



Performance Indices for Double Use Installations of Foldable PV Generators

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Switzerland, Winterthur, 2020-09-10 EUPVSEC IEA Task13 side event



- Objectives of double use PV systems
- Folding PV principle
- Folding PV application on top of wastewater infrastructure
- Benefits of foldable PV on wastewater infrastructure
- Outlook

Objective: Double Use on top of infrastructure



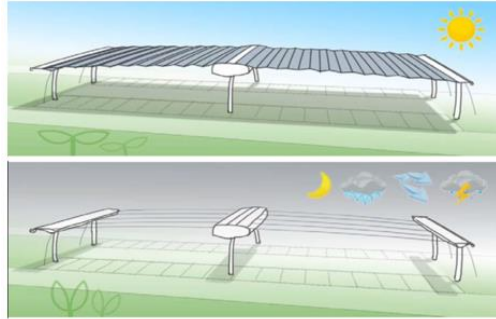
- Saving land for PV greenfield plants
- Double use = infrastructure purpose + PV electricity
(triple use) + other benefits
- other individual benefits like shading of cars
 - avoided energy for cars air condition
 - less stress to jump in a hot car
 - (but no single number fits to all of it)



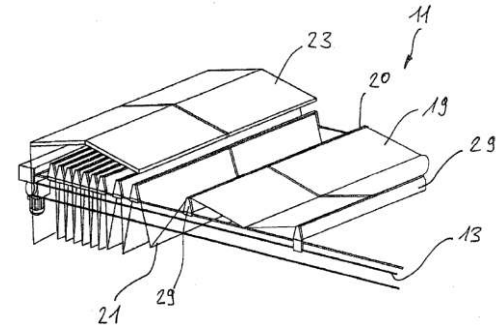
Foldable PV System



Less mounting
material needed
less wind, snow
and hail load



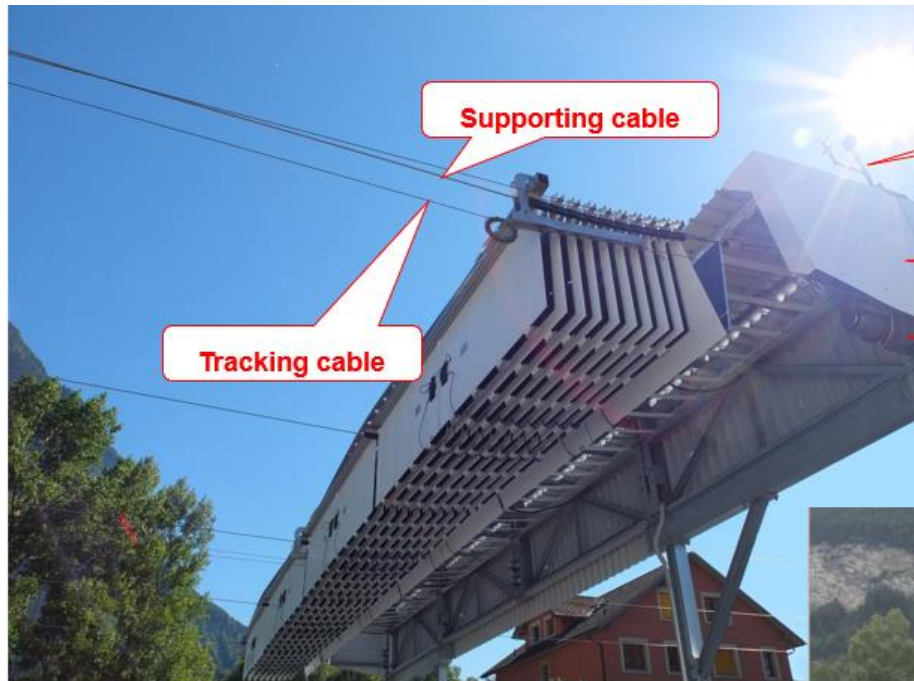
Patent:
2012; CH20120000750; A. Büchel, F. Baumgartner
2013; EP2669594 (A1); A. Büchel, F. Baumgartner
2014; WO2014179894A1; A. Büchel, F. Baumgartner
2016; EP2669594B1 Büchel, Baumgartner, Diem, Hügli



Foldable System Principles



ZHAW 2013
Bachelor Thesis



Supporting cable

Tracking cable

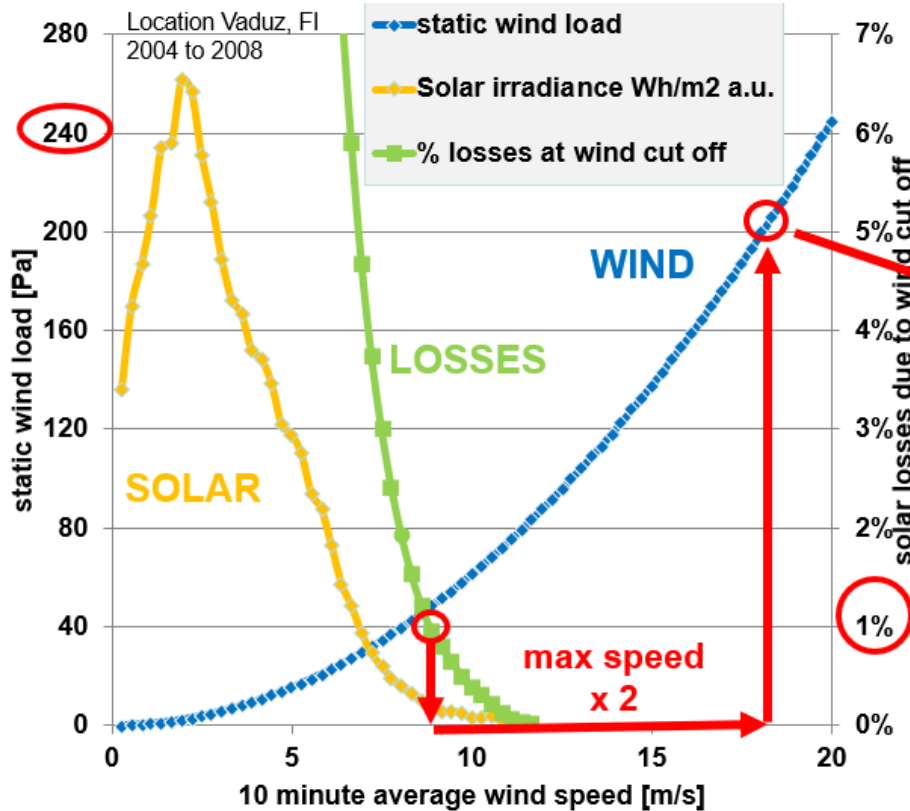
weather sensors

weather protection box

electrical motor tracks
50kWp PV-power



No PV production at heavy wind conditions



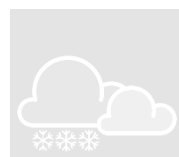
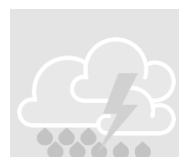
Weather related mechanical loads

- Wind load – module test **2400Pa**, IEC 61215
- Snow 5400 Pa, ASTM E1830

Foldable PV system of wastewater systems Chur



Wind speed below 15m/s, no snow, no hail
1.5% PV losses



IBC Energie Wasser Chur, 2016–2018, PV Power 643 kWp



PVPS

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PV production fits to the local needs



- 95% of PV electricity used on site
- 20% of electricity consumption powered by PV
- About 1.5 % PV losses due to heavy wind (CH <3%)
- 2.3% gain winter (snow)
- 60 seconds – move in
- 40 000 cycles in/out
- 130kg steel for each kWp

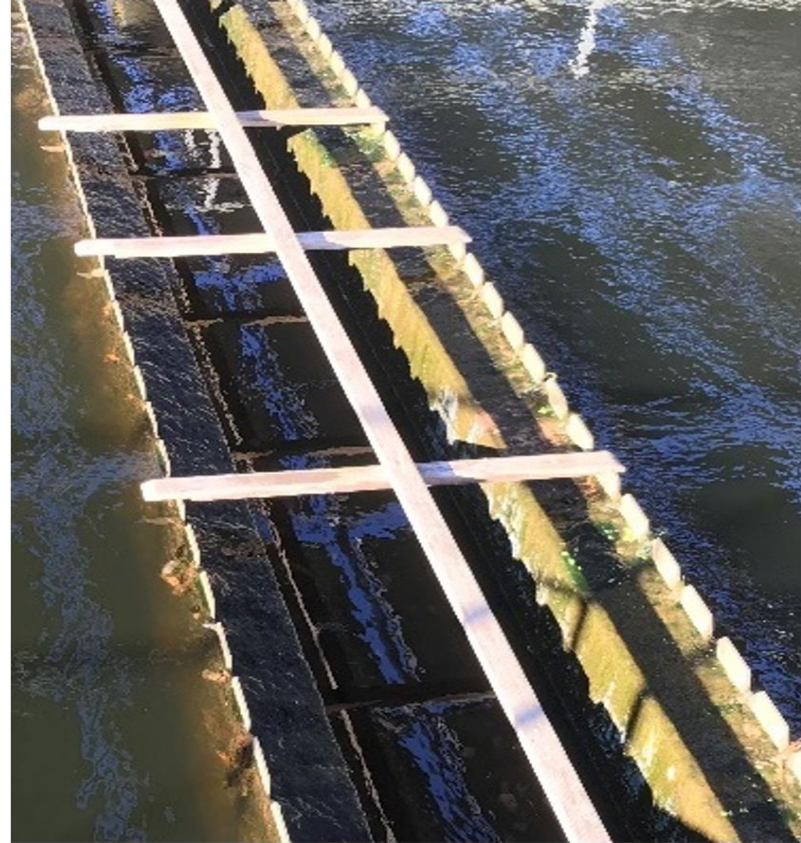
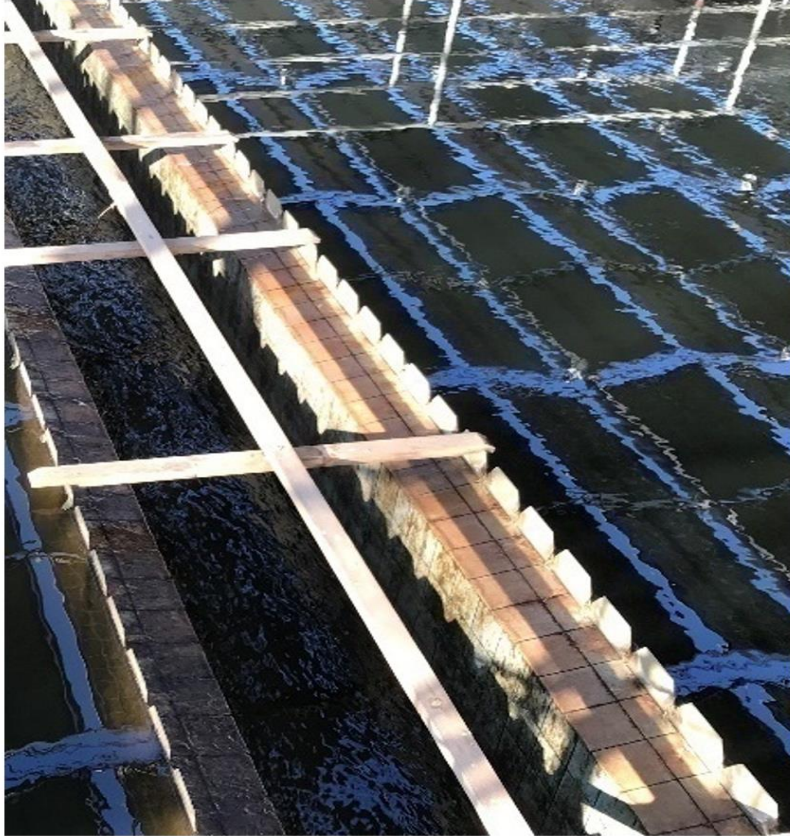
PVPS



PV shading reduce Alge growth rate



PVPS



Foldable PV system facilitates service tasks



- Fixed PV mounting systems are limiting the flexibility of service tasks



Foldable PV parking



PVPS

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Foldable PV Parking



- Appenzell, Switzerland
- SAK St.Gallisch-Appenzellische Kraftwerke AG
- 2019-2020
- 429kWp
- Realisation:
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Folded PV parking



- Wood replaces steel construction
- Future project higher wood content

- **DHP project status** total 3.500 kW
- 7 projects in Switzerland in operation
- 3 projects planning phase in Germany

PVPS



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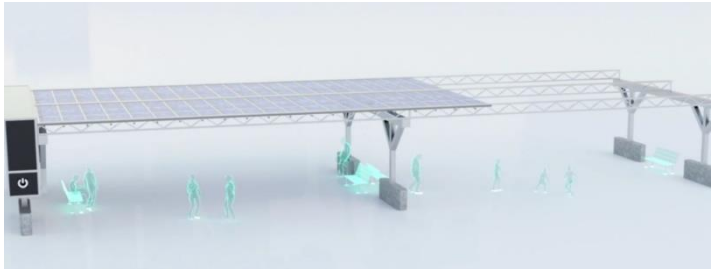
Summary



- Foldable PV systems shows highest benefit if the infrastructure area below the PV panels have to be accessible temporarily
- Shading by the PV panels reduces the growth rate of algae (cost relevant)
- Shading is also beneficial for service works cleaning the settling basins
- High level of local PV self consumption possible using foldable PV on wastewater systems or PV electrical carports equipped with charging stations
- Higher PV performance during wintertime at higher snow fall rates
- Less mechanical stress applied to PV modules during heavy wind load
- One single performance key figure is not practicable



- Why not using foldable PV as flexible AGRO PV System for special crops?
- Development of other PV mounting systems with retractable PV panels are under way like URBANBOX using standard PV modules



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- Comparison of total CO₂ emission analyses of foldable PV systems relative to conventional PV systems have to be carried out including the cradle to grave of all mounting systems materials and fundaments

Thank you for your attention

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