SOLAR ENERGY PROMOTION & URBAN CONTEXT PROTECTION : LESO-QSV (QUALITY-SITE-VISIBILITY) METHOD

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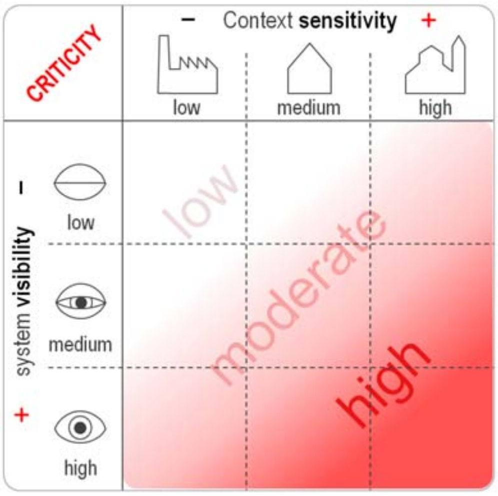

Fig 1: architectural *criticity* of city surfaces

Research summary

Increased use of solar collectors in buildings is necessary but poses major challenges in existing built environments, especially where architectural coherence is an issue. The large size of solar systems at the building scale requires careful planning, as they may end up compromising the aesthetics of buildings, threatening the identity of entire contexts. A new method named Leso-QSV has been developed to help authorities preserve the quality of pre-existing urban areas while promoting solar energy use. The method is based on the concept of architectural "*criticity*" of building surfaces. The level of "*criticity*" of a surface is defined by the Sensitivity of the urban context and by the Visibility of this surface from the public domain: the more sensitive the urban area, the more visible the surface, the higher its "*criticity*" (Fig.1), and consequently, the need for Quality in integration. The method is composed of two complementary tools, "Leso-QSV Acceptability" and "Leso-QSV Crossmapping". The first is meant for city protection and is addressed to authorities, to support assessing solar systems acceptability: a simple integration quality evaluation method is proposed, and software is provided to help adapt acceptability requirements to city specificities. The second is addressed to planners. It maps the architectural *criticity* of city surfaces and superimposes it with the GIS solar irradiation map, so as to weight the solar potential of each surface with the expected architectural integration effort. The result shows the interest/difficulty to use the various city surfaces for solar energy production, and helps tailor energy policies to city specificities.

The vision underlining the approach is that solar integration is possible also in delicate contexts, if appropriate design efforts and adequate cost investments are made. If these investments cannot be afforded it may be better to postpone the operation, as poor integrations usually end up just discouraging new users. By contrast, if well designed, such examples can be among the strongest driving forces for solar change, repaying by far their extra cost.

K-words: solar integration, criticity, solar energy, architectural quality, urban context protection, solar map.

1. Introduction

The reduction of building energy consumption and the replacement of fossil energy by renewables have become priorities for authorities and planners. New energy regulations, together with mandatory solar fractions for electricity and DHW are introducing new materialities and geometries in buildings, resulting in new forms of architectural expression which are slowly modifying our old city landscapes (Fig.2).

The increased use of active solar collectors in buildings is necessary, but clearly poses major challenges in the existing environments. The large size of solar systems at the building scale asks for thoughtful planning, as these systems may end up compromising the aesthetics of the buildings, and may affect the identity and the quality of entire contexts (Fig.3).

Fig.2: New Solar Buildings (left : 3M office building, Milan, M.Cucinella; Endesa pavilion, IAAC, Barcelona)

Fig.3: Solar renovations (left : Franciscan Monastery,Graz, Austria; right: SchlossWalbeck-Castel, Germany).

Sacrificing architectural quality to promote solar spread can be counterproductive, leading straight to the opposite effect in the long term. Hot discussions are already ongoing in most cities between the different involved parties. On one side “solar pros”, concerned by the urgency of maximizing renewable energy use ask for a total installation freedom; on the other side, architects and building heritage institutions express their worries about the urban impact of such systems and ask to restrict their use to certain urban contexts only. De facto, both concerns of maximizing solar energy spread and protecting the architectural quality of the built environment are justified, and both should possibly be satisfied at the same time. Furthermore, good architectural integrations can be possible also in the most critical situations, but they clearly need appropriate design and cost investments (Fig.4). If well-conceived, these examples can actually be very convincing and become strong driving forces for the energetic transition, repaying by far their extra design and cost.

2. LESO-QSV approach objectives

The question is no longer to be in favour or against the use of solar systems in cities, but becomes rather to define minimal local levels of integration quality, and to identify the factors needed to set smart solar energy policies, able to preserve the quality of pre-existing urban contexts while allowing solar energy use. The LESO-QSV approach gives clear and objective answers in this debate.

a- First it clarifies the notion of *architectural integration quality* and proposes a simple quality evaluation method (see Section 3);

b- Then it helps authorities set and implement local acceptability requirements based on the notion of *architectural "criticity" of city surfaces (LESO-QSV acceptability)* (see Section 4 and Section 5);

c- Finally it proposes a way to tailor solar energy policies to local urban specificities by mapping the architectural "criticity" of city surfaces, and crossing this map with the city solar irradiation map (LESO-QSV-*crossmapping*) (see Section 6).

Fig. 4: Photovoltaic system integrated on the roof of Aula Pierluigi Nervi, Vatican

3. Assessing architectural integration quality

Requiring a certain level of integration quality implies to be able to assess that quality. Often this is considered a matter of personal taste, but recent studies have confirmed the existence of implicit criteria shared by the architects community and leading de facto the architectural integration quality perception [Krippner et al. 2000]; [Munari Probst et al 2007]; [Munari Probst et al 2012]. To be perceived as integrated, the system has to be designed as an integral part of the building architecture, i.e. all the formal characteristics of the solar system (*field size/position; visible materials; surface textures; colours; module shape/size; joints*) have to be coherent with the global building design logic.
Based on these findings the LESO-QSV approach proposes a qualitative assessment method articulated into 3 simple steps, grouping the integration criteria to keep the procedure light and making the evaluation as objective as possible (Fig.6).
The coherency of *System geometry*, *System materiality*, and *System details*, is evaluated using a three level scale (fully - partly - not coherent). This being a qualitative evaluation, the partial results cannot be expressed by numbers and cannot be synthesized in a single mean value. Hence the choice to represent each partial evaluation as a coloured arc of a circle (green, yellow or red according to the level of coherency) to be combined with the others to form a complete circle made of 3 sectors. The global system quality is given by the number of sectors of each colour (Fig.5).

4. Architectural "*criticity*" of city surfaces

Integration quality is always desirable, but not always that crucial. In a concern to spread the use of solar energy, expectations toward integration quality may be reduced, for instance in industrial or commercial areas and/or on not visible city surfaces like flat roofs. The level of visibility of the surface from the public domain and the level of sensitivity of the urban context determine de facto the architectural criticity of a city surface, and the related need for integration quality. To structure the issue, a criticity grid is established by crossing the three identified levels of

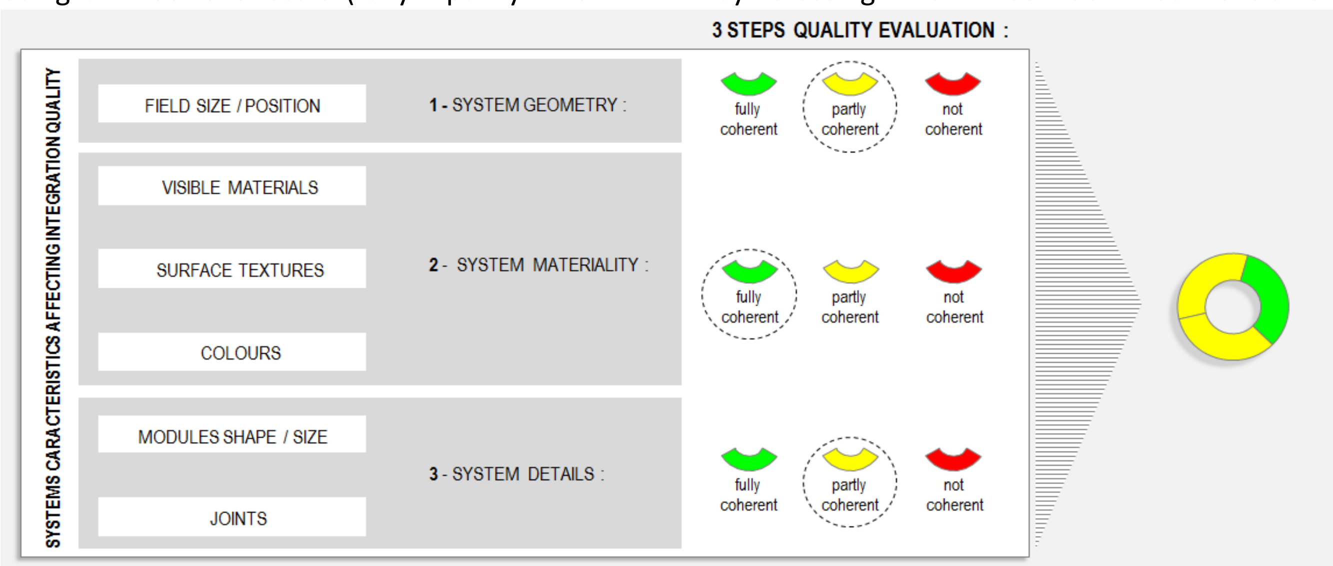

Fig. 5: Three steps quality evaluation method

visibility (low-medium-high, Fig 6) with the three identified levels of sensitivity (low-medium-high, Fig.7), defining nine criticity situations for which quality expectations have to be set (see criticity grid in the first page, Fig.1).

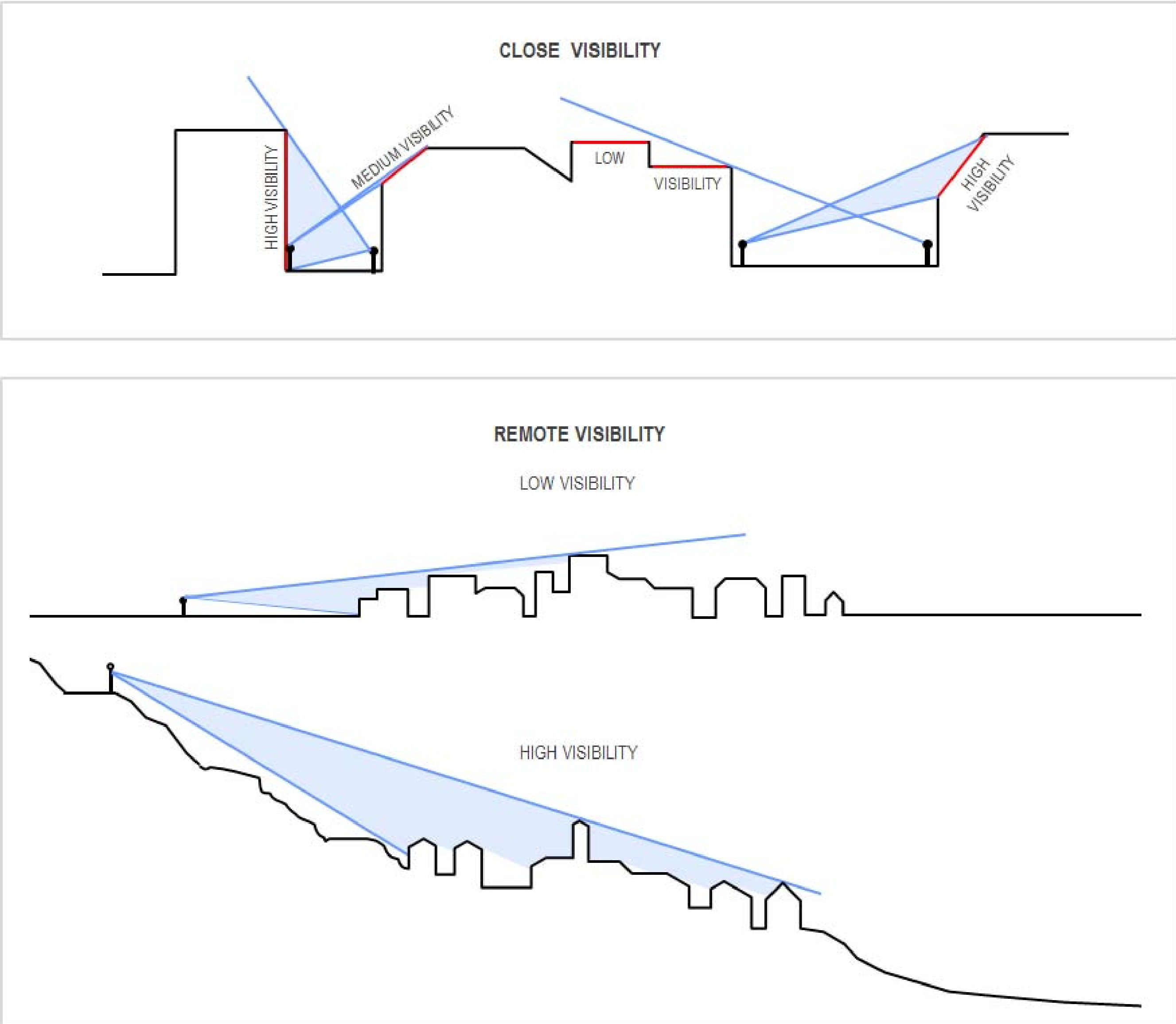

Fig. 6 : different levels of visibility of city surfaces from the public domain

Fig. 7: different degrees of sensitivity of existing urban contexts

5 "LESO-QSV Acceptability" tool

The level of quality to be required for each criticity situation is not absolute and constant, but depends on many temporal and local factors, such as the energy context, the availability of other renewable energy sources, the general integrability of market products and the consequent difficulty in designing good integration solutions, the city identity and image, its political orientation and economic structure, etc.. For this reason the method does not provide an *absolute* grid of quality requirements, and is rather conceived to support authorities in establishing *local* quality expectation grids, more or less severe depending on the local reality.

5.1- LESO-QSV GRID software

To help authorities apply this method, a multi-purpose software tool has been developed, called LESO-QSV GRID (Fig 9, next page). Quality expectations are represented by the same three sectors circles used for the

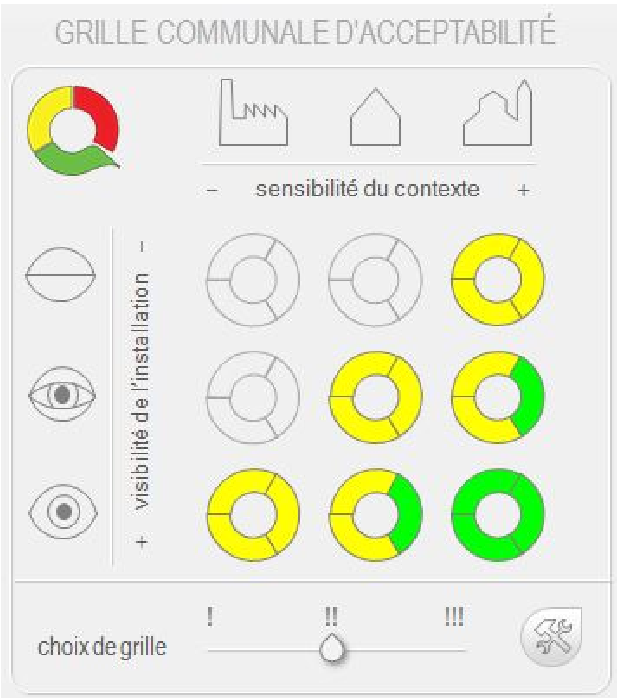

Fig. 8 : acceptability grid setting.

evaluation of the integration quality described in Section 4. Three "standard" sets of quality requirements of gradual severity (demanding - standard - permissive) are made available to authorities ("choix de grille"), together with the additional option of setting a fully customized grid (Fig.8).

To help authorities choose the most appropriate "acceptability grid", a large palette of integration cases is displayed that shows in real time which integrations would be acceptable and which ones would have to be rejected with the selected settings. This examples database can be scrolled through, showing the effect of the grid over a very extensive set of integration approaches and criticity situations.

The same software is intended to be used with minor adaptations also as an education tool for architects, installers and building owners. The wide palette of examples can provide inspiration from good examples, show errors to be avoided or give ideas on how to improve the quality of a project which would be rejected in its present state. It can also help municipalities explain in an interactive and visually convincing way how the method works and justify to users eventual projects rejections.

Selection buttons are available in the bottom part of the screen, to display a chosen subset of integration examples, in selected situations (visibility / context sensibility / type and size of solar systems, …) (Fig 9).

6 - "LESO-QSV Crossmapping" tool

If the above described acceptability tool is reactive and meant mainly for protection, the second tool derived from the criticity concept, called "LESO-QSV Crossmapping", is proactive and meant for energy policy planning.

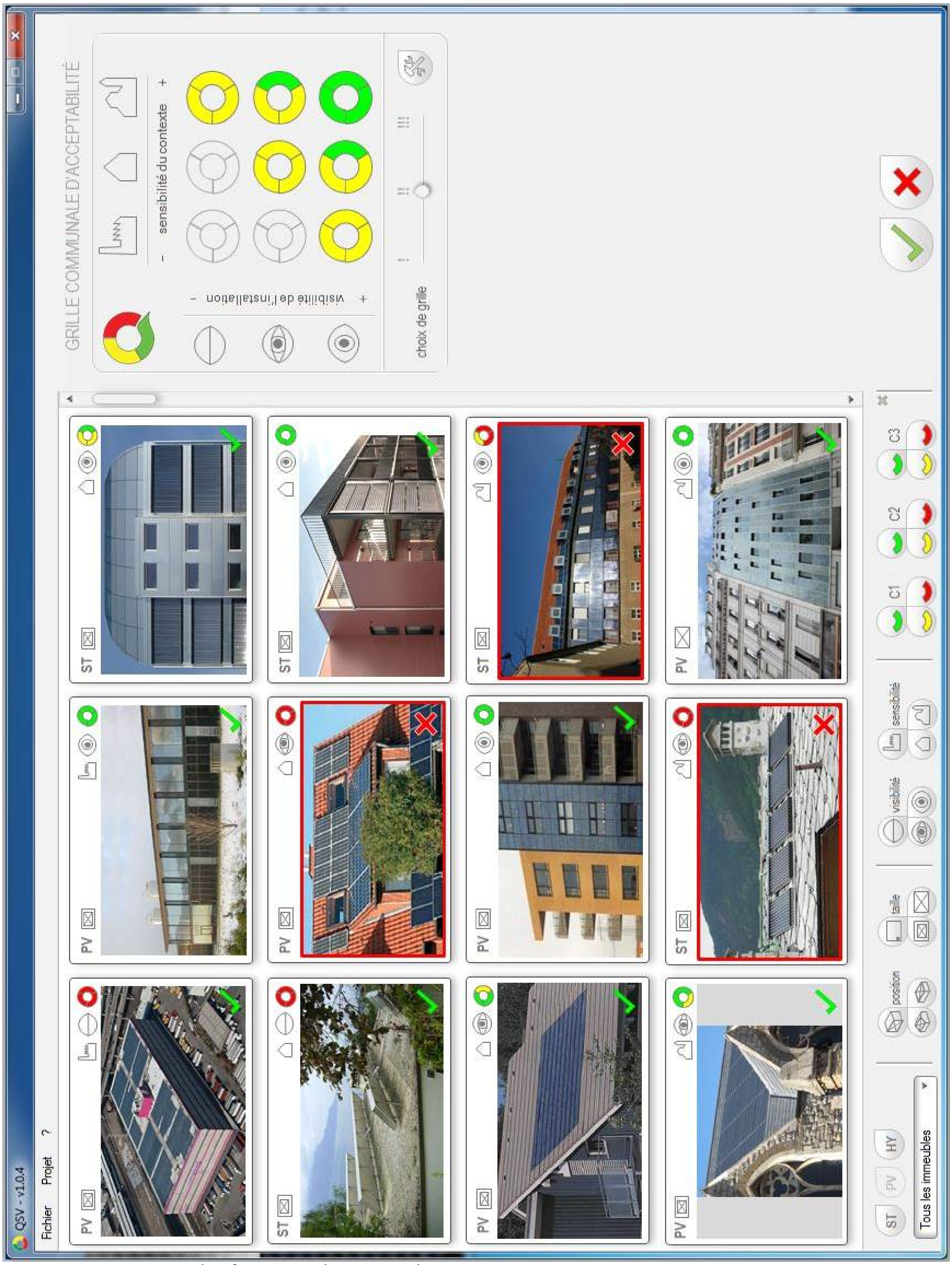

Fig. 9 : LESO-QSV grid software tool - screen shot

Presently, the only information available to planners and authorities to make decisions on solar promotion, regulations or financial incentives is the *amount of solar energy* received by the various city surfaces, displayed on solar maps (GIS). These maps vary in accuracy and detail levels (rough surfaces only, roofs tilt or not, facades…) but their only goal is always to assess the solar potential of city surfaces, with no concern for their urban specificities. As already explained, these specificities have in reality a major impact on solar application strategies and should therefore also be made available to planners. To answer this need the "Leso QSV-Crossmapping" tool proposes to map the architectural criticity of city surfaces, as defined in Section 4, and to superimpose this information over the GIS solar irradiation map. This allows to weight the solar potential of each surface with the expected architectural integration effort.

Differentiated policies and educated decisions can then be based on this more comprehensive information, keeping in mind that solar integrations are possible also in delicate situations (Fig4). In these cases though, design efforts and cost investments will probably be higher. If these extra efforts cannot be afforded it might be preferable to postpone the operation, as poor integrations usually end up just discouraging new users. By contrast if well designed, such examples can be among the strongest driving forces for the solar change, repaying by far their extra cost.

6.1 Next steps

The criticity map mentioned above indicates for each city surface its visibility from the public domain, and its sensitivity in relation to the urban context. A process to automatically establish the visibility of the surfaces in the 3D models of cities is currently being developed at our laboratory, as part of a PhD thesis work. The information related to surface visibility will not only consider the purely physical visibility from the public domain, but will also hierarchize the different points of view in relation to their importance (the view from a major city square being usually more crucial than the one from a secondary parking lot).

7- Conclusion

As more and more pressure is building up to increase the use of solar as a replacement for fossil energies, there is an urgent need for new responsible ways to implement the solar collecting elements in the urban contexts.

We strongly believe that the concept of “architectural criticity” at the basis of the LESO-QSV method offers valuable possibilities to implement such responsible policies.

We do hope that the two inferred tools will contribute to finding valuable solutions to the problematic “*Solar Energy promotion AND Urban Context Protection*” equation.

8 - Acknowledgments

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9- References

Krippner, R. , Herzog, T., *Architectural aspects of solar techniques – Studies on the integration of solar energy systems*, in Proceedings Eurosun 2000, Copenhagen, Denmark, 2000.

Munari Probst, MC., Roecker, C., *Towards an improved architectural quality of building integrated solar thermal systems (BIST)*, Solar Energy,2007,doi:10.1016/j.solener.2007.02.009

Munari Probst, MC., Roecker, C., editors, *Solar energy systems in architecture - integration criteria and guidelines*, IEA SHC Task 41 , 2012.