Review of Various Solutions for avoiding critical levels of Legionella Bacteria in Domestic Hot Water System

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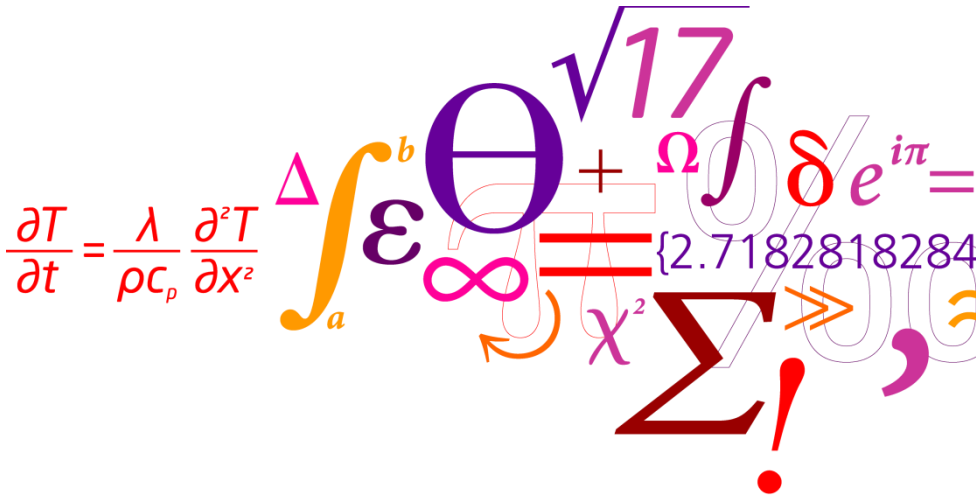

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Content of the paper

- Background of legionella bacteria
- Regulations and polices in some European countries
- Comparisons among different treatments
- Potential solution for LTDH in Denmark

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Background of Legionella

- Main infection route: through inhalation or aspiration of contaminated aerosols
- Common disease
  - Pontiac fever
  - Chronic lung disease
  - Immunodeficiency…

Table 1 Influence of temperature

Temperature (°C)	Existence of Legionella
>60	legionella can not survive
55-60	be sterilized gradually
50-55	growth inhibited
20-50	proliferation boost
0-20	very few

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Regulations and Polices

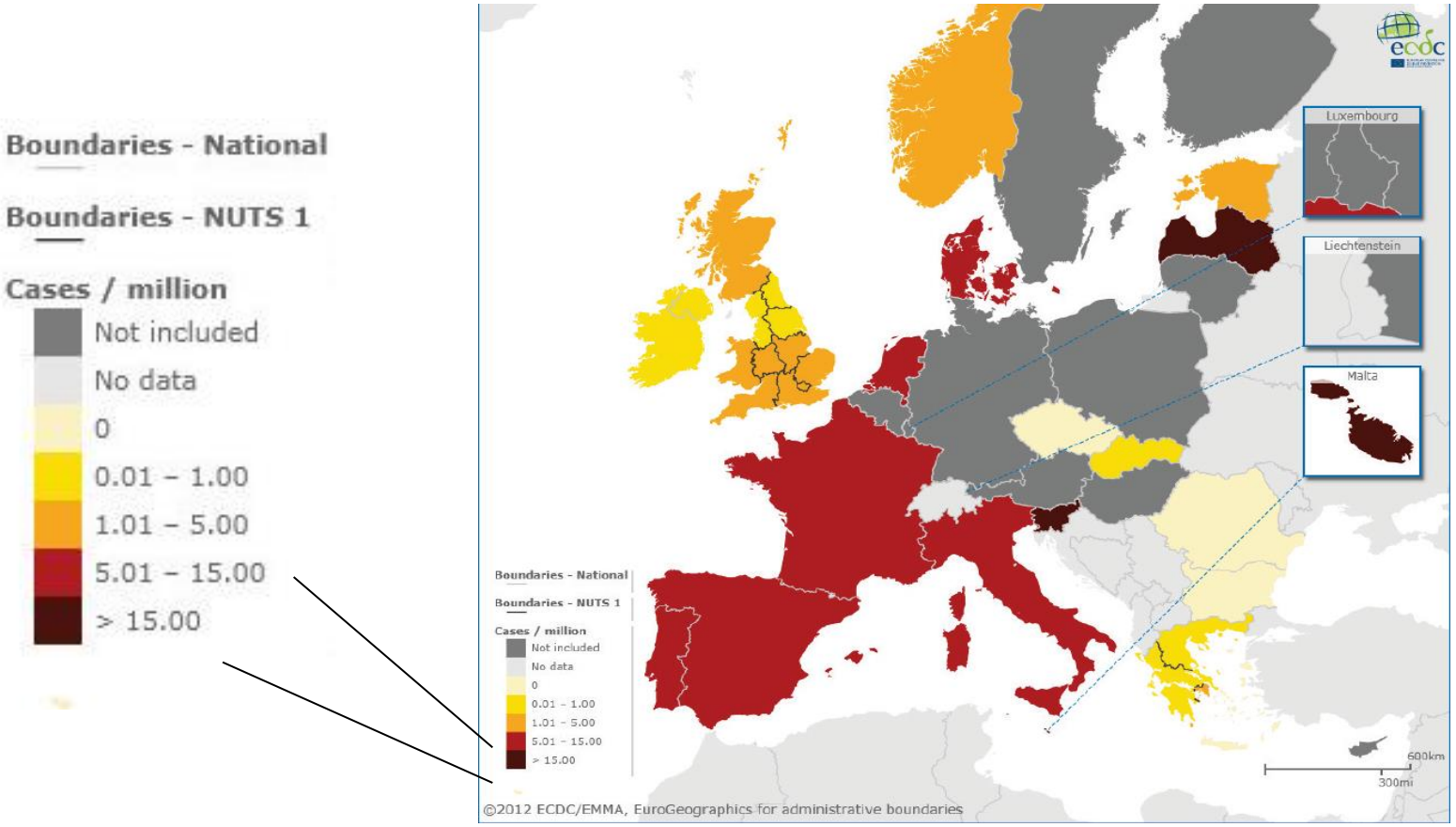

Fig 1 Notification rate of community-acquired Legionnaires' disease, EU/EEA, 2011 (n=2 642)

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Regulations and Polices

Table 2 minimum temperature regulations of some countries

country	temperature of cold water(° C)	temperature at the tap (° C)	DHW producing temperature (° C)	concentration to take activity (CFU/L)
Netherland	-	-	≥60	as soon as legionella is detected
Denmark	-	≥50	≥60	1000
Belgium	≤25	≥55	≥60	-
Germany (large system)	-	≥45	≥60	-
Finland	≤20	≥55	≥60-65	-
Sweden	-	≥50	≥60(in the tank)	-
France	-	≤50	≥60	-
Italy	-	45-48	≥60	-
Spain	≤20	≥50	≥55	-
United Kingdom	≤20	≥50	≥60	1000

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Sterilization treatments

Treatments	*Efficacy Term*	*Operation Points*	*Advantages*	*Disadvantages*	*Cost*
Thermal method					
Superheating	short term	Temperature should be lift to no less than 60oC; operating time depends on the temperature.	Good transient effect;easy to control	labor intensive;Little effect on biofilm; should be used with other methods	mainly for labor cost; €14100 for 380 water point

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Sterilization treatments

Treatments	*Efficacy Term*	*Operation Points*	*Advantages*	*Disadvantages*	*Cost*
Chemical method					
Ionization	long term	high water quality and low PH value are required; electrodes should be changed regularly	good long-term effect;able to minimize recolonization	little effect on contaminated system; hard to maintain precise concentration	investment + maintenance fee (electrodes replacement ranging from $1500 to $4000 every year)
Chlorine	long term	2-6mg/L for continuous effect; 1-2 hours acting time is required	provide residual concentration for whole system; good transient effect	pipe corrosion; hard to maintain same concentration throughout the whole system; potential to cause carcinogen	investment + maintenance fee(labor cost and change of corrosion pipes); €28600 annual cost for 380 water points

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Sterilization treatments

Treatments	*Efficacy Term*	*Operation Points*	*Advantages*	*Disadvantages*	*Cost*
Chemical method					
Chlorine dioxide	long term	0.5-0.8 ppm for continuous effect; should be produced on site; not suitable for high temperature	more effective than chlorine	chemical unstability; cause cross-linked polyethylene pipes damage	investment + management fee; €11640 for380 water points annually
ozone	short term	0.36 mg/L for inhibitation; should be produce on site	fast reaction; less required dosage (0.1 mg/l ozone has equivalent effect versus 1 mg/l chlorine)	fast decomposition; should be applied with other chemicals	more expensive than chlorine because on-site installation and dosage loss; €30-40,000 per 1,000 beds for 0.5 mg/l of concentration

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Sterilization treatments

Treatments	*Efficacy Term*	*Operation Points*	*Advantages*	*Disadvantages*	*Cost*
Chemical method					
UV light	short term	wavelength of 254 nm ultraviolet light; should be installed on site	good transient effect; easy installation; no chemical by-products; no contamination on water quality	no residual protection; little effect on contaminated system; requires high water quality	mainly for investment; $50000 for 500-bed hospital
Photocatalysis	short term	wavelength of the ultraviolet should be no more than 385 nm	chemical stability; high effect; no toxic residual	very limit effective wavelength; no documents about long-term effect	investment + maintenance fee; could be economical because the potential to use sunlight

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Sterilization treatments

Treatments	*Efficacy Term*	*Operation Points*	*Advantages*	*Disadvantages*	*Cost*
Physical method					
Water filter	long term	needs to be changed frequently	high efficacy	cost could be increased by frequent use of the filter	mainly for replacing the filter; much more expensive than other kinds

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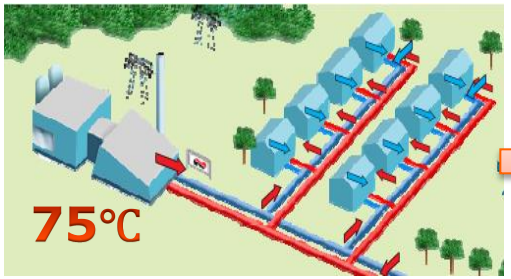
DHW Renovation Blueprint

Current situation



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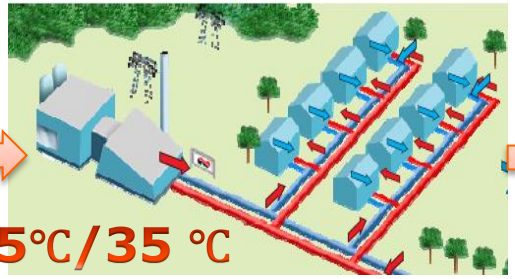
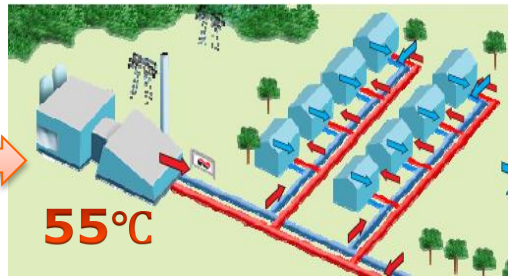
Transition period



LTDH



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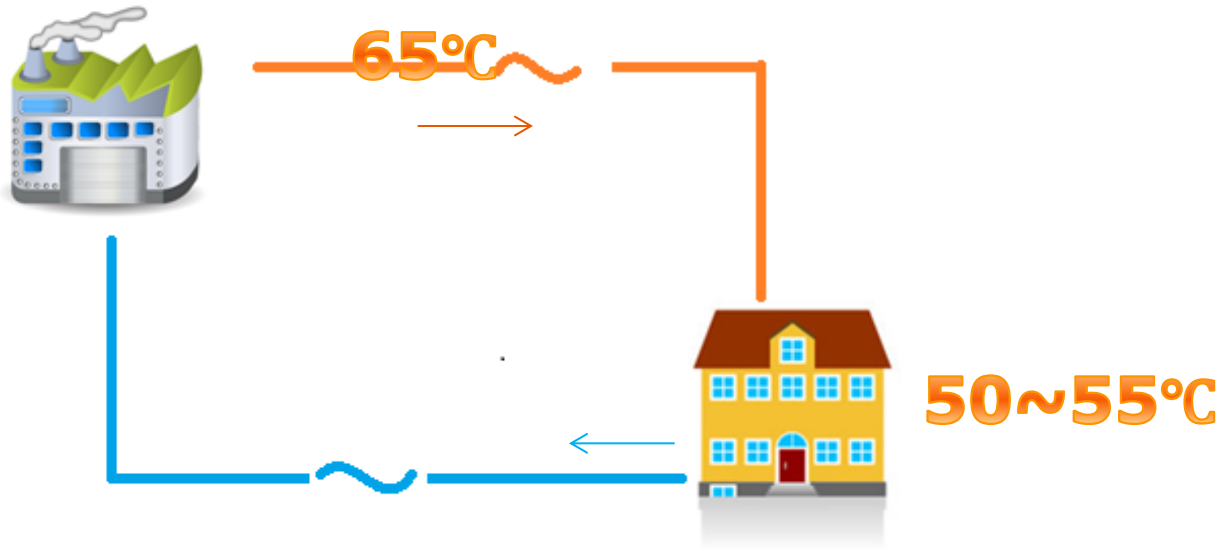
Potential solution 1

Low temperature district heating at 65°C

- *Existing buildings (with upgraded heat exchanger)*



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Potential solution 2

Low temperature district heating at 50C

Existing large buildings with sterilization of DHW system:

- temperature treatment
- chemical treatment
- UV treatment
- micro filtration
- ……

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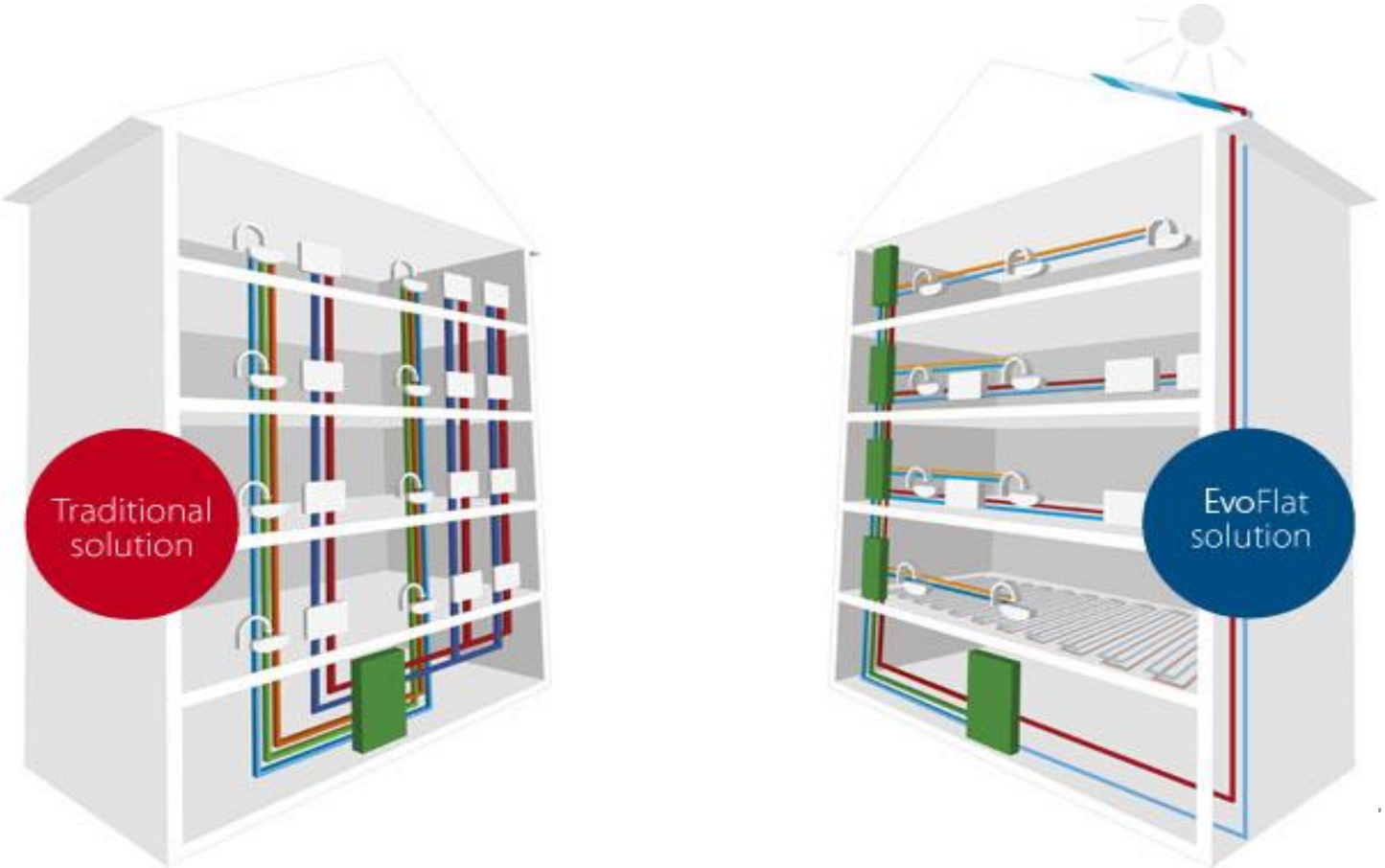
Potential solution 3

Low temperature district heating at 50C

Renovated large buildings with DHW heating in each flat



Potential solution 4

Low temperature district heating at 50C

Small buildings with small volume of DHW system

- German Standard W551

  the system is safe with temperature below 50 ^{o}C if the total volume of the DHW system excluding HEX is less than 3 L.

- Experience: small DHW system, no ciculation cools down to room temperature

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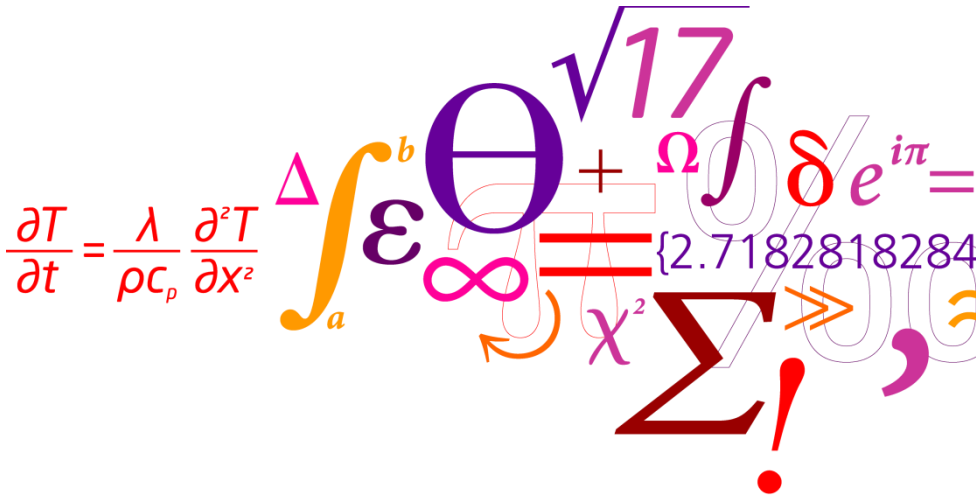
THANK YOU!



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