T7.2: User manual

Tool: Toola — T7.2 Cleanroom-Oriented Technological Chain Optimization Tool (HVAC: ventilation, heating, cooling, humidity control)

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UI language: English (field names in this manual match the interface)

1. Purpose

T7.2 is the **HVAC** module in Toola (Step 2 tile T7.2 – Cleanroom-Oriented Technological Chain Optimization Tool). It provides a screening-level annual balance of ventilation, cooling, heating and humidity control (dehumidification / humidification) for research spaces, and folds it into the T4.1 electrical chain.

The module lets you:

enter building design conditions (summer / winter / humidity / envelope),
define zones in the **HVAC Advisor**, compose the air-handling unit (AHU code compatible with T7.1) and compute peak AHU capacities and annual energy,
enter or import ready-made annual equipment packages,
view the electricity split (fans / cooling / dehumidification / humidification / heating), fuel CO_2, lifecycle cost and an indicative climate horizon.

It is not detailed HVAC design, an hourly simulation, BMS/SCADA or a PLC generator. The humidity calculation is a design-point h-x balance plus an annual bin estimate, not a full psychrometric simulation.

2. Relation to T4.1

Both tasks live in **one workflow**:

Step 1 (location, SSP, horizon) is shared,
in Step 2 you turn on the **T7.2** tile — alone or together with T4.1,
HVAC electricity is added to Level 3 demand (Total Annual Demand = base + HVAC); HVAC fuel CO_2 enters the facility operational balance.

If T4.1 is off and T7.2 is on, you work in HVAC-only mode. Step 1 is still required for location and the climate API.

3. Getting started

On the landing page click **Start Toola Assessment**.
Complete Step 1 (see T4.1 User manual, Section 5).
In Step 2 tick **T7.2 – Cleanroom-Oriented Technological Chain Optimization Tool**.

If both modules are on, switch **Electrical** / **HVAC** tabs in Steps 2–5.

The header links **Methodology** (includes the HVAC methodology PDF) and **User Manuals** are available at any time.

HVAC configuration is stored in the browser (`toola.hvacVztConfig.v1` and session `toola.session.v1`). To transfer a case, use **Download Config (JSON)** in Step 5.

4. Step 2 — Building & Climate

The HVAC tab in Step 2 has four cards: **Summer**, **Winter**, **Humidity**, **Building**. Changes are saved continuously.

4.1 Summer

Field	Default	Meaning
Outdoor design (°C)	32	Summer outdoor design temperature
Wind (m/s)	3	Context; not used in peak capacity
Indoor — operation (°C)	24	Indoor temperature during operation
Indoor — off hours (°C)	28	Off-hours (context)
Max indoor summer (°C)	26	Limit (context)

Outdoor design and **Indoor — operation** enter the Advisor sizing engine (envelope + ventilation). Other summer fields are design context.

4.2 Winter

Analogous: Outdoor design default −12 °C, Indoor — operation 21 °C, Indoor — off hours 16 °C, Min indoor winter 18 °C, Wind 5 m/s. Heating peak uses outdoor design and indoor operation.

These design temperatures are **not** replaced automatically by the Copernicus annual mean. The Step 1 API supplies annual-mean **temperature** (the T7.2 climate data query) for the horizon table; the user enters design extremes (see T7.2 Part B).

4.3 Humidity

Used by zones with the **Dehumidification & humidity control** principle in the HVAC Advisor (laser and optics halls, clean rooms, metrology labs, sample stores, IT rooms).

Field	Default	Role in the calculation
Indoor humidity target (%)	45 (20–70)	RH held in dehumidified zones at the summer operating temperature. Can be overridden per zone (Advanced config).
Outdoor design dew point (°C)	18	Highest outdoor dew point the plant must handle (e.g. ASHRAE 0.4 % dehumidification condition).

With a dew point entered, the engine computes summer dehumidification (latent load, cooling-coil over-cooling and reheat) from an h-x (Mollier) balance at the design point and an annual bin estimate, and — if the AHU has a humidifier — winter humidification. If the dew point is left **empty**, the simplified legacy +12 %

latent allowance on cooling is used instead and no humidification is calculated. The card shows a live summary (required coil dew point, etc.).

4.4 Building

Field	Role in the calculation
Thermal resistance R ($m^2 \cdot K/W$)	Envelope: UA = area / R. Default 2.5.
Energy label (today)	A–E. Context, not an equation input.
Peak / Off-peak HVAC power (kW)	Context for installed capacity.
Heat source	Heat pump / Electric / Direct gas / District / water — whether heat (incl. reheat and humidification heat) is electricity or fuel.
Cooling source	Heat pump / Water chiller — COP/EER from reference assets.
District/water primary source	Shown for District / water: gas-fired, industrial waste heat, geothermal, biomass, other. Sets the heat emission factor.

5. Step 3 — AHU Devices

Routes to a package:

HVAC Advisor — recommended for new zones,
+ Add configuration — manual row,
Import JSON — external package snapshot (one package, an array or `{ "packages": [...] }`).

One empty row is shown by default. A row enters the totals when it has a **Device ID** and **Revision** and no validation error (e.g. duplicate Device ID + Revision); errors are shown in red under the row. Advisor, manual and imported rows are marked accepted automatically.

5.1 HVAC Advisor

HVAC Advisor opens the zone wizard.

Zone type: Office / admin, Laboratory, Clean room / controlled environment, Laser / beamline hall, Server / IT room, Machine / equipment hall, Auditorium / meeting, Storage / warehouse, Sanitary (WC / shower), Kitchen / canteen. The reference norm for the type is shown.
HVAC principles (pre-selected by zone type, click to toggle): Dehumidification & humidity control, Outdoor air & ventilation, Heating & cooling loads, Local exhaust, Pressure cascade, Process heat removal, High-efficiency filtration.
Zone parameters: Zone name, Volume (m^3), Occupancy (persons), Air changes (1/h). Occupancy is pre-filled from volume and type; a manual edit is kept. **Use recommendation** restores the default.
AHU composition (AHU Naming Convention · T7.1) — suggested from zone type, principles and the Step 2 heat/cool sources; each axis can be changed:
Airflow, Heat recovery, Cooling, Humidity, Control (one choice each); Heating and Special (several chips each),
Heat recovery efficiency (%) — default from Ecodesign (EU) 1253/2014: 73 %, run-around coil 68 %; this value feeds the sizing engine,
Moisture recovery (supply + extract units) — none / enthalpy plate / sorption rotary wheel,

Humidifier (zones with humidity control) — electric steam / adiabatic water spray / none (dehumidification only).

The resulting code (e.g. `AHU-SAEA-ROT-WC-WCC-NHU-CAV`) and warnings are shown live. **Reset to suggested** discards custom choices.

Optional **Advanced config** — Operating hours, Fan SFP, EFLH cooling, EFLH heating, Zone RH target, Outdoor-air share, Winter RH target, RH tolerance, Process moisture, Latent EFLH override. Blank field = zone-type default.
+ Add to list — zone into the proposed list on the right.
Apply to Step 3 — the sizing engine runs for each zone and creates an editable AHU row.

The Advisor shows **Sources & methodology** (European standards behind the defaults: EN 13779, EN 16798-1/-3, EN 14825, Ecodesign) and the PECD annual-mean outdoor temperature when Step 1 is loaded.

One larger device may serve several zones if it has enough capacity — the model does not merge zones into one AHU automatically; you can combine values manually in Step 3.

5.2 AHU row fields

Group	Fields
Identity	Device name, AHU code, Device ID, Revision, Served zones, Quality (estimated / modelled / measured)
Capacity	Fan design power (kW), Cooling capacity (kW), Heating capacity (kW), Heat recovery (%)
Annual energy	Fan elec., Cooling el., Heating el., Fuel (MWh/yr), Fuel CO_2 (t/yr)

A valid AHU code shows ✓ **T7.1 compatible** with **Copy code** and **Open T7.1 ↗** (opens the device in the T7.1 repository of program blocks). Advisor rows also show zone type, volume and a humidity-control badge. If fuel is entered but Fuel CO_2 is 0, a warning appears (fuel emissions then count as 0 t).

After Advisor acceptance, all numbers in the AHU fields remain **editable**.

6. Step 4 — HVAC energy balance

HVAC tab in Step 4:

metric cards: **HVAC Electricity** (fan + cooling + heating), **Design Capacity** (cooling / heating / fan kW), **Share of Facility Demand**, **Fuel CO_2** and — with humidity-controlled zones — **Humidity control** (MWh/yr and range),
HVAC Supply Breakdown — fan, cooling (sensible), dehumidification (latent + reheat), humidification, heating (electric), humidity-control heat (fuel / district), heating fuel,
HVAC Climate Development & Horizon (see Section 7),
HVAC energy & direct fuel CO_2 table per package (CSV export),
Lifecycle CO_2 / CAPEX / O&M — HVAC per package.

Heat delivered as fuel/district heat is not added to electricity again. The shared top of Step 4 (national mix, demand metrics) includes HVAC electricity in Total Annual Demand when the module is on; HVAC electricity CO_2 is part of grid CO_2 on the Electrical tab.

7. Step 5 — HVAC Results

Humidity control (dehumidification & humidification) — results & recommendations — design loads, required coil dew point, reheat, humidifier electricity, h-x (Mollier) chart of the summer/winter processes per zone and humidity-specific recommendations (shown when humidity-controlled zones exist),
HVAC annual package overview, **HVAC Carbon Overview (Lifecycle)** and **HVAC Investment Overview** (CAPEX, O&M, embodied CO_2 from reference assets scaled by design capacity),
HVAC summary,
HVAC Climate Development & Horizon: temperature and relative humidity (start / end / change / P10–P90) plus an indicative cooling / heating / dehumidification projection for Advisor packages.

The projection **does not overwrite** demand, import, self-sufficiency or economics — those stay on the as-configured totals. It is a planning signal, not a new balance.

Step 5 recommendations may flag a high HVAC electricity share, warming vs. cooling load or missing heat recovery. They are not commissioning approval or a controls change order.

8. Export and comparison

Action	HVAC content
Download Config (JSON)	Packages + facility context (design temperatures, humidity, heat/cool sources) + climate snapshot
Import Config (JSON)	Restores HVAC as well as electrical
Download Full Report (PDF)	HVAC section including humidity control, h-x charts and horizon
HVAC methodology PDF	Header → Methodology; standalone module methodology
Compare Configurations	HVAC electricity in demand; climate snapshot from the export
User manuals (PDF)	Header → User Manuals

The main JSON and report need not carry the full internal Advisor state; accepted packages and Step 2 context are what matter.

9. Recommended workflow

Step 1: location and SSP (shared).
Step 2: turn T7.2 on; fill summer/winter design temperatures, humidity target and dew point, R; choose heat/cool source.
Step 3: HVAC Advisor → zone type, principles, parameters → check AHU composition → Add to list → Apply to Step 3.
Check kW and MWh in the AHU rows; overwrite if needed.
Steps 4–5: split, humidity control, CO_2, horizon. If T4.1 is also on, confirm HVAC electricity raised Total Annual Demand.
Export JSON / PDF.

10. Common situations

Situation	Check
Empty HVAC Steps 4/5	No valid package (missing Device ID / Revision); Advisor without **Apply to Step 3**.

Zero MWh after Advisor	Volume 0, air changes 0, or load principles off.
Heat in both electricity and fuel	Heat source: heat pump/electric → electricity; gas/district → fuel.
No dehumidification result	Zone lacks the Dehumidification & humidity control principle, or the outdoor dew point is empty (legacy +12 % mode).
No winter humidification	Humidifier set to None — dehumidification only, or airflow is extract-only.
AHU code “Not readable by T7.1”	Fix the code in the row or re-apply from the Advisor.
Horizon not shown	Only packages from the HVAC Advisor are projected; ΔT from the API is required. Manual/imported packages are not projected.
Different temperature in Advisor vs. PECD	Design extremes (Step 2) vs. annual mean (API) — deliberately different quantities.

11. Legal disclaimer

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