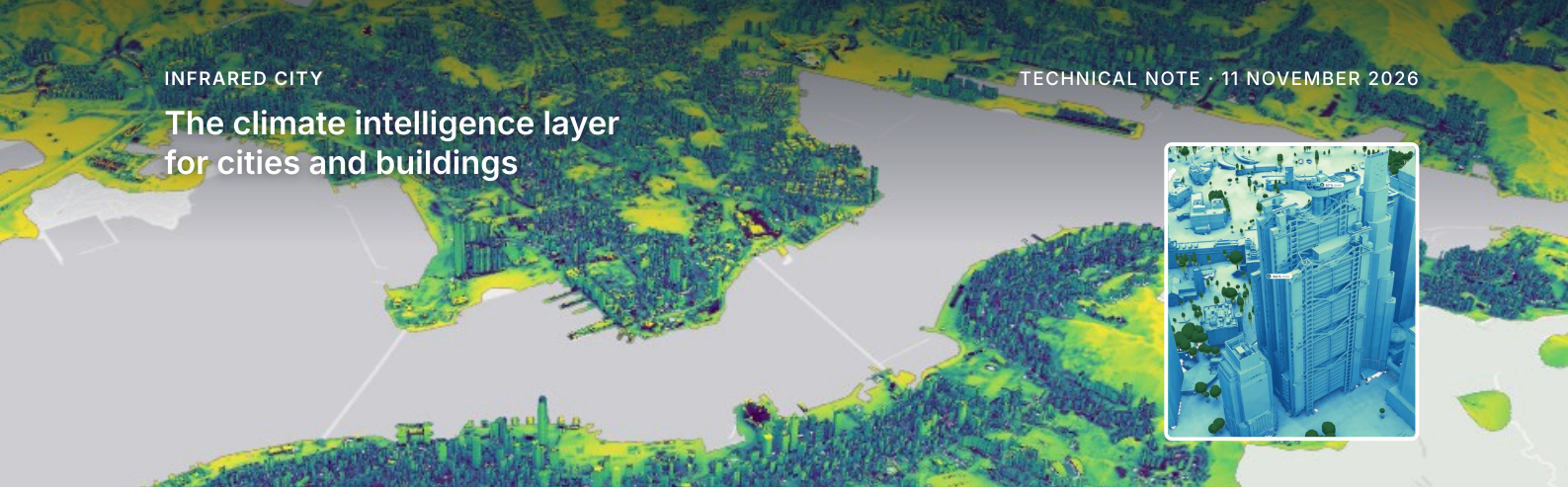


INFRARED CITY

The climate intelligence layer for cities and buildings

TECHNICAL NOTE · 11 NOVEMBER 2026

Banner: Hong Kong, hours of direct sun per year on streets, parks, façades and roofs, from the Infrared City digital twin. Base data: Lands Department, HKSAR; Census and Statistics Department; Esri basemap; OpenStreetMap contributors.

# Fast enough to have impact.

Checked against street measurements. Compared with PALM-4U.

Infrared City shows heat, sun, wind and comfort for any site, from one building to a whole city. One 512 m × 512 m scenario takes about 5 seconds (standard mode).

OUR QUESTION

## Does a fast tool give the right answer for a **design decision**?

Every model simplifies reality. The question is: which model is ready when the decision is made?

**Infrared City complements detailed simulations such as PALM-4U.** It adds fast iterations for design decisions: many options in seconds, with the same direction of impact.

KEY RESULTS

A · STREET MEASUREMENTS

**3 of 4 sites**

lower error than SOLWEIG, a widely used research model for street heat

Same geometry and weather. Melbourne about equal

SPEED

**~5 s vs ~1 h**

one 512 m × 512 m scenario

Standard mode vs PALM-4U on 64 cores

B · PALM-4U

**r = 0.92–0.94**

same pattern of cooling as PALM-4U

Cooling about half as strong as PALM-4U in Prague

B · PALM-4U

**0–3 of 1,655**

cells with an opposite change

Prague, three tree scenarios

B · PALM-4U

**−4.2 vs −4.3 °C**

cooling below new trees

Gothenburg, standard mode

Error = typical error (RMSE) of the radiant temperature (Tmrt); lower is better. 1 K is about 0.3–0.5 °C of felt temperature (UTCI).

FUNDED AND SUPPORTED BY

# A Against street measurements

This is our main test of quality: we compare with real instruments, not with a model. Instruments in the street measure the radiation that reaches a person. This gives the mean radiant temperature (Tmrt). We compared Infrared City with these measurements at four sites on three continents. We ran SOLWEIG with the same geometry and weather.

| Site | Climate | Measured | Infrared City | SOLWEIG |
|---|---|---|---|---|
| Gothenburg, Sweden | mild, wet | 85 hours | **4.5** | 5.0 |
| Phoenix (Tempe), USA | hot desert | 438 points | **11.1** | 14.3–15.7 |
| Guelph, Canada | cold, wet | 140 points | **9.7** | 12.3 |
| Melbourne, Australia | mild, wet | 989 points | **11.8** | 12.5 |

**Table 1.** Typical error of Tmrt against the instruments (RMSE in K). Lower is better. Details: scope note below.

## Lower error than SOLWEIG at three of four sites; Melbourne about equal.

**Weak spots:** in Guelph the sample is small. Guelph, in shade: +7 K (Infrared City is too warm).

### The geometry is different

SOLWEIG uses a height map: one height for each ground cell. It cannot see under a roof or a bridge. Infrared City uses the 3D model as given.

In Phoenix, under roofs and bridges, the error of Infrared City is 39–49 % lower. But it is still too warm there (+9.7 K). Better, but not solved.

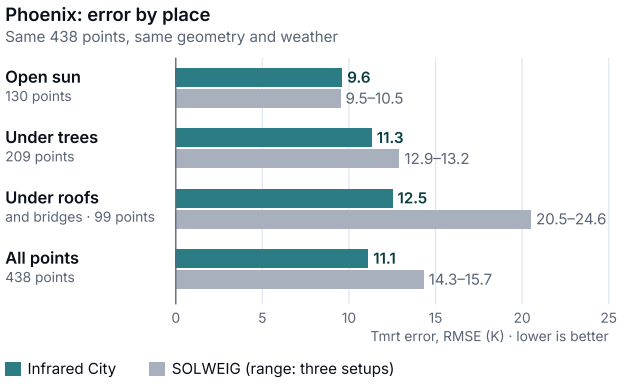



**Figure 1.** Phoenix: typical error of Tmrt, by place. Source: Infrared City validation data, October 2026.

### SCOPE OF TEST A

**Measurements.** Six-direction radiometers in Gothenburg (3 sites), Phoenix (one park) and Guelph (9 of 23 sites kept after a sky-view check); globe thermometers in Melbourne (3 courtyards). Measured weather of the test days. **Melbourne.** Corrected site positions; City of Melbourne building and tree data. Globe reference recomputed with the ISO 7726 forced-convection formula; the globe diameter (150 mm) is an assumption. With the Tmrt as published (with the City of Melbourne input data): equal within 0.2 K. Station positions inside the courtyards and the Guelph site model are approximate. **Phoenix.** Rebuilt site model; SOLWEIG range = three setups. **Gothenburg.** With trees as single points ("point view"), Infrared City gives 6.1 K. **SOLWEIG versions.** UMEP SOLWEIG v2025a (Phoenix, Melbourne); solweig Python package 0.1.0b96, an experimental port (Guelph); default settings (Gothenburg).

# B Side by side with PALM-4U

PALM-4U is also a model, with its own simplifications. We ask: do two independent methods give the same direction of impact? We ran both on the same areas, weather and sun, without and with new street trees. We compare the change on 10 m blocks, the scale of a design decision.

## B.1 Prague: three scenarios

In one Prague street we tested 1, 5 and 10 new trees. The change maps agree: r = 0.92 to 0.94. Where Infrared City cools by more than 1 °C, PALM-4U cools too, in 93 to 100 % of the area. Only 0 to 3 of 1,655 cells change in opposite directions. Both models put the three scenarios in the same order.

## B.2 Gothenburg

In Gothenburg we tested a new group of street trees. The change maps agree: r = 0.94. The cooling below the trees is almost the same: −4.2 °C in Infrared City and −4.3 °C in PALM-4U.

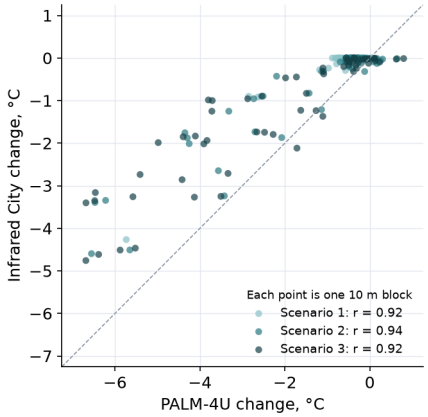



**Figure 2.** Prague: change of felt temperature (UTCI) per 10 m block, PALM-4U against Infrared City (local-wind option), three scenarios (62 blocks each). Dashed line: equal change.

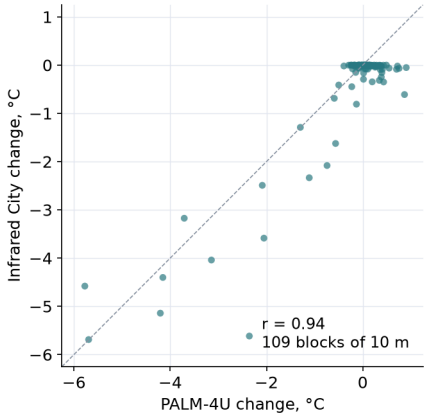



**Figure 3.** Gothenburg: change of felt temperature (UTCI) per 10 m block within 50 m of the new trees (109 blocks), standard mode. Dashed line: equal change.

The size of the cooling differs: Infrared City gives about 0.5–0.6 of the PALM-4U cooling in Prague and about 0.9 in Gothenburg.

> **Why the size differs**
>
> PALM-4U works on a grid of 2 m blocks. Façades become staircases and tree crowns become boxes. Infrared City uses the 3D model. Each model simplifies the city in its own way; part of the differences come from this.

### SCOPE OF TEST B

Two models side by side, not measurements. Two districts, one sun position each: Prague (16 July 2024, 10:00 UTC, 512 m × 512 m) and Gothenburg (7 July 2010, 12:00 UTC). Prague runs used the local-wind option; Gothenburg the standard mode. In Gothenburg, the local-wind option gives more cooling below the trees (−6.2 °C). On 2 m cells the Prague change maps give r = 0.85 to 0.86. The PALM-4U runs are idealized: small domain, fixed sun, 90 minutes; values are means over minutes 60 to 90. The air warms during such a run, so the absolute PALM-4U level depends on the period. Infrared City was 1.9 to 3.8 °C warmer in Prague and 0.5 °C cooler in Gothenburg; this largely cancels when two options are compared. In the PALM-4U run without trees the tree module was off, so the ranking is more reliable than the absolute size. Inside areas fully in sun or fully in shade the agreement is low; it comes mainly from where the shade falls, the main design lever.

## C Why speed matters: 20 variants in one meeting

A planner asks many questions: this street or the next one, few trees or many. If each answer takes an hour and a specialist, the simulation is done once, at the end. If each answer takes seconds, a design team can test 20 variants in one meeting. It answers “which option is better?” in seconds, PALM-4U “what exactly happens here?” in hours to days. Both have a job.

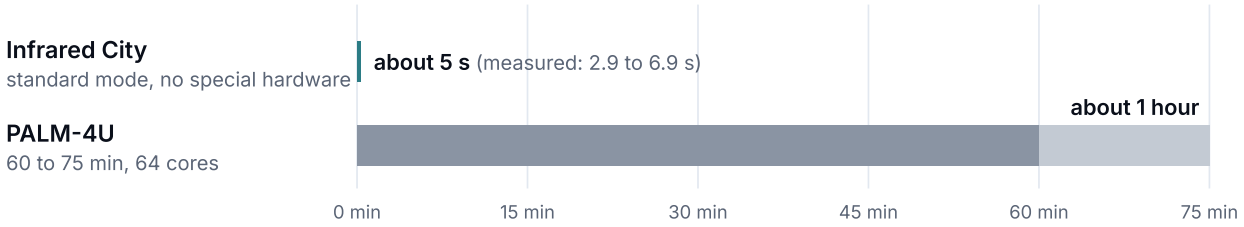



**Figure 4.** Time for one 512 m × 512 m scenario, on a linear scale. The two systems are different; this is not a controlled speed test.

| | PALM-4U 25.10 | Infrared City |
|---|---|---|
| Preparation | Grid input files, flow driver, solver tests; specialist work | 3D model with the measure, one weather row |
| A whole city | No standard time; it grows steeply with area and detail. Example: Bochum, 8.8 km × 8.5 km: 11 days on 112 cores | 400 km² in 44 s (one analysis at ground level); 100 km² in about five minutes (eight analyses, with façades). Infrared City measurements |

**Table 2.** Speed and effort, from request to result, on different systems. Bochum: van der Linden et al. 2023, PLOS Climate 2: e0000197.

## D What we claim, and what we do not

| Shown | Not claimed |
|---|---|
| Lower error than SOLWEIG at three of four measured sites; Melbourne about equal. Better under roofs and bridges, where the 3D model counts | A correct absolute value everywhere (error 4.5 to 11.8 K by site; Phoenix under roofs +9.7 K). Results for every climate: four measured sites, one park in Phoenix |
| The same ranking of the three Prague scenarios as PALM-4U, and the same pattern of cooling (r = 0.92 to 0.94) | An exact size of the cooling (see B). The absolute UTCI level in the PALM comparison (offset −0.5 to +3.8 °C) |
| Fast answers that complement PALM-4U in design decisions | That Infrared City replaces PALM-4U for a climate study or an expert opinion |

**Table 3.** What the results support, and what they do not.

## E Next step: a pilot in one Prague district

One district, a few design variants, a short report.

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# F What a planner can test with Infrared City

| | | | | |
|---|---|---|---|---|
| Wind speed | Pedestrian wind comfort | Solar radiation | Direct sun hours | Daylight |
| Sky view factor | Felt temperature (UTCI) | Thermal comfort over time | Interior daylight | Building energy (energy balance) |

**Figure 5.** Simulations that Infrared City runs.

This study tested trees only.

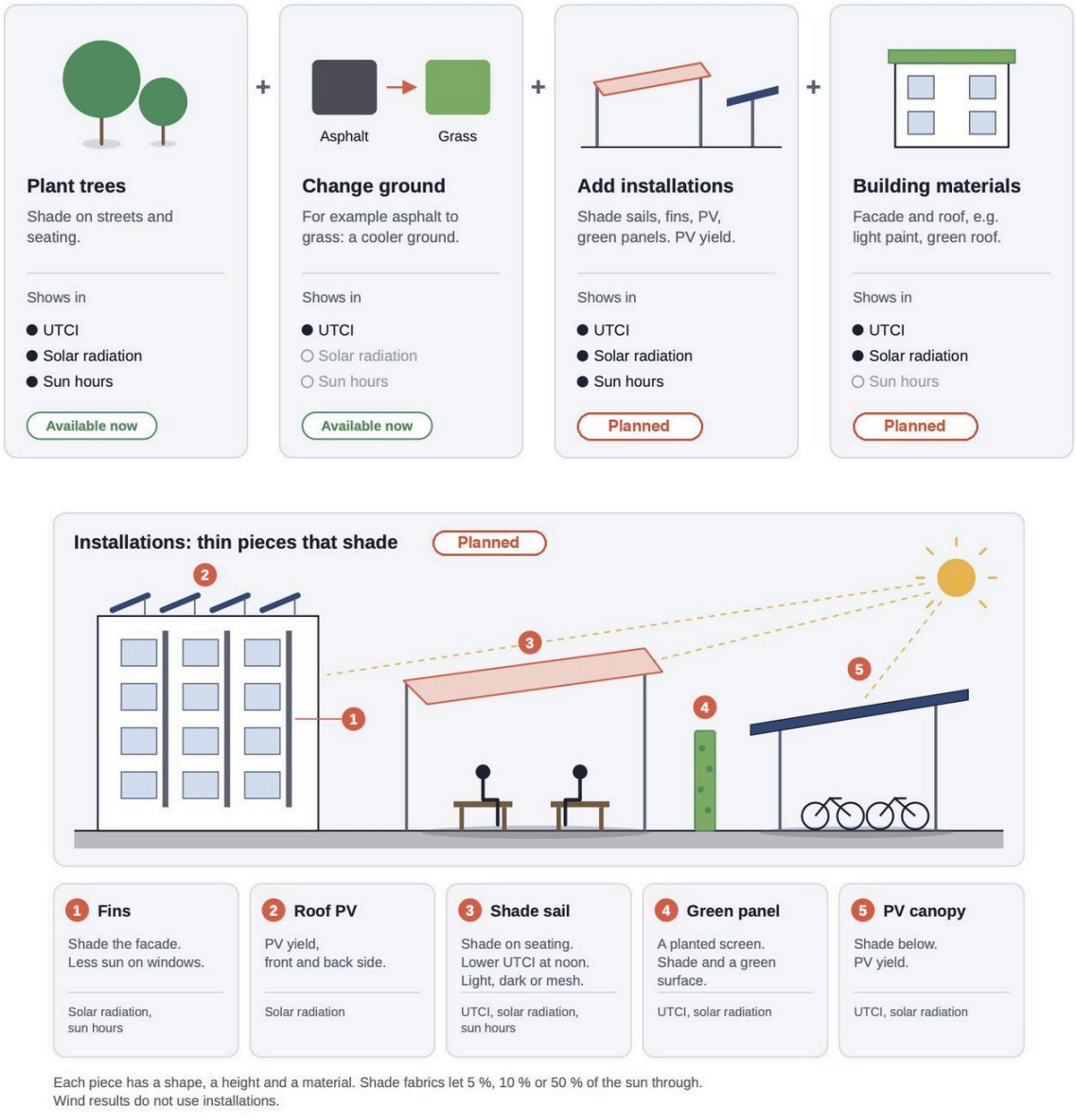



**Figure 6.** Interventions that a planner combines in one scenario. Available now: trees and ground. Planned: installations and building materials.

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