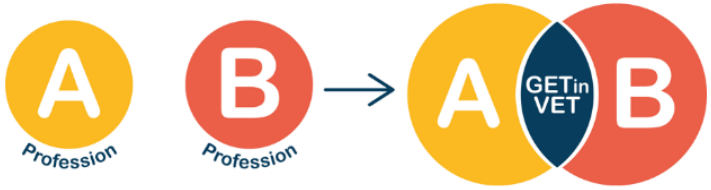
Blanc for learning modules = presentation on the project website

Module 4: **Troubleshooting in building services and building installations:**

The trainees collect possible reasons for a cold room and present them in a graphical overview, e.g. as a mind map. On this basis, the trainees create an action plan for effective and structured troubleshooting and present it in a graphical overview, e.g. as a flow chart.

The target group for this module are trainees in the fields of supply engineering, construction engineering and electrical engineering (EQF level 4).

To successfully complete the learning module, skills from various professions are required. For this reason, the traditional skills of one profession are supplemented by skills from other professions.



These are specific to this module:

Supply engineering:

- Basic knowledge of thermal insulation for walls, ceilings, floors and windows/doors, as well as possible causes of faults.
- Basic knowledge of the electrical power supply for boilers.

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Electrical engineering:

- Knowledge of the basic functions and possible causes of faults in heating systems with gas boilers and flat radiators.
- Basic knowledge of thermal insulation for walls, ceilings, floors and windows/doors, as well as possible causes of faults.

Roofer, Window maker, drywall builder and similar branches:

- Basic knowledge of thermal insulation for walls, ceilings, floors and windows/doors, as well as possible causes of faults.
- Basic knowledge of the electrical power supply for boilers.

all:

- Systematic approach to identifying an error or malfunction.
- Targeted customer consultation to obtain information for narrowing down the cause of the error.

The module is designed to take approximately 7 to 12 teaching hours, depending on how deeply the structure and function of a heating system and the insulation of the building envelope are dealt with and to what extent the trainees are competent in using tools for brainstorming and creating a flow chart.

Learnin unit	**Description and teachung materials** Brief description and links to PDFs/digital tools/etc.	**How to use?** Methodological and didactic explanations (approx. 10 sentences as initial guidance) + link to further documentation (PDFs) if applicable

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Scenario for introduction to the learning situation	A customer bought a second-hand house in the summer. In autumn, the customer notices that one room in the house does not get warm. It is bedroom II (see floor plan below). He has no idea what the problem is and asks you for help. The customer gives you the following information about his house: The building is single-storey and was built in the 1980s. The exterior wall of the house is a double-skin exterior wall with facing brickwork. The interior walls also are made of sand-lime bricks and are plastered. The building does not have a basement. The windows and the glass door to the terrace have double glazing and a wooden frame. A gas boiler heats the radiators and provides the hot water supply. The temperature is regulated by two temperature sensors. An outside temperature sensor on the outside wall, which regulates the flow temperature, and a room temperature sensor in the living room. The control unit of the boiler is placed in the living room. The radiators are all fitted with thermostatic valves. The heating control unit with a display is in the living room.	The scenario involves identifying possible causes for the cold room described by the customer and creating a set of instructions for a systematic and targeted search for possible faults. The example of the given building can be adapted to the region if necessary. For Germany, for example, it is a single-storey residential building that was built in the 1980s.. **Target groups and level:** Trainees in the following professions: • Electrical engineering • HVAC system mechanic • Roofer, drywall installer, window installer and related professions All at EQF level 4 **Objectives:** The trainees should be able to present possible causes for the cold room in a clear diagram (e.g. mind map).

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		Based on this, the trainees create instructions for targeted troubleshooting and document these graphically, e.g. as a flow chart. During a customer meeting, the trainees obtain additional information about the building or room, if necessary.
Tasks:	To complete the scenario, the tasks described below must be completed:	**Working methods and materials:** The tasks are completed in groups. In a study group with members from different industries (e.g. trainees from the fields of construction engineering and HVAC mechanics), the groups should be mixed. The material is available in the form of documents (links and PDFs).
Part 1: Introduction to the learning situation	The trainees analyse the task, describe the customer's problem and develop a solution strategy. Competence: The ability to solve problems systematically. Duration: 1 - 2 h	Discuss the scenario and the problem described therein with the trainees. The scenario can be given to the trainees as a text or PDF document, but it can also take the form of a role play between a customer and a tradesperson, for example.

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		Define the products to be created by the end of the learning situation. These are: • Product 1, graphical representation of possible causes of errors, e.g. as a mind map. • roduct 2, graphical representation of a structured approach to troubleshooting, e.g. in the form of a flow chart. Organisation of working groups, across trades where possible. **Material:** • *01-Scenario-Tasks-v3-eng.docx*
Part 2: Brainstorming: possible reasons for the cold room	The trainees describe possible reasons for the cold room. The trainees document the possible reasons in a structured manner in the form of a clear graphic. Competence: Systematic description and presentation of possible reasons of errors.	The trainees collect possible reasons of errors for their working groups based on their previous professional experience and using the materials provided. The results of their work are documented using a suitable tool, e.g. a mind map programme. Optional: If the trainees are not familiar with documenting brainstorming sessions using mind maps,

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	Duration: 2 - 4 h	presentation of the mind map using a suitable example. Material: • 02a-Information Heating systems.docx • 02b-tasks-Heatingsystems-blanc.docx • 02b-sample-solution-tasks-Heatingsystems-blanc.docx
Part 3: Presentation of work results (product 1, mind map)	The trainees assess and supplement the work results of the other groups. Competence: Technical communication, including with employees from different trades. Duration: 1 - 2 h	The mind maps are presented to each other, e.g. as a presentation or a gallery walk. Mssing aspects are added by the trainees or the teacher. Material: • 04-mindmap-v2-example-eng.docx • 04-mindmap-v2-example-eng.mm
Part 4: Structured troubleshooting	The trainees describe a structured approach to determining the cause of the failture in the form of a clear diagram. Competence: The ability of systematically and purposefully troubleshooting a technical system and document the procedure.	Description and graphical representation of a systematic and structured error cause to identify the possible cause of the cold room, e.g. as a flow chart. Optional: If the trainees are not familiar with the schematic representation of troubleshooting using a flow chart,

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	Duration: 2 - 4 h	presentation of a flow chart using a suitable example.
Part 5: Presentation of work results (product 2, flow chart)	The trainees discuss and evaluate the work results of the other groups. Competence: Technical communication, including with employees from different trades. Duration: 1 - 2 h	The flowcharts are presented, e.g. as a gallery walk. The different approaches developed by the groups are discussed by the trainees and assessed according to the following aspects: • Complete? • Logical? • Effective? Material: • 05-Flowchart-troubleshooting-example-eng.pdf • 05-Flowchart-troubleshooting-example-eng.vsdx
Evaluation	Duration: 10 min.	Online evaluation using suitable tools such as Forms

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Module 4: Troubleshooting in building systems and building installations: The customer reports a cold room.

Scenario:

A customer bought a second-hand house in the summer. In autumn, the customer notices that one room in the house does not get warm. It is bedroom II (see floor plan below). He has no idea what the problem is and asks you for help.

The customer gives you the following information about his house:

The building is single-storey and was built in the 1980s.

The exterior wall of the house is a double-skin exterior wall with facing brickwork. The interior walls also are made of sand-lime bricks and are plastered. The building does not have a basement.

The windows and the glass door to the terrace have double glazing and a wooden frame.

A gas boiler heats the radiators and provides the hot water supply. The temperature is regulated by two temperature sensors. An outside temperature sensor on the outside wall, which regulates the flow temperature, and a room temperature sensor in the living room. The control unit of the boiler is placed in the living room. The radiators are all fitted with thermostatic valves. The heating control unit with a display is in the living room.

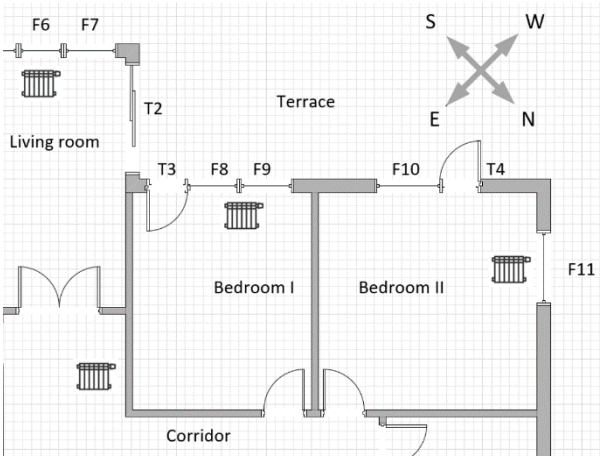

Fig. 1, floor plan

Drawing: M. Sorger

Fig. 2, picture of the cold room

Picture created by ChatGPT

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Tasks:

1. What could be the reasons for the cold room?
   - Collect possible causes for the cold room and present them clearly in the form of a graphic, e.g. as a mind map.
   - Discuss the results of the individual working groups.

2. How would you proceed to find the cause of the cold room in the customer's building?
   - Work out a scheme that can be used to carry out structured troubleshooting and present your scheme graphically, e.g. as a flowchart.
   - Also discuss the results of the individual working groups.

Documents and links about heating:

- 02a-Information Heating systems.docx
- 02b-tasks-Heatingsystems-blanc.docx
- https://www.youtube.com/watch?v=F8Tpwxgtb4A

Documents and links about the building envelope:

- 03-Information sheet_Building wall_cold room_eng.docx

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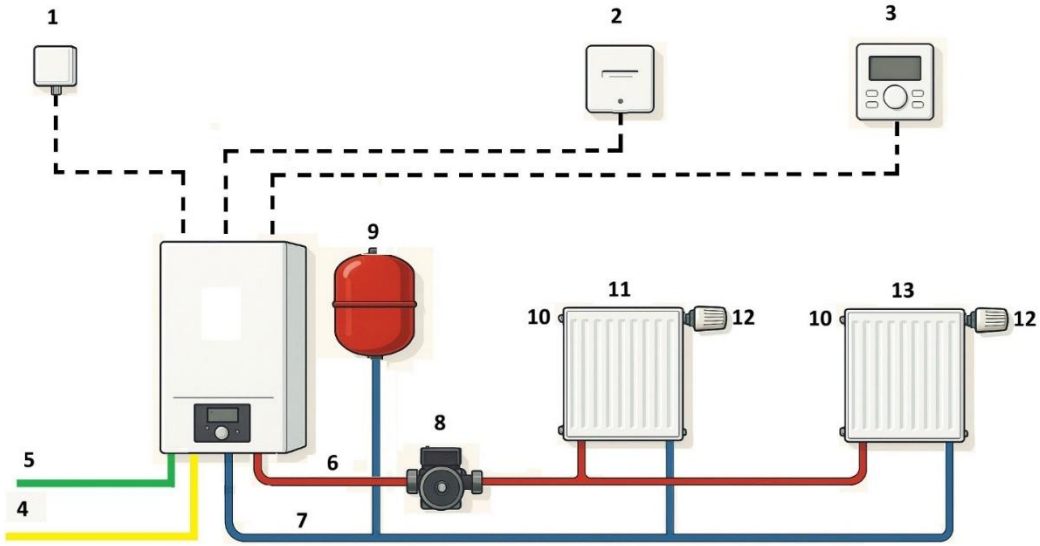
Modul 4: Troubleshooting in building systems and building installations: The customer reports a cold room.

Information Heating Systems:

This graphic shows the structure of a simple heating system



Graphic: ChatGPT

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Information Heating Systems, Part II

The following table shows an overview of the many different heating systems, categorized by primary energy source.

Primary energy source / fuel	Typ of heating	Function	Heat transport and heat transfer in the building	Temperature control
Oil	Oil boiler	Heating water through the combustion of oil	Heat transport through water Heat dissipation mainly via convection through: • Radiators • Heating coils (underfloor heating)	Boiler: Weather-dependent boiler flow temperature (central for each heating circuit) • Radiators: Thermostate valves • Underfloor heating: temperature-dependent regulation of the flow rate per room or zone using electrically operated valves
Gas	Gas boiler	Heating water through the combustion of oil and utilization of the thermal energy of the burner exhaust gas		
Wood	Wood pellets	Heating water through the combustion of wood pellets, wood chips or firewood		
	Wood chips			
	Firewood			
	Stove	Burning wood logs	Heat dissipation through heat radiation	
Electricity	Night storage heaters Electric radiant heater	Heat generation through heating rods or heating coils	Heat transport through air	by switching the heating elements or the heating coils on and off (2-point control)

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	Electric panel heating: wall heating or underfloor heating	Heating wires in the wall or wallpaper or in the floor	Heat dissipation through heat radiation	
Solar Energy	Collectors (flat-plate collector or tube collector)	Heating of a liquid by the radiant energy of the sun in the solar collectors. The liquid transfers the heat energy to a hot water tank in a heat exchanger, which feeds the heating water circuit.	Heat transport through water Heat dissipation: mainly via convection through • Radiators • Heating coils (underfloor heating)	• hot water tank: 2-point control by solar thermal controller • Radiators: thermostatic valves • Underfloor heating: temperature-dependent control Temperature of the flow rate per room or zone using electrically operated valves.
Ambient heat (earth, air, water)	Heat pump	Extraction of heat outside and release inside the house. Physical principle: Joule-Thomson effect Cooling is also possible by reversing the process		
Ambient heat of the air	Special case air-to-air heat pump: Split air-conditioning system	Works like a heat pump: Cooling and heating possible	Heat transport through air	by switching the split air conditioning system on and off using thermostats (2-point control)
Different energy sources possible	Combined heat and power plant	Heat generation: Utilization of waste heat from a combustion engine or a fuel cell. Power generation: By fuel cell or generator driven by the engine.	Heat transport through water Heat dissipation: mainly via convection through • Radiators	Flow temperature is specified by the provider and cannot be influenced • Radiators: thermostatic valves Underfloor heating: temperature-dependent control Temperature of the flow rate per room or zone using electrically operated valves.

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Different energy sources possible	District heating	Use of a fossil thermal power plant, a fossil power plant to generate electricity or a CHP unit. The thermal energy is not generated at the user's location, but is routed to the buildings via a network of district heating pipes.	• Heating coils (underfloor heating)	Flow temperature is specified by the provider and cannot be influenced Temperature control of the radiators: Thermostatic valves Underfloor heating: temperature-dependent regulation of the flow rate per room or zone using electrically operated valves.

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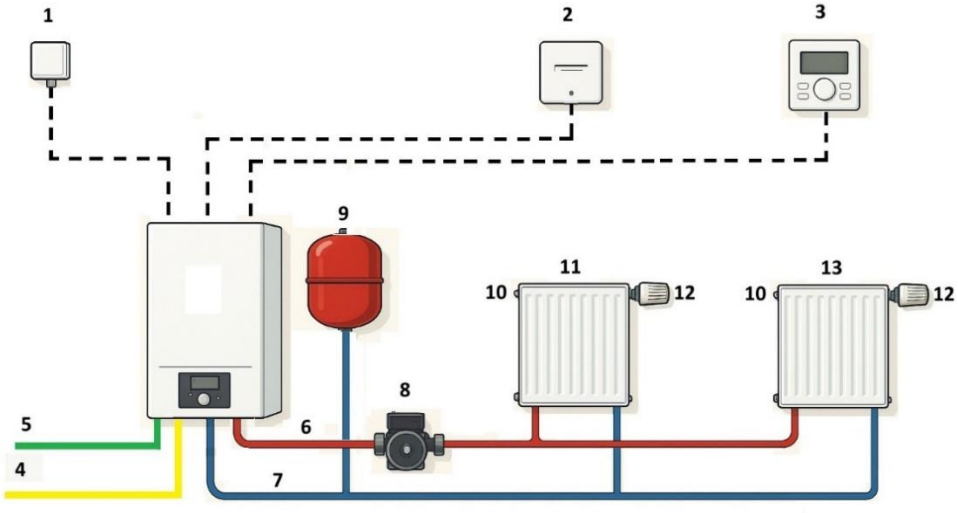
Module 4: Troubleshooting in building systems and building installations: The customer reports a cold room.

Components of a heating system, task:

1. Name the components shown in positions 1 to 13 in the heating diagram.
2. Briefly describe the function of the components.



Pos.	Name	Task
1		
2		
3		
4		

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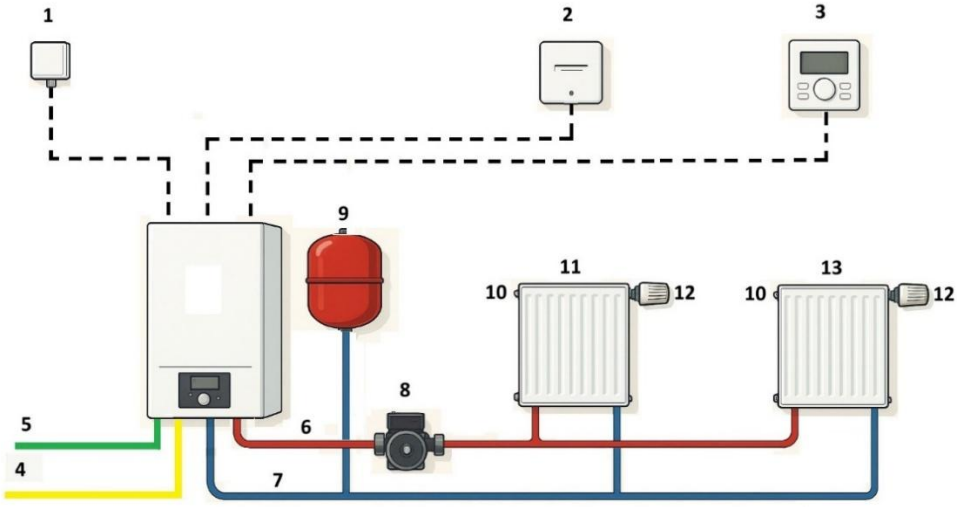
Module 4: Troubleshooting in building systems and building installations: The customer reports a cold room.

Components of a heating system, task:

3. Name the components shown in positions 1 to 13 in the heating diagram.
4. Briefly describe the function of the components.



Pos.	Name	Task
1	Outdoor sensor	Measurement of the outside temperature
2	Room sensor	Measurement of the room temperature
3	Romm controller	Combination controller/operating unit; regulates the flow temperature of the heat generator depending on the outdoor and room sensor
4	Gas connection heat generator	Fuel supply for the heat generator
5	Power connection Heat generator	Supply of electrical energy for the heat generator
6	Pipe flow	Pipes for transporting the hot water to the radiators

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7	Return flow	Pipes for transporting the cold water back to the heat generator
8	Heating pump	Ensures the transport of water in the heating circuit
9	Membrane expansion vessel	Ausgleich temperaturbedingter Volumenschwankungen im Heizungskreislauf
10	Vent valve Radiator	Equalisation of temperature-related volume fluctuations in the heating circuit
11	Radiator	Release of thermal energy to the room air mainly by convection
12	Thermostat valve	Regulates the volume flow of hot water through the radiator and thus the amount of heat energy emitted.
13	Radiator	Release of thermal energy to the room air mainly by convection

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Infoblatt: Gebäudewand oder Fenster / Türen als Ursache für einen kalten Raum

In manchen Fällen kann die Ursache für einen kalten Raum nicht in der Heizungsanlage, sondern im Wandaufbau des Gebäudes liegen. Besonders bei älteren Gebäuden mit ungedämmten Außenwänden oder fehlerhaften Konstruktionen kann es zu fühlbaren und messbaren Problemen kommen, welche auf kalte Innenwände- und -flächen zurückzuführen sein können.

Ebenso können undichte Fenster oder Türen zu einem kalten Raum führen. Hierbei sind entweder die Dichtung oder Rahmen des Fensters bzw. der Tür defekt oder die Fenster bzw. Türen schließen nicht richtig.

Grundlagen zum Wandaufbau

Außenwände bestehen meist aus mehreren Schichten, z. B. einer tragenden Innenschale aus Mauerwerk, einer Luftschicht oder Dämmschicht und einer äußeren Wetterschale (z. B. Klinker). Fehlt eine ausreichende Wärmedämmung, kann es an der Innenwand zu kalten Oberflächen kommen.

Typische Anzeichen für Probleme in der Wand

- **Zugerscheinungen**: kalte Luftzüge spürbar, oft in der Nähe von Steckdosen, Fenstern oder Fugen.
- -**Feuchte Wände**: Tauwasser kann an der kalten Innenwand kondensieren. Mit einem Hygrometer messbar.
- **Kalte Innenwandtemperatur**: dauerhaft niedriger als die Raumlufttemperatur. Mit Infrarotthermometer prüfbar.
- **Schimmelbildung**: entsteht durch dauerhafte Feuchte – sichtbar als schwarze oder grünliche Flecken. Meist fällt das Vorhandensein von Schimmel durch den muffigen Geruch auf, lange bevor dieser auf den betreffenden Wandflächen sichtbar ist.

Mögliche Ursachen

- Fehlende oder mangelhafte Wärmedämmung
- Wärmebrücken (z. B. an Fensterlaibungen, Deckenanschlüssen)
- Durchfeuchtung der Wand durch Schlagregen oder aufsteigende Feuchte
- Luftundichte Stellen, z. B. durch Risse oder defekte Abdichtungen

Hinweis zur Fehlersuche

Die Ursachenanalyse erfolgt meist durch Sichtprüfung, Temperaturmessung, Feuchtemessung und ggf. Wärmebildkamera. Eine bautechnische Fachkraft kann bei Bedarf hinzugezogen werden.

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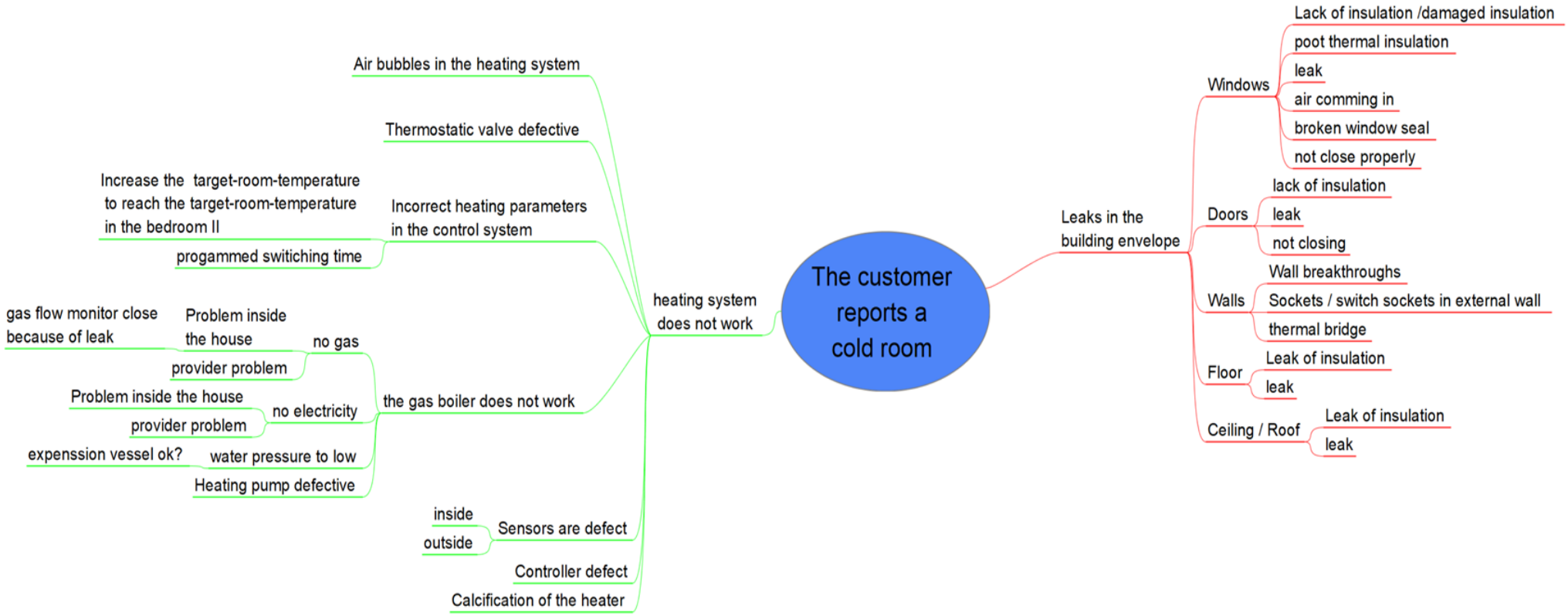

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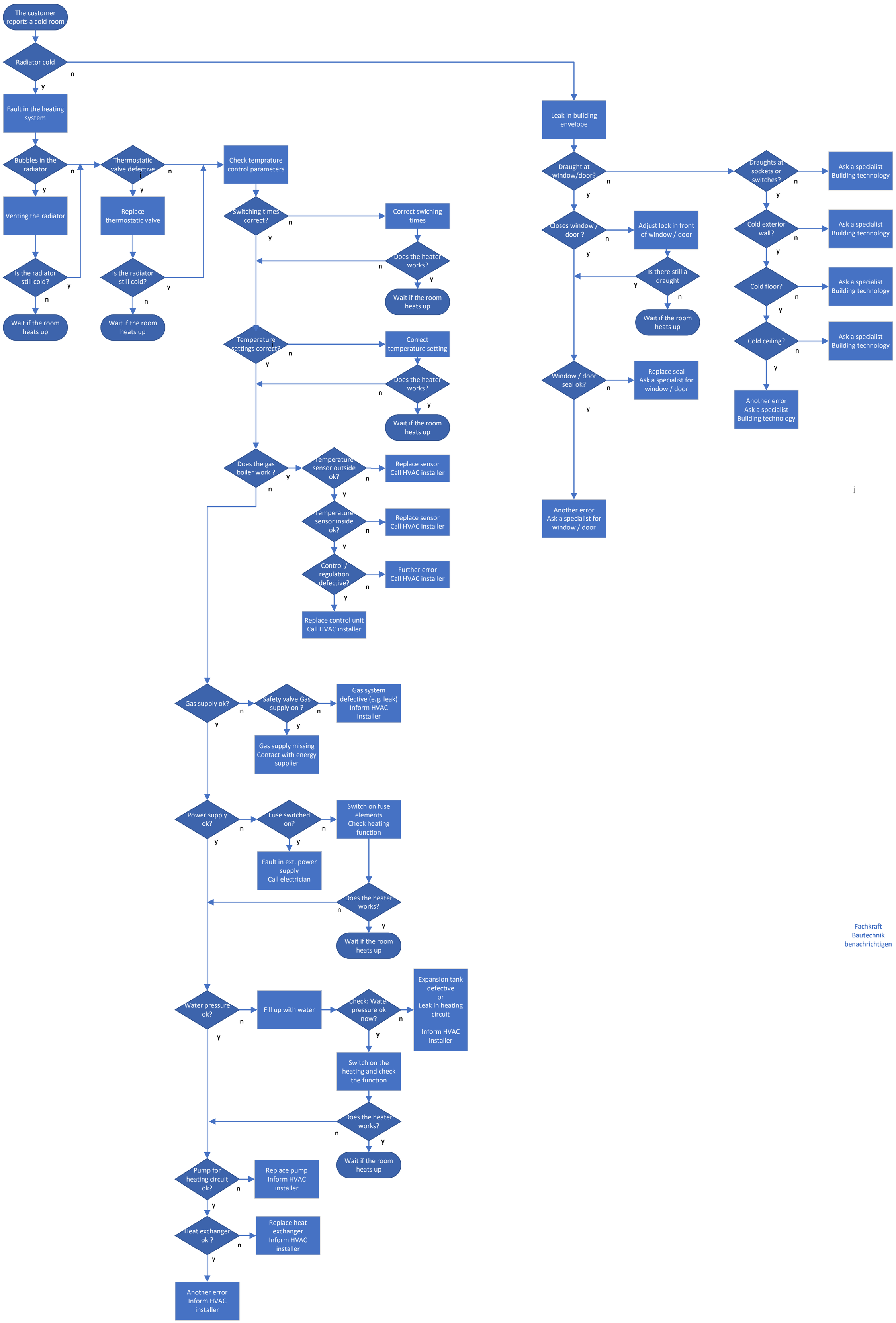

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