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Arbeitsbereich für
Energieeffizientes Bauen

Energy efficiency first: High efficient buildings and the key role of heat recovery

EPBD Debate Series #1, April 26, 2020

Rainer Pfluger, Assoz. Prof. Dr.-Ing.

REPowerEU: 8th of March, 2022

*Commission President **Ursula von der Leyen**: "The quicker we switch to renewables and hydrogen, combined with more energy efficiency, the quicker we will be truly independent and master our energy system."*

REPowerEU will seek to diversify gas supplies, speed up the roll-out of renewable gases and replace gas in heating and power generation. This can **reduce EU demand for Russian gas by two thirds before the end of the year**.

The First Renewable Energy #EfficiencyFirst

Energy efficiency improvements deliver high economic net benefits, high comfort and independence from fossil fuels.

International campagne by

» IG PASSIVHAUS
» PASSIVHAUS Austria
» IPHA
» https://www.passivehouse-international.org/index.php?page_id=569

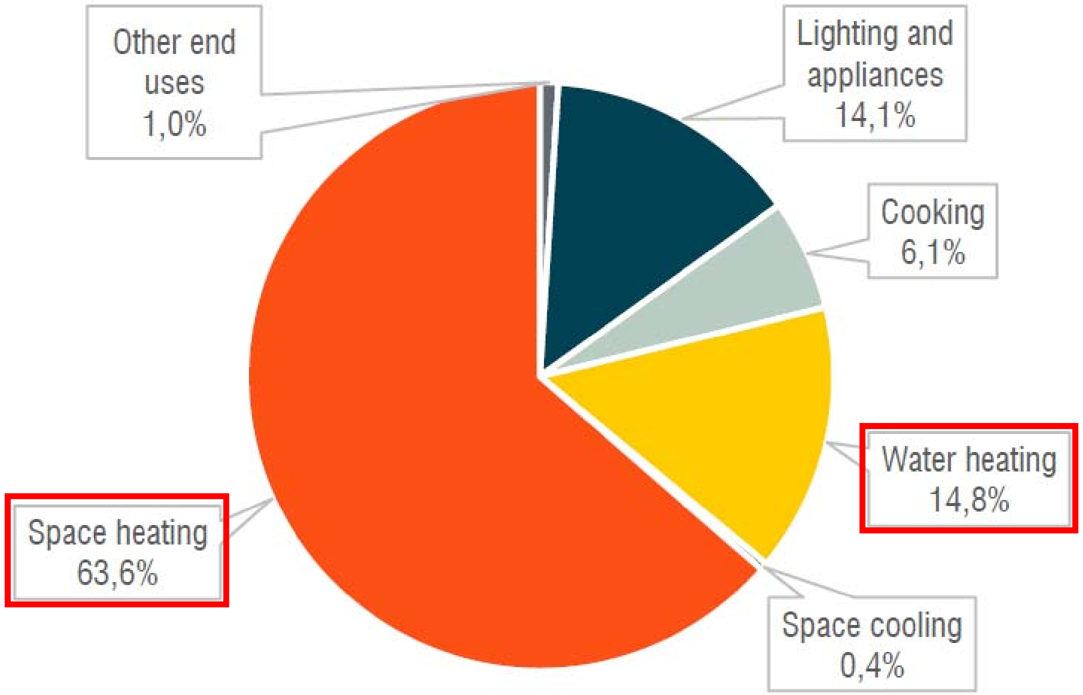
EU’s "Fit for 55" package for the building sector

» Reducing its energy consumption of heating and cooling by 18%, compared to energy consumption (delivered energy) levels in 2015

- **Renovations improving the quality of the thermal envelope and increasing the efficiency of the HVAC systems**
- **Increasing the share of renewable energy solutions in buildings.**

For space heating, energy savings of up to a factor of 10 are already best practice if the thermal envelope is first renovated and made airtight and a ventilation system with heat recovery is installed.

Delivered energy consumption in the residential sector by use in the EU



Source: Eurostat database; https://ec.europa.eu/eurostat/de/data/database

Paving the road to zero-emission-buildings

Energy efficient building envelope

» Reduction of transmission losses

» Reduction of thermal bridges

» Improving airtightness

» Ventilation heat recovery as general standard

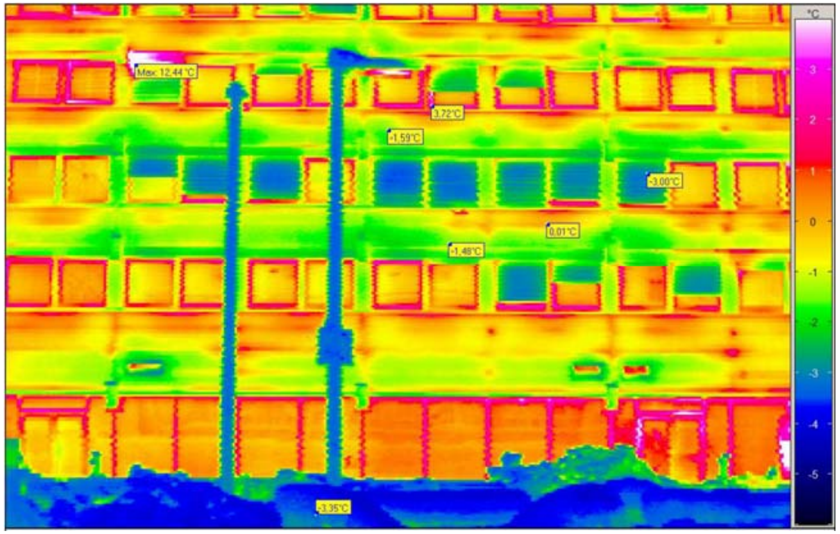
Domestic hot water

» Reduction of distribution and storage losses

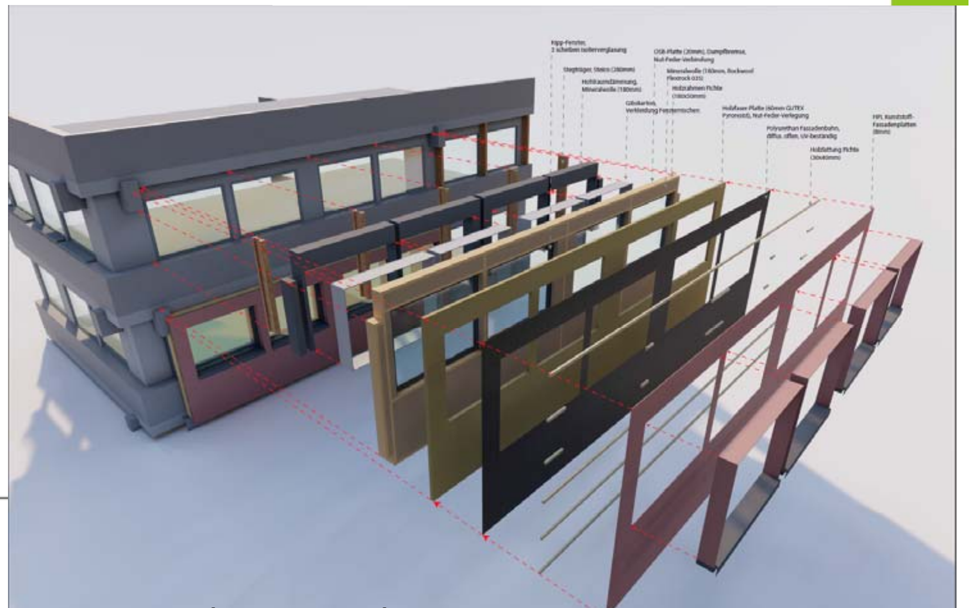
» Heat recovery on domestic hot water (WWHR)

» Removing barriers of WWHR

Thermal bridges and air-leakages at university building (Innsbruck, Bruno-Sander-Haus)



outPHit



Source: Elias Spitaler, UIBK

https://outphit.eu/de/

outPHit

Deep retrofits made faster, cheaper and more reliable

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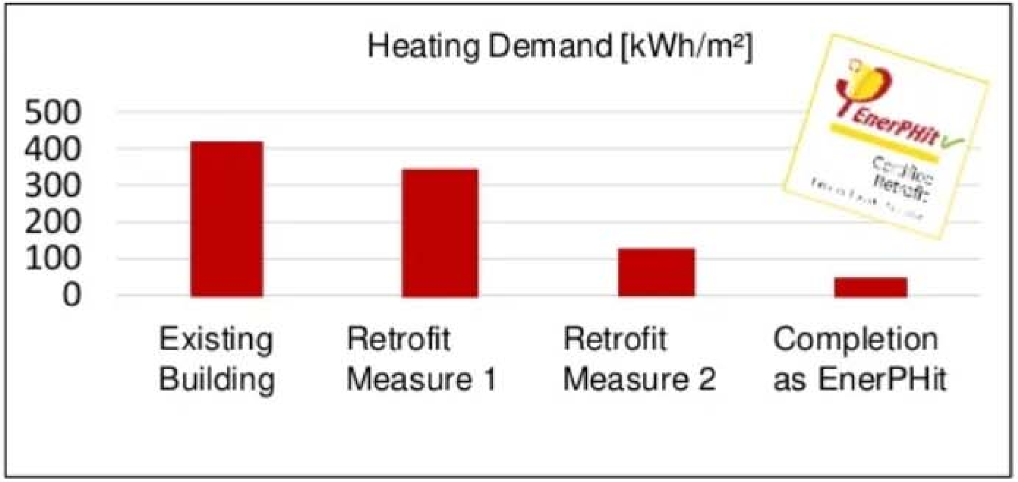
Energy balance calculation tool and overall retrofit plan

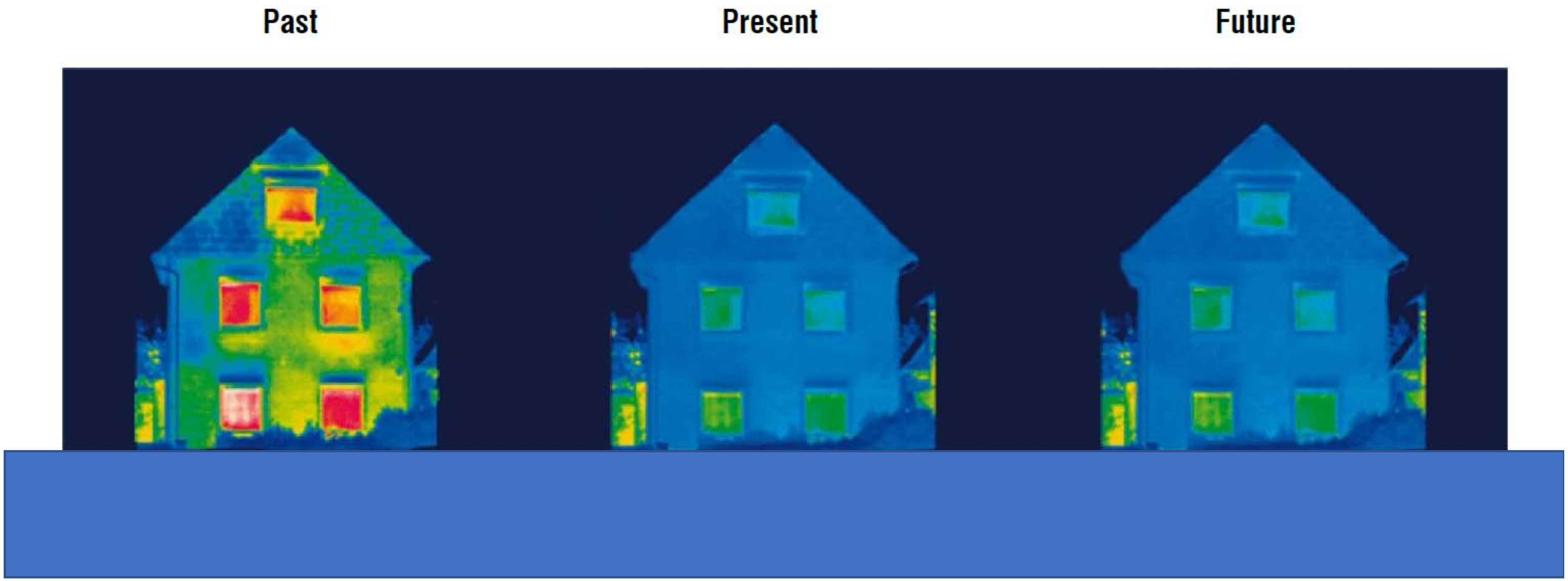
EuroPHit



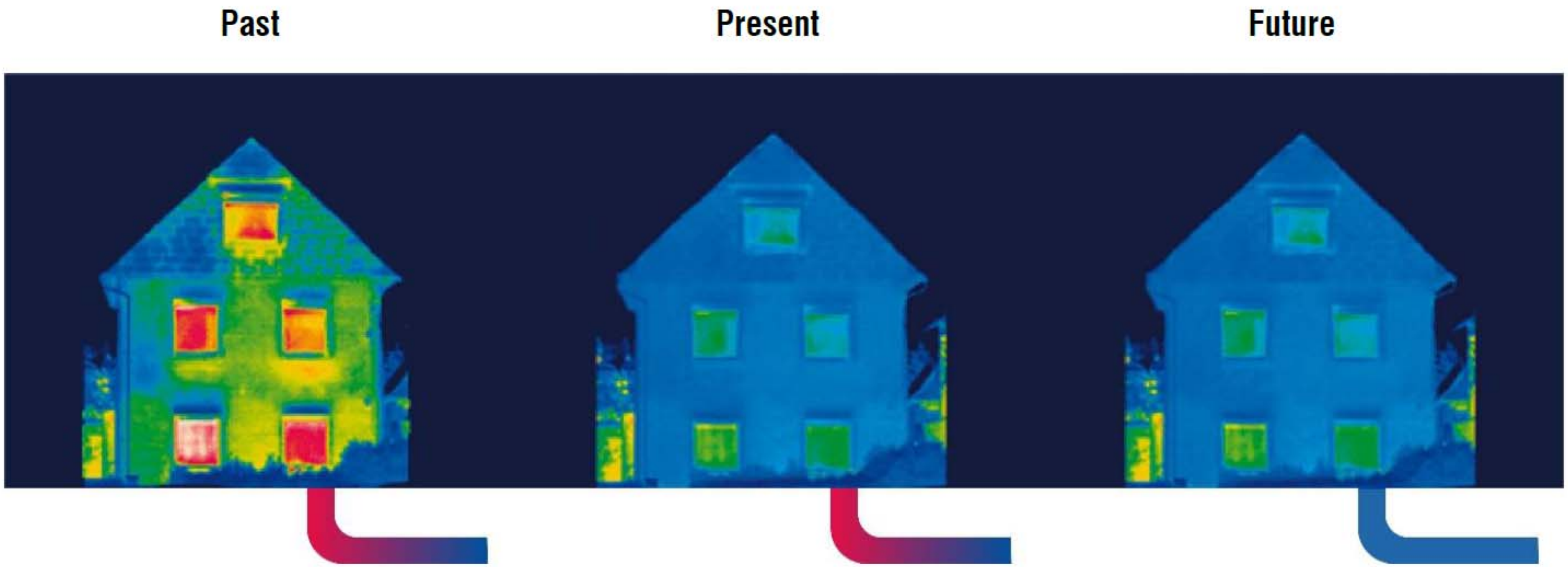
Select the active variant here >>>>>>>		Active: 1-Existing	Existing	Windows + heat recovery vent.	Basement ceiling + roof + PV	External walls + Entrance door
	Units	1	1	2	3	4
Heating demand	kWh/(m²a)	246,7	279,7	246,7	189,0	20,6
Heating load	W/m²	100,0	129,2	100,0	79,8	15,6
ehum. demand	kWh/(m²a)	2,3	6,2	2,3	1,1	0,3
Cooling load	W/m²	18,2	31,9	18,2	12,8	5,8
ating (> 25 °C)	%					
PER demand	kWh/(m²a)	770,4	855,8	770,4	624,9	203,0
EnerPHit Plus?	yes / no	no	no	no	no	no

Co-funded by the Intelligent Energy Europe Programme of the European Union

Out of sight – out of mind!
Keep an eye on the sewage losses….

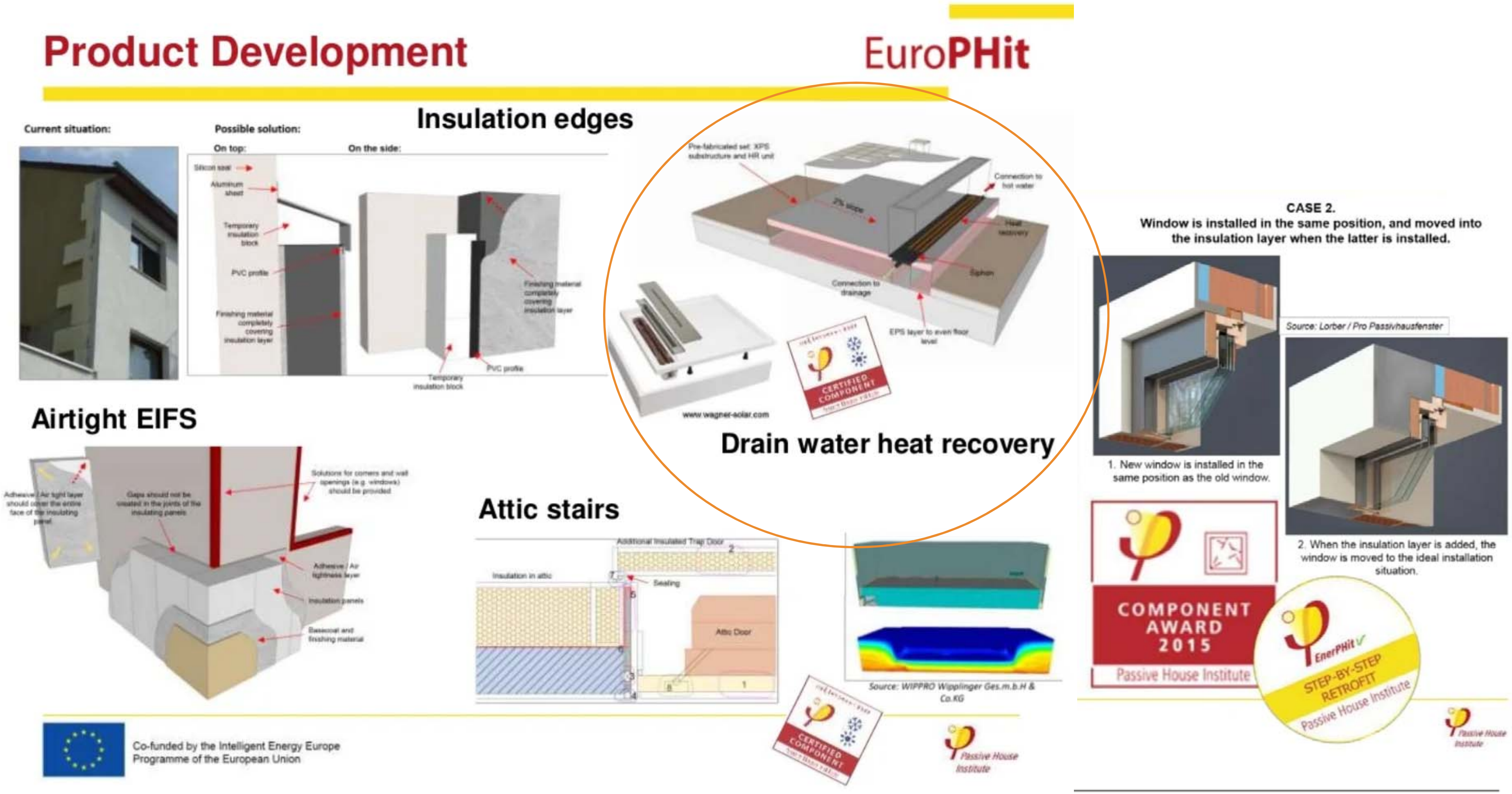


Out of sight – out of mind!
Keep an eye on the sewage losses....



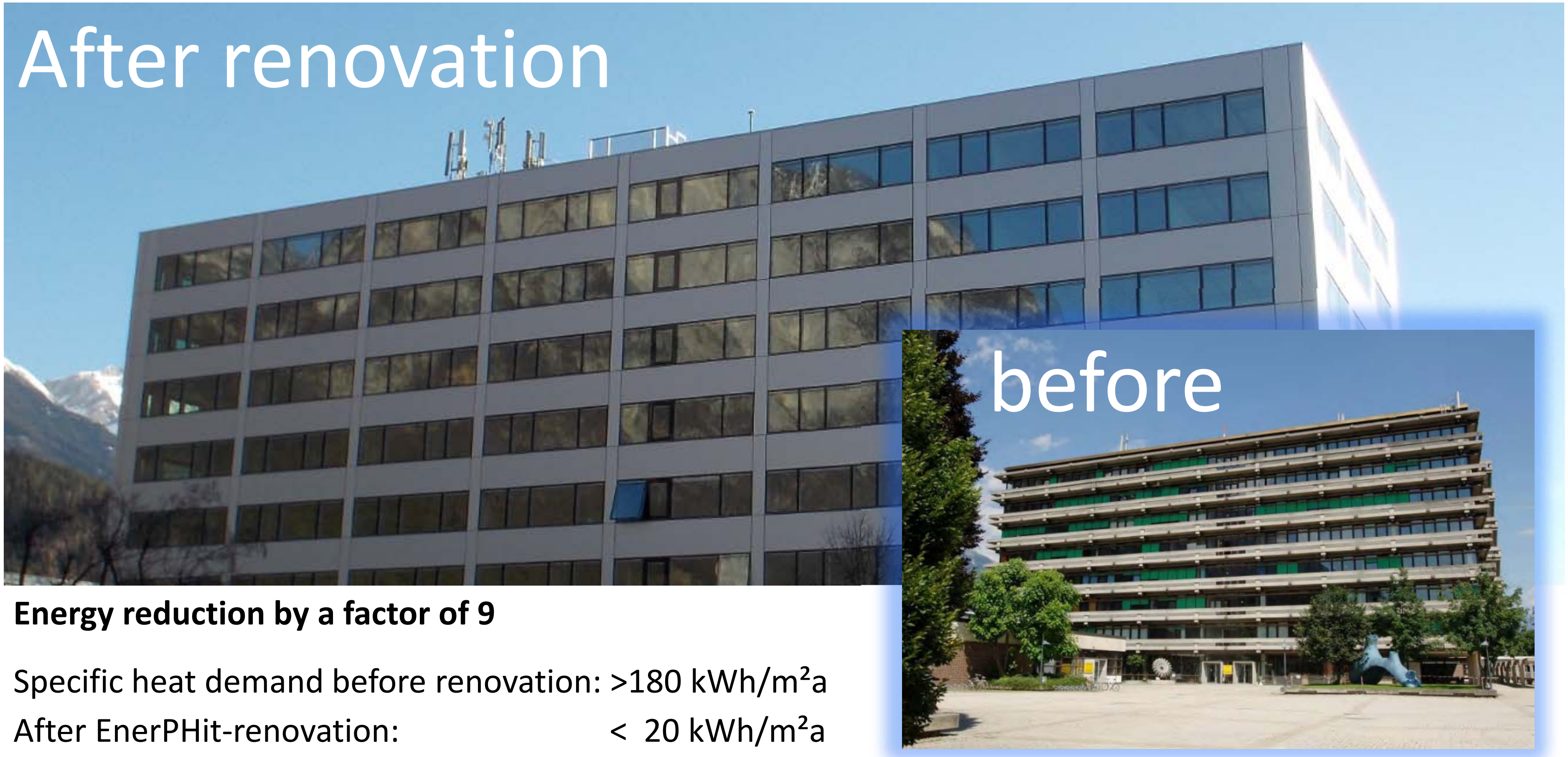
Insulation, thermal bridge reduction, airtightness, high efficient windows, heat recovery – Product development within EuroPHit

https://europhit.eu/



EnerPHit-renovation of University Building in 2014 (Faculty of technical sciences)

https://link.springer.com/article/10.1007/s12053-021-10008-7



Energy reduction by a factor of 9

Specific heat demand before renovation: >180 kWh/m²a

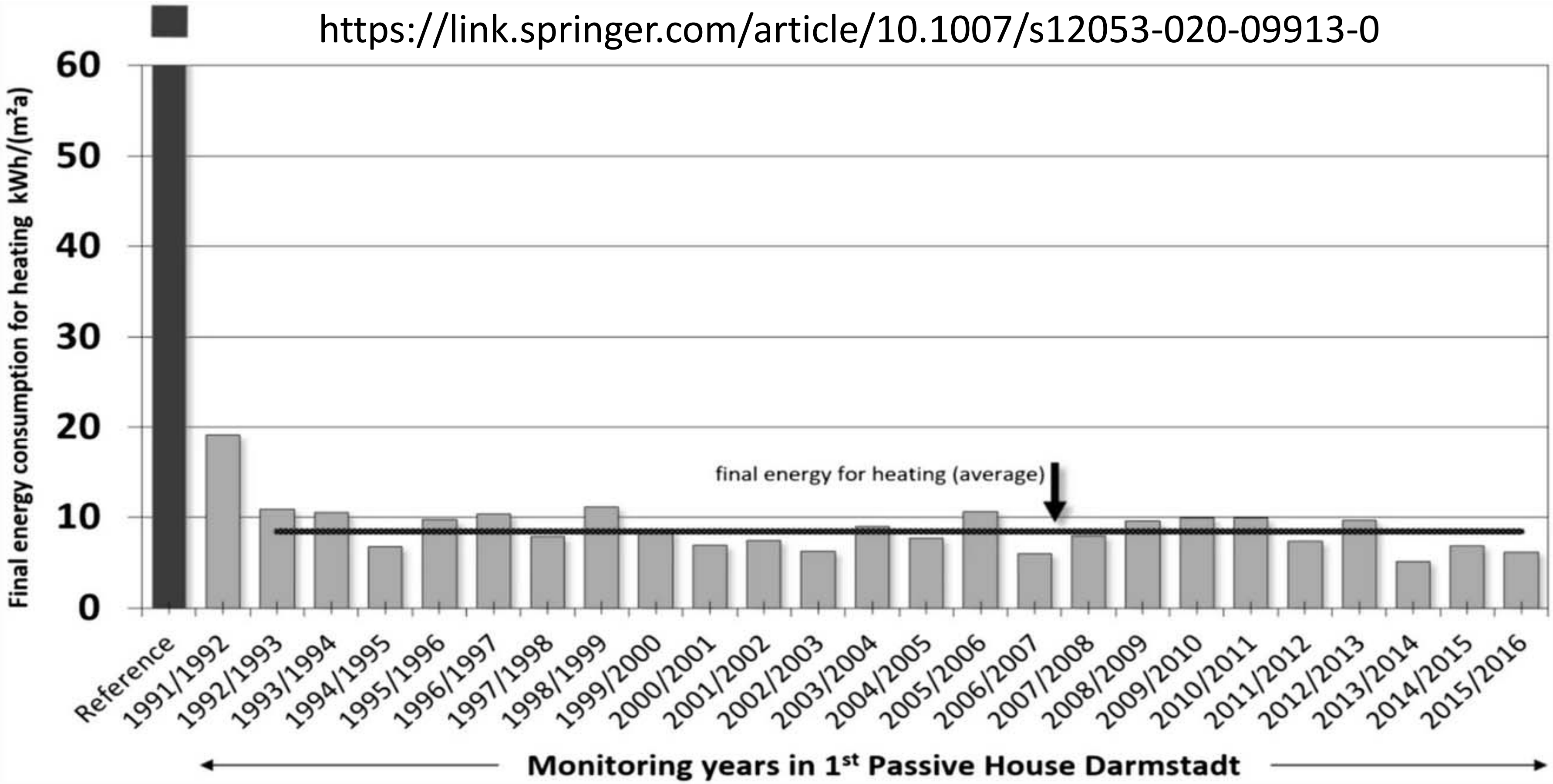
After EnerPHit-renovation: < 20 kWh/m²a

30 years Passive House Kranichstein, Germany

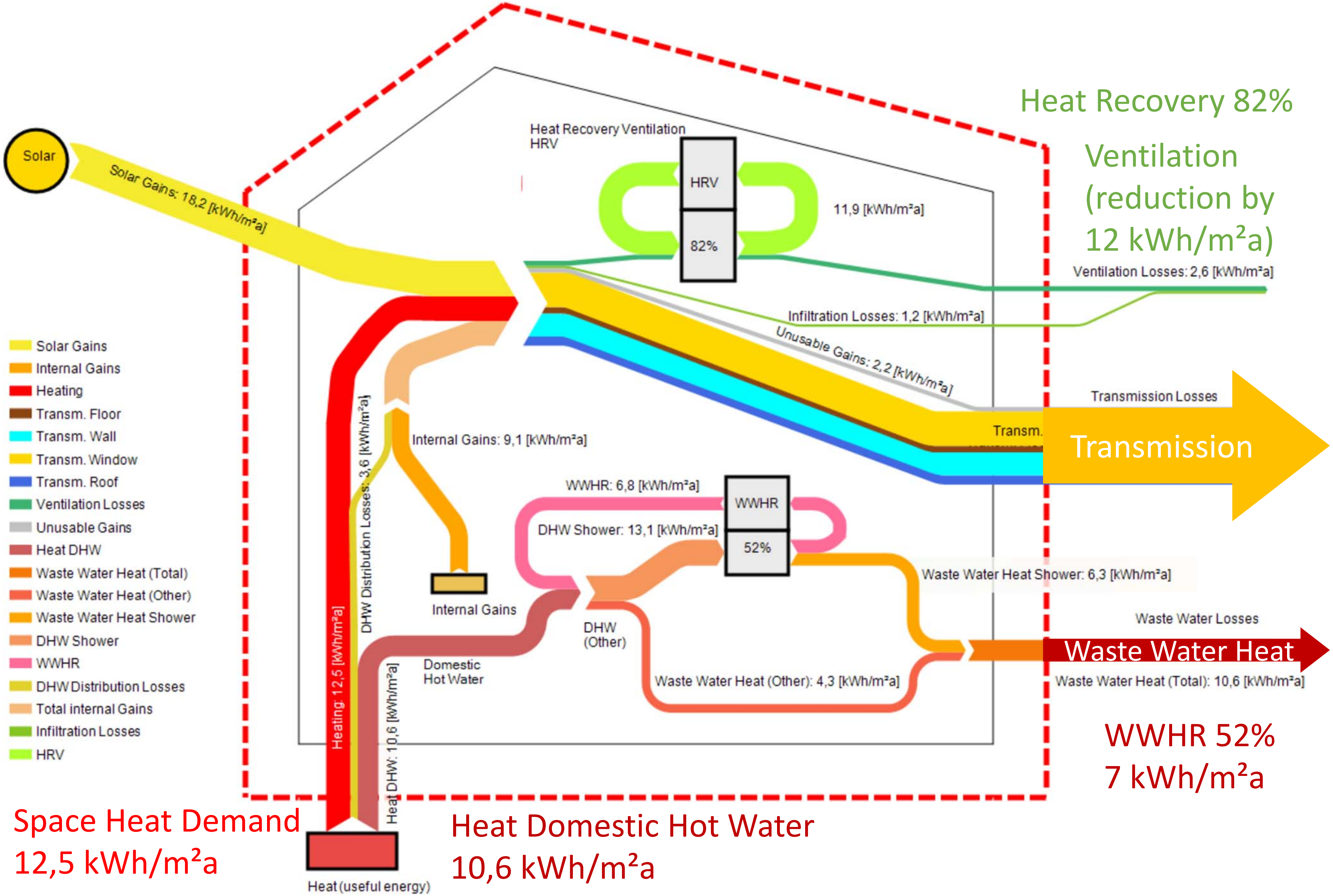
https://link.springer.com/article/10.1007/s12053-020-09855-7

30 years Passive House Kranichstein, Germany

https://link.springer.com/article/10.1007/s12053-020-09913-0



Monitoring results of final energy consumption for heating; natural gas metering for the total of all four dwelling units; heating and domestic hot water (dhw) discriminated by heat metres; reference: German ordinance 2016; data from (Feist et al. 2016b)



WWHR: 39% reduction in the energy need (useful heat) for DHW. If distribution, storage, and thermal losses in single pipes are also considered, the effect of WWHR amounts to 27 % of the delivered heat for DHW.

STUDY Waste Water Heat Recovery Systems

Authors: MSc. **Pavel Sevela**[B], MSc. **Johannes Frenger**[B]; Dr. **Jürgen Schnieders**[A], Assoz. Prof. Dr.-Ing. Rainer Pfluger[B] A Passive House Institute, Darmstadt, Germany [B] University of Innsbruck, Department of Energy Efficient Buildings, Innsbruck, Austria

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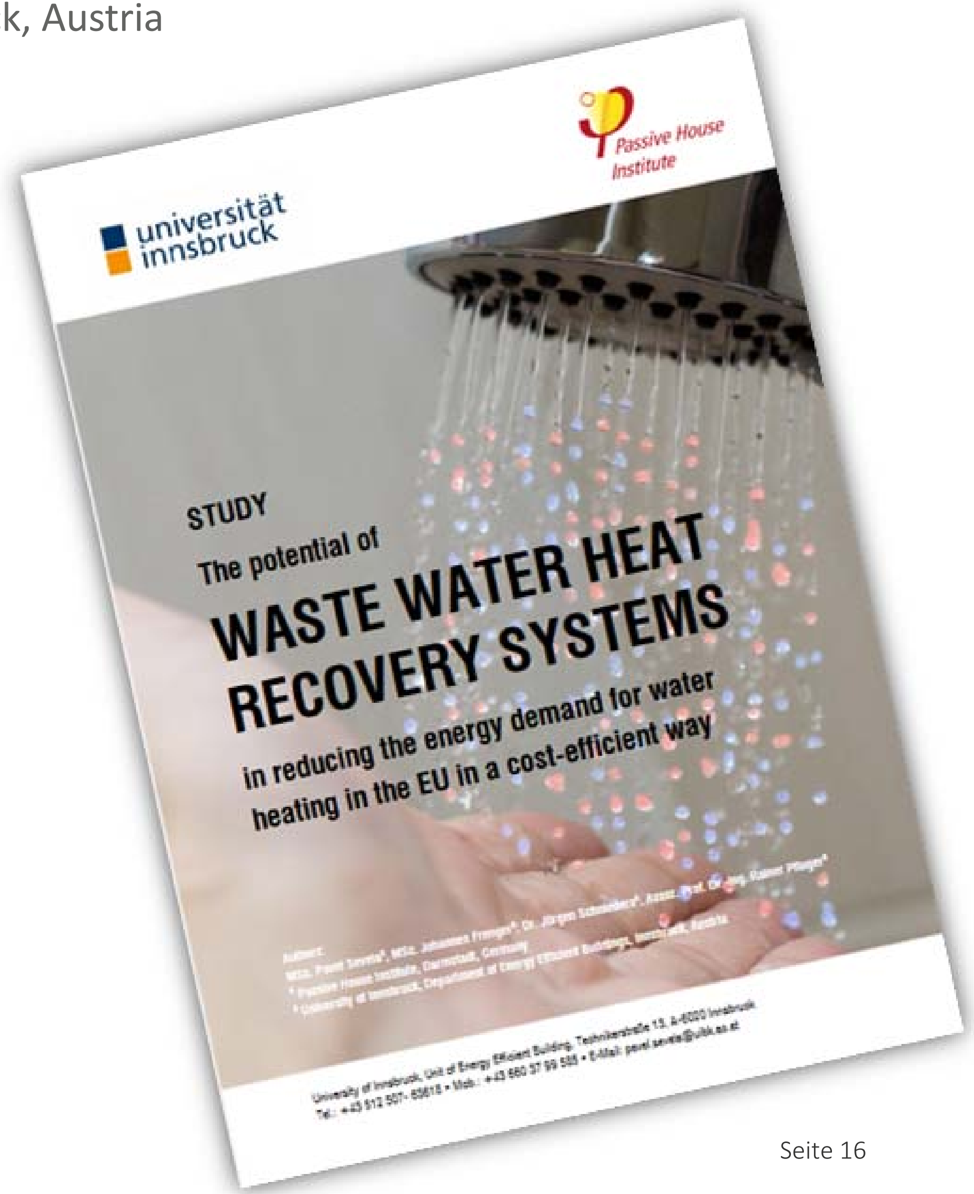
"Waste-Water Heat-Recovery (WWHR) technology was identified as the most promising emerging technology for unlocking the under-addressed potential for reducing the energy need for water heating. "



Heat Recovery – from sewage and building-wise

Source: BERDING BETON GmbH (left); Q-Blue b.v. (right)

Shower water heat exchanger

Steady state efficiency

57-78%

Vertical application

37-60%

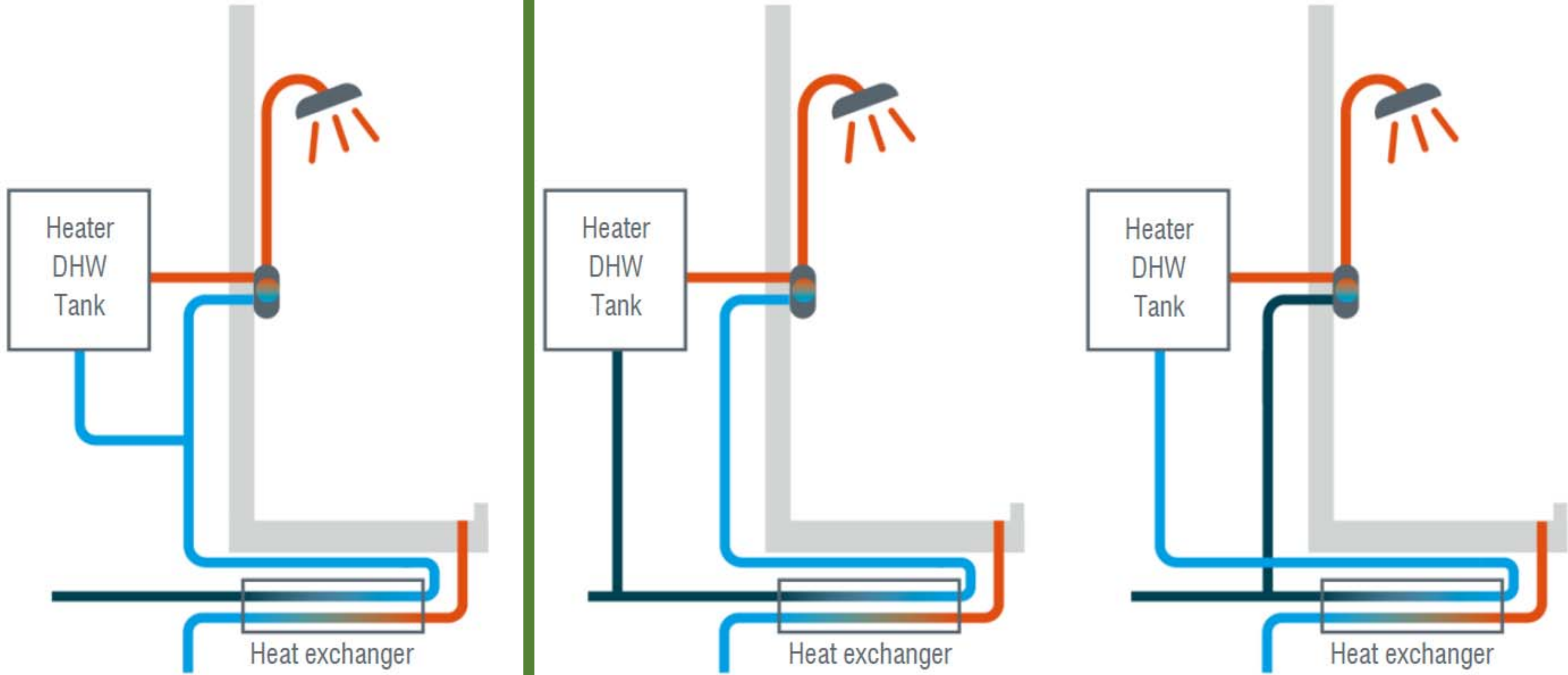
horizontal application

60-82%

active application

Hydraulic Connection

Highest possible efficiency

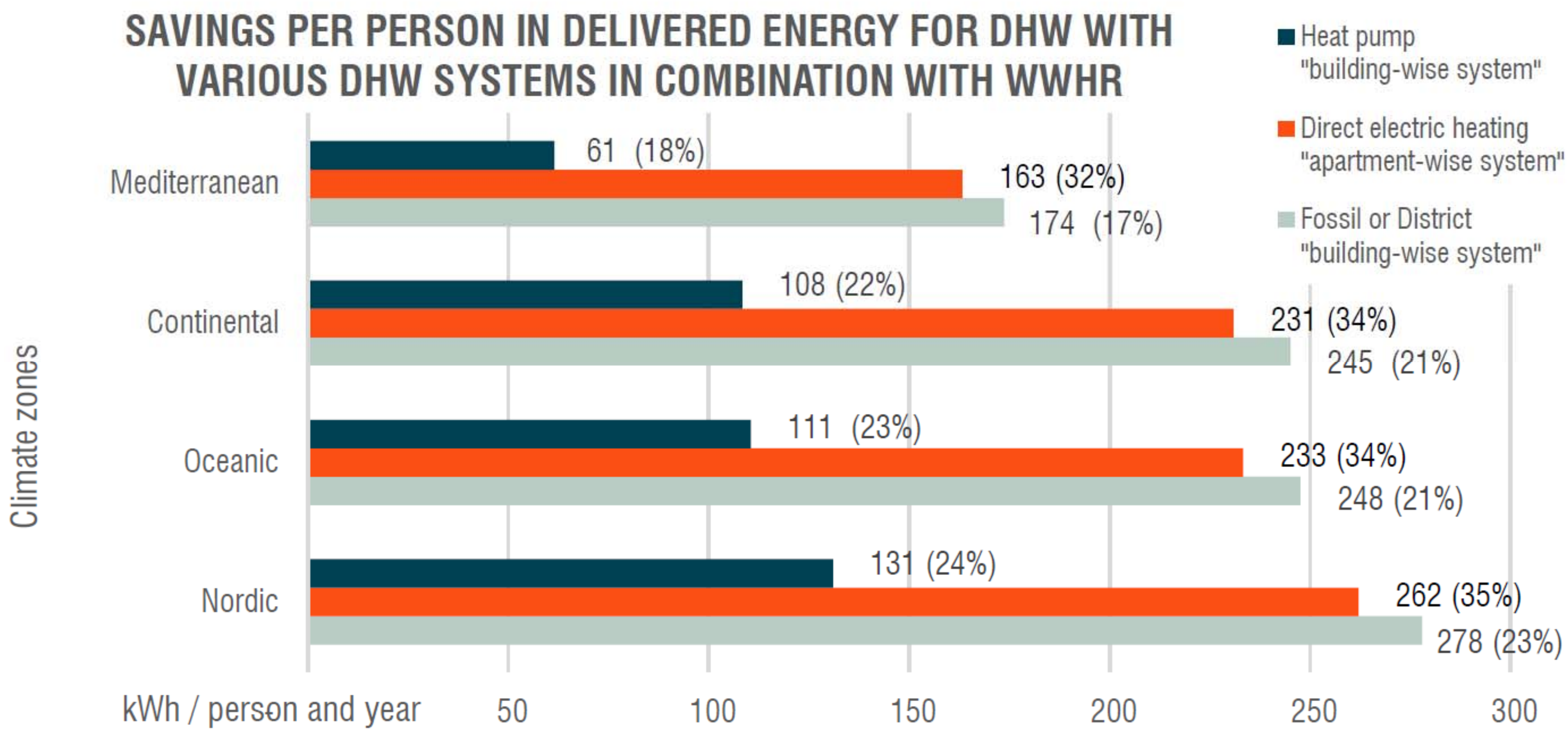


A) **Preheating** for "**cold** and **warm**" water
(balanced volume flow-rate)

B) **Preheating** for "**cold** water"
(dis-balanced volume flow-rate)

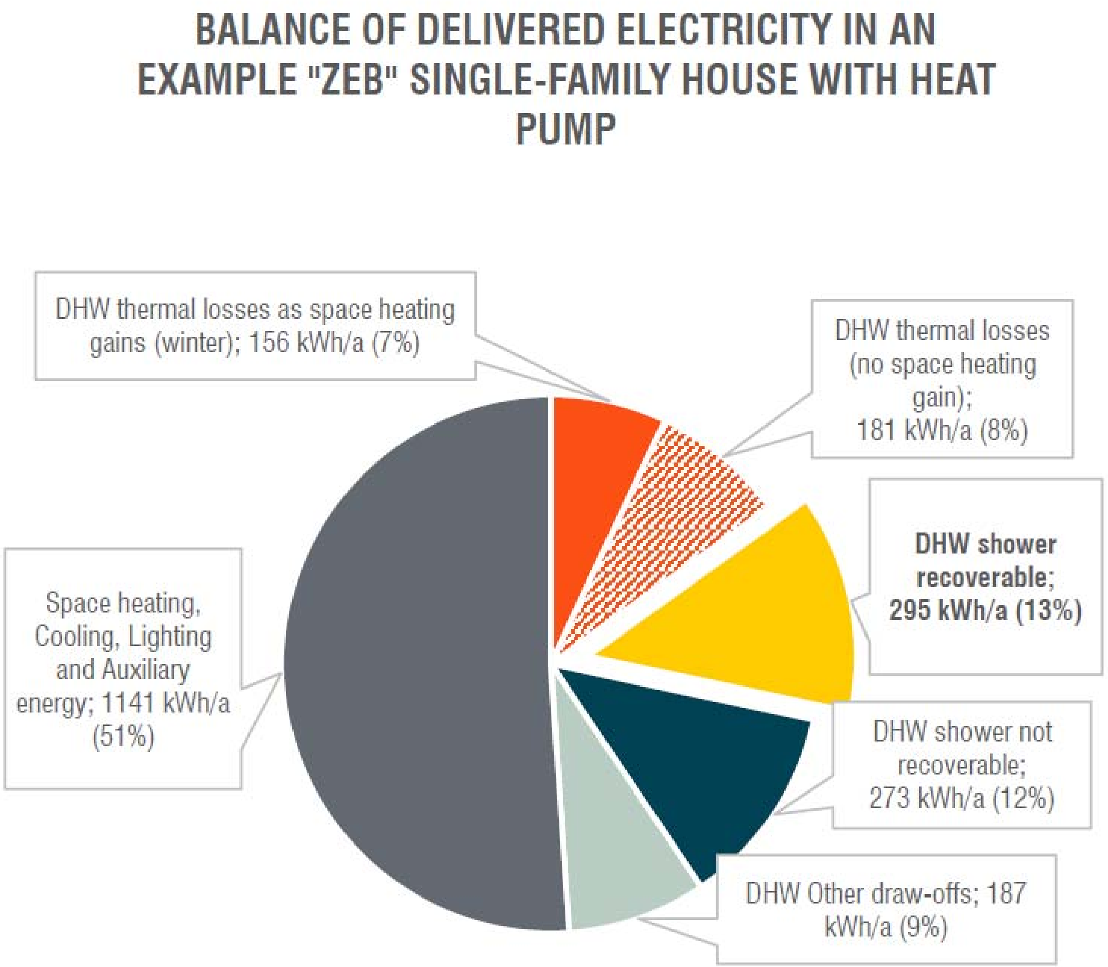
C) **Preheating** for "**warm** water"
(dis-balanced volume flow-rate)

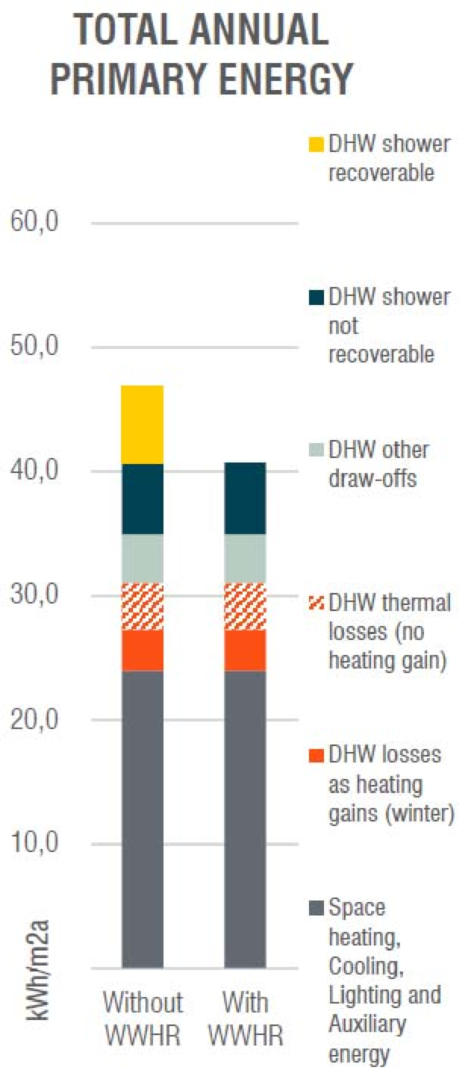
Savings depending on climate zones



(in brackets: as percentage of total delivered energy)

Possible Contribution of WWHR to Zero-Emission Building Standard





Delivered energy & primary energy with respect to the recoverable share with WWHR in a single family "ZEB" house

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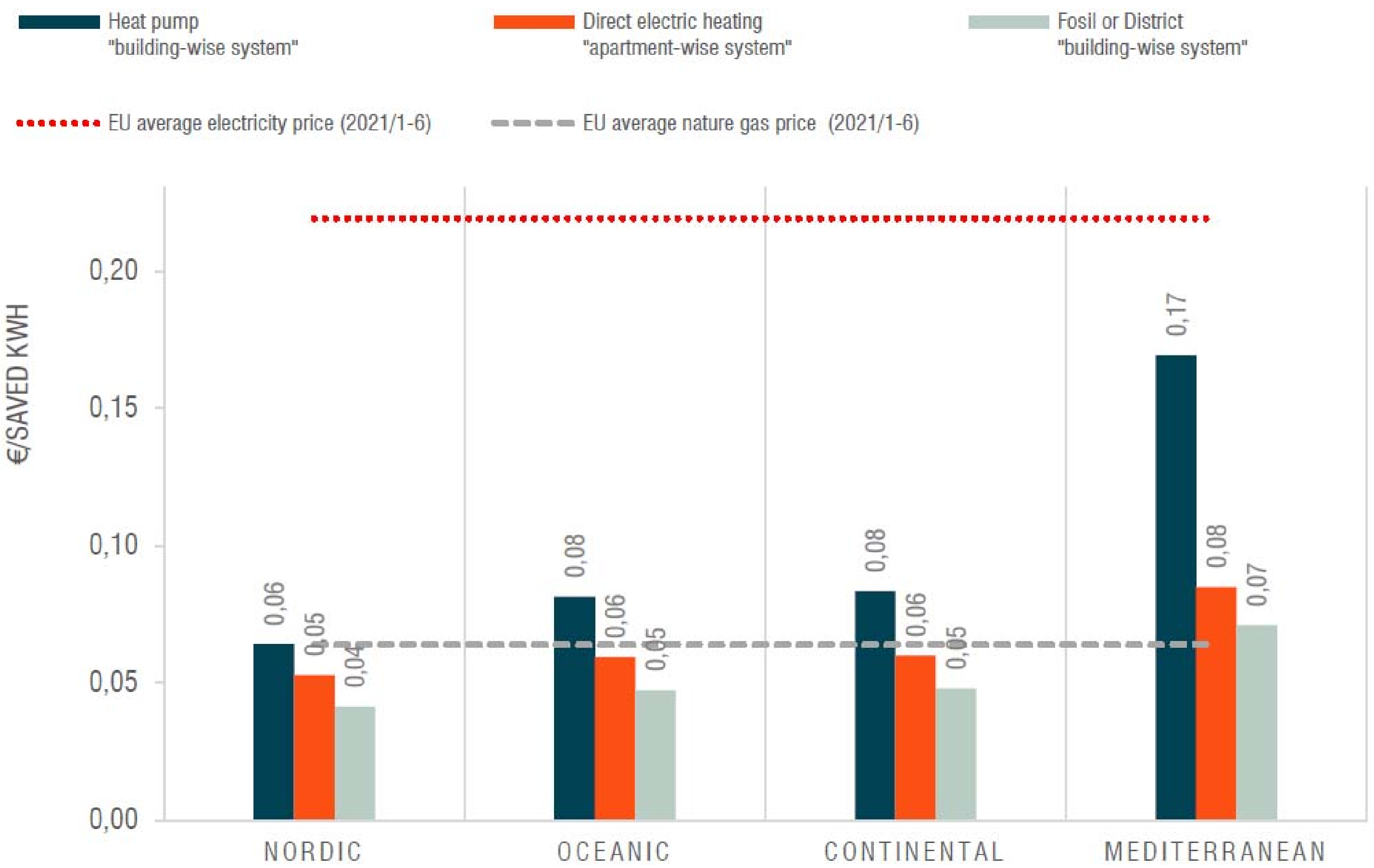
Cost of the saved energy with WWHR [€/kWh]



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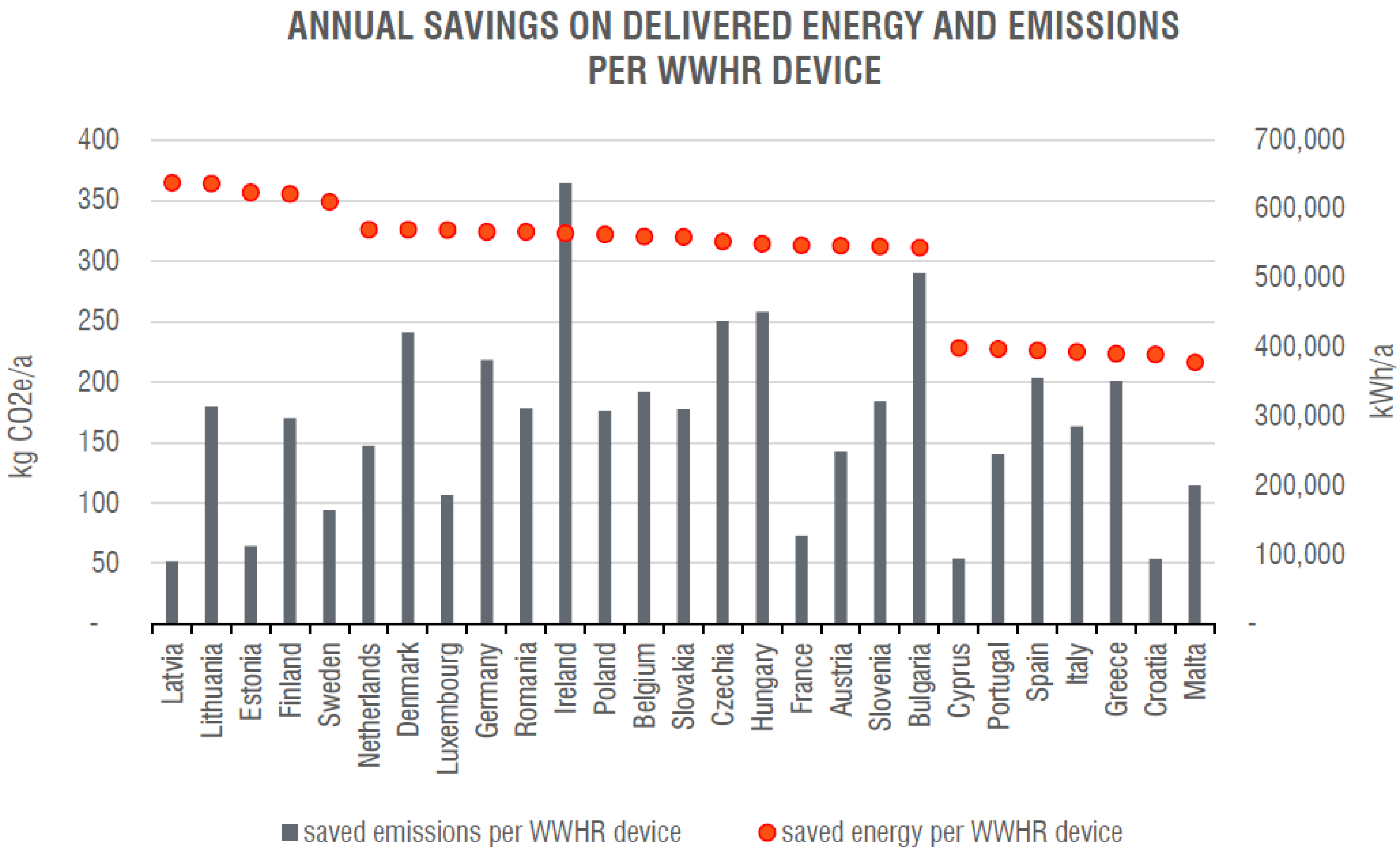
Savings of CO2-emissions and delivered energy



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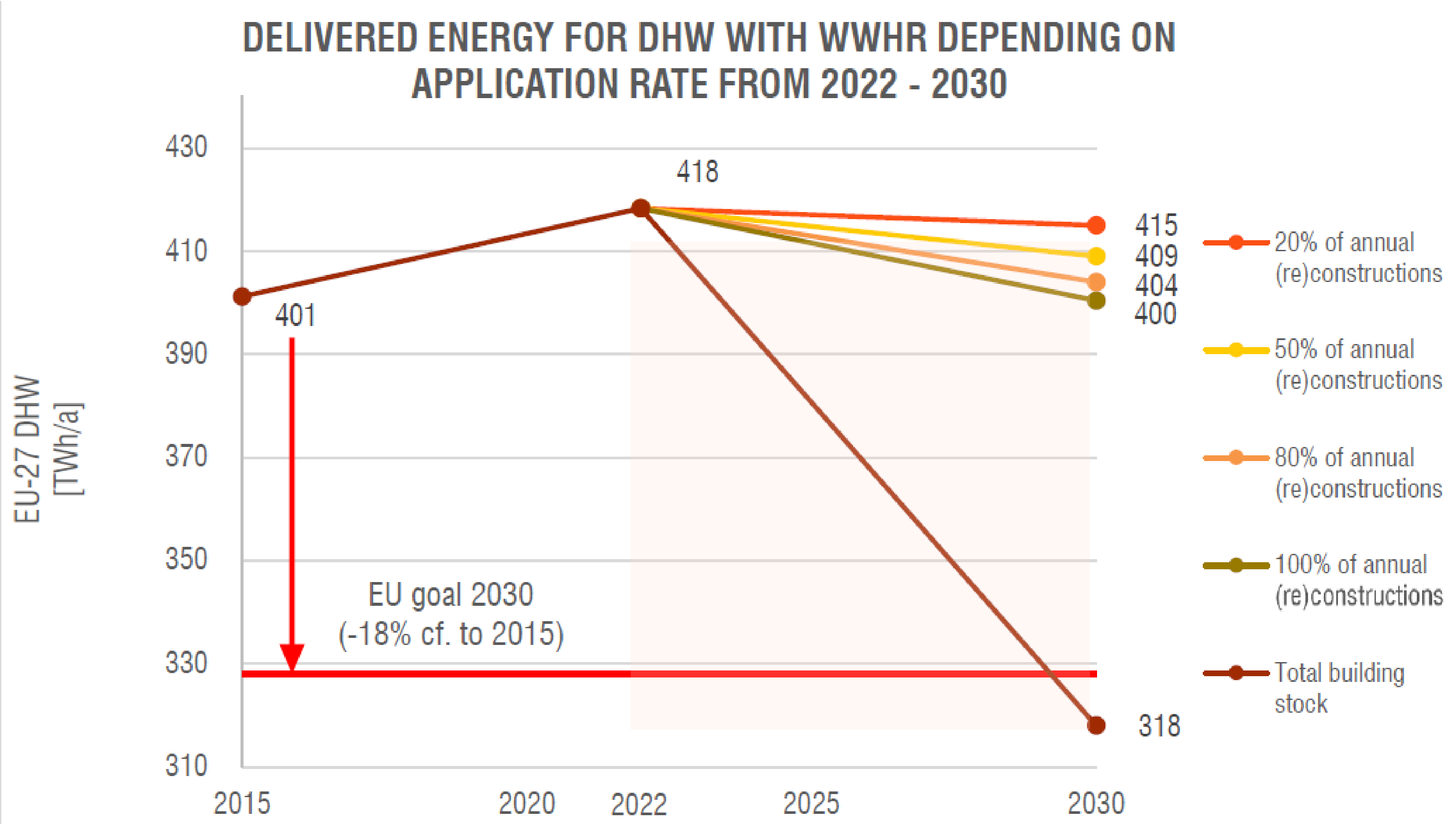
WWHR Emissions Footprint

Compensation of GHG emissions due to production, transport and disposal (50 kg CO_{2e} per device) by CO2-conservation from operation of WWHR already within the first year!

Assumption: saving 80% of primary energy input by copper recyling

Contribution of WWHR to 2030 „Fit for 55“

If every renovated or newly built building in Europe were to be equipped with WWHR starting 2022, 25% of the 2030 “Fit for 55” goals in the warm water sector could be expected.



If the total current building stock would be equipped with the described WWHR until 2030, a significant consumption-drop of 100 TWh/a could be observed and the energy conservation goals for hot water would be surpassed by WWHR only.

Total saving potentials in the EU

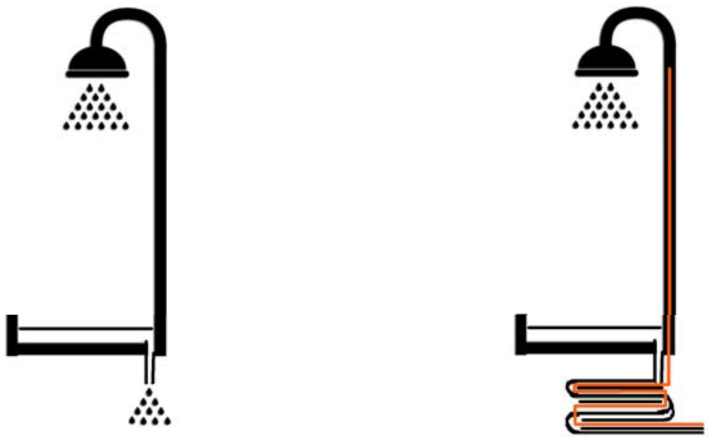
"If between 2022 and 2030, every second renovated or newly constructed building in Europe were equipped with the WWHR system, 35.7 TWh less energy would have to be generated and 6.6 Megatons of CO_{2e} emissions less emitted. "

If the **total current building stock** would be equipped with the described WWHR until 2030, a significant **consumption-drop of 100 TWh/a** could be observed and the energy conservation **goals for hot water** would be surpassed by WWHR only.

STUDY Waste Water Heat Recovery Systems

Saving potentials for domestic hot water in percentage

"WWHR technologies offer a significant saving potential of energy need for domestic hot water by up to 50%, especially for showering, therefore **leading to savings on delivered energy of up to 40% for water heating**, including system inefficiencies such as distribution and storage losses."



Suggestions for a European Legal Framework

» **Information Campaign** for customers, craftsmen and industry

» **Training for professionals** (craftsmen, planers, university)

» **Granting of subsidies**

» **Removal of legal and practical hurdles**

EUROPEAN
COMMISSION

WWHR not fully considered in Energy Performance Certificate Calculations

- Amendment of the Energy Performance of Buildings Directive to include heat recovery into calculations: Proposal for Amendment Annex 1: Up to now not mentioned (Water heater and piping systems yes, but WWHR not!)

EPPD

Annex 1

> *"4. The methodology shall be laid down taking into consideration at least the following aspects:*
>
> *(b) heating installation and hot water supply, including their insulation and heat recovery characteristics;"*

- Energy Labelling: Consider WWHR products

Specific Energy Consumption Classes SEC for Heat Recovery Ventilation

COMMISSION DELEGATED REGULATION (EU) No 1254/2014

of 11 July 2014

supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of residential ventilation units

ANNEX II

Specific energy consumption classes

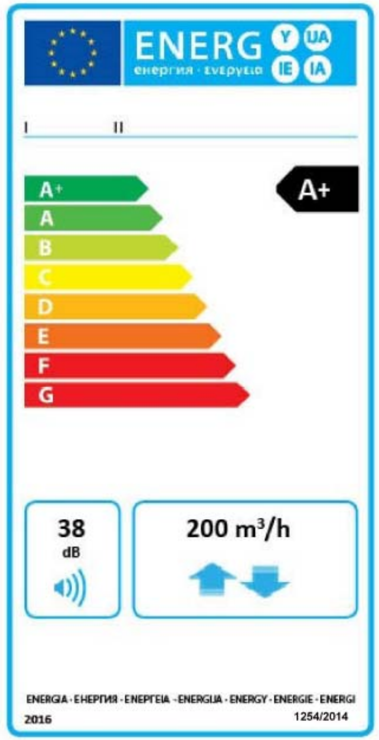
EUROPEAN COMMISSION

Specific energy consumption (SEC) classes of residential ventilation units calculated for average climate:

Table 1

Classification from 1 January 2016

SEC class	SEC in kWh/a.m²
A+ (most efficient)	SEC < – 42
A	– 42 ≤ SEC < – 34
B	– 34 ≤ SEC < – 26
C	– 26 ≤ SEC < – 23
D	– 23 ≤ SEC < – 20
E	– 20 ≤ SEC < – 10
F	– 10 ≤ SEC < 0
G (least efficient)	0 ≤ SEC



I, II

III

IV, V

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1254&from=DE

Energy Labelling of water heaters

Regulation (EU)812/2013 (Energy labelling of water heaters, hot water storage tanks and packages of water heater and solar device) is getting revised in 2022 to **introduce WWHR in combination with water heaters** to improve their EU energy label.

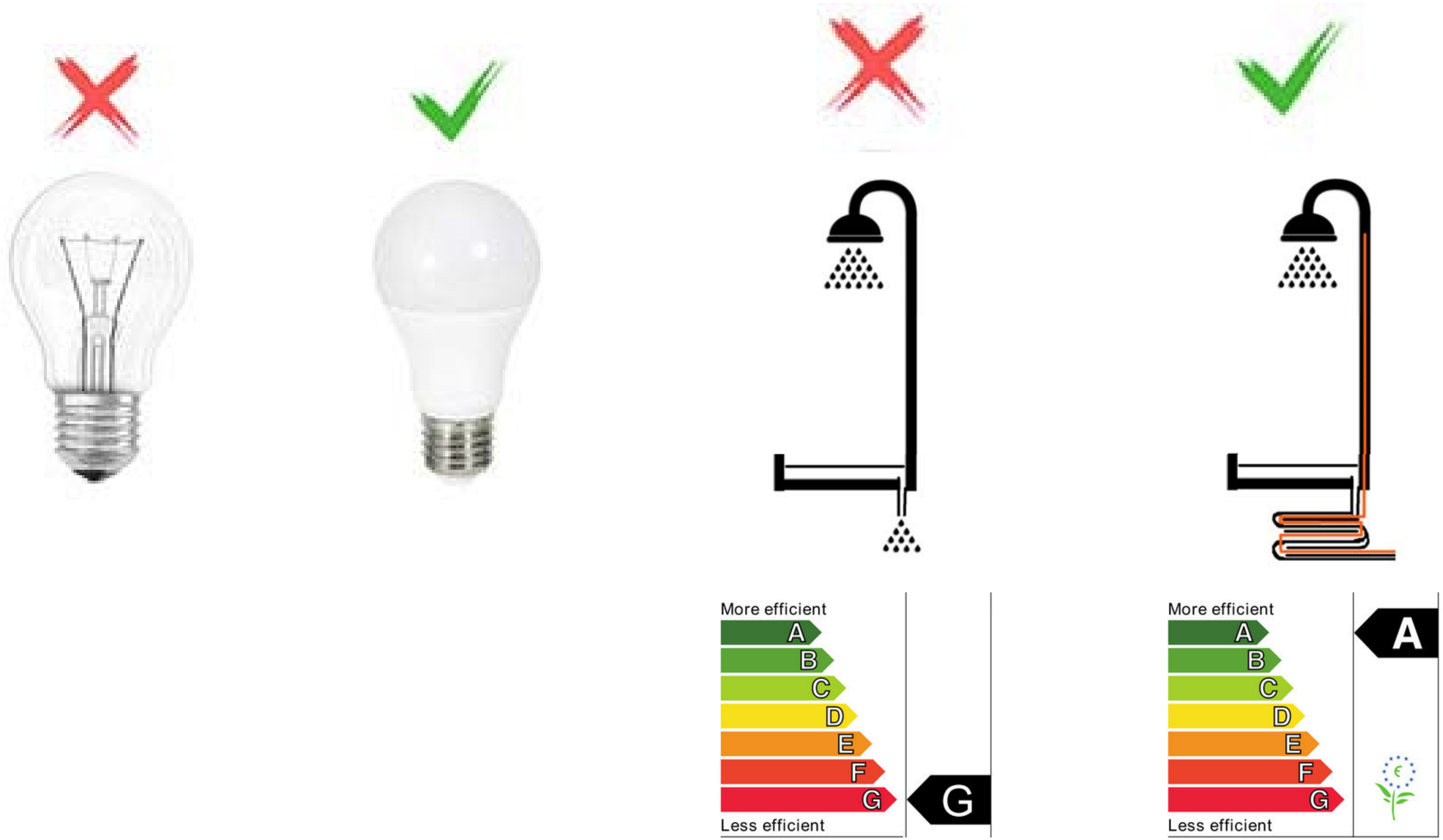
Removing barriers of WWHR

- Harmonized performance and hygiene test procedure for WWHR devices to indicate the efficiency
- Mass production and price reduction
- Exceptions for mandatory double-wall construction according to EN1717 if drinking water safety is given (see exception in the Netherlands since 2021) by overflow
- Professional know-how for application
- Failsafe installation by prefabrication of systems

Summary and Conclusion

- **Passive House principle** for new buildings <u>and</u> refurbishment
- **Efficiency First** in the building sector: Reduction of heat losses from envelope, ventilation and domestic hot water by insulation and heat recovery
- **Heat losses from domestic hot water distribution** systems represent 30 to 50% of the delivered energy, **focus on reduction!**
- **Waste water heat recovery can save about 40%** of the total energy need for DHW
- WWHR helps to reduce the water heater device as well as the storage volume and/or temperature

The future of a „standard“ shower



Thank you for your attention!

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www.passiv.de

Any questions?

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