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Photovoltaic plants in the landscape. Typing ...
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**PHOTOVOLTAIC PLANTS IN THE LANDSCAPE.
TYPING AND GUIDELINES IMPACTS
LANDSCAPE INTEGRATION**

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ABSTRACT
The recent emergence and expansion of photovoltaic power generation has led problem of nature landscape in rural areas. This article will offer the main results of a research project that addresses the characterization ing landscape of photovoltaic plants, and the criminalization of impacts on the landscape that generates, as a starting point for the preparation of proposals landscape integration of these facilities. The study area is analyzed the region of Andalusia, a region where the development of this renewable energy source has been particularly intense.

Keywords: landscape, photovoltaics, landscape integration, Andalusia.

Photovoltaic powerplants in the landscape. Impacts standardization and principles integration of landscape

ABSTRACT
The recent emergence and expansion of Central photovoltaic power stations have led to the appearance of a problem of scenic nature in the rural areas, introducing a new use of the ground In These types of areas. In this document the main results from a research project are provided. This project tackles the landscape features of the photovoltaic power plants, as well as the standardization Impacts on the generated landscape as the starting

point for the elaboration of Proposals Regarding the landscape integration of These types
of facilities. The field of study has been Analysed Which is the Andalusian territory, region
where the development of this renewable energy source has been Especially intense.
Key words: landscape, photovoltaic energy, landscape integration, Andalucia.
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This paper presents results from the research project "Estimation of impacts and pro-landscape integration sunsets generating installations of solar PV in Andalusia " conducted between 2008-2009 and funded by the Ministry of Public Works and Transport
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1. INTRODUCTION

Photovoltaic plants have experienced a major expansion in Spain in the last decade and have led to the emergence of problems territorial in nature, Environmental and especially landscapes. Its location in rural settings, the extensive area occupied, at least for conventional energy sources, and the typological uniqueness of its facilities, has led to abrupt landscape changes in areas where they are located. The transformation has occurred landscape also an accelerated and in short time, so that any action planning and city planning have gone into this intense expansion trailer. Moreover, the PV has a positive image among the population and among the gover-ing politicians, by nature of clean, renewable energy. Arises therefore a *paradox Environmental:* potentially impactful facilities on the landscape, but perceived and environmentally positive.

The solar PV production has grown significantly

in Spain in recent years. Its development, supported by government subsidies, has been
so brilliant that has shattered the provisions of the Administration. The high cost economic and speculative motion detection prompted the Government to Working-ration of a more restrictive. In spite of this slowdown, the sector outlook PV still point to an important development in the future. Thanks to the boost in recent years, Spain has become the world's second largest energy photovoltaics. Much of this development is due to photovoltaic plants had lower the contribution of deck installations.

Andalusia is one of the Spanish regions where development of solar photo-voltaic been greater and now stands in second place in photovoltaic power installed, with 584 MW. In the research project from which this paper emanates (Mérida
and Lobón, 2009) have analyzed 88 photovoltaic systems, representing a percentage very high the total in the whole of Andalusia.

The photovoltaic plants have an obvious landscape dimension, causing intense appearance of the landscape changes. Among the factors involved in condition the landscape is, first, typological uniqueness. Materials employees and their arrangement and distribution intensity increases visual impact. This typological uniqueness is enhanced by its location in rural areas where the introduction of this new land use causes strong contrasting landscapes with dominant agricultural uses. Extension reaching these plants, requiring a vo-lumen very important field, and its orientation in areas of high insolation reinforces their role landscape. Finally, his intense profusion away to these facilities an individualized landscape treatment and closer to it as
a new land use.

Two. TYPOLOGICAL CHARACTERIZATION AND LANDSCAPE PLANT PHOTOVOLTAIC

2.1. Location and site

In addition to factors of production, the introduction of photovoltaic answers nature also geographical factors. Among them, firstly, the insoluble-Annual ratio. Andalusia receives a high number of hours of sunshine, so the chances development of photovoltaic systems are very broad. The second factor location is the proximity to electrical distribution networks. Therefore, mountainous areas,

away from the main distribution networks have a lower implantation this type of facility. Finally, the location of the photovoltaic plants depends also the performance of pre-existing land uses.

In Andalusia the facilities show a clear preference for the valley of Guadalquivir and its countryside, as well as dips and plateaus of the Surco Intrabético, being under development in the Betic Cordillera and Sierra Morena. Most land devoted to this new land use land agricultural vocation are being degraded rarer functional spaces and scenically.

The usual sites are concentrated in two major physiographic units: the hills and foothills, with 42% of cases, and the plains (river, plateaus, intramountains, etc..) account for 41% of them. Have analyzed facilities, so mainly large viewshed. Almost three-quarters of them exceed 10,000 hectares. and of these, 27% viewshed gather over 30,000 hectares. They also with a high degree of visual impact: many photovoltaic plants are in the major road infrastructure environment.

The area occupied by photovoltaic plants analyzed reaches 1,171 hectares. Comcomparatively with other energy sources, this is a high figure, on the contrary, compared to other land uses, stood still in a very discrete thresholds.

2.2. Morphology and composition of the photovoltaic

In general, the continuous type photovoltaic plants with panels available rows, the most common designs are the runs. When panels are arranged isolated structures, plants take on a larger and more variable in their design, although the dominant plane remains the homer.

Sometimes they produce a kind of land consolidation process, forming several facilities one floor, very extended form has been abolished with the latest regulations. The result, scenically, are compartmentalized facilities Tadas into sectors, with the absence of treatment in the intermediate spaces, generated high incidence landscape discontinuities.

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2.3. Earthworks

Some facilities significantly affect the topography of the land, generating clearing, terracing and retaining walls. The selected sites structures used determine the impact on the ground. Usually locations in slope, especially if the slope is important, and isolated structures followers usually the more aggressive combination with the relief. At other times, the terraces and platforms pose the greatest impact, chromatic and morphological impacts of cuttings and embankments created.

2.4. Component design

2.4.1 Structures

There are two major modes of structures, the continuous line (Figure 1) and fan isolated (Figure 2). Scenically characterized respectively by the continuity or discontinuity of the sensors as well as the lesser or greater height structures.

Figure 1. Continuous structures in rows.

The authors.

System compactness and lower row height approaching these installations ing a continuous, horizontal texture, resembling other components of the landscape as water, while the greatest height discontinuity and dominant in the fan isolated takes the tree reference. Row over facilities morphologies hilly terrain usually follow the contour, achieving a good fit. Arrangements are used occasionally in the direction of the slope, the more striking.

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The fans are arranged in the ground on individual platforms altering the topographic graphy on slopes, their bases sometimes reach considerable prominence landscape.

Figure 2. Structure followers isolated.

The authors.

The design of these structures in both rows as followers, derives only its functionality. Far facilities suffer from the absence of any formal research in design, dominating quadrant morphologies singular in the panels. There is surprisingly little standardization level, clear symptom of an initial phase of development of the productive industry. On-site continuous rows, its length is determined by both mechanical factors as productive. The height of the rows is generally scale lower than the human and formed as a stand which allows the inclination of the panels or the formation of the horizontal axis, if tracking systems. In the case of isolated followers, their scale is always above the human; generally ranges between 3-4 meters and 15-18 meters in height.

The color feature of these structures is the metal gray, both are steel galvanized and aluminum materials used, evoking industrial elements.

2.4.2. Modules

The most common material is silicon monocrystalline or grayish blue hue (Figure 3) and multicrystalline bright blue iridescent (Figure 4). Octagonal shape

monocrystalline silicon cells causes a discontinuity in the module as lozenge. For its part, the square cell multicrystalline silicon allows for greater continuity, while the grid is still visible. Finally, the amorphous silicon is ho-

geneous chromatic continuity and allows the module. The tone can range from shades of blue-gray to dark red close to black.

Figure 3. Monocrystalline silicon modules.
The authors.

Figure 4. Multicrystalline silicon modules.
The authors.

The design of the modules, both isolated as followers rows are also located exclusively in the context of its functionality. The only interruption in the continuity of the panel is the provision of separate rows to decrease resistance

the wind. So far, the modules do not have any formal search in design morphologies dominated rectangular elongated in continuous rows and provided in isolated followers.

The size of the modules is variable being determined by manageability. Must be self-supporting, so that permits once associated with contiguous form the panel. The dominant color is the beam, the sun exposure, and the material is derived

Photoelectric used (gray monocrystalline silicon, multicrystalline bluish in, dark hues in amorphous silicon.) For its part, the underside is composed of the es-support structure and dominate him light gray metallic color.

In the frames surrounding the material used modules usually galvanized steel and aluminum, metallic gray shades. Compared with the color of the cells, increases contrast, appearing halfway as whites.

2.4.3. Other facilities

The different scales Row compact installations and followers isolated, make additional facilities have a different role in one and the other. All in the first fencing elements, signaling, processing and electrical transport are often exposed visually. By contrast, those of

followers isolated, these facilities are at or below the height of the
sensors and spend more unnoticed.
Accommodations for transformers and investors are elements in goose-
sions of great relevance landscape of the photovoltaic plant. Its impact can be greater
the photovoltaic panels themselves, and, among other reasons, often derived
on their type (Figures 5 and 6). Are placed individually associated with the same
structure
catchment, or partners in specific enclosure.
Figures 5 and 6. Typological models ancillary technical systems.
The authors.
Exposure of the main technical characteristics of the facilities by
a poster is a mandatory requirement for these facilities. The large dimensions

of these posters stand out in continuous row installations over the fence,
forming in areas of flat topography the most visible element of the installation. By
In contrast, isolated followers facilities, especially large sensors,
are somewhat less important.
The perimeter fences arise from the need for security of facilities. Of
somewhat larger scale than human, these enclosures are distinguished by the existence
or absence of topographic changes to its construction and the type of material
used. You can differentiate between fences translucent, generally consisting of
galvanized steel wire mesh or laminated, and massive, forming an enclosing wall
with materials such as concrete or more infrequently, natural materials such as
stone, creating dry stone masonry bonded.
The significance of landscape and interior access roads due to their dimension
sions, the characteristics of the firm, and its layout, especially in mountainous areas.
Also relevant are scenically the intermediate and peripheral spaces,
may represent an area larger than that occupied by vials.
The existing soil beneath the structures has a greater relevance in the systems
discontinuous, offering as much visible floor between them. In some installations
tions remains natural herbaceous vegetation, in other cases specimens are preserved
tree, especially in wooded areas or in areas conserving agricultural
specimens of trees within the plot or tall bush on the edge.

2.5. Interior components ordination

Continuous rows facilities are arranged in parallel strips, aligned to
South. On sloping ground, the bands usually follow the contours,
adapting to the terrain, more exceptionally, are arranged along the lines of slope.

On-site isolated composite arrangement followers most followed is that of regular plane, similar to that used by the type tree fruit farms. Between cases considered, there are none irregular ordination of structures, being distribution of rhythmic and geometric followers.

Three. LANDSCAPE IMPACT PHOTOVOLTAIC PLANT

The impact on the landscape of photovoltaic serves two criteria: condition on the quality of the landscape where it is located and the alteration that occurs in the existing views in its environment. Regarding the first criterion, the potential impact is pro-tional to the quality of the landscape. In landscapes of high value, an intervention of this nature is, in principle, not recommended, on the contrary, degraded landscapes location of these facilities can contribute to landscape restoration. In other landscapes the sign of the impact is given largely by the quality of design installation and its ability to integrate into the landscape and even to improve, although beginning the sign will be negative, since, by their location in rural areas, represent a drastic change in land use. The absence of these treatments formal

facilities, subject to production efficiency largely determines its possible positive perception.

The second criterion, its impact on the views, involves analyzing different parameters visual basins as visual or visual incidence, ie the number of potential observers as well as the possible alteration of the views or perspectives of existing quality tees. The intensity of the visual impact will be a function of two variables: the characteristics PV plant, especially its dimensions, and the distance that occurs observation. Even its sign, negative at close range, can be modified at high dis-distance, due to similarities that can adopt physiognomical with other components of landscape viewed positively, particularly water bodies. By contrast, other physiognomical similar reinforce possible negative impact as with greenhouses or industrial buildings, except where these massively to surface.

A photovoltaic system has a certain generic characteristics confer a high prominence landscape. First, its reflectance, the

visible from large distances, secondly, its dimensions, sometimes added
tens of hectares, thirdly, the typological uniqueness of its components and their
particularly internal organization. In any case, the impact can occur landscape
both by the interaction of different factors and components such as visual relevancy
acquiring any of them. In the following lines are discussed in more detail
the various factors involved in the landscape impact of photographic facilities
voltaic.

3.1. Location

Levelto large landscape types, the impact of the photovoltaic plant location
ing occurs mainly in mountainous character, as further
higher the average gradient. The vertical arrangement of the facilities that the relief
imposes a high impact generated when placed perpendicular to the viewing plane.
In addition, other components of the system landscape acquire greater relevance in
sloping terrain, such as access roads. For the greater complexity of the installation,
addition to its remoteness of electric transmission lines, are unusual plants
photovoltaic mountain scenery, if it occurs, the choice of a suitable site
acquires a core value.

Other types of landscape where the impact is larger photovoltaic plants are
natural areas, especially forest land. In these cases, regardless of their
more or less visible, the impact resulting contrast emanates location
these facilities in little spaces transformed by man and which uses dominate
natural soil. Therefore, in areas of important natural component but where there
presence of human action, such as areas converted to pasture or managed forests,
these facilities generate less impact, provided they meet the relevant
landscape integration criteria and have adequate site.

In general, transformed landscapes receiving less impact by the location
photovoltaic plant. However, in some cases, its traditional character traits
physiognomic and frailty discouraged them the location of such facilities.

One example, among other possible, it may represent the traditional irrigation
landscapes
tions.

3.2. Location and density

The impacts on the landscape derived from the location of a photovoltaic plant
be more to the site selected it to its location at a particular
mined landscape type. From the topographical point of view, hillside sites
are most striking, greater extent the greater the slope (figure 7). The

impact due to the inclined arrangement of the system, tending to perpendicularity with the viewing plane. By contrast, other sites, such as summits or within of the slopes, intermediate landings or shoulder pads offer a better result from the terms of landscape impact.
Figure 7. Construction on steep slopes.
The authors.
The conditions on the landscape are increased if the site chosen has high visual watershed. Another criterion to consider is the visual impact, ie the number of potential looks up a site can receive. In
Sometimes the landscape impact is also derived from the topological proximity unique elements of the landscape, historic, monumental or religious. Can emerge finally alteration of valuable insights, particularly on urban centers.

The impact on the landscape, like any other kind of impact you can have a character synergistic: a single intervention can generate a limited impact but multiple small interventions accumulate and increase their impact.

3.3. Design entire installation

One of the main drivers of landscape impact of a plant PV is its extension. They are usually large facilities, but in certain dimensions sometimes reach particularly high, exceeding in some cases the 100 has. Also the general morphology of the photovoltaic plant can potentially represent an impact factor, especially when introduced geometric shapes, normally runs, in natural or agricultural land marked by the irregularity of the parcel.
A determining factor in the production of impact is the inadequacy of the facility the preexisting embossed. The alterations of the terrain (slopes, clearing, terracing) imply abrupt morphological and chromatic changes are a component very significant overall impact (Figure 8).
Figure 8. Slopes.
The authors.
The fragmentation of the facility itself sectors produces considerable impact by the introduction of orthogonal axes corresponding to the separate spaces training. Finally, with respect to overall plant design, the enclosures or perimeter fences are in some cases generating elements impacts on the landscape.

3.4. Components of the photovoltaic

3.4.1. Structures

Usually followers isolates produce a greater impact on the landscape continuous rows, by its nature free, which generates discontinuities physiognomy micas, its vertical, perpendicular to the plane of view, and the movement introduced.

Panels of continuous rows are less impressive because continuity and its horizontal development. The combination of both types in the same facility PV has a significant impact as the landscape generated unstructured by installation complicates readability, continuity breaks and makes it more difficult to adaptation to other landscape components.

The panel runs morphologies affect the landscape by the introduction geometric shapes in rural settings, usually devoid of them. Impact structures is smaller in the case of rows and more accentuated followers isolated, which are more visible. It is worth noting the effect on the image in some cases generate followers bases, usually concrete and di-dimensions only slightly smaller than the panel. The panels generate a greater impact on according to their size, or how many more modules contain, if used modules standard measures. Another condition of the landscape is produced by the combined use structures of different size, which breaks the continuity of the installation possible.

The color characteristic of these structures is the functional, the metallic tone grays, typically galvanized steel. In general, it is not a variable especially shocking, except for the bases of the followers, which in some cases stands visually by the absence of color treatment of the concrete (Figure 9).

Figure 9. Concrete bases.

The authors.

3.4.2. Modules

Module type depends on the material of which it is composed. The monocrystalline silicon
has a basic tone (blue-gray) for less impact, because of its resemblance to the color of the water,
heaven or plastics. However, the hexagonal cell morphology generates numerous and rhythmic discontinuities in the module, in a diamond shape, that accentuate its impact and
integration difficult. For its part, the multicrystalline silicon has not this problem, the be its square cells, although still visible separation lines, on the other
hand, the color of these cells is heterogeneous, predominantly blue, brighter, being their adaptability to other components of the landscape more limited. The amorphous silicon (Fig. 10) has the advantage of evenly arranged along the module, generating a continuous surface, with less impact. However, the hues they generate can increase their impact, especially the darker ones. Finally, should be noted that mixtures of materials in a single plant PV
generate a greater impact than individual use.
Figure 10. Amorphous silicon.
The authors.
The dominant morphologies are rectangular, reproducing the dominant
the panel, so it does not generate a different impact. However, its incidence increases if combined different arrangements of modules, vertical oblong in the same
panel.
In principle, the larger module, they do not affect the size-
NO panel, are less striking, for the creation of a continuous surface and eliminate gaps between. Profiles or frames of PV modules
produce a visual impact far more important than its relevance in the installation. The material used is usually aluminum, being his usual tone the gray metal

midway appearing white hues. In rows, played a mesh
highly striking geometric (Figure 11).
Figure 11. Frames modules.
The authors.
3.4.3. Other facilities
Transformers, alternators, batteries, monitoring booths, etc.., Con-
stitute photovoltaic plant components highly relevant landscape. Sometimes impact is greater than the photovoltaic panels themselves, and, among other things, this

impact often is derived typology, especially its chromaticism.
The turrets and wiring are potentially powerful for morphological contrasts logical (turrets) and chromatic (wired) producing, particularly if the turret bad located or if the wiring is striking color like red. Posters and their frames produced in some cases a significant visual impact, derived from their magnitudes, its location, its morphology (vertical cloth) or colors used (Figure 12).
Regarding the road, usually the higher incidence element in the image is the firm, potentially very powerful when the color contrast is charged, along to the width, sometimes excessive, and in sloping areas, the layout and the clearing and
embankments. Sometimes also the gutters and drains can cause a high impact, particularly when adopting or when inclined paths are formed by concrete without any coating.
Among the structures between the different parts of the facility or on its perimeter, clearances usually abundant, and produce a visual impact signs sometimes cant, especially when the land is bare and have an important albedo. Lesser extent under the existing floor structures also has some degree of visual impact, especially when the photovoltaic plant is composed of isolated followers.

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Figure 12. Impact of posters.
The authors.

3.5. Interior components ordination

3.5.1. Structures

The structures and their corresponding photovoltaic panels can impact landscape, in addition to its design, its internal organization. In the case of rows continuous, the impact is produced by the sight of the panels alternating stripes and land free, and is increased if different orientations are mixed in the same facility or There are no such rows in the environment (such as olive or citrus).
The impact of the management of isolated fans, meanwhile, is due to its own spacing, which generates large gaps between, and its pattern of organization, particularly if sharp contrast with its surroundings. Using the patterns unanimous defective geometric shape fits in environments marked by patterns of organization irregular. On the contrary, the impact is considerably reduced if the environment has a regular arrangement, more so if it fits the available alignments.

3.4.2. Plant auxiliary
Because typological characteristics, sometimes sharper than own
structures can generate a greater impact than photovoltaic panels. The provisions
tions rhythm, especially when combined with a high density, typically have a
high impact landscape. For the same reason, clusters are less striking,
except if they are on the most visible areas of the facility.

Integration into the landscape of a particular installation is achieved by
application of one or more measures of landscape integration, organized in different
strategies (Merida and Lobón, 2009). Its application may be useful for various models
landscape management, and the protection of valuable landscapes, landscapes
improving deteriorated-
Rados, recovery of degraded areas (mining lands, suburban wastelands, etc..) and
even for the creation of landscapes.
The first strategy is to adapt the system to the physiognomic characteristics
landscape unit which is inserted, reducing their prominence landscape and diluting
its contents from the existing formal in their environment. This strategy can be applied
more comfortable in landscape types and semantically identical physiognomically
(Renewable landscapes) or similar (eg greenhouses landscape, landscapes
water). Similarly, the strategy is appropriate for intervention in landscapes of great
quality through the mimesis of its components with the existing landscape.
The second strategy aims at adapting the plant components to re-
lift in characterizing a given landscape. This mechanism is more versatile
as above, and enables the integration is achieved, for example by
adaptation to individual industrial facilities, small bodies of water facilities
energy production and distribution, etc.
The third strategy is based on referencing the existing landscape. Referencing
is understood as a state prior to the full adaptation. It involves establishing a language
Formal and content with the existing landscape and take it as a reference, without
giving
to identity landscape. For example, choose the existing distribution pattern on a
homogeneous landscape into the fresh design of the facility, or incorporate certain
character traits of a landscape in the location of a facility.
The fourth strategy is to referencing one or more of the components
ing the landscape. In this case, no one looks at the whole landscape, but their

components, provided they have an appropriate mark on your unit or type of landscape.
For example, transport infrastructure (roads, highways, etc..), Or habitat.
The fifth strategy involves referencing landscapes or landscape components historic or heritage value. This strategy is not modeled on the existing landscape or the main components, but existing landscapes or landscape components, but that somehow maintain some connection with the current landscape or your social representation, although they have more presence than as fingerprints or traces. A
second condition to be met is that by its nature (functionality, morphology, etc..) are likely to be taken as references.

4.1. Criteria and specific measures of landscape integration

4.1.1. Location

Always in the context of a territorial scale, the location of PV conforms more to certain types of landscape and landscape components

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present in other types of landscape, which must have preferred consideration for implementation of this activity.
Greenhouses. Both types of landscape as other components landscape (Eg, irrigation, coastal suburban landscapes), offers similarities physiognomy micas with photovoltaic structures, both in color and texture. Similarly, the meaning has a clear parallel, both being modified landscapes by man. They also share their reversibility, especially important in land use Dynamic broadly replacement material uses preestablished it, regardless of its actual probability, feasible.
Facilities and industrial landscapes. Photovoltaic plants also possess appreciable ble similarities to industrial facilities, both formal (materials, colors, texture) and semantic (transformation). At the same time enables its introduction possibility of introducing visual resting points in the industrial areas of raised stronger. But it is more viable for industrial facilities located along isolated in rural areas (sugar, oil, etc..) and unique components other landscapes (Figure 13).
Figure 13. Location next to industrial facilities.
The authors.
Landscapes isolated miners and mining. It is intensely landscapes transformed, whose meaning can fit new production facilities. Also

are perceived as degraded land, messy and, at least for the relief, unstructured (mounds, embankments, etc..).
Suburban landscapes. Peri-urban areas are characterized, among other issues, existing mixes land uses, which often leads to a degree of confusion in the landscape. They also frequently include landscape-down areas

mind as social wasteland, waiting for their next development, tips, edges infrastructure, etc.. The inclusion of photovoltaic plants would have the beneficial effect introducing order confusing nature landscapes.
Landscapes of wetlands and floodplains. In general, water landscapes, or water components, represent a suitable location for such a facility, due to physiognomic similarities with photovoltaic panels. Specifically, the landscapes of wetlands and floodplains are a good reference, because the presence of water joins the predominance of horizontal lines and, when it does, the presence of geometries like, for example in the paddies or in the salt. However, the choice of final location must be taken into account, apart from the necessary assessment of possible impacts, the environment protection in these landscapes by their values natural.
Landscapes lake. The current environment lagoons can pose potential especially appropriate location. Fisonómica similarity with water panels PV is the main argument, but also support this location factors such as limited attention, the viewshed reduced and lower incidence visual. However, most of these landscapes enjoying different levels of pro-protection, according to their natural values. Most likely be opened if exploited the site of ancient lakes, now dried.
Landscape irrigation. Water appears as a component of the landscape in a type of landscape widely represented in Andalusia, landscape irrigation. Apart from the reservoirs, treated in another section, water accumulations of medium and small size can potentially mean proper location. Diversion dams and particularly irrigation ponds mind as examples of this argument.
Renewable landscapes. A location generic guidance is to group the ins-photovoltaic installations with other renewable energy facilities, especially the more extensive: solar, wind, hydro. Besides semantic affinity

share all of them (clean energy, innovative, current), in the case of hydro-
trical or thermal physiognomic similarities appear.
Conventional energy landscapes. The common meaning of energy equipment
can serve as a pathway for association of photovoltaic installations with other
tions of production (thermal, combined cycle), as well as processing and distribution
(Stations and substations), away from urban centers.
Transport infrastructure. The connections between photovoltaic installations
taicas and transport infrastructure are diverse. On one hand, there are similarities cro-
matic, particularly with the road. For another, they share common meanings as
transformed landscape character, its modernity as new landscapes or their potential
landscape detached from its functionality (creating quality landscapes).
Their complementarity can be achieved by the existence in infrastructure
transport of large tracts of land. The inclusion of photovoltaic
may occur within these infrastructures or nearby. Potentially
could locate PV plants in large transport facilities:
ports, airport spaces, complex and railway stations.

A special section deserve major road infrastructure, highways and au-
toll roads. It is public land, with spaces available and they have
perimeter fences that isolate. The landscape generated by these infrastructure sharing
physiognomic similarities with the image of photovoltaic plants: asphalt, furniture,
etc..
They also have a common meaning transformed and functional landscape. Another
advantage is
the ability to adapt to existing functional elements in the highway, doubling
useful, as in the case of visual displays.
Commuter roads and highways. The areas adjacent to the road infrastructure
may also be an appropriate location (Figure 14). Maintain the proximity
conceptual and physiognomy, but would gain in viability by the possibility of
acquiring ma-
OLDER dimensions and a more massive and less linear. However, this location
new problems: the transformation of the landscape, the possible alteration of the
views
existing far from the road, and high visual impact.
Figure 14. Location along roadways.
The authors.

Railway lines. Just as on motorways, the railway lines
roads have the advantage of perimeter fencing and the possibility of inclusion
installing the infrastructure landscape itself. The common meaning of landscape
transformed by man seen here enhanced by the use of electric energy
in rail transport, physiognomically recognizable in the presence of overhead lines and
wiring.

4.1.2. Location

In a first approximation scale, pending a more detailed study
in each case, the position suitable for photovoltaic installations shall con-
tuning the following:

Land horizontal. The horizontal lines are better integrated into the landscape, avoiding
ruptures the viewing plane and reducing the installation space visible. Are thus
clearly preferable flat areas and in hilly areas, subsiding areas.

Normally, the site on slopes hinders their integration landscape in higher
As the higher the slope of the hill, in the case of slopes are preferable
intermediate landings or pads.

Reduced visual Basin. The most appropriate location would be on the inside of small-
sized basins or carports, as subsiding areas or narrow river valleys

Reduced visual impact away from hotspots or transit
population, such as large road infrastructure.

Withdrawal from unique elements of the cultural landscape, as, inter alia,
cemeteries or traditional farmhouses.

Conservation of existing quality prospects in their environment (Figure 15), is-
pecial those emitted from roads and areas frequented by people.

Figure 15. Location in villages prospects.
The authors.

4.1.3. Density of PV

In general, a low density of photovoltaic beyond timely installation
(Which should be treated as a single element of the landscape), to reduce its impact
by applying landscape integration measures, especially if your design

also pursues this goal and if the size of the facility is at least moderate.
In this regard, care should be also the separation or distance between plants, preventing it from joining in midway perception.

4.1.4. Design set of the photovoltaic

Extension. Integration into the landscape is more feasible with small areas or moderate. From the viewpoint of the relative extent, it is advisable to adjust the su- occupied by the installation surface with the average extension parcel in the zone where
is to be located.

External *morphology.* External morphology of the installation must also conform the dominant existing parcel or key landscape components:
regular or irregular, linear or mass.

Adaptation to *relief.* Facilities should avoid altering the conditions
tions physiographic location, pursuing the best adaptation possible to highlight preexisting. In steep terrain, structures should be arranged parallel to contours. In particular, avoid large earthworks and land clearing.

Internal composition. Although in many cases the partitioning of the plant is due to legal reasons, you should generally avoid subdivisions and at least limit the dimensions of the separation strips. The composition must tend to be unitary, as this is more feasible their integration. It is also advisable to follow a single internal organizational pattern.

Incorporation of existing elements. The design of a photovoltaic must incorporate the human and natural components of the landscape, is- timberline special (isolated trees) and structures (isolated or in small clusters) and agricultural facilities. In the case of buildings crumbling, the project reuse can be contemplated, such as plant auxiliaries.

Perimeter fences. As best choice, it is preferable that the fence is made with visual prominence of scarce materials, semi-transparent, like wire mesh, whose chromaticism is very similar to the installation structures. Regarding the trace- two, it provides a greater degree of integration into the landscape if the hedges are ancient
boundaries and adapts to the lines of the existing landscape.

4.1.5. Design of the components of the photovoltaic plant

Structures. In general, integrated into the landscape more easily facilities
Still, with rows of panels, which consist of followers exempt. Major reasons are the lower height with the rows, their horizontal arrangement in the field and better continuity of the panels. By contrast, the followers are isolated

scenically integrate complicated. Generating vertical lines, and its discontinuity limits its horizontal development and continuity of the texture of the panels, in addition, in-
troducen movement. In any case, should be avoided in mixtures typologies same PV system.
From the point of view of its integration into the landscape, it would be important advance in-
innovations in the design of these structures in both isolated as followers in rows, regardless of its functionality. Incorporating innovative ways bring to install a quality image. So far, lack facilities
aesthetic intentions, dominating the morphologies runs in the panels, both the fixed (rectangular) and those located on followers (square).
Panels, both in fixed and on followers integrate with higher ease the smaller size, or, in other words, the smaller the number of modules (if they are standardized). Avoid the use of different structures size, since they produce discontinuities increase their impact on the landscape.
A color change to hues present in your environment can be a good integration strategy for the case of the followers. For fixed structures for ground chromatic treatment is less necessary, since they are less visible. At followers special attention should be paid to color or textural treatment of its base.
Photovoltaic modules. The material may produce a better result ac-
presently is the monocrystalline silicon, for its gray tones, against the blue most intense and darkest multicrystalline and amorphous variables. However, their internal discontinuities condition their integration, so you should pay attention tion chromatic treatment of these discontinuities. It would be wise also to the multicrystalline silicon chromatically act on cell gridlines. Its
Meanwhile, the amorphous silicon has the advantage of generating a continuous surface, although
colors used so far are not fully satisfactory.
A line to explore the design of photovoltaic is the creation of new module designs. So far, rectangular morphologies dominate. The only variation is available, portrait or landscape, the combination is better avoided. However, only find innovative designs photovoltaic performances unique and symbolic, as so-called photovoltaic trees.
Regarding the size of the modules, large modules are desirable. Thereby continuity increases, fading profiles and hollow spaces between the modules.
The color of the modules is another way to go in introducing designs quality in these facilities: environment green cultivated areas or yellow ocher arid, etc.. Are commercially available photovoltaic cells of different hues, both as multicrystalline monocrystalline silicon, although its efficiency

decreases to a greater or lesser extent, depending on the pitch chosen. Amorphous silicon,
which compensates for its lower efficiency with lower manufacturing cost, it also allows
a certain range of colors, from reddish brown to dark gray. Regarding the profiles, solutions should be chosen small frames containing visual impact, and preferences tive of dark hues.
Other components. On-site ancillary techniques are desirable designs
with domain of horizontal lines over vertical, and above all, with adequate work chromatic and textural treatment using, for example, earthen hues and coatings

stone or masonry or wood. In any case, it is necessary to prevent mixing of colors on the same plant photovoltaics. Finally, it is advisable to take existing abandoned buildings as plant auxiliaries.
It is proposed to replace the wiring harness for other colors red or coatings, if the nor-Mativa permitted, and otherwise inconspicuous place them in points. To the location of the turrets should be selected visually less impressive site. The
posters and mountings, usually translated into one large poster,
treatment should have a quality that permits a greater degree of integration into the landscape,
both the material used as in morphology, in the colors, or typography. Must avoid the proliferation of posters, especially advertising.
Treating vials serve its dimensions (especially the width), and special cially strong, chromatically adapting to their environment. In vials in areas inclined the path must adapt to the topography, avoiding cuts and fills. To drainage ditches and morphological adaptation is required, textures and chromatic their environment.
The immediate treatment of open spaces, both the intermediate and the perimeter, is the plant, with herbaceous species, particularly those in the surrounding land. It represents a conservation success tree specimens, especially wooded environments. Alternatively, treatment of open spaces could be, in certain areas, the stone, using dominant materials in their environment.
The existing soil beneath the structures, especially under the followers, must be also some treatment to reduce the visual impact of bare ground
occur in areas where a great contrast. The two alternatives given above,
the plant (Figure 16) and the stone, could also apply to these lands.

Figure 16. Soil treatment plant.
The authors.

4.1.6. Interior components ordination

Structures. To ensure a higher degree of integration, the rows must be disregularly placed parallel to the contour lines on slopes, and the minimum separation is technically required. Greater separation involves the appearance horizontal stripes between rows themselves. It is also advisable to prolong, where appropriate, existing alignments in their environment. Is recommended eventually avoid The combination of different orientations on the same floor.

Isolated fans, meanwhile, must tend also to its concentration, intenTando create a homogeneous mass of panels. His willingness to keep similarities with those in their environment, especially if it is planted.

Plant auxiliary. Whenever we allow technical requirements so it is preferable to irregular arrangement of these buildings, and even grouped certain points, particularly in the least visible. If they are grouped, it advisable that the technical facilities tend to organize in space following the habitat distribution pattern of dispersed or tool sheds.

4.2. Corrective measures

Given its size, the effectiveness of corrective measures on the whole photovoltaic plant is limited, being practically impossible to hide or dilute its impact. Instead, they may be very appropriate to adjust the landscape of some parts of plant: slopes, perimeter fences or interior roads. Are also desirable in the treatment of structures, especially its rear and lateral views.

Among the corrective measures, the screens are the most common vegetable, however, its application is limited because they can not shade the facility, has more sense in the case of systems with followers, which reach greater heights, or installation at higher levels that the points of view. Used in greater As in the treatment of perimeter fences. In the vegetable display design is very important to choose plant species, adapting to those in their unit landscape, and to evaluate the effect that the introduction of geometries can produce. Another possibility is the creation or maintenance of plant screens away from the facility and located within existing perspectives from the points of greatest visual impact.

Other corrective measures are topographical nature, as the use of light

earth movements and the use as displays of the platforms (Figure 18) created to other neighboring infrastructure (canals, roads). More specifically, the measures corrective can range from building stone walls to the planting of plants (herbs, shrubs) through the coating color or textural certain system components.

Figure 17. Platform road and visual display.
The authors.

Corrective measures can be applied in priority to the different margins installation, although a preferred on the sides and at the rear.

May. CONCLUSIONS

Forecasts indicate that, at least in the medium term, the development of energy photovoltaic continue, although at a much more sustained. Therefore, fitting in the middle this new rural land use emerges as a challenge territorial nature and landscape. His ordination and above all, the introduction of quality design in their creation, should understood, both by the government and by private initiative, as inescapable to ensure proper integration. In this context, measures the incorporation of landscape integration is a very useful tool for this purpose.

While photovoltaic plants become new work objects to develop generic methodologies landscape integration, and opens new application prospects.

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