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SU[N]STAINABLE SYSTEM
Façade restoration and energy adaptation

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Abstract

The work presented is the result of research carried out on the occasion of participation in an international competition for the restoration and energy adaptation of the PAN-AM Building in New York held in 2016.
The concept of the intervention was based on two principles: the energy adaptation and the architectural respect of the original project. The architectural design of the project did not intend to change the division into three parts of the facade or to lose the formal continuity of the plans that define the geometry of the volumes. So, for this purpose, we sought (researched) a geometric / volumetric principle that could guarantee respect for this assumption and the creation of an energy-sustainable façade system.
Through the use of parametric procedures (grasshopper) the façade was divided into compositional units of different sizes but all included within the single compositional planes. The individual compositional units host the different technological solutions for the energy adaptation of the building.

Key words: architectural composition**,** sustainability, architectural restoration, energy saving.

1.Premise

In 2016, an international competition to redesign the external façade is banned from the property of the former PAN-AM building[1].
The design group[2] has set as a goal of its work the respect of the compositional principles applied in the original project, and the redesign of the facade necessary for energy adaptation.
The skyscraper, built in the sixties of the last century, was designed by Emery Roth & Sons and Pietro Belluschi whit advise from Walter Gropius.
The curtain wall system that expresses the unity of the three overlapping volumes that make up the building was inspired by the original principles of the project.
The challenge was: is it possible to combine energy efficiency with the architecture project? and is it possible to do this also in interventions on existing buildings? especially in buildings of particular architectural value?
So the theme was the search to combine technological needs with architectural composition.

2.The concept

From the energy point of view, we have assumed a vision that images a building that links together the "exposed areas" to the "shaded areas" through the concept of energy compensation, intended as a mutual aid relationship.
This leads to a reduction of energy dissipation and to a more uniform energy distribution, so that all indoor environments can experience a homogeneous comfort.
In fact, the system is currently unbalanced, in which the energy is not equally distributed: areas completely exposed to the sun are opposed to completely shaded areas. This leads to a higher energy consumption.
The working hypothesis, instead, wants to pursue a Responsive System that realizes an energy compensation in which the areas exposed to the sun "give support" to completely shaded areas. This is the principle of subsidiarity applied to architecture (Greefhorst and Proper, 2011).
Furthermore, in a balanced system, where the energy is equally distributed, the stanzas enjoy a more homogeneous and natural lighting comfort. This optimizes the overall energy consumption of the building.

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1 METALS IN CONSTRUCTION MAGAZINE ***Reimagine a New York City Icon***

2 Design Group: prof. arch. **Carlo Coppola** (Napoli) – *team leader*, arch. **Rosa Buonanno** - *architectural design* (SCIA Napoli), arch. **Vincenzo Nigro** - *architectural design* (SCIA Napoli), arch. **Giuseppe de Matteo Manzo** (SCIA Napoli) - *architectural design*, ing. **Adriano Brancaccio** – *structure* (New York), **Vidaris, Inc**. - *MEP system* (New York).

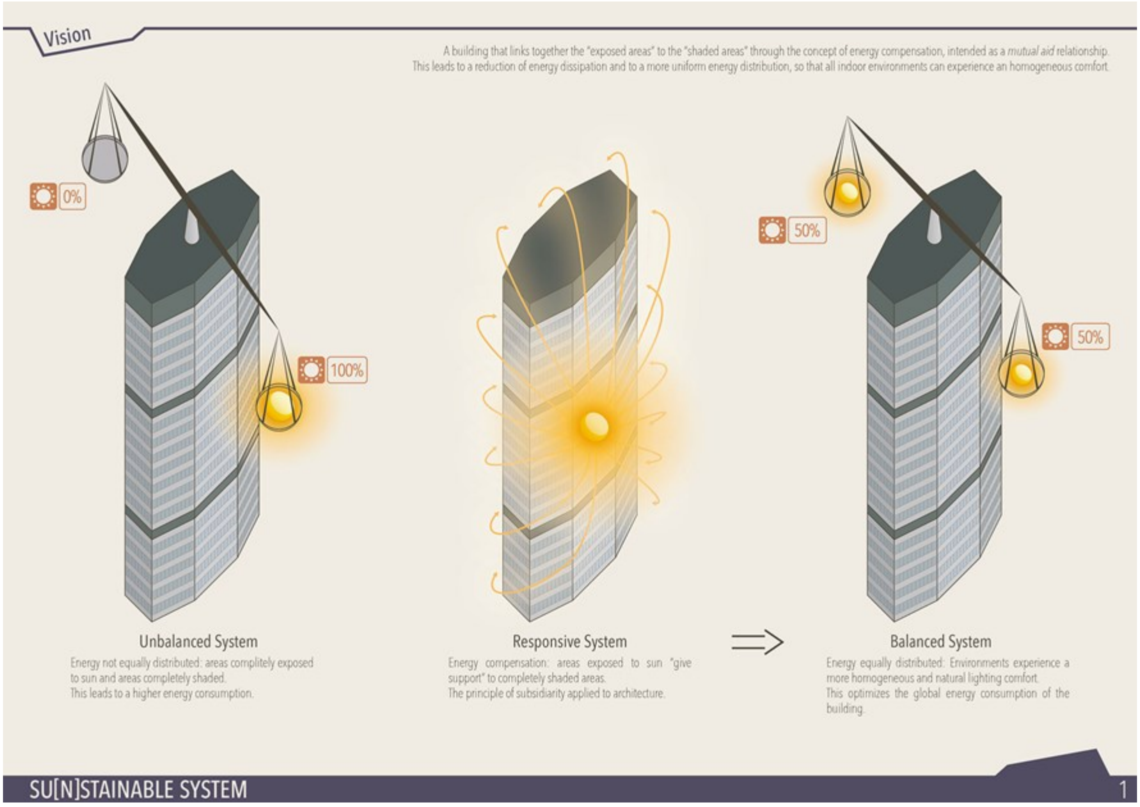


Fig.1 - The principle of subsidiarity applied to architecture

The concept is referred to:

- the Greenhouse Effect

This is one of the oldest and simplest energy saving systems (the Romans first applied this concept in their "hortus" to force the growth of certain kinds of plants). The solar greenhouse (passive thermal machine producing free thermal energy) is the space membrane that stands between the inside and the outside: the wide glass surfaces catch the solar energy and convey it inside the building, consequently improving its thermal and acoustic comfort.

- the Light amplification

The application of the physical principle of light reflection to increase natural indoor lighting production. (Franchino and Violano, 2017) Through this principle, light is reflected inside the building instead of being dissipated after hitting opaque surfaces. This leads to a consistent reduction of dissipated light and, at same time, higher comfort with no additional costs.

- the Light transmission

The least invasive system to efficiently carry the solar light into the blind inner areas: natural light is carried inside the building through optical fibers and spread over the rooms thanks to special devices.

- the Energy production (PV)

The active solar system that integrates with traditional passive systems, aiming to achieve energy self-sufficiency of the building. (Gevorkian, 2016) The installation of PV panels allows the conversion of solar radiation into electric energy thanks to the photovoltaic effect. This is one of the best green energy systems as it does not produce any kind of pollution.

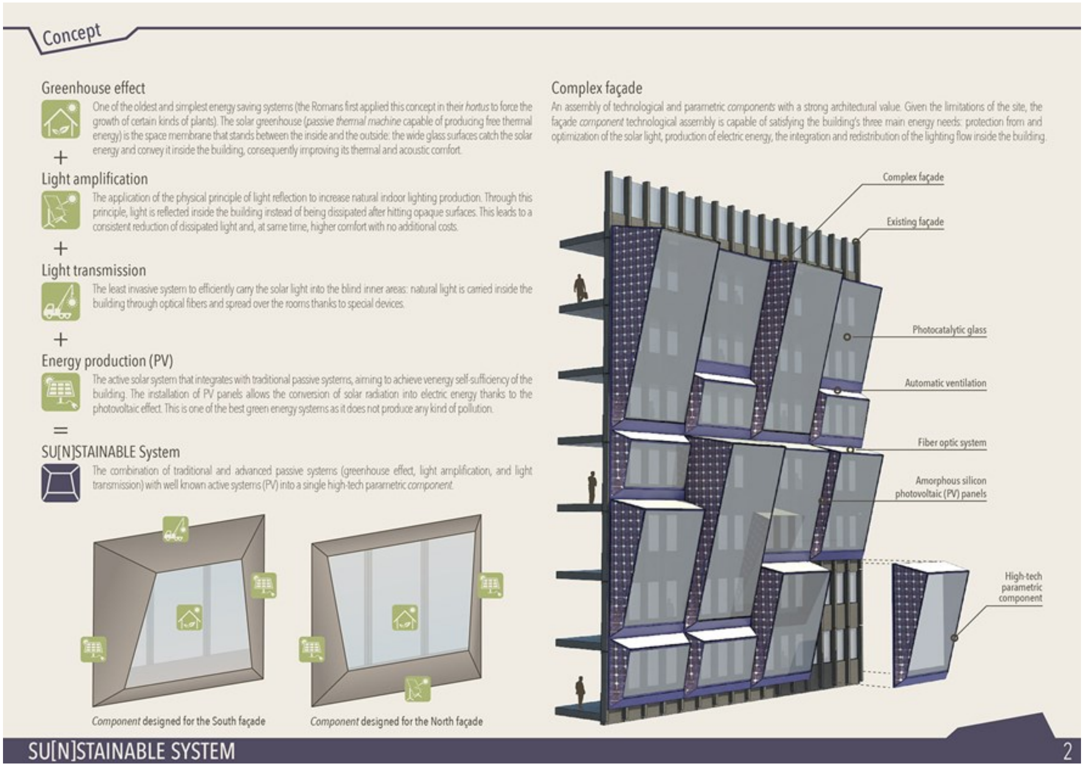


Fig. 2 – Complex façade system

The SU[N]STAINABLE System is a combination of traditional and advanced passive systems (greenhouse effect, light amplification, and light transmission) with active systems (PV) into a single high-tech parametric component.

The Complex façades formed assembling technological and parametric components with a strong architectural value. Given the limitations of the site, the façade component technological assembly meets the building's three main energy needs: protection from and optimization of the solar light, production of electric energy, the integration and redistribution of the lighting flow inside the building.

2.The Project

The adopted envelope solution is installed on the building as a double skin, allowing it to preserve its original sense of façade. Its design was based on three different types of elements that make up the pattern of the image and their apparently random distribution serves to give the surface a vibration of planes and lights such as to fit it more appropriately into the city of New York.

The elements adopted were designed using a generative algorithm (grasshopper) which distributed elements of different sizes over the entire surface of the façade. The algorithm allows to obtain many different equivalent solutions for elements distribution. The elements were chosen also for the optimization of relationship between the facade and the interior spaces that they delimited.

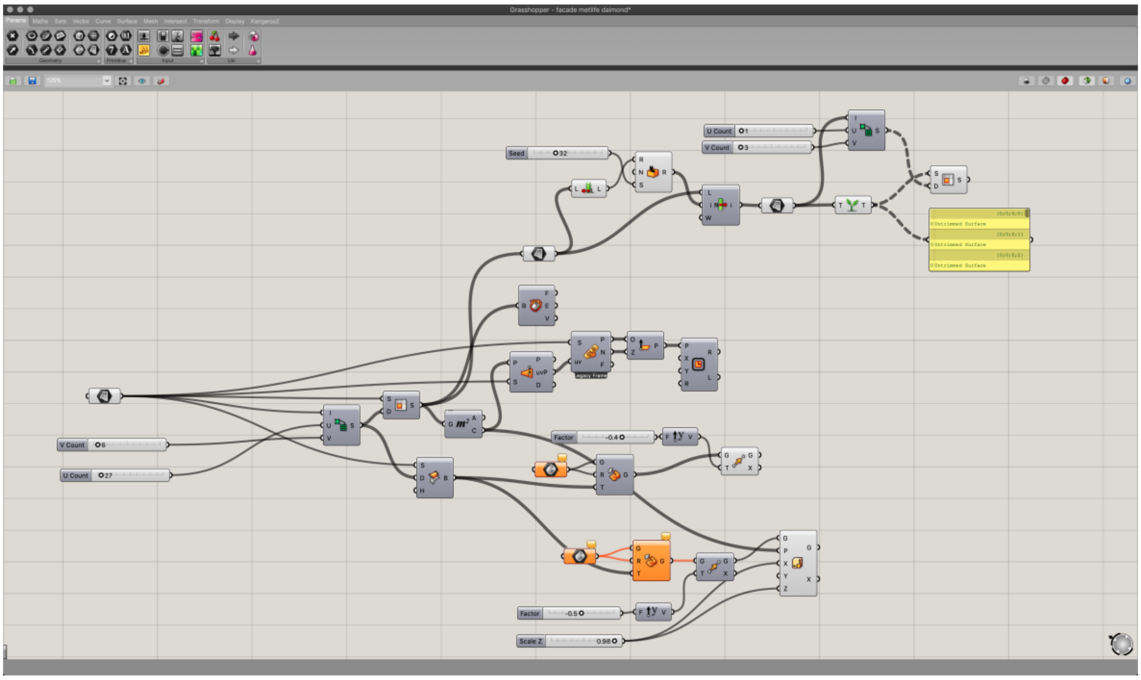


Fig. 3 – Grasshopper algorithm for façade system

The objective was to evaluate the different yields of the ecological addition elements on the façade according to the exposures and the need to enjoy the panorama from the various work areas.

This provides not only a consistent economic benefit, without disregarding the aesthetic, but also avoids annoying interferences with the ongoing building activities during construction.

It is not of minor importance the decision to use a single component capable simultaneously of producing energy, shading from sunlight and propagating natural light. Further, the shape of the component, although subjected to the aforementioned functional aspects, returns a new and strong architectural significance to the MetLife Building[3], while preserving its original spirit of composition.

The SU[N]STAINABLE System represents the combination of existing and well-known technologies with a static component perfectly compatible with the existing facade. Every single piece of the component is designed to be assembled on site to guarantee constructability and reduce costs of installation. Maintenance costs are also reduced thanks to the choice of passive and static components of bioclimatic architecture that do not employ any kinematic mechanism on the façade.

[3] MetLife is the new name of the Pan-Am building

The attached table shows a breakdown of the building's energy demand before and after the installation of the new façade. This calculation has been developed considering also potential upgrading interventions to the current and probably aged M.E.P.[4] systems of the building, as a crucial action to be performed during building energy renovation projects.
In the analysis of heating and cooling improvements, estimations of the new reduced U-values have been considered to reflect the presence of the new double-skin facade made of low emissivity glasses, steel metal trusses and insulated panels. Given that the characteristics of the existing M.E.P. systems and actual envelope are unknown, the numbers shown in the table are an estimation with an accuracy of likely 10-20%.
For the PV panels, applied only to the South façade of the building, a capacity of 15 Watt/sq.ft has been assumed.

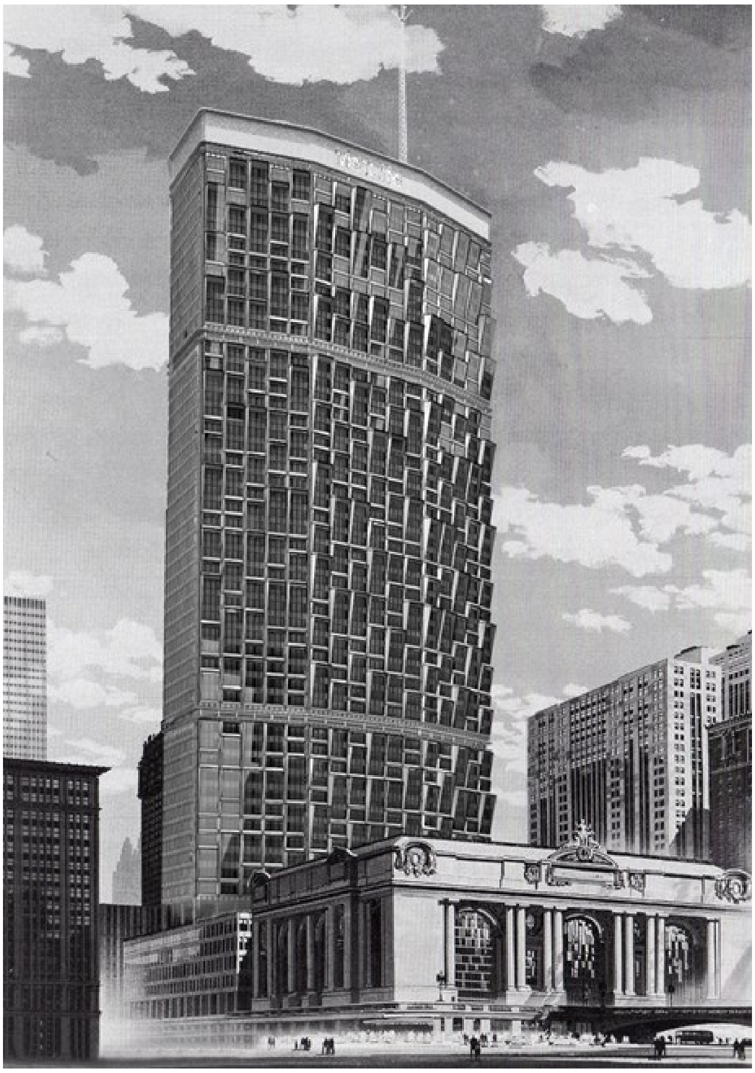


Fig. 4 – Architectural sketch by design team

[4] Mechanical, Electrical and Plumbing systems

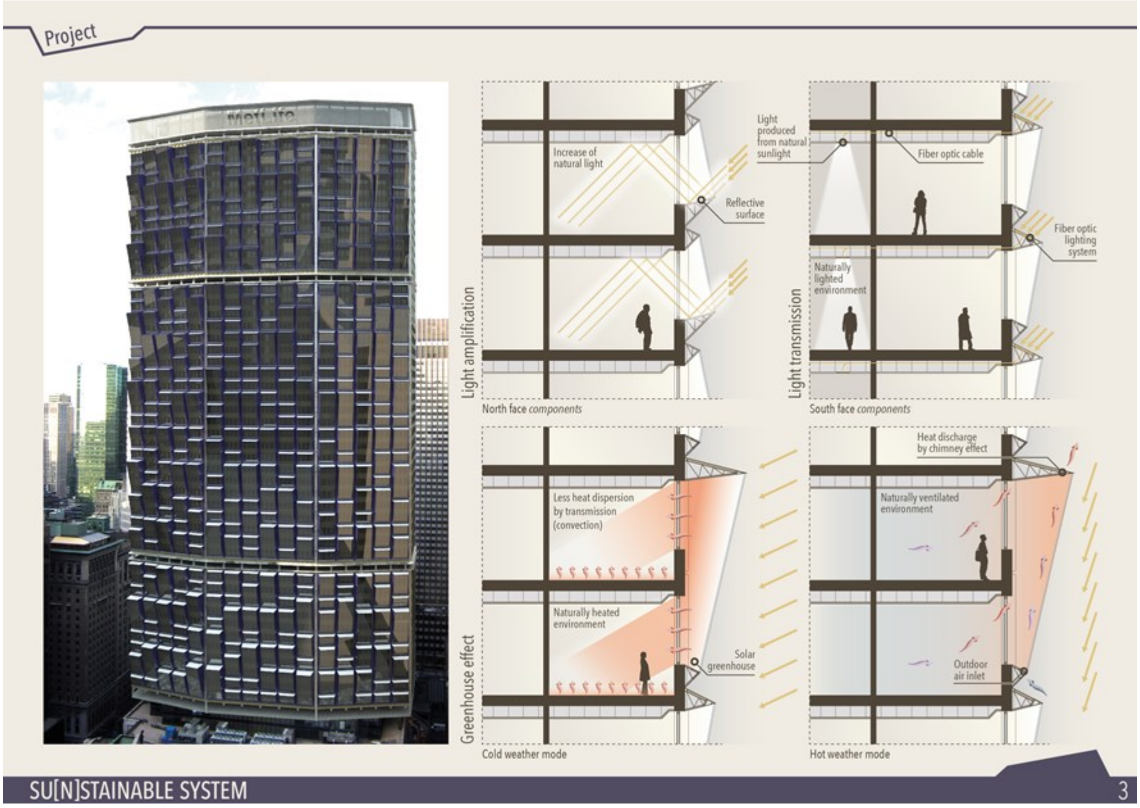
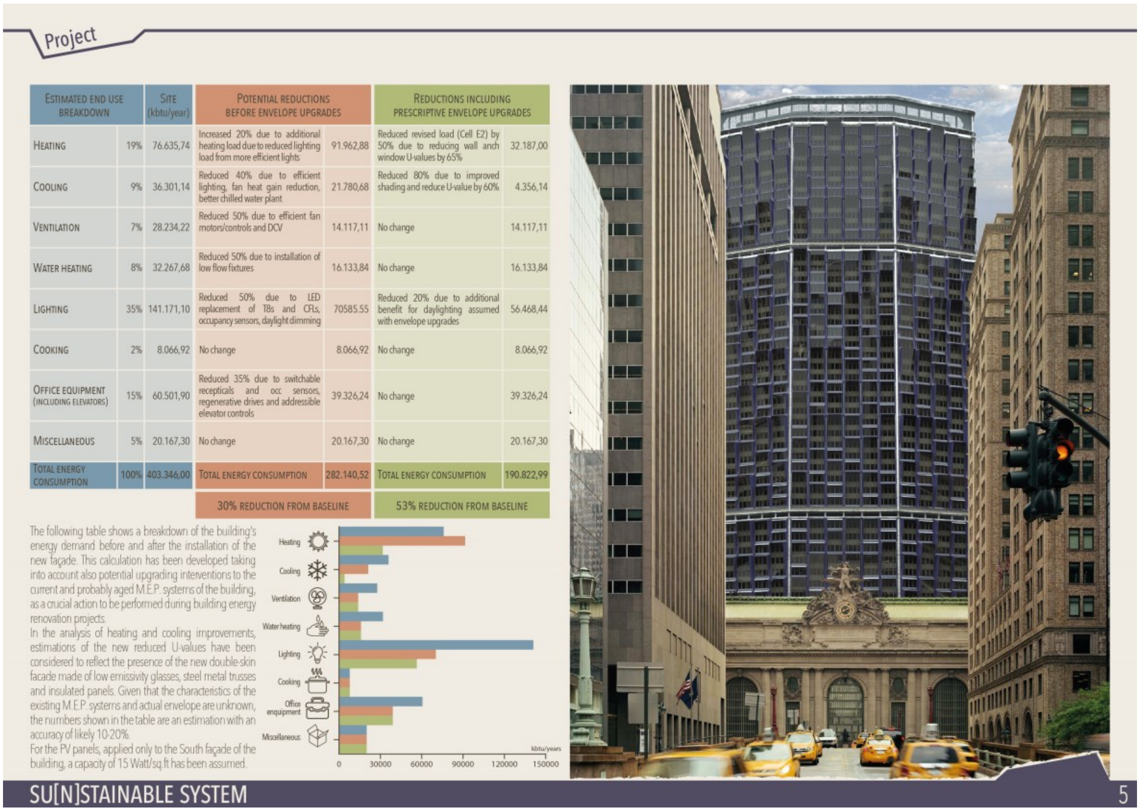


Fig. 5 - Greenhouse effect (competition table)



Estimated end use breakdown		Site (kbtu/year)	Potential reductions before envelope upgrades		Reductions including prescriptive envelope upgrades	
Heating	19%	76.635,74	Increased 20% due to additional heating load due to reduced lighting load from more efficient lights	91.962,88	Reduced revised load (Cell E2) by 50% due to reducing wall anch window U-values by 65%	32.187,00
Cooling	9%	36.301,14	Reduced 40% due to efficient lighting, fan heat gain reduction, better chilled water plant	21.780,68	Reduced 80% due to improved shading and reduce U-value by 60%	4.356,14
Ventilation	7%	28.234,22	Reduced 50% due to efficient fan motors/controls and DCV	14.117,11	No change	14.117,11
Water heating	8%	32.267,68	Reduced 50% due to installation of low flow fixtures	16.133,84	No change	16.133,84
Lighting	35%	141.171,10	Reduced 50% due to LED replacement of T8s and CFLs, occupancy sensors, daylight dimming	70585.55	Reduced 20% due to additional benefit for daylighting assumed with envelope upgrades	56.468,44
Cooking	2%	8.066,92	No change	8.066,92	No change	8.066,92
Office equipment (including elevators)	15%	60.501,90	Reduced 35% due to switchable recepticals and occ sensors, regenerative drives and addressible elevator controls	39.326,24	No change	39.326,24
Miscellaneous	5%	20.167,30	No change	20.167,30	No change	20.167,30
Total energy consumption	100%	403.346,00	Total energy consumption	282.140,52	Total energy consumption	190.822,99
			30% reduction from baseline		53% reduction from baseline	

Fig. 6 - Energy balance table and Rendering (competition table)

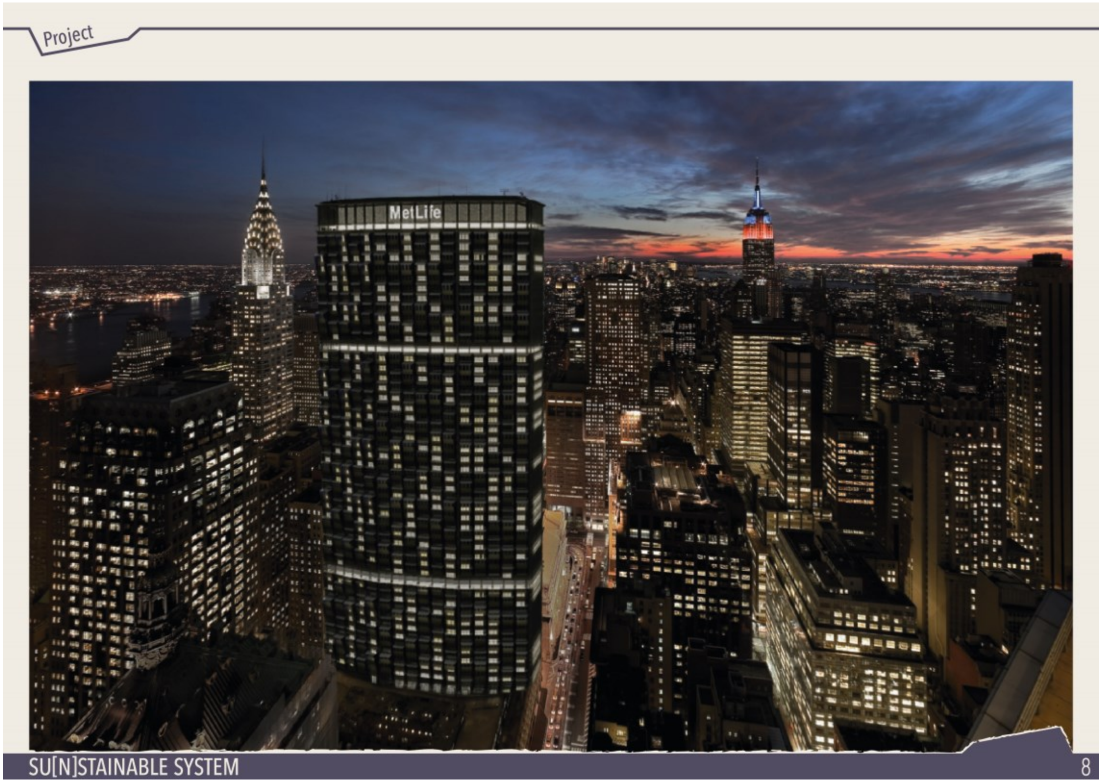


Fig. 7 - Night rendering (competition table).

3. Conclusion

The façade renovation project achieved the required energy efficiency. From the architectural point of view the original composition of the skyscraper has been respected, the expressive continuity of the curtain wall plans was not lost, and the overall image was not altered. The images of the project show how the results obtained have preserved the character and the landscape role of the building, having allowed the proposal to be mentioned by the jury[5].

In conclusion, all this considered, we believe that the architectural result obtained may be what the original design team himself would have designed with the current ecological sensitivity and today's technologies.

References

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[5] **Areta Pawlynsky**, AIA, **Ben Tranel**, AIA, LEED AP, **Billie Faircloth**, AIA, LEED AP BD+C, **Fiona Cousins**, PE, LEED AP BD+C, **Sameer Kumar**, AIA, LEED AP, **Peter Arbour**, Associate AIA (Moderator).
The jury mentioned the project for the application of the principle of subsidiarity in architecture.