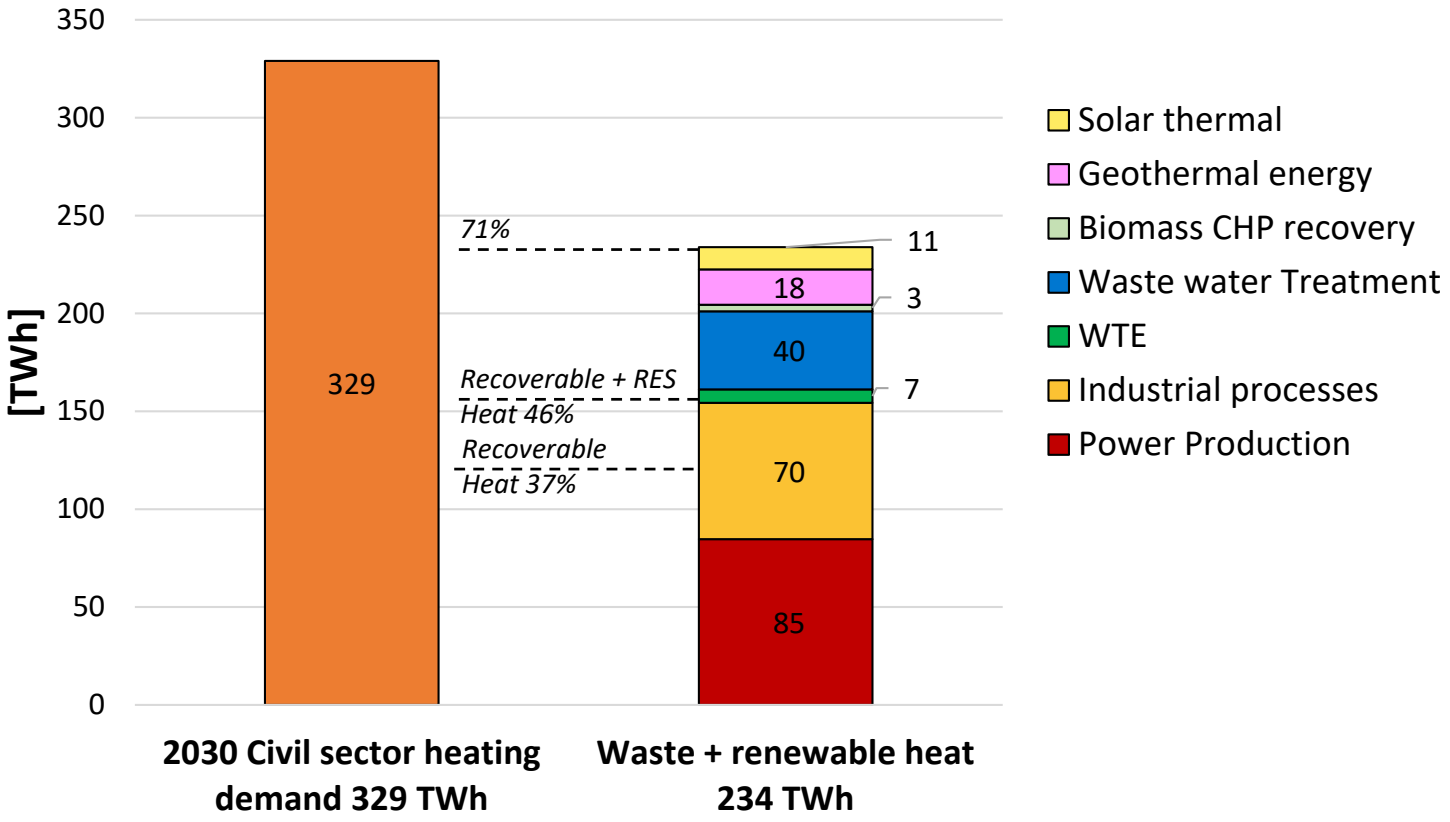
Hypothesis on geothermal energy exploitation

- T>90°C at 2000m → 100% coverage
- T>50°C a 1000m → 30% coverage
- Shallow/Hydrothermal→30% coverage

→ Needs further deeper analyis

Stratego ENHANCED HEATING & COOLING PLANS
AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Final results



AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION Den Europæiske Fond for Regionaludvikling Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

Final results

AALBORG UNIVERSITY DENMARK
energy CLUSTER DENMARK
sEEnergies
Innovation Fund Denmark
reINVEST
midt regionmidtjylland
DEN EUROPÆISKE UNION
Den Europæiske Fond for Regionaludvikling
Vi investerer i din fremtid
GRØN ENERGI
kamstrup
LOGSTOR
Ørsted
Aalborg Forsyning

CONCLUSIONS

Highly detailed mapping tool

Untapped potential of waste and renewable heat use

Important fraction of heat demand covered by RES and waste heat through expansion of DH and storage technology

6th International Conference on Smart Energy Systems
6-7 October 2020
#SESAAU2020

Thank you for your attention

Alice Dénarié PhD,
Energy Dept. Politecnico di Milano
alice.denarie@polimi.it

References

[1] Persson U., Moller B., Werner S., *Heat Roadmap Europe: Identifying strategic heat synergy regions.* Energy Policy 74 (2014) 663–681

[2] Persson U., Werner S., *District heating in sequential energy supply.* Applied Energy 95 (2012) 123–131 Contents

[3] Berthou M., Bory D. *Overview of waste heat in the industry in France.* ECEEE 2012 SUMMER STUDY Energy effic, Ind, Arnhem, The Netherlands (2012)