APIS GUIDE 02 · ENERGY

District heating connection *& conversion.*

A readiness, design and commissioning guide for building owners, housing associations and municipalities converting an existing building to a district heating network.

APIS · DISTRICT HEATING & COOLING

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ABOUT THIS GUIDE

Two numbers decide *your bill.*

Almost every district heating tariff has two parts: a fixed annual charge based on the capacity you contract, and a variable charge based on the energy you draw. Most buildings get the first number wrong at connection and never revisit it, and most buildings never measure the second one properly at all.

The contracted capacity is agreed once, on the basis of a heat load calculation somebody performed under time pressure, and then billed every year for the life of the connection. The return temperature — how cold the water is when your building sends it back — governs how efficiently the whole network runs and, in an increasing number of tariffs, what you pay for it. Both are decided by work done inside your building, before the meter, by people who are usually thinking about something else.

This guide covers what to establish before you commit to a connection, what the substation and the building-side works actually involve, how to avoid contracting capacity you will never use, and how to commission a system that returns water cold enough to be worth having. It ends with a forty-point readiness checklist you can take into your own feasibility study or tender.

Who this is written for

- Owners and managers of existing buildings within reach of a district heating network
- Housing associations and residents' committees considering a collective connection
- Municipalities and public bodies converting schools, clinics and administrative buildings
- Developers connecting new buildings, where most of this applies in a simpler form
- Consultants and contractors preparing or reviewing a connection scope

What this guide is not

It is not a design document and does not replace a qualified heating designer. It does not cover the design of the network itself — the buried distribution mains and the production plant are the operator's territory and a different subject. It states no tariffs, no connection fees and no payback periods, because those are set locally, change frequently, and a number quoted here would be wrong somewhere and out of date everywhere.

> A NOTE ON STANDARDS AND LOCAL RULES
>
> Standards are cited by number so that you can find and read them. Editions are revised; confirm the current edition and any national adoption before writing a citation into a contract. More importantly for this subject: **every district heating operator publishes its own connection rules** — permitted connection type, pressure and temperature limits, metering arrangements, substation requirements and tariff structure. Those rules govern. Obtain them in writing at the very start, before any design work begins.

How to use it

Sections 01 to 03 are the feasibility stage: is this building a candidate, what does a connection involve, and what must be surveyed before committing. Sections 04 to 07 are the technical core — the two numbers, the substation, the building side, and commissioning. Section 08 sets out where the money goes. If you are reviewing a proposal somebody else has prepared, start at the checklist in Section 09.

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SECTION 01

Is your building *a candidate?*

Five questions answer this, and four of them can be settled in an afternoon without engaging anybody. The fifth is the one that matters.

Conversion to district heating is usually a good decision for a building that is well placed for it, and a poor one for a building that is not. The difference is knowable early, and it is worth knowing before a feasibility study is commissioned rather than after.

Question 1 · Is the network physically within reach?

Ask the operator for the position of the nearest distribution main and the nearest connection point with available capacity. These are different things: a main running past the building does not mean there is spare capacity on that branch, and a branch with capacity may be some distance away.

The service pipe from the main to your substation is normally the single largest civil cost in the whole project, and it scales with distance, with what it has to cross, and with who owns the ground it crosses. A service run under a public road, through a third party's land, or across a paved courtyard the residents have just resurfaced, is a different proposition from a ten-metre run across your own plot.

Question 2 · Does the operator want you?

Networks have capacity limits, seasonal load profiles and expansion plans. An operator may welcome a large winter load on an under-used branch, and may decline a connection that would overload a constrained one — or grant it subject to reinforcement works at the applicant's cost. Establish this in writing before spending anything. A verbal encouragement from someone at the operator is not a connection offer.

Question 3 · What are you replacing, and what condition is it in?

The economics of conversion depend heavily on what is being displaced.

- **An old central boiler at end of life** is the strongest case. The replacement cost you avoid is a real, dated, quantifiable alternative, and the comparison is honest.
- **A recently replaced boiler** is the weakest. You are writing off an asset with years of life in it, and the case has to be made on running cost, emissions or risk rather than on avoided capital.
- **Individual apartment boilers or individual electric heating** is the most complex, because there is no existing central distribution to connect to. The building-side works become a substantial project in their own right, and the decision involves every owner rather than one.

Question 4 · Do you have a distribution system to connect to?

District heating delivers heat to a single point. From there it is your building's problem. A building with a functioning central wet system — risers, emitters, a plant room — is connecting a new source to existing infrastructure. A building without one is installing a heating system and connecting it to a district source, which is a much larger project that happens to include a connection.

Both are legitimate. They are not the same decision and should not be compared using the same figures.

Question 5 · Can the building actually use low-temperature heat?

This is the question that separates a good conversion from a disappointing one, and it is almost always asked too late.

Modern district heating networks operate at progressively lower supply temperatures, because lower temperatures reduce distribution losses, allow a wider range of heat sources including waste heat and heat pumps, and improve the efficiency of the whole system. A building whose emitters were sized for a high flow temperature — typical of older systems designed around a coal or oil boiler — may not deliver enough heat on the coldest days when fed at a lower temperature.

The consequences are unpleasant and they arrive in the first cold spell: rooms that will not reach temperature, occupants who open the bypass or the mixing valve to force flow, and a return temperature that climbs and stays high. Section 05 explains why that last part costs money indefinitely.

> THE SCREENING QUESTION TO ASK FIRST
>
> **What supply temperature will the operator guarantee at my substation, at design outdoor conditions, and does the operator intend to reduce it?** Then ask your designer whether the building's emitters can deliver the design heat load at that temperature. If the answer is no, you have not found a reason to abandon the project — you have found the scope of work that belongs in it, and the moment to price it is now, not after connection.

What a candidate looks like

Strong candidate	Network main close by with confirmed capacity · existing central wet distribution in serviceable condition · a boiler at or near end of life · emitters with headroom at lower flow temperatures, or a fabric upgrade already planned · a single decision-maker or a functioning owners' association
Needs a proper feasibility study	Longer service run or third-party land · emitters sized for high flow temperature with no upgrade planned · domestic hot water currently produced by something that will also have to change · mixed ownership with no established decision process
Weak candidate for now	No spare capacity on the nearest branch without reinforcement at your cost · no central distribution system at all and no appetite for installing one · a heat source installed within the last few years and performing well

A weak candidate today can become a strong one. Networks extend, boilers age, and a fabric or emitter upgrade undertaken for other reasons removes the main technical obstacle. The purpose of screening honestly is to know which conversation you are having.

SECTION 02

How a connection *actually works.*

Two hydraulic circuits, one heat exchanger, and a boundary that determines who is responsible for what.

A district heating connection has two sides, and almost every misunderstanding on a conversion project comes from confusing them.

- The **primary side** is the network. Water is produced and pumped by the operator, at the operator's temperature and pressure, through the service pipe to your building. You do not control any of it.
- The **secondary side** is your building. Its temperature, its pressure, its water quality and its control are yours, and the whole of it is downstream of the substation.

The substation is the boundary. It transfers heat from one side to the other, measures how much, and protects each side from the other.

Indirect and direct connection

Indirect connection	A heat exchanger separates the two circuits. Network water never enters the building system, and building water never enters the network. The building is protected from network pressure, network water quality and network faults; the network is protected from whatever is in your pipework. This is the normal arrangement for a conversion and the one most operators require.
Direct connection	Network water circulates in the building emitters, usually through a mixing arrangement to reduce temperature. Simpler and cheaper, with no heat exchanger losses — but the building system must withstand network pressure, and any leak or contamination in the building is a network problem. Permitted only where the operator allows it and the building system is verified as suitable.

Assume indirect unless the operator's connection rules say otherwise. If direct is offered as a saving, establish in writing that the building's pipework, emitters and safety devices are rated for the network's static and differential pressure, including the pressure that arises on a network fault — not just the normal operating pressure.

What sits in the substation

A conventional indirect substation contains, in roughly this order from the network inwards:

1. **Isolation valves and a strainer** on the primary, protecting everything downstream from debris carried in the network. The strainer is not optional and it must be cleanable in service.
2. **A differential pressure controller**, so that the control valves see a stable pressure regardless of what the rest of the network is doing. Without it, valve authority varies with network conditions and stable control is impossible.
3. **The heat meter** — a flow sensor, two matched temperature sensors and a calculator. Its position, orientation and the straight lengths of pipe around it are prescribed, usually by the operator.
4. **Control valves** on the primary, one per circuit, modulating the network flow to hold the secondary temperature at set point.
5. **Heat exchangers** — typically one for space heating and a separate one for domestic hot water, because the two have very different load profiles and temperature requirements.
6. **Secondary-side equipment** — circulating pumps, expansion vessel, safety valves, fill and make-up arrangement, and the water treatment provision.

7. **The controller**, running weather compensation for space heating, hot water priority or blending logic, and — increasingly — return temperature supervision.

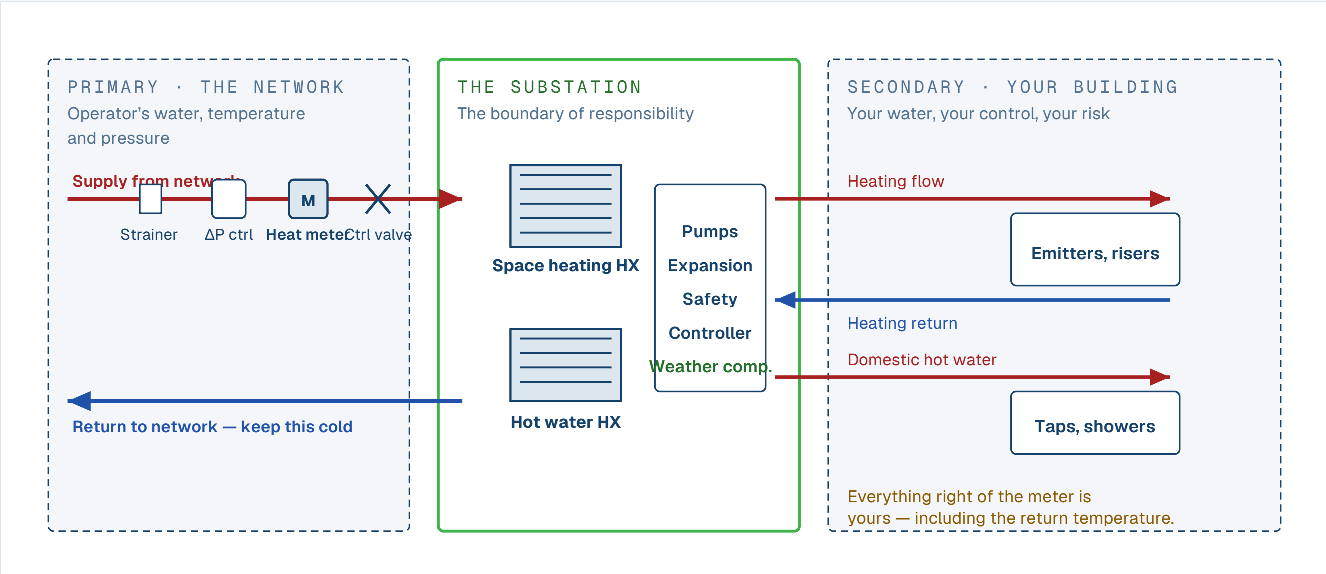


Figure 2.1 — An indirect connection. The heat exchangers separate the two circuits completely; the meter sits on the primary side and records what crosses the boundary. Arrangement varies with operator rules and with the building.

Where responsibility changes hands

Operators define the boundary differently, and it is worth having it drawn on a diagram and signed. Typical questions that need an answer in writing before contract:

- Who owns, installs and maintains the service pipe, and up to which valve?
- Who owns the substation — is it the operator's plant in your room, or your plant on the operator's network? This determines who pays for its replacement in fifteen years.
- Who owns and calibrates the heat meter, and how often? What happens if it fails, and how is consumption estimated for the period it was faulty?
- Who is responsible for the substation room — its structure, access, drainage, ventilation and electrical supply?
- What access rights does the operator have, at what notice, and to which parts of your building?
- What happens on a network outage, and is there any compensation or guaranteed availability?

> THE DOCUMENT TO OBTAIN FIRST
>
> Before any design work, obtain the operator's **technical connection conditions** in writing: available supply temperature at design conditions and its planned trajectory, static and differential pressure at your connection point, maximum permitted return temperature, permitted connection type, metering requirements, substation space and access requirements, and the tariff structure with its capacity basis. Every technical decision in the remainder of this guide depends on that document, and designing without it means redesigning with it.

SECTION 03

The building-side *survey.*

What has to be established about your building before a capacity is contracted or a substation is sized. Most of it cannot be recovered later.

A connection is sized, priced and contracted on the basis of what the building needs. If the survey is thin, every number downstream inherits the error — and the contracted capacity, once agreed, is billed annually whether or not it was right.

1 · The design heat load, calculated rather than assumed

The design heat load is the heat the building needs at the design outdoor temperature for its location. It should be calculated by an established method — EN 12831 is the European standard for this — using the building as it is and as it will be after any planned fabric works.

What it should **not** be is the rating of the boiler being replaced. Existing boilers in the region are very frequently oversized, sometimes by a wide margin, because they were selected with generous safety factors, because the building has since been insulated or had its windows replaced, or because the original calculation was itself a rule of thumb. Carrying that figure forward into the contracted capacity is the most expensive single error in a conversion project, and it is also the most common.

NEVER SIZE THE CONNECTION ON THE OLD BOILER

An oversized contracted capacity is paid for every year, forever, and reducing it later usually requires the operator's agreement and sometimes a fee. Calculate the load. If the calculation and the boiler rating disagree substantially, that is not an error in the calculation — it is the finding.

2 · The domestic hot water demand, separately

Hot water and space heating have entirely different profiles. Space heating is seasonal and varies with weather; hot water is year-round and peaks sharply, morning and evening, for short periods. A residential block's hot water peak can be a large fraction of its space heating load, and it occurs at times when space heating demand may be low.

Establish how hot water is produced today, how it will be produced after conversion — instantaneous through a dedicated exchanger, or stored — the number and type of dwellings or fixtures served, and the diversity assumption used. Storage reduces the peak capacity required and therefore the contracted capacity; instantaneous production avoids storage losses and stagnation. The choice has consequences for both the bill and the water hygiene regime, and it should be an explicit decision rather than a default.

3 · The emitters and their operating temperatures

For a representative sample of the building, record the emitter type, size and location, the room it serves, and — critically — the flow temperature the system was designed around. Then have the designer establish whether those emitters deliver the room's design heat load at the supply temperature the operator will actually provide.

Where they do not, the options are ordinary and all of them have a cost: enlarge or add emitters in the affected rooms, improve the fabric so the room needs less, or accept a higher secondary flow temperature, which limits how cold the return can be and undermines Section 05. The point of the survey is to know which rooms are affected and to price the remedy inside the project, rather than discovering it in the first cold week after commissioning.

4 · The distribution system and its condition

- **Pipework** — material, age, insulation, evidence of corrosion or previous leaks. Old distribution carries debris, and debris ends up in heat exchangers and control valves. Plan for flushing, and specify it.
- **Hydraulic arrangement** — one-pipe or two-pipe, and whether the system was ever balanced. One-pipe systems are common in older blocks in the region and behave very differently; they need specific attention and they constrain what return temperature is achievable.
- **Existing valves and controls** — what is fitted, what works, and what is seized. Thermostatic radiator valves that no longer modulate are a direct cause of high return temperature.
- **Bypasses** — find every one. Section 05 explains why.
- **Water quality** — take a sample and have it assessed. Filling a new heat exchanger with the existing system water, unfiltered and untreated, is a reliable way to lose the exchanger's performance in the first season.

5 · The substation room

The substation has to go somewhere, and the operator will have requirements. Confirm early: floor area and headroom, a route by which a heat exchanger can physically be brought in and taken out, floor drainage, ventilation, an electrical supply with the right protection, water supply for filling, lighting, and independent access for the operator if the operator's rules require it. An existing boiler room is often suitable and often smaller than it looks once the boiler, the flue and the fuel store are removed — which is usually a gain.

6 · Metering intentions inside the building

The operator meters at the boundary. How the resulting cost is allocated among apartments or tenants is a separate question and it is a source of prolonged dispute if left unresolved. Decide before design whether the building will apportion by heated area, by individual heat cost allocators, or by individual meters, because each implies different pipework and different devices, and retrofitting the decision afterwards is disruptive and expensive.

> SURVEY OUTPUTS TO CARRY INTO THE DESIGN
>
> - Calculated design heat load, with the method, the design outdoor temperature and the assumptions stated
> - Separate hot water peak demand, with the diversity assumption stated
> - Schedule of rooms whose emitters are inadequate at the operator's supply temperature
> - Condition report on distribution pipework, valves and water quality
> - Register of every bypass and every constant-flow circuit
> - Substation room drawing showing access route and services
> - Agreed cost allocation method for the building

SECTION 04

Contracted capacity — the number *you pay for forever.*

Agreed once, on a calculation nobody revisits, and then billed every year for the life of the connection.

District heating tariffs are conventionally built from two components. The exact names and the balance between them vary by operator and by country, and yours must be taken from the tariff document itself — but the structure is near-universal:

Capacity charge	A fixed annual amount, based on the capacity you have contracted — expressed in kW, or sometimes derived from heated area or another proxy. Payable whether or not you use it. This pays for the operator's fixed costs: the network, the production plant, the capacity held available for you on the coldest day of the year.
Energy charge	A variable amount for the heat actually delivered, measured by the meter. This tracks what you consume, and it is the part that responds to insulation, control and occupant behaviour.
Sometimes a third component	An increasing number of operators apply a bonus or a penalty linked to return temperature or to measured cooling of the network water. Where this exists it turns Section 05 from good engineering into a direct line on the invoice.

Why over-contracting is the standard mistake

Nobody sets out to contract more capacity than they need. It happens through an accumulation of individually reasonable decisions:

1. The load is taken from the existing boiler rating, which was itself oversized
2. A safety margin is added because the designer is being careful
3. A further margin is added because a future extension is contemplated
4. The hot water peak is added to the space heating peak, rather than being combined with a defensible diversity assumption
5. Nobody revisits the figure after the fabric works are complete

Each step is defensible on its own. Together they can produce a contracted capacity well above anything the building will ever draw — and the difference is paid annually, indefinitely, for nothing.

> ASK THREE QUESTIONS BEFORE SIGNING
>
> **One.** On what basis is the capacity charge calculated — contracted kW, heated area, metered peak, or something else? The answer changes what you should optimise.
> **Two.** Can the contracted capacity be reduced later, on what notice, and at what cost? Some operators permit periodic revision; some do not.
> **Three.** What happens if I exceed it — is there a penalty, a limiter, or a reassessment? An under-contracted building that is limited on the coldest day of the year is a worse outcome than a slightly over-contracted one.

Getting the number right

- **Calculate, do not inherit.** A design heat load calculated by an established method, for the building as it will be at connection, including any fabric works in the same programme.

- **Combine the two loads properly.** The space heating peak and the hot water peak do not occur at the same moment in most buildings, and adding them arithmetically overstates the requirement. Use a stated diversity assumption, and record it — if the operator later challenges the figure, the assumption is your evidence.
- **Consider hot water storage.** Storage converts a short, sharp hot water peak into a longer, lower draw, and can materially reduce the capacity that has to be contracted. Weigh that against the standing losses and the water hygiene regime storage brings with it.
- **Do not build in the extension.** Contract for the building you have. Ask instead what it would cost and take to increase the capacity later — a defined future path is almost always cheaper than paying for unused capacity for a decade.
- **Revisit after the first winter.** The meter records your actual peak. If it is far below the contracted figure, you have evidence for a revision — which is why Question Two above matters at signing rather than afterwards.

The related decision: what the substation is sized for

The contracted capacity and the physical size of the substation plant are connected but not identical. The heat exchangers, valves and pumps are selected for a duty at stated temperatures. If the operator later reduces the network supply temperature — which is the clear direction of travel for district heating generally — a heat exchanger selected with no margin at the original temperature may no longer deliver its duty.

The sensible position is a substation with reasonable headroom at reduced supply temperature, and a contracted capacity with none. Those are different margins, applied to different things, for different reasons. Confusing them produces either an under-performing substation or an over-contracted connection, and frequently both.

SECTION 05

Return temperature, and why *it decides everything.*

The single most important performance metric of a district heating connection, and the one almost nobody looks at after handover.

Heat is delivered to your building by water arriving hot and leaving cooler. The energy transferred depends on the flow rate and on the difference between the supply and return temperatures. For a given amount of heat, a building that returns water cold needs less flow than a building that returns it warm.

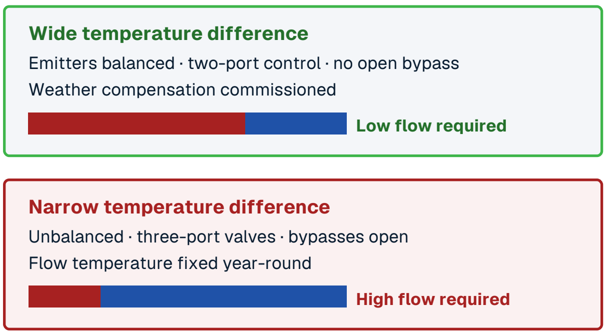
That single relationship drives almost everything that matters about a district heating system:

- **Less flow means less pumping energy** across the whole network, and pumping is a significant part of an operator's running cost.
- **Less flow means more capacity in the same pipes**, so the network can serve more buildings without reinforcement.
- **A cold return allows a lower supply temperature**, which reduces distribution heat losses and — increasingly important — makes it possible to use heat sources that cannot produce high temperatures: industrial waste heat, large heat pumps, solar thermal, flue gas condensation.
- **A cold return improves the efficiency of the production plant itself**, particularly where condensing or heat recovery equipment is installed.

The operator therefore cares about your return temperature a great deal. Where a tariff includes a return temperature component, you have a direct financial interest in it too. Where it does not yet, it is a reasonable expectation that it will.

> *A building that returns water warm is drawing more flow than it needs, occupying network capacity that belongs to somebody else, and forcing the whole system to run hotter than it should.*

THE SAME HEAT, DELIVERED TWO WAYS



A warm return costs, in order:

1 · More pumping energy across the network

2 · Network capacity consumed that another building needed

3 · A higher supply temperature for everyone, and higher distribution losses with it

4 · Heat sources that cannot be used — waste heat, heat pumps, solar thermal

5 · Where the tariff includes it, a direct penalty on your own invoice

ALL FIVE CAUSES SIT INSIDE YOUR BUILDING

Figure 5.1 — For the same heat delivered, a building returning water cold draws far less flow than one returning it warm. Bar lengths are illustrative of the principle only, not of any particular temperature regime.

What raises the return temperature

All of the causes are inside the building, all are visible to a competent survey, and most are cheap to correct before connection and expensive afterwards.

1 · Bypasses

Any arrangement that lets supply water reach the return without passing through an emitter raises the return temperature directly, and does so continuously. Bypasses are installed for legitimate reasons — to keep flow at a pump, to keep a riser warm, to guarantee prompt hot water at a distant tap — and they are then forgotten. Find every one during the survey, decide in each case whether it is still needed, and where it is, control it rather than leaving it permanently open.

2 · Three-port mixing and diverting valves

A three-port valve on a circuit maintains an essentially constant flow and varies the temperature by mixing. That is exactly the wrong behaviour for a district heating connection, which wants variable flow at the lowest achievable return temperature. Two-port control, with variable flow, is the arrangement that suits a district connection. Where three-port valves exist in the building system, they are a specific item for the conversion scope.

3 · Radiator valves that no longer modulate

A thermostatic valve that is seized open, has lost its head, or has been overridden by an occupant passes full flow regardless of room temperature. The room overheats, the window opens, and the return runs hot. Replacing failed valves is among the cheapest interventions available and among the most consistently effective.

4 · An unbalanced system

Without balancing, circuits close to the plant take more flow than they need and distant circuits are starved. The near circuits return water barely cooled; the far ones underheat, and somebody responds by raising the flow temperature or opening a bypass — which makes the return hotter still. Balancing is not optional on a conversion, and it should be specified with a documented result rather than left as an assumed part of commissioning.

5 · Domestic hot water, especially in summer

In summer, with space heating off, the hot water circuit is the only load — so it alone determines the return temperature the operator sees from your building. An uncontrolled hot water circulation loop, an oversized or poorly controlled exchanger, or a storage arrangement that keeps the primary side hot continuously, will hold the return temperature high for months at a time. Summer return temperature is where the worst readings in most networks come from.

6 · No weather compensation, or a heating curve set too high

A secondary flow temperature held constant year-round means the system runs hotter than it needs to for most of the season, emitters cannot cool the water properly, and the return climbs. A properly set weather-compensated curve reduces flow temperature as outdoor temperature rises, which lowers the return with it. The curve must actually be commissioned to the building, not left at the controller's factory default — this is one of the most common findings on a post-occupancy inspection.

THE TENSION YOU MUST RESOLVE DELIBERATELY: HOT WATER HYGIENE

Domestic hot water systems are subject to temperature requirements intended to control legionella, and those requirements set a floor below which storage and circulation temperatures must not fall. Those requirements take precedence, always. They also conflict with the objective of a low primary return temperature.

Resolving that tension is a design task — it involves the choice between instantaneous and stored production, the exchanger arrangement, the control of the circulation loop, and sometimes a staged or cascaded arrangement that pre-heats cold water before the final exchanger. It must be designed, not left to be discovered. Take the applicable temperature requirements from the national rules and the operator's conditions, and have the design reviewed against them.

What to require in the specification

1. A **stated maximum return temperature** at defined conditions, taken from the operator's connection conditions, written into the contract as a performance requirement — not an aspiration in the design narrative.
2. **Two-port control** on all new circuits, with three-port arrangements identified and removed or justified.
3. **Every bypass identified, and each one either removed or fitted with control.**
4. **Documented hydraulic balancing**, with the measured results issued as part of the handover pack.
5. **Weather compensation commissioned to the building**, with the curve recorded and the basis for it stated.
6. **Continuous logging of supply and return temperature** from the controller or the meter, available to the building manager — because a return temperature that is correct at commissioning and never looked at again will drift, and nobody will notice until the invoice or the operator says so.

SECTION 06

The *substation.*

Small, unglamorous, and responsible for the performance and the bill of the entire building for the next twenty years.

The substation is where the connection is realised. Everything the operator sees of your building, and everything your building experiences of the network, passes through it. It is also the item most often bought on price, because it looks like a package.

Heat exchangers

Plate heat exchangers are the normal choice: compact, efficient, and capable of a close approach between the two circuits. Selection is not simply a matter of duty.

- **Select at the temperatures the network will actually provide**, including the reduced supply temperature the operator intends in future. An exchanger selected with no margin at today's temperature may not meet duty at tomorrow's.
- **The approach temperature drives the achievable return.** A closer approach costs more plate area and allows a colder primary return. Given Section 05, that trade is usually worth making, and it should be an explicit decision rather than the outcome of a price comparison.
- **Separate exchangers for space heating and hot water.** The two loads have different profiles and different temperature requirements, and combining them compromises both.
- **Fouling and cleaning.** Specify whether gasketed and openable, or brazed and non-openable. Gasketed units can be opened, cleaned and re-plated; brazed units are cheaper and are replaced rather than serviced. For a long-life building asset the distinction matters, and it should be a conscious choice.
- **Space to remove and replace.** Confirm the route into and out of the room at design stage, with the plant room drawing.

Control valves and differential pressure

The primary control valves modulate network flow to hold the secondary temperature at set point. Two conditions must be met for that to work:

1. **Valve authority.** The valve must take a meaningful share of the circuit's pressure drop, or it will control coarsely and hunt. This is a sizing calculation, not a matter of matching the pipe diameter.
2. **A stable differential pressure across it.** Network differential pressure varies with what other buildings are doing and with the operator's pumping strategy. A differential pressure controller on the primary makes the valve's environment stable. Without it, control quality varies with the time of day and the outdoor temperature.

Metering

A heat meter is three components: a flow sensor, a matched pair of temperature sensors, and a calculator. EN 1434 is the European standard for thermal energy meters, and in most jurisdictions the meter used for billing is also subject to legal metrology requirements.

Points that decide whether the meter reads correctly for twenty years:

- **Sizing.** A meter oversized for the actual flow is inaccurate at the low flows that occur for most of the year — which is precisely the condition a well-performing building spends most of its time in. Size on the real flow range, not on the pipe.
- **Installation position and straight lengths.** Prescribed by the meter manufacturer and usually reinforced by the operator's rules. Get them from both.
- **Sensor pockets.** Correctly positioned and correctly immersed, on the pipes specified. A sensor in the wrong place produces a plausible, wrong reading indefinitely.
- **Strainer upstream.** Protecting both the meter and the exchangers.
- **Remote reading and data access.** Establish whether you can read your own consumption data, at what interval, and in what form. A connection whose data you cannot see cannot be managed — and Section 05 is unmanageable without it.
- **Calibration and verification.** Who is responsible, at what interval, and what the procedure is if the meter is found to be reading incorrectly.

Secondary-side equipment

- **Pumps** — variable speed, with a control strategy suited to variable flow. Constant-speed pumping on a variable-flow system wastes energy and encourages bypasses.
- **Expansion and pressurisation** — sized for the actual system volume and temperature range. Existing vessels in converted buildings are frequently undersized, waterlogged or both.
- **Safety devices** — safety valves, temperature and pressure limitation, discharge routed safely to drain. These follow the applicable heating system standards; EN 12828 is the European reference for the design of water-based heating systems in buildings.
- **Fill, make-up and water treatment** — the arrangement for filling and topping up, with backflow protection to the potable supply, and a defined water quality regime for the secondary circuit. Continuous unmonitored make-up is a leak with a longer name, and it destroys heat exchangers.
- **Insulation** — of everything in the room. An uninsulated substation heats a plant room all year at your expense.

> WATER QUALITY IS NOT A DETAIL
>
> Filling a new plate heat exchanger with the untreated water from an old building system — carrying sludge, corrosion products, and whatever has accumulated over decades — will foul the exchanger and degrade its performance within a season, and the symptom will present as a high return temperature that nobody can explain. Specify flushing of the existing system, filtration, a defined water quality standard for the secondary circuit, and a means of monitoring it. Then require evidence that it was done.

Controls

The controller is the cheapest item in the substation and it determines whether the rest of it performs. Require:

- **Weather compensation** for the space heating circuit, with the curve commissioned to the building and recorded
- **A hot water strategy** — priority, load limitation or parallel operation — stated and set to suit the contracted capacity, because hot water priority is one of the legitimate ways to hold the peak down
- **Return temperature supervision**, limiting primary flow if the return exceeds a set threshold, where the operator's conditions permit it

- **Night and unoccupied setback**, with an optimum start arrangement so the building is warm when it is used rather than heated when it is not
- **Frost protection**, independent of the main control strategy
- **Logging and alarms**, with supply and return temperatures, flow and energy recorded and retained, and the data accessible to the building manager

> THE COMMISSIONING RECORD IS PART OF THE ASSET
>
> Every set point in the controller — the heating curve, the hot water set point, the setback times, the return temperature limit — should be recorded on paper at handover, with the reason for each. Set points that exist only in the controller are lost at the first replacement, the first firmware update, or the first well-meaning adjustment by somebody who was cold. A building that has lost its commissioning record cannot be diagnosed; it can only be re-commissioned.

SECTION 07

Commissioning, metering *and the first winter.*

A connection that is energised is not a connection that is commissioned. The difference shows up on the invoice.

Handover on a district heating conversion tends to be defined by a single event — the day heat first flows. That is the least informative moment in the whole project. A substation can deliver heat on day one and still be badly balanced, wrongly compensated, over-contracted and returning water far too warm. None of that is visible from the fact that the radiators are hot.

The sequence

1. **Flush and clean the existing system** before the new heat exchangers are connected, with the result evidenced. Everything that was in the old pipework is otherwise now in your exchanger.
2. **Fill and treat the secondary circuit** to the specified water quality, and record the result.
3. **Pressure test** both sides as required, with the operator witnessing the primary side.
4. **Verify the meter installation** — position, orientation, straight lengths, sensor pockets — before insulation covers it.
5. **Set the primary differential pressure controller** and confirm valve authority in practice, not only in the selection sheet.
6. **Balance the secondary system** and record the measured flows circuit by circuit. This is the step most often skipped and most often the cause of the first winter's complaints.
7. **Commission the controls** — heating curve, hot water strategy, setback schedule, return temperature limit, frost protection — and record every set point with its reason.
8. **Verify performance** at the closest available approximation to design conditions, and record supply and return temperatures on both sides at measured load.
9. **Train the people who will operate it**, and hand over the documentation.

COMMISSIONING IN SUMMER PROVES VERY LITTLE

Most conversions complete outside the heating season, because that is when the building can be without heat. A system commissioned in July has not been tested at anything approaching design conditions, and the balancing, the heating curve and the return temperature cannot be properly verified.

The remedy is to plan for it rather than pretend otherwise: a **seasonal commissioning visit** in the first cold period, written into the contract and priced within it, at which the balance is checked under real load, the heating curve is adjusted to the building's actual response, and the return temperature is measured and recorded. Without that clause, the visit becomes a variation, and it usually does not happen.

What to measure, and what “good” looks like

The targets themselves come from the operator’s connection conditions and the designer’s intent — this guide states none, deliberately. What matters is that each of the following is measured, recorded against a stated target, and handed over:

Primary return temperature	At measured load, against the maximum permitted by the operator. Recorded in both heating and non-heating conditions, because the summer figure is usually the worse one
Primary and secondary temperature difference	Across each heat exchanger, at measured load, against the selection
Measured peak demand	Against the contracted capacity — this is the evidence for any later revision
Circuit flow rates	Measured, circuit by circuit, against the balancing schedule
Heating curve as commissioned	Recorded with the outdoor and flow temperature pairs actually set, not the factory default
Hot water delivery temperature and time to temperature	At representative outlets, against the applicable hygiene requirements and the design intent
Room temperatures	A sample across the building, near and far from the plant, at design-adjacent conditions — the practical test of whether balancing worked

The handover pack

- Design heat load calculation, with method, design outdoor temperature and assumptions
- Hot water demand calculation with the diversity assumption stated
- Contracted capacity, and the calculation supporting it
- Operator’s technical connection conditions, and the signed boundary-of-responsibility diagram
- Heat exchanger selection sheets at both current and anticipated future supply temperatures
- Meter details — type, serial number, size, sensor positions, calibration status and due date
- Flushing and water quality records for both circuits
- Balancing report with measured flows, circuit by circuit
- Full controller set point schedule with the reason for each value
- Performance record from the seasonal commissioning visit
- Operation and maintenance manuals, spares list, and the maintenance schedule
- As-built drawings of the substation and the distribution alterations

The first winter, and what to do in it

Three things are worth doing in the first heating season, and they are worth more than anything done after it:

1. **Read the meter data regularly.** Not the invoice — the data. Peak demand, daily energy, supply and return temperatures. A weekly glance for one season establishes what normal looks like, and everything afterwards is measured against it.
2. **Compare measured peak to contracted capacity.** If the gap is large, open the conversation with the operator while the evidence is fresh. This single action has the largest financial return of anything in this guide.

3. **Log the complaints and map them.** Cold rooms cluster. A pattern of complaints at one end of the building, on one riser, or on top floors, is a balancing diagnosis handed to you for free — and it is far cheaper to act on it in the first season while the contractor is still on risk.

SECTION 08

Where the *money goes.*

The structure of the cost, and which parts of it are decided by you rather than by the tariff.

This section states no prices. Connection fees, tariffs and construction rates are local, they change, and a figure printed here would be misleading somewhere and out of date everywhere. What is stable is the structure — what the money is spent on, which items are one-off and which recur, and which are within your control.

One-off costs

Connection fee	Charged by the operator, often related to contracted capacity. Frequently the item that most rewards getting the capacity calculation right
Service pipe and civil works	Excavation, the buried pipe, reinstatement, entry into the building. Scales with distance and with what the route crosses. Third-party land, public roads and recently resurfaced areas each add cost and time
Substation	Exchangers, valves, pumps, controls, pipework, insulation, electrical. The item most often value-engineered, and the item that determines twenty years of performance
Building-side works	Emitter upgrades where required, valve replacement, balancing devices, alterations at the plant room, hot water arrangement
Decommissioning	Removal of the boiler, the flue, the fuel storage and any associated tanks, plus making good. Fuel tank removal in particular can carry environmental obligations — establish them early
Fees and approvals	Design, supervision, permits, operator inspection, metering approval

Recurring costs

Capacity charge	Fixed, annual, driven entirely by the contracted capacity. See Section 04. This is the item that most rewards, or most punishes, the quality of the initial calculation
Energy charge	Variable with consumption, and therefore responsive to fabric, control and occupant behaviour
Return temperature component	Where the tariff includes one. Entirely within your control, and entirely determined by the work described in Section 05
Substation maintenance	Depends on who owns the substation — establish this at contract, because it is a twenty-year cost that is often assumed away
Metering	Meter rental, calibration or replacement, depending on the operator’s model

What is displaced

An honest comparison prices what disappears as well as what arrives. A building converting from its own boiler stops paying for fuel purchase and storage, boiler maintenance and annual servicing, chimney inspection and sweeping, statutory pressure vessel and burner inspections, operator or caretaker attendance, boiler insurance loadings, and — eventually — the boiler replacement itself. It also releases floor area: a fuel store, a chimney and a boiler room occupy space that has an alternative use.

Less easily priced, but real: the removal of combustion, fuel storage and a flue from the building changes its risk profile, and the building's emissions become the operator's problem rather than yours — which increasingly matters for institutional owners with reporting obligations.

> HOW TO PRESENT THE CASE, IF IT NEEDS APPROVING
>
> Compare like with like across a defined period, and state every assumption:
>
> - **Do-nothing is not a real option** where the existing plant is near end of life. The honest comparison is against replacing the boiler, with that cost and its date stated
> - Separate the one-off costs from the recurring, and state which recurring items are within the building's control
> - Show the capacity charge at the calculated capacity and at the inherited boiler rating side by side — the difference over twenty years is usually the most persuasive line in the paper
> - State the energy price assumption explicitly and test the result against a range, rather than presenting a single figure that depends on a price nobody can forecast
> - Include the building-side works. A comparison that omits the emitter upgrades needed to run at the operator's supply temperature is not a comparison

Where the savings actually are

In order of typical impact, and none requiring any reduction in comfort:

1. **A correctly calculated contracted capacity.** Recurring, permanent, and decided by one calculation performed before signature
2. **A low return temperature**, where the tariff rewards it — and, where it does not yet, insurance against the day it does
3. **Weather compensation and setback, properly commissioned**, reducing consumption every hour of every heating season
4. **Balancing**, which removes the overheated rooms that are paid for and then vented out of a window
5. **Fabric improvement** undertaken in the same programme, which reduces the design heat load and therefore the capacity that has to be contracted in the first place — which is why sequencing fabric works before the capacity calculation, rather than after, is worth planning for

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On savings claims generally. Any percentage saving quoted for a conversion depends on the building, the displaced fuel, the tariff, the climate and the occupancy. A figure quoted without a measured baseline for your specific building is marketing, not engineering. Establish the baseline first — a year of actual fuel consumption and actual internal temperatures — and everything after it can be evaluated honestly.

SECTION 09

The forty-point *readiness checklist.*

Take this into your feasibility study or your tender. If every box can be ticked before contract, the first winter will be uneventful.

A · BEFORE ANYTHING IS DESIGNED

- [ ] Operator's technical connection conditions obtained in writing
- [ ] Guaranteed supply temperature at design conditions confirmed, together with the operator's intention to reduce it
- [ ] Static and differential pressure at the connection point confirmed
- [ ] Maximum permitted return temperature confirmed
- [ ] Permitted connection type — indirect or direct — confirmed
- [ ] Tariff structure obtained, including the basis of the capacity charge
- [ ] Nearest connection point with confirmed spare capacity identified
- [ ] Service pipe route established, with land ownership and crossings resolved

B · SURVEY AND LOAD

- [ ] Design heat load calculated by an established method, not inherited from the boiler
- [ ] Design outdoor temperature and all assumptions stated in the calculation
- [ ] Planned fabric works included in the calculation, and sequenced before it where possible
- [ ] Hot water peak demand calculated separately, with the diversity assumption stated
- [ ] Emitter survey completed, with rooms inadequate at the operator's supply temperature scheduled
- [ ] Remedy for those rooms priced within the project
- [ ] Distribution pipework condition and hydraulic arrangement recorded
- [ ] Every bypass and constant-flow circuit identified and registered
- [ ] Existing water quality sampled and assessed
- [ ] Substation room confirmed for area, headroom, access route, drainage, ventilation and power
- [ ] Cost allocation method within the building agreed before design

C · CAPACITY AND CONTRACT

- [ ] Contracted capacity based on the calculation, with diversity applied and recorded
- [ ] Future extensions excluded from the contracted figure, with an agreed path to increase later
- [ ] Route and cost to reduce contracted capacity after the first winter established at signing
- [ ] Consequence of exceeding the contracted capacity established
- [ ] Boundary of responsibility drawn on a diagram and signed by both parties
- [ ] Ownership, maintenance and replacement liability for the substation stated
- [ ] Meter ownership, calibration interval and faulty-meter procedure stated

D · SUBSTATION AND CONTROLS

- [ ] Heat exchangers selected at both current and anticipated future supply temperature
- [ ] Approach temperature stated as a deliberate decision, not a price outcome
- [ ] Separate exchangers for space heating and hot water
- [ ] Gasketed or brazed construction chosen deliberately, with the service implication accepted
- [ ] Differential pressure controller fitted on the primary
- [ ] Control valve authority calculated, not assumed from pipe size
- [ ] Meter sized on the real flow range, with position and straight lengths per the operator's rules
- [ ] Access to your own metering data confirmed, with interval and format
- [ ] Two-port control on all new circuits; three-port arrangements removed or justified
- [ ] Weather compensation, hot water strategy, setback and return temperature supervision all specified

E · COMMISSIONING AND FIRST WINTER

- [ ] Flushing, water treatment and water quality regime specified with evidence required
- [ ] Documented hydraulic balancing required, with measured flows issued at handover
- [ ] Seasonal commissioning visit in the first cold period written into the contract and priced within it
- [ ] Full controller set point schedule, with the reason for each value, required in the handover pack

Readiness sign-off

Complete and retain with the feasibility study or the tender documents.

CONNECTION READINESS SIGN-OFF

Item	Name and role	Date and signature
Building and address		
District heating operator		
Technical connection conditions received		
Design heat load calculated by		
Contracted capacity proposed, with calculation attached		
Checklist points 1–40 confirmed		
Outstanding items listed and owned		
Released for tender by		

> IF YOU CAN ONLY DO THREE THINGS
>
> **One.** Calculate the design heat load properly, and contract the capacity on that figure rather than on the boiler being replaced.
> **Two.** Find and deal with every bypass, every three-port valve and every unbalanced circuit before connection, because they set your return temperature for the life of the system.
> **Three.** Write the seasonal commissioning visit into the contract and price it there, so that the system is verified once under real load.
>
> Those three carry most of the value in this guide.

REFERENCE

Standards referred to *in this guide.*

Listed by number and subject so that you can obtain and read them. Confirm the current edition, and the applicable national adoption, before citing any of them in a contract document.

STANDARDS REGISTER

Reference	Subject
EN 12831 series	Energy performance of buildings — method for calculation of the design heat load
EN 12828	Heating systems in buildings — design for water-based heating systems
EN 14336	Heating systems in buildings — installation and commissioning of water-based heating systems
EN 15316 series	Energy performance of buildings — method for calculation of system energy requirements and system efficiencies, including distribution and generation
EN 1434 series	Thermal energy meters — general requirements, constructional requirements, data exchange and tests
EN 13941 series	District heating pipes — design and installation of pre-insulated bonded pipe systems
EN 253	District heating pipes — pre-insulated bonded pipe systems, pipe assembly of steel service pipe
EN 448 · EN 488 · EN 489	District heating pipes — fitting assemblies, valve assemblies and joint assemblies for pre-insulated bonded pipe systems
EN 806 series	Specifications for installations inside buildings conveying water for human consumption
EN 1717	Protection against pollution of potable water in installations, and general requirements of devices to prevent pollution by backflow
EN ISO 12241	Thermal insulation for building equipment and industrial installations — calculation rules
ISO 50001	Energy management systems — relevant where the building or the estate operates a formal energy programme
VDI 2035	Prevention of damage in water heating installations — water quality guidance, widely applied across the region

HOW TO USE THIS REGISTER — AND WHAT GOVERNS ABOVE IT

Standards are revised, withdrawn and superseded. Verify the current edition with the national standards body applicable to your project, confirm whether a national adoption exists, and confirm that the clause you intend to rely on still says what you think it says. Nothing in this guide should be relied upon as a statement of the content of any standard.

For a district heating connection specifically, the operator's own technical connection conditions and the applicable national legislation govern above all of the above. Where they differ from anything in this guide, they prevail.

About APIS

APIS is an integrated engineering group founded in Kosovo, operating across the Western Balkans and into the European Union. The Group delivers mechanical, electrical, energy and infrastructure works through twenty-one delivery divisions across two strategic business units — Building Systems & Technologies, and Energy, Industry & Infrastructure — supported by four engineering excellence centres. APIS operates management systems certified to ISO 9001, ISO 14001, ISO 45001 and ISO 50001.

The **District Heating & Cooling Division** delivers connection and conversion projects from feasibility through survey, design, substation installation, building-side works, commissioning and seasonal verification. Work is delivered under the Group's DBOM lifecycle model — design, build, operate and maintain — so that the party which sizes the connection is accountable for what it costs to run.

Prepared by the APIS District Heating & Cooling Division · **Document** APS-GD-02 issue v1.0 of 18 August 2026 · **Contact** apisgroup.net/contact

Considering a connection, or living with *one that underperforms?*

The two numbers that decide your bill — contracted capacity and return temperature — are both set by work done inside your building. Our engineers will calculate the load, survey the building against the checklist in Section 09, and tell you what the connection should actually be sized for.

SPEAK TO THE DISTRICT HEATING & COOLING DIVISION

Connection feasibility · design heat load calculation · building-side survey · substation design and installation · balancing and seasonal commissioning · return temperature diagnosis

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