Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

Environmental Regulation and alternative technologies in heating and refrigeration

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CAPACITY BUILDING ON INNOVATIVE APPLICATIONS OF ENERGY-EFFICIENT CLIMATE-FRIENDLY COOLING AND HEATING TECHNOLOGIES IN UKRAINE

Workshop in Kyiv, Dnipro, Odessa

3.-6. September 2019

Umwelt Bundesamt

HEAT

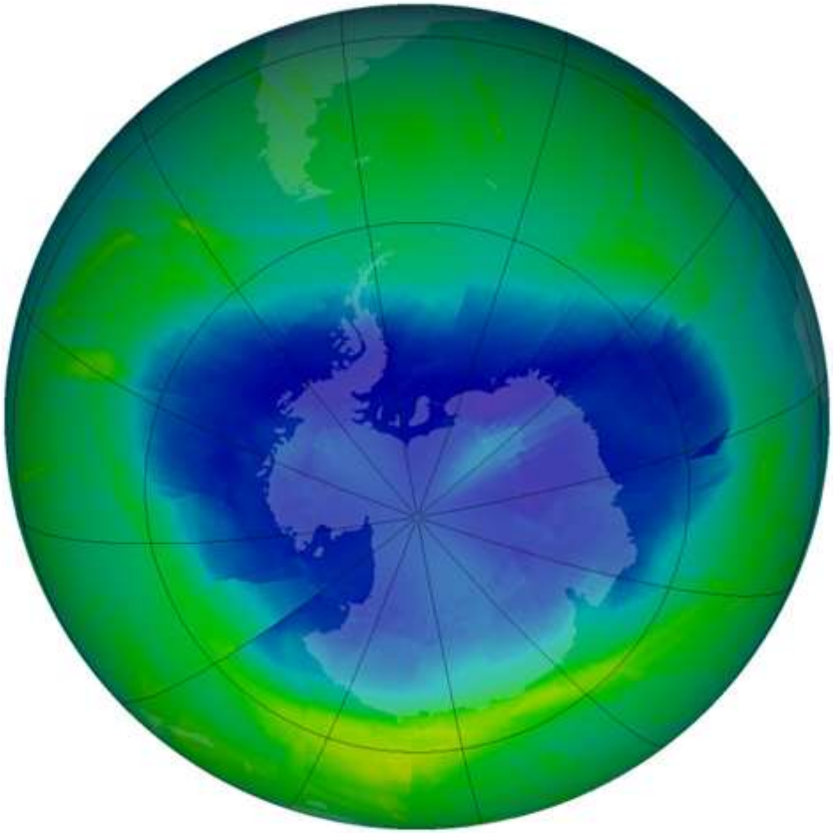
REFRIGERATING ASSOCIATION OF UKRAINE

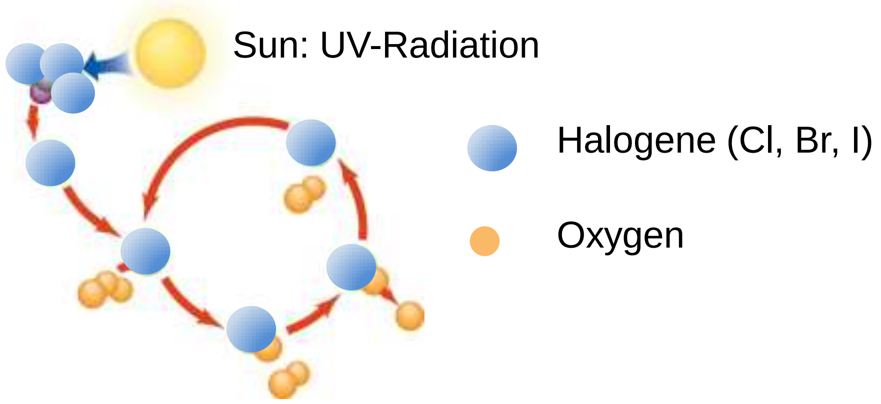
Environment Regulation - Alternative Technologies RAC&HP

☞Background Motivation

- Environmental Regulations
- The role of renewable energy
- RAC HP: Green working fluids
- Heating. HP and boilers
- Refrigeration outlook: Green cooling
- Summary

Ozone Depletion





Sun: UV-Radiation

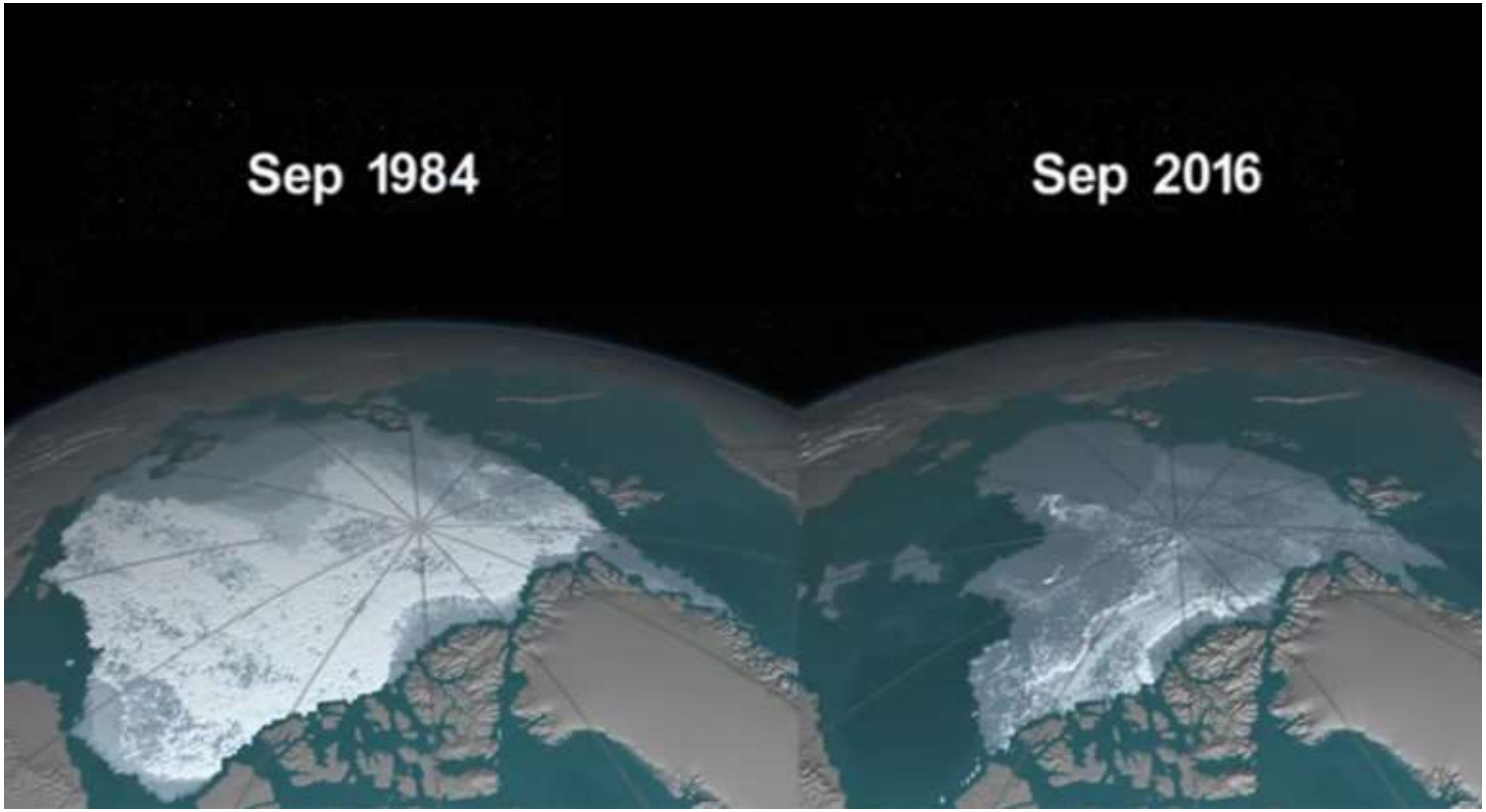
● Halogene (Cl, Br, I)

● Oxygen

- Ozone Depletion Thesis:
  Molina & Rowland & Crutzen 1974
- CFCs as major contributor

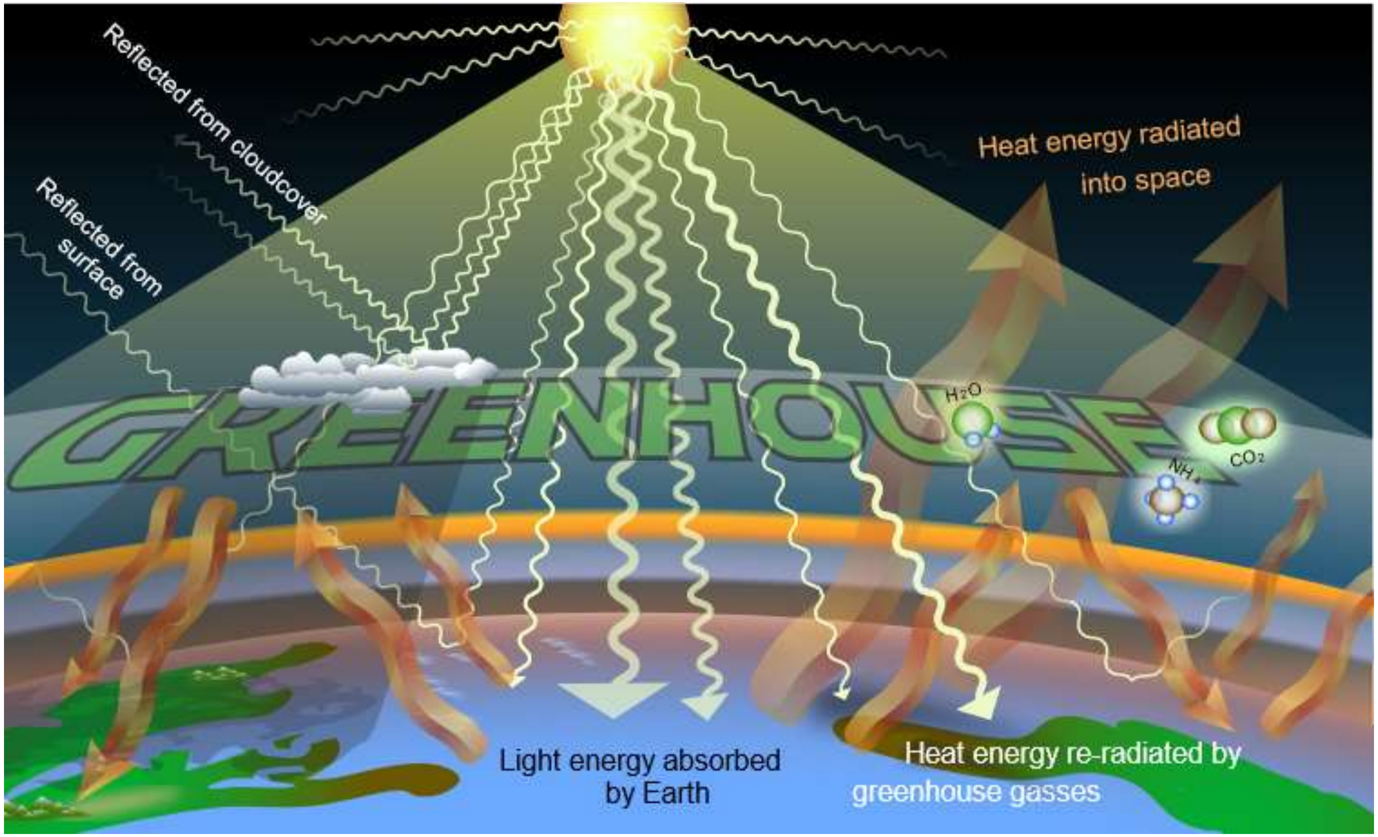
Source: NASA Goddard Space Flight Center from Greenbelt, MD, USA - Snapshot of the Antarctic Ozone Hole 2010, Public Domain, https://commons.wikimedia.org/w/index.php?curid=69017095

Global Warming



Quelle: © NASA Goddard Screenshot youtube.com

The Greenhouse Effect

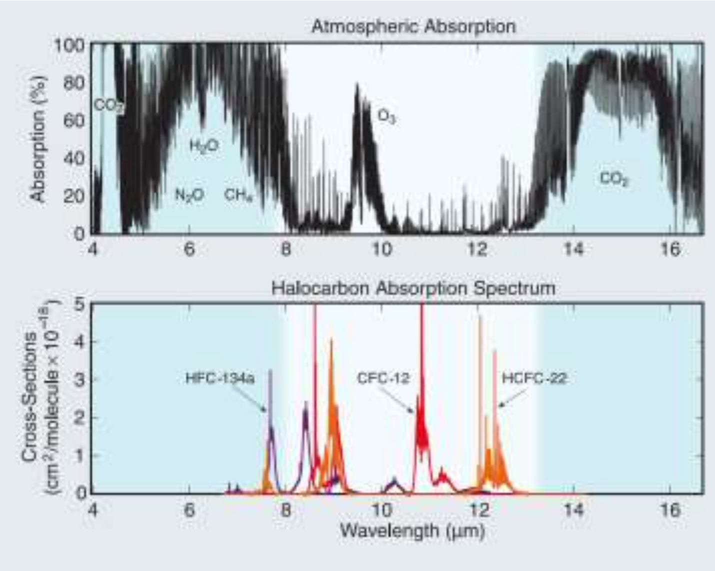


Source: A loose necktie - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=78336181

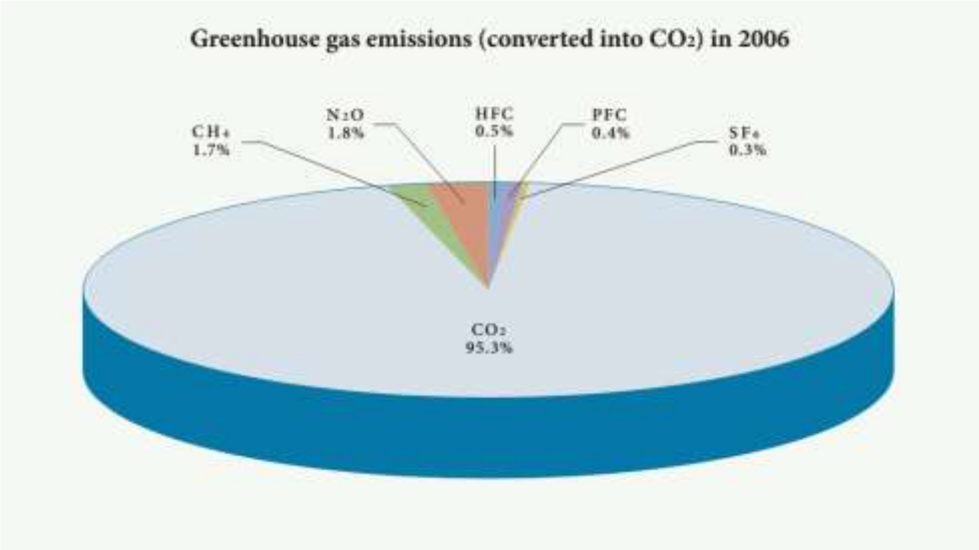
Gloabl Warming

GWP: Global Warming Potential: relative contribution to Greenhouse Effect

- Relative to CO_2 = 1, e.g. R134a = 1430
- Calculated for a certain period (standard 100 years)



Quelle: IPPC / TEAP Special report: Safeguarding the Ozone Layer and the Global Climate System – Issues Related to Hydrofliurocarbons and Perflourcarbons



Quelle: http://www.meti.go.jp/policy/chemical_management/ozone/files/pamplet/panel/08e_basic.pdf

Environment Regulation - Alternative Technologies RAC&HP

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☞Environmental Regulations

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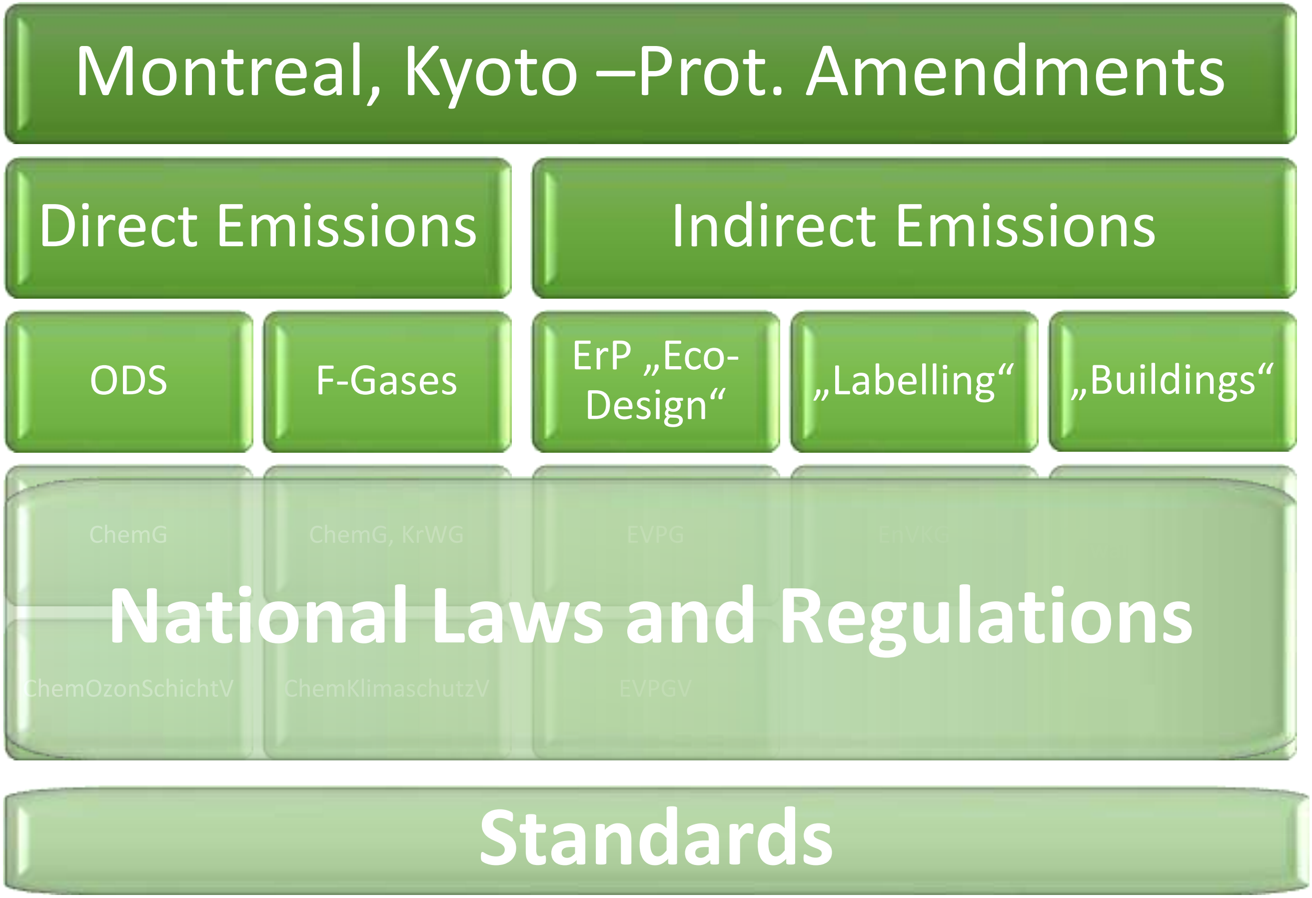
Fighting the consequence: Environmental Legislation

- Global Conventions
- Ratification

- EU Targets
- EU Legal Instruments

- National Laws
- „Standards“

Environmental Legislation: Example EU and Germany



Montreal, Kyoto –Prot. Amendments

Direct Emissions

Indirect Emissions

ODS

F-Gases

ErP „Eco-Design“

„Labelling“

„Buildings“

ChemG

ChemG, KrWG

EVPG

EnVKG

ChemOzonSchichtV

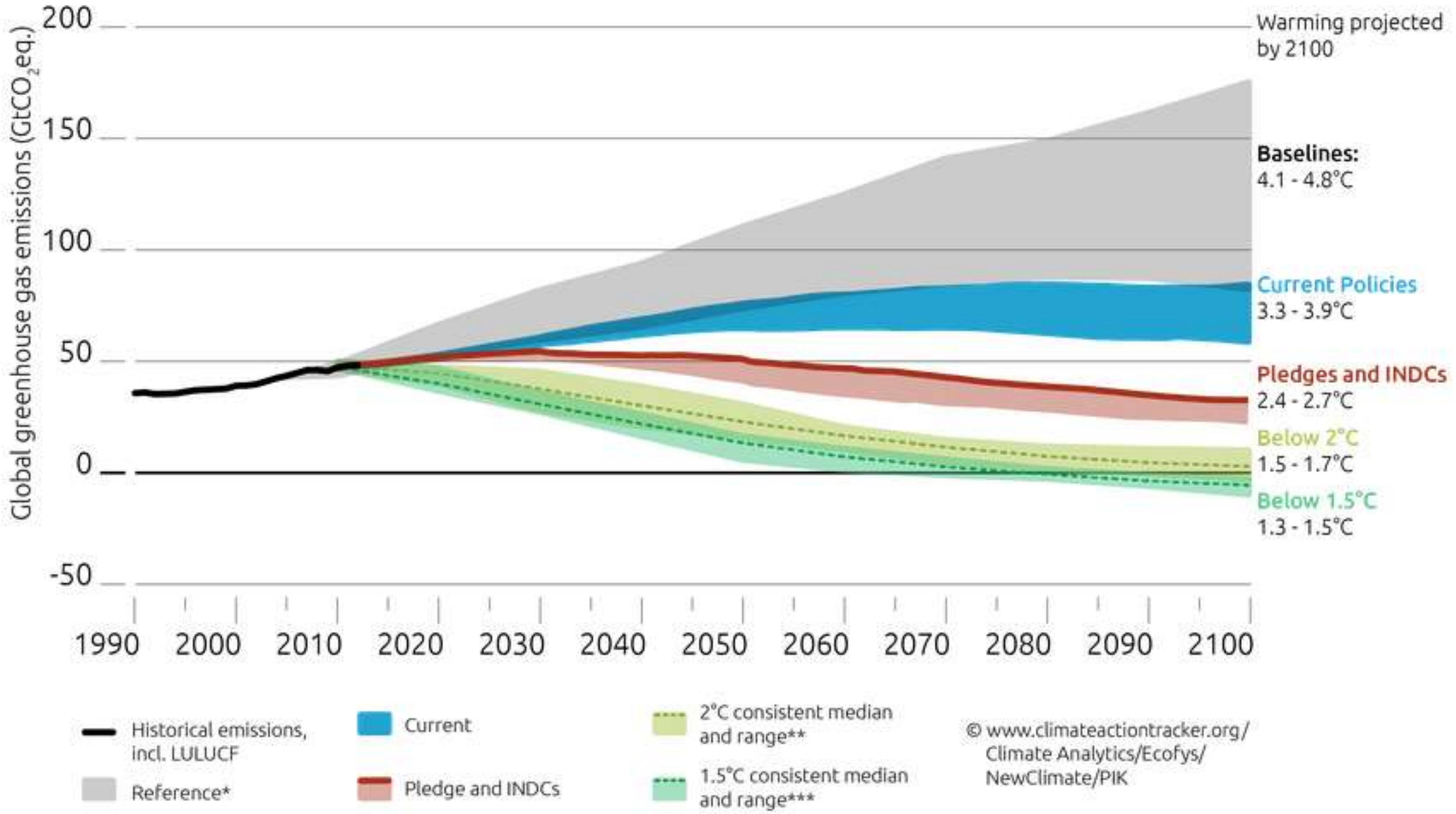
ChemKlimaschutzV

EVPGV

National Laws and Regulations

Standards

The need for global GHG mitigation



© www.climateactiontracker.org/ Climate Analytics/Ecofys/ NewClimate/PIK

Climate Conventions

- Montreal Protocol (1987) 197 countries as parties (all UN members)
  - Based on Vienna Convention (1985)
  - Originally focussed on Protection of the Ozone layer
  - Phase out/down of ODS Ozone Depleting Substances
  - Broader approach on GHG Greenhouse Gases
  - Kigali Amendment (2016):
    - Focussed on phase down of F-Gases
    - 15% target value of baseline
- Kyoto Protocol (1997) 191 countries + EU ratified
  - Focussed on GHG emissions
  - Paris agreement (2015) to limit global warming to 1,5 °C, ratified by 185 nations

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☞Environmental Regulations – Example Case EU

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Direct Emission EU-Regulations

- ODS:

“REGULATION (**EC**) No **1005/2009** OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 September 2009 on substances that deplete the ozone layer”

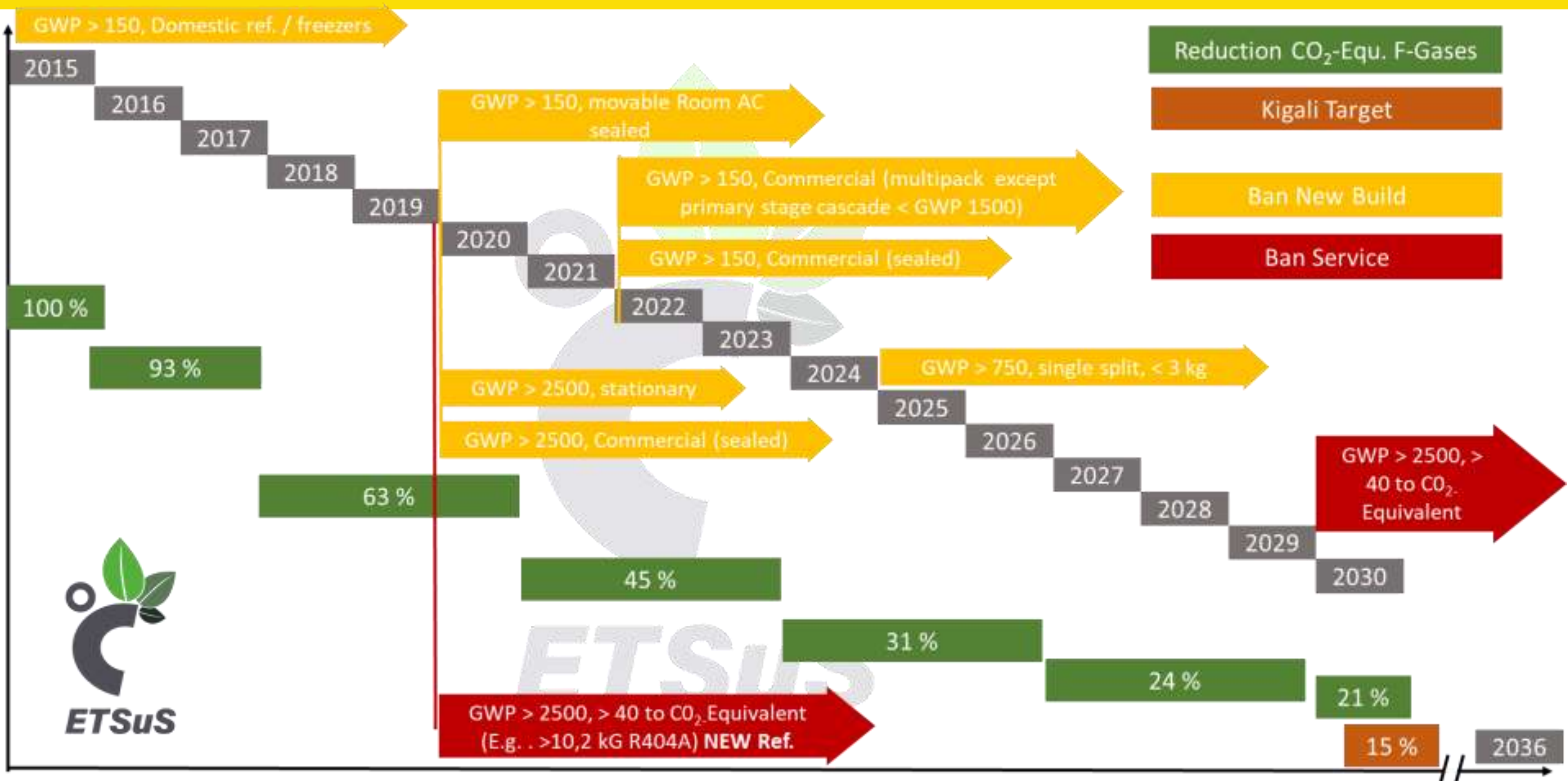
- F-Gases:

“REGULATION (**EU**) No **517/2014** OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006”

F-Gas Regulation - Content

Chapter	Content	Articles
I	General Provisions	1-2
II	Containment (“Emission reduction”)	3-10
III	Placing on market – control of use	11-14
IV	Reduction of quantity (“Quota allocation”)	15-18
V	Reporting	19-20
VI	Final provisions	21-27
AI - AVIII	Annex I controlled substances	
	Annex II substances under reporting	
	Annex III Placing on market prohibitions (“Dates”)	
	Annex V Maximum quantities (“Phase down”)	

F- Gas Regulation at a glance



- Reduction CO_2-Equ. F-Gases
- Kigali Target
- Ban New Build
- Ban Service

2015: GWP > 150, Domestic ref. / freezers

2015 – 100 %

2016 – 93 %

2018 – 63 %

2020: GWP > 150, movable Room AC sealed

2020: GWP > 2500, stationary

2020: GWP > 2500, Commercial (sealed)

2020: GWP > 2500, > 40 to CO_2 Equivalent (E.g. . >10,2 kG R404A) **NEW Ref.**

2021 – 45 %

2022: GWP > 150, Commercial (multipack except primary stage cascade < GWP 1500)

2022: GWP > 150, Commercial (sealed)

2024 – 31 %

2025: GWP > 750, single split, < 3 kg

2027 – 24 %

2030 – 21 %

2030: GWP > 2500, > 40 to CO_2 Equivalent

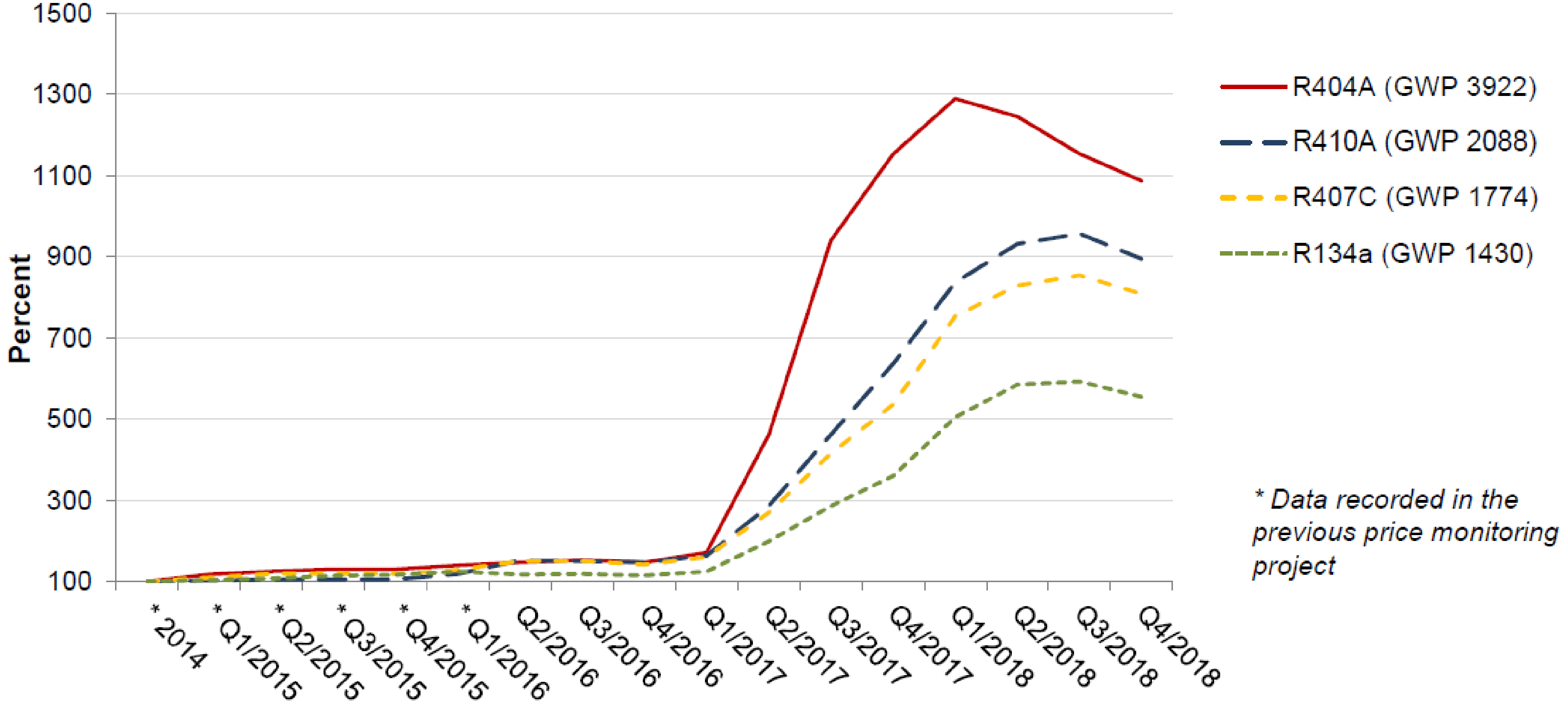
2036 – 15 %

ETSuS

Source: ETSuS UG, Kulmbach

F-Gas Regulation: The quota effect

Average purchase prices of various HFC refrigerants (price index, 2014 = 100 %)



* Data recorded in the previous price monitoring project

Source: Öko-Recherche (2019)

Indirect Emission EU-Regulations

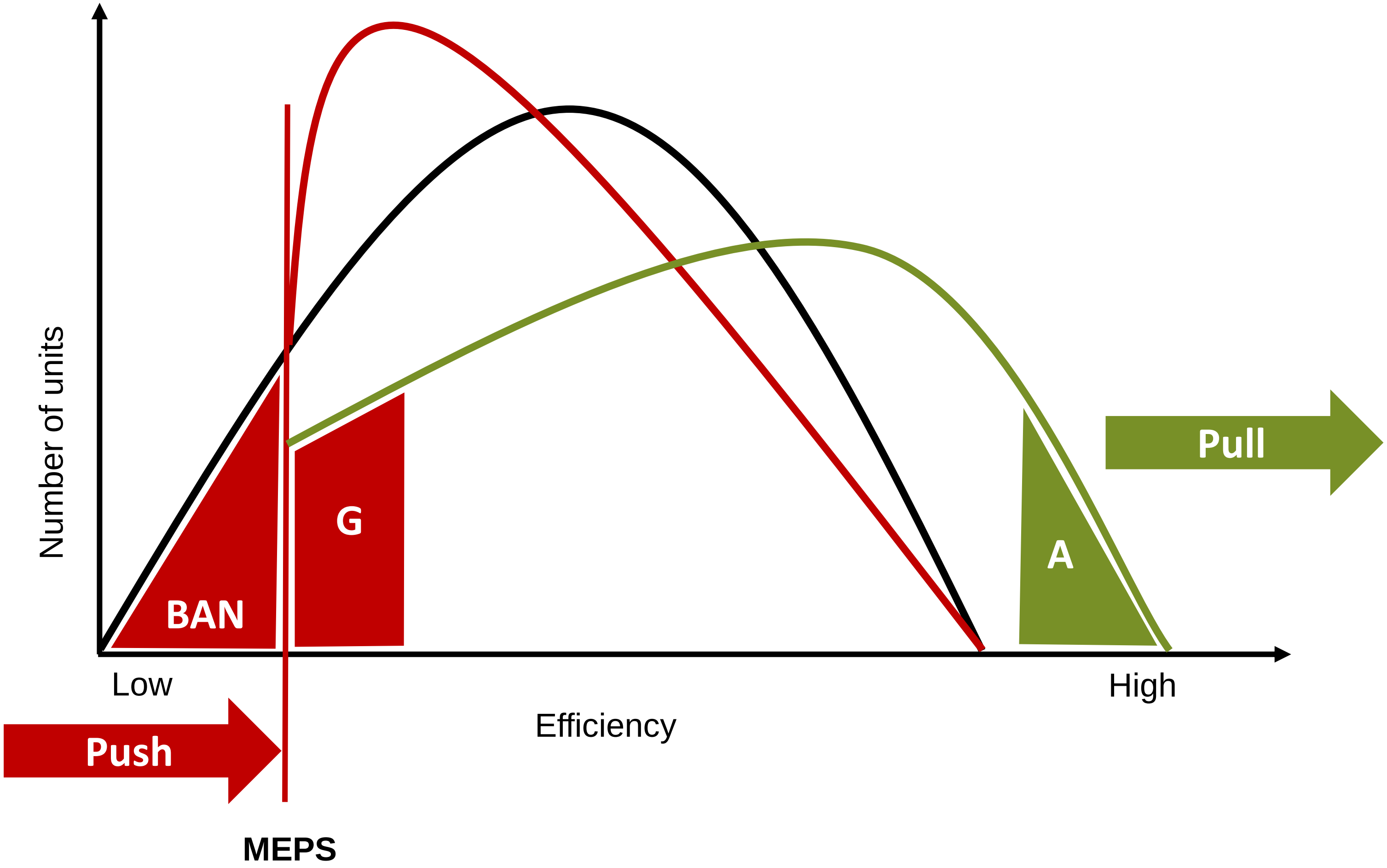
- ErP-Directive ("Eco-Design")

  "DIRECTIVE 2009/125/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products"

- Energy Performance of buildings (EPBD)

  "DIRECTIVE (EU) 2018/844 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency"

Basic Concept of MEPS and Labelling

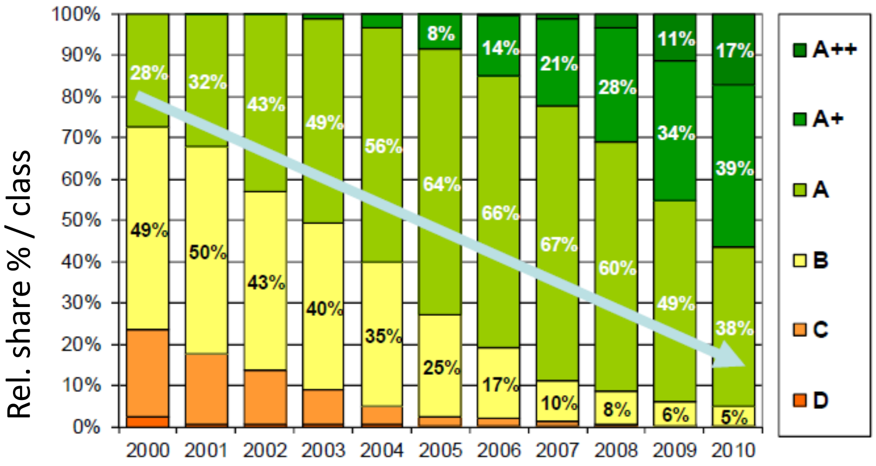


Labelling

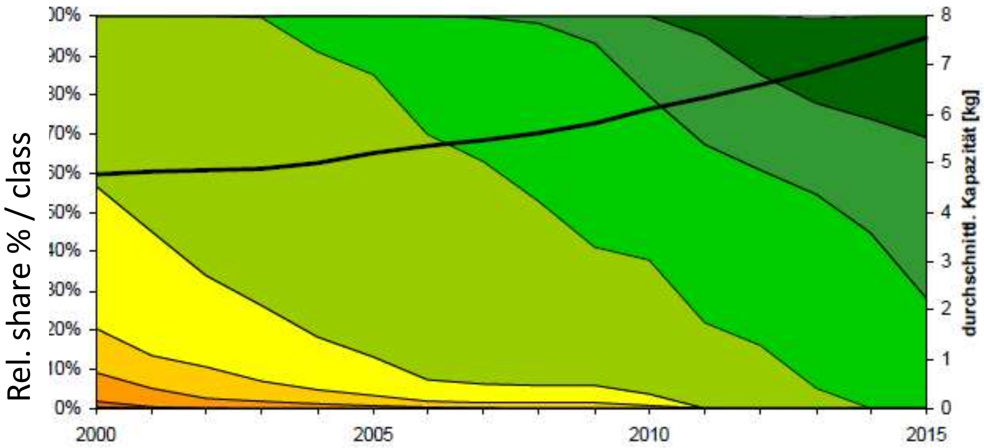
Effectivity

Sustainability?

Refrigerators DE



Washing machines DE



Source: B. Schäppi, EU-Prozess zur Entwicklung von Ecodesign-Standards und Labels – Aktueller Status, Chancen und Herausforderungen für den Zeitraum 2012-2014

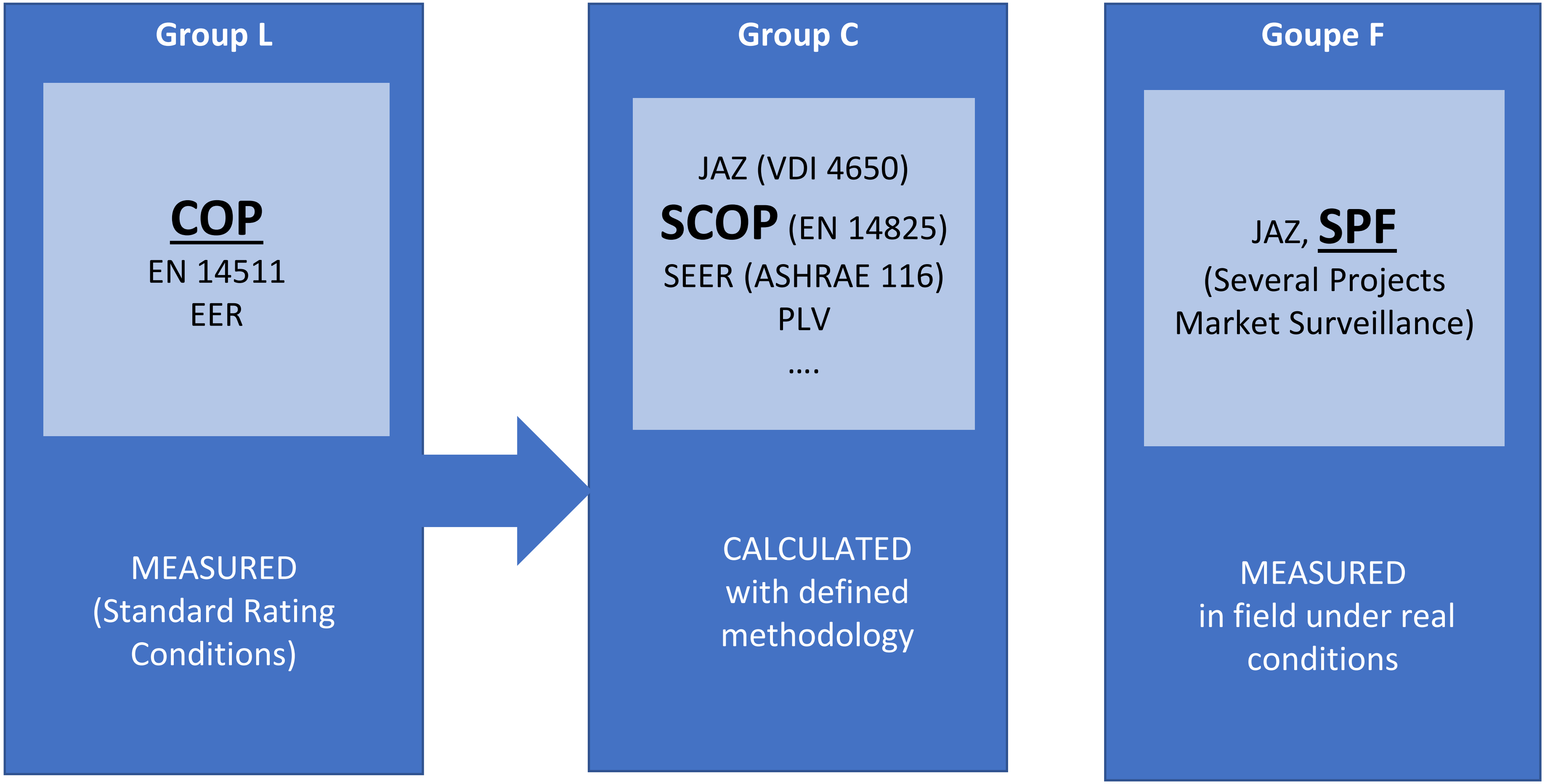
Umwelt Bundesamt

REFRIGERATING ASSOCIATION OF UKRAINE

Eco-Design Directive: Lots

Lot	Prodcut Group	Status
ENER 1	Space Heaters	VO (EU) 813/2013, VO (EU) 811/2013
ENER 2	Warmwater Heaters	VO (EU) 814/2013, VO (EU) 812/2013
ENER 10	Domestic AC	VO (EU) 206/2012, VO (EU) 626/2011
ENER 11	Electric motors	VO (EG) 640/2009
ENER 11	Pumps	VO (EG) 641/2009
ENER 11	Fans	VO (EU) 327/2011
ENER 13	Domestic Refrigeration	VO (EG) 643/2009, VO (EU) 1060/2010
ENER 17	Vacuum cleaners	VO (EU) 666/2013, VO (EU) 665/2013
ENER 21	Central air heaters	VO (EU) 2016/2281
ENER 31	Compressors	Consultation
ENTR 1	Process Chillers	VO (EU) 2015/1095, VO (EU) 2015/1094
ENTR 6	AC, Ventilation	VO (EU) 1253/2014, VO (EU) 1254/2014

Key indicators for energy efficiency



Group L

COP
EN 14511
EER

MEASURED
(Standard Rating Conditions)

Group C

JAZ (VDI 4650)
SCOP (EN 14825)
SEER (ASHRAE 116)
PLV
….

CALCULATED
with defined methodology

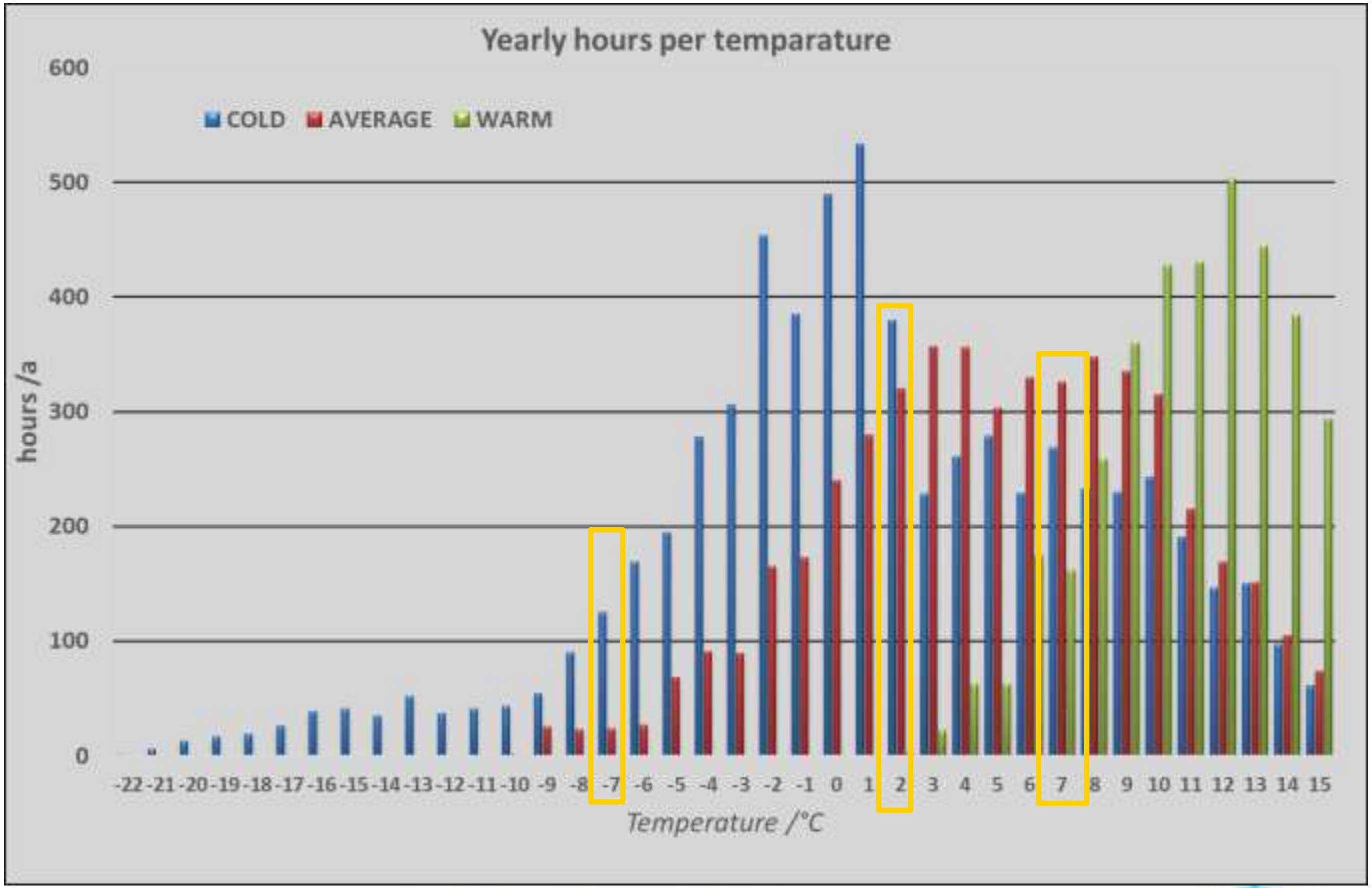
Goupe F

JAZ, **SPF**
(Several Projects Market Surveillance)

MEASURED
in field under real conditions

Source: According M. Miara et al “Wärmepumpen”, Fraunhofer IRB Verlag2013 own rework ETSuS UG

Seasonal efficiency



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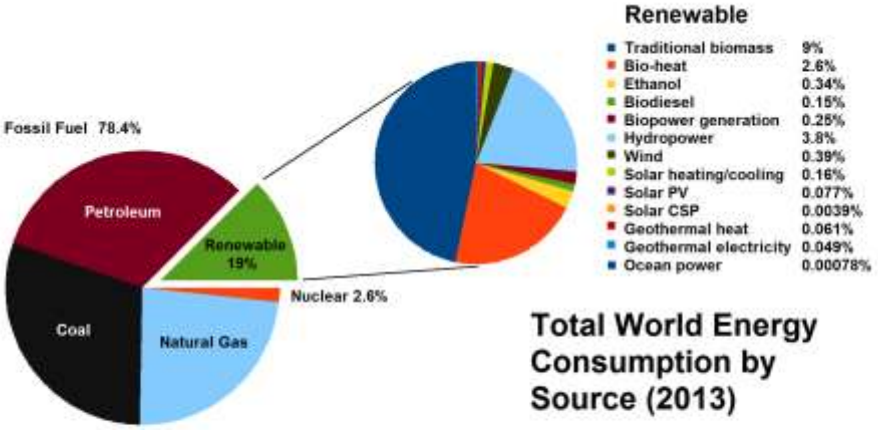
Energy sources and renewables

World. Total Energy Consumption

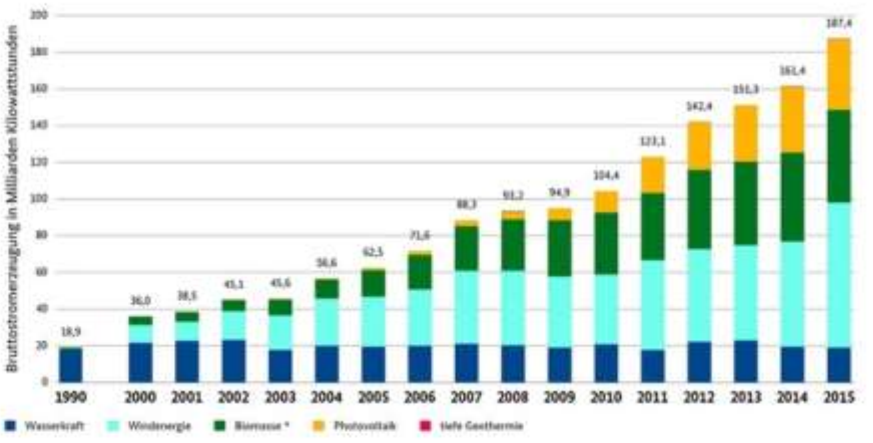


Total World Energy Consumption by Source (2013)

Source: By Delphi234 - Own work, CC0, https://commons.wikimedia.org/w/index.php?curid=33567170

DE: 1990 – 2015
Electricity production from RES

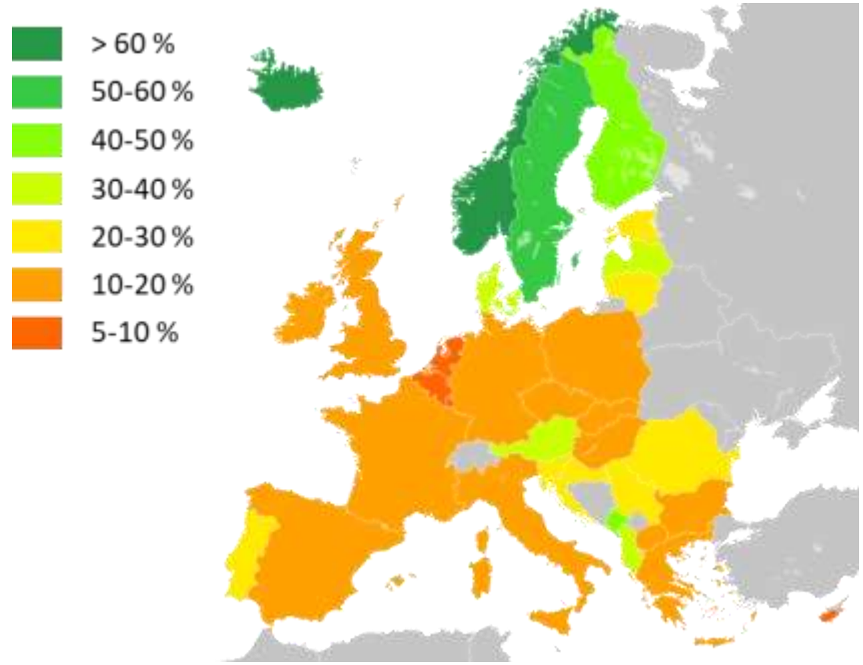
Entwicklung der Stromerzeugung aus erneuerbaren Energien in Deutschland



* inkl. feste und flüssige Biomasse, Biogas inkl. Biomethan, Klär- und Deponiegas und dem biogenen Anteil des Abfalls, ab 2010 inkl. Klärschlamm; BMWi auf Basis Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: Dezember 2016; Angaben vorläufig

Source : *BMWi nach Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat)*

Use of renewable energy

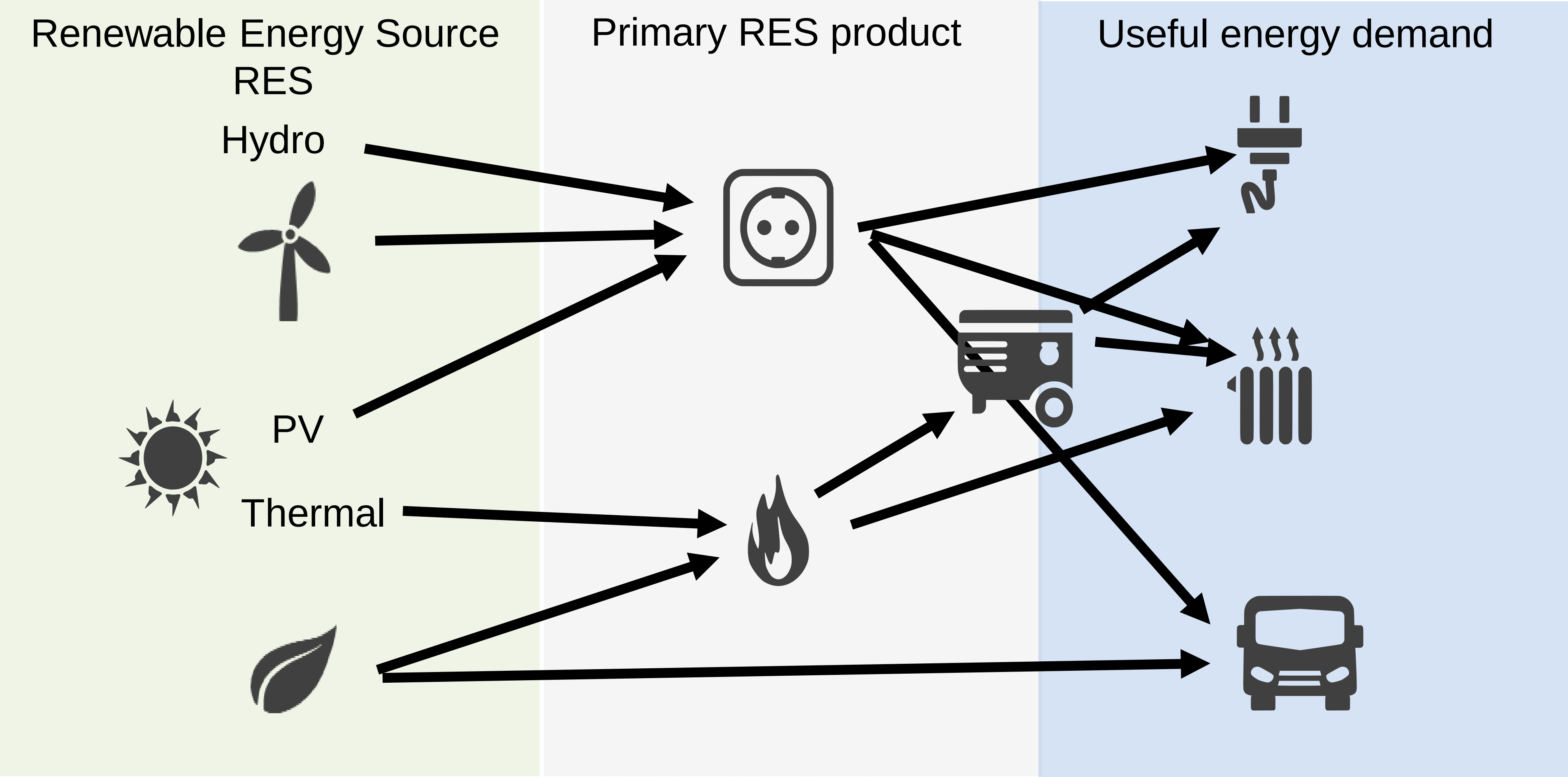


Source: By Edroeh - Location European nation states.svg: Ssolbergjdata source: Share of renewable energy in gross final energy consumption, Eurostat, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=79119369

Renewable issues

- Installed capacity vs. use (consumption)
- Power vs. work (kW vs kWh)
- Work vs. energy (time, location)
- Demand vs. production
- Primary vs. useful energy
- …

Renewable issue: setting the scene for mechanical RAC & HP



Renewable Energy Source RES

Primary RES product

Useful energy demand

Hydro

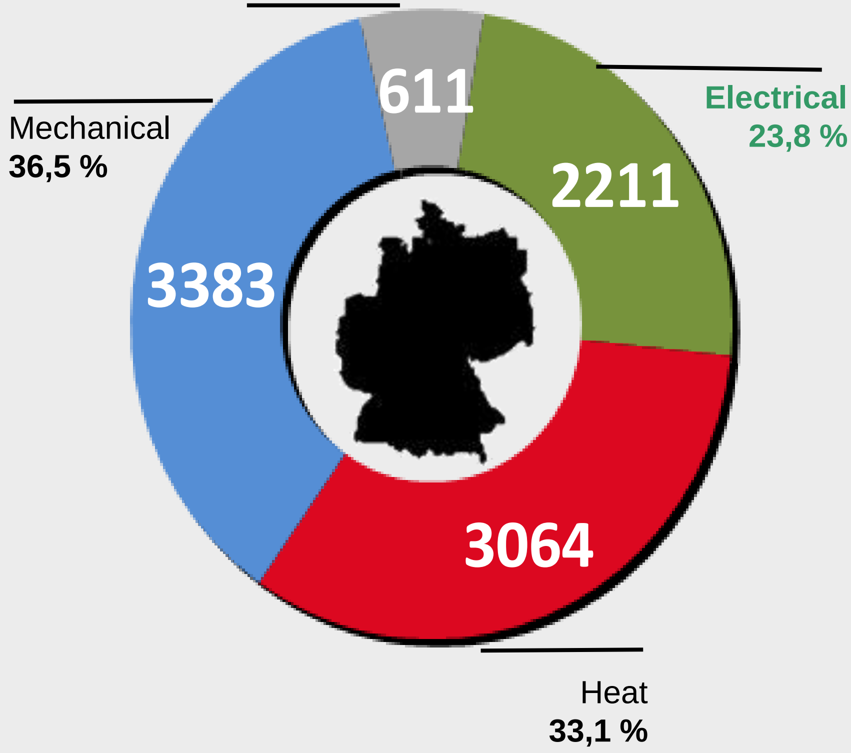
PV

Thermal

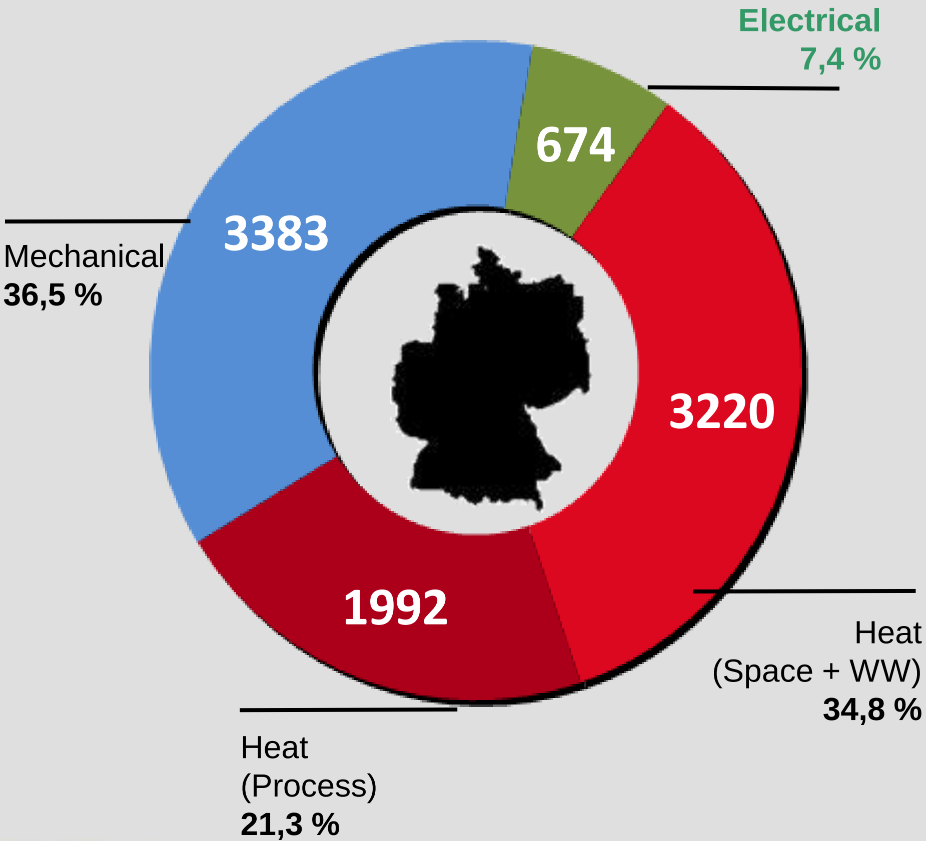
Primary and – useful energy

Energy consumption DE 2013
9.269 PJ (Peta-Joule) = 2.575 TWh

Primary energy



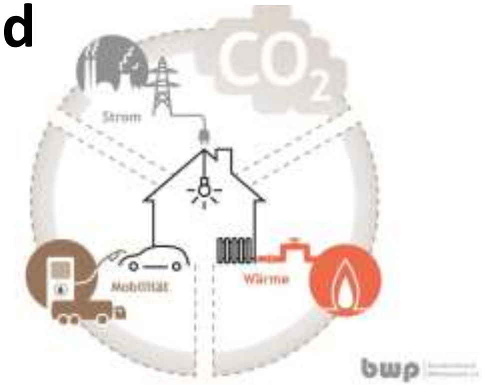
Use of energy



Quelle.
BMWi Energiedaten 03.2015

Coupling the (v)sectors

Old world



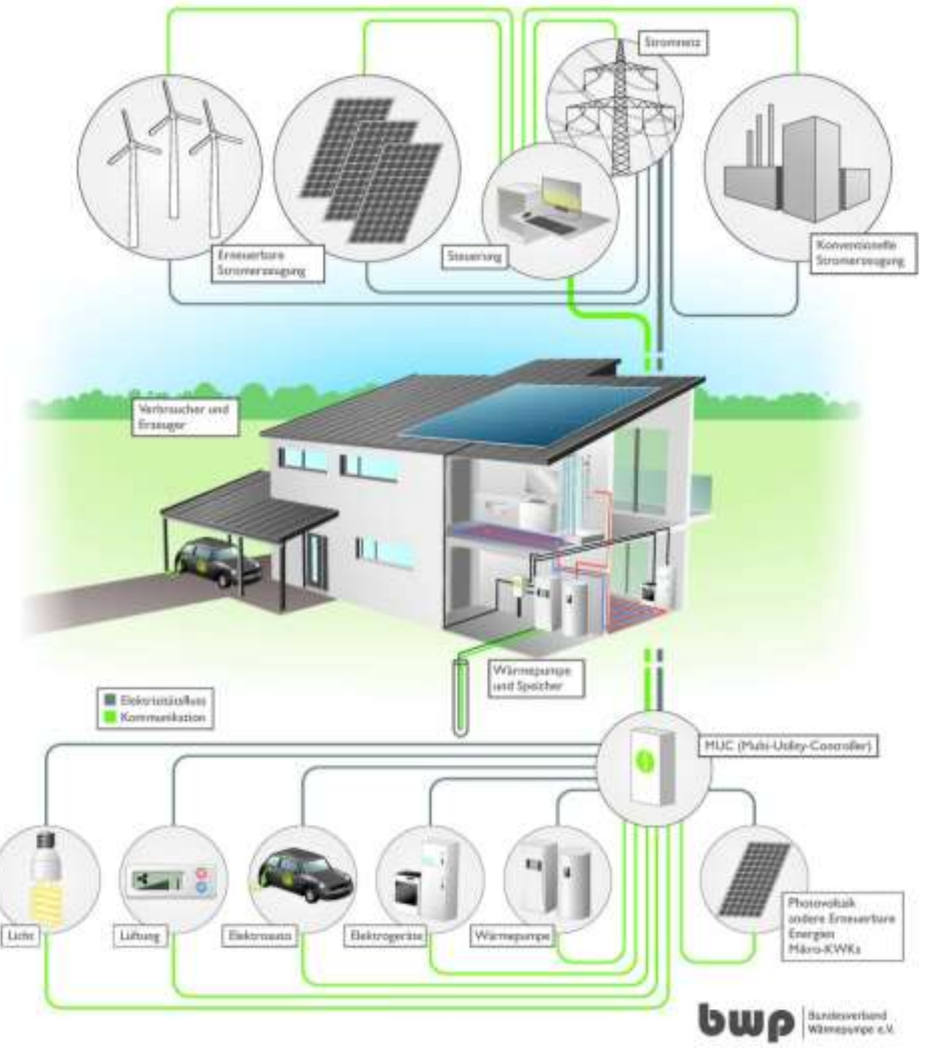
- Separate (central) production and(decentral) consumption
- Separate sectors and vectors:
  - Electrical, thermal, mechanical
  - Domestic, traffic, commercial, industrial

New world

- Combined decentral production/consumption: Prosumer
- Sector and vector coupling
- Smart Grids
- Need for storage, transformation and distribution

Source: bwp Bundesverband Wärmepumpe e.V

Heat Pumps in Smart Grids



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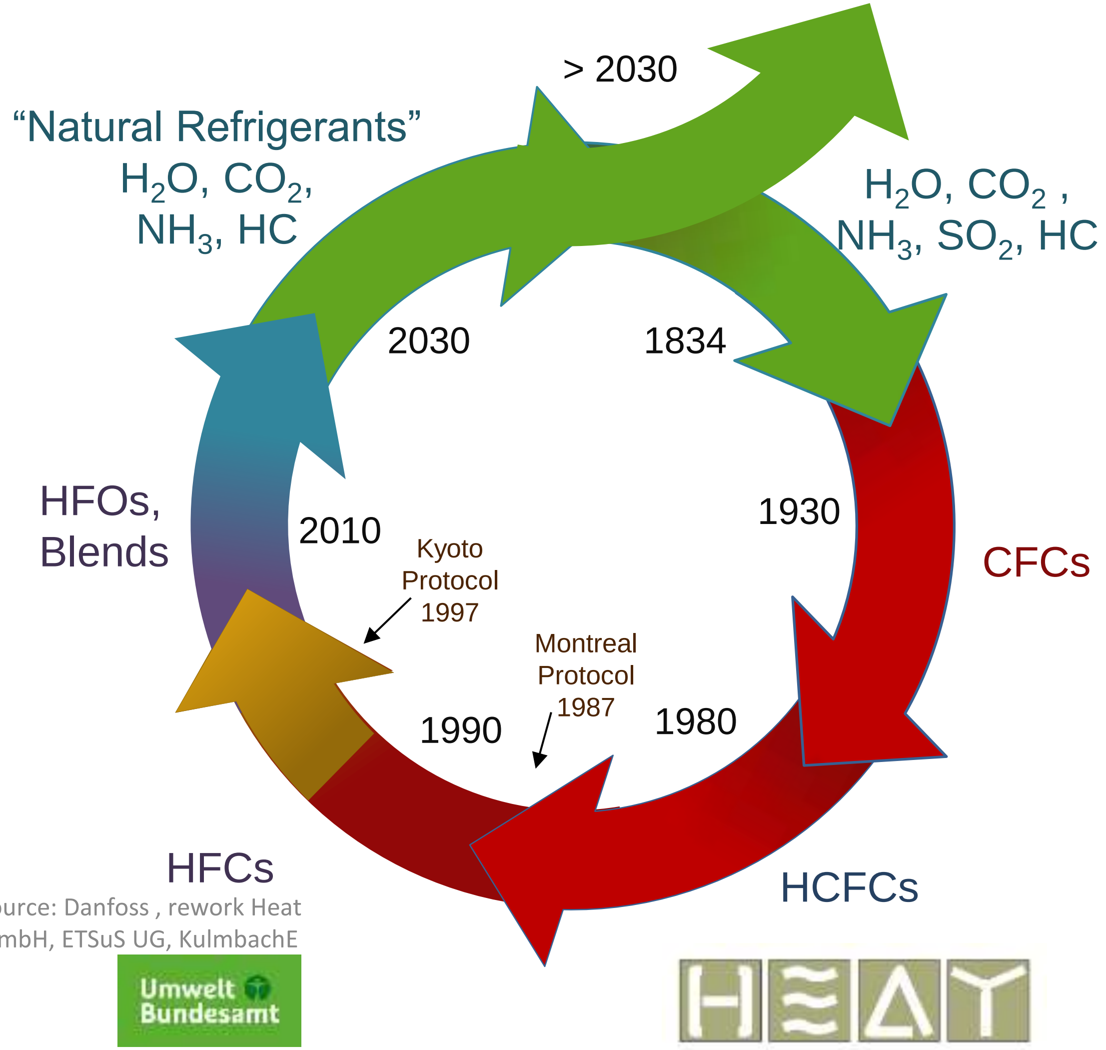
Refrigerants – Historical Devlopment



Source: Danfoss , rework Heat GmbH, ETSuS UG, KulmbachE

🟥

Ozone Depleting Substances (ODS): Artificially substances and significant high Global Warming Potential (GWP) **highest** environmental impact

🟨

No Ozone Depletion Potential (ODP), but **high** GWP

🟦

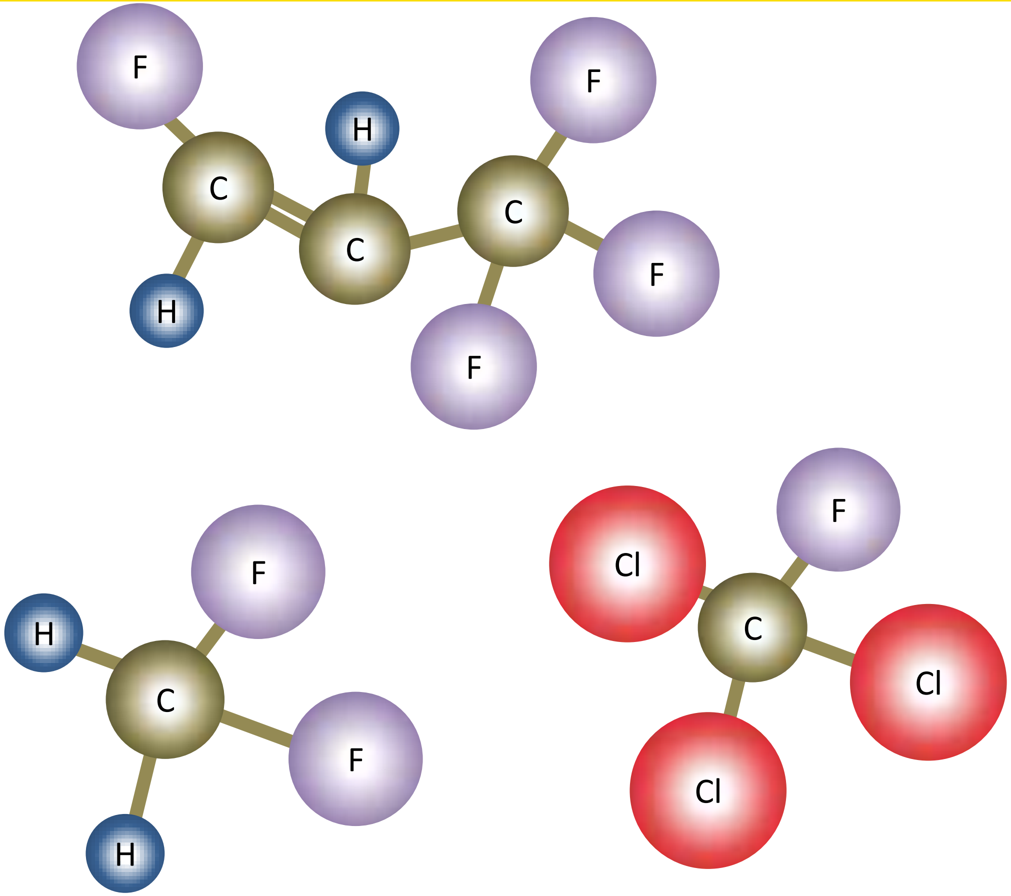
No ODP, lower (GWP) artificial substances with **lower** environmental impact

🟩

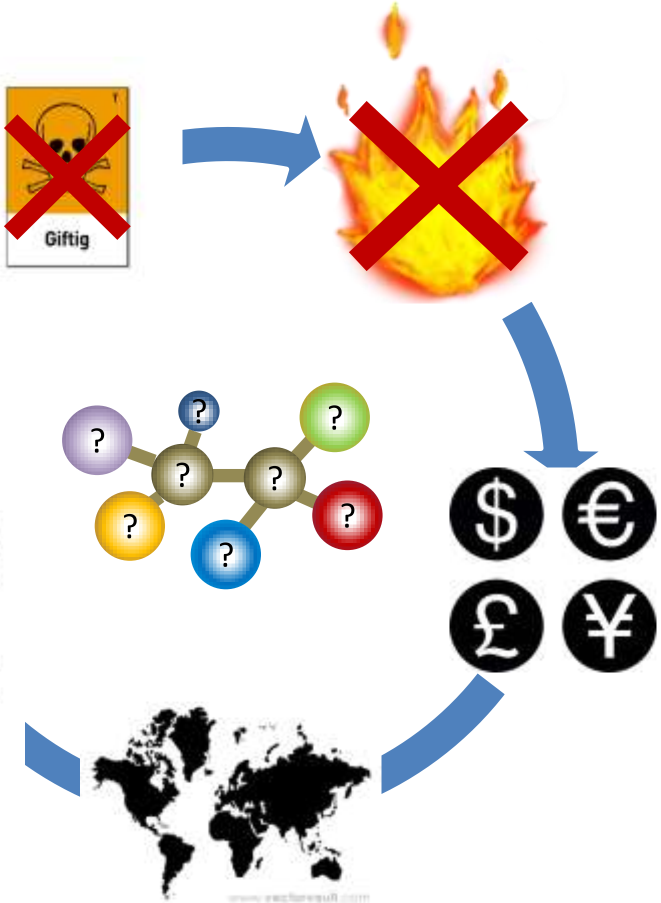
Naturally occurring substances with **lowest** environmental impact, (no ODP and lowest GWP)

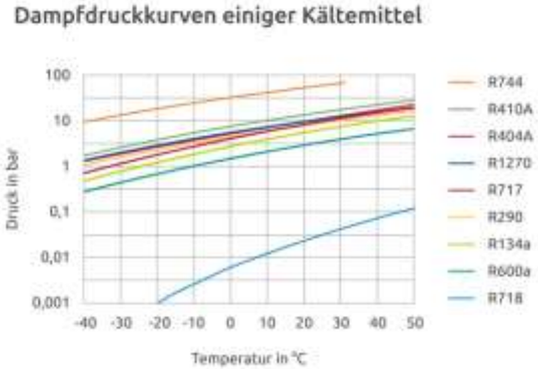
Refrigerants

- CFCs, HCFCs, HFCs
  - R11, R22, R134a, R32, R125
- Mixtures
  - Azeotropic
    - R502, R507
  - Non/Azeotropic
    - R410A, R407C
- HFOs
  - HFO1234yf, HFO1234ze,
- Natural Refrigerants”
  - R744, R717, …
- HCs
  - R290, R170, R600a,



Refrigerants: The ideal choice

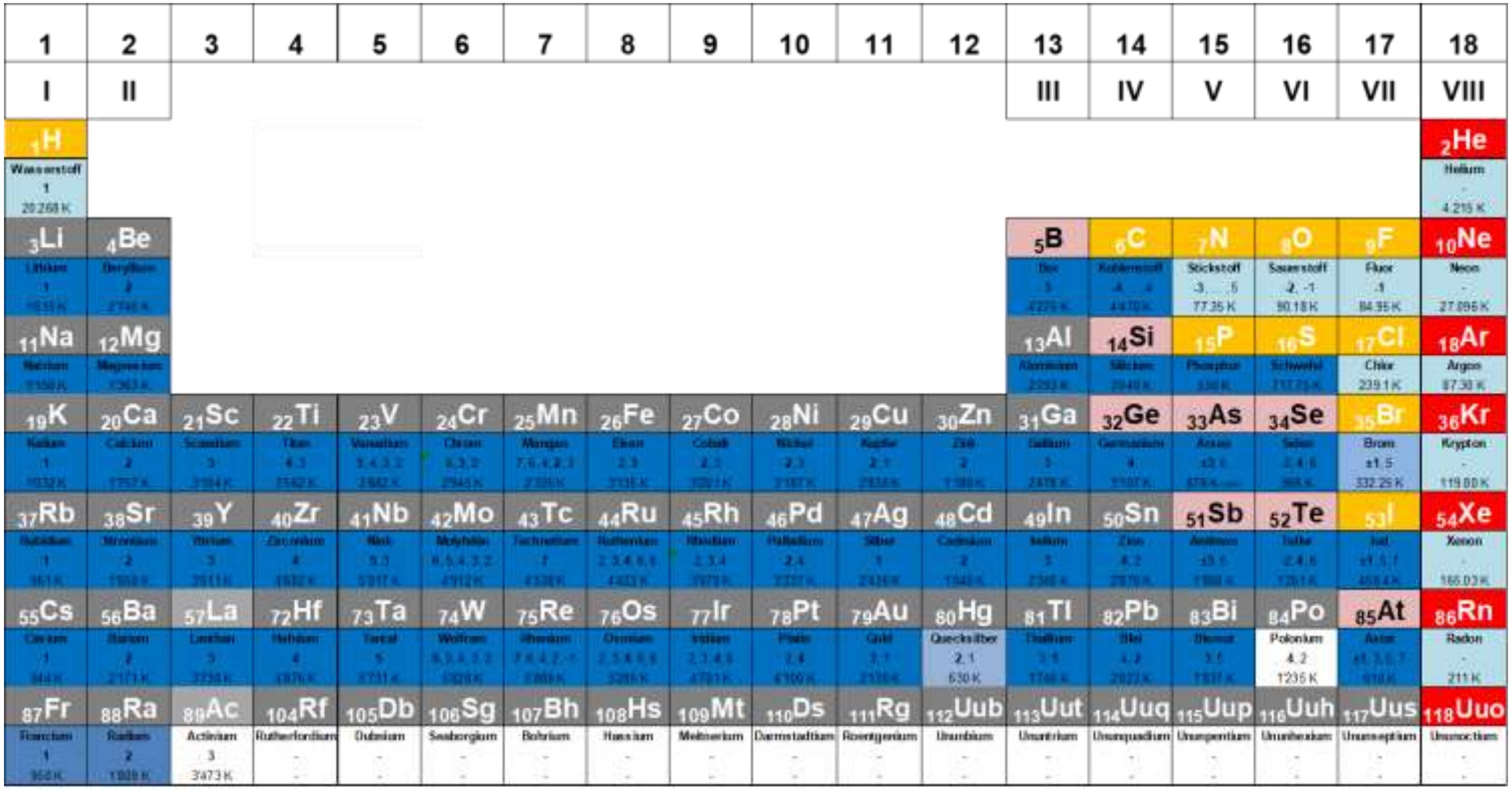




Quelle: https://efficient-energy.com/kaeltemaschine-echiller/wasser-als-kaeltemittel/, aufgerufen 7.9.2017

A little refrigerant cooking cooking session in the witches kitchen

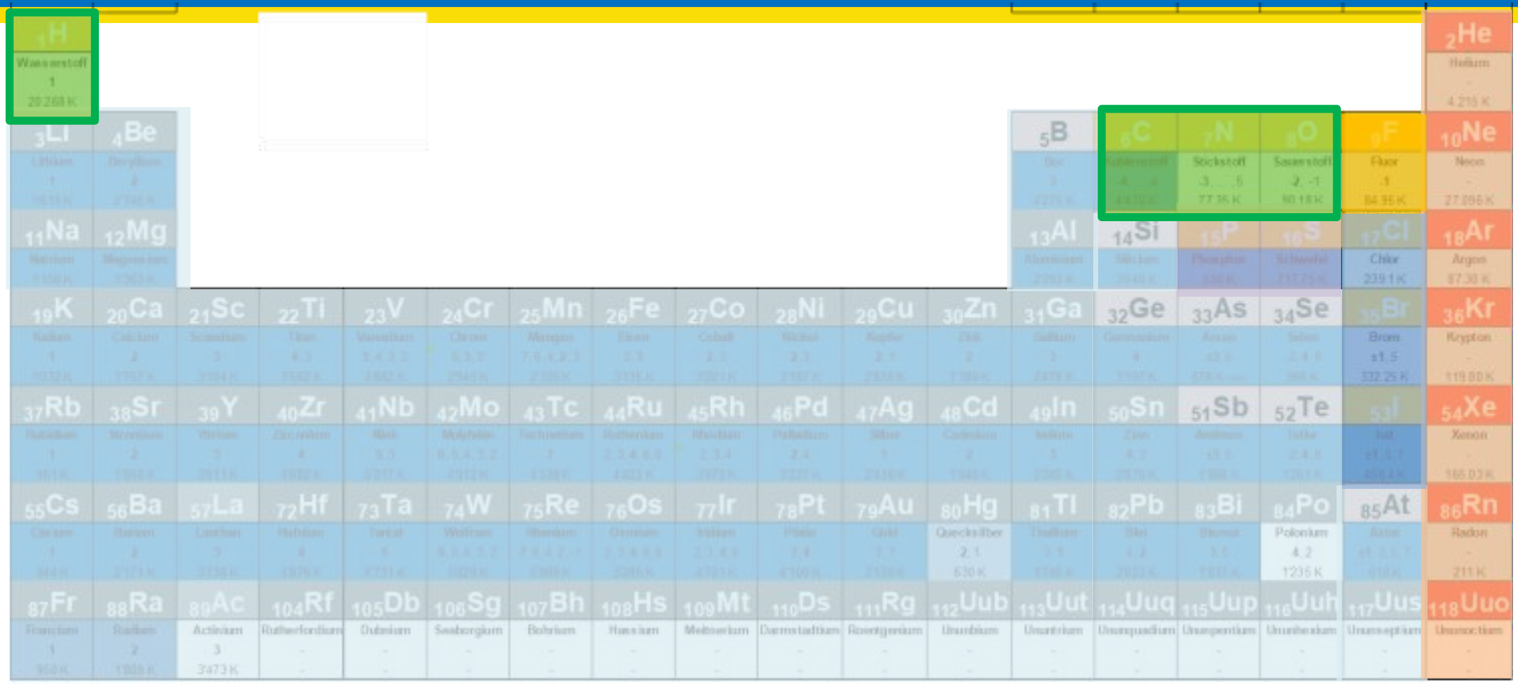
Refrigerant cooking session – the ingredients



1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I	II											III	IV	V	VI	VII	VIII
$_{1}$H Wasserstoff 1 20.268 K																	$_{2}$He Helium - 4.215 K
$_{3}$Li	$_{4}$Be											$_{5}$B	$_{6}$C	$_{7}$N Stickstoff -3, ..., 5 77.35 K	$_{8}$O Sauerstoff -2, -1 90.18 K	$_{9}$F Fluor -1 84.95 K	$_{10}$Ne Neon - 27.096 K
$_{11}$Na	$_{12}$Mg											$_{13}$Al	$_{14}$Si	$_{15}$P	$_{16}$S	$_{17}$Cl Chlor 239.1 K	$_{18}$Ar Argon 87.30 K
$_{19}$K	$_{20}$Ca	$_{21}$Sc	$_{22}$Ti	$_{23}$V	$_{24}$Cr	$_{25}$Mn	$_{26}$Fe	$_{27}$Co	$_{28}$Ni	$_{29}$Cu	$_{30}$Zn	$_{31}$Ga	$_{32}$Ge	$_{33}$As	$_{34}$Se	$_{35}$Br Brom ±1, 5 332.25 K	$_{36}$Kr Krypton - 119.80 K
$_{37}$Rb	$_{38}$Sr	$_{39}$Y	$_{40}$Zr	$_{41}$Nb	$_{42}$Mo	$_{43}$Tc	$_{44}$Ru	$_{45}$Rh	$_{46}$Pd	$_{47}$Ag	$_{48}$Cd	$_{49}$In	$_{50}$Sn	$_{51}$Sb	$_{52}$Te	$_{53}$I	$_{54}$Xe Xenon - 165.03 K
$_{55}$Cs	$_{56}$Ba	$_{57}$La	$_{72}$Hf	$_{73}$Ta	$_{74}$W	$_{75}$Re	$_{76}$Os	$_{77}$Ir	$_{78}$Pt	$_{79}$Au	$_{80}$Hg Quecksilber 2, 1 630 K	$_{81}$Tl	$_{82}$Pb	$_{83}$Bi	$_{84}$Po Polonium 4, 2 1235 K	$_{85}$At	$_{86}$Rn Radon - 211 K
$_{87}$Fr Francium 1	$_{88}$Ra Radium 2	$_{89}$Ac Actinium 3 3473 K	$_{104}$Rf Rutherfordium - -	$_{105}$Db Dubnium - -	$_{106}$Sg Seaborgium - -	$_{107}$Bh Bohrium - -	$_{108}$Hs Hassium - -	$_{109}$Mt Meitnerium - -	$_{110}$Ds Darmstadtium - -	$_{111}$Rg Roentgenium - -	$_{112}$Uub Ununbium - -	$_{113}$Uut Ununtrium - -	$_{114}$Uuq Ununquadium - -	$_{115}$Uup Ununpentium - -	$_{116}$Uuh Ununhexium - -	$_{117}$Uus Ununseptium - -	$_{118}$Uuo Ununoctium - -

Source: ETSuS UG

Refrigerant cooking session – the ingredients – What's left?



Do not form gases

Ozone depleting

Remaining candidates

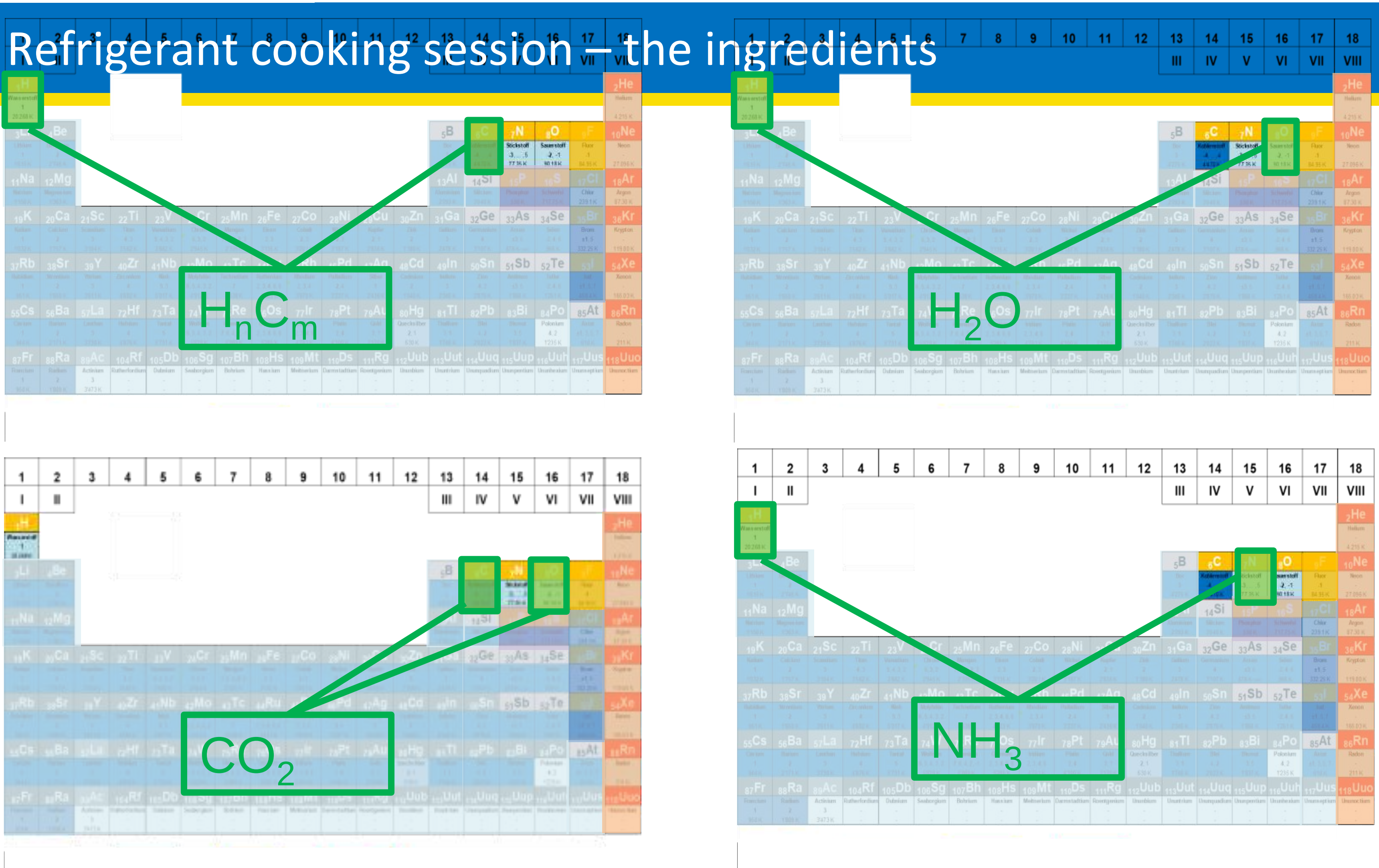
Do not react at all

Greenhouse effect

Toxic

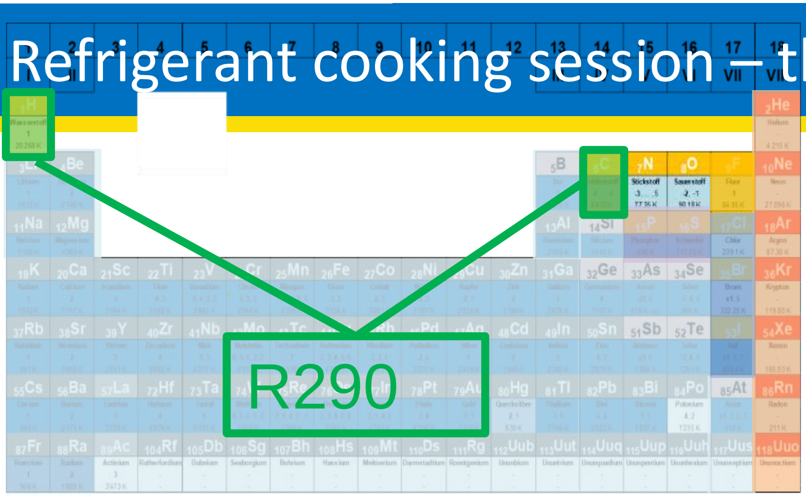
Source: ETSuS UG

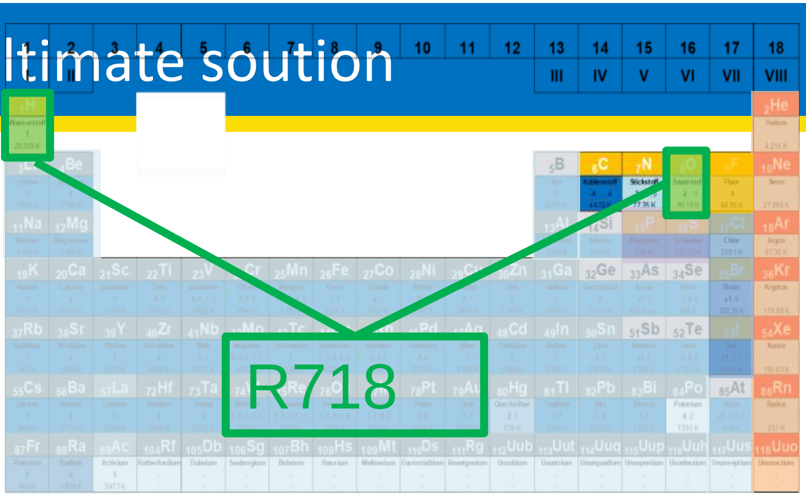
Refrigerant cooking session – the ingredients

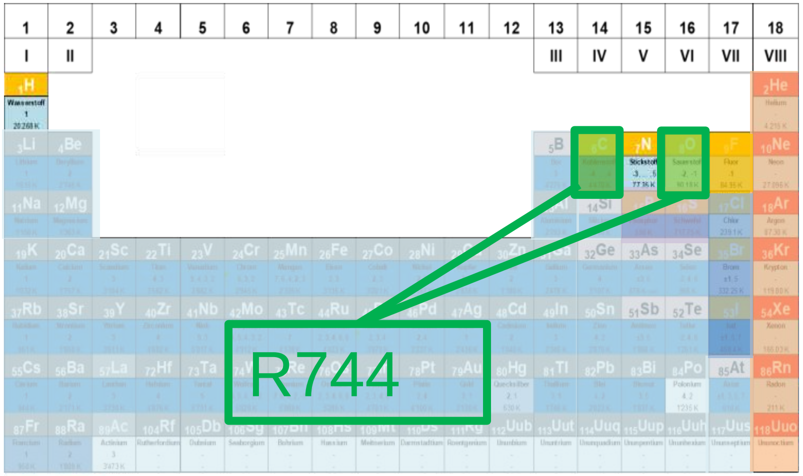


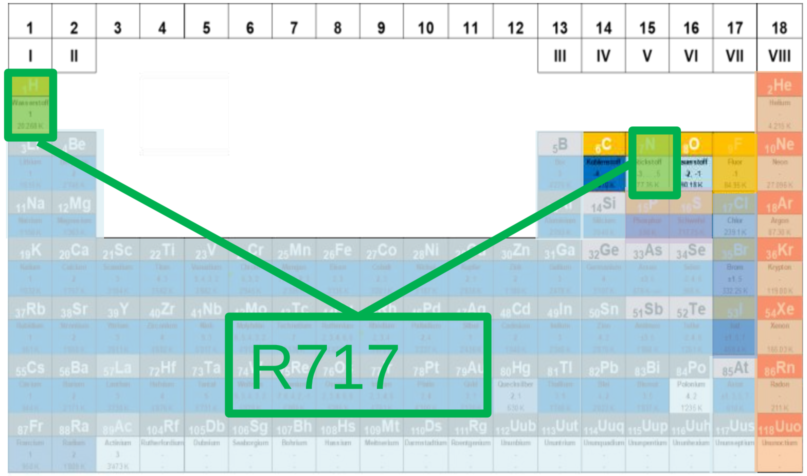
Source: ETSuS UG

Refrigerant cooking session – the ultimate soution



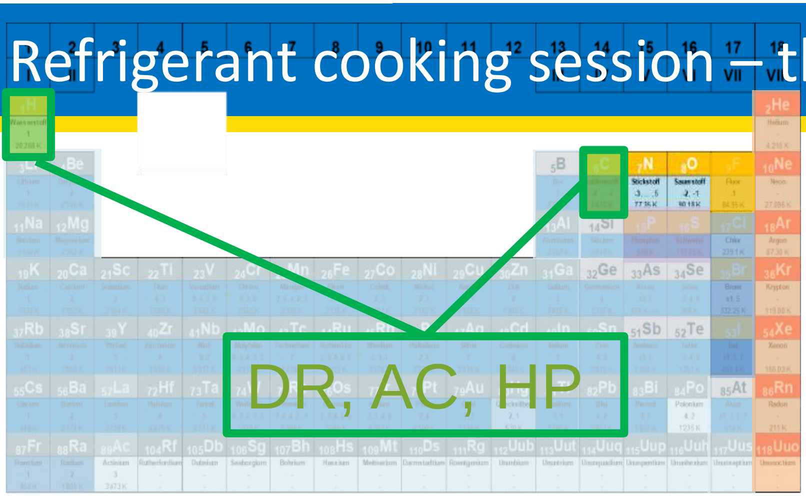


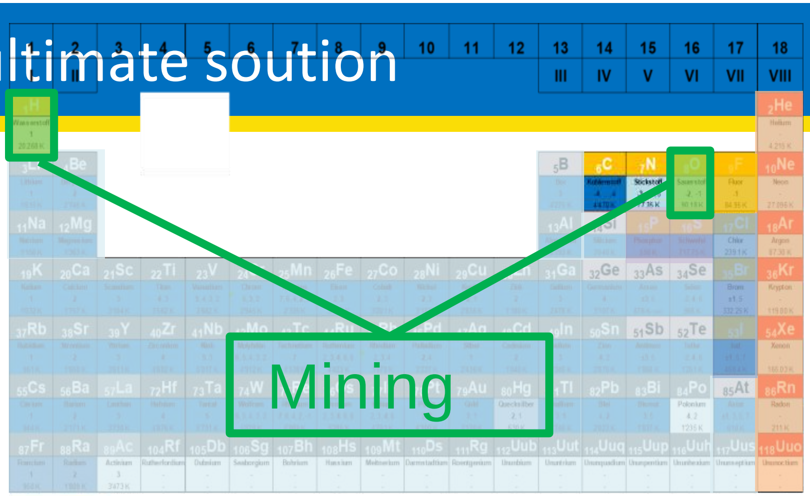


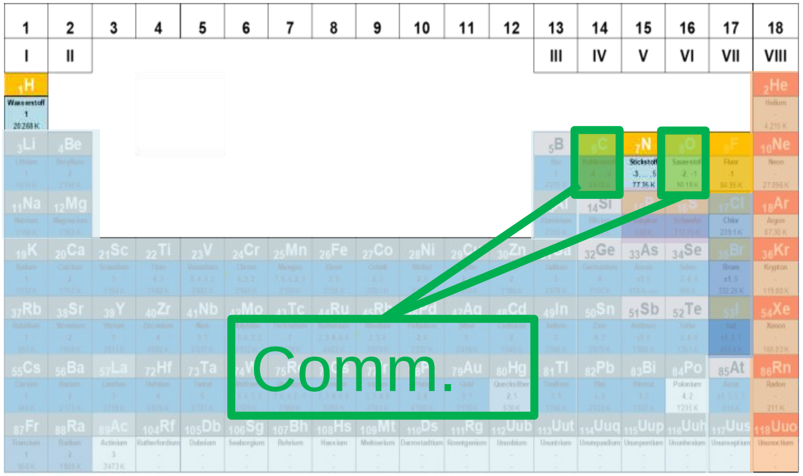


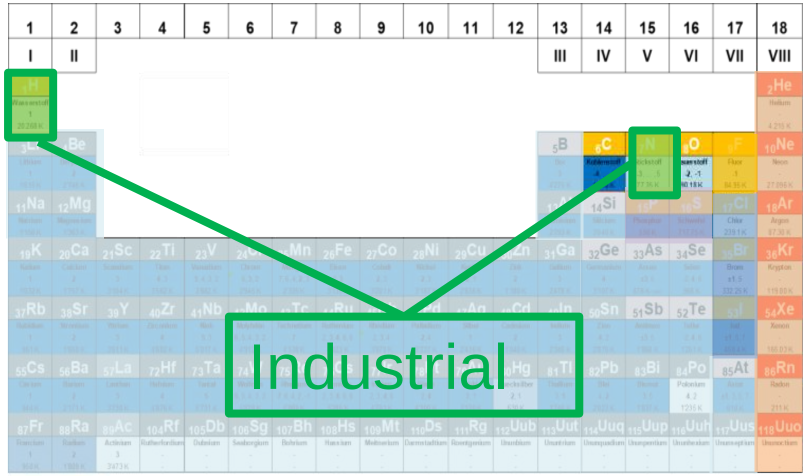
Source: ETSuS UG

Refrigerant cooking session – the ultimate soution







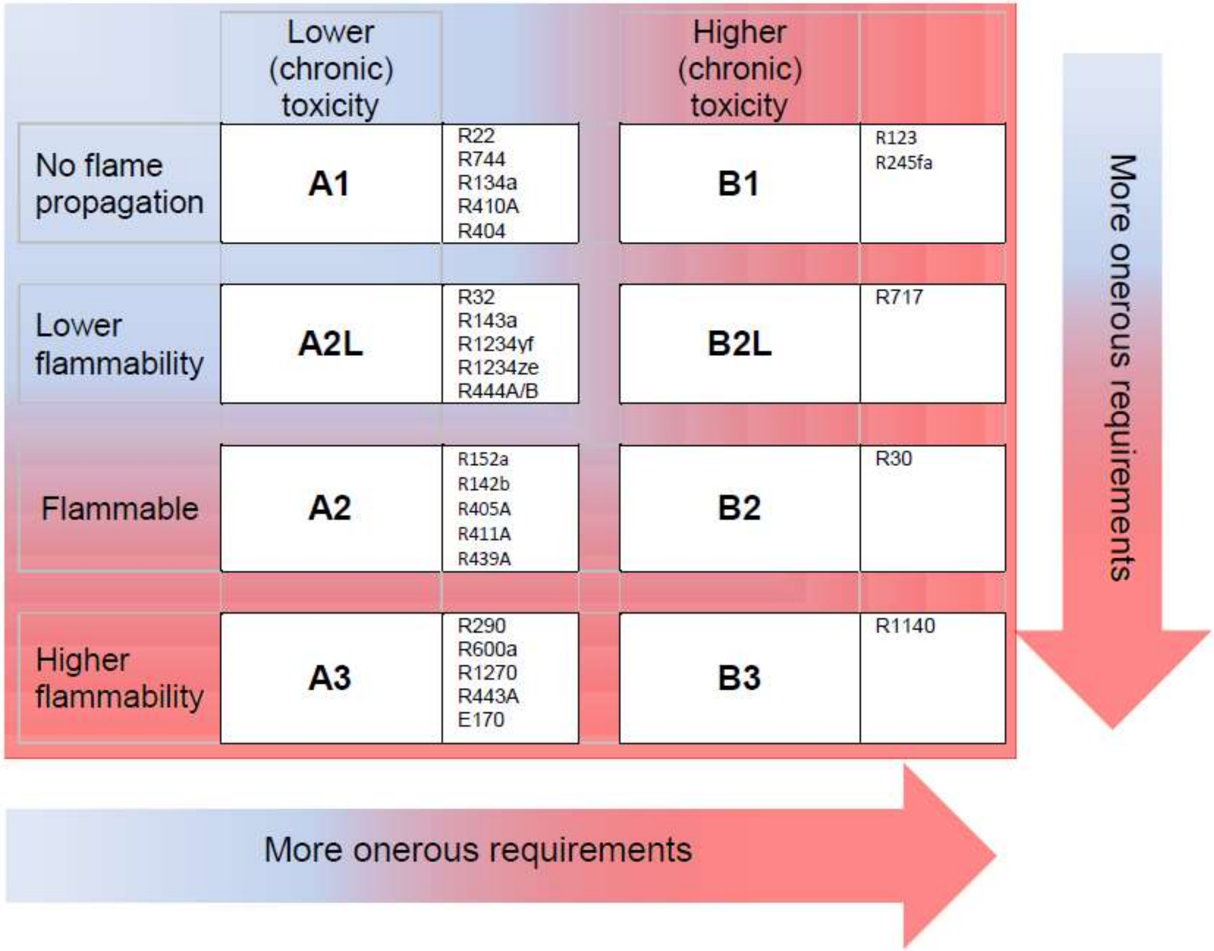


Source: ETSuS UG

Safety Classification of refrigerants

A “higher” classification (i.e. toxicity class B instead of class A, and flammability class 3 instead of class 1) means:

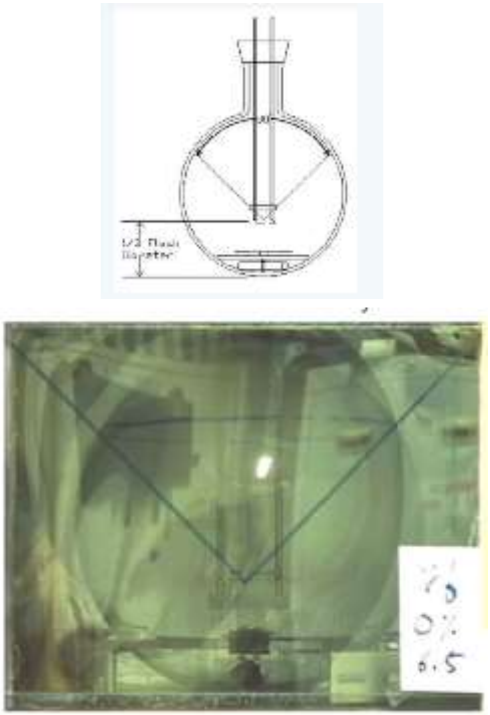
- ➢ the refrigerating system has more demanding design requirements,
- ➢ in order to handle the higher risk represented by the refrigerant.



	Lower (chronic) toxicity		Higher (chronic) toxicity	
No flame propagation	**A1**	R22 R744 R134a R410A R404	**B1**	R123 R245fa
Lower flammability	**A2L**	R32 R143a R1234yf R1234ze R444A/B	**B2L**	R717
Flammable	**A2**	R152a R142b R405A R411A R439A	**B2**	R30
Higher flammability	**A3**	R290 R600a R1270 R443A E170	**B3**	R1140

SO 817: Safety Classification – Flammability Classification

Class	Flame-propagtion	LFL / Vol. %	H_c Combustion Heat / kJ/kg	S_u Flame-velocity / cm/s
Reference	(60 °C; 101,3 kPa)	(23 °C; 101,3 kPa)	(25 °C; 101,3 kPa)	(23 °C; 101,3 kPa)
1	Nein	NA	NA	NA
2L	Ja	> 3,5	< 19.000	≤ 10
2	JA	> 3,5	< 19.000	> 10
3	JA	≤ 3,5 or ≥ 19.000		ND



Quelle: Challenges of the New Landscape of Flammability. Kenji Takizawa,. 1st IIR International Conference on the Application of HFO Refrigerants, Birmingham, 3-5.9.2018

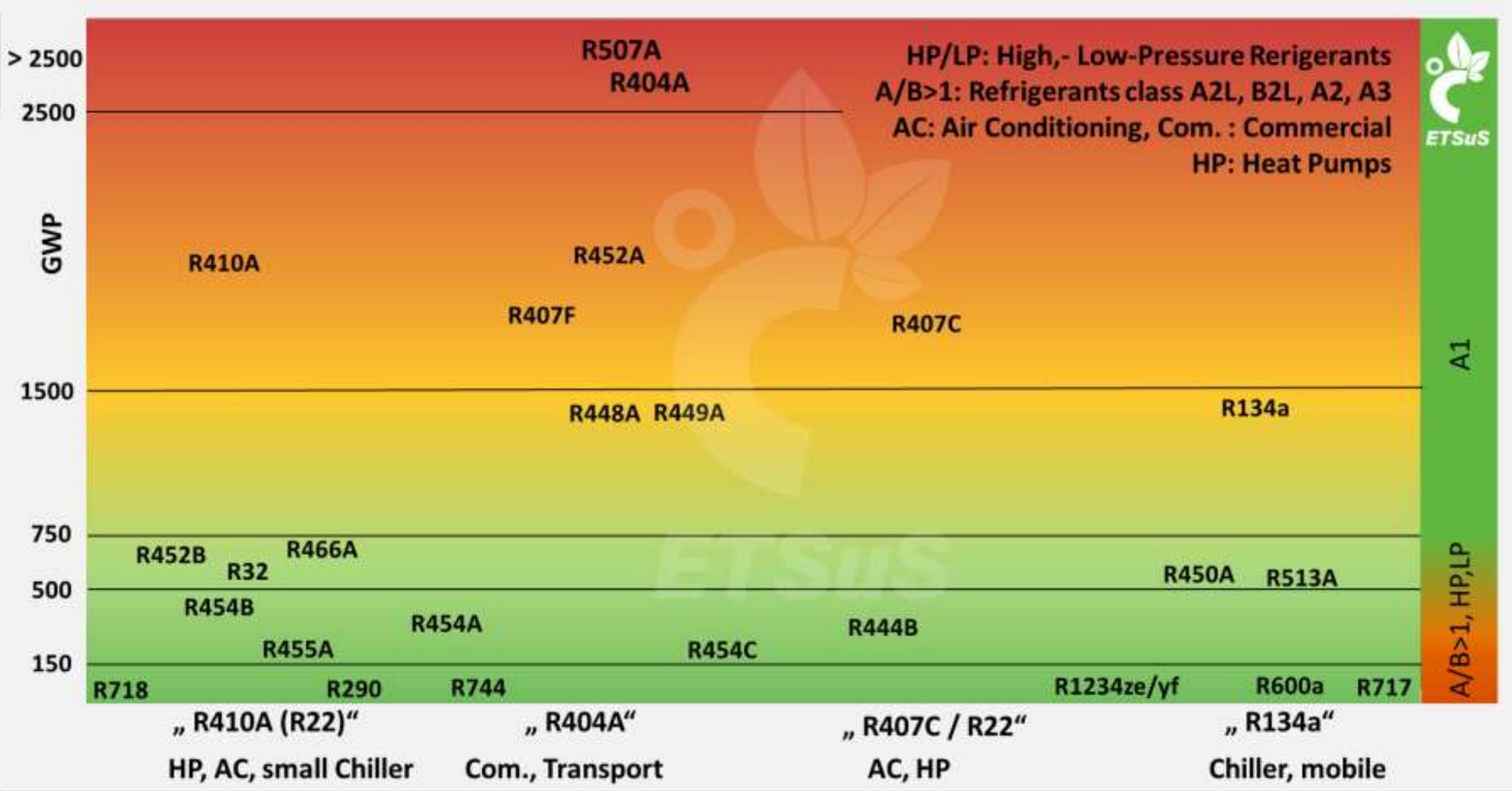
„Flammability is not a fluid property, it is question of measurement methods and definition!“

The Safety vs. “Environmental” classification dilemma

Toxicity Flammability	Lower Chronic Toxicity	Higher Chronic Toxicity
No Flame Propagation	A1	B1
Lower Flammability	A2L	B2L
Flammable	A2	B2
Higher Flammibility	A3	B3

	GWP
Highest GWP	A1
High GWP	A2, A2L
Lower GWP	A2L
Lowest / GDP	A3, B2L, R744

CAPACITY BUILDING ON INNOVATIVE APPLICATIONS OF ENERGY-FICIENT CLIMATE-FRIENDLY COOLING AND HEATING TECHNOLOGIES



SOURCE: ETSuS UG

Alternative Refrigerants (selection)

Refrgerant	ODP	GWP (AR4/AR5)	NBP/NDP /°C	Critical Temp. / °C	Critical Pressure / MPa	Klasse ISO 817	CLP classification	LFL Kg/m^3	LFL Vol%	S_u* burning velocity / cm/s	H_c Verbrenn.-wärme / MJ/kg	ATEL / ODL / kg/m^3
R32	0	675/677	-52	78	5,8	A2L	H220/H280	0,307	14,2	6,7	9,5	0,300
R152a	0	124/138	-25	113	4,5	A2	H220/H280	0,130	4,7	23	16,3	0,140
R290	0	3/3	-42	97	4,2	A3	H220/H280	0,038	2,1	46	46,3	0,090
R454B	0	698/676	-51/-50,2	77		A2L	H220/H280	0,298	7,3	5,2	9,9	0,47
R454C	0	148/146	-45,9/-39,9	82		A2L	H220/H280	0,289	6,1	<4	10,5	0,37
R466A	0,01-0,05	733	-51,7/-50,2	80,6	5,9	A1	H280	-	-	-	-	?
R600a	0	3/3	-12	135	3,6	A3	H220/H280	0,043	1,8	41	45,6	0,059
R717	0	0/0	-33	132	11,3	B2L	H221/H280/H331/H314/H410	0,116	16,7	7,2	18,6	0,00022
R718	0	0/0	100	374	22,1	A1	-	-	-	-	-	-
R744	0	1/1	-78	31	74	A1	H280	-	-	-	-	0,072
R1234ze(E)	0	4/1	-19	109	3,4	A2L	- /H280	0,303	6,4	1,2	10,1	0,28
R1234yf	0	7/1	-26	95	3,6	A2L	H220/H280	0,289	6,1	1,5	10,7	0,47

Primary Application Relevance

* ISO 817 Nominal Formulation or WCF

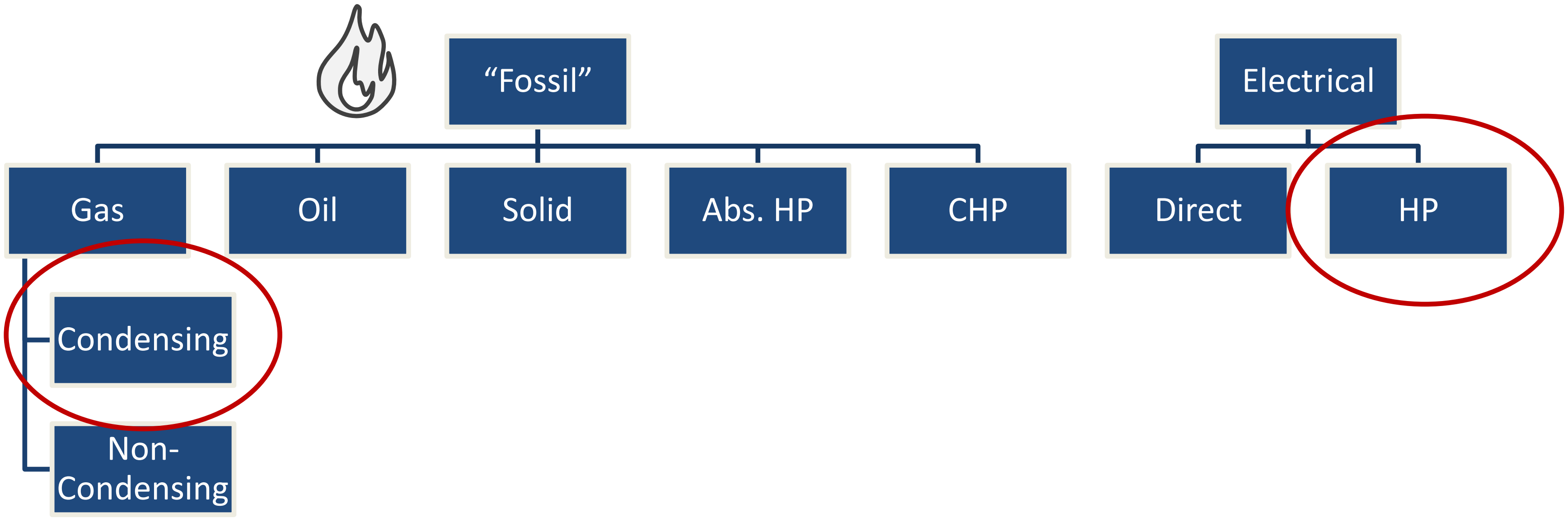
Environment Regulation - Alternative Technologies RAC&HP

- Background Motivation
- Environmental Regulations
- The role of renewable energy
- RAC HP: Green working fluids

☞ Heating. HP and boilers

- Refrigeration outlook: Green cooling
- Summary

Heating Technologies



“Fossil”

Electrical

Gas

Oil

Solid

Abs. HP

CHP

Direct

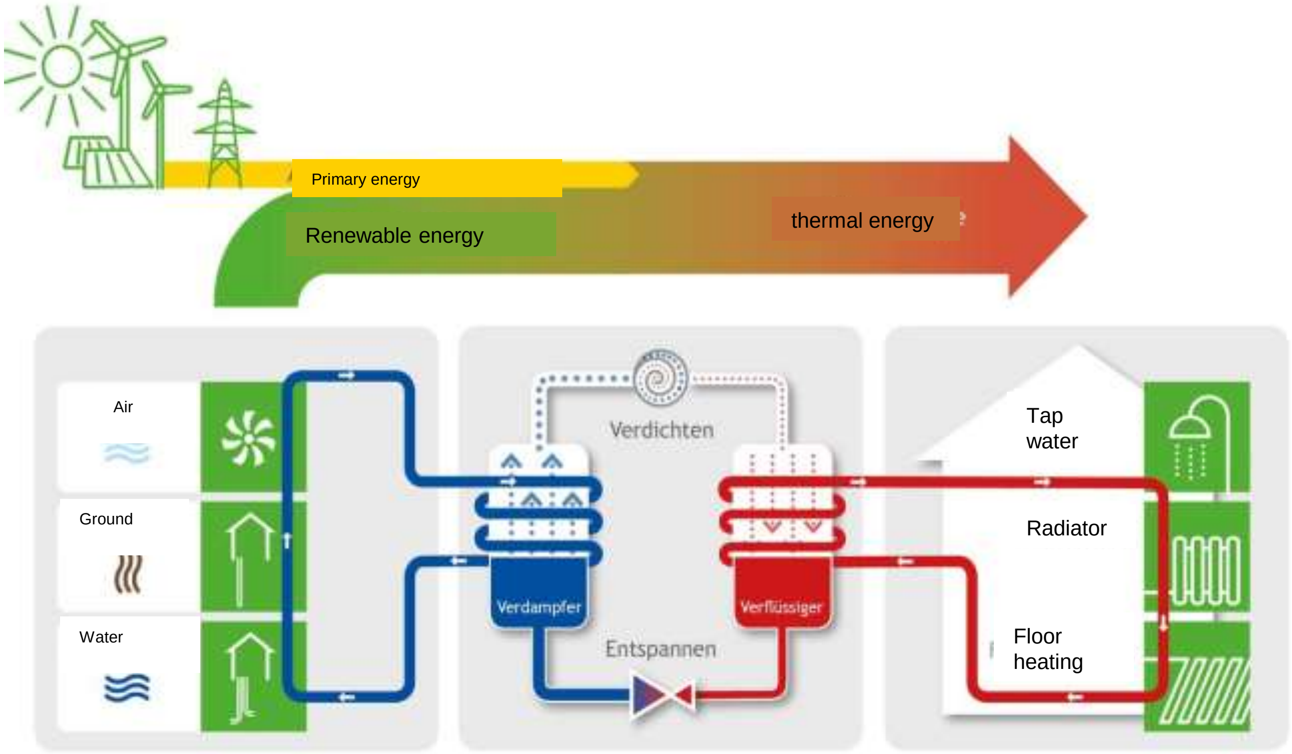
HP

Condensing

Non-Condensing

Space Heating: New Build – Renovation

Heat pumps basics



Heat Source

Heat Pump

Heat Sink, distribution and storage

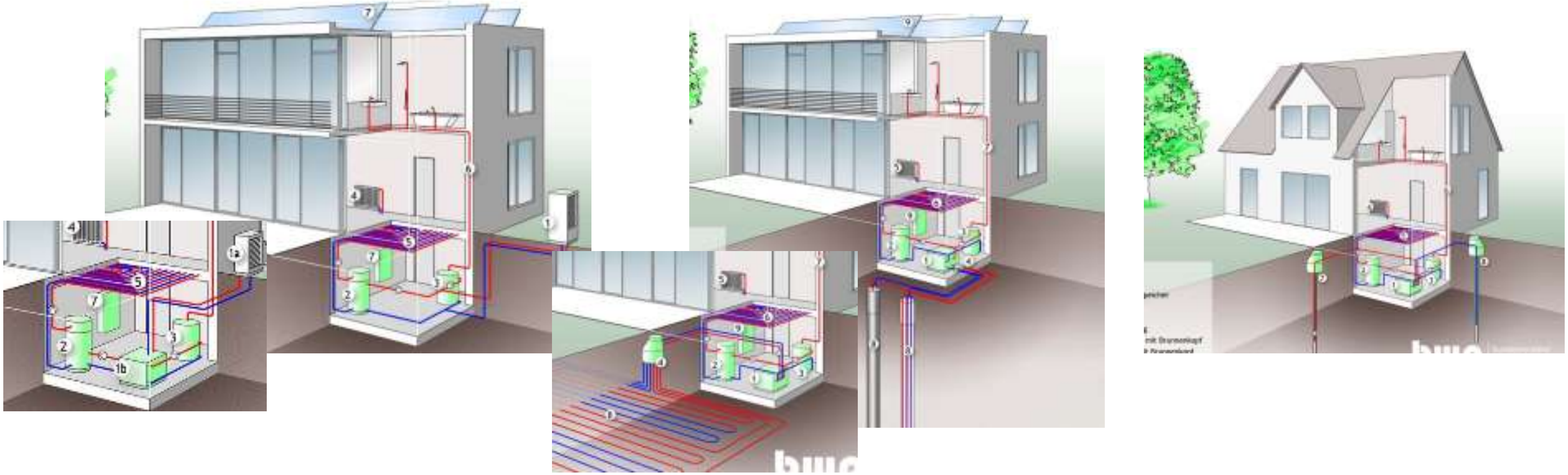
bwp Bundesverband Wärmepumpe e.V.

Umwelt Bundesamt

HEAT

REFRIGERATING ASSOCIATION OF UKRAINE

Heat pumps basics (typical serial product)



Air-Source
- Source temp : min. -20 °C
- Capacity: 5- 60 (100) kW
- SPF: ~3

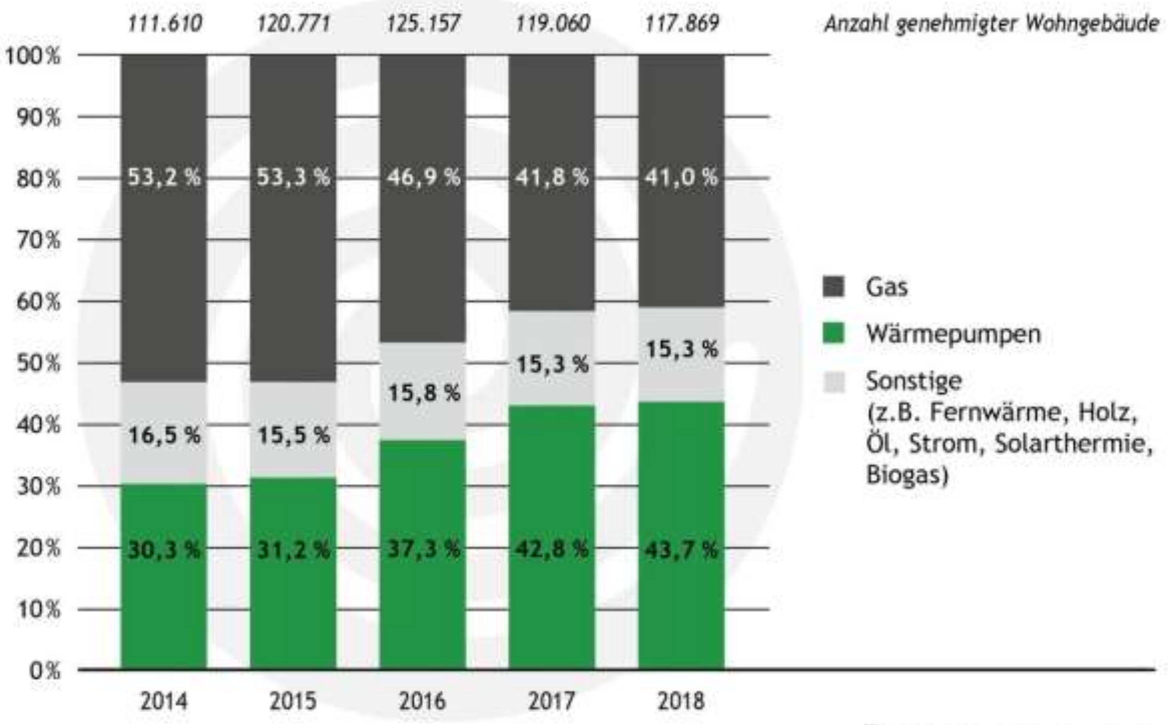
Ground-Source
- Source temp : min. 0 °C
- Capacity: >10 - 150 kW
- SPF: ~4

Water-Source
- Source temp : 10 °C
- Capacity: > 10 - 200 kW
- SPF: ~5

Heat Pump Development DE

Wärmepumpen-Marktanteile in Deutschland

Baugenehmigungen neuer Wohngebäude 2014 - 2018

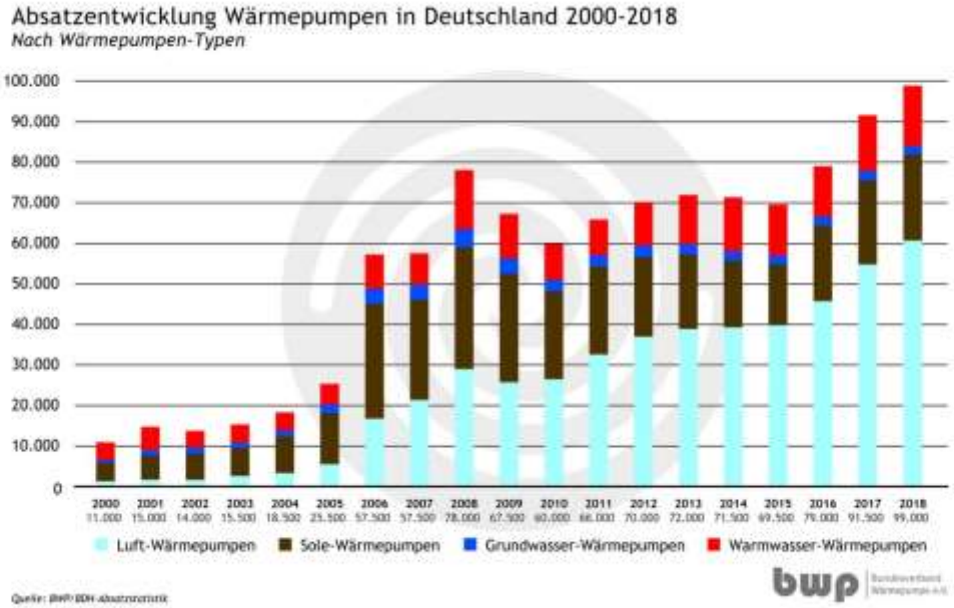


Quelle: Statistisches Bundesamt, Bautätgkeit, Baugenehmigungen für Wohngebäude nach primär verwendeter Energie zur Heizung

bwp Bundesverband Wärmepumpe e.V.

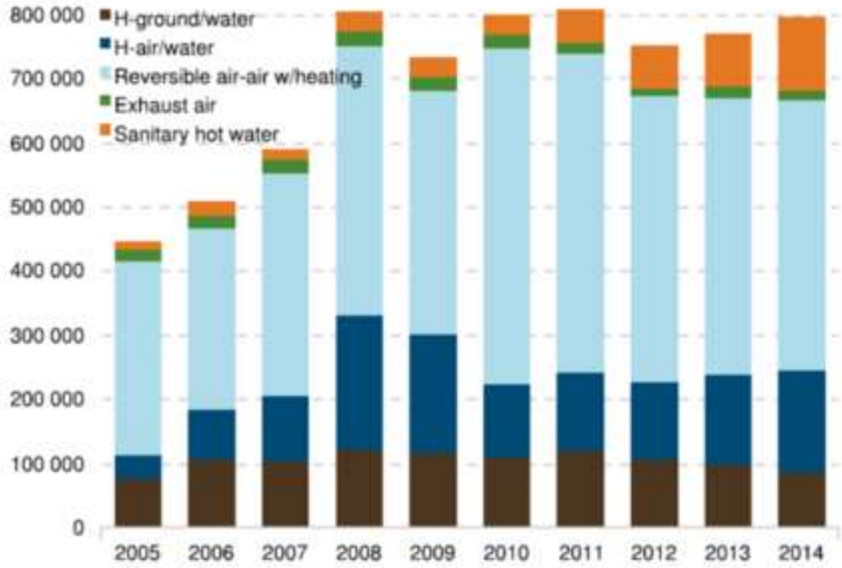
Heat Pump Development

DE

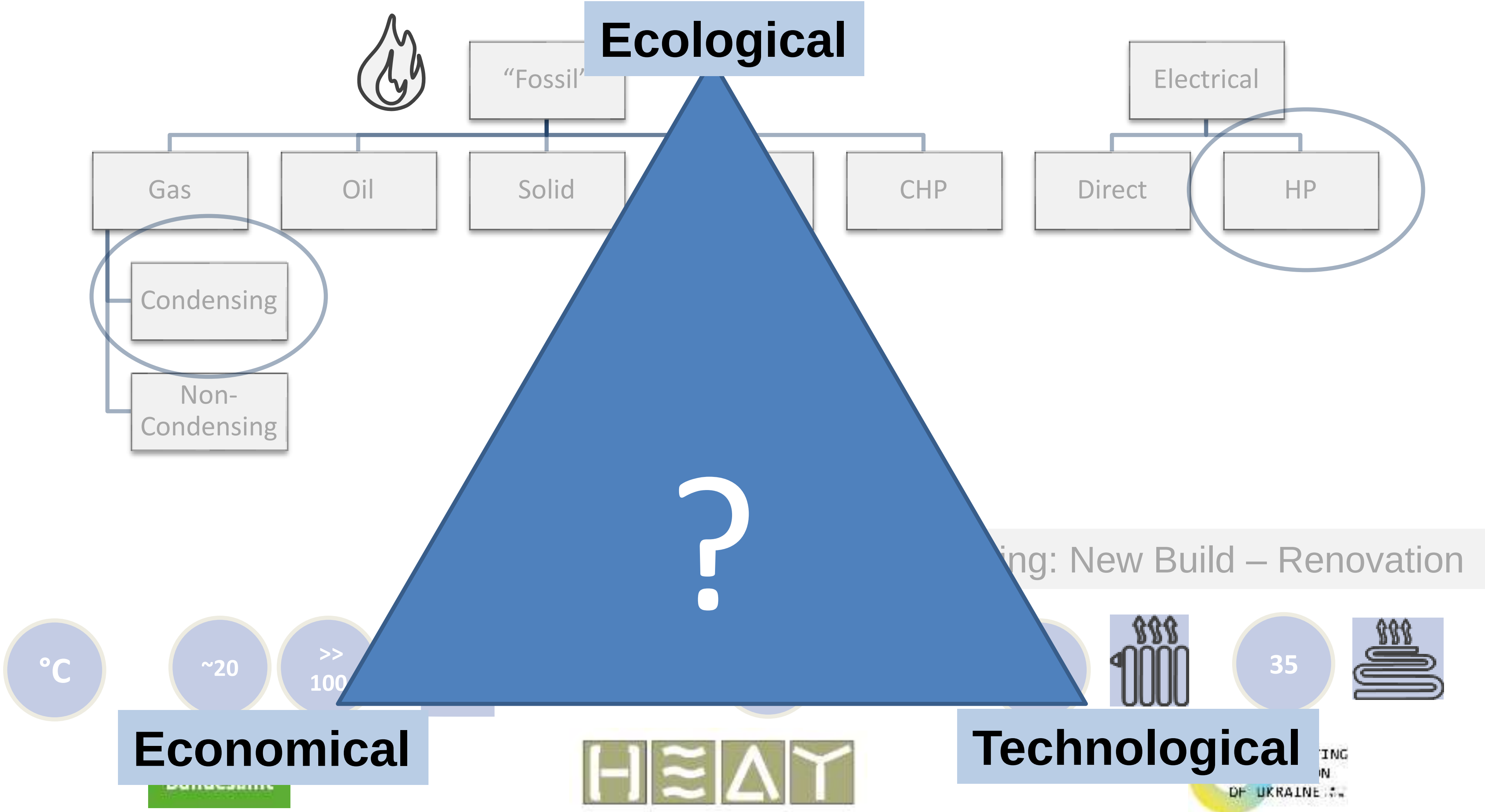


Quelle: BWP/BDH Absatzstatistik

Europe



Heating Technologies - Assessment



Ecological

“Fossil”

Electrical

Gas

Oil

Solid

CHP

Direct

HP

Condensing

Non-Condensing

?

ing: New Build – Renovation

°C

~20

>> 100

35

Economical

Technological

Primary energy assessment acc. VDI 4650

HP

Boiler

Solar thermal

el. back up

RES

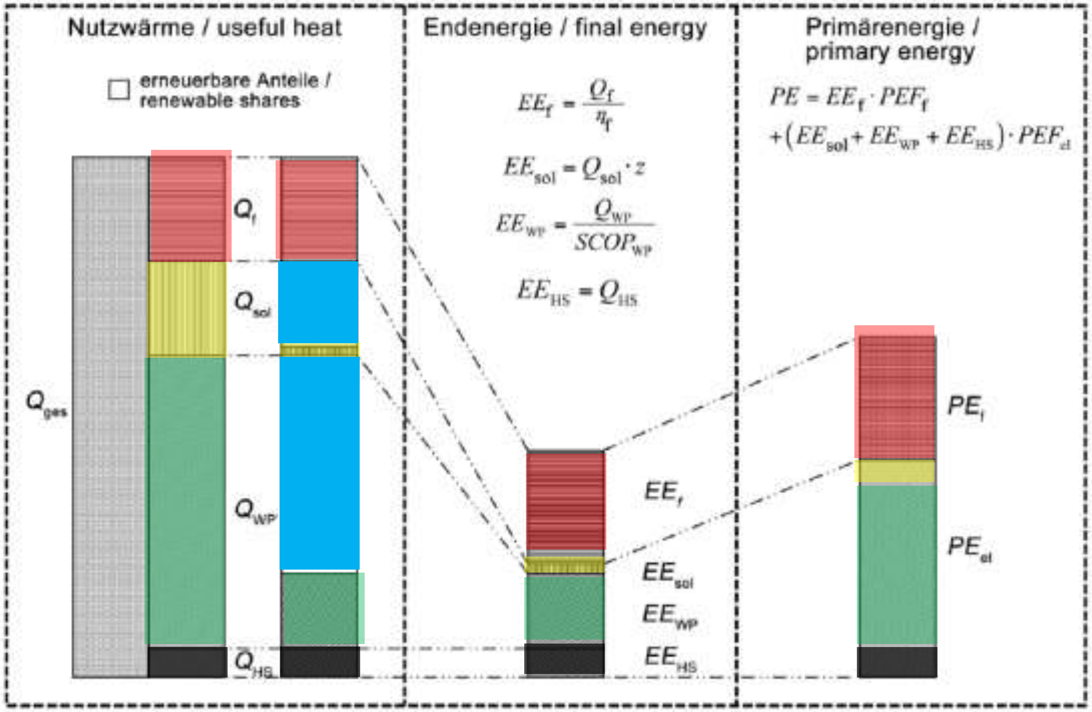
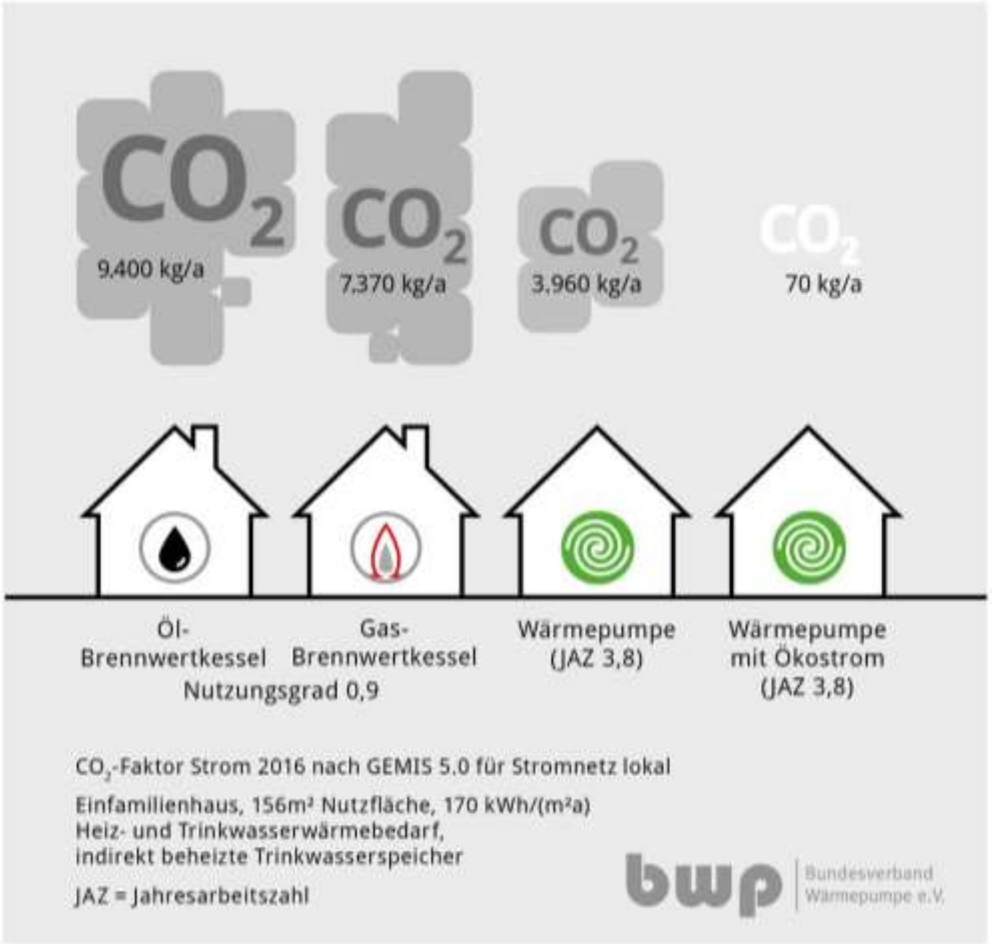


Bild 8. Berechnung der End- und Primärenergie einer bivalenten Wärmepumpenanlage mit mehreren Wärmeerzeugern (z = Stromverbrauch der Solarpumpe)

Figure 8. Calculation of the final energy and primary energy of a bivalent heat pump system with several heat generators (z = electrical power consumption of the solar pump)

Source: VDI 4650 Rework ETSuS UG

Heating Technologies CO2 – Emissions for renovation



CO_2-Faktor Strom 2016 nach GEMIS 5.0 für Stromnetz lokal

Einfamilienhaus, 156m² Nutzfläche, 170 kWh/(m²a)
Heiz- und Trinkwasserwärmebedarf,
indirekt beheizte Trinkwasserspeicher

JAZ = Jahresarbeitszahl

Heat Pumps vs. Boilers

Heat Pump

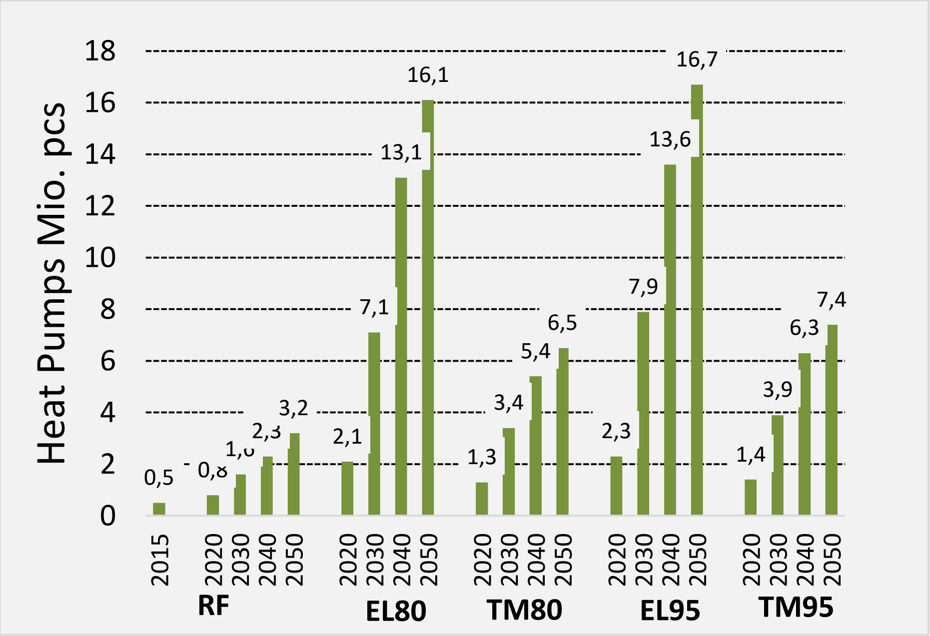
- Highest primary energy efficiency ++
- Best CO_2-Footprint ++
- Application temperature + 0
- Best RES fit
- DSM possible (Smart grids)
- Higher Up-front Cost –
- Running costs 0
- LCC ?

Boiler

- Lower primary energy efficiency +
- Worse CO_2-Footprint -
- Application temperature ++ -
- Low RES fit
- No fit for DSM
- Lower Up-front cost +
- Running cost 0
- LCC ?

Indirect emissions: climate change in DE, role of HPs

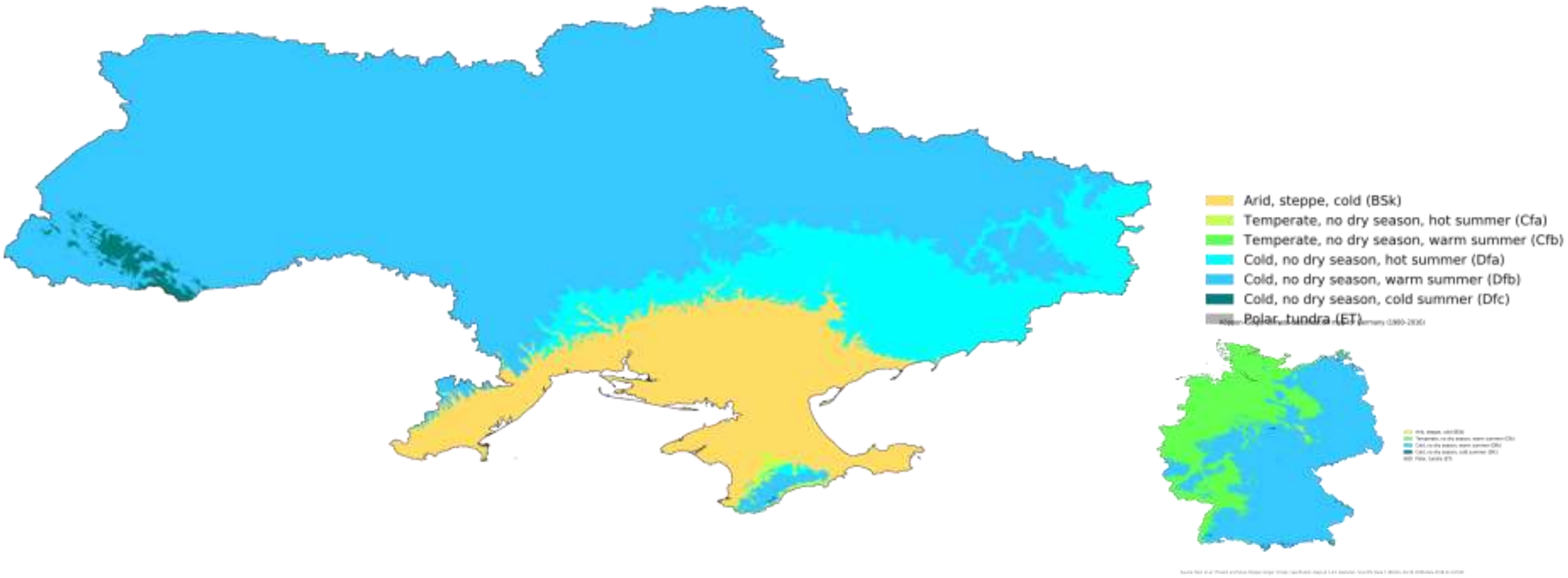
- Building envelope, installed technology und energy production
- 3 main scenarios
  - RF: „Reference“:
  - EL: „Electrification“: HP, Increase RES in E-Production
    - EL80
    - EL95
  - TM: „Technology Mix“: GHG-mitigation - RES Electricity, synthetic Bio-Fuels
    - TM80
    - TM95
  - EL und TM projection: significant increase of HP use



Source; dena geea Gebäudestudie, rework ETSuS UG

Climate Conditions for Heating (and cooling?)

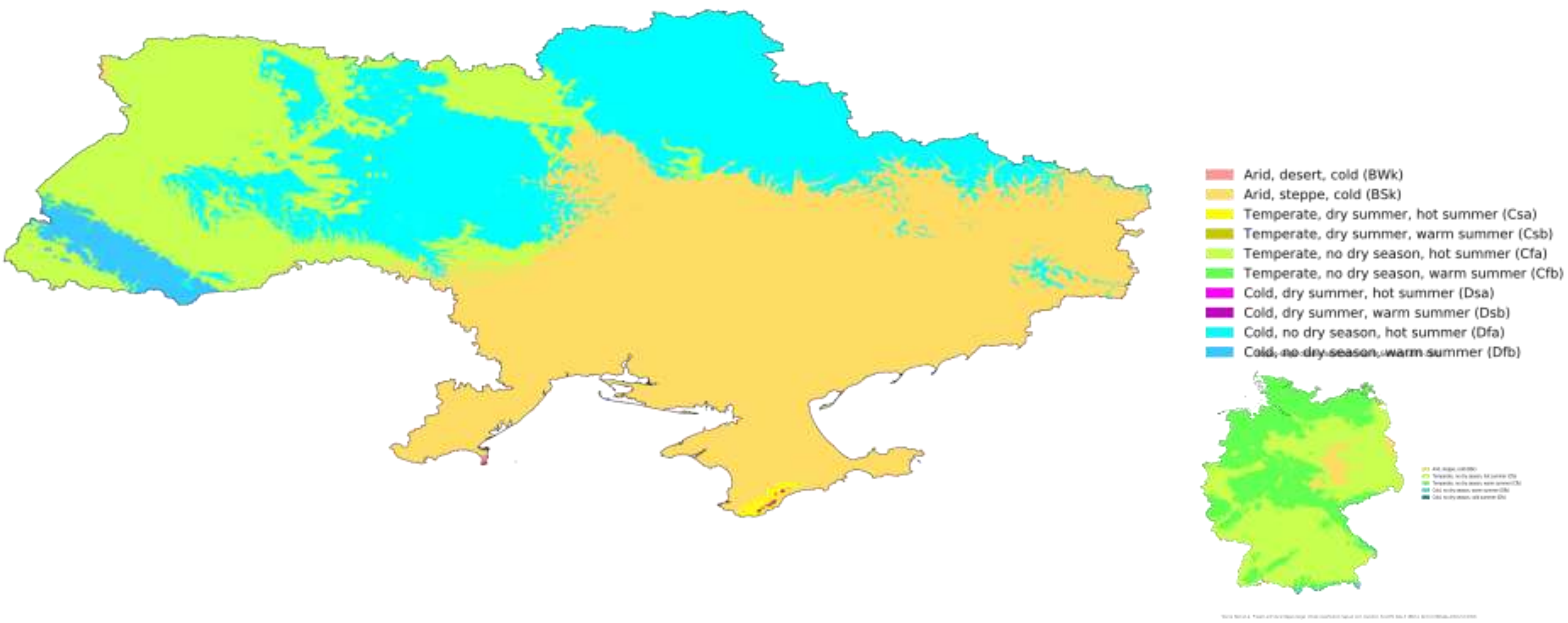
Köppen-Geiger climate classification map for Ukraine (1980-2016)



Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018)

Climate Conditions for Heating (and cooling?)

Köppen-Geiger climate classification map for Ukraine (2071-2100)



Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018)

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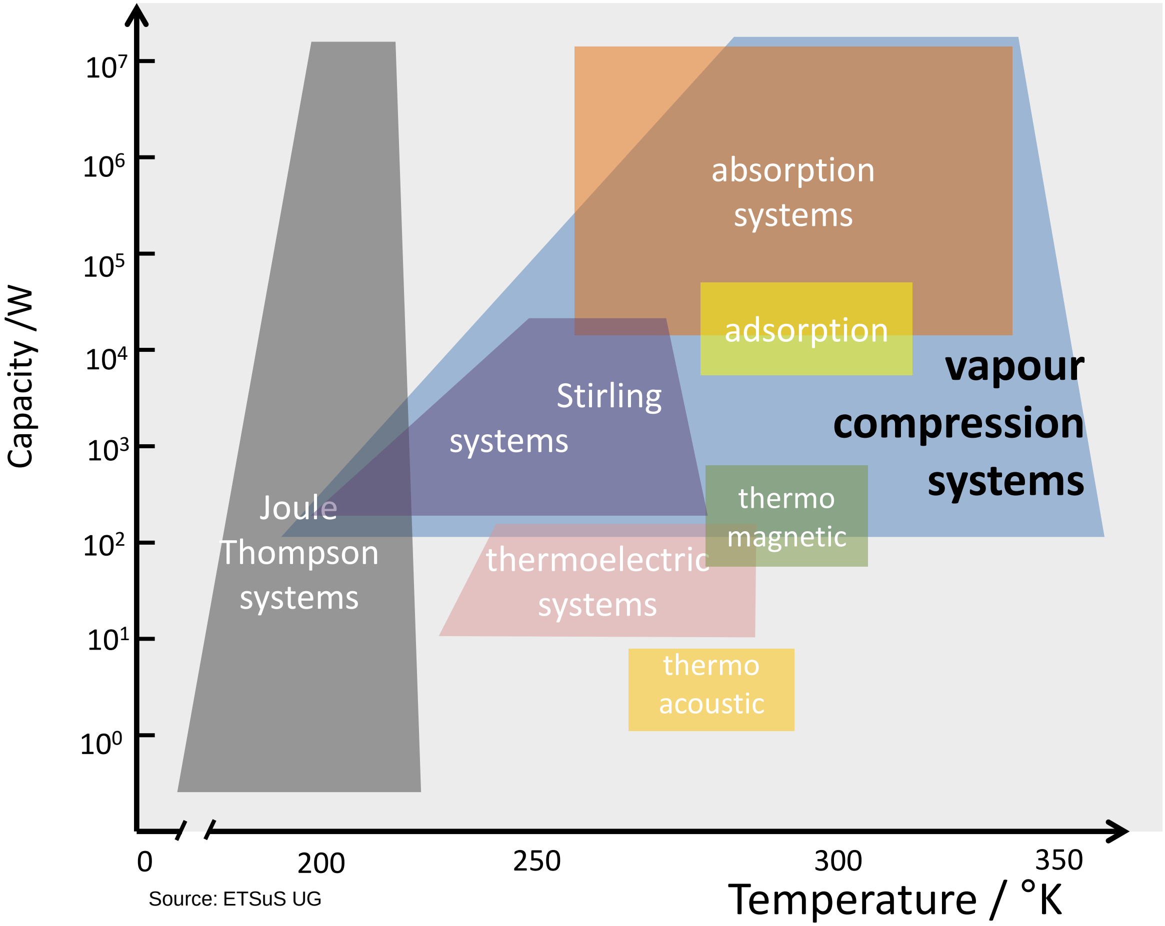
☞ Refrigeration outlook: Green cooling

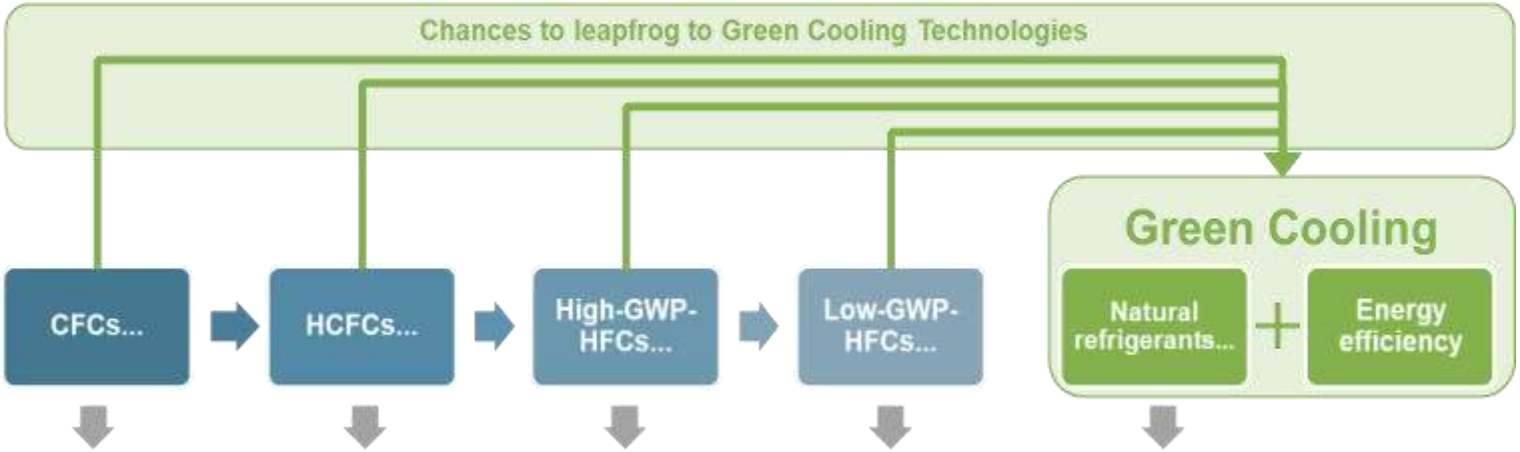
- Summary

Cooling Technologies – New working fluids



Source: ETSuS UG

Leapfrog to Green Technologies



CFCs...

... are ozone depleting and contribute to global warming

... deplete natural resources

... are phased out by the Montreal Protocol

HCFCs...

... were introduced as transitional substitutes for CFCs

... deplete natural resources

... are less ozone depleting but contribute to global warming

... are phased out by the Montreal Protocol

High-GWP-HFCs...

... were introduced as transitional substitutes for CFCs and HCFCs

... deplete natural resources

... contribute to global warming

... are controlled by climate regime and may be phased down by the Montreal Protocol

Low-GWP-HFCs...

... were developed as „climate-friendly“ alternatives

... deplete natural resources

... produce dangerous hydrogen fluoride when they burn and transform to trifluoro-acetic acid in the atmosphere

...are patented and manufactured by chemical industry and costly

Natural refrigerants... + Energy efficiency

... are naturally occuring substances that can be used as refrigerants in almost all RAC applications

... are typically more energy efficient than F-gases

... do not harm the environment

... can be handled safely with due care

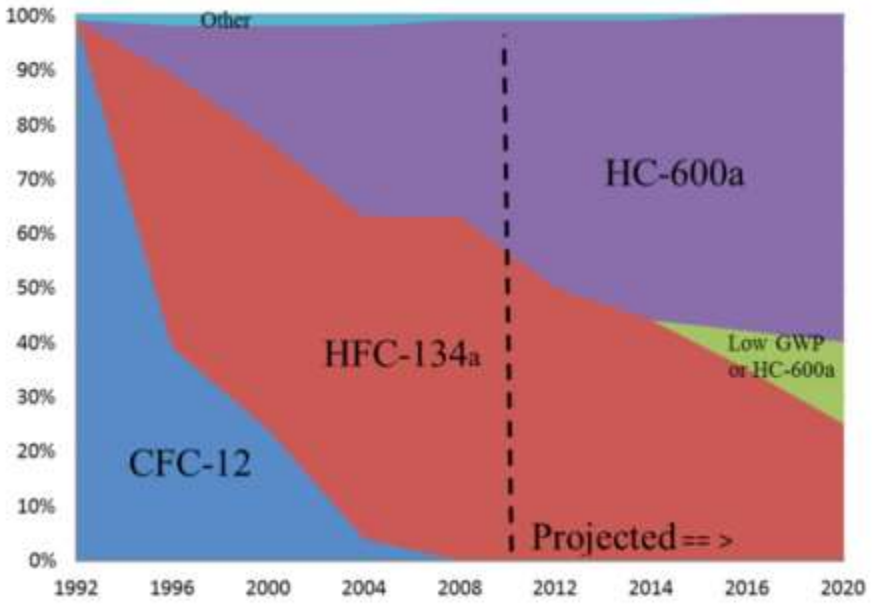
... are not patented by chemical industry and less costly than HFCs

Umwelt Bundesamt

HEAT

REFRIGERATING ASSOCIATION OF UKRAINE

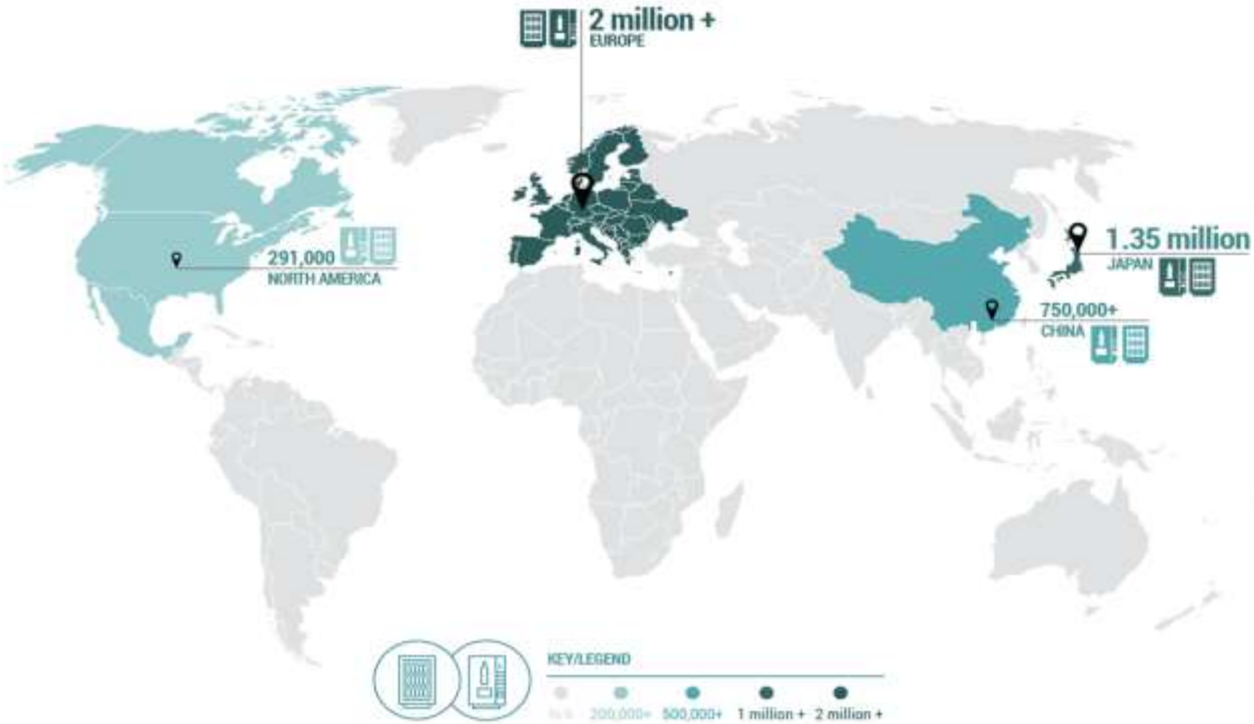
Domestic refrigeration: Hydrocarbon success story



- More than 700 million domestic refrigerators already use hydrocarbons today
- HC is the standard for 50% global production of new domestic refrigeration equipment
- By 2020, 75% of new production globally will use R600a/ R290

Light commercial HC

- self-contained water loop HC-based refrigeration systems are a clear trend
- used with leading retailers in DE ,UK - now also coming to North America, Asia and Australia
- 90% reduced refrigerant charge, better capacity than R404A and a fast break-even to recover invest.



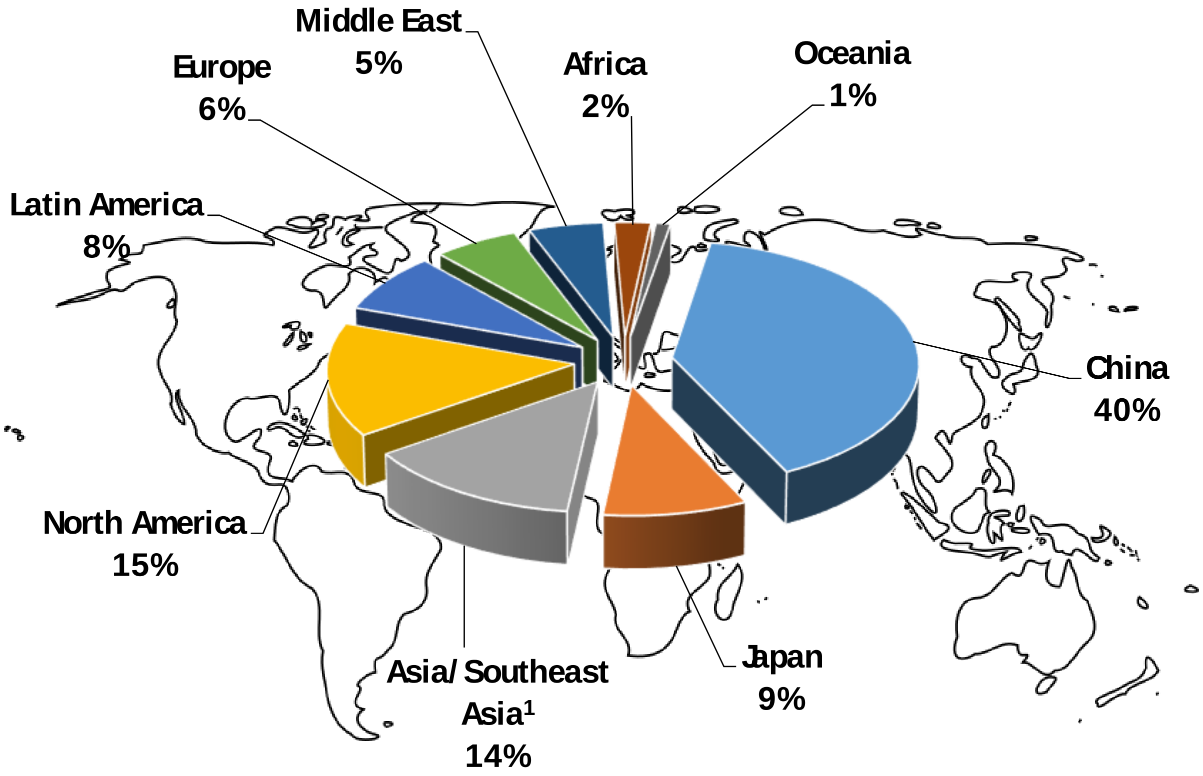
Commercial refrigeration: CO_2

CO_2 TC STORES GROWING GLOBALLY (FEB 2018)

shecco Base Webinar

sheccobase.com

Air Conditioning: Global 105 Mio/a, installed > 2 billion



~ 105m units

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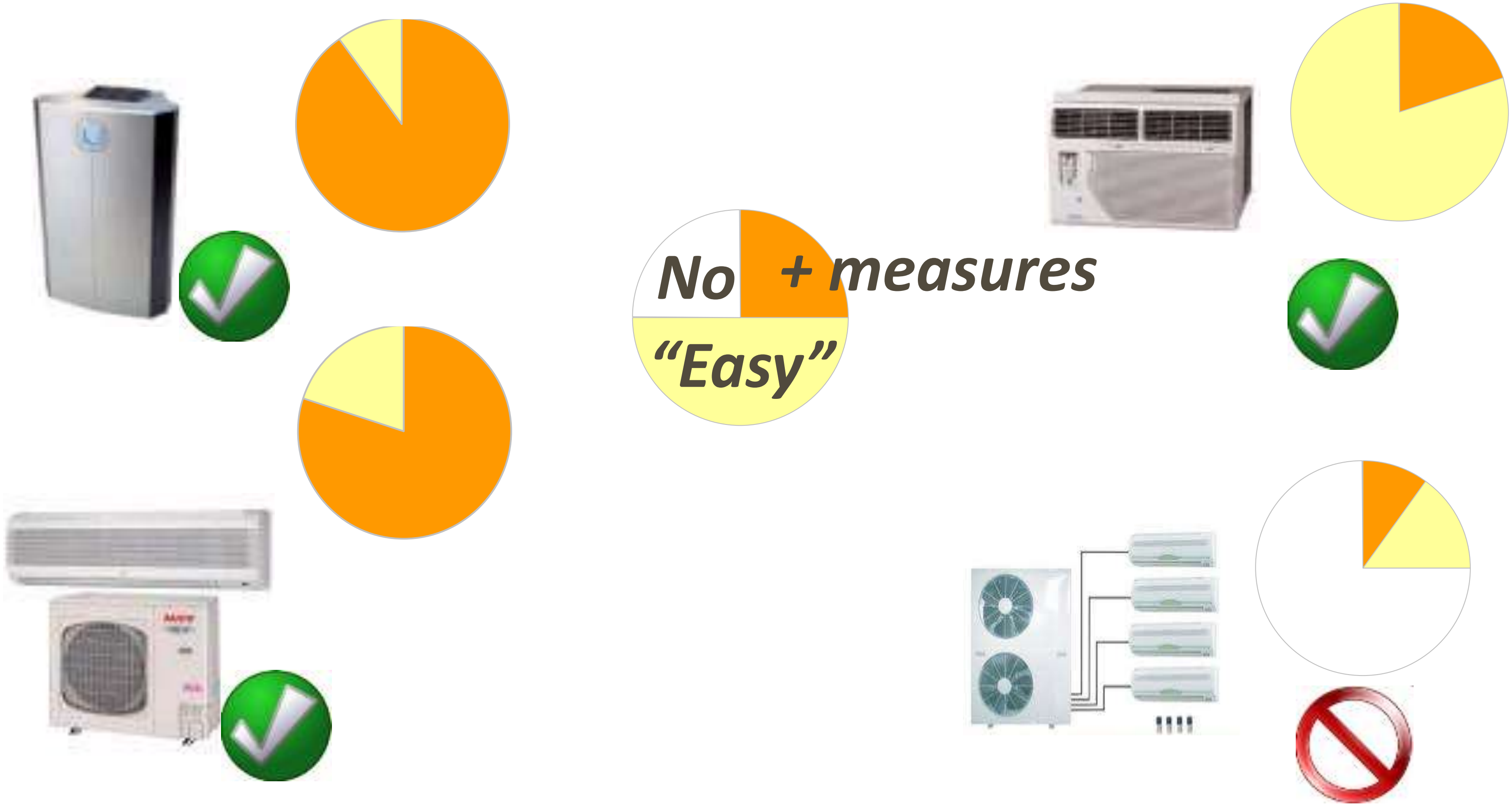
[1] excl. China and Japan

Sources: JRAIA, JARN, BSRIA (2015)

Viable application of HCs in air conditioners



No

+ measures

“Easy”

Environment Regulation - Alternative Technologies RAC&HP

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☞Summary

Summary- Outlook

Source By Public Domain, https://commons.wikimedia.org/w/index.php?curid=83798

Thank you for your attention !

Contact : regina.karakina@heat-international.de

www.heat-international.de

Twitter @HEAT_GmbH

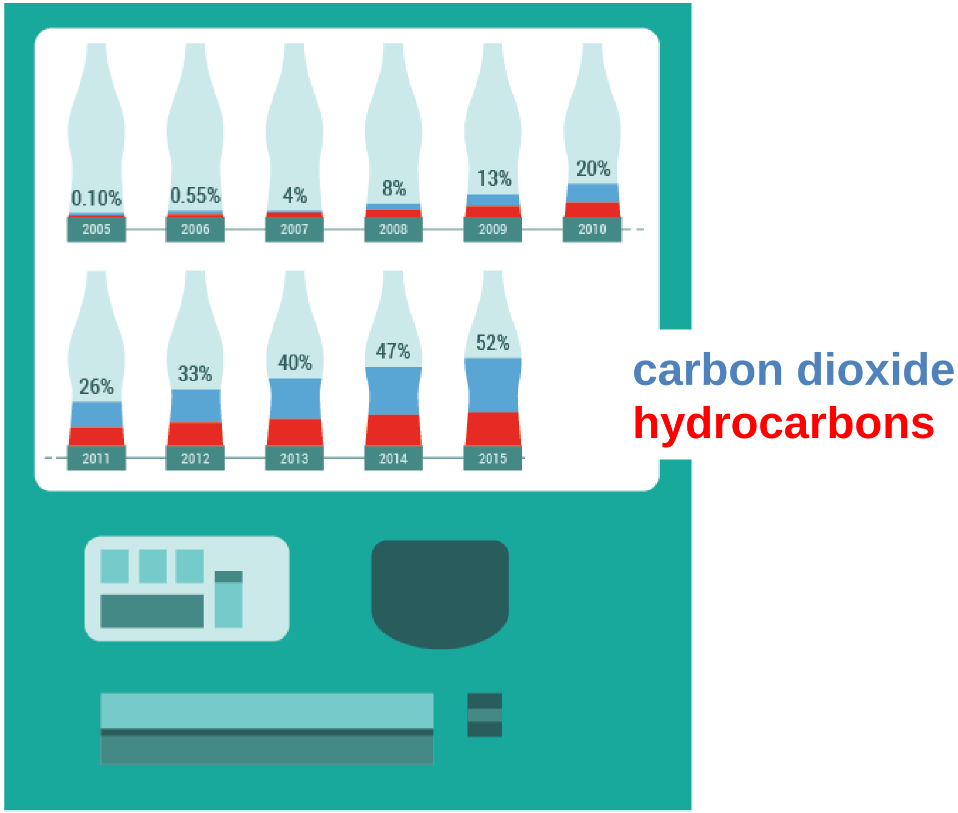
Summary LCC

	Boiler	New EE HP
Heating capacity (kW) (Tedsign at - -10 °C)	15	15
Unit price (USD)	1.000	8.000
Installation price (USD)	1.800	200
Maintenance cost (USD/year)	20	20
Total investment (USD)	**2.820**	**8.220**
SCOP		4
Total input power (kW)		
Energy consumption (kWh/year)	**27.409**	**6.781**
Annual electricity cost (USD)	**19**	**237**
Gas price (USD/year)	1.654	-
Total energy cost (USD/year)	1.674	237
LCC (USD)	**14.875**	**9.912**

Commercial: Supermarkets (plug-ins and centralised) Europe

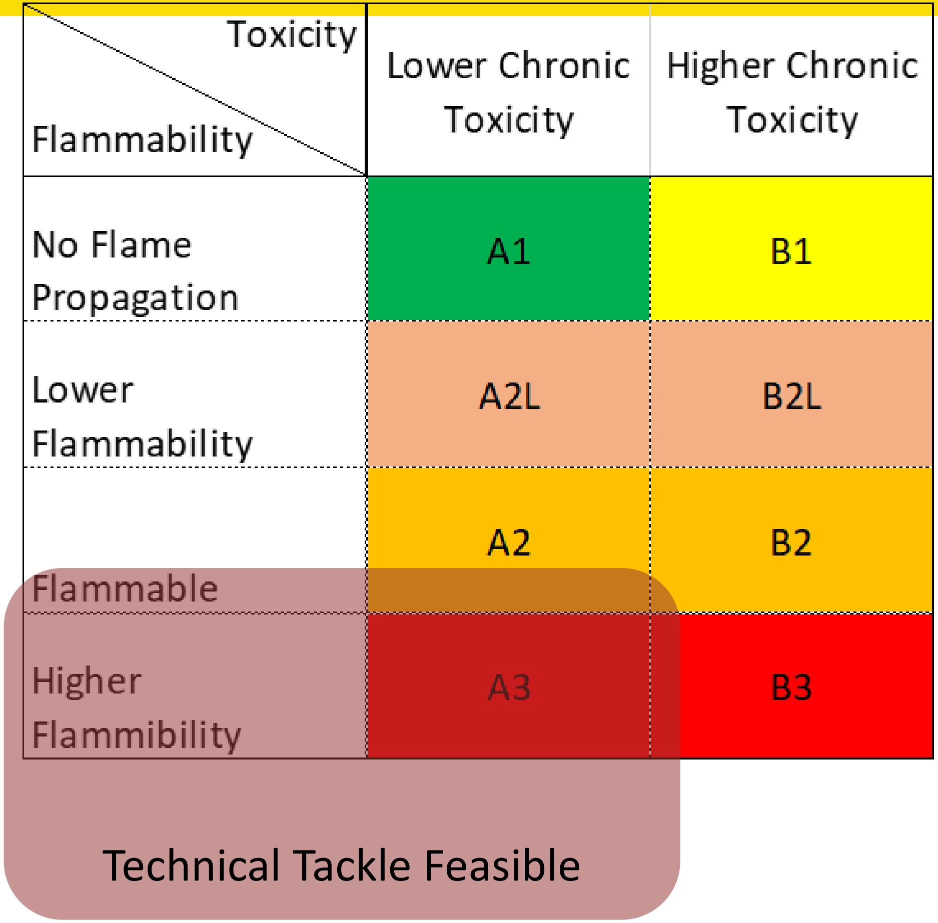
Source: Shecco, 2014

Light commercial in Japan



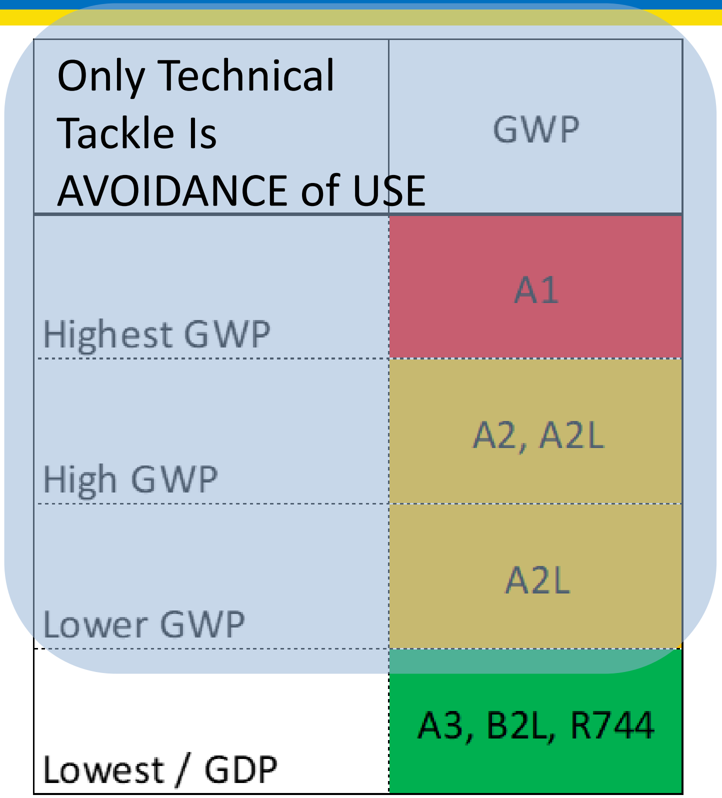
- 1.35 million beverage vending machines in Japan use either hydrocarbons or CO2
- natural refrigerants make up over 50% of the market
- from 0.1% to 52% market share in just 10 years ! = a clear Japanese success story

Safety vs. Enivonmental classification



Toxicity / Flammability	Lower Chronic Toxicity	Higher Chronic Toxicity
No Flame Propagation	A1	B1
Lower Flammability	A2L	B2L
Flammable	A2	B2
Higher Flammibility	A3	B3

Technical Tackle Feasible



Only Technical Tackle Is AVOIDANCE of USE	GWP
Highest GWP	A1
High GWP	A2, A2L
Lower GWP	A2L
Lowest / GDP	A3, B2L, R744

Relevant publications

Policy and market:

- GCI Market trends in selected refrigeration and air conditioning subsectors
- Promoting Food Security and Safety via Cold Chains
- RAC Inventory Vietnam
- RAC Inventory Philippines

Relevant publications

Technical:

- Good practices in refrigeration (primarily refrigerators)
- International Safety Standards in Air Conditioning, Refrigeration & Heat Pump
- Guidelines for the safe use of hydrocarbon refrigerants
- C4 resources guide for R290 Split Air Conditioners (as soon as published)
- Safe use of hydrocarbon refrigerants (focus on training, will be published)

Relevant publications

U4E publications:

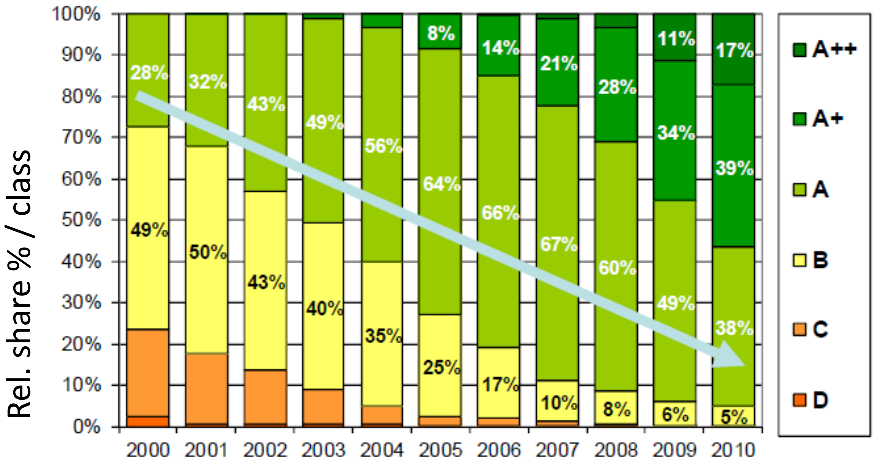
- Country assessment

https://united4efficiency.org/country-assessments/ukraine/

Labelling

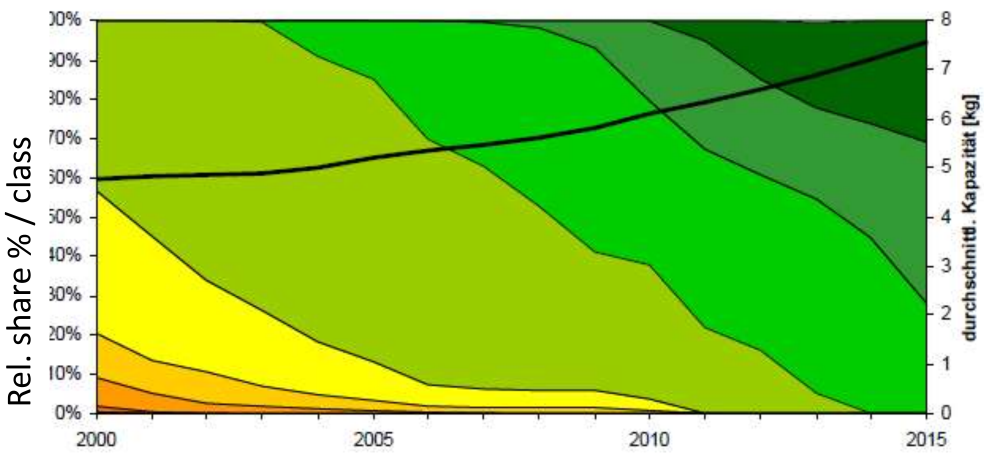
Effectiveness

Refrigerators DE



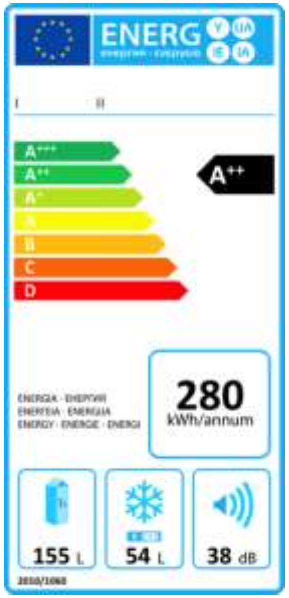
Sustainability?

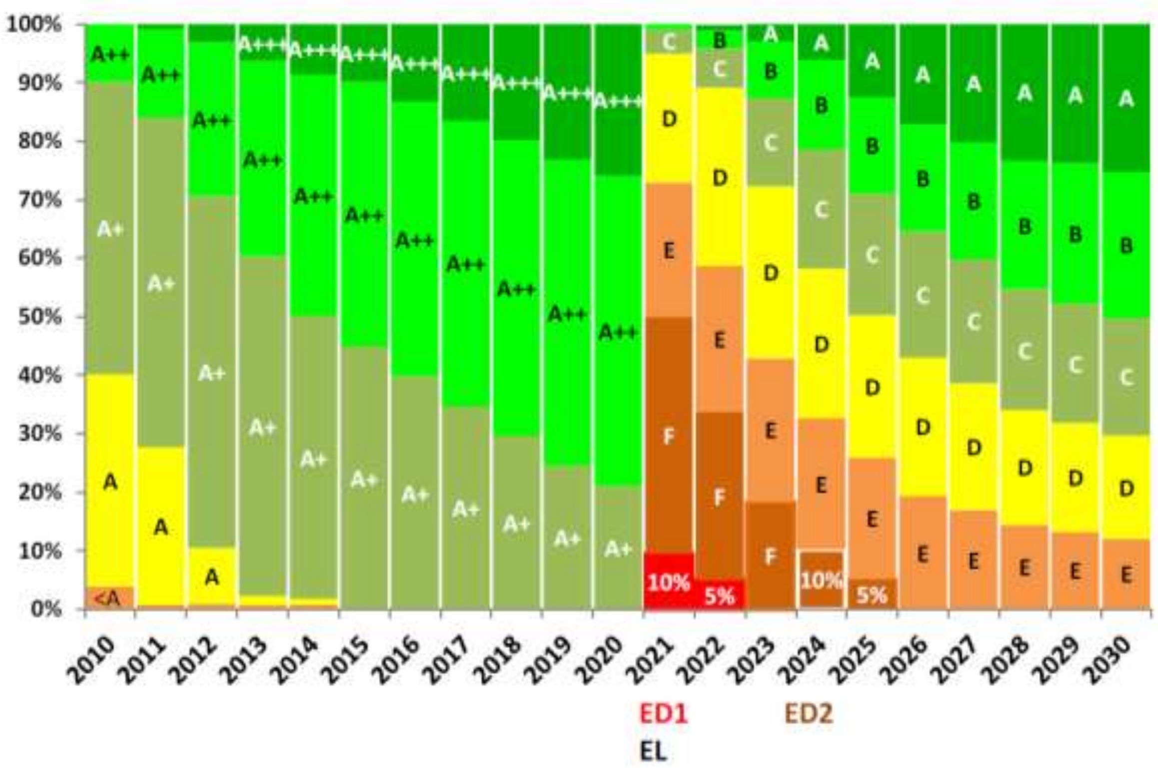
Washing machines DE

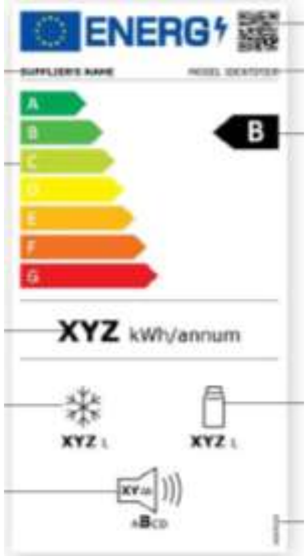


Source: B. Schäppi, EU-Prozess zur Entwicklung von Ecodesign-Standards und Labels – Aktueller Status, Chancen und Herausforderungen für den Zeitraum 2012-2014

MEPS & Labels: Rescaling – the new case in the EU

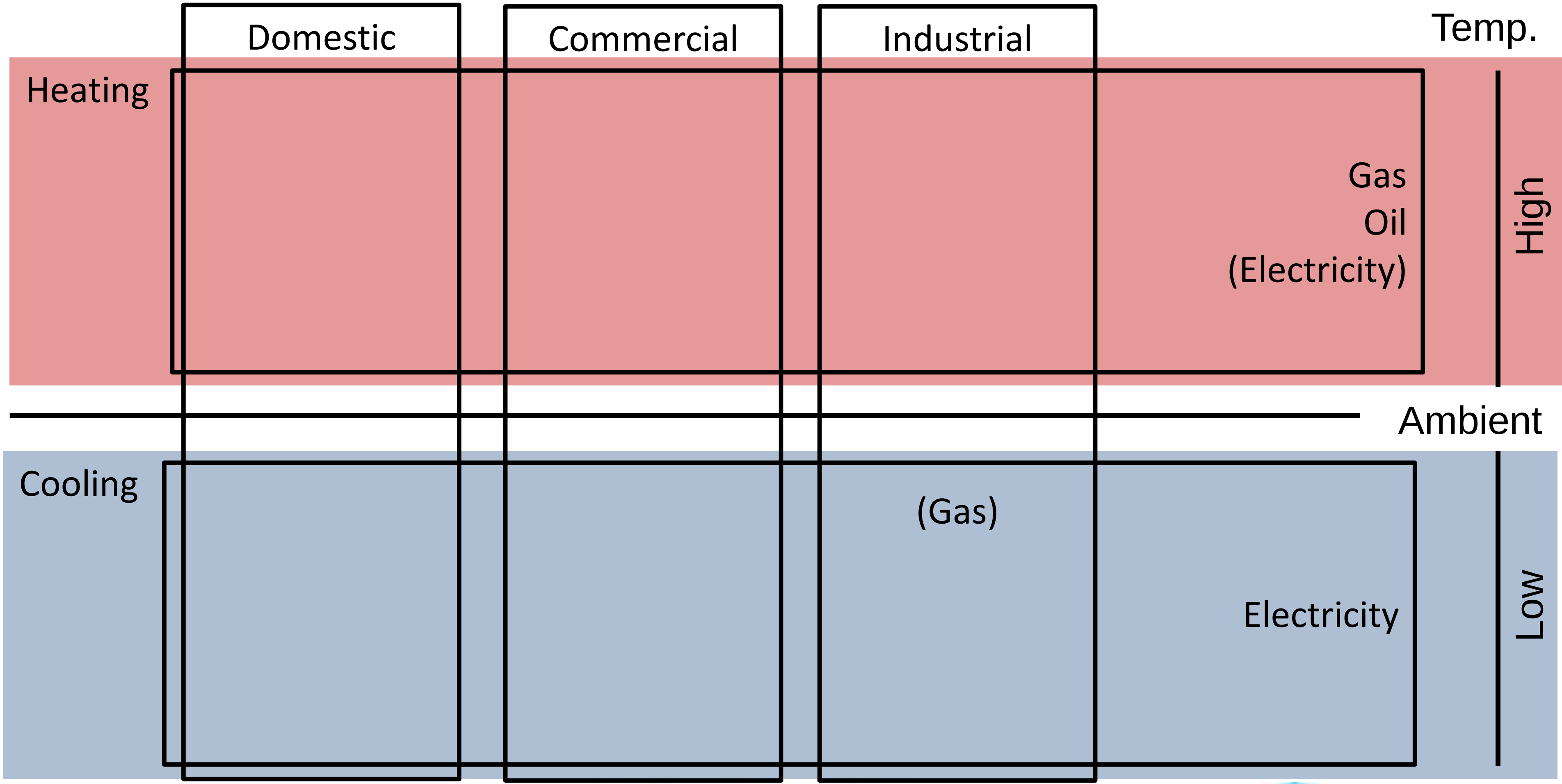






Fuente: Draft regulation

Heating and Cooling



Domestic

Commercial

Industrial

Temp.

Heating

Gas
Oil
(Electricity)

High

Ambient

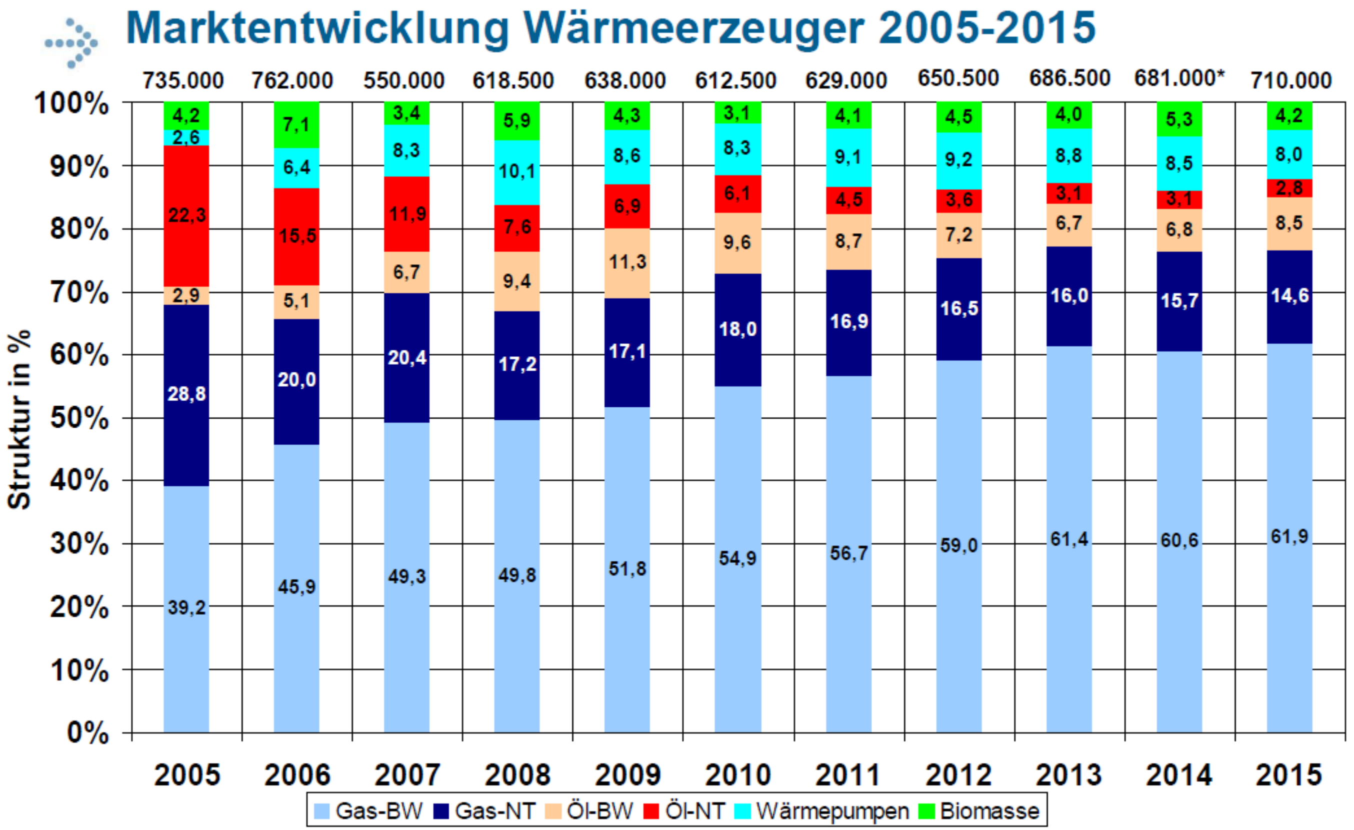
Cooling

(Gas)

Electricity

Low

Heating Generation by type DE



Marktentwicklung Wärmeerzeuger 2005-2015

BDH
Bundesverband der
Deutschen Heizungsindustrie

** Eine Erweiterung des Meldekreises in der Produktstatistik „Biomassekessel" im Jahr 2014 führte zu höheren Stückzahlen im Vergleich zum Vorjahr. Die prozentuale Entwicklung zum Vorjahr ist aber negativ.*

Umwelt Bundesamt

REFRIGERATING ASSOCIATION OF UKRAINE