Heat Roadmap Europe 2050
A low-carbon heating and cooling strategy

4DH
4th Generation District Heating Technologies and Systems

reINVEST

3RD INTERNATIONAL CONFERENCE ON

SMART ENERGY SYSTEMS AND 4TH GENERATION DISTRICT HEATING

COPENHAGEN, 12–13 SEPTEMBER 2017

AALBORG UNIVERSITY
DENMARK

World DH status and Transformation Roadmap for 4GDH

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3rd international conference on
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www.4dh.eu www.reinvestproject.eu www.heatroadmap.eu

Background

A. International review of district heating

- Concerning the market, technical, supply, environmental, institutional, and future contexts

B. Transformation Roadmap project within the IEA-DHC Technology Collaboration programme.

- Elaboration of main features for transition to 4th generation system temperatures

Outline

1. **Global heat deliveries and heat demands for buildings**
2. **Heat and fuel supply**
3. **Carbon dioxide emissions**
4. **Global status conclusions**
5. **IEA-DHC Transformation Roadmap**
6. **Condensed Transformation Roadmap**
7. **Main conclusions**

1. Global heat deliveries

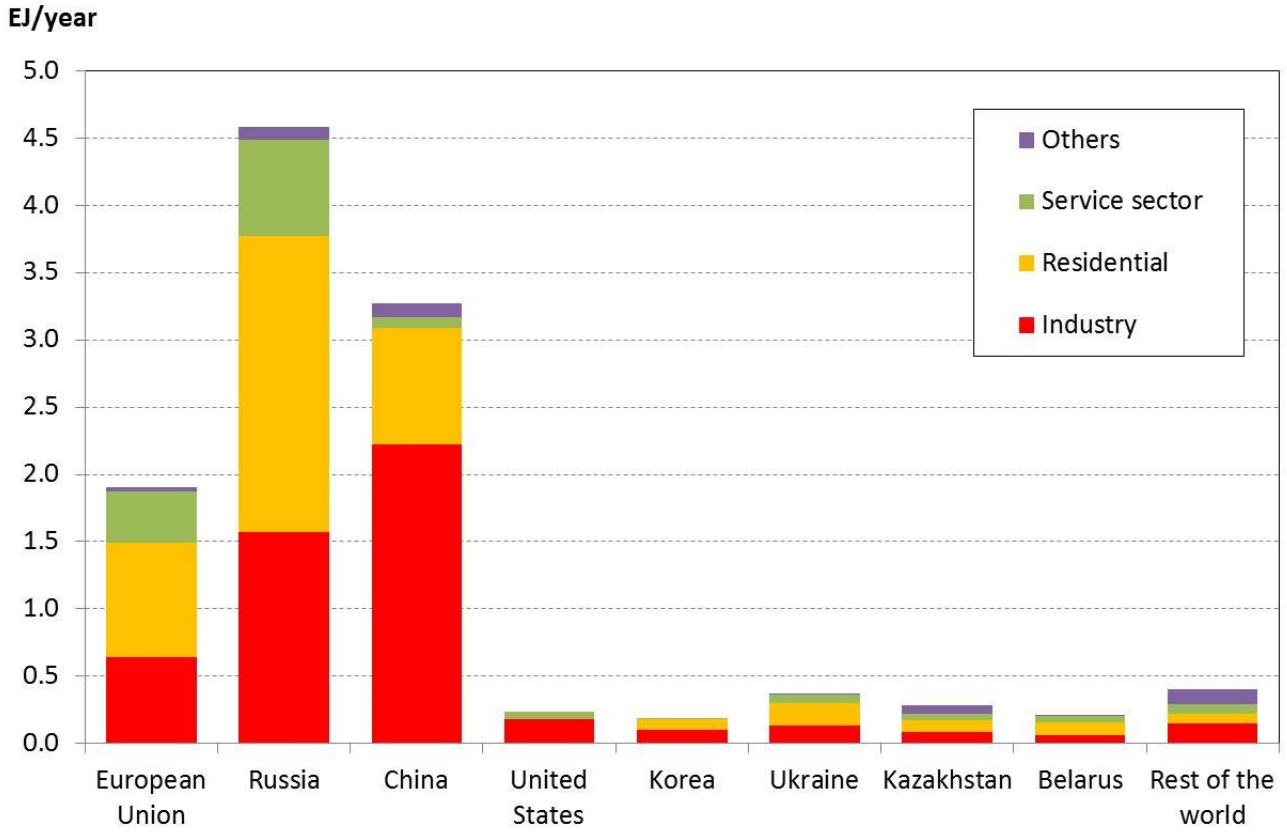

Figure 1. Heat deliveries in various regions and countries during 2014 with respect to user categories according to (IEA, 2016).

1. Global heat demands for buildings

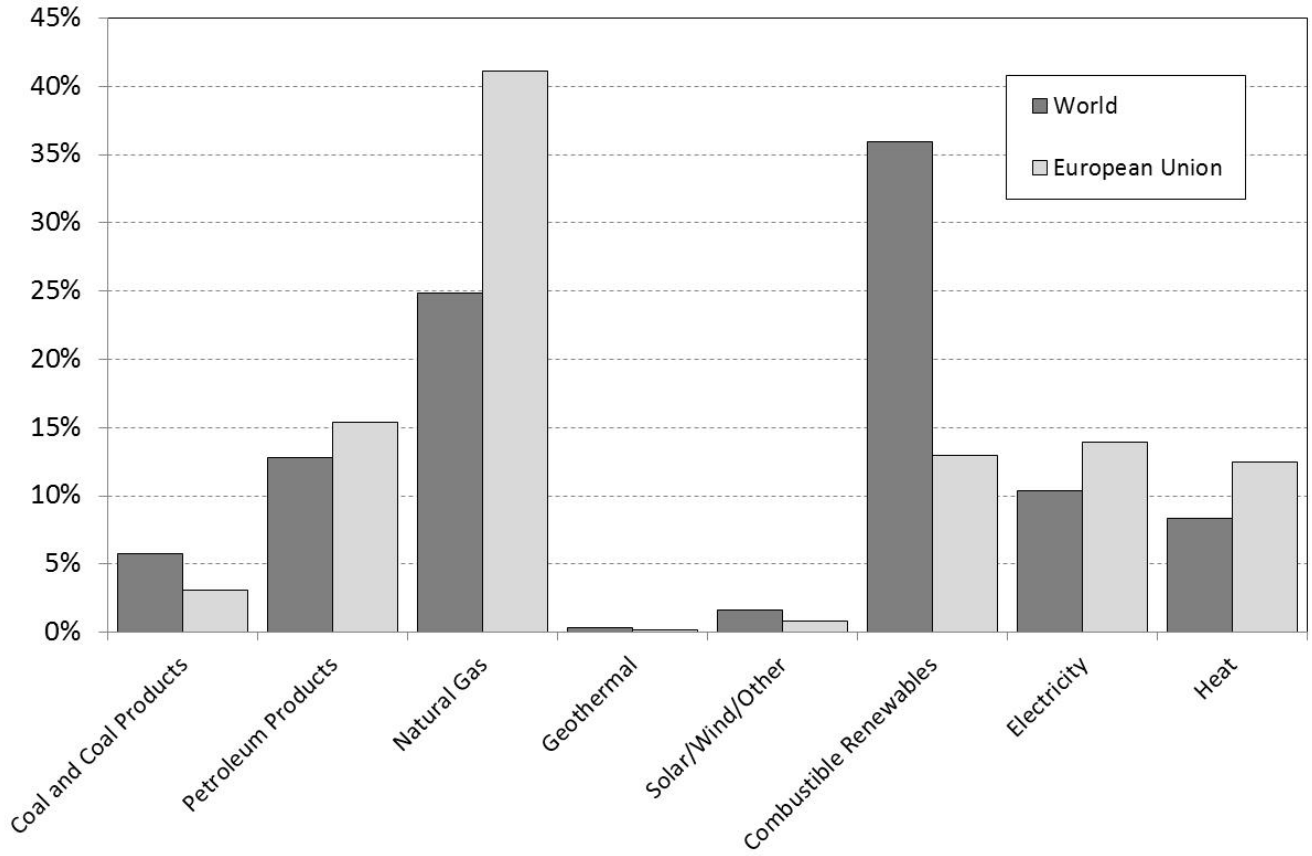

Figure 2. Estimated proportions of heat use in residential and service sector buildings in the world and in the current European Union during 2014 with respect to origin of energy supply group according to (IEA, 2016).

2. Heat supply, world

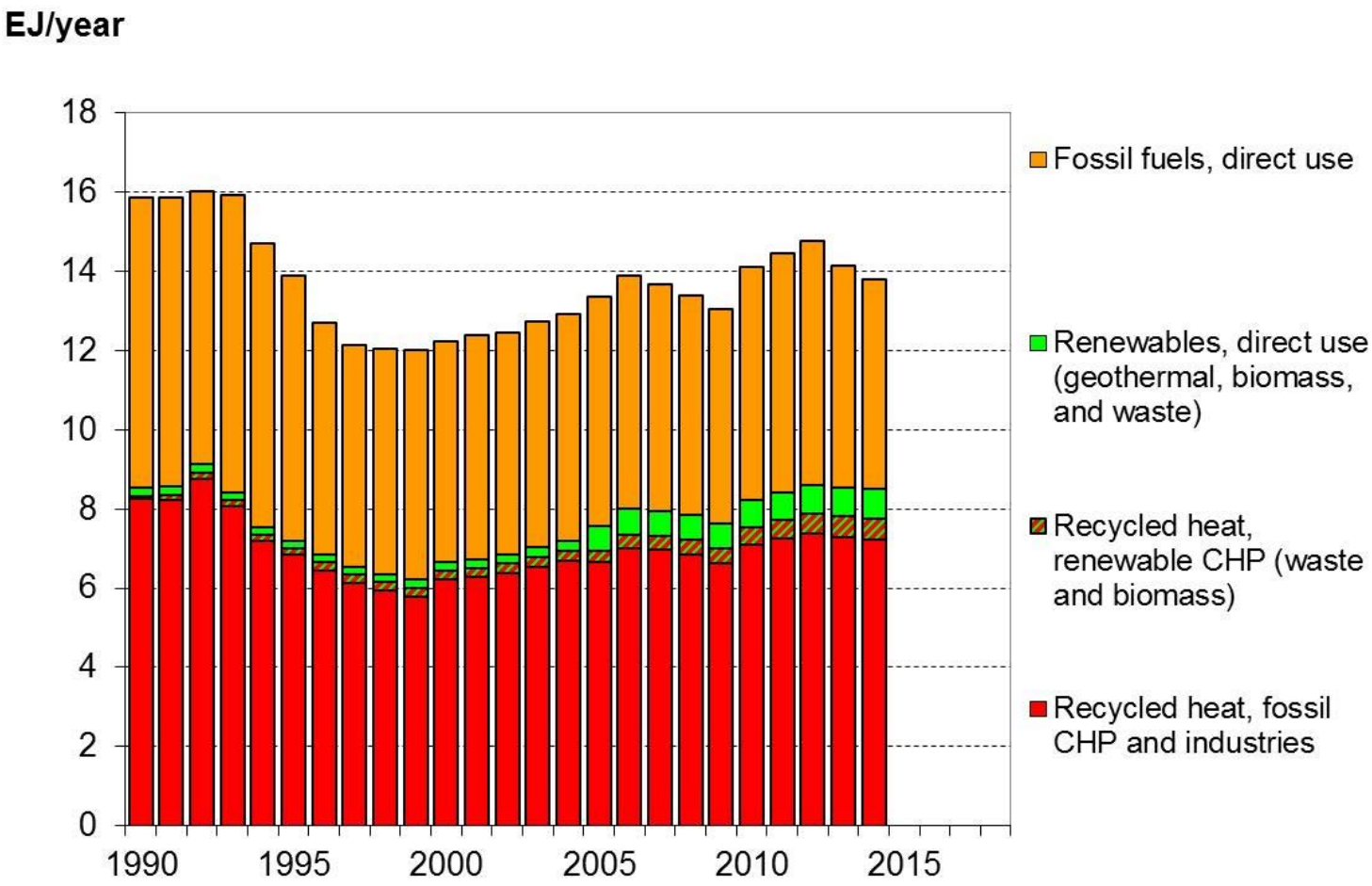

Figure 3. Heat supplied into all district heating systems in the world 1990-2014 according to four different heat supply methods.

2. Heat supply, EU

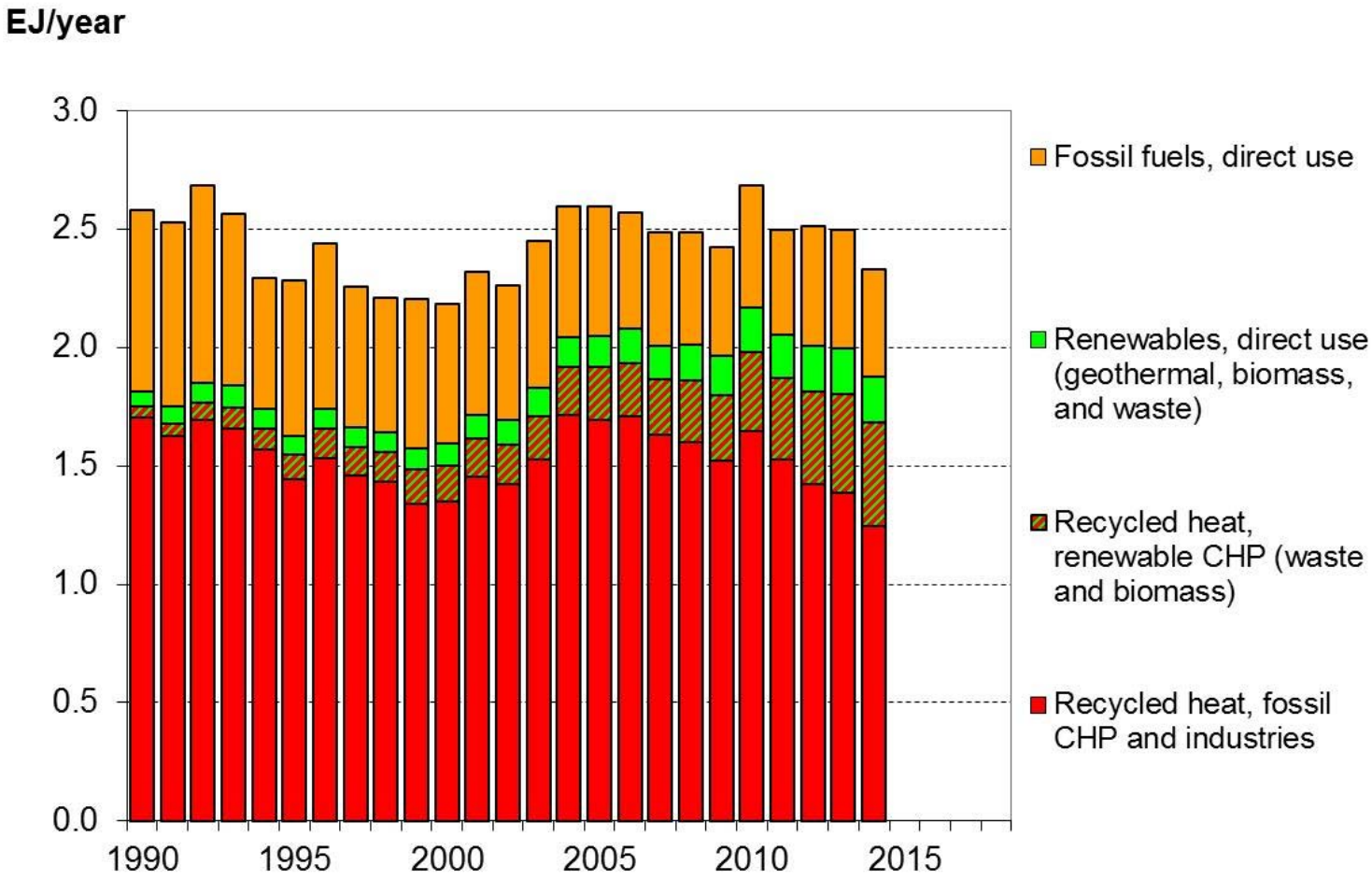

Figure 4. Heat supplied into all district heating systems in the current European Union 1990-2014 according to four different heat supply methods.

2. Fuel supply, World

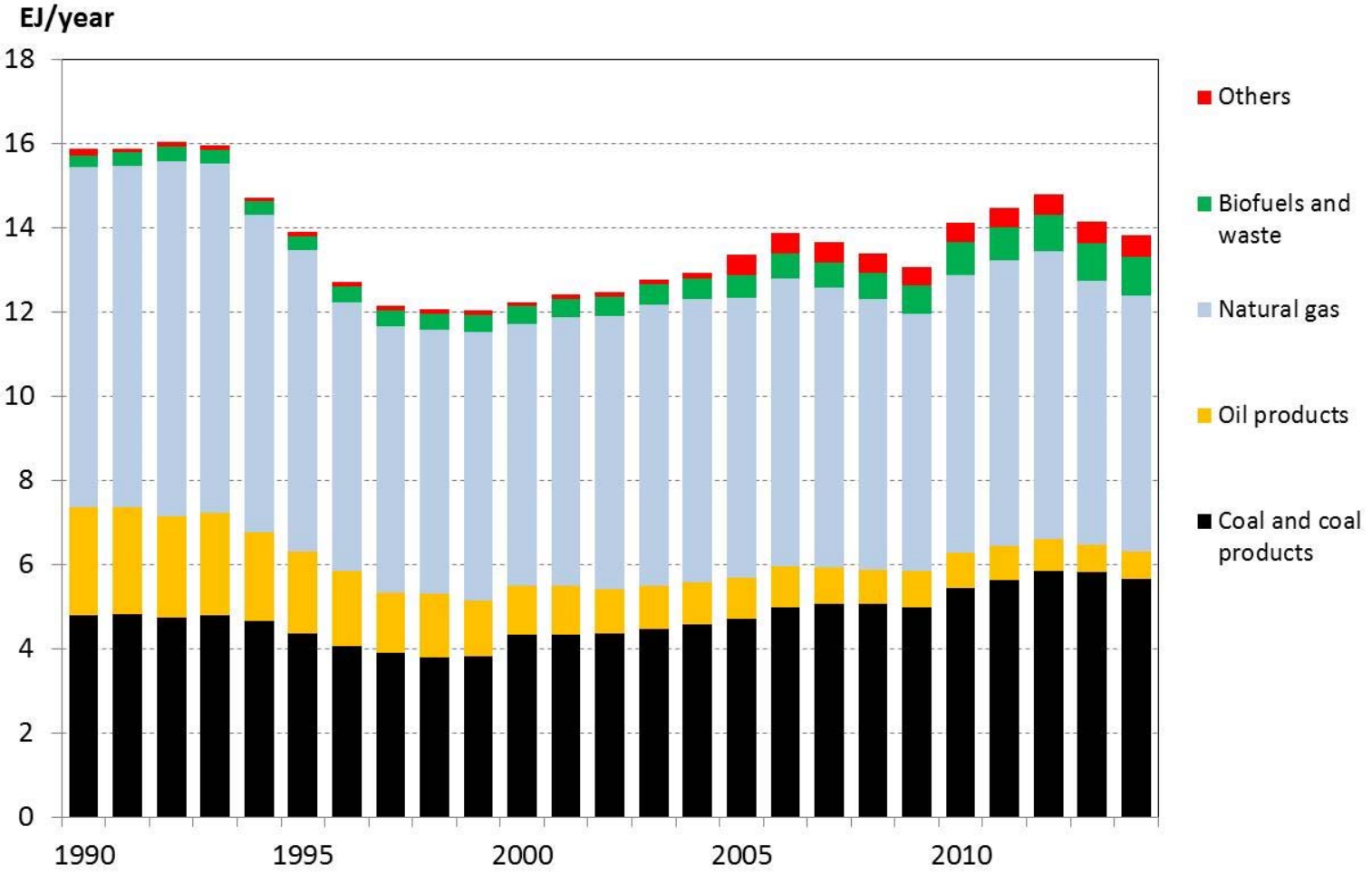

Figure 5. Heat supplied into all district heating systems in the World 1990-2014 according to original energy supply sources used.

2. Fuel supply, EU

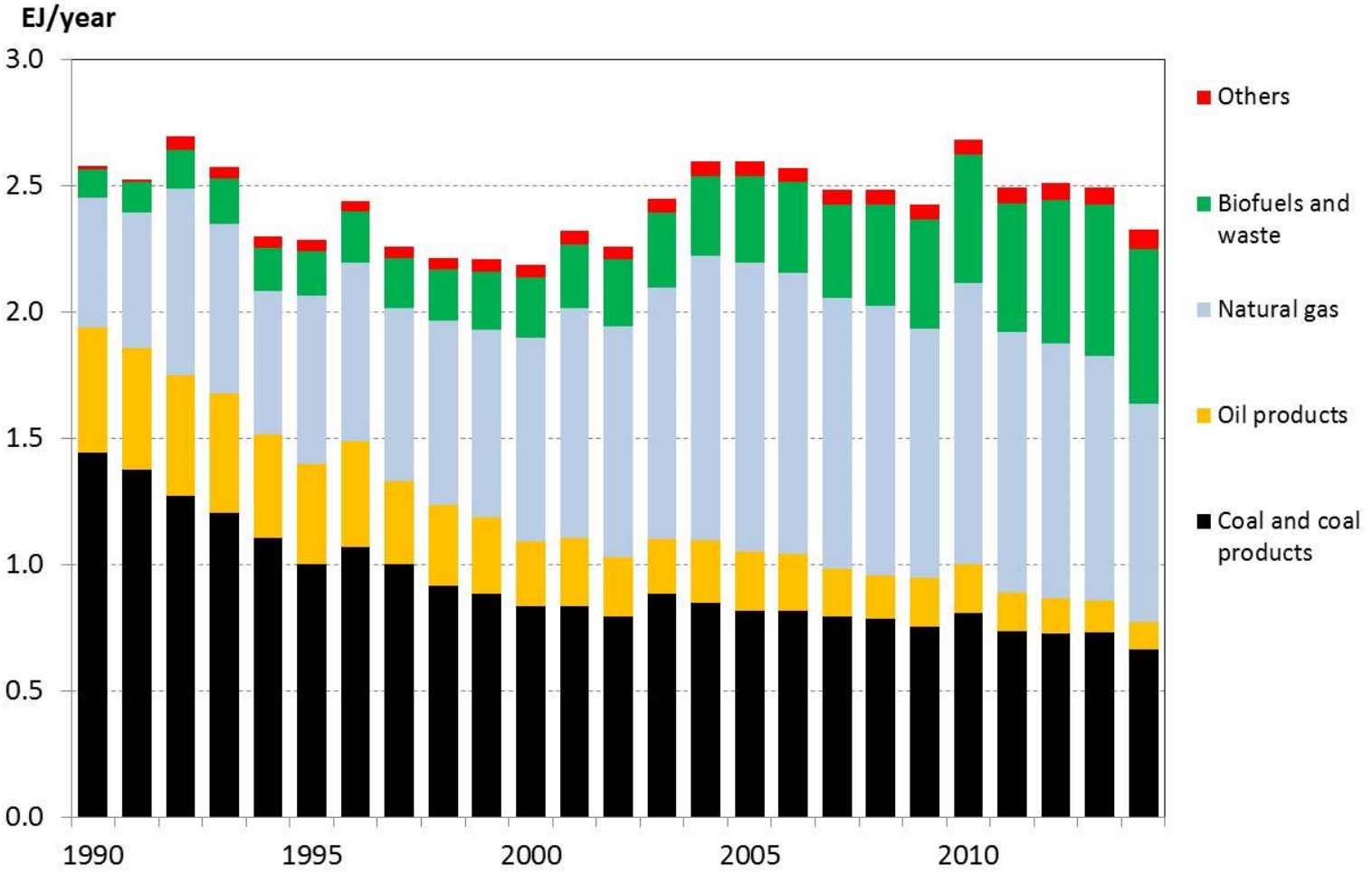

Figure 6. Heat supplied into all district heating systems in the current European Union 1990-2014 according to original energy supply sources used.

3. Carbon dioxide emissions

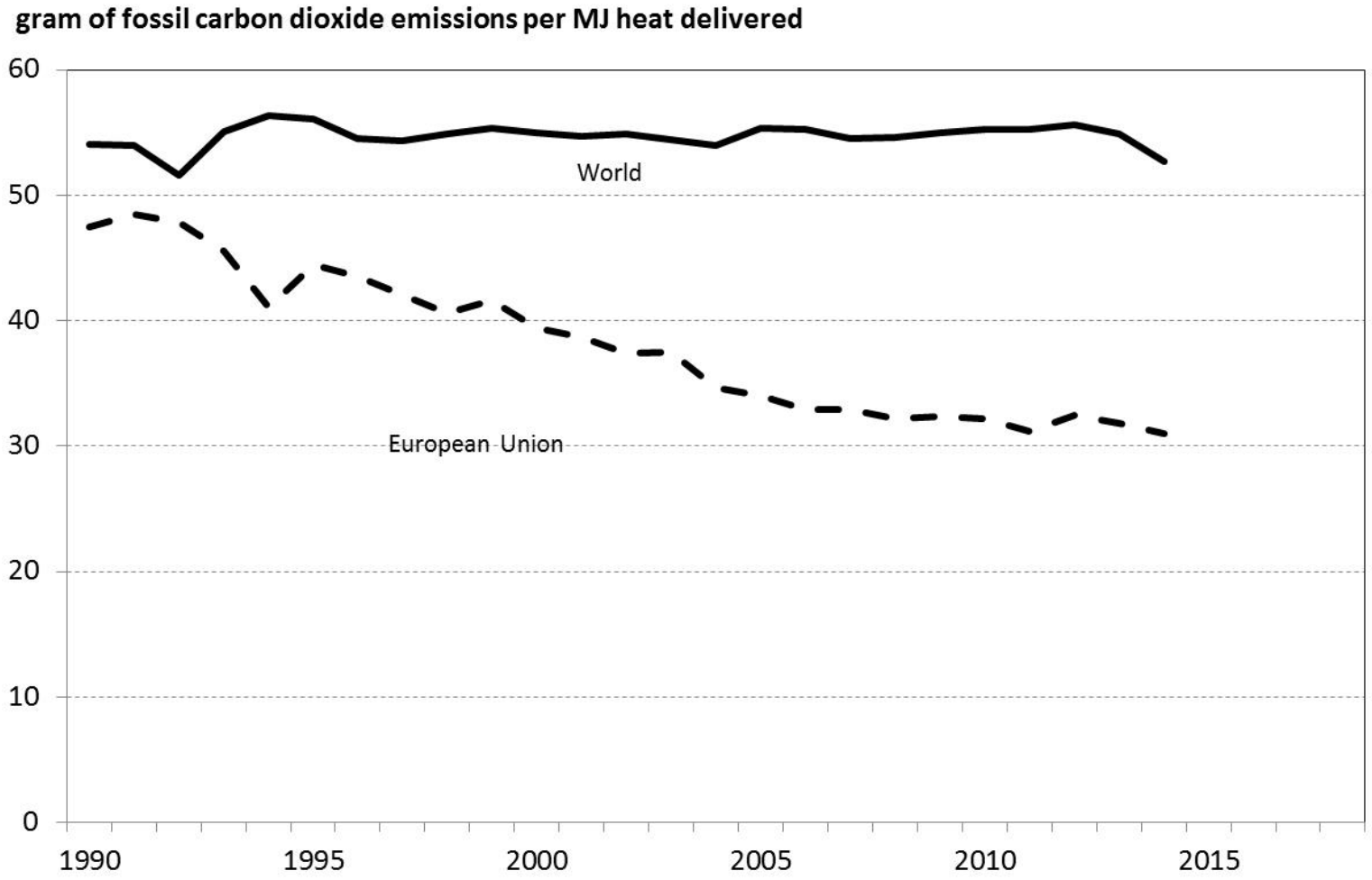

Figure 7. Estimated specific carbon dioxide emissions 1990-2014 from all district heating systems in the world and in the current European Union.

3. Carbon dioxide emissions

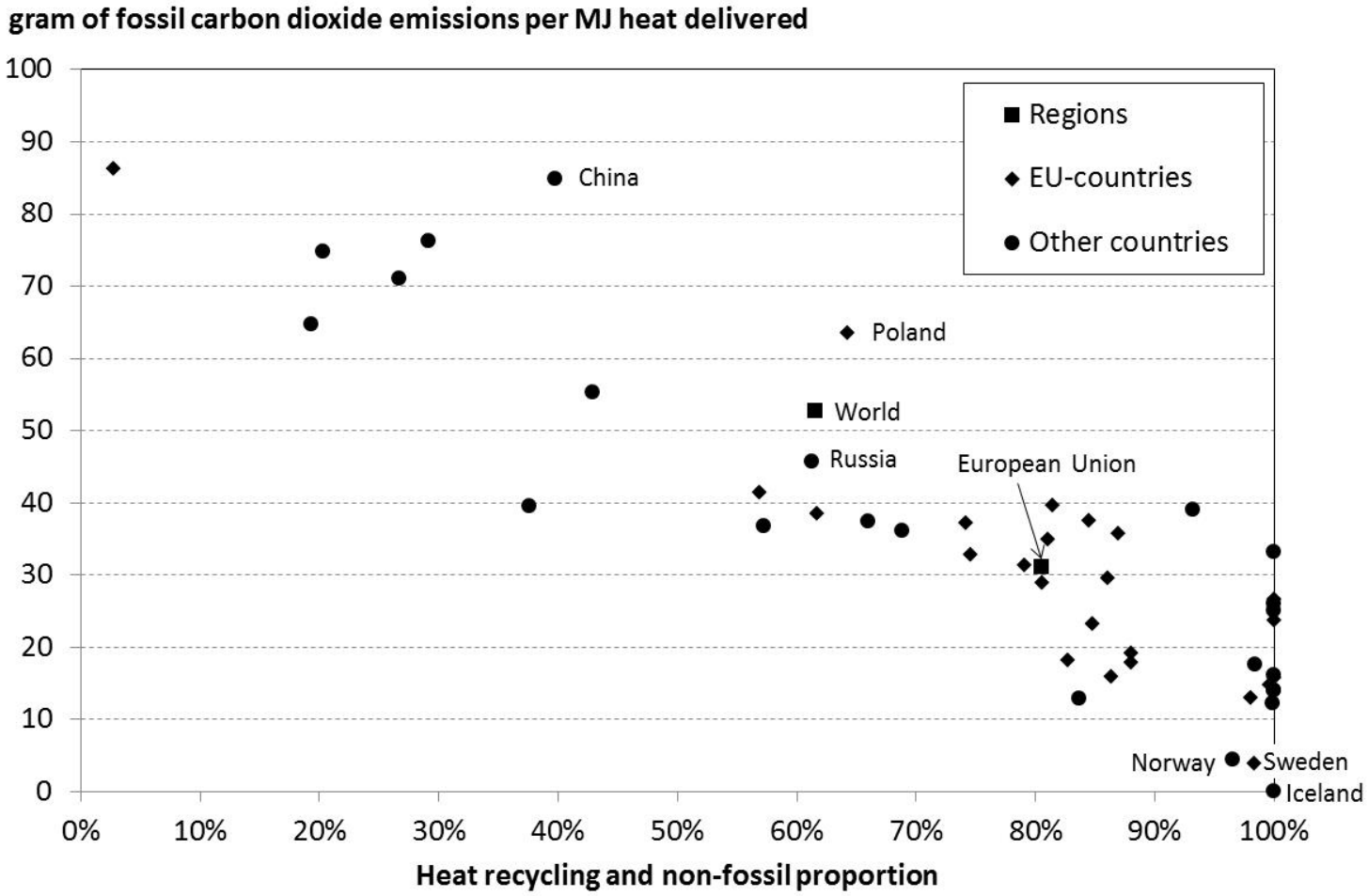

Figure 8. Estimated specific carbon dioxide emissions during 2014 from all district heating systems in the two regions presented in Figure 7, 24 EU-countries, and 23 other countries.

4. Global status conclusions

- District heating and cooling systems have strong potentials to be viable heat and cold supply options in the future
- However, more efforts are required for identification, assessment, and implementation in order to harvest the global benefits with district heating and cooling

IEA DHC|CHP

Annex XI, 2014-2017

Transformation Roadmap
from High to Low Temperature District Heating Systems

Technical University Dresden
Building Research Establishment
University of Geneva
Denmark Technical University
Halmstad University

5. IEA-DHC Transformation Roadmap

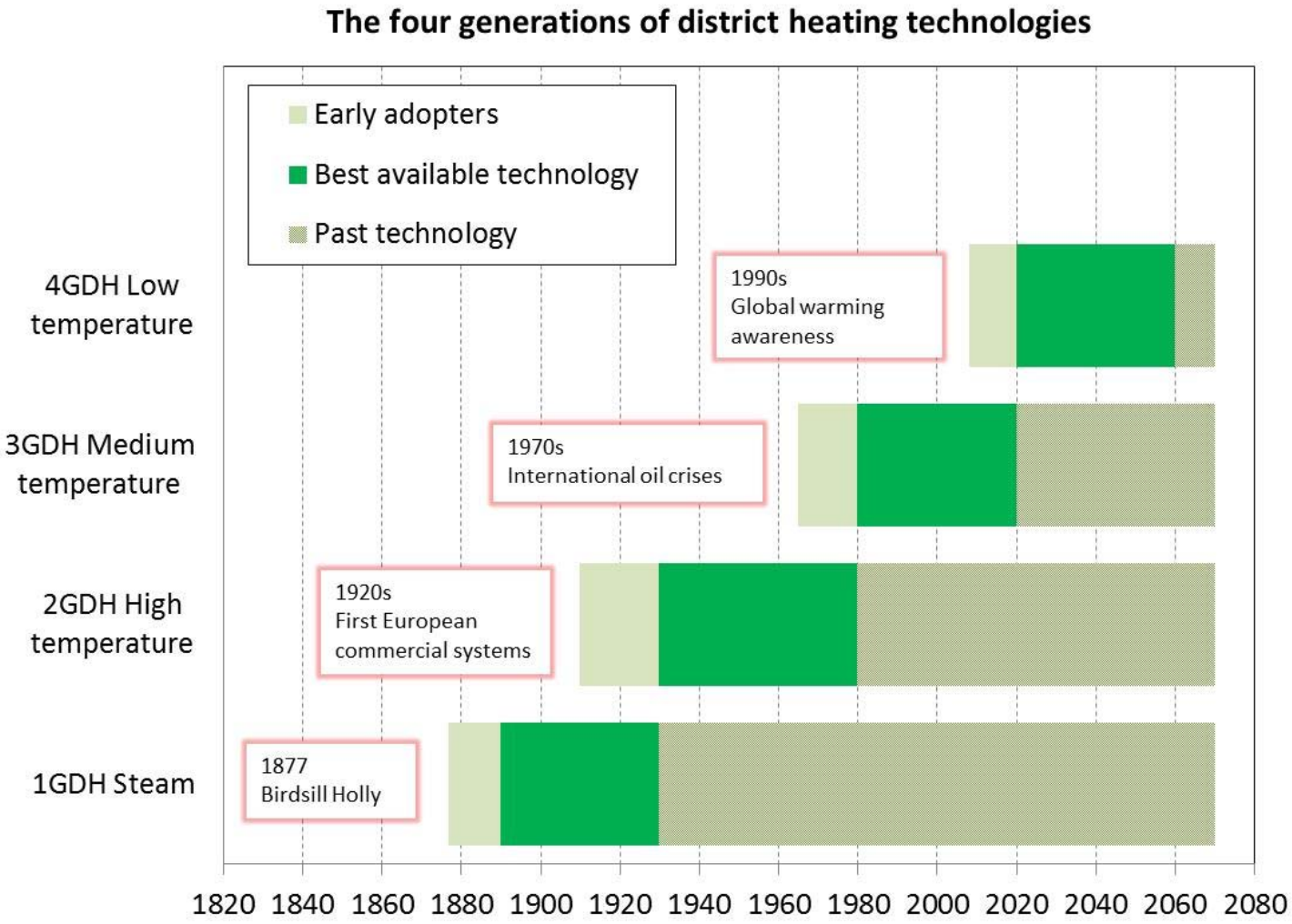

Figure 1. Overview of the four different technology generations of district heating.

5. IEA-DHC Transformation Roadmap

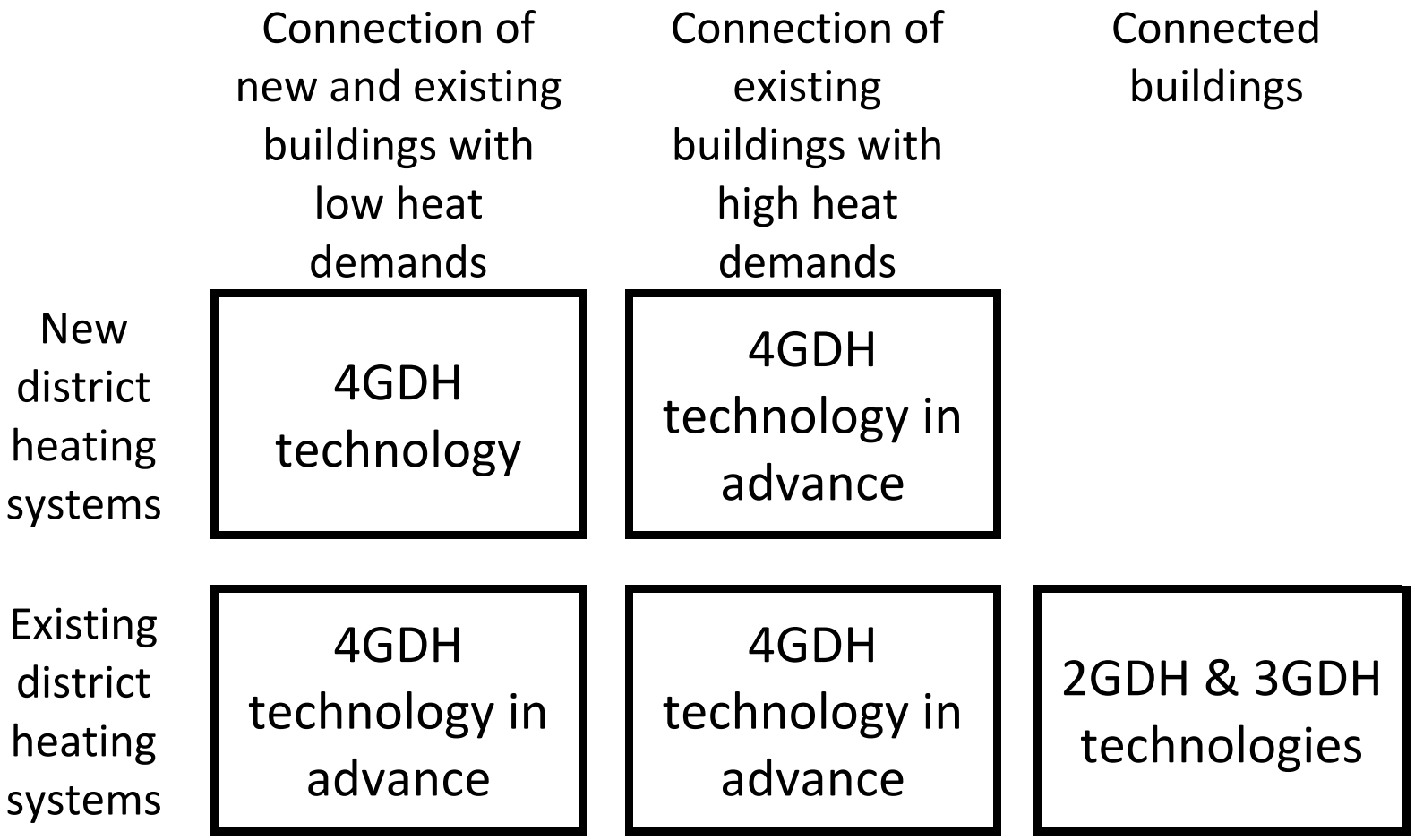

Figure 7. Overview of the five possible transformation strategies in order to obtain future district heating systems fully operating according to the 4GDH principles.

Chapter contents

Chapter 2
Previous generation shifts

Technology shifts from 1GDH

- Keeping the steam distribution system (New York)
- Converting to hot water distribution with loop (Paris), changeover (Copenhagen, Kiel, Ulm, Salzburg, St Paul), and makeover solutions (Munich, Vancouver, and Univ of Rochester)
- Closing down the steam distribution system (Chicago)

Technology shifts from 2GDH and 3GDH

Chapter 3
Temperature levels in district heating systems

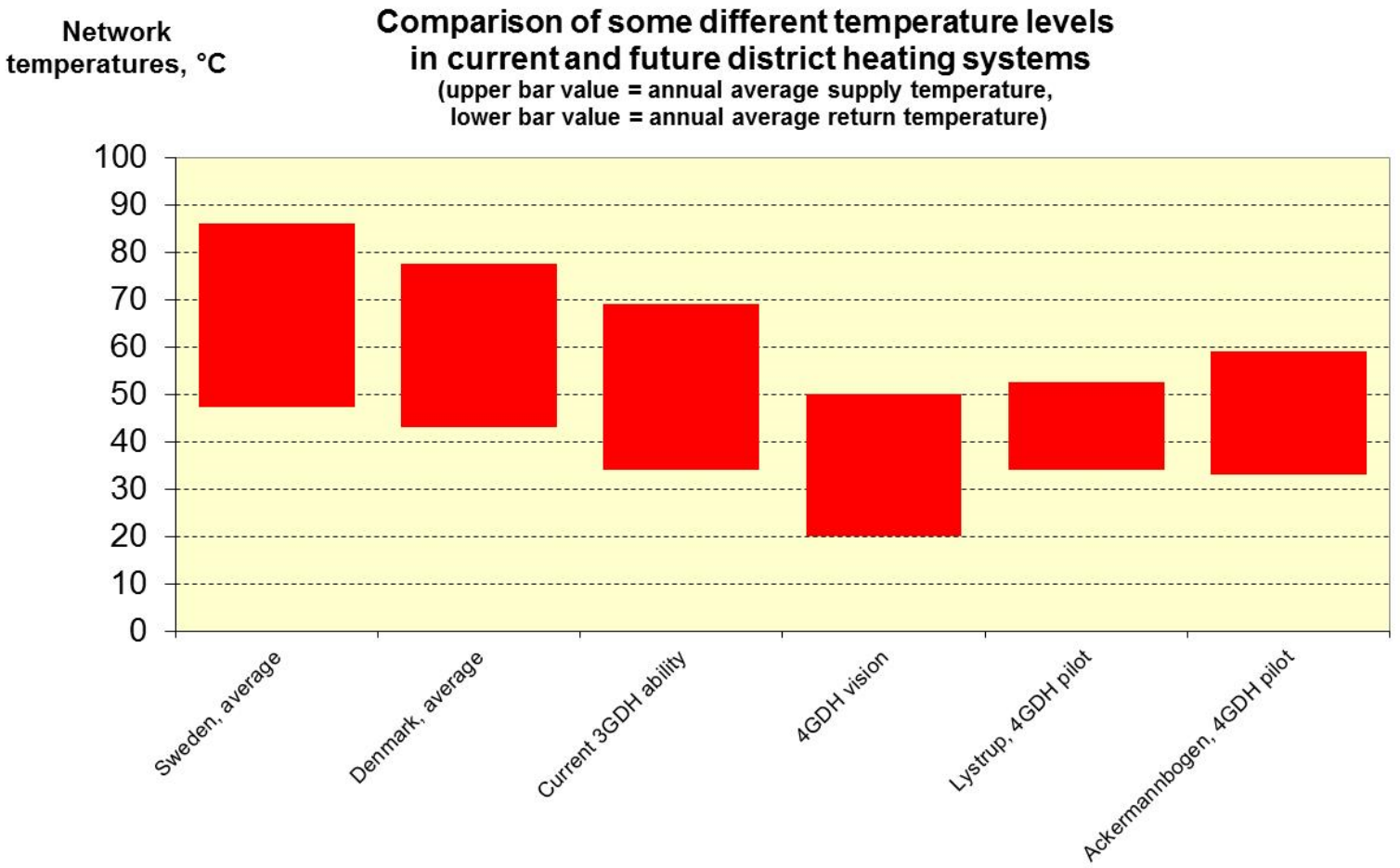

Figure 23. Typical annual average supply and return temperatures in heat distribution networks for both current and various 4GDH systems.

Chapter 3
Temperature levels in district heating systems

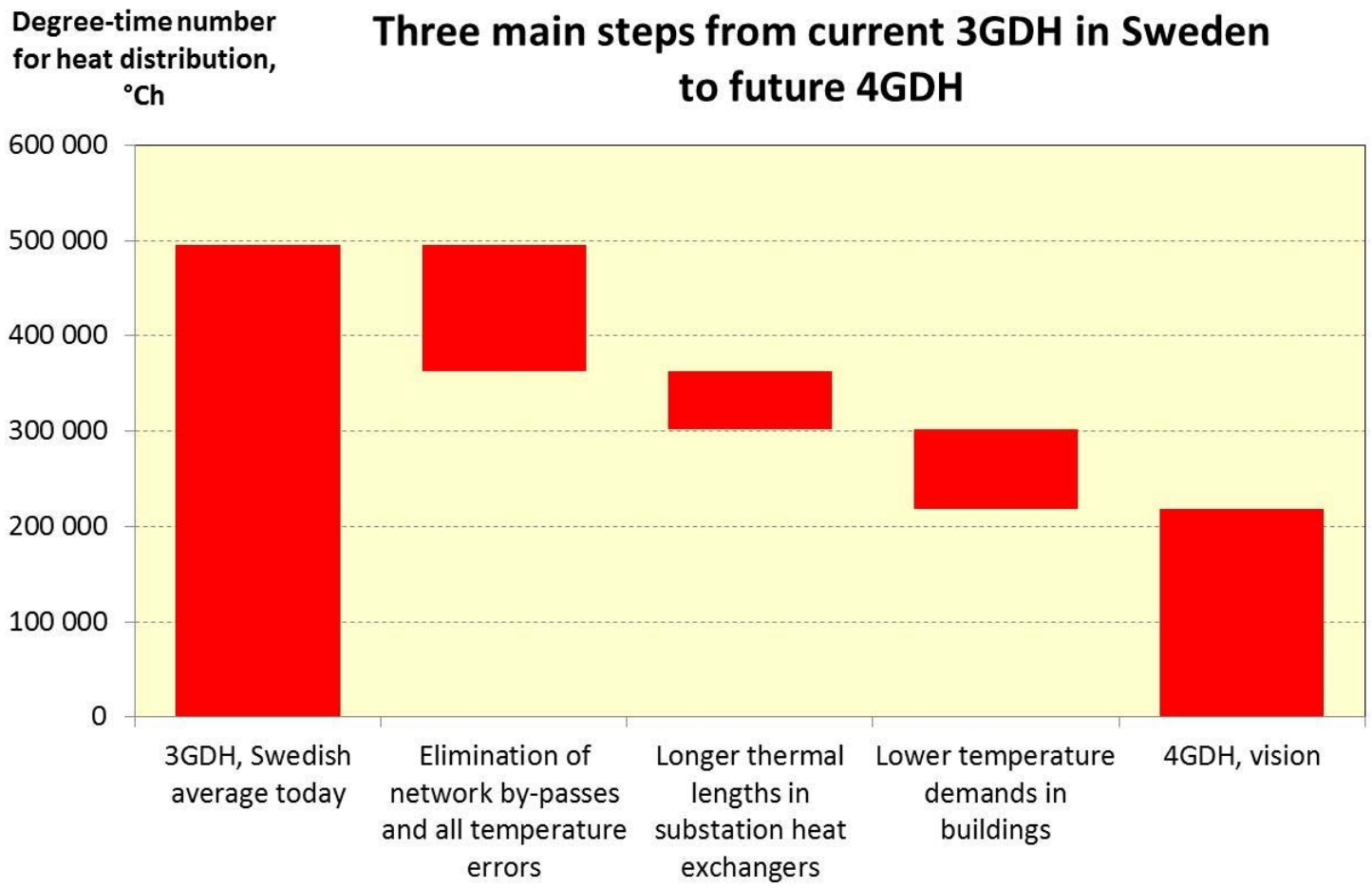

Figure 27. Estimation of the three main steps for obtaining lower temperature levels in Sweden.

Chapter 4
Temperature levels in customer heating systems

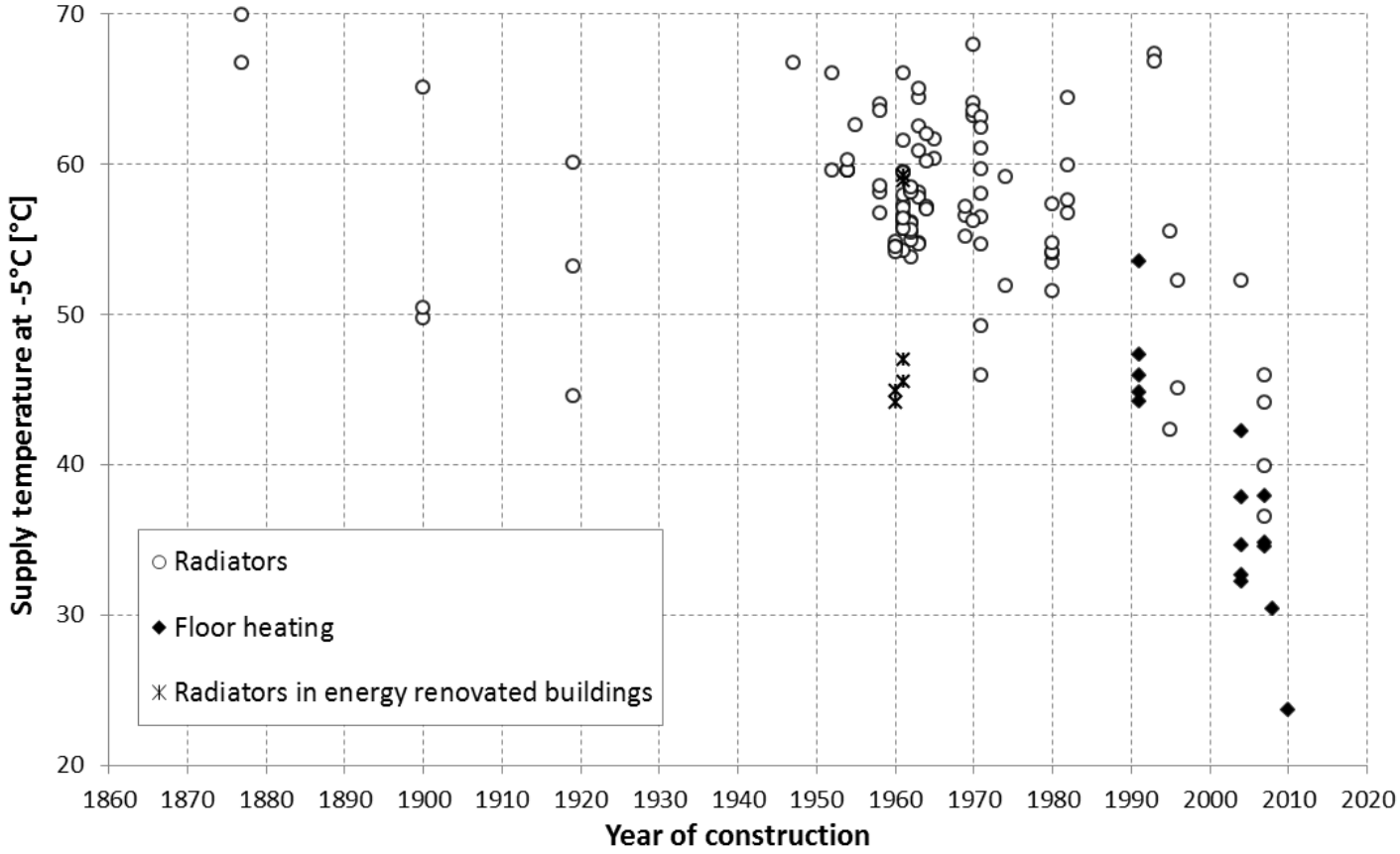

Figure 30. Supply temperature for ambient temperature -5°C (radiators and floor heating systems) vs. building age. From linear regressions on hourly values.

Chapter 5
Future temperature levels in customer heating systems

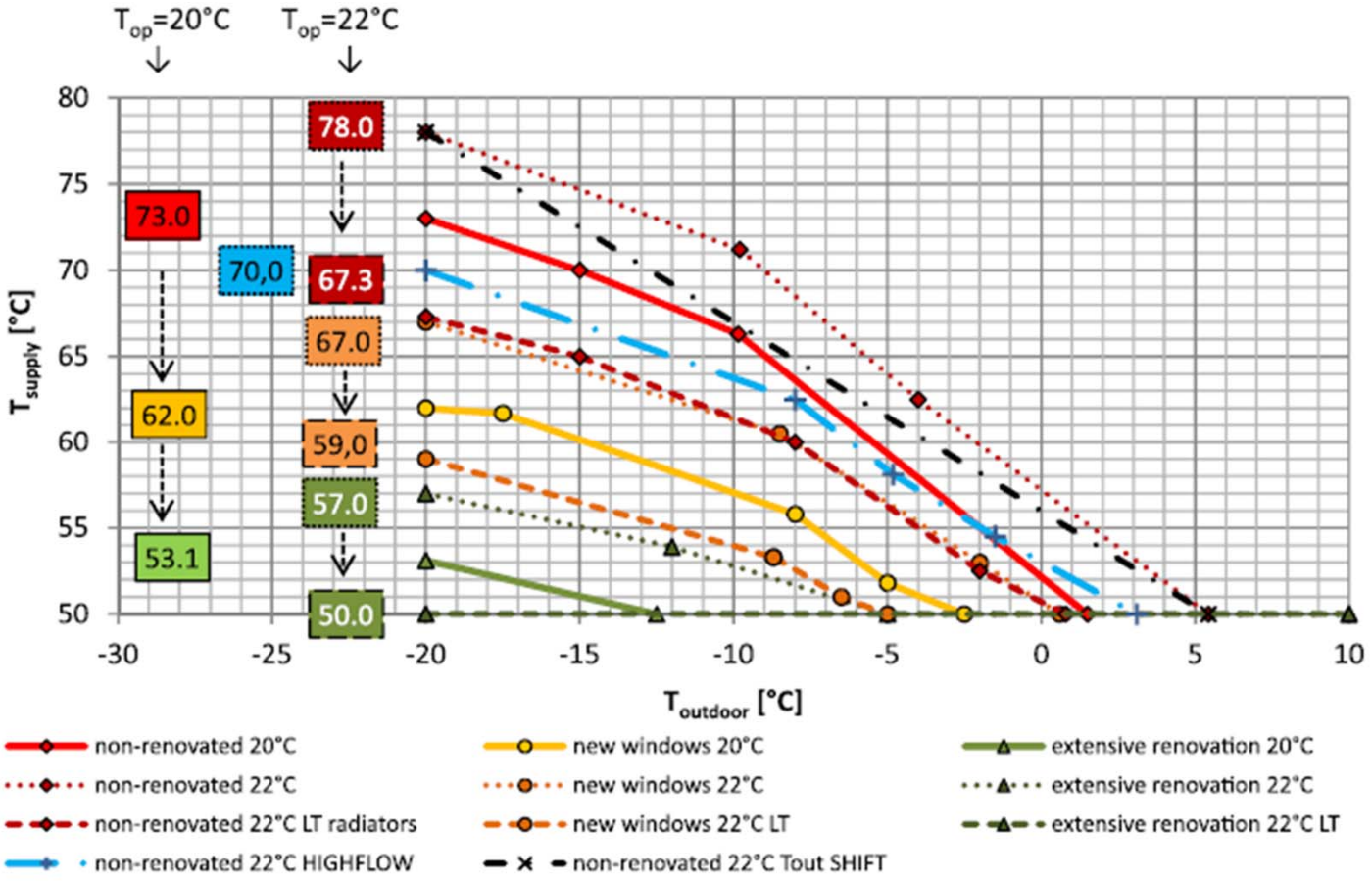

Figure 39. Radiator supply water compensation curves for different levels of renovation of the investigated building.

Chapter 6
Concurrent operation of different generations

Current experiences of concurrent operation

- Multi-level temperature systems (as in the SEMHACH system, outside Paris)
- Division between primary and secondary networks (as in Vienna)
- Supply-to-supply connections
- Return-to-return connections

6. Condensed Transformation Roadmap

1. Eliminate temperature errors in existing distribution networks and substations in order to make existing systems more efficient. This will reduce existing temperature levels.
2. Avoid these temperature errors in new network parts and in new substations.
3. Use heat exchangers with longer thermal lengths in substations for indirect connection of customer heating systems and closed hot water preparation. This will reduce the temperature differences between the warmer distribution waters and the colder fluids to be heated.

6. Condensed Transformation Roadmap

4. Reduce existing customer temperature demands by elimination of local temperature errors, reduction of heat demands by means of energy efficiency measures, and by installation of larger heating surfaces in radiator and ventilation systems.
5. New low temperature network parts in conjunction with existing systems can be connected by concurrent operation of these parts as secondary networks.
6. The long-term vision is to deliver heat to substations with a supply temperature of 50°C, while obtaining a return temperature of 20°C. However, the technical solutions for obtaining this low return temperature have yet not been completely defined.

7. Main conclusions

- **Europe is closer to reach the 4th generation features than rest of the world**
- **The lower network temperatures in 4th generation systems can be reached by a combination of elimination of current temperature errors, longer heat exchangers, and lower customer temperature demands**

The End

Thank you for your attention

More info here:

http://www.sciencedirect.com/science/article/pii/S036054421730614X
about the international review

http://www.iea-dhc.org/the-research/annexes/2014-2017-annex-xi/annex-xi-project-01.html
about the Transformation Roadmap report

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