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#### Waste and Energy System Integration



- The Role of Refused Derived Fuel in

**Future District Heating** 



AALBORG UNIVERSITY DENMARK 4th Generation District Heating Technologies and Systems

#### 1.1. Problem 占古 4th Generation District Heating **Technologies and Systems** Ø Today 2035 2020 Re Inci сус nera Incin Recy tion lin Rec Inc erat cling 35% yclin ine on 50% g 65% rati 50% 0...

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#### 1.2 Problem

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 $\rightarrow$ Less local waste available for increasing district heating demands

 $\rightarrow$  Free incineration capacity

 $\rightarrow$  Electricity price fluctuations



#### 2.1. Approach







#### 2.2. Approach





→System design in 2020 & 2035?

→Thermal storage yes/no?

 $\rightarrow$  RDF boilers competitive to biomass boilers?



































# 4.1. System Analysis 2035

**Business Economic Modelling** 



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#### 4.2. System Analysis 2035 **Business Economic Modelling** 600 550 Priorities (NPC) 500 450 400 4th Generation District Heating 350 **Technologies and Systems** 30 250 200 15 Mon 01/01/35 Thu 01/02/35 Thu 01/03/35 Sun 01/04/35 Tue 01/05/35 Fri 01/06/35 Sun 01/07/35 Wed 01/08/35 Sat 01/09/35 Mon 01/10/35 Thu 01/11/35 Sat 01/12/35 Tue 01/01/36 - RDF Boiler Heatpump 110 100 9 Heat [MW] 8 RDF boiler Wed 01/08/35 Sat 01/09/35 Thu 01/02/35 Tue 01/05/35 Sun 01/07/35 Thu 01/11/35 Sat 01/12/35 Mon 01/01/35 Thu 01/03/35 Sun 01/04/35 Fri 01/06/35 Mon 01/10/35 Tue 01/01/38 Heat pump Socio Economic Modelling Heat consumption 400 Priorities (NPC) 35 300 250 200 150 Mon 01/01/36 Thu 01/02/35 Thu 01/03/36 Sup 01/04/35 Tue 01/05/36 Eri 01/06/35 Sup 01/07/3 Wed 01/08/35 Sat 01/09/34 Sat 01/12/36 Tue 01/01/3/ 110 100 90 80 70 60 50 Heat [MW] 20 Tue 01/01/36

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# 5.1. Economic Analysis 2035





# 5.2. Economic Analysis 2035





### 6.1. Conclusion

- System design:
  - Business economics: 25% HP + 50% RDF boiler capacity + 61,000 m<sup>3</sup> store
  - Socio economics: 25% HP + 25% RDF boiler capacity + 550,000 m<sup>3</sup> store

→ RDF has an important role in energy systems in short- and long-term
→ Scenarios including thermal storage appear to be more attractive





# 6.2. Conclusion



Heating

#### $\rightarrow$ RDF is competitive to woodchip boilers in all analysed scenarios

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#### Thank you for your attention.



### **Open Questions**

- Enough RDF available in Europe for Denmark, Sweden, Norway, Germany?
- seller's market: maximum RDF import price
- reserve capacity
- PSO



