The bright side of snow cover effects on PV production - How to lower the seasonal mismatch between electricity supply and demand in a fully renewable Switzerland

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Switzerland's path a fully renewable electricity production

Large existing hydropower production including pumped-hydropower

Good potential for "New Renewables"

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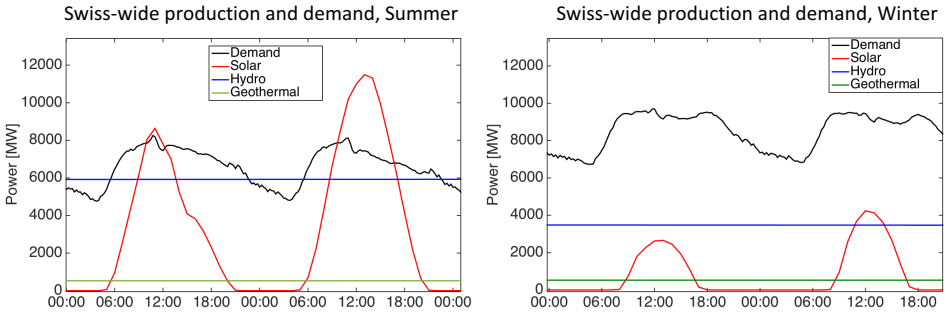
Challenges remain:
Mismatch in supply and demand

Mismatch in time:

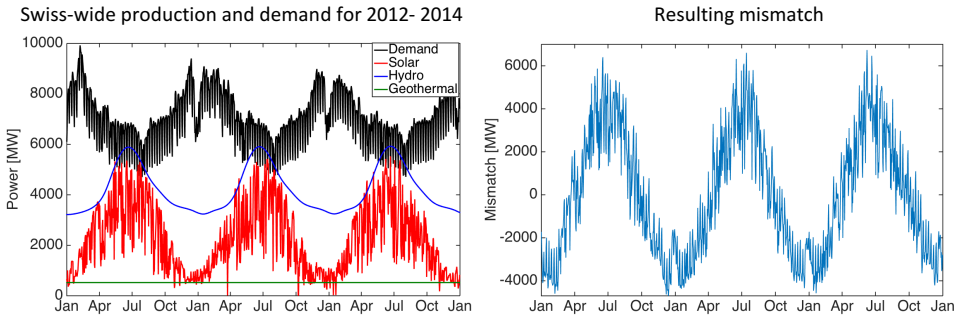
1. Throughout the day



Can be alleviated by conventional and pumped hydropower

2. Throughout the year

Critical to penetration of PV in the future energy market – Needs to be addressed!



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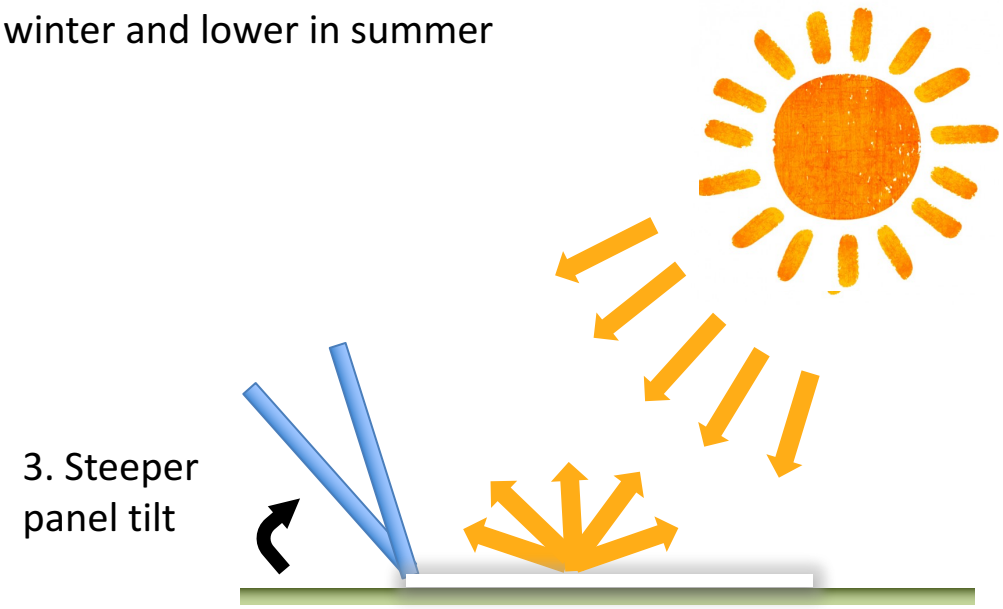
How to address the seasonal energy gap in PV production?

1. Install a lot of storage

2. Change the production profile to have higher production in winter and lower in summer

How?



Goal:
Quantify impact of these 3 measures

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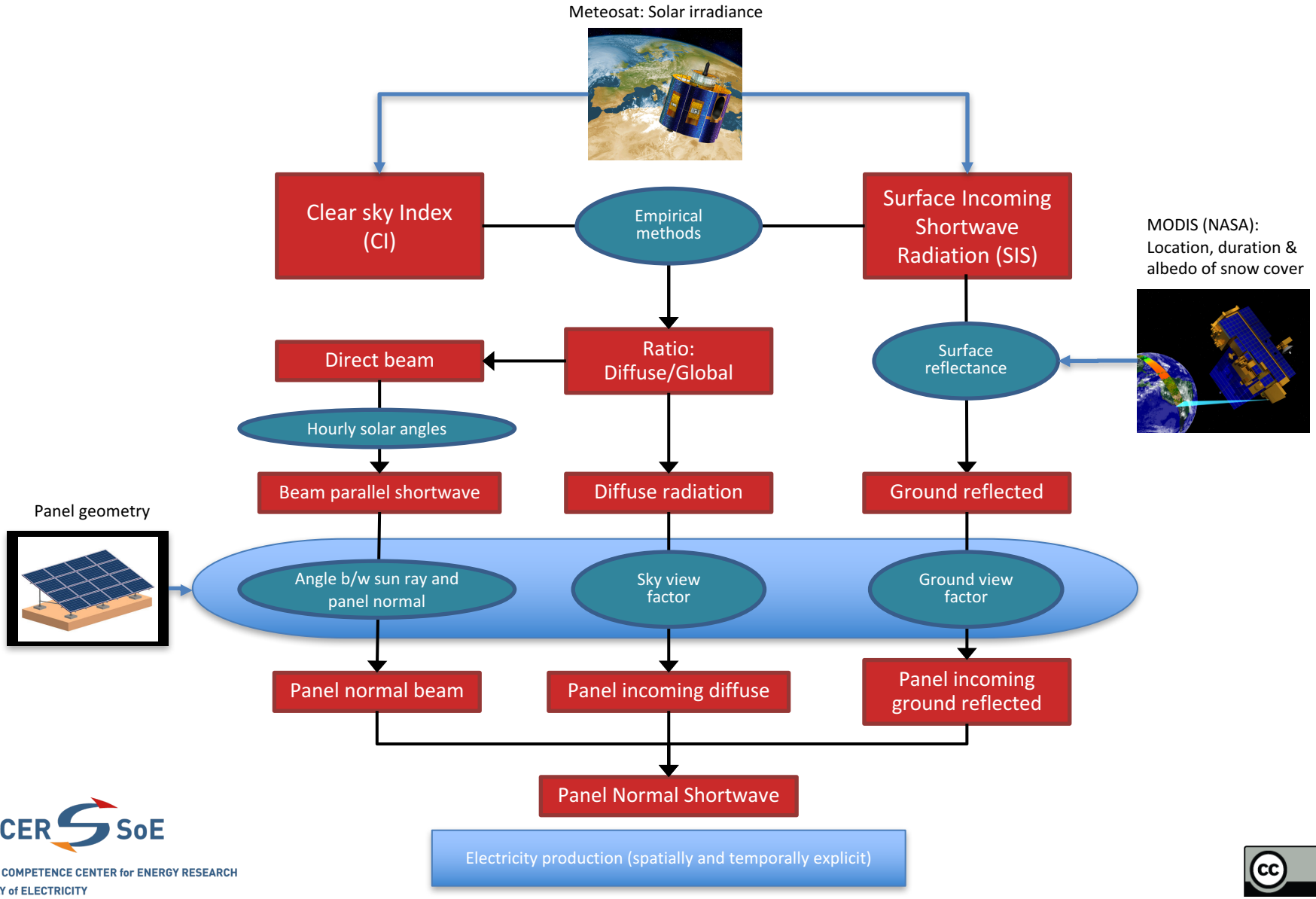
Method: Model production potential based on satellite-derived information and panel tilt



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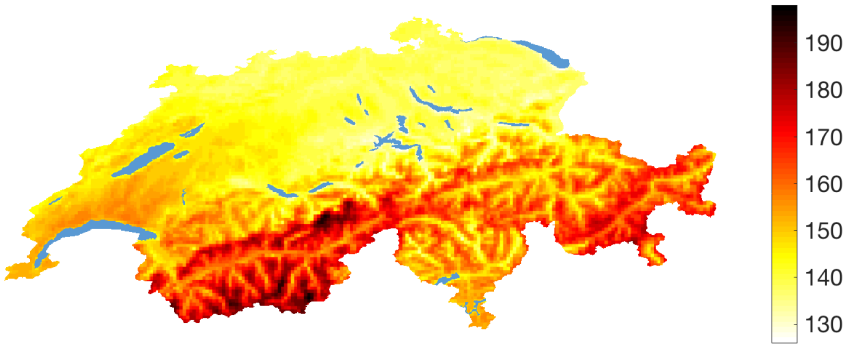
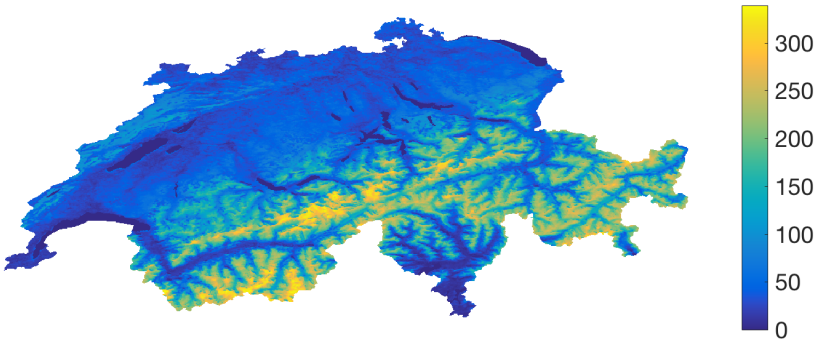
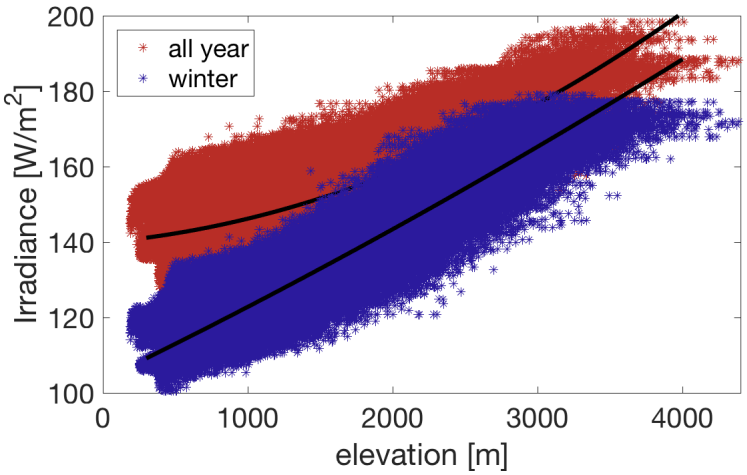
The environmental drivers

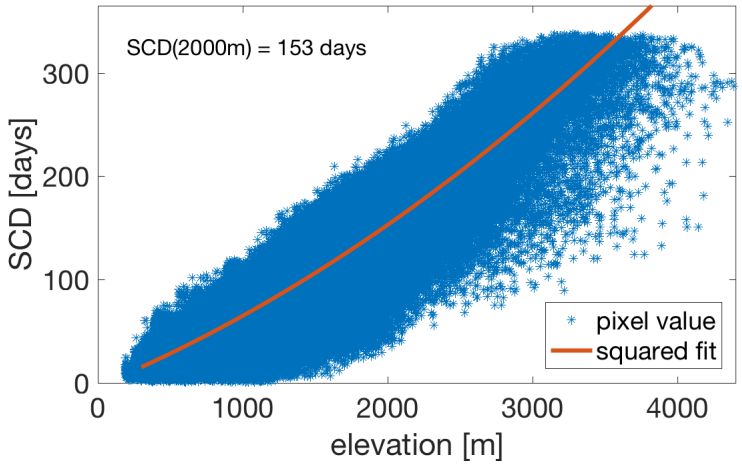
Irradiance [W/m^2]



Snow Cover Duration (SCD)







The higher the better !!

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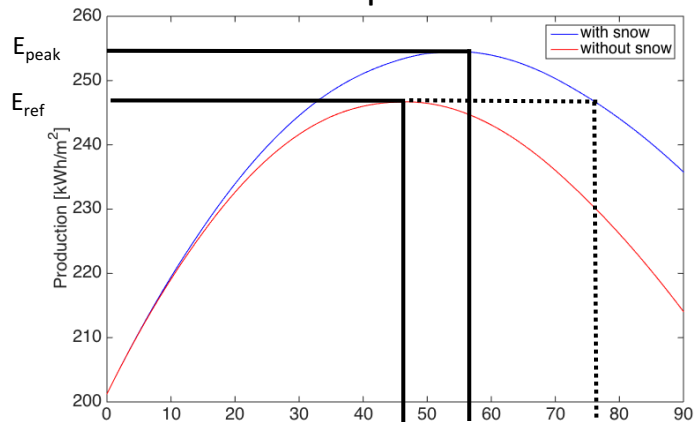
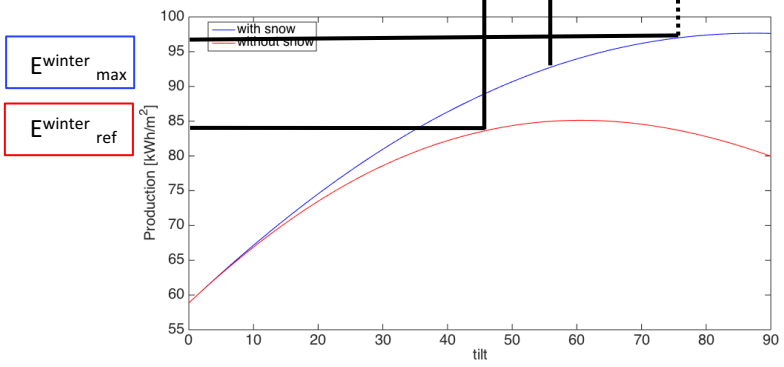
The technical dial: Panel tilt

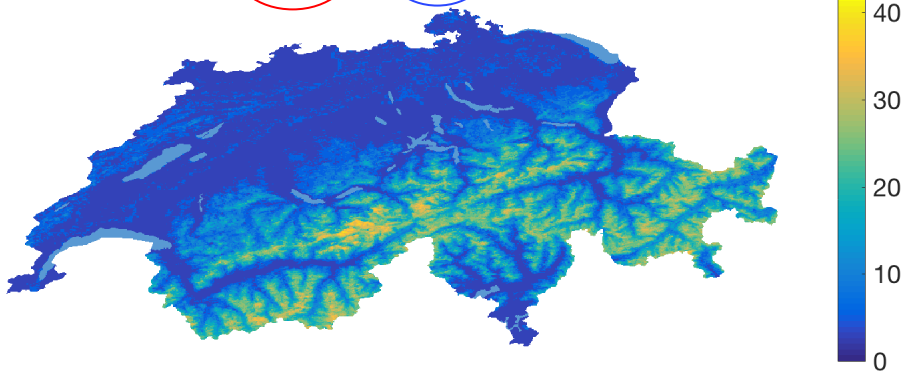
Annual total production



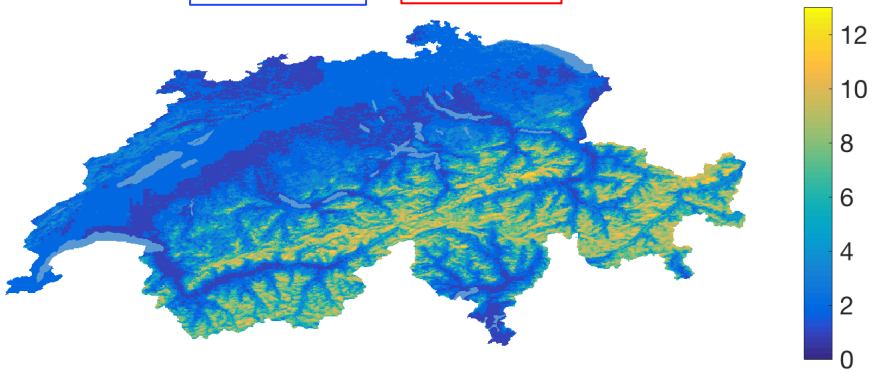


Winter production (1st Jan – 30th April)

$tilt_{max}$ - $tilt_{ref}$ [degree]



E^{winter}_{max} - E^{winter}_{ref} [%]



Steeper tilts allow gain in winter production without loss in annual total

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PV Placement Scenarios – 12TWh/year

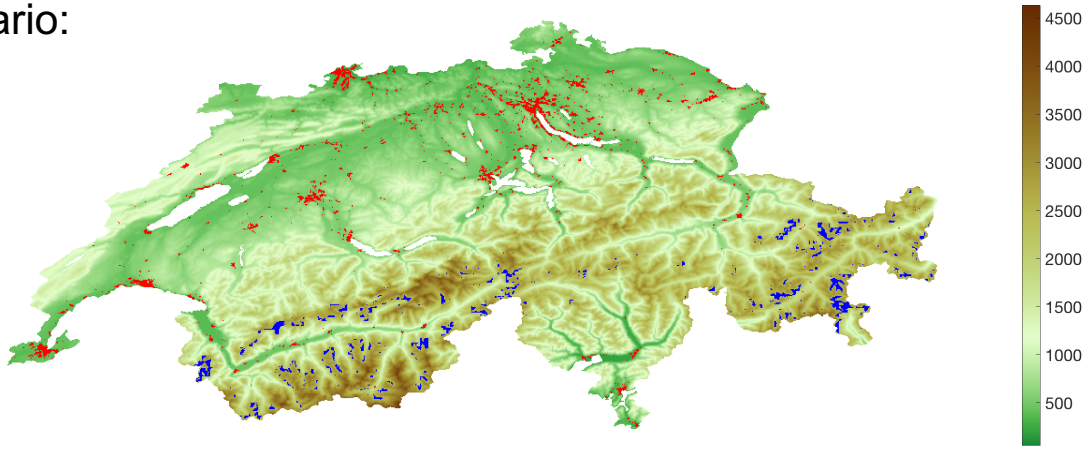
Urban scenario:

Conventional

Roof-top installation

Close to demand

Lowest productivity



Mountain scenario:

Innovative

PV farms/mountain infrastructure

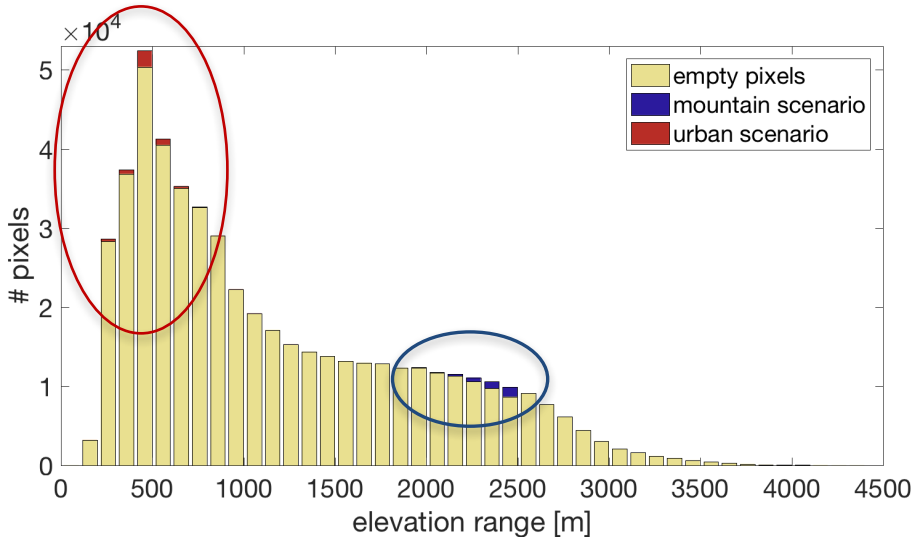
Far from demand

Highest productivity

Pixel Selection:

With population

Max. cover fraction (0-8%) per pixel



Pixel Selection:

Below 2500m

Max. cover fraction (0-8%) per pixel

Mountain No Snow:

Re-run at constant surface reflectance of r=0.2

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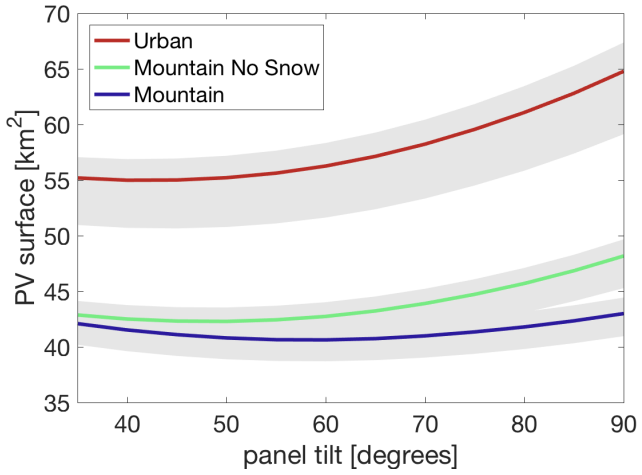
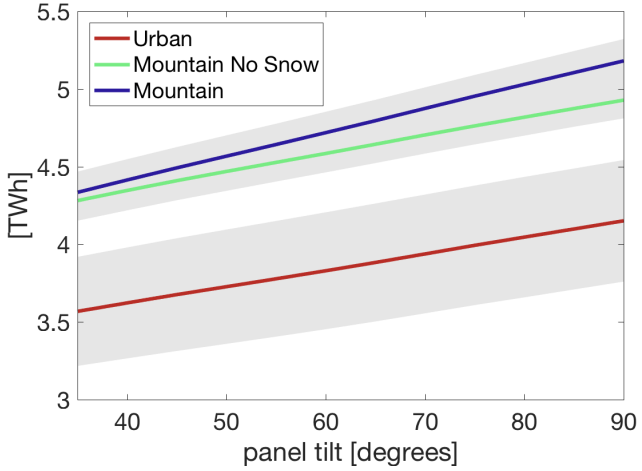
Scenario Comparison
Urban, Mountain Snow, No Snow

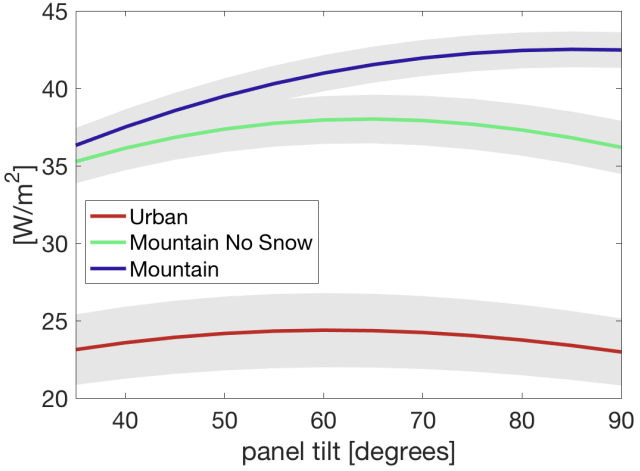
Required surface area to produce 12 TWh/year



Winter production [per scenario]



Winter production [per unit area]



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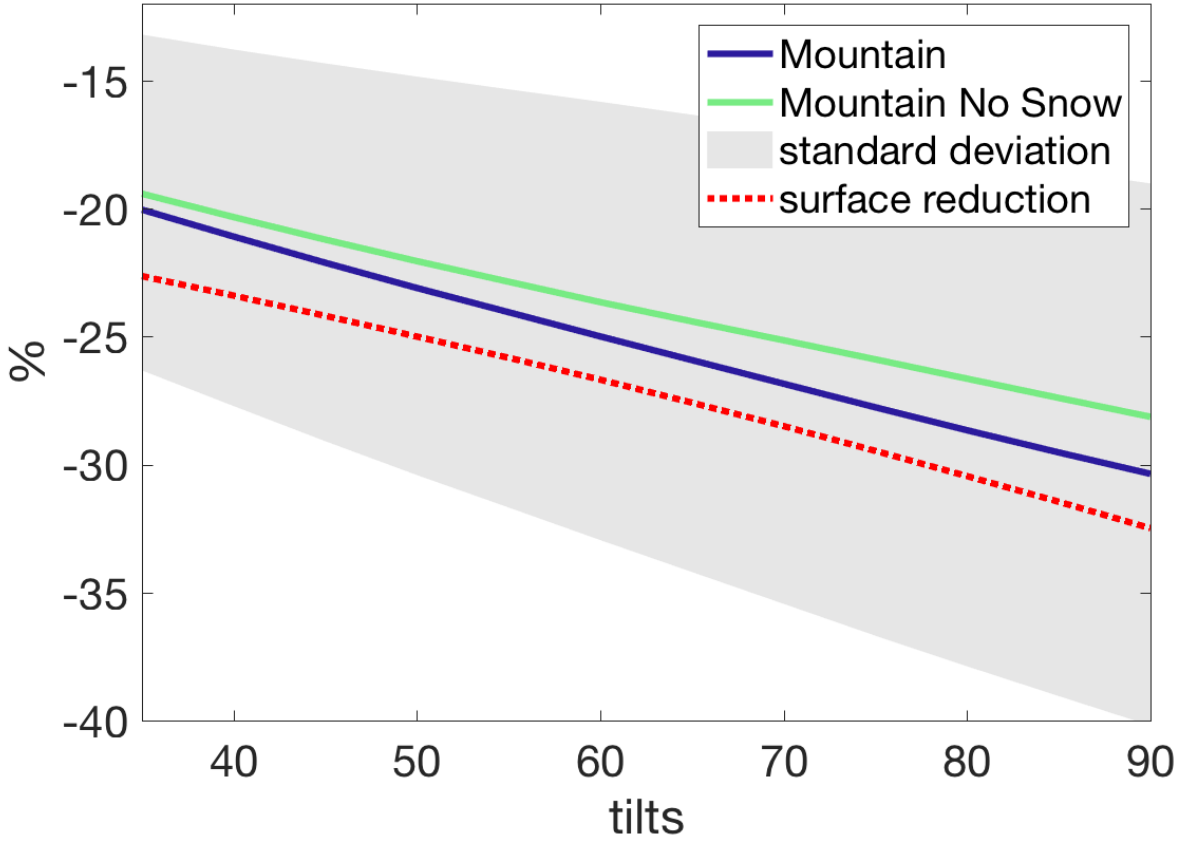
Import reduction for mountain scenario (with respect to urban)



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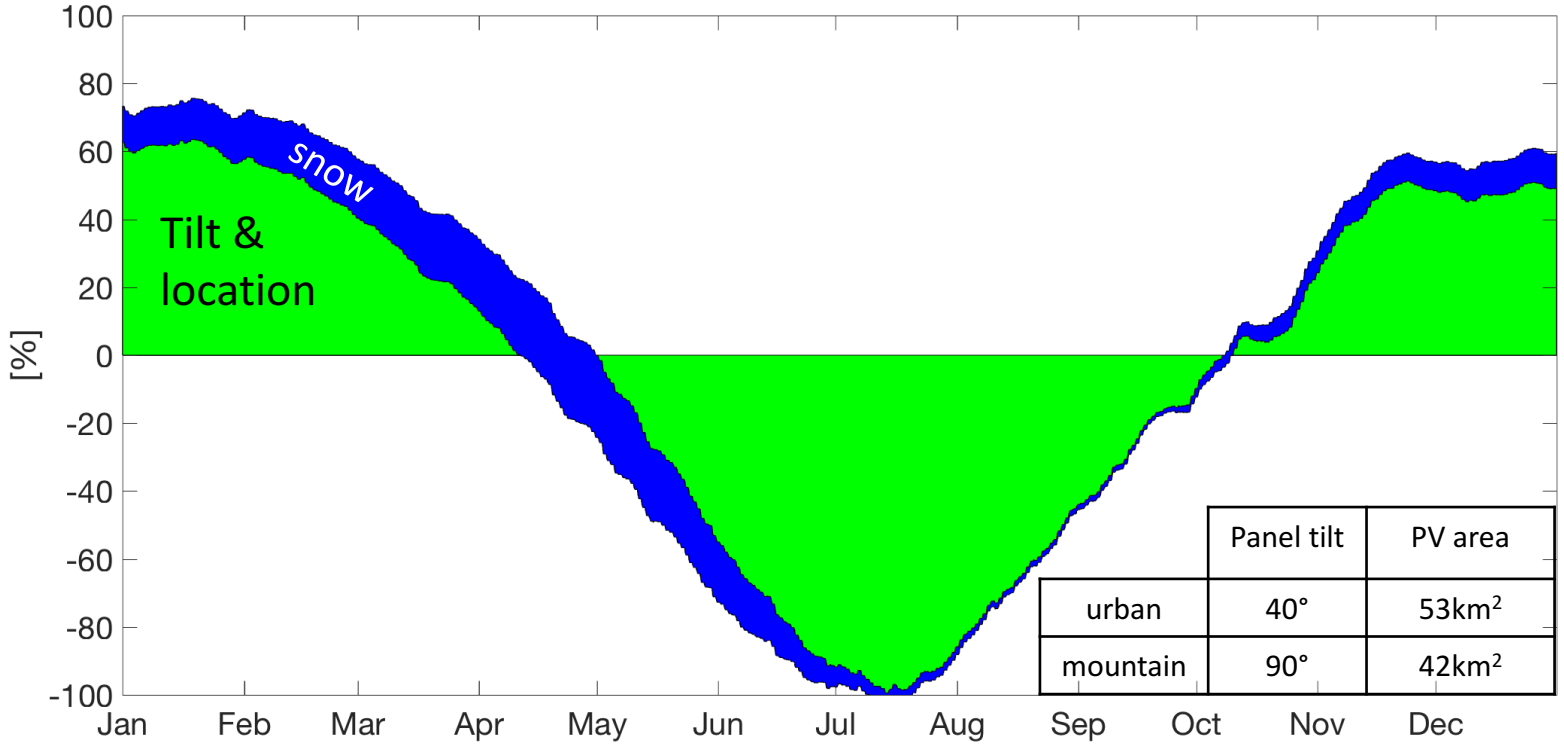
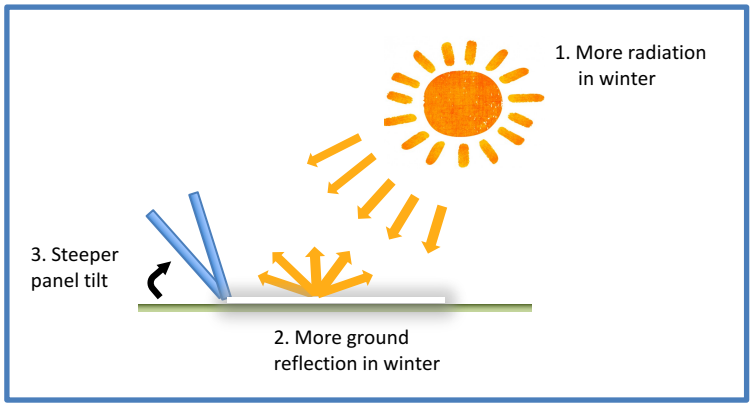
Shift from summer to winter production

Difference in production profile between urban and mountain



	Panel tilt	PV area
urban	40°	53km^2
mountain	90°	42km^2



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