Assessment of the Potential for Solar Energy Applications in Urban Sites

Hes·so — Haute Ecole Spécialisée de Suisse Occidentale

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How to quantify the potential of facades and roofs located in urban areas for solar energy ?

Proposed method:

$$[\text{Urban solar and daylight availability}] = [\text{Sky model}] \otimes [\text{3D buildings model}]$$

Sky models contain average radiances distributions for the sun and the whole sky vault

Solar irradiation (in [kWh/m2]) values are computed by positioning virtual pyranometers at points located in front of all building external surfaces. An accurate ray-tracing program performs these simulations.
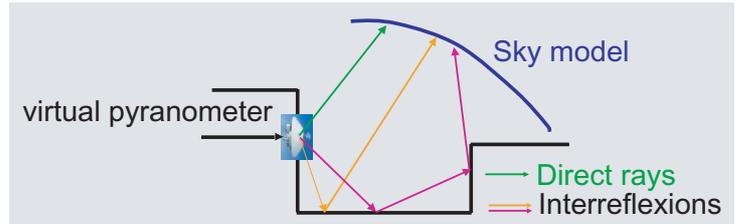
Simulation results are grouped into histograms. Horizontal axis is subdivided into equal intervals of solar irradiation. Vertical axis shows the amounts of building external surfaces (either facades or roofs), which are lit by the corresponding irradiation level. For a specific solar technique, sufficiently lit areas appear above a threshold value. Current technical limitations as well as economic factors are taken into account in setting up the threshold.
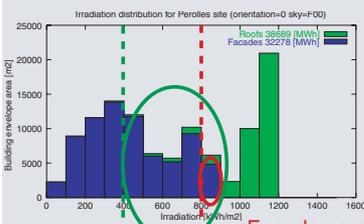
Facades area suitable for solar thermal collectors

Facades area suitable for photovoltaic systems
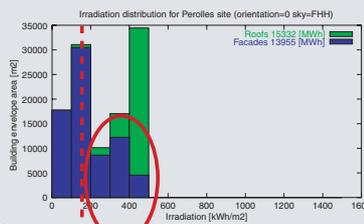
Facades area suitable for passive solar techniques

Solar irradiation threshold values:

photovoltaic systems in facades: 800 kWh/(m^2year)
solar thermal collectors in facades: 400 kWh/(m^2year)
passive solar techniques:
151 kWh/m^2 (heating season in Switzerland)

Application example: comparison of the facades' solar availability for an existing area and some hypothetical denser urban forms with plot ratio = 2.0
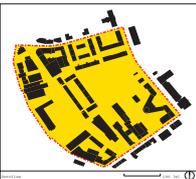
	Present situation	Comb (6 storeys)	Court (4 & 8 storeys)	Towers (15 storeys)
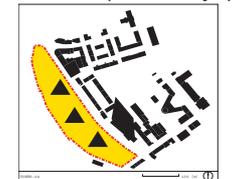
Fractions of facades suitable for:
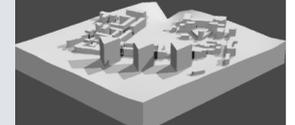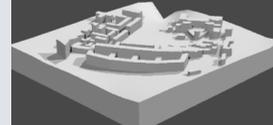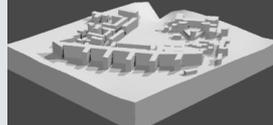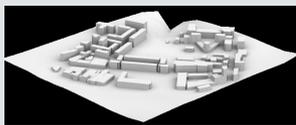
	Present situation	Comb (6 storeys)	Court (4 & 8 storeys)	Towers (15 storeys)
Photovoltaic systems:	6.5%	10%	15%	21%
Solar thermal collectors:	50%	83%	78%	100%
Passive solar techniques:	54%	83%	82%	100%

More than the half façade area is suitable for passive and active solar techniques in the existing area although it was built without special planning measures regarding solar availability. When care is taken to maximise solar penetration, a large increase of the suitable facade area can be achieved even for denser planning proposals !

Last step: visualisations

Annual solar irradiation:
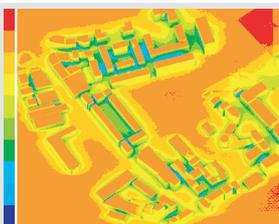
Areas suitable for PV systems:

Areas suitable for passive solar techn. :