6th EUSALP-action group meeting

Comparison of the building regulations and energy requirements in the Lake Constance region

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EUROPÄISCHE UNION
Europäischer Fonds für regionale Entwicklung
IBK Internationale Bodensee Konferenz

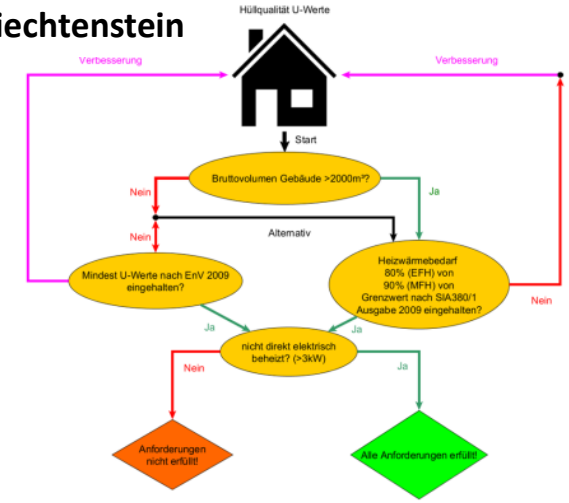
Problem

- ***Is it legally possible to put up a building in state* X with the same configuration that is legally possible in state Y?***
- The minimum requirements and energy standards of the building sector are not directly comparable in the states of the IBK, because of:
  - Different **evaluation criteria** (heating demand, PE, CO_2…)
  - Different levels of requirements and **limits**
  - Different **calculation methodologies** with different **input parameters**, for example:
    - Definition of the reference surface
    - System boundaries: heating, cooling, domestic hot water, auxiliary electricity, household electricity
    - Boundary conditions like thermal bridges, shading, occupancy rate, efficiencies
    - Conversion factors PE or CO_2,

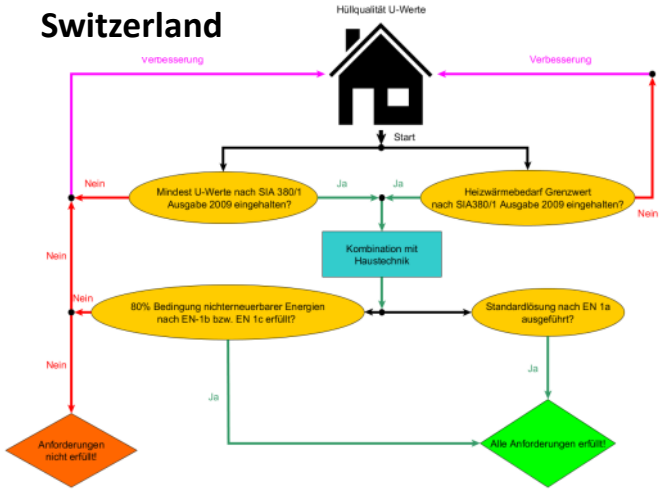
*The states considered in the study are the federal states and cantons of the IBK: Baden-Württemberg, Schaffhausen, Zürich, Thurgau, St.Gallen, Appenzell Ausserrhoden, Appenzell Innerrhoden, Fürstentum Liechtenstein, Vorarlberg and Bayern.

Verification procedures of the individual states (2017)

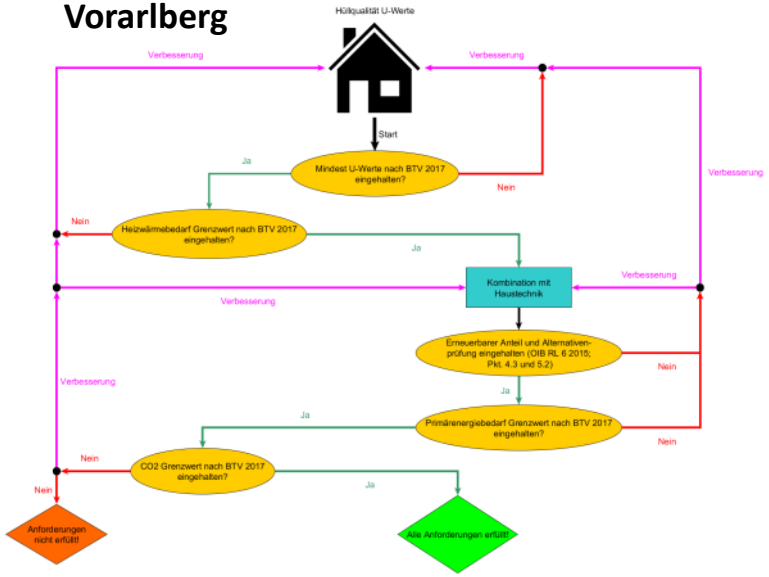
Liechtenstein



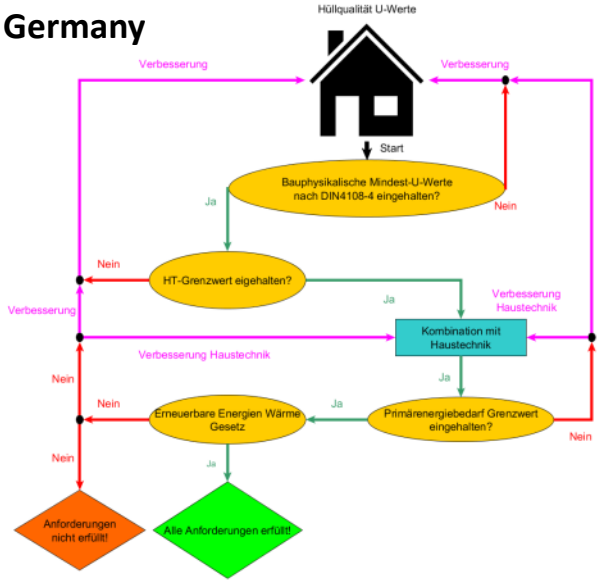
Switzerland



Vorarlberg



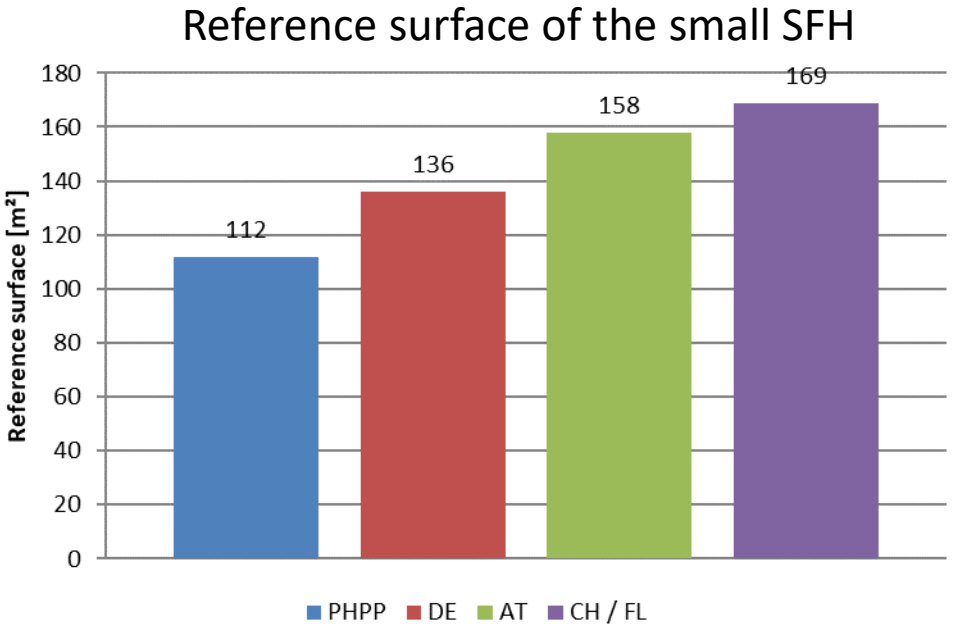
Germany



The verification procedures of the individual states vary greatly.

Difficulties in the comparability example 1: Definition of the reference surface

Are characteristic values, like the heating demand or final energy demand, not stated as absolute values but as specific values referred to the **reference surface**, a **difference of up to 50%** can be the result (example small single-family house)



e.g. absolute heating demand:	1,680 kWh/a
According to OIB (AT):	1,680/158 = 10.6 kWh/(m²a) (gross floor area)
According to PHPP:	1,680/112 = 15.0 kWh/(m²a) + 42% (net floor area)

Difficulties in the comparability example 2: Conversion- or weighting factors

- Austria: PE renewable and non-renewable as a sum
- Germany: PE only the renewable share
- Switzerland: national weighting factors of the EnDK (Konferenz Kantonaler Energiedirektoren) Verification with document EN-101b
- → remarkable differences, in particular with biomass

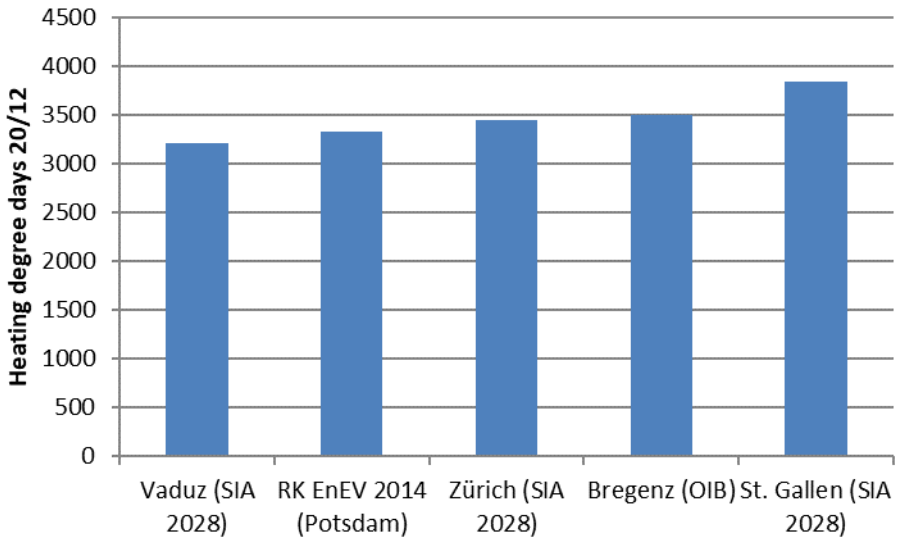
	Austria	Germany	Switzerland
	f PE (renewable + non-renewable)	f PE (non-renewable)	National weighting factors
Coal	1,46	1,1-1,2	1
Heating oil	1,23	1,1	1
Natural gas	1,17	1,1	1
Biomass	1,08	0,2	0,5
Electricity (purchase)	1,91	1,8	2
District heat from heat plant (renewable)	1,6	0,1	0,4-0,8
District heat from heat plant (non-renewable)	1,52	1,3	1
District heat from high efficient CHP	0,3-0,94	0-0,7	0,4-1,0
Waste heat	0,3-1	-	0,4-1,0
Sun, environmental heat, geothermal energy	-	0	0

Difficulties in the comparability example 3: Different climates / heating degree days

The climate data as an input parameter have a high impact on the result of the energy demand calculation. For the same building the heating energy demand is lower at a milder compared to a cooler climate. The locations of the states are:

- Germany: always Potsdam
- Vorarlberg: location of the building
- Switzerland: a reference location per canton
- Liechtenstein: Vaduz or Engelberg

Heating degree days (20/12) for different IBK-locations



According to the difficulties in the comparability: Use of standard buildings

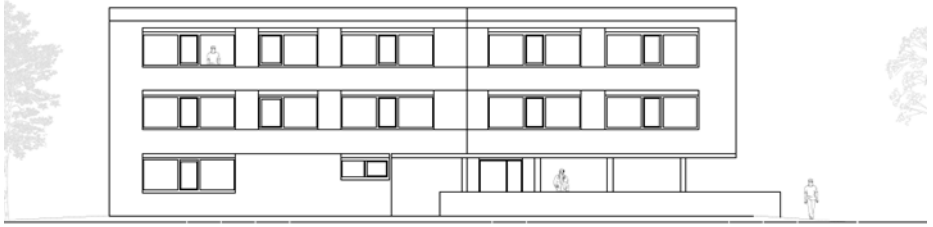
- Simple comparison of the requirements is not effective
- The comparison is made with **4 standard buildings**

Single family house (SFH) small

SFH typical

Multi family house (MFH) medium

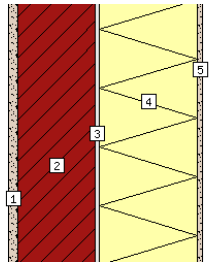
Office small



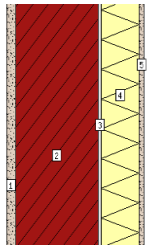
Approach / Search for limit

Question:
How can the requirements just be met?

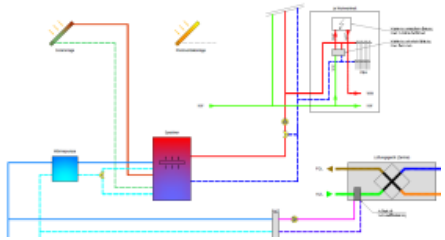
Standard building initial state

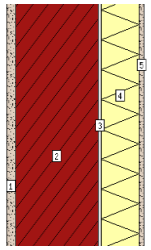


Deterioration of the average U-value

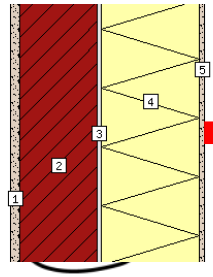


Variation of the buildings services





Improvement of the average U-value with different systems



Presentation with the average opaque U-value

- The **average opaque U-vale** considers all opaque components of the energy-relevant **building envelope** according to their proportion:
  - Base plate or **basement ceiling** (bottom connection)
  - **Exterior** walls or walls adjacent to unheated rooms (vertical connection)
  - **Roof** or top ceiling (upper connection)
- **Windows** and transparent components are **not considered** in the average opaque U-vale, but in the energy balance

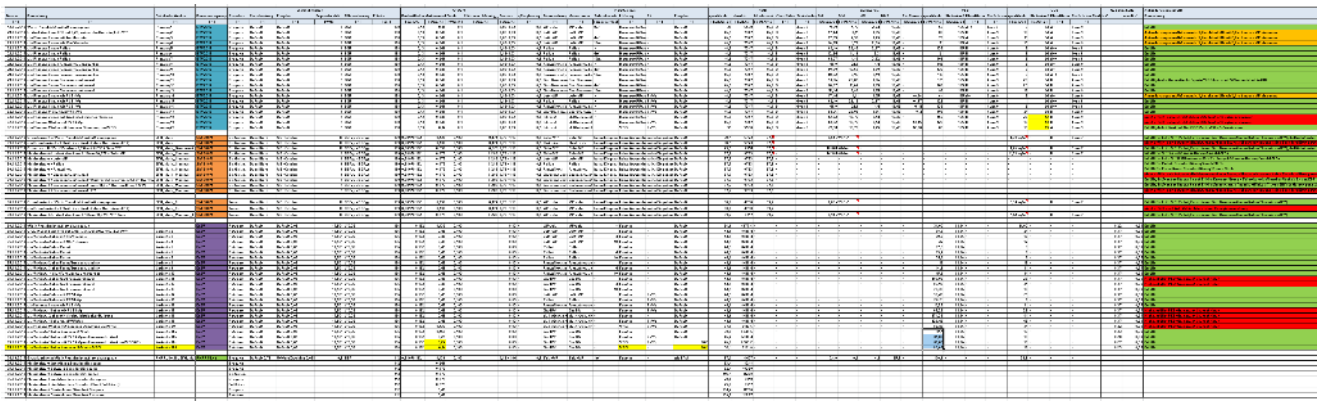
- ➔ The average opaque U-value is easier to understand than an average value with the windows

Analysed building services variants

- Heat producers/energy sources
  - Air-to-water heat pump (as the energetic worst heat pump variant)
  - Pellet boiler
  - District heat (largely from renewable sources)
  - Condensing gas boiler
- Solar collector
  - No solar collector
  - Small solar collector (SFH 4m², MFH 47m²)
  - Large solar collector (SFH 10m², MFH 115m²)
- PV system
  - No PV system
  - Available (SFH 5 kWp, MFH 35 kWp)

Framework conditions of the calculation

- For all standard buildings together more than **470** variants were calculated. The used software are:
  - Vorarlberg: GEQ
  - Switzerland and Liechtenstein: Lesosai
  - Germany: Hottgenroth
- **Default values** were used if possible. Inputs were made in compliance with the standard values if needed (e.g. heat bridges, shading).



Exemplary presentation of the results of a building

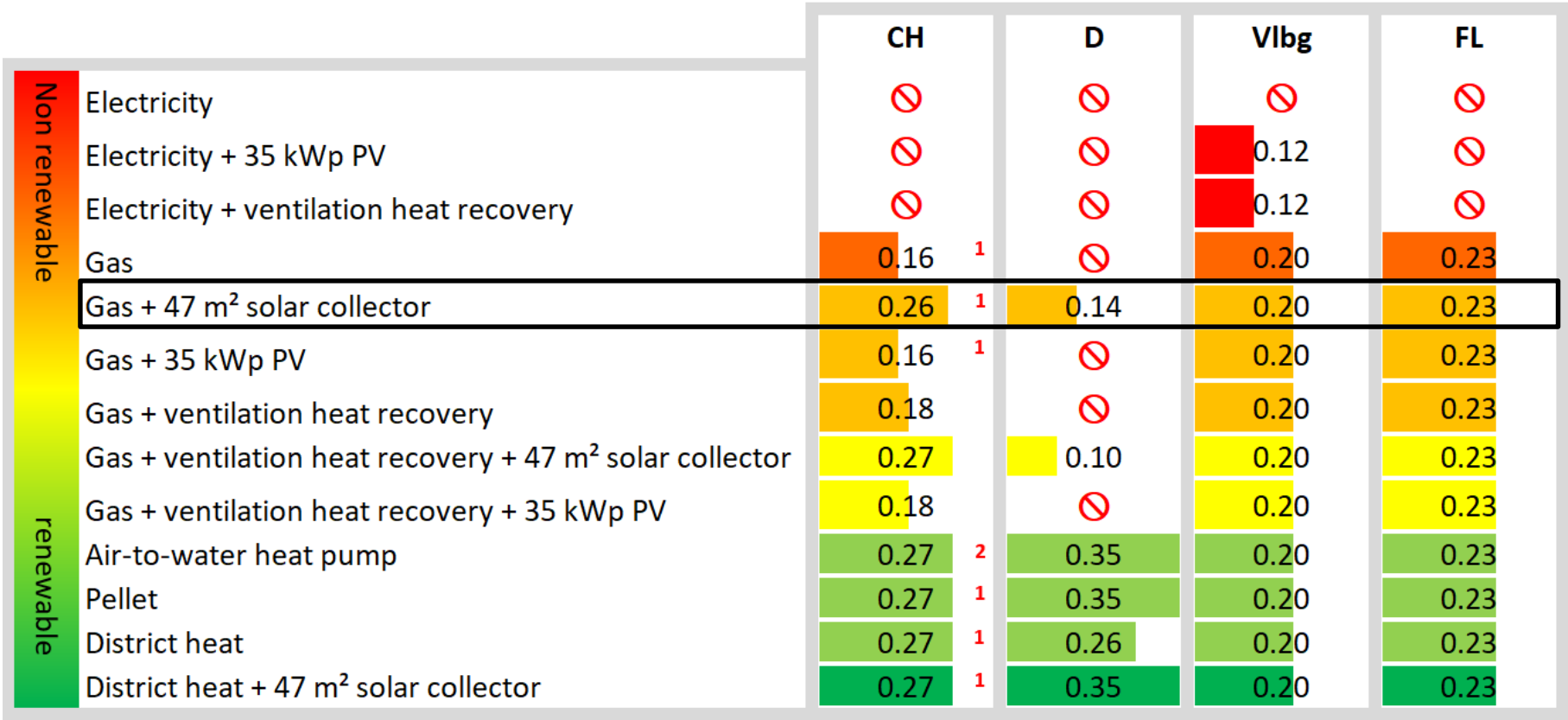
Analysis for the year 2017 and 2020

1. Comparison of the current policies and minimum requirements (2017) and calculation of the standard buildings.
2. Comparison of the planned policies and minimum requirements for the year 2020 and calculation of the standard buildings.
3. Direct comparison of the current and planned policies and minimum requirements.

Problem

- ***Is it legally possible to put up a building in state* X with the same configuration that is legally possible in state Y?***
- Yes, if…

Average U-value and building services variants MFH medium (2017): Reading example 1

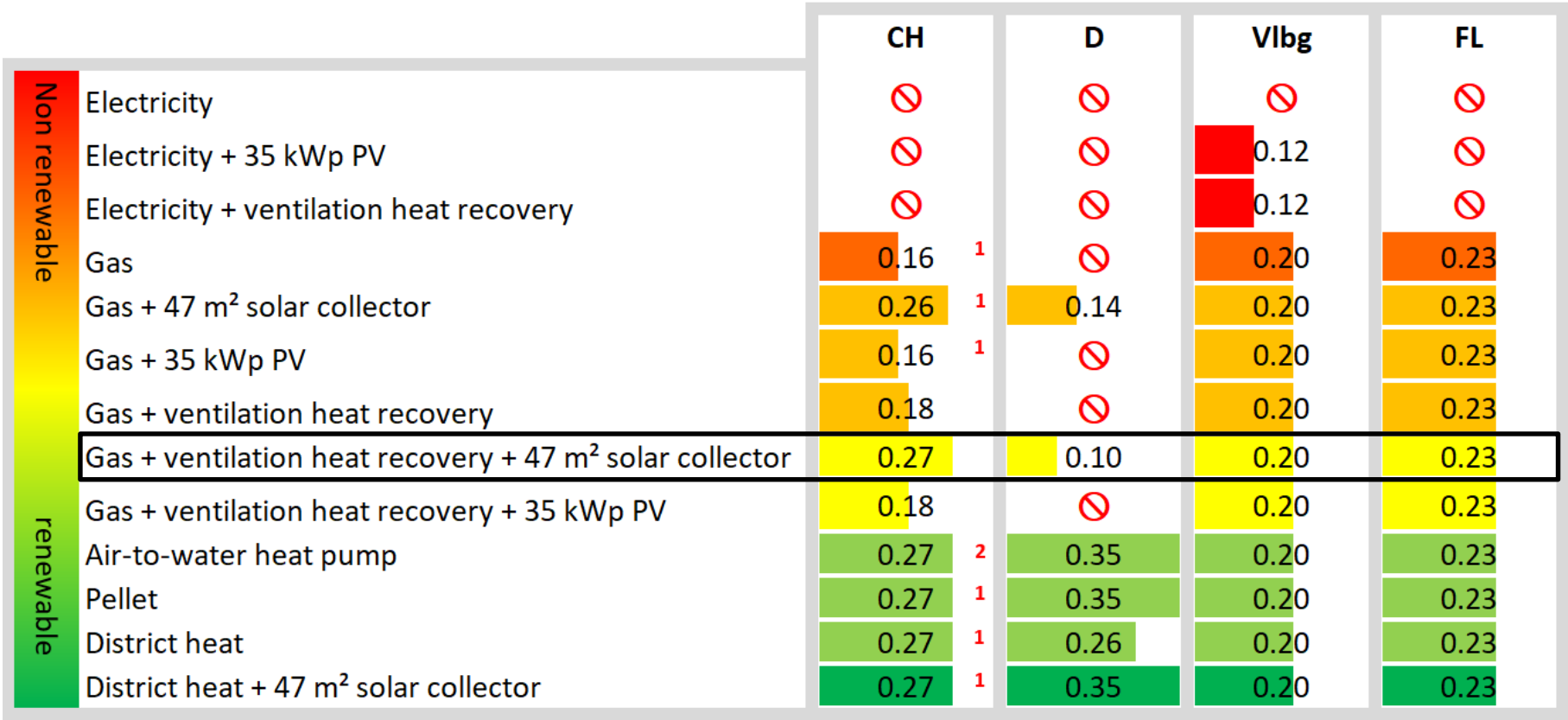


[1] only with window ventilation, if an exhaust air system is used a waste heat utilisation is compulsory → exhaust air heat pump

[2] window ventilation → air-to-water heat pump, exhaust air system → exhaust air heat pump

Cost optimum KliNaWo: 0.12

Average U-value and building services variants MFH medium (2017): Reading example 2

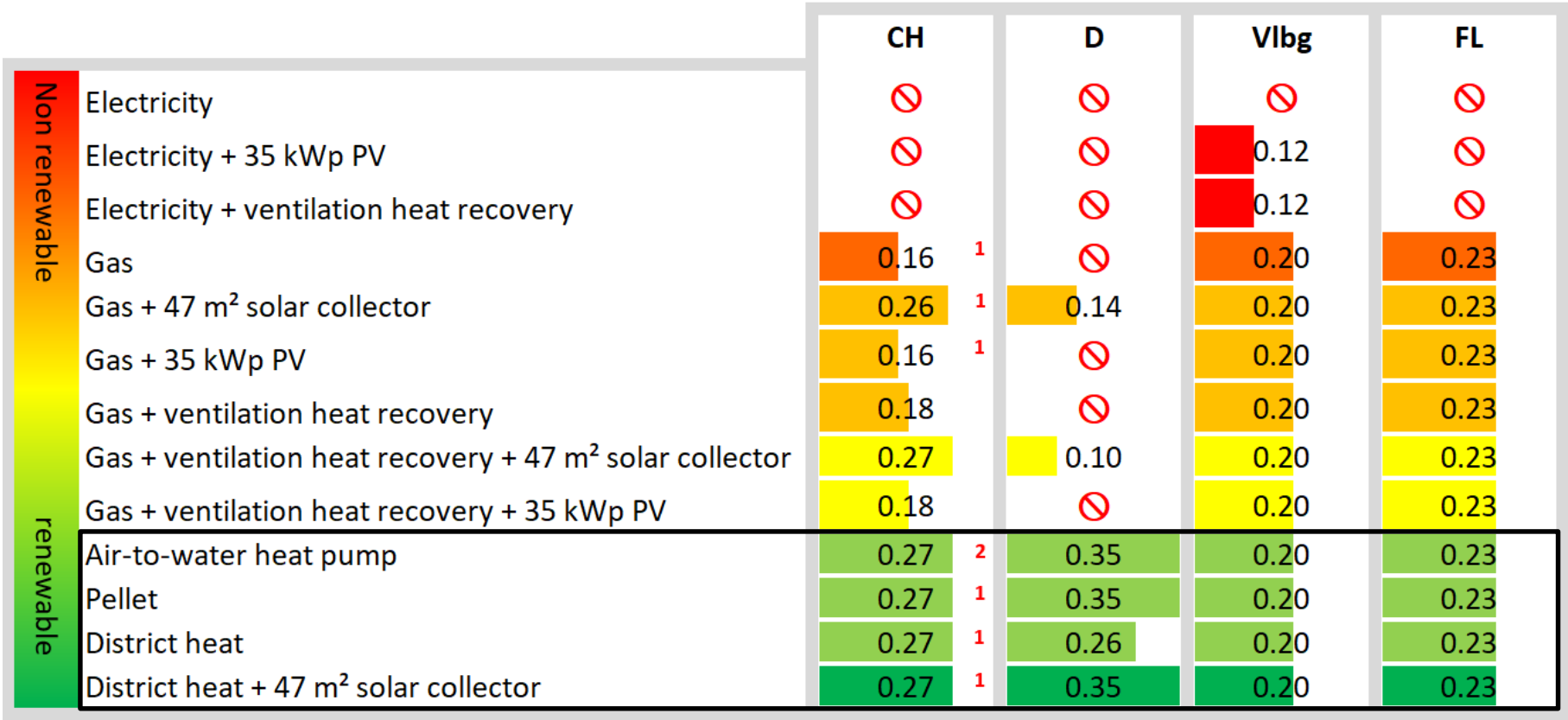


[1] only with window ventilation, if an exhaust air system is used a waste heat utilisation is compulsory → exhaust air heat pump

[2] window ventilation → air-to-water heat pump, exhaust air system → exhaust air heat pump

Cost optimum KliNaWo: 0.12

Average U-value and building services variants MFH medium (2017): Reading example 3



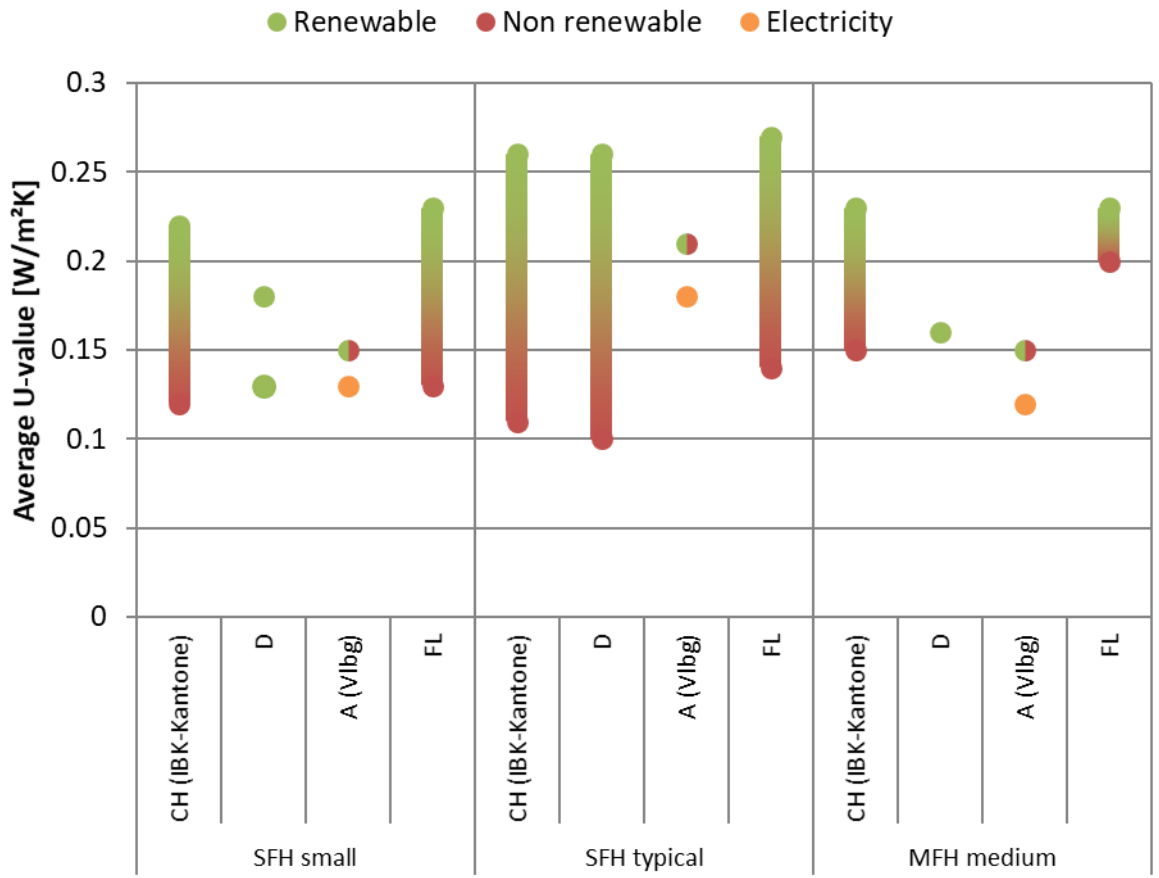
0.20

[1] only with window ventilation, if an exhaust air system is used a waste heat utilisation is compulsory → exhaust air heat pump

[2] window ventilation → air-to-water heat pump, exhaust air system → exhaust air heat pump

Cost optimum KliNaWo: 0.12

Maximum average U-value of all standard buildings (2017)



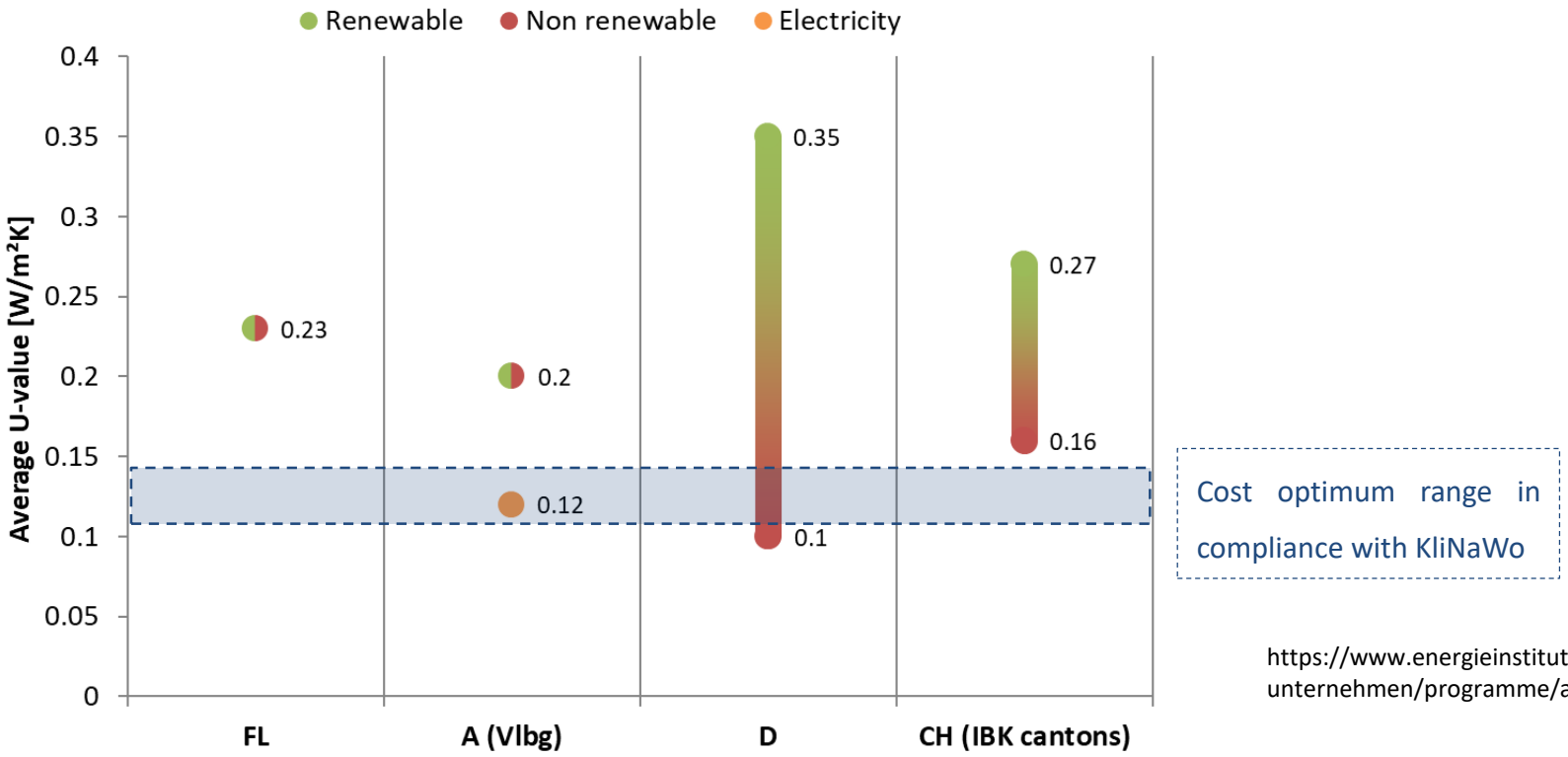
Summary:
Current minimum requirements (2017)

- **Quality of the thermal envelope** or requirements concerning the thermal envelope:
  - If **non-renewable** energy sources are used, mostly **stricter requirements** concerning the thermal envelope are the result, except in Liechtenstein and with some reservations in Vorarlberg.
  - Germany: very large range of the quality of the thermal envelope, especially the requirements for natural gas are very strict.
  - Vorarlberg and Liechtenstein: On average the strictest requirements for the quality of the thermal envelope, except for natural gas.

Summary:
Current minimum requirements (2017)

- Heat producers/energy sources/building services:
  - In Germany **natural gas** without an additional solution is not possible. In the other states it is possible, but in Switzerland the quality of the thermal envelope has to be improved.
  - **Electrical** heating systems are permitted as a main heating system only in Vorarlberg, but only if the total CO_2-emissions are not higher than 13 kg/(m²a) → very efficient thermal envelope in combination with a PV system necessary.
  - Liechtenstein: at the moment no differentiation of the building services and energy sources (only electrical heating systems > 3 kW).
  - PV systems are considered in Vorarlberg and Germany. No consideration in Switzerland and Liechtenstein.
  - Ventilation with heat recovery is considered in the calculation of PE and CO_2 in Vorarlberg and Germany. In Switzerland it is considered in the standard solutions and the 80/20 rule. No consideration in Liechtenstein.

Cost optimum solution according to the project KliNaWo from Vorarlberg



https://www.energieinstitut.at/unternehmen/programme/alps-klinawo/

In this study **no** feasibility studies were made, which could used to determine the cost optimum of each state. The results of the research project of Vorarlberg are presented here only as an **information** and to have a comparison to the minimum requirements of the states. The **cost optimum** will **vary** from **state to state** due to different energy prices and construction costs.

Minimum requirements vs. built average quality

- The **built average quality** is mostly higher than the minimum requirements due to:
  - **Subsidies** as an incentive for a higher quality
  - Builders and developers are motivated to implement a higher quality, e.g. Minergie P or passive house standard
  - The state of the art (products available on the market) has a higher quality than the minimum requirements
  - Planners consider reserves as experience shows

➔ **The results only represent the minimum requirements of the standard buildings in each state.**

Average U-value and building services: Office building (2017)

- The requirements concerning the thermal envelope of the office building are less strict in Switzerland, Vorarlberg, Liechtenstein and Germany compared to the MFH medium, which has a similar compactness.

	CH	D	Vlbg	FL
Gas + window ventilation	0.20	⊘	0.21	0.34
Gas + exhaust air system + PV	⊘[1]	⊘[5]	0.27	0.34
Gas + ventilation heat recovery	0.23[2]	⊘[4+5]	0.27	0.34
Geothermal heat pump + ventilation heat recovery	0.38	0.24[3]	0.27	0.34
District heat + ventilation heat recovery	0.38	0.28[3]	0.27	0.34

[1] if an exhaust air system is used a waste heat utilisation is compulsory → exhaust air heat pump with an average U-value of 0.38

[2] improved ventilation system (target value SIA 380/4), otherwise like the variant Gas + window ventilation

[3] only in combination with the best lighting default values possible

[4] only in combination with a PV system possible

[5] this building services variants are realised in real office buildings in compliance with the minimum requirements. The minimum requirements could not be met only with this standard office building.

Planned requirements for the year 2020

- Depending on the state, the following points apply for the year 2020:
  - The requirements are not (exactly) defined yet
  - The requirements are not politically decided or implemented yet
  - The calculation methods are not implemented yet in the programs
  - The boundary conditions (e.g. conversion factors) are not known yet

➔The results of 2020 are subject to considerable uncertainties compared to the results of 2017. Therefore they should only be used as an assessment of the probable trend.

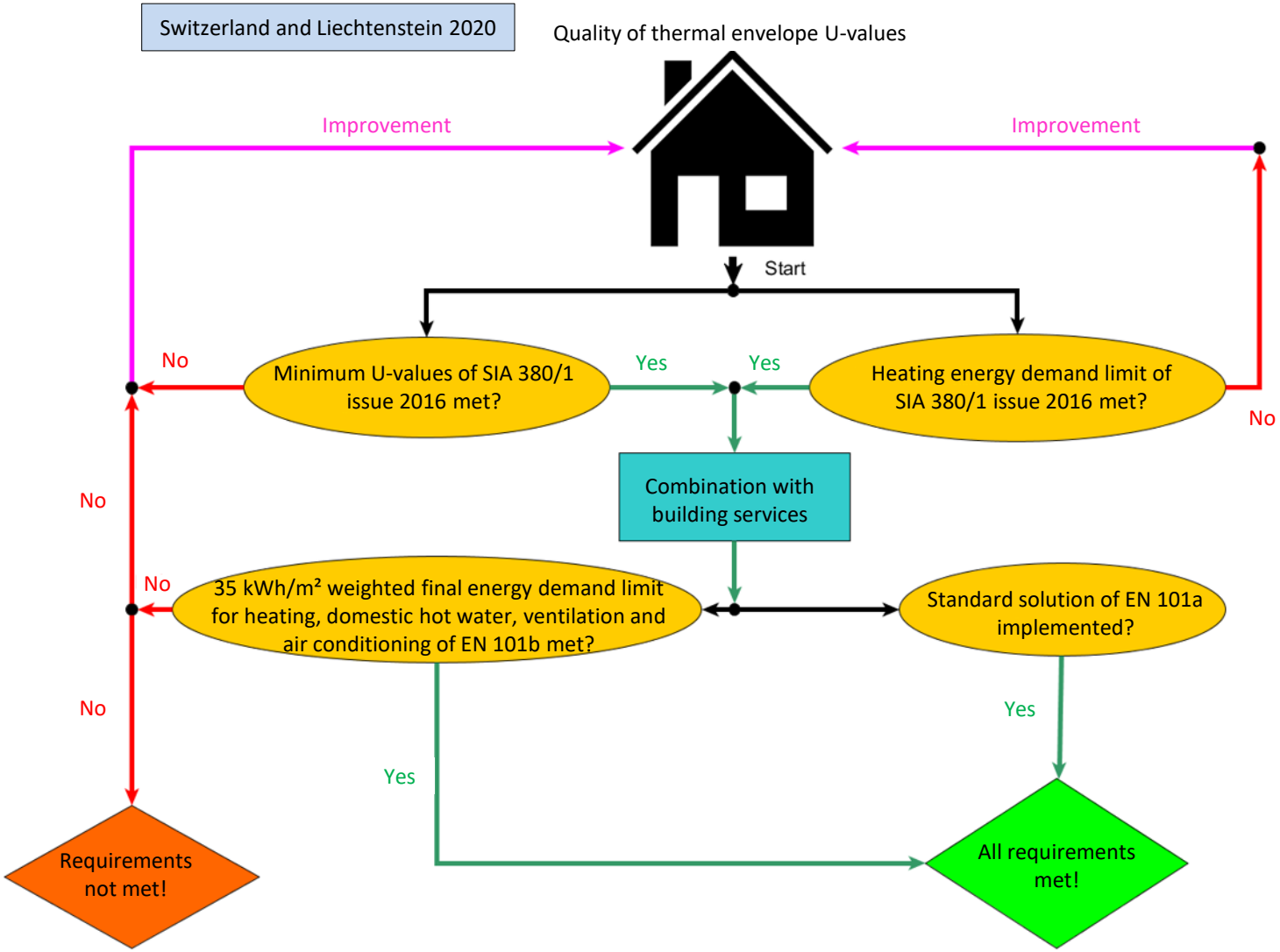
Limits 2020 Switzerland and Liechtenstein

- Planned implementation of the MuKEn 2014
- Requirements for the thermal envelope quality according to SIA 380/1 issue 2016
- Limits for the weighted final energy demand for heating, domestic hot water, ventilation and air conditioning
  - Residential building: 35 kWh/m²
  - Office building: 40 kWh/m²

➔ The MuKEn 2014 is applied in Switzerland and Liechtenstein for the calculation of the minimum required quality of the standard buildings in 2020.*

(*Coordinated with the project management at the meeting held on 5.10.2017)

Verification procedures of Switzerland and Liechtenstein (2020)



Limits 2020 Germany

- A completed draft law is available (GEG – “Gebäude-Energie-Gesetz”), which combines the EnEG (“Energieeinspargesetz”), the EnEV (“Energieeinsparverordnung”) and the EEWärmeG (“Erneuerbare Energien-Wärme-Gesetz”).
- The draft is not adopted yet.
- The suggested calculation method complies with the German standard DIN V 18599, which is only applicable for non-residential buildings at the moment and is planned to be adapted for residential buildings.

➔ The calculation of the minimum required quality of the standard buildings in 2020 using this method is not possible yet. Therefore, the current calculation method in combination with the KFW 55 standard (quality standard for subsidies in Germany) is used, which represents approximately the planned minimum requirements for 2020.*

(* Coordinated with the project management at the meeting held on 5.10.2017)

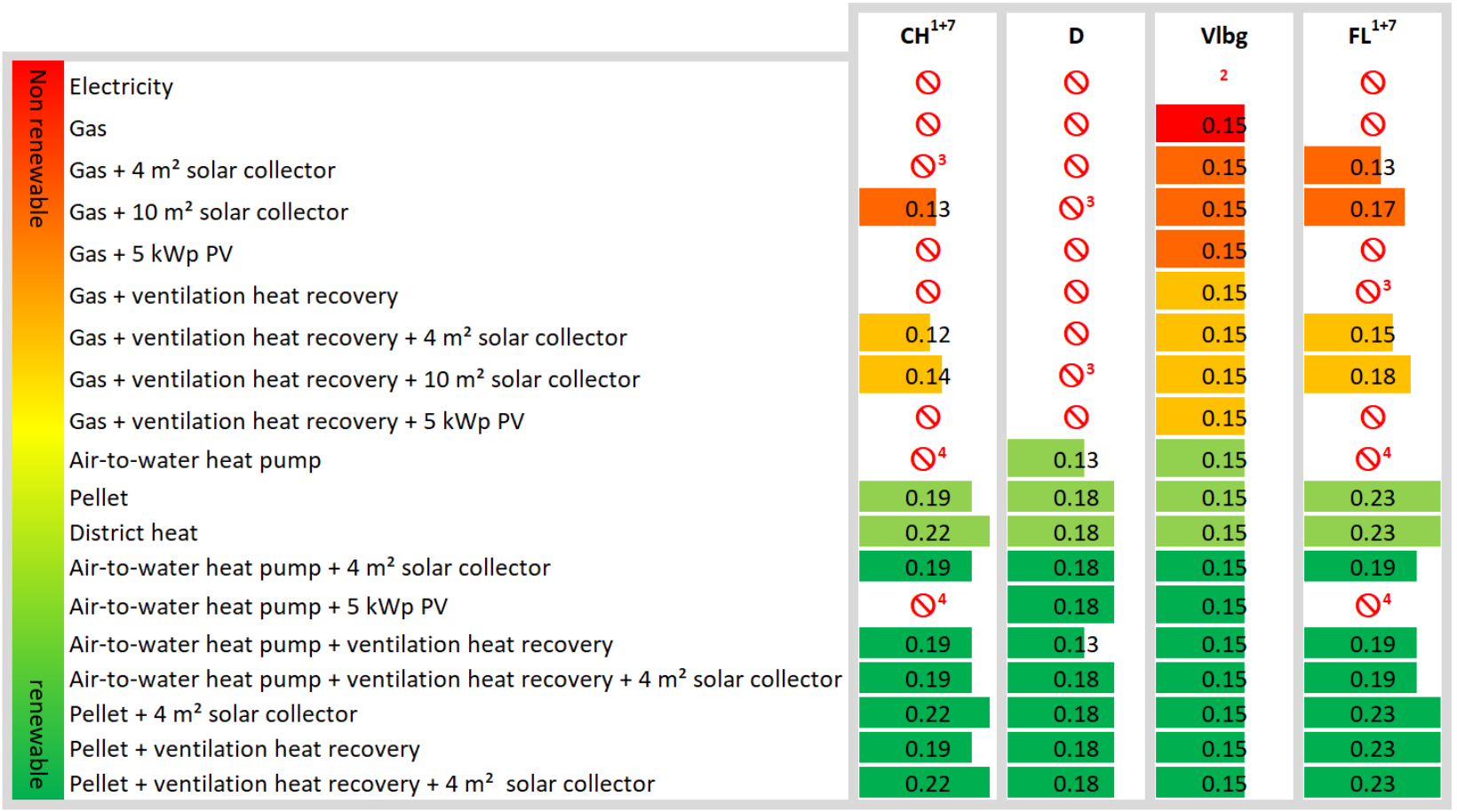
Limits 2020 Vorarlberg

- In Austria there is a valid national plan, which determines limits for 2020.
- At the time when the study was made the original plan form 2014 was under revision, because the calculation method of the heating energy demand has changed. Back then no information on the adapted version was available.
- The new version of the national plan is available since February 2018, but couldn't be taken into account for this study.

➔ The calculation of the minimum required quality of the standard buildings in 2020 is made with the 12 line for the heating energy demand (requirement function depending on the compactness of the building) and the PE and CO_2 limits of the national plan from 2014.*

(* Coordinated with the project management at the meeting held on 5.10.2017)

Average U-values and building services variants SFH small (2020)



	CH[1+7]	D	Vlbg	FL[1+7]
Electricity	⊘	⊘	[2]	⊘
Gas	⊘	⊘	0.15	⊘
Gas + 4 m² solar collector	⊘[3]	⊘	0.15	0.13
Gas + 10 m² solar collector	0.13	⊘[3]	0.15	0.17
Gas + 5 kWp PV	⊘	⊘	0.15	⊘
Gas + ventilation heat recovery	⊘	⊘	0.15	⊘[3]
Gas + ventilation heat recovery + 4 m² solar collector	0.12	⊘	0.15	0.15
Gas + ventilation heat recovery + 10 m² solar collector	0.14	⊘[3]	0.15	0.18
Gas + ventilation heat recovery + 5 kWp PV	⊘	⊘	0.15	⊘
Air-to-water heat pump	⊘[4]	0.13	0.15	⊘[4]
Pellet	0.19	0.18	0.15	0.23
District heat	0.22	0.18	0.15	0.23
Air-to-water heat pump + 4 m² solar collector	0.19	0.18	0.15	0.19
Air-to-water heat pump + 5 kWp PV	⊘[4]	0.18	0.15	⊘[4]
Air-to-water heat pump + ventilation heat recovery	0.19	0.13	0.15	0.19
Air-to-water heat pump + ventilation heat recovery + 4 m² solar collector	0.19	0.18	0.15	0.19
Pellet + 4 m² solar collector	0.22	0.18	0.15	0.23
Pellet + ventilation heat recovery	0.19	0.18	0.15	0.23
Pellet + ventilation heat recovery + 4 m² solar collector	0.22	0.18	0.15	0.23

[1] PV-system is compulsory (min. 10 Wp/m², max. 30 kWp): min. 1.7 kWp for the SFH small

[2] No prediction is possible

[3] Average U-values < 0.10 (CH: 0.09; D: 0.08; FL: 0.08)

[4] Average U-value of 0.17 with $U_W \leq 0.8$ or geothermal/ground water heat pump

[7] Results vary due to different climate locations

Average U-value and buildings services variants SFH typical (2020)

Non renewable → renewable

	CH[1+7]	D	Vlbg	FL[1+7]
Electricity	⊘	⊘	[2]	⊘
Gas	⊘	⊘	0.21	⊘
Gas + 4 m² solar collector	0.11	0.10	0.21	0.14
Gas + 10 m² solar collector	0.13	0.15	0.21	0.17
Gas + 5 kWp PV	⊘	⊘	0.21	⊘
Gas + ventilation heat recovery	⊘	⊘	0.21	⊘
Gas + ventilation heat recovery + 4 m² solar collector	0.12	0.14	0.21	0.16
Gas + ventilation heat recovery + 10 m² solar collector	0.15	0.14	0.21	0.19
Gas + ventilation heat recovery + 5 kWp PV	⊘	⊘	0.21	⊘
Air-to-water heat pump	⊘[4]	0.26	0.21	⊘[4]
Pellet	0.21	0.26	0.21	0.27
District heat	0.26	0.26	0.21	0.27
Air-to-water heat pump + 4 m² solar collector	0.19	0.26	0.21	0.19
Air-to-water heat pump + 5 kWp PV	⊘[4]	0.26	0.21	⊘[4]
Air-to-water heat pump + ventilation heat recovery	0.19	0.26	0.21	0.19
Air-to-water heat pump + ventilation heat recovery + 4 m² solar collector	0.19	0.26	0.21	0.20
Pellet + 4 m² solar collector	0.26	0.26	0.21	0.27
Pellet + ventilation heat recovery	0.21	0.26	0.21	0.26
Pellet + ventilation heat recovery + 4 m² solar collector	0.26	0.26	0.21	0.27

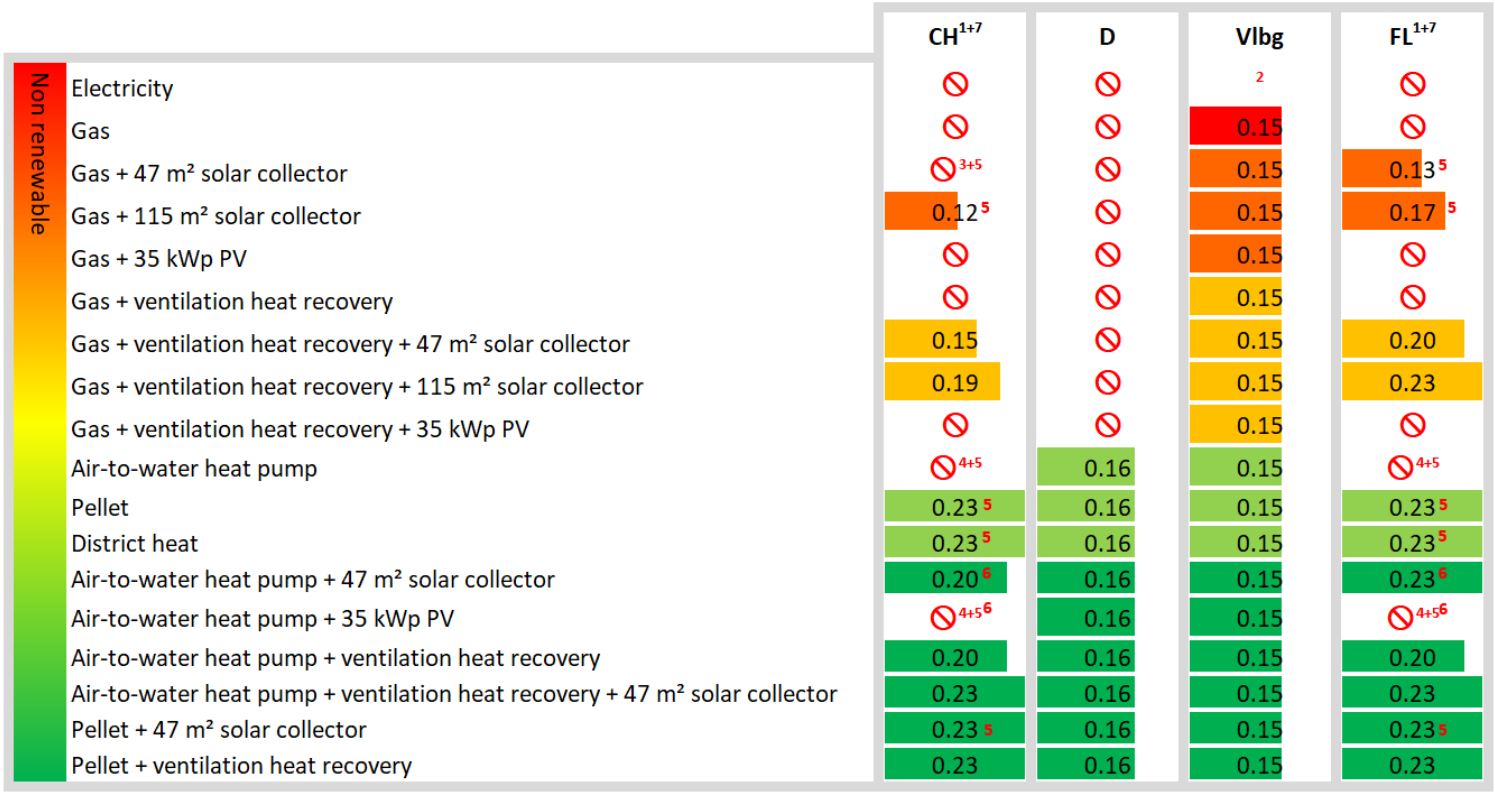
[1] PV-system is compulsory (min. 10 Wp/m², max. 30 kWp): min. 2.1 kWp for the SFH typical

[2] No prediction is possible

[4] Average U-value of 0.18 with $U_W \leq 0.8$ or geothermal/ground water heat pump

[7] Results vary due to different climate locations

Average U-value and building services variants MFH medium (2020)



[1] PV-system is compulsory (min. 10 Wp/m², max. 30 kWp): min. 18.6 kWp for the MFH medium

[2] No prediction is possible

[3] Average U-value < 0.10 (CH: 0.08)

[4] Average U-value of 0.18 with $U_W \leq 0.8$ or geothermal/ground water heat pump

[5] only with window ventilation, if an exhaust air system is used a waste heat utilisation is compulsory → exhaust air heat pump

[6] window ventilation → air-to-water heat pump, exhaust air system → exhaust air heat pump
→ Average U-value 0.20 (CH, FL 47 m²) or 0.21 (FL 115 m²)

[7] Results vary due to different climate locations

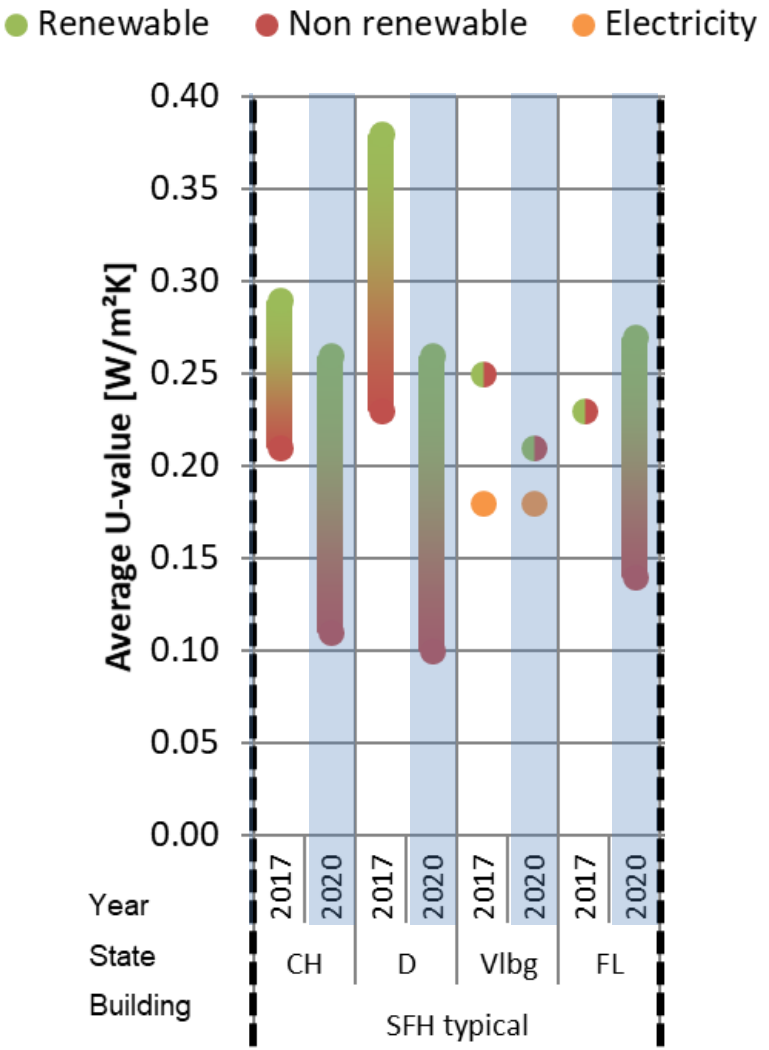
Trend
of the minimum requirements for 2020

- Quality of the thermal envelope or requirements concerning the thermal envelope:
  - If non-renewable energy sources are used, mostly stricter requirements concerning the thermal envelope are the result, except in Vorarlberg.
  - Germany, Switzerland, Liechtenstein: very large range of the quality of the thermal envelope, especially the requirements for natural gas are very strict.

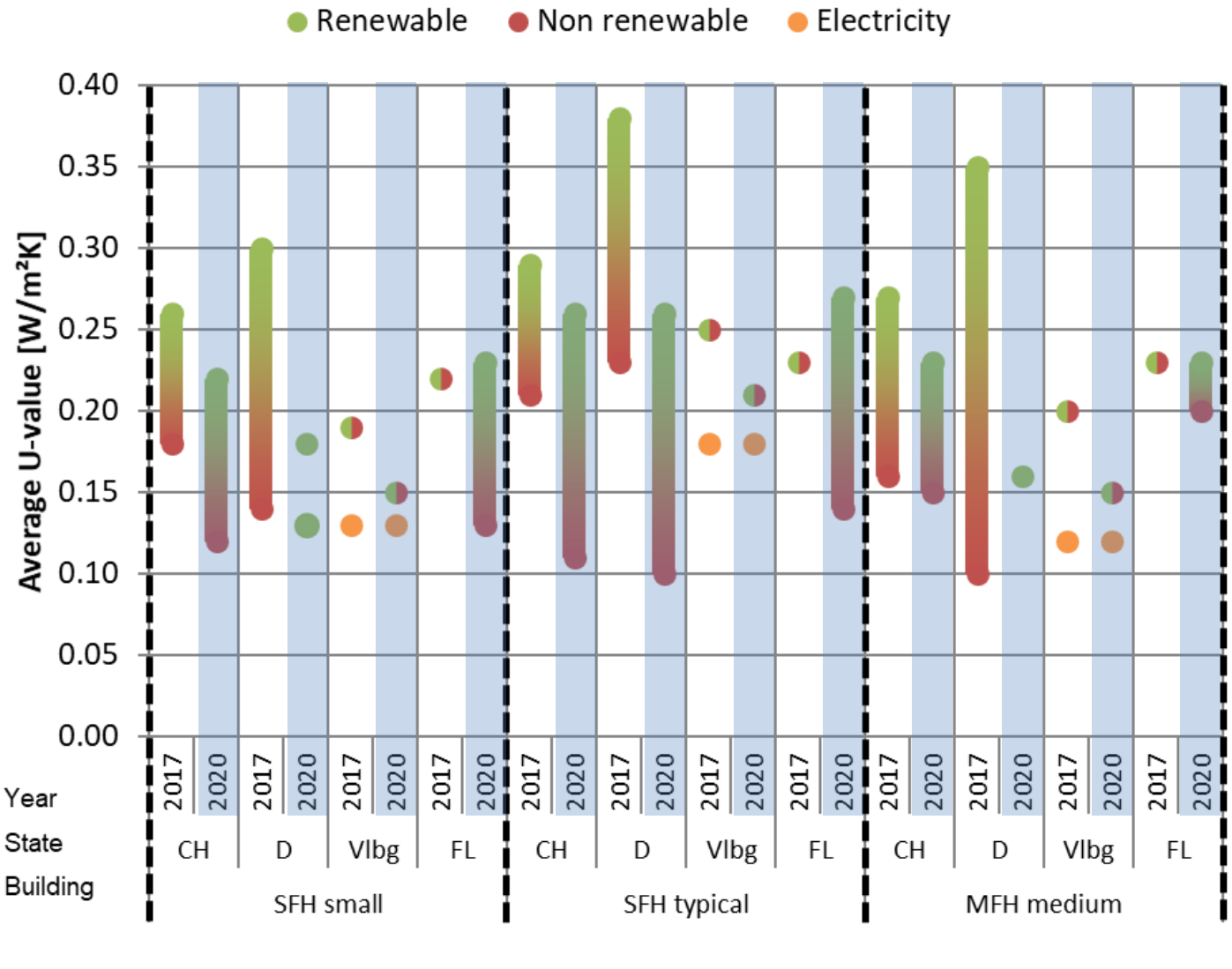
Trend
of the minimum requirements for 2020

- Heat producers/energy sources/building services:
  - In Germany, Switzerland and Liechtenstein **natural gas** without an additional solution is not possible. In Vorarlberg it is possible.
  - In Germany, Switzerland and Liechtenstein **natural gas** with an additional solution is only possible with strict requirements for the thermal envelope quality. In Vorarlberg there is no differentiation between the energy sources.
  - **Electrical** heating systems are not permitted as a main heating system in Germany, Switzerland and Liechtenstein. No prediction for Vorarlberg is possible.
  - PV system is compulsory in Switzerland and Liechtenstein. In Vorarlberg and Germany the PV system is considered in the calculation.
  - Ventilation system with heat recovery is considered in the calculation of PE and CO_2 in Vorarlberg and Germany. In Switzerland and Liechtenstein it is considered in the standard solutions and the weighted final energy demand.

Comparison of the maximum average U-value of all standard buildings (2017 - 2020)



Comparison of the maximum average U-value of all standard buildings (2017 - 2020)



Trend
Change of the minimum requirements 2017-2020

- Quality of the thermal envelope:
  - With the assumptions made for the year 2020 the requirements for the quality of the thermal envelope are more stricter compared to 2017 in all states. The only exception is Liechtenstein if a renewable energy source is used. In this case it is possible to built a thermal envelope in 2020, which is slightly more inefficient compared to 2017.

Trend
Change of the minimum requirements 2017-2020

- Heat producers/energy sources/building services:
  - In comparison to 2017, the building services will be considered in Liechtenstein in 2020. This leads to stricter requirements especially for non renewable systems.
  - With the assumptions made for the year 2020, de facto only the quality of the thermal envelope will be assessed in Vorarlberg but not the building services and the energy sources.
  - In Germany, Switzerland and Liechtenstein non renewable energy sources (in this study by the example gas, in Switzerland also heating oil possible) are only possible in combination with a very efficient thermal envelope, if at all. In Vorarlberg there is de facto no differentiation between the energy sources.
  - PV system is compulsory in Switzerland and Liechtenstein in 2020. This is a separate requirement. The PV system is not considered in the energy demand calculation.
  - Electrical heating systems are not permitted as a main heating system in Germany, Switzerland and Liechtenstein. No prediction for Vorarlberg is possible.

Thank you for your attention!