Barriers for transition to 4th generation district heating in existing large networks

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Goal and tasks of research

The goal of research was to identify the most important barriers for large DH system transition to 4th generation DH

1. **Improve the methodology for the evaluation of DHS transition process to 4th generation district heating:**
   - **Analysis of DHS transition process in time**
   - **Define the most important key performance indicators by it impact on transition process and indicator achievement rate**
2. **Large DH system case study (Tallinn district heating system)**
3. **Analyse the obstacles for large DH system transition to 4th generation and solutions.**

4th generation district heating concept

- **supply low-temperature DH for space heating and domestic hot water to buildings**
- **distribute heat in networks with low heat losses;**
- **enlarge the share of renewable non-fuel heat sources and recycle heat from low-temperature sources;**
- **become an integrated part of smart energy systems;**
- **ensure sustainable planning, cost and motivation structures**

Key performance indicators

- **supply and return DH annual average temperature,ºC, t_s, t_r**
- **weighted average pipe diameter, m, D_a**
- **network effective average heat transmission coefficient, W/m²K, K**
- **the share of consumers covered by intelligent metering, %**
- **annual total non-fuel renewable energy for heat generation, MWh, $E_{nf.th}$**
- **heat produced by CHP, MWh, Q_{thCHP}**
- **share of short-term TES from CHP heat capacity, %**

DH transition evaluation criteria

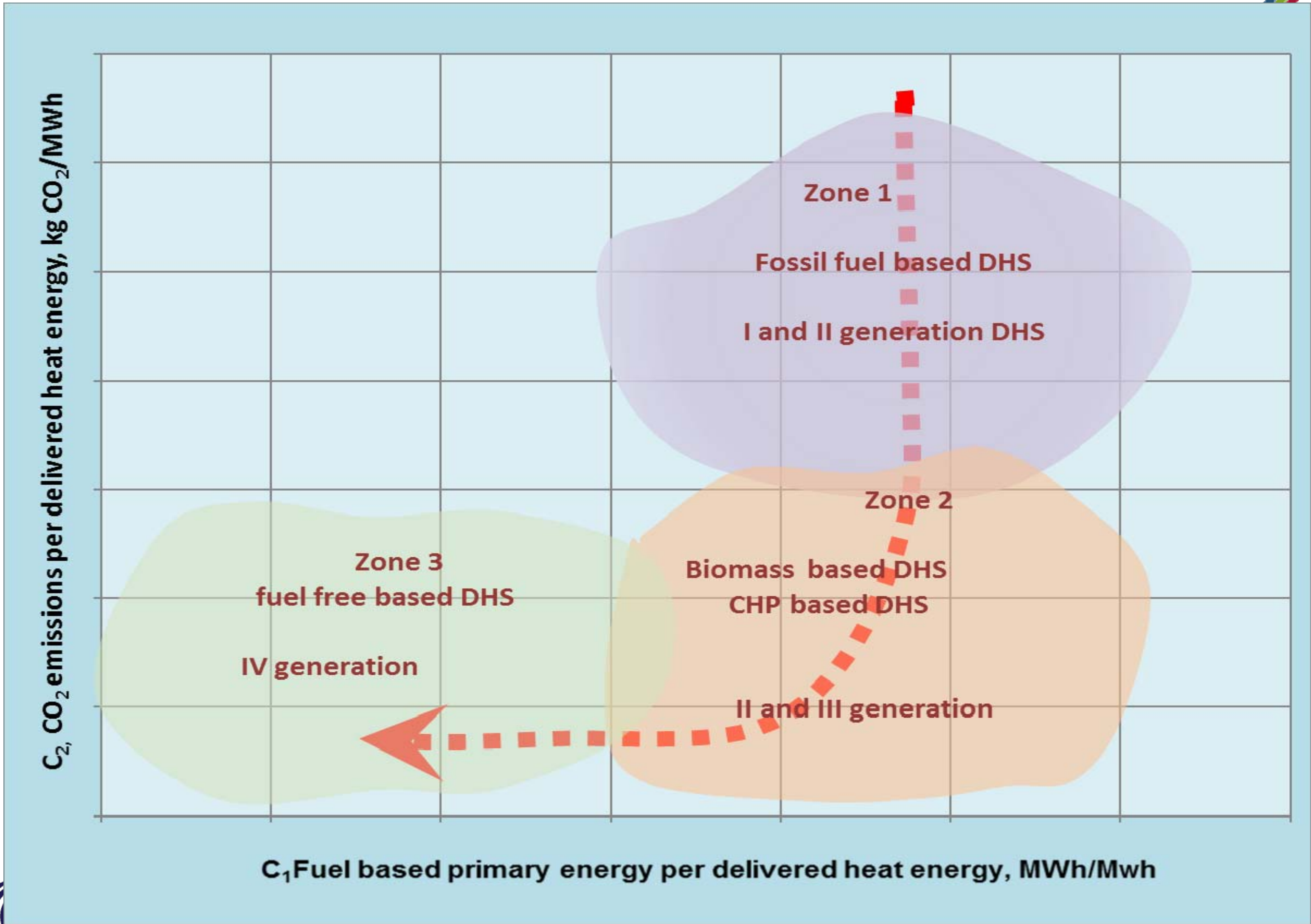
C₁ Fuel based primary energy per delivered heat energy, MWh/MWh

$$C_1 = \frac{\sum B_{f.h.} \cdot H_f + \frac{\sum B_{f.CHP} \cdot Q_{th_{CHP}}}{Q_{e_{CHP}} + Q_{th_{CHP}}} \cdot H_f - E_{nf.th}}{Q_p - K \cdot \pi \cdot D_a \cdot 2L \cdot \left(\frac{1}{2}(t_s + t_r) - t_{amb}\right) \cdot 8760}$$

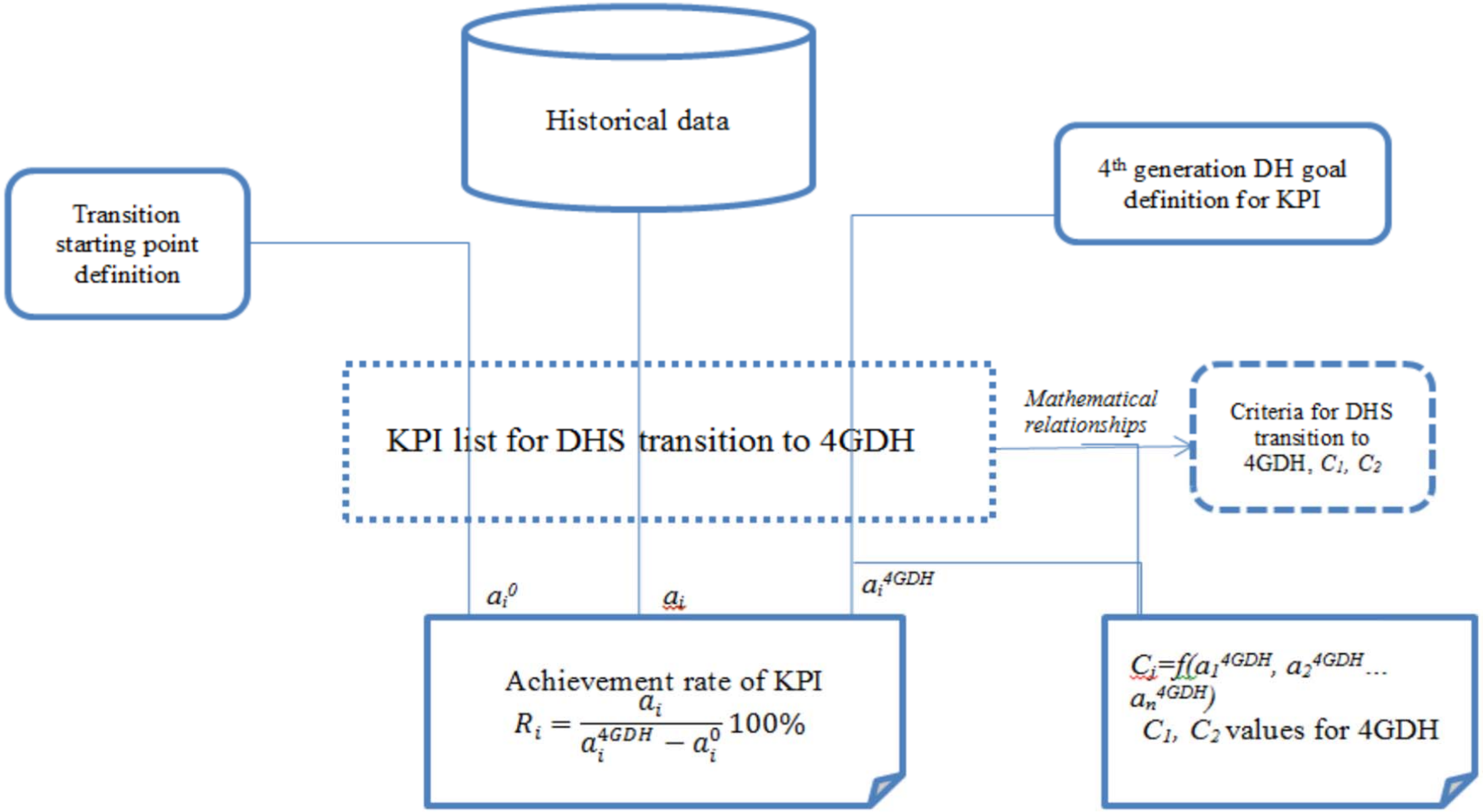
C_2 CO_2 emissions per delivered heat energy, $kgCO_2$/MWh

$$C_2 = \frac{\sum E_{f.h.} \cdot \gamma_f + \sum E_{f.CHP} \cdot \gamma_f - \sum E_{f.CHP.e} \cdot \gamma_{nat}}{Q_{fp} + E_{nf.th} - K \cdot \pi \cdot D_a \cdot 2L \cdot \left(\frac{1}{2}(t_s + t_r) - t_{amb}\right) \cdot 8760}$$

DH transition criteria

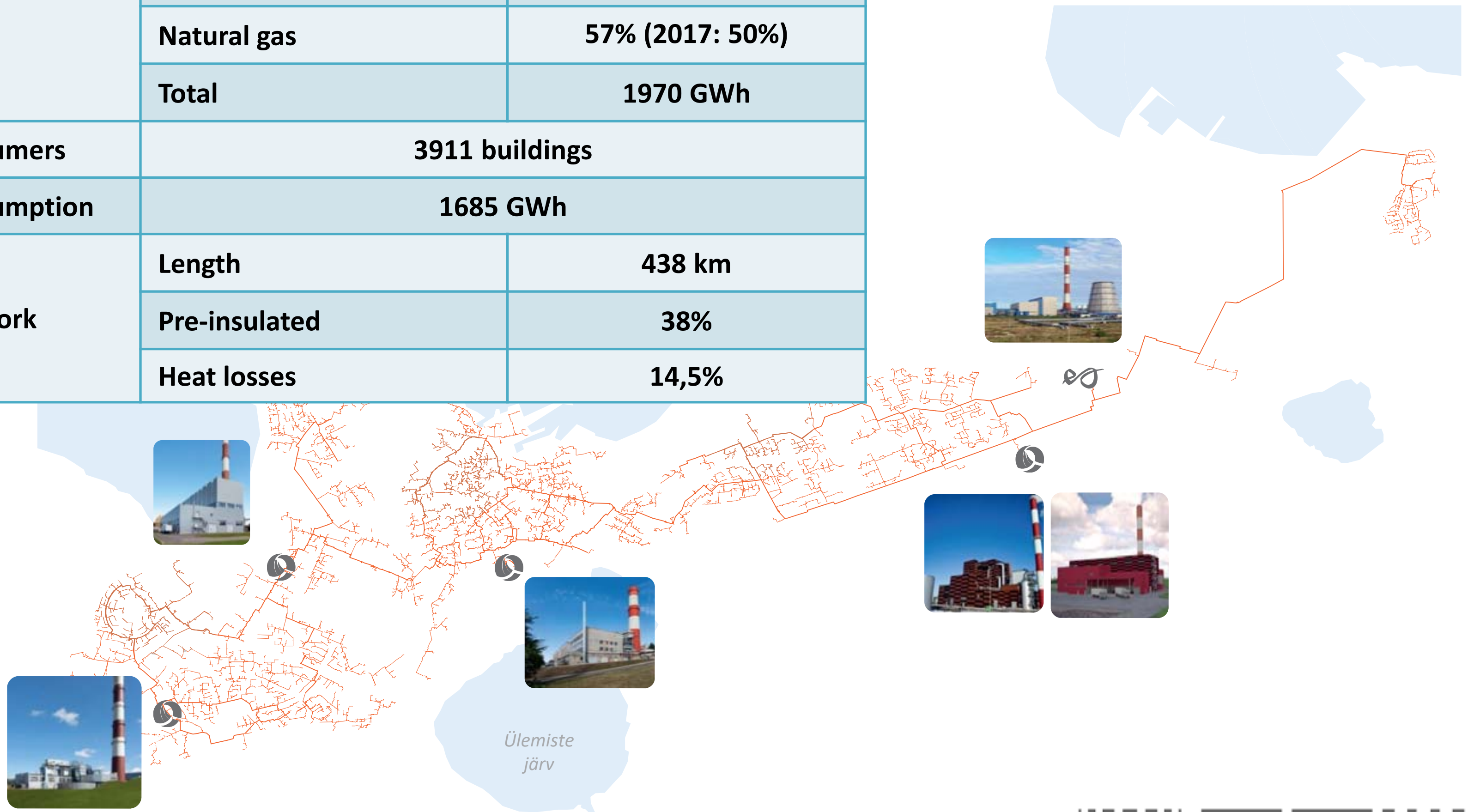


KPI achievement rate evaluation



Tallinn district heating system

Production	Biomass, CHP	28% (2017: 35%)
	Waste inceneration, CHP	15% (2017: 15%)
	Natural gas	57% (2017: 50%)
	Total	1970 GWh
Consumers	3911 buildings	
Consumption	1685 GWh	
Network	Length	438 km
	Pre-insulated	38%
	Heat losses	14,5%



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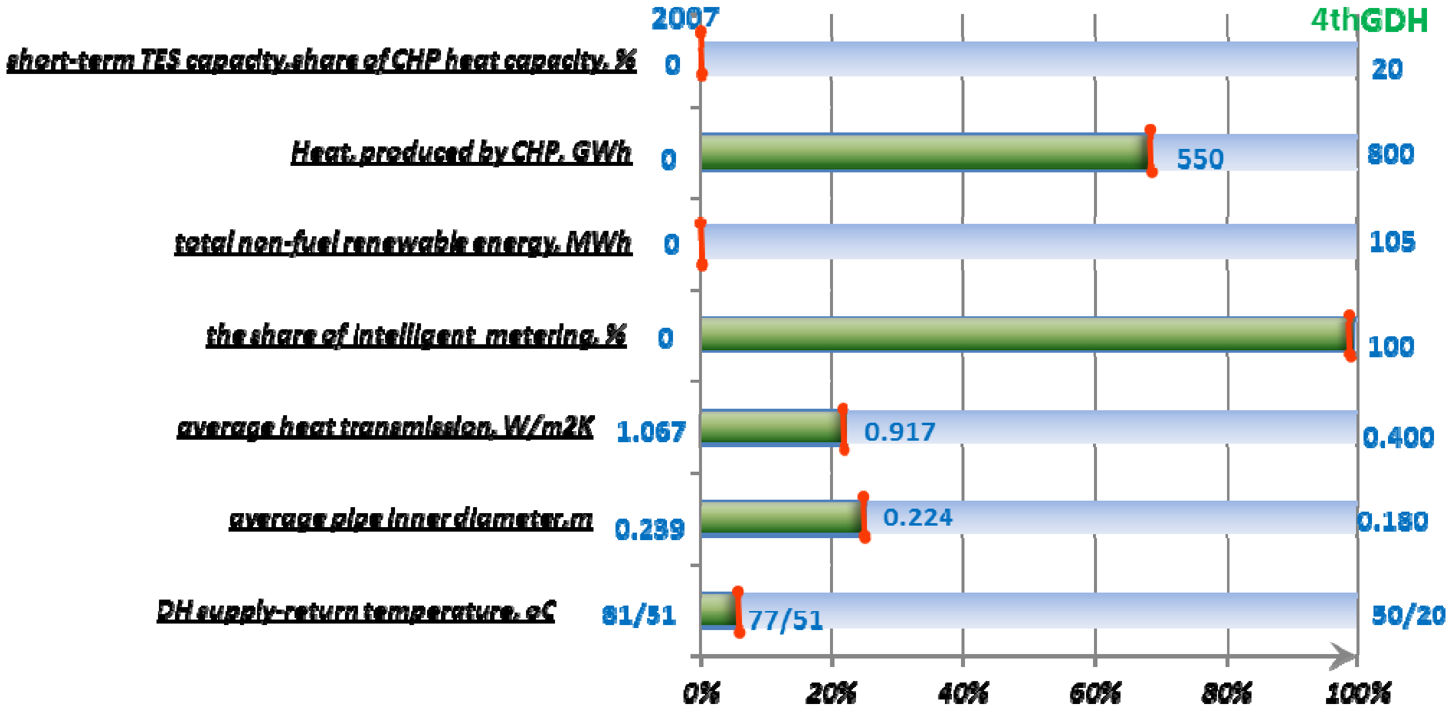
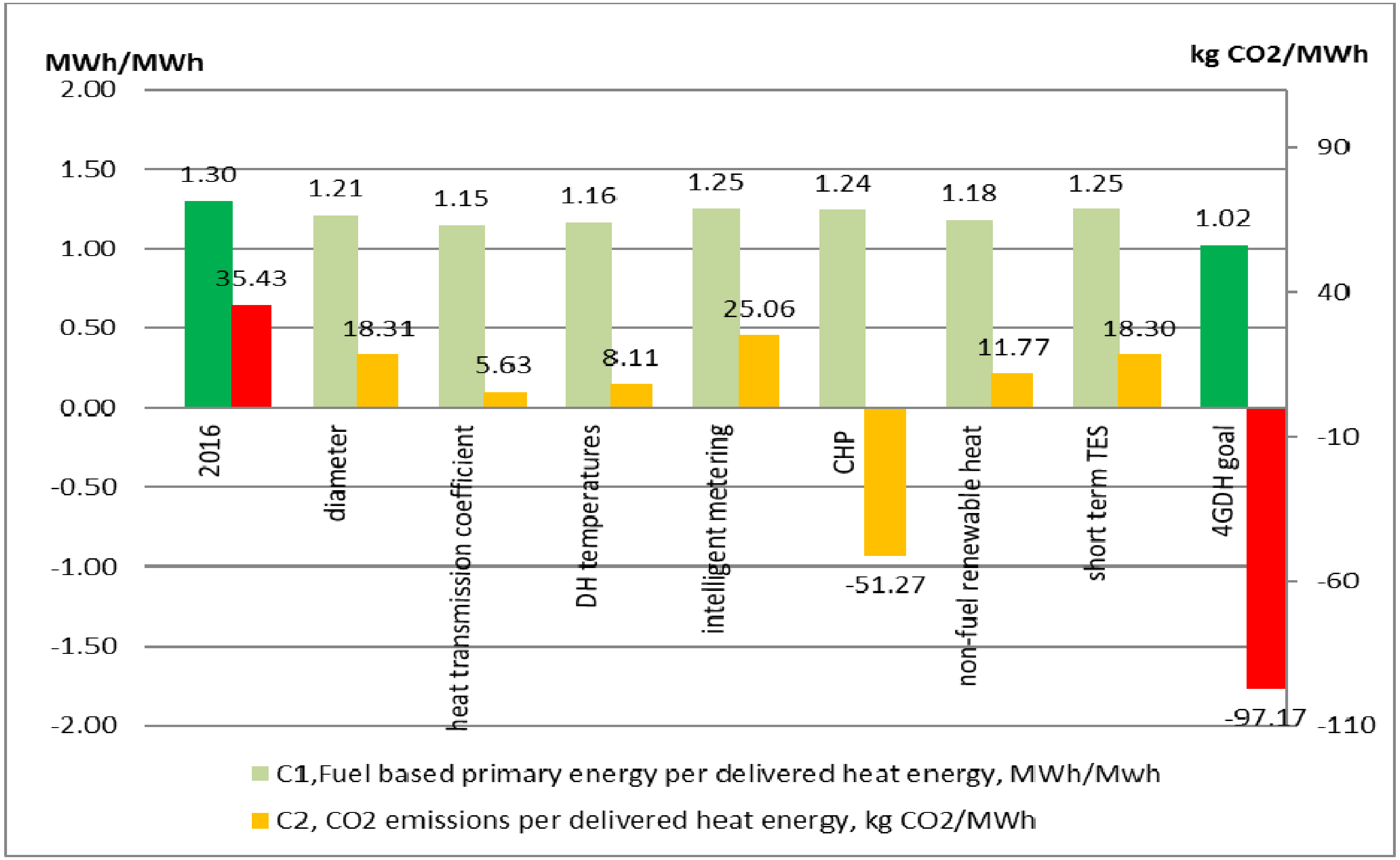
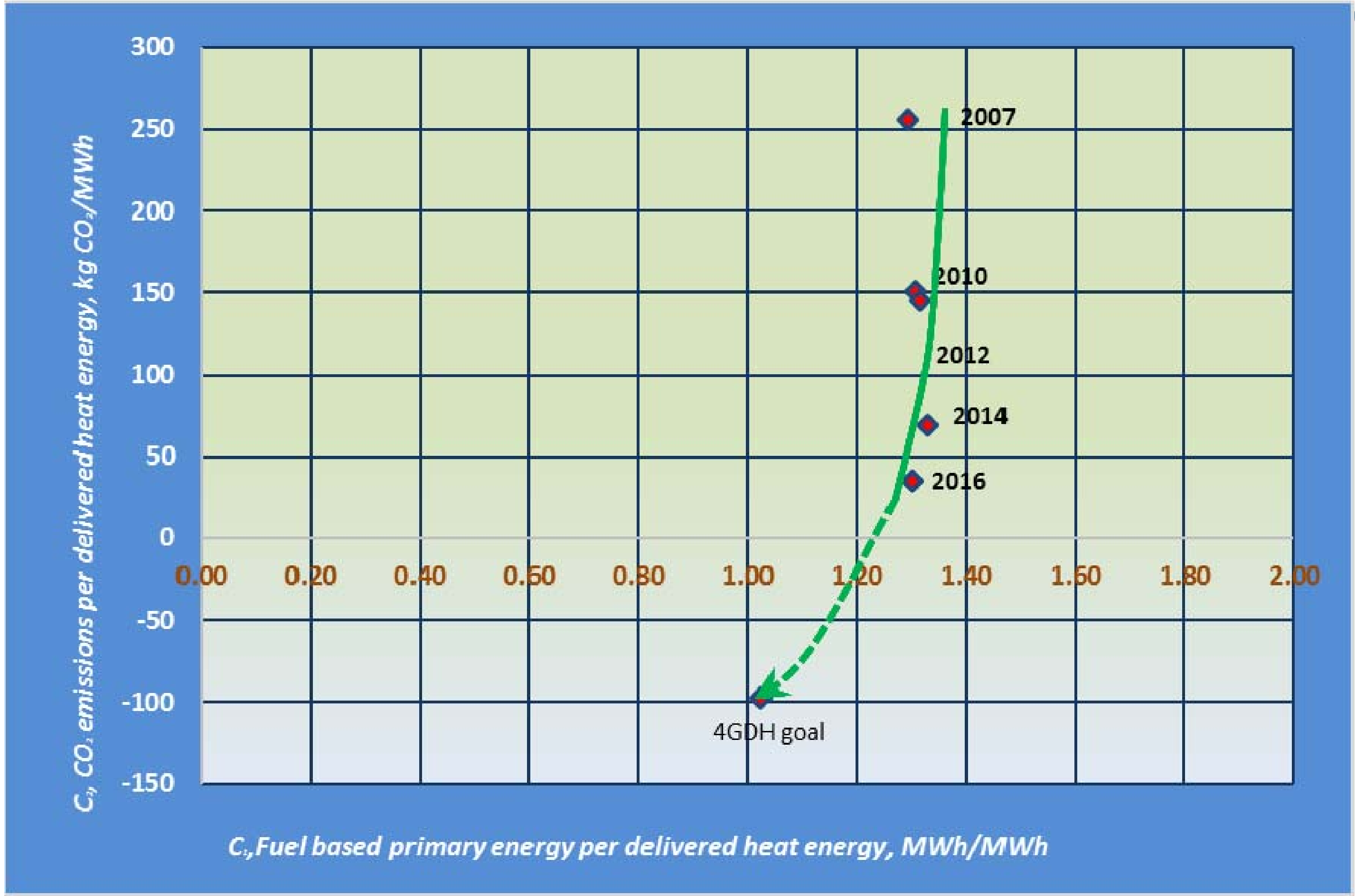
Key performance indicators achievement rate



Key performance indicators affect on C_1 and C_2



Tallinn DHS transition process



Main barriers for large DH

Renewable and surplus energy recycling

- Location problems:
  - Surplus energy absence
  - Geothermal/wind/solar energy depends on location and might be limited
- No technical problems

- Consumption problems (in next slides)

Low heat losses

Low heat losses

- Production side losses can be under control
- Pipe change from heat loss reduction point might be economically unreasonable
- It is hard to change insulation in whole large DH in short time

- Solution: careful and long term planning of network

Low supply temperature

- Very welcome from production and network side
- Problem for existing consumers, design schedule 90/70°C is common
- Underfloor heating is
buildings

- **Solution**: benefits an

Low return temperature

- Even more welcome from production and distribution side
- Problem for existing consumers:
  - Heating devices with low ΔT in use
  - DHW circulation at 45-50°C

Solution: benefits and motivation, multi component tariffs

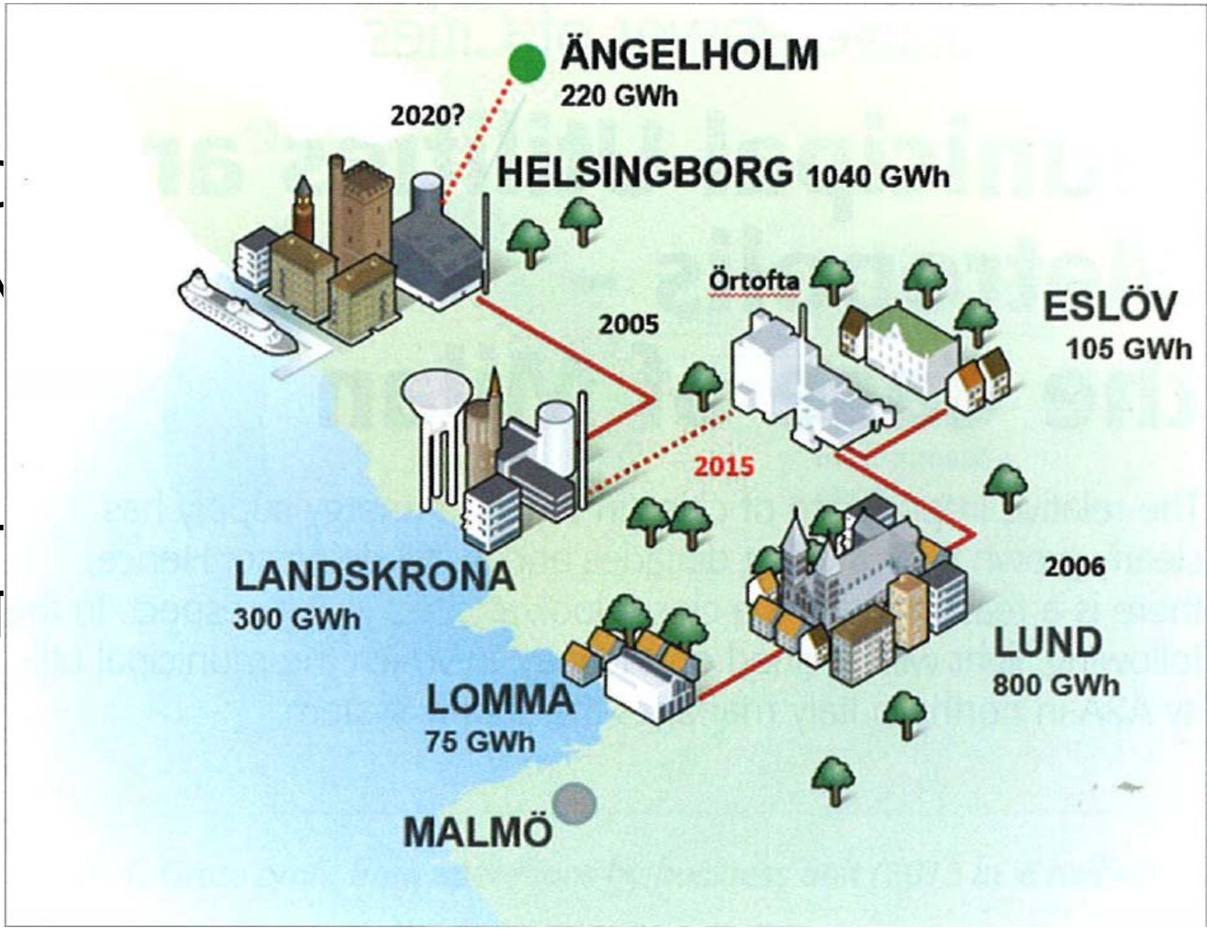
Smart control and metering

- No technical problems today:
  - Devices available
  - Internet connection is inexpensive
  - GSM technology is fast and secure

- Trust between company and consumer

System integration with DC and electricity grids

- D … rsa
- N
- L
- T … es



Conclusions

Methodology:

- Allow to evaluate network progress towards to 4GDHN
- Find most important indicators

Barriers in large DHN:

- Energy might be unavailable
- Consumer heating devices
- Large scale
- Trust and legislation

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Acknowledgements: