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# Energy Upgrade to Buildings

## IENE Conference «Investing in Energy Efficiency»


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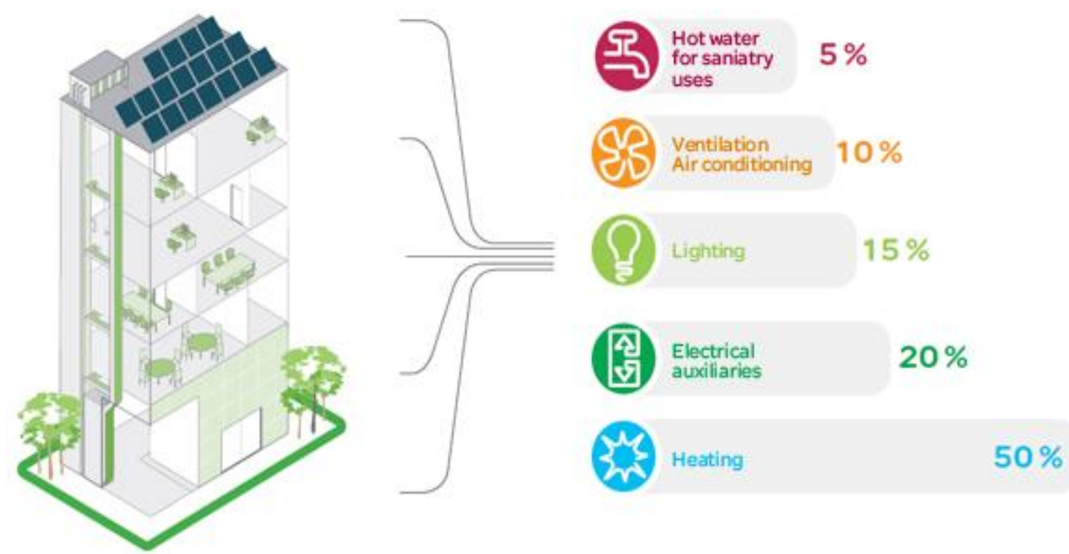
# Why Energy Upgrade to Buildings

- Energy upgrade, aims to ideally convert buildings to Nearly Zero Energy Consumption Buildings.
- However this objective can not be achieved only by increasing energy efficiency and saving energy consumed in buildings but also requires the active production of renewable electricity in them.
- Solar energy through photovoltaics can cover electricity consumptions of the building and not just water heating loads, as it is traditionally happening mainly with thermal solar systems.
- Buildings, account for approximately 40% of the total energy consumption and that is more that transportation or industrial sector.



# Advantages of PVs in buildings and their energy upgrade

PVs as a source of renewable electricity, combine a range of assets for use in buildings even within cities. Such advantages are:

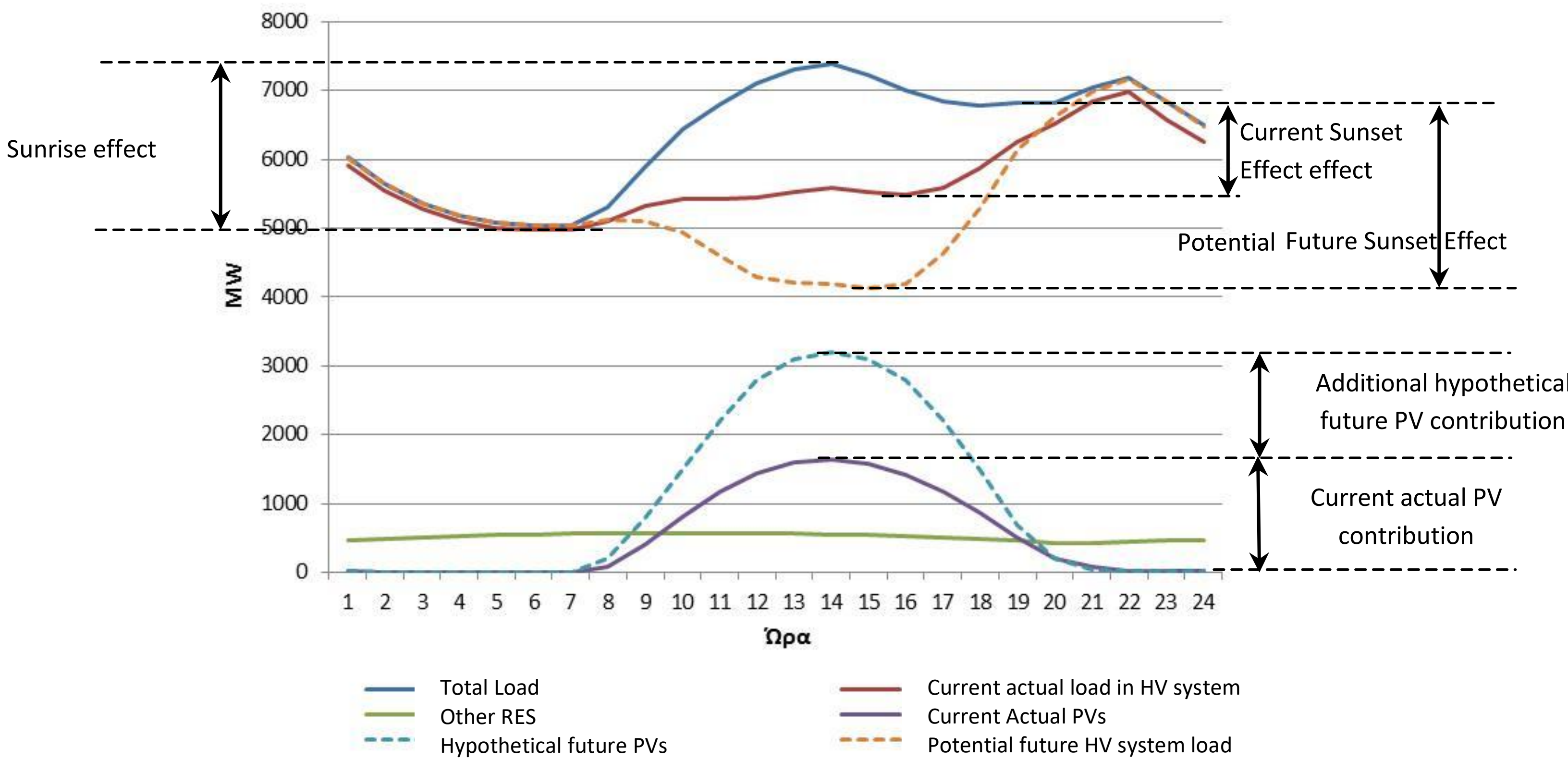
- The renewable raw material is the inexhaustible solar energy, where negative developments for our country in terms of availability-abundance are not expected in the future (the opposite is estimated to happen i.e. with waters).
- The absence of moving parts in the installation and hence the complete lack of noise.
- The very low maintenance costs beyond the initial installation cost.
- Their long life (25 years) without significant aging and reduction of their initial production performance (usually the guaranteed yield is performing at 80% of their initial production capacity at the end of a 25 years period).
- The constantly further declining equipment cost.
- In terms of power balance for the system there is still margin in Greece for new PVs, until i.e. negative Sunset Effect exceeds the benefits from the positive Sunrise Effect due to PVs.

# PV Sunrise vs Sunset Effect

Based on actual 2015 system data, where PVs contribution remains practically the same till today, positive to the system Sunrise Effect due to PVs exceeds their negative Sunset Effect.

It seems to be 1GW margin for new added PV penetration until this situation is potentially reversed.

Whatever further PV penetration should be spread among all categories i.e. plants, buildings and under any remuneration scheme i.e. independent producers, net metering, virtual net metering, energy communities etc.



# Challenges of PVs in buildings and their energy upgrade

However, there are also challenges under policies aiming to massive PV penetration in buildings under i.e. net-metering or virtual net-metering schemes, which are:

- Their time-focused and regionally coordinated production during day hours.
- Their floating production when weather is partly cloudy and their complete shutdown at night.
- The potential surplus in terms of power balance between production and consumption of the buildings that are installed, especially during noon hours.
- The congestion of the grid in cases of high penetration that will not be able to absorb and transmit their surplus production peripherally, resulting to the automatic disconnection to a part of these PV systems.

# Decentralized storage for PV systems

- Decentralized storage (behind the meter) of the exceeding PV production compared to the electricity consumption real-time in the building, is maybe a “one-way road” for the massive incorporation of PVs into the buildings.
- Alternatively, local decentralized storage units acting as clusters could maybe also help for better and faster economies of scale.
- Centralized storage in HV according to earlier studies remains unknown if it can help and how much in the "dense" system of LV and MV.
- Although battery storage cost has declined radically during the last few years, it still overall remains high in terms of electricity produced and stored compared to electricity from fossil fuels.
- In a small 3 kWp net metering PV system, which meets the electricity demand of a typical household per year, the installation of a useful 3 KWh Li-ion storage system (i.e. a standard storage capacity of approximately 1.2 hours of peak production of the relative PV system) doubles the total installation cost from € 4,500 to € 9,500 (source: CRES study under PV-ESTIA program).

# The challenging today's cost of a decentralized PV system with storage

| Cost analysis of a typical building PV system with batery storage | PV system | PV system with Li-Ion batteries |
|---|---|---|
| PV panels | 1200 | 1200 |
| Metal Base | 300 | 300 |
| Cables | 150 | 300 |
| Electrical panels | 300 | 500 |
| Mounting Cost | 500 | 1000 |
| Inverer DC to AC 3 kWp | 900 | 900 |
| Battery of usefull 3kWh capacity | | 1167 |
| Inverter and Chrager that accepts batteries of 3kWh capacity performing at AC approx. 2.5-3kVA | | 1850 |
| Management and Communication System for Battery, Self Consumption etc | | 250 |
| Meter | 230 | 230 |
| Subtotal | 3580 | 7697 |
| VAT 24% | 859.2 | 1847.20 |
| **Grand Total** | **4439.2** | **9543.87** |

*Source: CRES study under PV-ESTIA program*

# Challenges of decentralized storage in PV systems

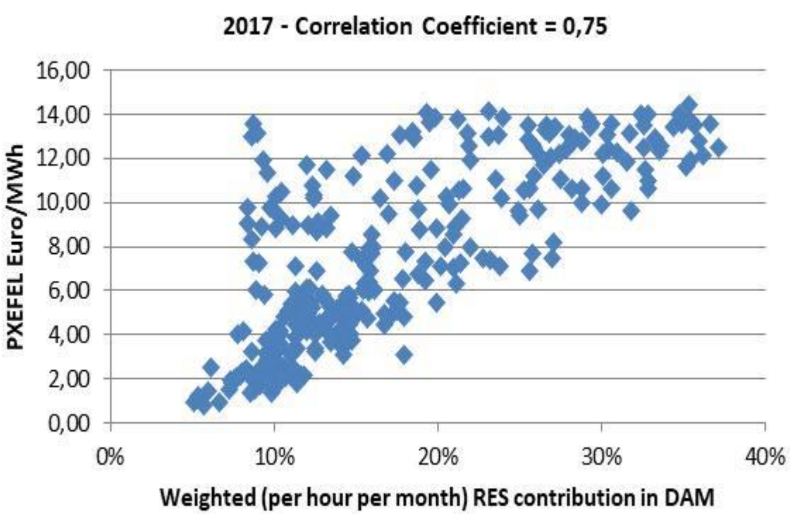
- According to CRES study the self-consumption percentage in such a system increases from just 35% to 50%.
- Today the system's amortization period (with a 90% storage performance ratio) reaches 16 years compared to about 8 years of a simple net metering system.
- In this example, the Li-ion battery with today's cost of 350 euro / kWh (at 90% depth of discharge) weights for only 25% of the total cost of installing storage infrastructure. Therefore, further reduction of battery costs alone cannot bring a drastic reduction to the overall system cost.
- Thus, in principle, a drastic further drop in the several costs apart from battery (i.e. PV panels, inverters, chargers, regulators, etc.), is also needed, in order to reduce the overall payback time of a PV system with battery storage.
- Further increase in $CO_2$ emission allowances to the zone of 30 euros/ton or even further compared to ~15 euros/ton of today can help storage projects.

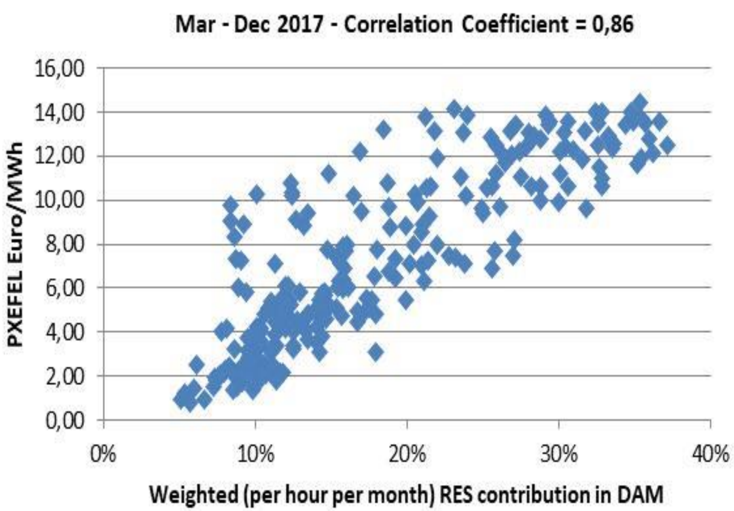
# Conflict between simple and coupled with storage net metering system

- Paradoxically, current net-metering and virtual net-metering schemes, inhibit decentralized storage alternative as they remain financially more attractive (8 years amortization period compared to 16 with battery storage), hence making prosumers (investors) indifferent to increasing their self consumption rate by investing additional money for decentralized storage.
- In other words, virtual storage to the grid through current net metering schemes at no cost to prosumers does not make real storage an attractive alternative (decentralized storage doubles the installation cost).
- Furthermore there is an additional concern of who is going to replenish the grid costs in the future, if electricity absorbed by prosumers from the grid drops dramatically when decentralized storage will become some time in the future cost effective.

# PVs in buildings and wholesale market

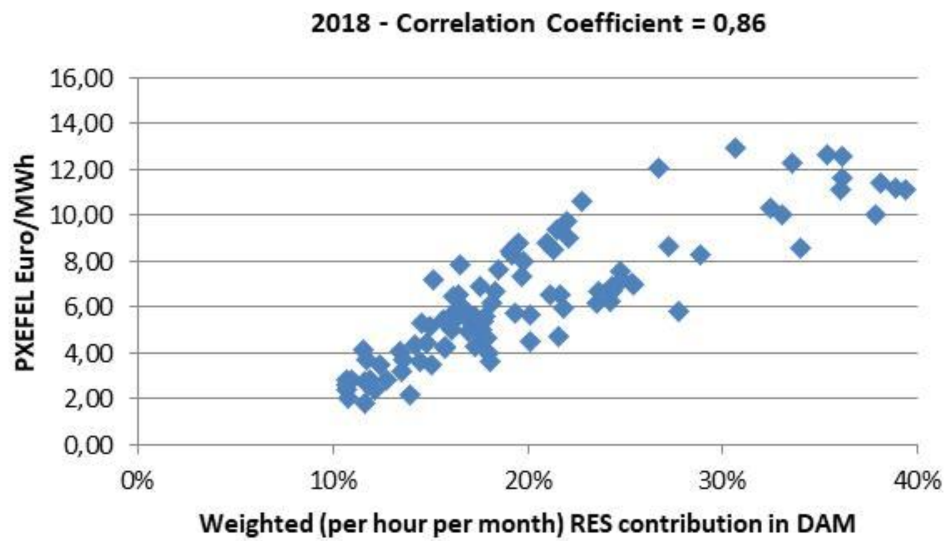
- PVs and generally RES installations in buildings or elsewhere under remuneration off-setting with consumption policies or net-metering or virtual net-metering schemes with or without storage infrastructure, normally participate to the Day Ahead Market under priority for their full production capacity.
- This means that Merit Order Effect (MOE) and its consequences to the whole market is present there too, hindering the massive development of such projects.
- Supplier's Surcharge mechanism (PXEFEL) introduced in Greek interconnected system through law 4414/2016, is the only successful and statistically solid measure ever taken to counteract MOE.
- Supplier's Surcharge, namely the drop in wholesale electricity price due to RES under priority participation, enjoys a very high Correlation Coefficient of up to 86% with RES active penetration in Day Ahead Market during 2017-2018 period.




(excluding Jan-Feb 2017 due to paneuropean energy crisis)

# PVs in buildings and wholesale market




So, from 2021 that the Special Surcharge mechanism will phase-out according to the recent agreement between the Greek Government and the Institutions, something else should successfully fill the gap (high enough $CO_2$ prices in ETS, Green Certificates etc) in order to:

- Protect and further boost the decarbonization of the electricity system though RES.
- Protect and boost their expansion to consumers making them active prosumers.

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**Thank You!**

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