GreEnFin Summes School 2020

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Our approach

Single adaptation Measure:

- Floating Solar Panel

Multiple adaptive measures for:

- Wildfires
- Floods
- Storms

Main Climate Threats

Wildfires:

➜ Severe mechanical damages to the plant and the infrastructure making access impossible

➜ Smoke and ashes block the sunlight thus reducing efficiency

Floodings:

➜ Even though panels can be submerged into water, other components of the power plant can be damaged and access blocked
rainfall reduces the efficiency

Storms:

➜NASA study from: global warming is causing the number of extreme storms to increase.

➜ The team also saw that for every 1 degree Celsius that SST increased, the number of extreme storms went up by about 21 percent. Based on current climate model projections, the researchers concluded that extreme storms may increase 60 percent by the year 2100.

Single Adaptation Measure: Floating Solar Panels

Floating Solar Panels: Structure

- A floating power plant can be set up on any body of standing water
- Because of its position on the water, it is not vulnerable to mechanical damages by wildfires, floodings or falling trees (due to storms). Also the other components and infrastrucutre on site is made to withstand exreme weather conditions
- Additionally, the water has a cooling effect on the panels thus enhancing efficiency
- Further, solar panels reduce the evaporation of water which has a beneficial effect on drought prone regions → can be used for agriculture or to combat wildfires

The Plant and its Floaters

- Panels are mounted on floaters using a clip system.
- Every floater has a walking platform on both sides.
- Floaters are assembled in lines and put into place
    - Plant is accessible by boat on any weather condition (standing water) and panels can easily be replaced

- **Whole construction is recyclable**

Conclusion

Floating solar power plants can be installed on already existing artificial water bodies (e.g. water processing plants, catchment lakes, rainwater storage basins, etc.) thus doubling their purpose on natural water bodies they can have beneficial effects on the ecosystem (e.g. reducing the propagation of invasive algae, reducing evaporation) but these effects are not well-studied

Multiple Adaptation Measures

Wildfires

Wildfires and Solar Panels: current risks

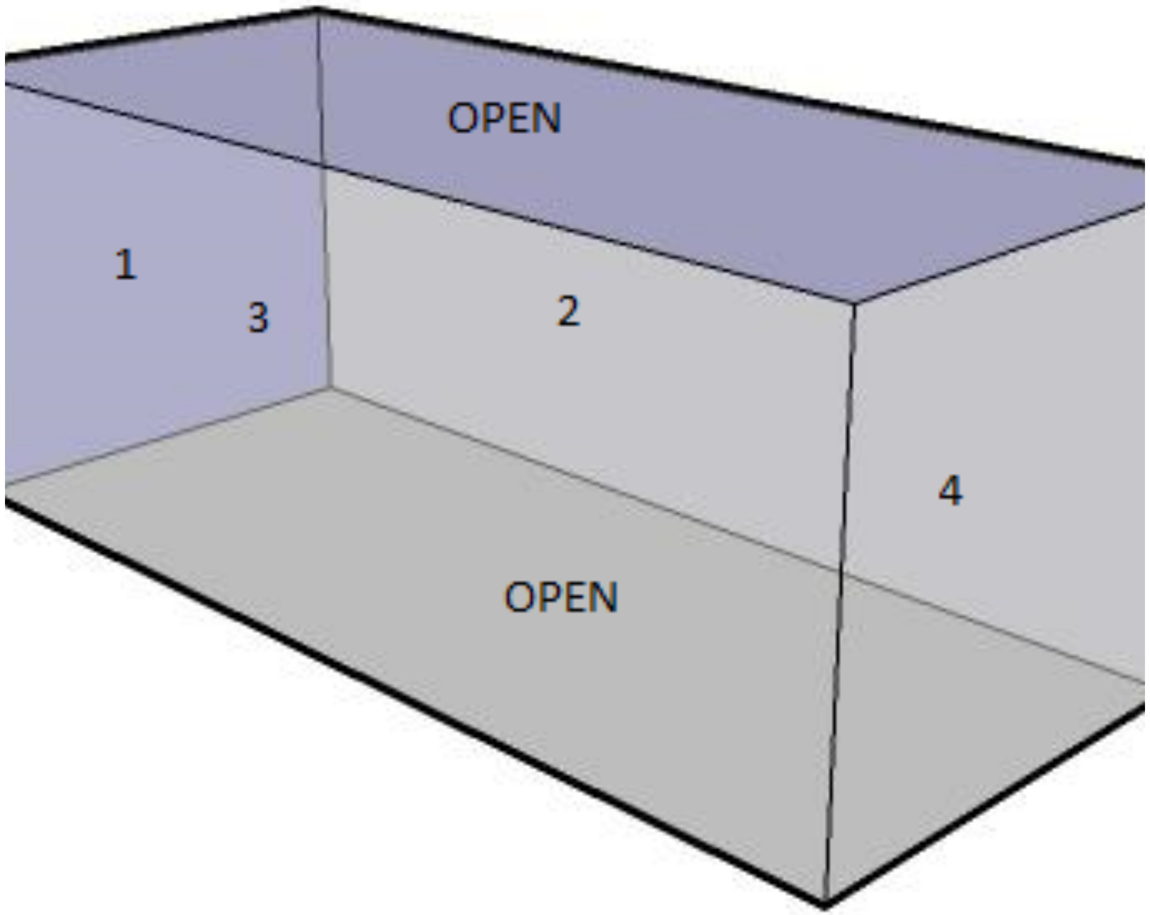
Adaptation activities:

- Fire barriers
- “Aquatic” fire barriers
- Fire Retardant Gel

Area	Wildfires impact on solar installation
Mechanical damage to installations	HIGH
Energy production from installations	HIGH
Access to the installation	HIGH

Fire barriers

- Placed inside the ground they rise when the temperature excedees a certain level (300 °C)
- Heat flux sensor to detect the temperature
- Cooling system to prevent damages due to high temperature
- Creation of a protective “cage”



Why not water?

We can think on “aquatic fire barrier”

Barrier made of water Water cage

Fire Retardant Gel

- It is a superabsorbent polymer slurries
- New kinds of fire retardant gel give protection for months

  A. C. Yu *et al*, Wildfire prevention through prophylactic treatment of high-risk landscapes using viscoelastic retardant fluids. Proc. Natl. Acad. Sci. U.S.A. **116**, 20820–20827 (2019).

https://doi.org/10.1073/pnas.1907855116

Black Hill National Forest example

- In 2007
- The most intense fire ever recorded in the Black Hills National Forest
- Nearly all homes coated with a slimy gel were saved while dozens of houses nearby burned to the ground

Floods

Floods and Solar Panels: mitigation and adaptation

Aim of the research:

- mitigation of mechanical damages;
- prevention from energy inefficiency consequences

Area	Floods impact on solar installation
Mechanical damage to installations	HIGH
Energy production from installations	HIGH
Access to the installation	HIGH

Adaptation Measures for potential Mechanical Damages

Preventive Measures:

1. Location choice
   - Soil erosion
     - Expected
     - Unexpected
   - Solution
     - Concrete base

2. Panel components
   - Solutions
     - High mounting height
     - Panel main components
     - Sensors and other Devices

Panels' life Measures:

- Frequent maintenance

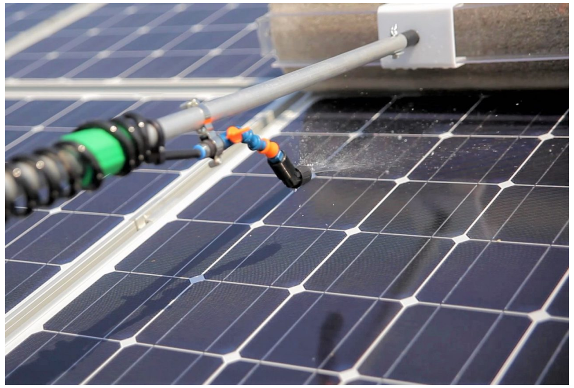
After-Flood Measures:

- Quality inspection on the state of the installation

Adaptation Measures for Energy Efficiency Reduction

Scope of Photovoltaic facilities: Generating electric energy from the sunlights

Related inefficiency problems:



Cause:

Bad weather (rainfalls, floods, overcast)

1. Lack of sunlight → Blur of solar panel surface
2. Cleanness of solar panels → Blur of solar panel surface

Solutions:

- Dirt-repellent chemicals
- Cleaning cycle

Storms

Storms and Solar Panels: current risks

Aim of the research:

- How to eliminate mechanical damages

Area	Storms impact on solar installation
Mechanical damage to installations	HIGH
Energy production from installations	HIGH
Access to the installation	HIGH

Storms and Solar Panels

- The National Renewable Energy Laboratory (NREL) researchers also work diligently to develop quality tests to ensure that solar panels will survive harsh weather - like in a hailstorm[3] - and not just in the wet or rainy seasons.
- In fact, a 2017 hailstorm in Denver that caused severe damage across the city proved the durability of solar panels. The hailstones were roughly 3 inches wide! However, out of 3,000 solar modules on NREL's Denver campus, only one panel was broken.[4] And the NREL has assured us in a recent report that solar modules will last for decades.

Adaptation Measures for potential Mechanical Damages

- Quality tests to ensure that solar panels will survive harsh weather
- Concrete foundations
- Gap protection
- Ceiling protection (Blanket)

Example

- A main campus in Golden, Colorado was hit with a severe hailstorm just last month. Of over 3,000 panels on or adjacent to the roof of a net-zero energy building, only one panel was broken during the storm. To get an idea of the intensity of the storm, the same weather system left shattered car windows and dents in vehicles and home roofs around the Denver area. The single broken panel appeared to have been hit simultaneously with several large hailstones in a very concentrated location, leading to micro-cracking of the surface glass.

Conclusion: hail may be an impressive physical force, but solar panels are well-equipped to withstand impacts even from large hailstones.

Thank you for listening!