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Upskilling Professionals to Accelerate Heat Pump Deployment in Multi-Family Building Refurbishments

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Abstract

Retrofitting multi-family buildings with heat pumps at scale is constrained less by nominal device efficiency and more by hydronic, architectural and organisational conditions. We report a mixed-method study in the alpine space combining a practitioner survey (n = 93) with interviews and workshops to characterise obstacles, derive training needs and sketch a lightweight digital/process support. The sample of the survey is highly experienced (≈70% with >10 years) but planner-heavy (84 planners/consultants; 9 installers). Respondents rate an integrated refurbishment process as critical to success (mean 4.14/5). The most frequently cited limiting factors are high upfront cost and subsidy complexity; envelope–system integration where emitter surface or distribution temperatures are restrictive; sizing and control under low supply-temperature limits; domestic hot-water hygiene requirements; acoustic siting and space; and, in some cases, electrical capacity. Toolchains are fragmented: spreadsheets and manufacturer tools dominate routine practice, while dynamic simulation and BIM/CAD appear mainly in technically specialised offices. Satisfaction with available training is modest (planners ≈3/5; installers ≈2/5) and stated priorities map directly to the observed barriers—commissioning discipline and hydronic balancing on the installer side; co-design of envelope and system, sizing and control under temperature constraints, and financial argumentation for planners. Based on these findings we propose a pragmatic "workflow spine" that links requirement capture, variant definition, commissioning checklists and monitoring hooks, designed to be embedded in curricula and day-to-day practice. While results reflect Alpine and near-Alpine contexts and a planner-skewed sample, the evidence converges across methods and indicates that role-specific upskilling, coupled with simple process tools, is a credible near-term lever to improve quality and scale of heat-pump refurbishments in complex residential stocks.

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Keywords: heat pumps; multi-family buildings; refurbishment; integrated planning; commissioning; training and upskilling

1. Introduction

Decarbonising heat in Europe's existing building stock is central to the European Green Deal and to the EPBD recast, which together steer Member States toward whole-building performance and planned, staged renovation [1–2]. Heat pumps are pivotal to this shift. While European installations have grown rapidly since 2020, market dynamics have been uneven, making quality and workforce capacity decisive for sustained progress [3–4]. Recent market data illustrate both momentum and remaining opportunity in the study region: by 2022 the national heat-pump stock was around 1.67 million units in Germany and 0.43 million in Austria, while Italy had reached around 3.25 million units; at the same time, Italy alone still counts roughly 17 million households heating with gas boilers, indicating substantial retrofit potential [13–15]. National roadmaps and scenario analyses for Austria and Italy likewise identify heat pumps as a key lever in meeting 2030 and 2040 climate targets and explicitly call for accelerated deployment, skills development and streamlined framework

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conditions to realise these trajectories [9–11]. Evidence from demonstrations and reviews shows that seasonal performance hinges on distribution system temperatures, partial-load control, domestic hot-water (DHW) hygiene, acoustic siting, and the complexities of ownership and coordination, rather than on nominal device efficiency alone [5–6]. Skills and process therefore become the bottleneck. The IEA highlights installer capacity and training quality as preconditions for scale-up [3], and the Commission's Heat Pump Accelerator Platform targets coordinated action on skills, data and best-practice exchange [8]. At the single-family scale, the German BMWK project WESPE-SHK has recently documented typical installation workflows, installation times and bottlenecks for retrofits in existing detached houses and is developing process and training interventions together with the SHK craft sector—again underlining that process optimisation and workforce capability are central to achieving national heat pump targets rather than device technology alone [12]. Against this backdrop, the EU-Life Project KnowHowHP responds by empirically mapping obstacles and knowledge gaps among practitioners who plan and deliver multi-family retrofits and by translating these insights into role-specific upskilling and a pragmatic workflow backbone for multi-family refurbishment projects in Alpine and near-Alpine contexts.

2. Methods

We conducted a mixed-methods study with three components. First, a structured online survey captured role-differentiated practice realities in the alpine space in German, Italian and English. Ninety-three professionals participated: eighty-four planners/energy consultants and nine installers. Experience levels were high: sixty-five respondents reported more than ten years in the field, twelve reported four to ten years, five reported one to three years, and two were below one year (nine nonresponses). Figure 1 summarises experience levels across the sample. Role distribution was skewed toward planners (90% planners/consultants, 10% installers); we therefore triangulated survey results with ten semi-structured interviews and four workshops to foreground installer practice.

Second, ten semi-structured interviews with practitioners from design offices, installation firms and advisory bodies deepened and nuanced the survey results. Interviewees covered Austria, Germany and Northern Italy, with purposeful variation in project type and organisational role. Third, four themed workshops validated preliminary insights and elicited consensus around a practical integrated process map for refurbishment projects that involve envelope measures, distribution adjustments and heat pumps.

The questionnaire combined close-ended items on challenge significance, tool usage, collaboration patterns and satisfaction with training offers with open questions on obstacles and suggested improvements. Quantitative analysis used descriptive statistics; open responses were inductively coded and iteratively collapsed into policy/regulatory, technical, process/collaboration and financial categories. The integrated-process question used a five-point Likert scale. We recognise limitations: the role distribution is skewed towards planners, the sample is not statistically representative, and self-selection likely favours engaged practitioners. High experience levels, interviews and workshops mitigate these concerns by foregrounding real-project constraints.

3. Results and discussion

3.1. Professional profile

The study draws on ninety-three valid responses from practitioners active in multi-family refurbishments, with a pronounced skew toward planning roles: eighty-four respondents identify as planners or energy consultants and nine as installers (which all of them are also doing planning services). Experience levels are high across the board. As shown in Figure 1, nearly seventy percent of all respondents report more than ten years in the field, and every installer in the sample has over a decade of practice. This senior, planner-heavy composition suggests that the patterns reported here reflect mature practice rather than novice uncertainty and should be read with the role imbalance in mind.

Geographically, the respondent base spans Austria, Germany and northern Italy with a clear Alpine focus. Several participants report multi-regional or cross-border work, which aligns with the project's transnational scope and broadly comparable climatic and regulatory conditions across the Alpine corridor.

Hands-on exposure to multi-storey projects is substantial but heterogeneous. Among planners there is a long tail from no prior multi-storey heat-pump projects through a handful of cases to more than twenty, whereas installers report uniformly deep experience with both retrofits and heat-pump-only refurbishments. In interpreting subsequent results, it is therefore appropriate to treat the evidence as a window into experienced practice in Alpine and near-Alpine contexts; where on-site execution pain points might be under-represented due to the planner skew, we triangulate survey findings with interviews and workshops to bring installer realities and stakeholder perspectives into view.

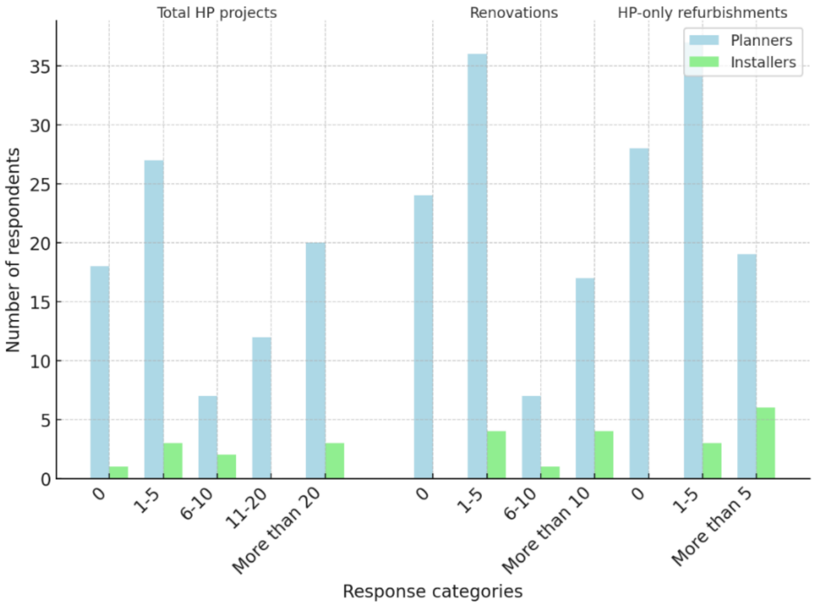

Figure 1. Respondents by years of professional experience (n = 93).

3.2. Challenge significance and obstacle clusters

As Figure 2 shows, respondents' ratings and open answers converge on a process-first barrier landscape. On the predefined significance scale, lack of space for installations, acoustic restrictions and high upfront costs are consistently rated among the most consequential challenges. In parallel, free-text answers cluster under coordination and hand-off issues across trades, hydronic compatibility and balancing, strategies to ensure DHW hygiene without locking in high supply temperatures, and friction linked to subsidies, permitting and approvals. Taken together, these patterns point to temperature regime, commissioning discipline and stakeholder coordination as the binding constraints rather than nominal device efficiency.

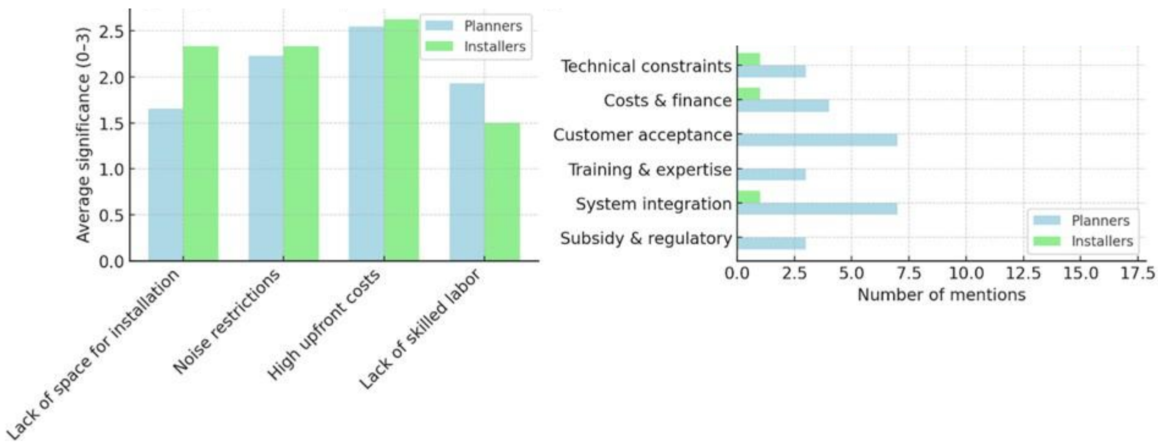

Figure 2. Challenge landscape: average significance of predefined challenges (left) and frequency of additional issues by cluster (right).

A cross-cutting theme is the centrality of achieving low distribution temperatures through emitter upgrades, hydraulic balancing and control tuning. This interpretation aligns with evidence from multi-country demonstrations in IEA HPT Annex 50 and with synthesised temperature–performance relationships reported by Lämmle et al [6].: seasonal performance hinges on the achievable supply temperature and the quality of hydronic design and commissioning; neglecting these factors undermines outcomes even where efficient equipment is installed [5–6]. Role-specific emphases are visible within the same pattern: planners tend to stress envelope–system integration, approval/subsidy complexity and toolchain fragmentation, whereas installers foreground commissioning practice, balancing, siting and noise—yet both groups agree on the salience of cost and space constraints. The strong stated preference for an integrated refurbishment process reported elsewhere in the results is therefore consistent with, and explained by, the obstacle structure depicted here. A descriptive stratification by primary operating country suggests that the obstacle patterns are broadly consistent across Austria, Germany and northern Italy: high upfront costs, space constraints and hydronic compatibility remain top-ranked in all three contexts, and the integrated-process importance rating stays high. Differences appear mainly in framework-related friction (subsidy and permitting practice) and in the relative emphasis on noise constraints, which is reported somewhat more strongly in the German subsample; given the modest and non-representative sample, these differences are interpreted qualitatively rather than as statistically robust cross-country effects.

3.3. Role-specific emphases

Figure 3 contrasts role-specific emphases and shows complementary—not contradictory—peaks. Planners and energy consultants foreground envelope–system interaction, sizing under restrictive supply-temperature limits, and the fragmentation of their digital toolchains, frequently noting the need to argue costs and subsidies to decision-makers. Installers emphasise commissioning discipline, partial-load behaviour, air removal and dirt separation, and the practical constraints of working in occupied buildings, including access, dust/noise management and tight installation windows. Both groups converge on the salience of cost and space. Read together, these patterns indicate that the limiting factors sit at the interface between temperature regime, hydronics and process coordination, which aligns with established guidance on hydronic balancing in multi-family buildings (Ruch et al. [7]) and with field evidence on the sensitivity of performance to distribution temperatures (Lämmle et al. [6]). The strong preference for an integrated refurbishment process reported elsewhere in the results is therefore consistent with the role-specific peaks depicted here.

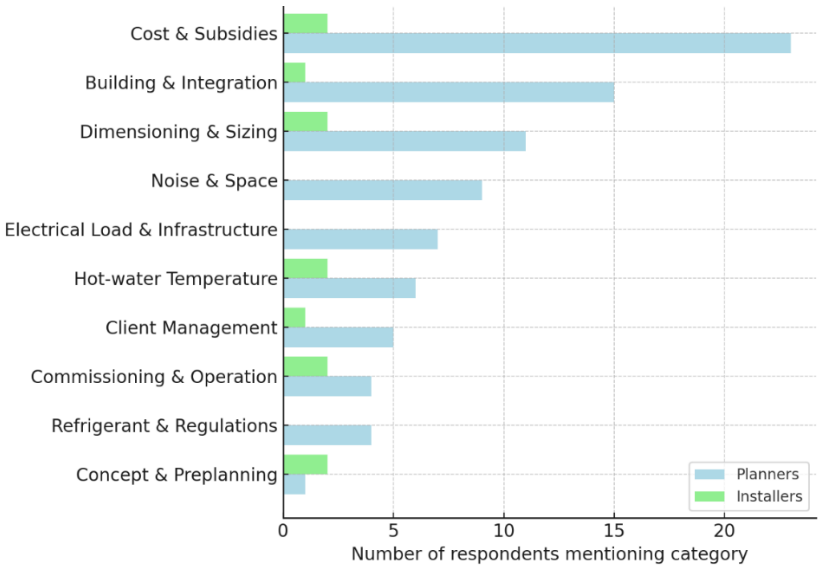

Figure 3. Role-specific challenges reported by planners/consultants and installers.

3.4. Installer challenge intensity and partial-load competence

Targeted questions to installers underline where execution risk concentrates. As Figure 4 indicates, upgrading or replacing radiators and distribution, managing occupant interfaces during installation, siting outdoor units under acoustic and spatial constraints, and handling vibration and noise mitigation are consistently rated from "challenging" to "very challenging." Partial-load competence is generally solid for seasonal operation principles and awareness of cycling risks, yet thinner where buffer-tank sizing and control, variable-speed pump settings, adaptive control under variable load, and coordinated defrost strategies require configuration beyond defaults (Figure 5). These findings translate directly into training priorities: commissioning checklists tied to temperature-regime targets, systematic balancing and air/dirt management, emitter upgrade criteria, and documentation standards that support fault finding—topics also reflected in Annex-level case material [5].

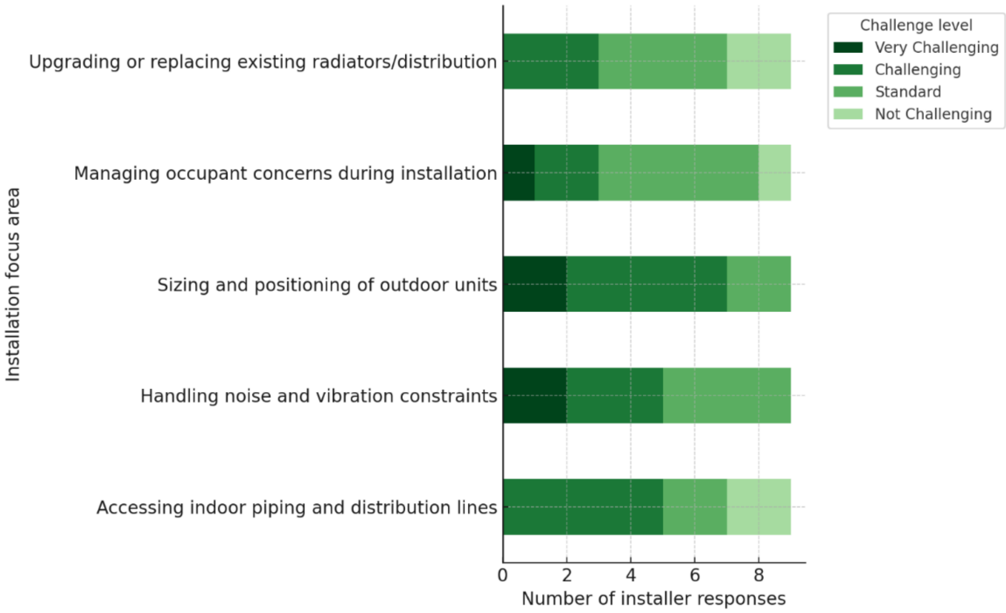

Figure 4. Installer-facing installation foci rated by challenge level.

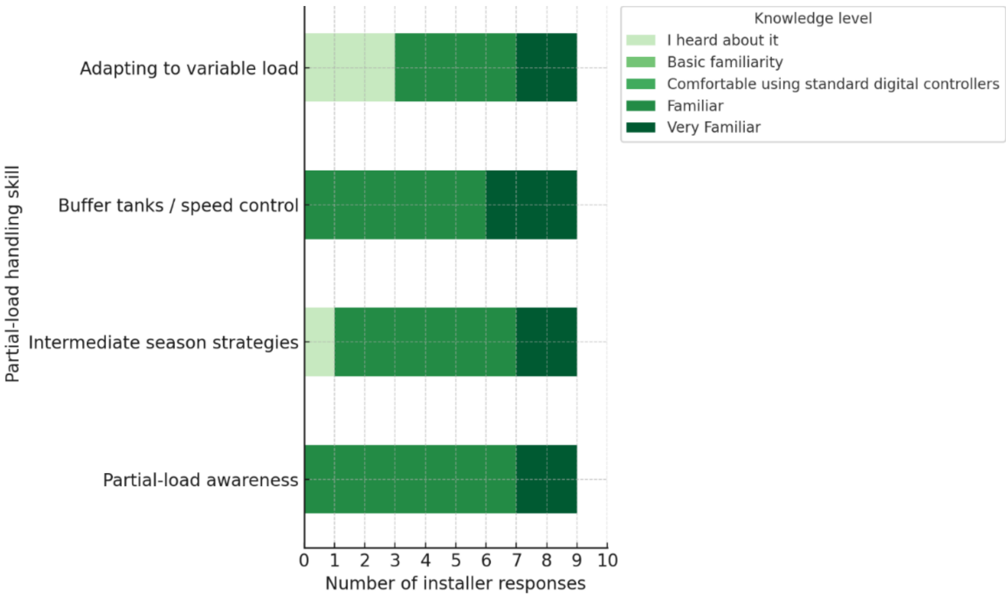

Figure 5. Partial-load handling skills: knowledge self-assessment for selected topics.

3.5. Toolchain fragmentation

The digital toolchain remains heterogeneous and brittle, as shown in Figure 6. Respondents report extensive reliance on spreadsheets and manufacturer-specific sizing tools for routine work, with dynamic simulation and BIM/CAD appearing mainly in technically specialised offices; custom in-house scripts and spreadsheet calculations are common among planners to bridge gaps. Data hand-offs are often manual, version control is ad-hoc, and few workflows maintain traceable assumptions from early sizing through commissioning.

Practitioners consistently ask for interoperability and workflow support rather than another monolithic simulator: import/export to common schemas, constraint checks around achievable supply temperatures and emitter suitability, links from design assumptions to commissioning targets, and simple ways to capture decisions for later troubleshooting. This preference echoes the European Commission's and the IEA's emphasis on best-practice exchange and training platforms as complements to industrial and market measures [3,8].

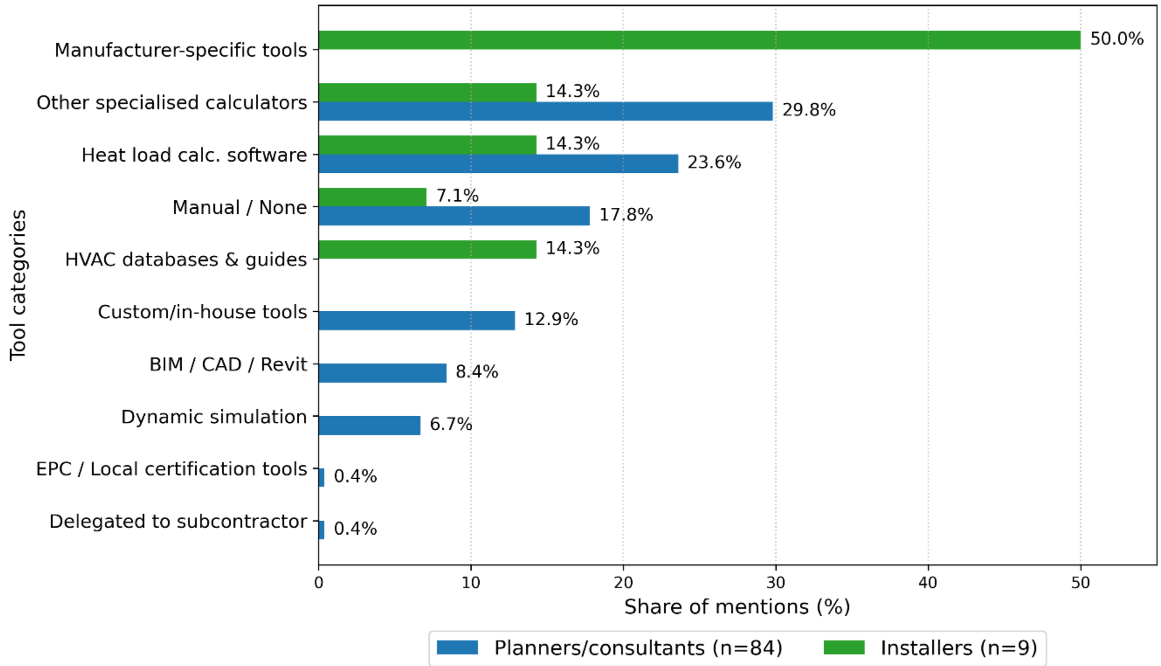

Figure 6. Planning tool usage reported by practitioners by role (planners/consultants n = 84; installers n = 9).

3.6. Collaboration patterns and appetite for process integration

Collaboration patterns show that early involvement of installers and structured engagement with occupants or homeowners' associations (HOAs) remain the exception rather than the rule (Figure 7).

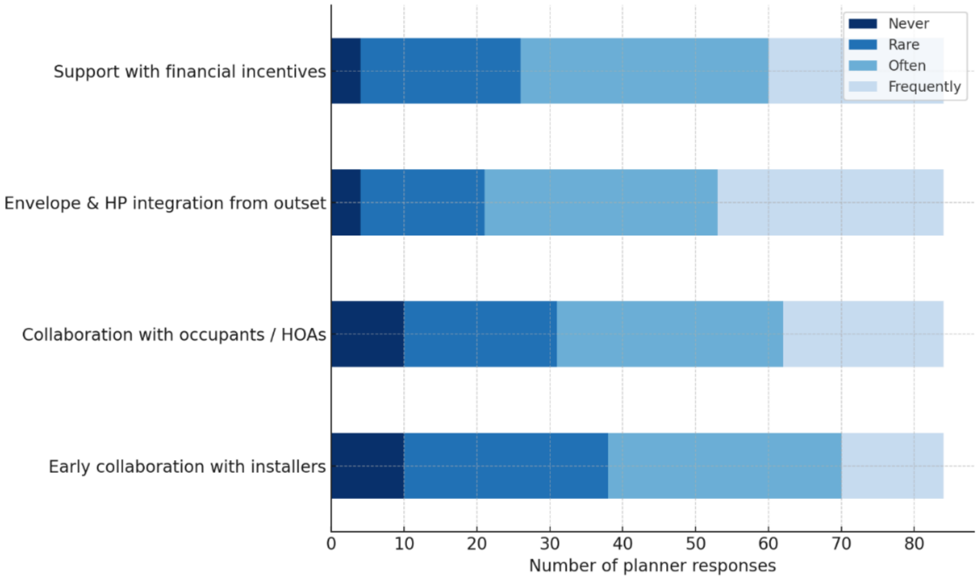

Figure 7. Collaboration patterns among planners (e.g., early collaboration with installers; engagement with occupants/HOAs), n=84.

At the same time, respondents express a clear willingness to change: the importance of an integrated refurbishment process clusters at the top end of the scale, with 33 responses at “4” and 40 at “5” (mean 4.14/5). Interviews explain the mechanism. An explicit, shared process map reduces rework and de-risks envelope decisions that carry hydronic implications, while making DHW/hygiene requirements—and their consequences for heat-pump selection and storage sizing—transparent across trades. This appetite aligns with the EPBD’s whole-building, staged-renovation logic [2] and with the Heat Pump Accelerator Platform’s focus on skills and knowledge transfer as enablers of reliable scale-up [8]. In short, practice is ready for integration; the missing pieces are shared structure and time to use it.

3.7. Satisfaction with and priorities for training

Satisfaction with existing training is modest among planners (mean 3.02/5; distribution 1:9, 2:11, 3:41, 4:15, 5:8) and low among installers (mean 2.0/5; distribution 1:3, 2:3, 3:3). Priority signals mirror the barrier map. Planners most frequently select energy-efficiency optimisation including occupant comfort (50 selections), financial analysis and subsidy navigation (46), an integrated refurbishment process (43), coordination with trades and occupant engagement (42), installation techniques including hydronic balancing and defrost cycles (40), and planning tools/dynamic simulation (35). Despite the small n, installers converge on the same core set, with particular emphasis on installation techniques, commissioning discipline, emitter/temperature-regime alignment and process integration. Free-text responses reinforce this picture, calling for checklists that tie design assumptions to commissioning targets (supply temperatures, flow rates, balancing), practical DHW strategies under hygiene constraints, and documentation standards that support troubleshooting. These empirical signals are consistent with broader European assessments that identify skills and training deficits—not nominal device efficiency—as the critical bottleneck to reliable, large-scale deployment [3–4,8]. Accordingly, core qualification priorities remain stable across the three countries, while modules on subsidies, permitting and documentation should be adapted to national schemes.

4. Implications for training and digital support

Satisfaction with current offers is modest for planners and low for installers, while priority selections cluster around commissioning discipline, hydraulic balancing, DHW strategies under hygiene constraints, envelope–system co-design, sizing and control under restrictive supply-temperature limits, and coordination with trades and occupants (see Section 3.7), while the integrated-process importance rating is shown in Figure 8. These preferences mirror the barrier structure identified in the survey and interviews—namely, that outcomes are governed by temperature regime, hydronic quality, and process coordination rather than nominal device efficiency—and they are consistent with multi-country demonstrations and field syntheses that tie seasonal performance to achievable supply temperatures and commissioning quality [5–7].

A scientific implication is that training should be role-specific, task-centred, and explicitly anchored in the temperature regime that a given building can credibly reach. For installers, this entails hands-on configuration beyond defaults: systematic air removal and dirt separation, balancing and pump speed control, emitter upgrades where required, buffer-tank criteria and coordinated defrost strategies, and DHW solutions that satisfy hygiene without locking in high distribution temperatures [6–7]. For planners and energy consultants, instruction should emphasise envelope–system co-design and variant definition under supply-temperature constraints, the translation of design assumptions into measurable commissioning targets, and the economic framing of options under national subsidy and approval regimes [2,5]. Given the planner-heavy sample and the lower satisfaction reported by installers, train-the-trainer pathways and case-based exercises are likely necessary to achieve reach and relevance in the installer base, while planners benefit from modules that improve cross-trade coordination and documentation practices [3,8].

Digital support should complement, not substitute, this competence. The evidence argues against introducing yet another monolithic simulator. Instead, a lightweight “workflow spine” is indicated, one that captures requirements, constrains variant generation by explicit supply-temperature limits, checks emitter suitability and distribution compatibility, and carries assumptions into commissioning via checklists and target values. Links to simple monitoring hooks then allow comparison of in-use data with design targets, enabling fault-finding and learning transfer. Interoperability with existing spreadsheets, manufacturer tools, BIM/CAD and documentation systems is essential, as practitioners already rely on these; the primary value of the spine is to make hand-offs explicit and verifiable rather than to replace incumbent tools.

In sum, Figure 8’s satisfaction and priority signals, together with the obstacle landscape reported in Sections 3.2–3.6, motivate a combined intervention: role-specific upskilling focused on temperature-regime attainment and commissioning quality, embedded in a simple, interoperable process tool that preserves traceability from early sizing to start-up and troubleshooting. The international evidence base on hydronics and temperature–performance relationships support this emphasis, and the policy framework provides a receptive context for its deployment [2,5–8].

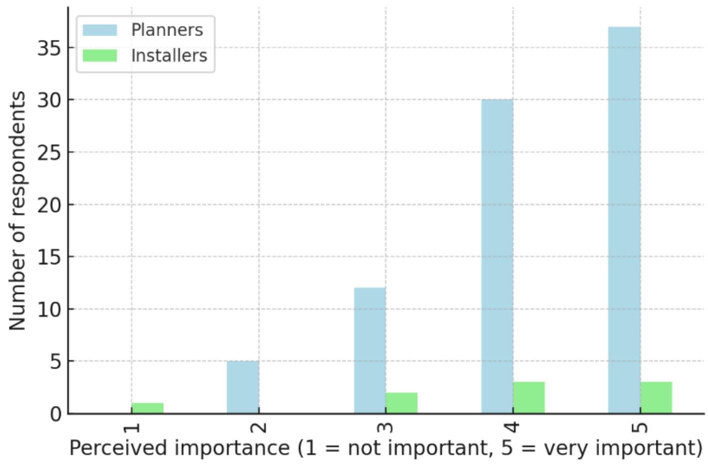

Figure 8. Importance of an integrated process for multi-family heat-pump retrofits, n=84+9.

5. Discussion and Conclusions

This study set out to understand why heat pumps struggle to scale in multi-family refurbishments and what kind of upskilling and process support would make the most difference in practice. Using a mixed-method design—survey responses from ninety-three practitioners triangulated with interviews and workshops—we find that the binding constraints are systemic and process-centred rather than rooted in nominal device efficiency. The sample is senior and planner-heavy, which means the signals described here reflect mature practice; where installer realities could be under-represented, qualitative material was used to bring execution pain points into view.

Across roles, the obstacle landscape is dominated by coordination and hand-offs, distribution compatibility under restrictive temperature regimes, DHW hygiene requirements, and siting constraints such as space and acoustics; in some contexts, electrical capacity also appears as a practical limit. These patterns are consistent with field syntheses linking achievable supply temperature and hydronic quality to seasonal performance. In short, outcomes hinge on reaching low distribution temperatures through emitter upgrades, balancing and control, thermal quality of the envelope, and on executing disciplined commissioning; neglecting these issues undermines results even where efficient equipment is installed. Toolchains are heterogeneous and brittle—spreadsheets, manufacturer tools and ad-hoc scripts carry routine work, while dynamic simulation and BIM/CAD are concentrated in specialised offices—which makes data hand-offs fragile and obscures traceability from early sizing to commissioning targets.

Collaboration practice has not yet caught up with these systemic needs. Early installer involvement and structured engagement with occupants or homeowners' associations remain the exception, yet practitioners strongly endorse a shift toward integration: the importance of an integrated retrofit process, considering heat pump and thermal quality of the envelope, clusters at the top of the scale (mean 4.14/5). Satisfaction with current training is middling for planners and low for installers, and the stated priorities map one-to-one to the identified constraints: commissioning discipline, hydraulic balancing, defrost and partial-load control, and DHW strategies on the installer side; envelope–system co-design under temperature constraints, financial argumentation and coordination/engagement on the planner side. These signals point to the same conclusion from two directions: reliable, scalable adoption depends on people knowing what to do together, in what order, and with what measurable targets.

A practical response follows directly. Rather than another monolithic simulator, practitioners ask for a lightweight workflow spine that couples requirement capture, variant definition under explicit supply-temperature limits, and simple checks for emitter suitability, with commissioning checklists and monitoring hooks that carry design assumptions into start-up and fault-finding. Such a spine should interoperate with existing tools, expose assumptions and targets at hand-off points, and provide regionally adapted templates for

DHW hygiene, acoustics, siting and subsidy documentation. Training should be role-specific and case-based, blending concise theory with hands-on configuration tasks and checklists that encode the above targets; a train-the-trainer pathway is likely required to reach the installer base at speed. Embedding this process support into curricula and day-to-day practice is the shortest path to quality at scale.

These recommendations are consonant with the EPBD's whole-building, staged-renovation thrust and with EU-level coordination efforts that explicitly link market measures to skills and knowledge transfer [1–3,8]. Policy can reinforce them by simplifying approvals and subsidy interfaces around transparent performance targets (e.g., documented temperature regimes and balancing), by recognising pre-approved solution packages for typical multi-family typologies, and by supporting shared repositories of commissioning/monitoring templates and anonymised case data.

Two limitations should frame interpretation. First, the installer sample is small relative to planners; second, results reflect Alpine and near-Alpine contexts where stock, tariffs and regulation have specific characteristics. Future work should replicate the survey in additional markets, pair the proposed workflow spine with pilot trainings and measure learning transfer into commissioning outcomes, and link monitoring data to pre-defined design targets to quantify how process discipline translates into seasonal performance.

Taken together, the evidence converges: heat-pump retrofits in multi-family buildings are an integration problem. Role-specific upskilling, executed within a simple, shared process and supported by interoperable tools, is a credible near-term lever to raise quality and scale—delivering outcomes aligned with European policy direction while reducing rework, de-risking envelope and DHW decisions, and making scarce expert time count where it matters most.

6. Limitations and future work

The sample over-represents planners relative to installers; interviews and workshops were used to foreground installer perspectives, and future studies should deepen installer sampling. Findings are derived from Alpine/near-Alpine contexts (Austria, Bavaria, Northern Italy) and should be re-tested where stock, regulation and electricity prices differ materially; survey n is modest for installers (n=9), so we use interviews/workshops to bring on-site realities into view. While the survey focuses on Alpine and near-Alpine practice, most identified constraints (temperature regime, hydronic integration, DHW hygiene, ownership/coordination) reflect generic multi-family retrofit characteristics; Alpine-specific factors (e.g., siting constraints and winter operating conditions) primarily affect the intensity rather than the type of barriers. Subsequent KnowHowHP phases will pilot the curriculum and toolbox with pre-/post-assessment of competence and project outcomes, including commissioning quality metrics and realised temperature regimes—an approach consistent with EU calls to couple deployment with quality assurance [2–3,8].

7. Outlook

Over the next two years, the insights generated in this study will form the foundation for the development of targeted training programmes for installers, planners and energy consultants. These courses will be delivered by the KnowHowHP project partners in southern Germany, Austria and northern Italy, allowing for regionally adapted content that reflects differences in building stock, subsidy schemes and regulatory frameworks. The training will operationalise the integrated renovation process highlighted in this paper and embed the emerging workflow spine and toolchain concepts into practice-oriented modules.

By the end of the project, the combined training and digital support package is expected to provide a replicable model for cross-trade upskilling and process integration in multi-family heat-pump refurbishments—addressing the systemic barriers identified in this study and offering a pathway for wider European adoption.

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