



# **South Europe Solar Plan**

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## Summary

The South Europe Solar Plan (SESP) target of 1kW/capita of building mounted PV is the fastest and most profitable way for southern EU countries - the EU's potential solar engine - to secure a green recovery. The wider EU will also gain vital climate and economic benefits.

Unlike other renewable electricity supply options, uniquely, installing PV modules on buildings can create rapid widespread employment, with PV installation jobs across all regions of southern EU countries. Additionally, the massively expanded PV installation market will stimulate manufacturing of PV and complementary technologies (e.g. batteries, heat pumps, hydrogen/fuel cells and electric vehicles/charging points) as well as exports.

The solar power production would also give business building owners and the businesses in them hit by the coronavirus recession crucial financial savings and extra income, protecting jobs. In addition, renewable electricity generation will accelerate economic development and job creation, with surplus power sales assisting southern EU countries' balance of payments.

The programme could be beneficially extended to cover the houses of employees to support continued home-working, meeting the growth in daytime domestic power demand. SESP would furthermore make a major contribution towards southern EU countries, their businesses and the wider EU achieving essential net zero carbon targets.

Crucially, SESP's pioneering and world-inspiring sustainability standard could encourage other countries, globally, to raise their vitally important COP26 NDC ambitions.

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## 1. Introduction

The South Europe Solar Plan (SESP) is the fastest and most profitable way for southern EU countries - the EU's potential solar engine - to secure a green recovery. SESP's objective is to achieve national targets of 1kW/capita of building mounted solar photovoltaic (PV) in each southern EU country. The wider EU will also gain vital climate and economic benefits.

Of all the low carbon electricity generation options, installing PV modules on buildings can, uniquely, create rapid widespread installation jobs across all regions of southern EU countries. Furthermore, building mounted PV involves the least electricity transmission costs and power losses as well as the least carbon-intensive material inputs.

Compared to the more northerly Germany, with a PV capacity of 0.58kW/capita, the ten southern EU countries on average have installed less than half that, at 0.23kW/capita. This is despite southern countries benefiting from about twice the solar intensity:

<https://commons.wikimedia.org/wiki/File:SolarGIS-Solar-map-Europe-en.png>

The double solar energy availability below 45° latitude (north Italy) makes PV twice as profitable in ten EU countries - the EU's potential solar engine. National targets of 1kW/capita could probably be installed solely on domestic rooftops. However, the most cost-effective location is on large modern buildings in industrial and commercial estates.

Funding solar power with zero interest loans would give business building owners and the businesses in them vital financial savings and extra income, protecting jobs.

The programme could also be extended to cover the houses of employees, and potentially their neighbours, friends and families. This would support continued home-working, with solar power sustainably meeting the growth in daytime domestic power demand.

In addition to nationwide urban installation jobs in all southern EU countries, SESP would stimulate the manufacturing of PV and complementary technologies (e.g. large batteries, heat pumps, hydrogen/fuel cells and electric vehicles/charging points) as well as expand export opportunities. The resulting renewable electricity generation would also sustainably accelerate economic development.

Furthermore, the businesses installing PV will make major advances towards achieving essential net zero carbon targets, with surplus solar power being sold to other organisations, helping the wider economies cut CO<sub>2</sub> emissions. Excess solar power production can be exported to other nations, benefiting the southern EU countries' balance of payments.

National targets of 1kW/capita could most rapidly be achieved by SESP countries first targeting their largest cities, to be completed by 2030. The programme could then be extended to cover all the remaining industrial/commercial estates of each country by 2040.

However, it would aid disadvantaged rural regions if they were developed in parallel with the largest cities. The employment rate potential would double if these ten year targets were replaced by more ambitious five year targets and treble with dynamic three year targets.

Climate authorities and international leaders are now linking the essential green economic recovery plans to the vital UNFCCC COP26 climate goals. With the coronavirus recession and the year's delay to November 2021, the COP26 conference is of even greater importance.

Through this motivational programme, Europe, with its major historical responsibility for CO<sub>2</sub> emissions, now has the opportunity to establish a pioneering and world-inspiring sustainability standard. Crucially, SESP projects can easily be developing well before the COP26 meeting to encourage other countries to raise their vitally important NDC ambitions.

## **2. Green recovery**

Renewable electricity generation is vital for fighting the climate emergency. However, it is also essential for economic development. An analysis which covered over 99% of the global economy over several decades (Electricity use and economic development, Ross Ferguson et al, Energy Policy 28 (2000) 923-934) had three basic conclusions:

1. Wealthy countries have a stronger correlation between electricity use and wealth creation than do poor countries.
2. For the global economy as a whole, there is a stronger correlation between electricity use and wealth creation than there is between total energy use and wealth.
3. In wealthy countries, the increase in wealth over time correlates with an increase in the proportion of energy that is used in the form of electricity.

Recovering from the coronavirus recession will therefore be accelerated with renewable electricity generation, assisting economic development and creating sustainable employment. Furthermore, both forestation and energy efficiency can, in contrast, actually increase greenhouse gas emissions.

It can take many years before greenhouse gas emissions from tree planting soil disturbance alone are recovered and decades for trees to mature sufficiently to sequester substantial levels of CO<sub>2</sub>. Achieving significant carbon sequestration by 2030 is simply not credible.

Soil disturbance made post-war peatland forestation exceptionally damaging with massive greenhouse gas emissions. All European peatlands should be urgently restored to prevent their continuing carbon loss, which would overwhelm all the savings from cutting fossil fuel use. However, grasslands, where most tree planting is now targeted, also have very large and vulnerable carbon stores as well, which it is vitally important to protect.

Of fundamental importance though, forests are not reliable, long-term carbon sinks or stores. In addition to the threat of legal or illegal logging/clearing, trees are increasingly vulnerable to damage from pests and diseases with rising temperatures as well as wildfires due to the growing frequency of extreme heatwaves and droughts.

With energy efficiency, the potential benefits of reduced fuel bills and CO<sub>2</sub> emissions from insulation are often instead taken as comfort improvement, through warmer winter and cooler summer internal temperatures. Occupants can even increase heating or air conditioning use afterwards because of the improved value for money.

When financial savings do result from energy efficiency techniques though, these are either spent or invested, both stimulating other economic activities which use energy, producing additional CO<sub>2</sub> emissions.

These further CO<sub>2</sub> emissions can be even greater than the initial reductions if the activities that the finance supports use fuels of higher carbon intensity. This is likely because in the EU it is probable that natural gas use will be reduced whereas elsewhere, particularly in developing nations which the EU rely on for many products, more coal and oil are used.

Higher CO<sub>2</sub> emissions may also result if the fuels abroad are cheaper, through lower taxes, and used in greater quantities. These internal/comfort and external/investment problems are the microeconomic and macroeconomic components of the Jevons Paradox.

With the limitations of forestation and energy efficiency, the only way that net zero carbon targets can be achieved is by decarbonising the economies and supplying all EU buildings with low carbon heat as well as low carbon electricity as rapidly as possible. There is therefore a far greater requirement for renewable electricity generation in the EU than has been widely acknowledged.

There is also the essential need to account for the carbon intensity of material inputs in low carbon energy technologies as well as imported and historical CO<sub>2</sub> emissions and mitigate these with reliable carbon negative techniques.

Energy efficiency and forestation are widely advocated for carbon offsetting to support continuing business as usual. The basic failure of attempting to offset one emission by reducing another though is that overall the combined system still adds to atmospheric CO<sub>2</sub>. This is not a net zero carbon approach but simply a continuation of the disastrous status quo.

True carbon offsetting can only be achieved with a reliable carbon negative technique removing atmospheric CO<sub>2</sub>. The IPCC special report on global warming of 1.5°C concluded that all pathways that keep the average global temperature rise below the UNFCCC Paris agreement's vital limit of 1.5°C (even those with limited or no overshoot) must use carbon negative techniques.

### **3. Renewable energy**

Most published national statistics for total greenhouse gas emissions fail to account for the carbon life cycles associated with products that are imported. As a result, the figures for CO<sub>2</sub> per capita and CO<sub>2</sub> per unit of GDP also cannot be accurately representative. Summary

assessments suggest that imported CO<sub>2</sub> emissions could as much as double the EU's carbon footprint.

In particular, many energy-intensive industries, notably steel making, have moved from older industrialized countries to developing, lower income economies in the last few decades. However, the CO<sub>2</sub> emissions related to their processes are not reallocated appropriately when these commodities are exported for use elsewhere. Another important example is cement manufacturing for concrete, which is a substantial source of CO<sub>2</sub> emissions.

The CO<sub>2</sub> emissions from the global manufacture of steel and concrete are each as high as those from the EU and together they are greater than those from the US. Through these and other material inputs, the low carbon energy technologies that the world is rightly adopting still have significant life cycle CO<sub>2</sub> equivalent emissions compared to fossil fuel power production.

Wind turbines are principally made of steel, with taller offshore structures requiring greater quantities, as will tidal stream turbines working against powerful ocean currents. Wind turbines also need concrete foundations and tidal range barrages are massively concrete-intensive. Compared to building-mounted solar PV modules, rural solar farms additionally require steel/aluminium supports and concrete foundations.

Concrete/steel intensive nuclear power stations, as well as remote renewable energy farms, also need long power transmission cables using copper, aluminium and alloys of other energy-intensive metals. Furthermore, plastic building insulation materials, applied in massive volumes, use extremely powerful greenhouse gases (HFCs) in their manufacture.

All these imported (or EU produced) material inputs need to be included in comprehensive carbon accounting to analyse the true carbon intensity for each low carbon technology. The essential mitigation consequently required to achieve net zero carbon emissions can only be genuinely secured with a reliable carbon negative technique.

The combined result of all these critical factors, in addition to the vital need for carbon negative mitigation for both current and historical emissions responsibility, is the requirement in the EU for substantially greater renewable electricity generation than is widely acknowledged.

This is even more important with the difficulties of converting buildings to be heated by hydrogen instead of natural gas. Currently, conventional gas boilers can only tolerate about 20% of hydrogen in the fuel. Boilers that can operate on 100% hydrogen exist but making these available to over two hundred million EU houses by 2030 would need an installation rate of about 100,000 per day.

This ignores converting the millions of commercial, industrial and public sector buildings. Furthermore, there is only one national gas pipeline network, making a final switchover particularly complicated.

The hydrogen also needs to be produced in a low carbon manner. There is insufficient bio-methane potential from EU biomass wastes and residues, or even from the land available for fast-growing energy crops to meet this demand.

#### **4. Solar power**

Intermittent wind power is fast replacing fossil fuels as the leading energy source in the EU's electricity supply mix. In addition, hydropower has growing unreliability through the increasing frequency of extreme heatwaves and droughts (as well as floods).

As a result, a complementary, rapidly expanding programme of solar PV electricity generation in the EU is vital. Furthermore, it is not widely appreciated that solar power is 90% predictable, more in arid regions.

The cost of PV electricity generation has fallen over a hundred fold in the last forty years and PV has now achieved grid parity, being cheaper than fossil fuel power production. PV costs continue to fall at the same time as the electricity conversion efficiencies of alternative PV technologies increase, particularly those of lightweight thin film PV materials.

In addition, with the length of time being uncertain before EU buildings can be heated by 100% hydrogen (produced in a genuinely low carbon manner), to achieve net zero carbon targets as soon as possible it is essential that SESP's massively accelerated programme of solar PV installations on buildings is started immediately.

Large-scale PV systems have recently been increasingly developed in rural solar farms. However, their visual and ecological impacts are considered unacceptable by many. Solar farms also have longer electricity transmission cables with higher costs and power losses as well as no benefits from onsite savings. Compared to building-mounted PV modules, rural solar farms additionally require steel/aluminium supports and concrete foundations.

In contrast, PV is more aesthetically and environmentally appropriate on modern commercial, industrial and public sector buildings. Building mounted PV systems also have shorter power transmission connections to neighbouring major users with lower costs and power losses as well as less carbon-intensive material inputs.

Electricity generation from roof-mounted PV systems can be used to meet immediate onsite power demand in buildings and a flexible range of other complementary applications. Industrial, commercial and public sector buildings are also particularly appropriate as they have greater power demand during daylight hours, when solar electricity is generated.

Of particular importance, peak air conditioning demand, which is growing rapidly with global heating, is logically and conveniently in phase with peak solar power production.

## **5. Complementary technologies**

In addition to surplus solar power being capable of transmission off-site (in contrast to solar water heating), it is increasingly being stored in large-scale, multi-megawatt hour batteries. New designs are rapidly reducing the price of these and they can also be used for regional electricity demand network balancing.

Where the electricity transmission network capacity limits on industrial and commercial estates would otherwise restrict potential PV installations, batteries can be included at the outset, benefitting from substantial economies of scale. Electricity storage can additionally meet power demand in non-daylight hours, including night-time electric vehicle (EV) charging. Regional battery networks could also help those locally vulnerable to fuel poverty.

As well as meeting power demand, solar PV systems can importantly produce heat efficiently using heat pumps. In particular, the EU also has the vital potential from water source heat pumps drawing on abundant river and marine resources. This maximises the benefits of PV solar power for space and water heating as well as air conditioning, the demand for which is growing with global heating.

In comparison with air source heat pumps, water source heat pumps perform more efficiently for both heating in low winter temperatures as well as for air conditioning in high summer temperatures. Ground source heat pumps are more costly to install, also needing substantial areas of land available. Borehole source heat pumps are even more expensive.

Surplus solar power can also produce hydrogen through electrolysis, which can be stored for later electricity generation using fuel cells, possibly in EVs. Hydrogen can additionally be transported in gas pipelines for use in steam or water heating and more efficient combined heat & power (CHP or cogeneration), as well as trigeneration incorporating air conditioning.

## **6. Solar parks**

Substantial economies of scale can be achieved in the bulk buying of solar PV systems if the industrial/commercial estates in cities, conurbations or regions are developed into solar parks. The price reductions secured for these businesses can also assist the development of domestic solar villages where solar PV is less cost-effective. Houses not only have smaller roofs, many are less occupied during daylight with lower power demand and a smaller proportion has air conditioning.

The establishment of urban solar parks - in contrast to rural solar farms - would enable solar parks members to receive substantial discounts on PV systems and installation costs through purchasing economies of scale. Solar parks members would also benefit from positive publicity in the local community and nationally/internationally for their PV installations.

In addition, solar park members could gain advice from the solar parks administration and other group members on complementary technologies including, EV charging points, batteries and heat pumps, as well as hydrogen production, storage and fuel cells.

Members could also benefit from solar parks co-ordination in sharing facilities that are only required part-time, in modern co-operatives, massively reducing the costs of switching to a net zero carbon future.

The solar parks could generate annual revenues from business membership fees, according to the scale of their PV installations, at the low rate of 1cent/watt (peak)/year. This would amount to less than 10% of the annual financial benefits in savings and income that solar parks members would receive from their discounted PV systems.

At the end of each financial year, any surplus income from membership fees could be used to provide discounted PV systems to reduce fuel poverty locally and assist community projects in developing nations.

Based on 1cent per watt peak (Wp) of PV installed per year, the resulting solar parks membership fees for different scales of PV installations are modest and as follows:

1. 1kWp     €10/y
2. 10kWp   €100/y
3. 100kWp   €1k/y
4. 1MWp     €10k/y

The potential PV capacity of SESP could be increased substantially if businesses joining solar parks extended the economy of scale benefits to their employees for additional PV installations on their houses, assisting them with zero-interest loans.

This would support a continuation of increased home-working from the coronavirus lockdown and the related growth in daytime domestic power demand. This opportunity could be extended even further if the employees' friends, neighbours and families were included, opening the possibility of developing solar villages.

Potential solar villages could subsequently be expanded with the involvement of local and regional authorities. These could also include the complementary technologies of EV charging points, batteries, heat pumps and hydrogen/fuel cells. Solar villages could additionally incorporate community buildings and help residents vulnerable to fuel poverty.

## **7. South Europe Solar Plan**

The motivational elements in the solar parks concept complement and amplify those provided by the SESP ambition. The target of 1kW/capita of building mounted solar photovoltaics

(PV) is the fastest and most profitable way for southern EU countries - the EU's potential solar engine - to secure a green recovery. The wider EU will also benefit with major advances towards achieving net zero carbon targets as well as sustainable economic development and job creation.

Of all the low carbon electricity generation options, installing PV on buildings can, uniquely, create rapid widespread installation jobs across all regions of southern EU countries.

Furthermore, building mounted PV involves the least electricity transmission costs and power losses as well as the least carbon-intensive material inputs. Smaller, modular systems are also faster to manufacture and install, with shorter energy and carbon payback periods.

National targets of 1kW/capita could probably be installed solely on domestic rooftops. However, the most cost-effective location for PV is on the large modern buildings of industrial and commercial estates.

Funding solar power with zero interest loans would give industrial/commercial building owners and the businesses in them hit by the coronavirus recession vital financial savings and extra income, protecting jobs. The southern EU countries and their businesses will also make major advances towards achieving vital net zero carbon targets.

In addition, surplus solar power could be sold to other EU organisations and individuals crucially helping the wider EU economy cut CO<sub>2</sub> emissions. The resulting renewable electricity generation will furthermore accelerate local, regional, national and EU sustainable economic development.

SESP will create a massively expanded EU PV installation market which will also stimulate sustainable employment in manufacturing PV and complementary technologies (e.g. large batteries, heat pumps, hydrogen/fuel cells and electric vehicles/charging points).

This will additionally open export opportunities for southern EU countries. Surplus national power production can also be exported to other European countries benefiting the southern EU countries and the wider EU's balance of payments.

Compared to more northerly Germany, with a PV capacity of 0.58kW/capita, the ten southern EU countries on average have installed less than half that, at 0.23. Of the largest economies, Italy has about 0.35kW/capita, Spain 0.19, Greece 0.27, Portugal 0.08 and Romania 0.07.

This is despite southern Europe benefiting from about twice the solar intensity. The double solar energy availability below 45° latitude (north Italy) makes PV twice as profitable, halving payback periods in these ten EU countries - the EU's potential solar engine, see map:

<https://commons.wikimedia.org/wiki/File:SolarGIS-Solar-map-Europe-en.png>

These much more productive national targets of 1kW/capita could most rapidly be achieved by each of the southern EU countries first targeting their largest cities, to be completed by 2030. This capacity could then be increased by covering the countries' remaining cities and towns with industrial and commercial estates, achieving the total national targets by 2040.

However, it would aid disadvantaged rural regions if they were developed in parallel with the largest cities. The employment rate potential would double if these ten year targets were replaced by more ambitious five year targets and treble with dynamic three year targets.

SESP could also be extended to cover the houses of the businesses' employees, and potentially their neighbours, friends and families. This would support continued home-working, with solar power sustainably meeting the growth in daytime domestic power demand.

Climate authorities and international leaders are now linking the essential green economic recovery plans to the vital UNFCCC COP26 climate goals. With the coronavirus recession and the year's delay to November 2021, the COP26 conference is of even greater importance.

Through this motivational programme, Europe, with its major historical responsibility for carbon emissions, now has the opportunity to establish a pioneering and world-inspiring sustainability standard. Crucially, SESP projects can easily be developing well before the COP26 meeting to encourage other countries to raise their vitally important NDC ambitions.

## **8. Conclusion**

In summary, the principal benefits of SESP are:

- The 1kW/capita building mounted PV ambition is the fastest and most profitable way for southern EU countries - the EU's solar engine - to secure a green recovery.
- The wider EU will also benefit with vital advances towards achieving net zero carbon targets as well as major sustainable economic development.
- Unlike other renewable electricity supply options, uniquely, installing building mounted PV can create rapid widespread employment with PV installation jobs across all regions of southern EU countries.
- The massively expanded PV installation market will stimulate manufacturing of PV and related systems (e.g. batteries, heat pumps, EVs and fuel cells) as well as exports.
- The solar power production would give business building owners and the businesses in them vital financial savings and extra income, protecting jobs.
- Renewable electricity generation will also accelerate sustainable economic development and job creation, with surplus power sales assisting the southern EU countries' and the wider EU's balances of payments.
- The programme could be beneficially extended to cover the houses of employees, and their neighbours, friends and families, to support continued home-working, meeting the growth in daytime domestic power demand.
- SESP would make a crucial, massive contribution towards the southern EU countries and their businesses, including those buying surplus power, achieving essential net zero carbon targets.
- The pioneering and world-inspiring SESP sustainability standard can encourage other countries, globally, to raise their vitally important COP26 NDC ambitions.