

# URBANBOX the Lightweight Retractable PV Plant

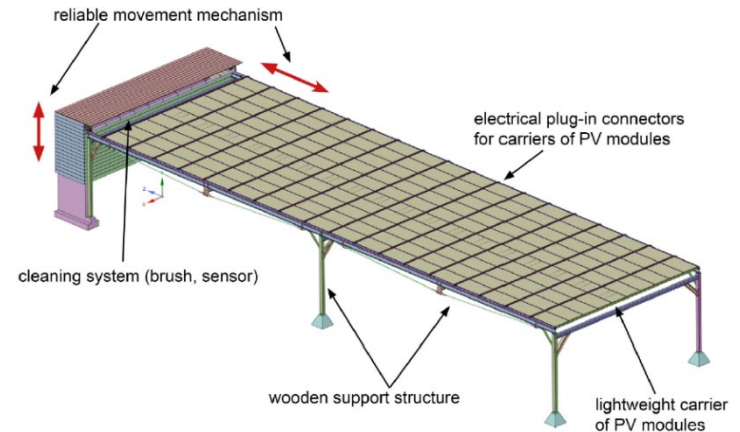


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# Content

- 1) Experience with dual use projects PV mounting
- 2) The Concept
- 3) Reducing CO<sub>2</sub> Footprint
- 4) Automatic PV Module Cleaning
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# Experience with dual use projects

Initiated by Arthur Büchel and Franz Baumgartner, ZHAW

<b>2009</b>		<b>648 kWp</b> Lonza Solarpark, Waldshut, Germany
<b>2011</b>		<b>70kW,</b> Solar Ski Lift, Tenna, Switzerland
<b>2013</b>		<b>20kW</b> Light Energy Plant, Balzers, Liechtenstein
<b>2022</b>		<b>50 kW</b> <b>URBANBOX</b> Bendorf, Liechtenstein

From **cable-based solutions**:

- the use of the area under the solar modules remains

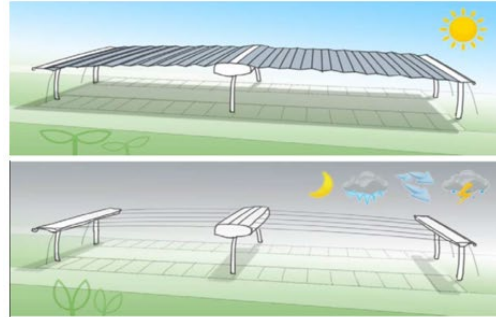
to **retractable solutions**:

- to folding PV roofs
- to sliding PV roofs with added benefits



# Retractable PV – Reduce Wind & Snow Loads

Less mounting  
material needed  
less wind, snow  
and hail load

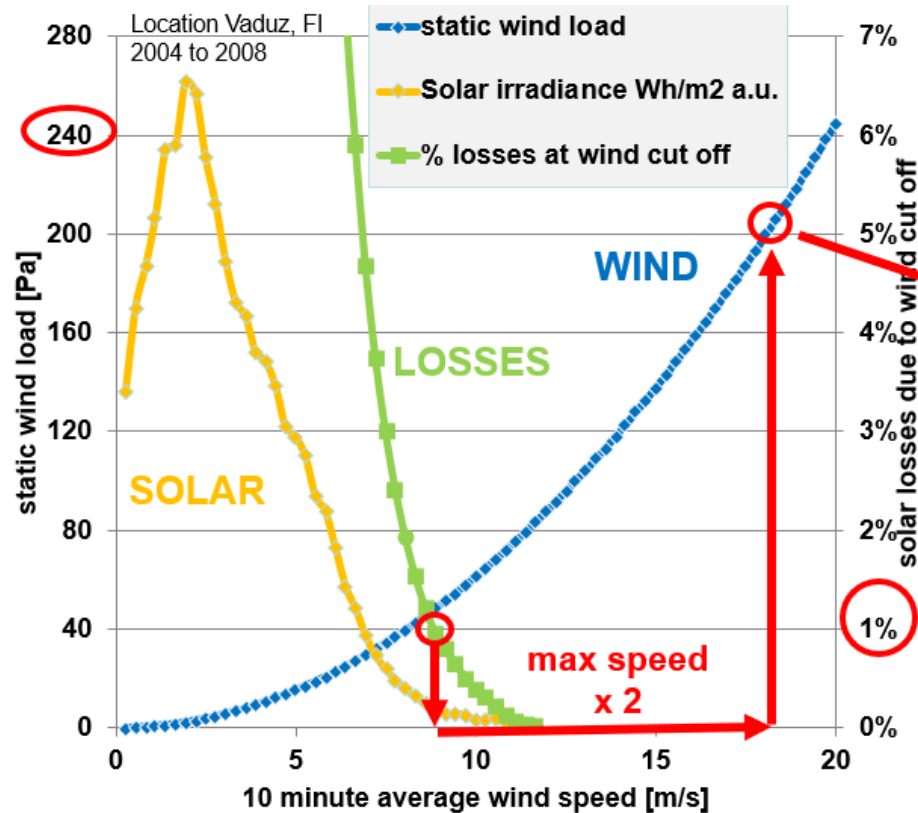


Patents:

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



# Heavy Wind leads to small PV losses



## Weather related mechanical loads

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

# The URBANBOX Concept

- Buffer Box with drives (V/H), where PV carriers are vertically stacked
- Up to 20 PV Module Carriers with 10 PV Modules move out/in horizontally
- Cleaning brush at carrier exit of BOX for auto-cleaning of modules
- Wind & snow sensors & auto control for retraction PV roof into buffer box

## Specifications commercial:

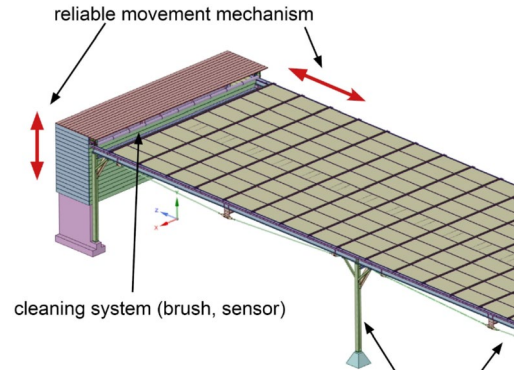
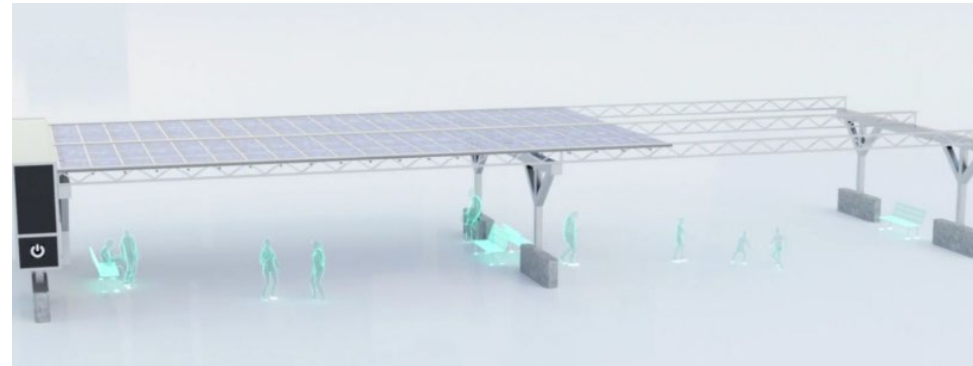
PV power 80 – 91 kWp/unit

Ground clearance std. 4.5m

Area of PV Generator: up to 38m x11.7m

Auto-cleaning of PV modules

70kg steel / kWp + wood construction



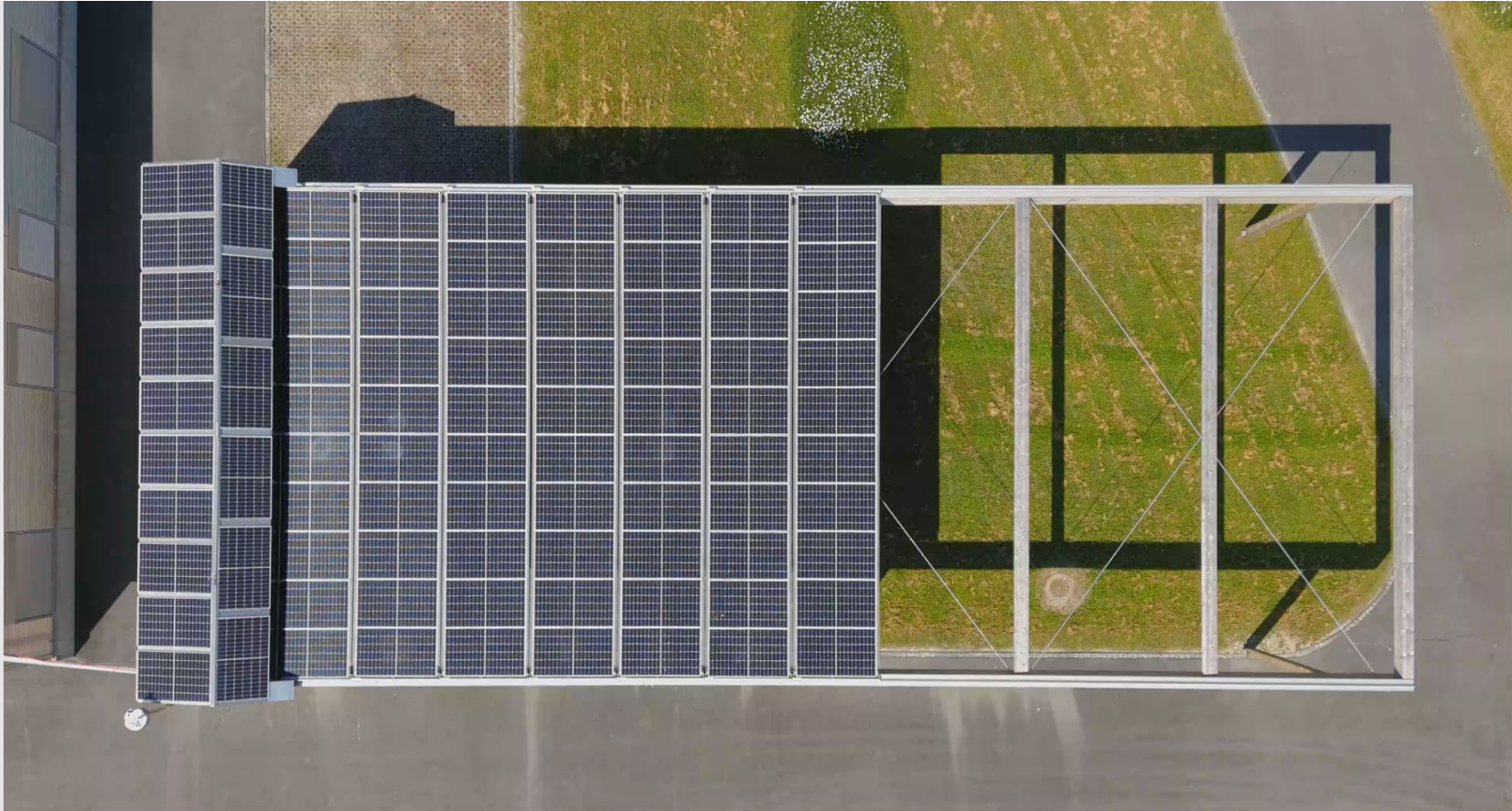
Patent  
Arthur Büchel  
WO 2019 144248A1  
<https://www.urbanbox.li/>

# URBANBOX Opening Event: 3<sup>rd</sup> Oct 2022



2022 URBANBOX demo system - 12 PV module carriers 10 PV module each carrier

# PV module carriers - extracting from buffer





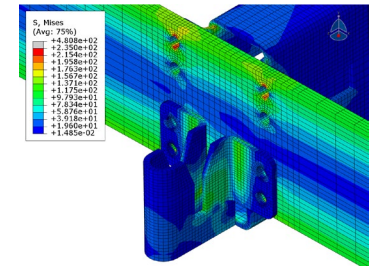
# Wood - a relevant part of URBANBOX construction



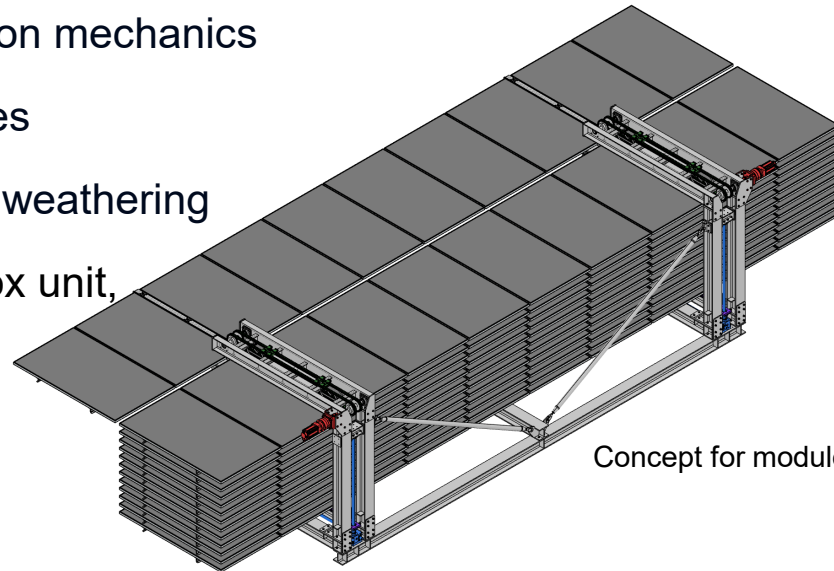
# URBANBOX lightweight module carrier

URBANBOX Industrialization - a project with demanding technical requirements

- Low structural weight combined with high carrier stiffness  
Carrier: 1.8m x 11.6m; Metal parts: 41kg/kWp  
Light weight steel only 29kg/Wp base frame + wood
- Robust and soiling resistant motion mechanics
- Maintenance-free, low-wear drives
- High resistance to corrosion and weathering
- Factory assembly of complete box unit, volume based savings
- Low maintenance requirements



Assessment of component loading by finite element analysis

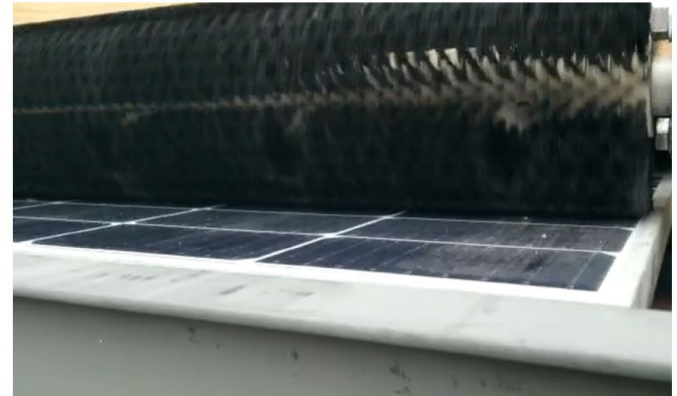


Concept for module movement

# URBANBOX automatic Cleaning



Rotating brush is automatically activated if needed by the weather algorithm & optical **soiling sensor**

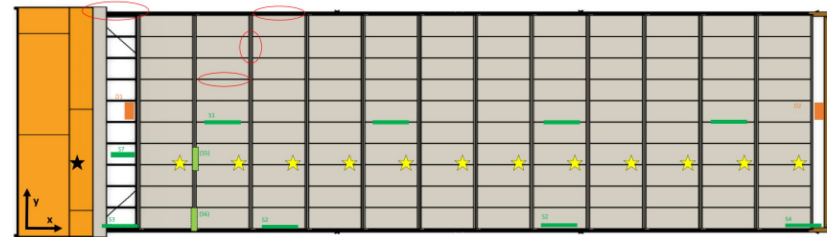
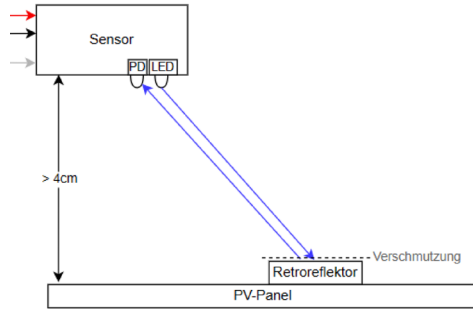


Tests and development rpm , distance carried out indoor and at the prototype in Bendern, FI

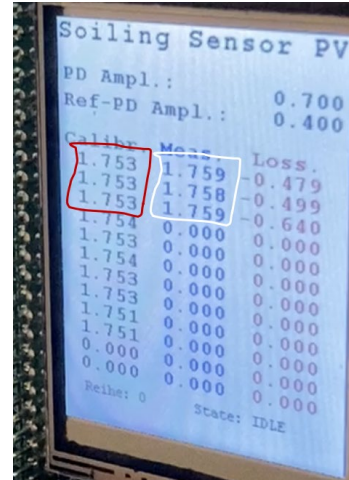


Drive and control  
Cleaning brushes

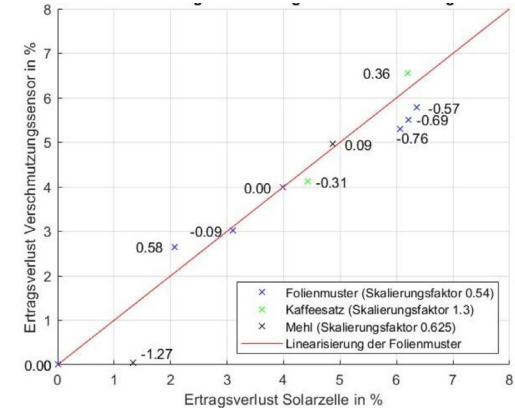
# Optical Soling Sensor Triggers Cleaning



Mounting Position in the BOX

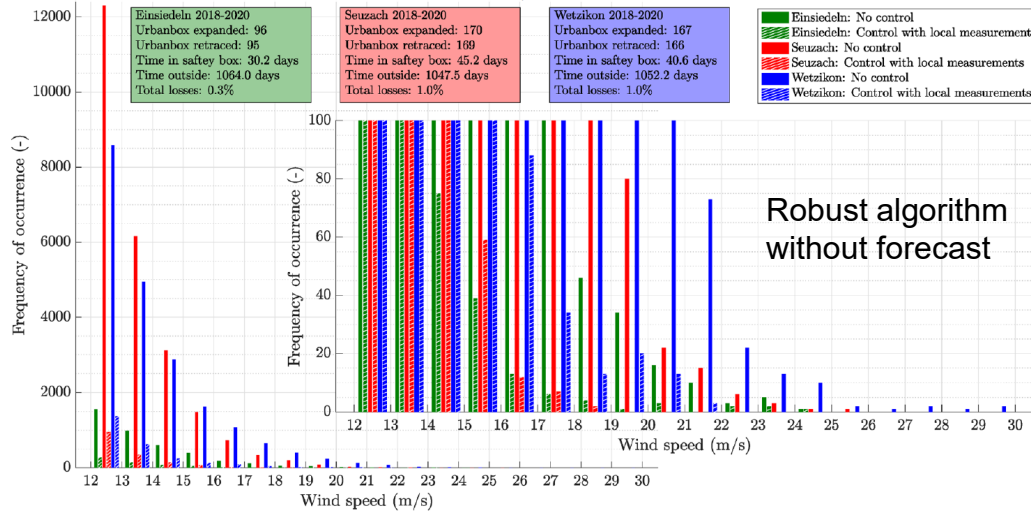


Reproducibility <1%



Calibration runs different soiling

# Analyses of historic wind data for as selected control algorithm



Robust algorithm without forecast

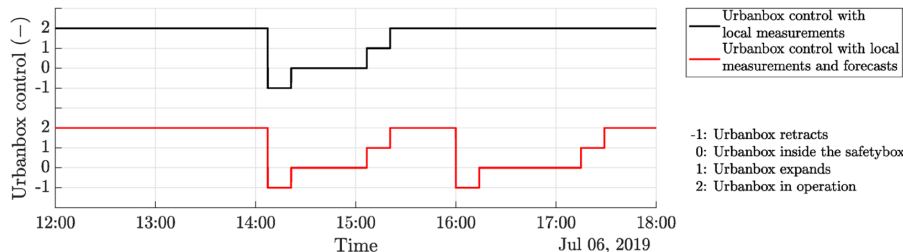
## Input variables for simulation:

3 locations in Switzerland, period of 3 years data, local wind measurements, 1 sec,

## Algorithm

IN at 12m/s wind, OUT at 10m/s, (hyst. +15min & solar >50W/m<sup>2</sup>), 14 minutes module movement

## Comparison using only local measurement or including forecast



## Findings with no forecast:

control reduce gust of wind below 19m/s, 22m/s, 25m/s; only few remaining carriers affected; annual 33, 55 and 56 IN/OUT Events irradiance losses <1%

# SUMMARY

A new retractable PV System with unique features has been validated:

- **Lightweight** at long span; < 70 kg/kW Steel at span width larger 15 meters
- **Modular Box Concept** – High Scalability – Volume Savings, pre-fabricated
- Integrated **auto cleaning** of PV Modules – for OPEX Savings / dry agricult.
- Ready for **reference** installations in 2024
- Ready for **international launch** in 2025



# Thank you for your attention



## **URBANBOX Research Project Team**

Innosuisse Switzerland funded project 2022 to 2024, No. 100.944 IP-EE

iWorks: Urbanbox Founder Arthur Büchel, Liechtenstein;

ZHAW Team at SOE

IEFE Energy and Fluid. Eng.

IMES Mech. Lightweight. Eng.

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<https://www.urbanbox.li/>