



Berner Fachhochschule  
Haute école spécialisée bernoise  
Bern University of Applied Sciences



# SCCER – FURIIES

Shaping the **F**UtuRe **S**wIss **E**lectrical **I**nfruStructure



## Ausblick PV-Systemtechnik Forschung 2017-2020

Urs Muntwyler, Professor Photovoltaik/ Leiter PV Labor, BFH Burgdorf

- ▶ PV-Labor, Jlcoweg 1, 3400 Burgdorf

# WP 4 Milestones 2017 - 2020

	Name of Milestones	Due date (MM/YY)	Topic
<b>M1</b>	Start PV-systems and -components: reliability, monitoring and failure prediction	1 / 2017	2
<b>M2</b>	Start fire prevention of PV-installations and batteries/ arc detector units	2/ 2017	2
<b>M3</b>	Start tests with “PV grid interfaces” for smart users	3/ 2017	3 + 4
<b>M4</b>	Start series of tests with Multi-Tracker inverters	9/ 2017	3 + 4
<b>M5</b>	Start tests with PV inverters + different batteries	6/ 2017	3 + 4
<b>M6</b>	Proposal for test norms Multi-tracker inverter	6/ 2018	3 + 4
<b>M7</b>	Proposal for test norms inverter-battery units	12/ 2018	3 + 4
<b>M8</b>	PV inverter tests with grid support measures	12/ 2019	4
<b>M9</b>	Cost calculations and forecasts	6/ 2020	2
<b>M10</b>	LCA batteries	6/ 2020	2

# WP 4 Deliverables 2017 - 2020

	Name of Deliverables	Related Milestone	Due date (MM/YY)
<b>D1</b>	Reliability of PV-systems + components	M1	Annually
<b>D2</b>	Test results “PV grid interfaces”	M3	12/ 2017
<b>D3</b>	Test results “multi-tracker” inverter	M4	12/ 2018
<b>D4</b>	Fire prevention for PV + batteries/ results arc detectors/ recommendation for professionals	M2	12/ 2018
<b>D5</b>	Efficiency results of PV inverter grid support measures	M8	9/ 2020
<b>D6</b>	Cost calculations	M9	-9/ 2020
<b>D7</b>	LCA and handling recommendations	M10	9/ 2020

# Demonstrator activities:

PV Laboratory plans to be active in:

## **Swiss Energy Park (BKW) – 2017-2020:**

- PV reliability and failure prediction (Topic 1)
- PV and battery-units: grid services (Topic 4)
- PV and arc detectors + EMC/ EMI Optimization (Topics 2+3)

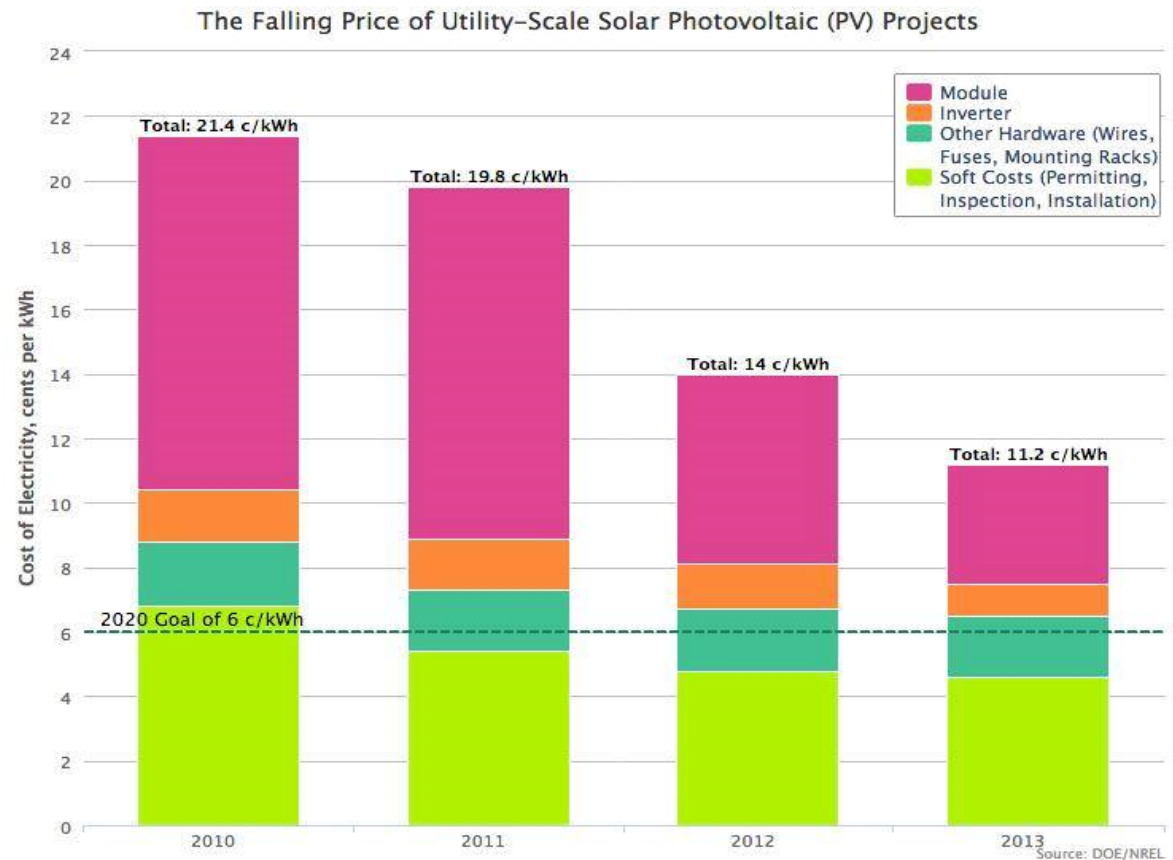
## **EWZ Zürich 2018 - 2020:**

- PV and comparison «Battery + EV's» (Topic 4)
- PV reliability and failure prediction (Topic 1 with Elektra Jegenstorf – high PV contribution 10% - 20%)

# Zukunft: Fallende PV Preise – soft costs

## Fragen:

- Wie bringen wir die «soft costs» in den Griff?
- Wie müssen PV Anlagen sein, um Richtung 5Rp./ kWh zu gehen!
- Wie sichern wir die Qualität der Anlagen?
- Wie nutzen wir PV Strom optimal PV2X?
- .....?





# Wie zeigen wir die Vorteile der PV auf?



**Beispiel BFH-Burgdorf:**  
Solarcarport mit 2,5 kWp  
spart in 30 Jahren 27'000  
Liter Benzin mit einem  
traditionellen E-Mobil wie  
dem Opel Ampera!

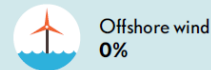
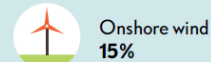
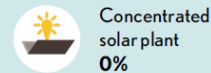
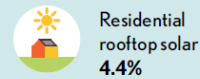
**Diplom BSc 2017:** Nissan  
Leaf mit bidirektionalem  
Lade-Entladeverhalten

Für 5 Mio PWs der Schweiz brauchen wir 12 TWh (=12  
GWp) – 15'000km/ Jahr mit 15 kWh/ 100km – mit  
effizienteren EVs 2/3 8 TWh or 8 GWp!

# Strategie Stanford University (CA/ USA):

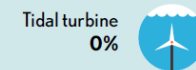
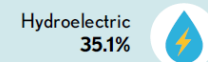
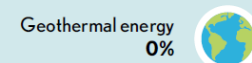
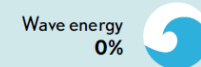
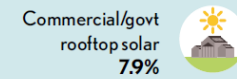
## 100% SWITZERLAND

Transition to 100% wind, water, and solar (WWS) for all purposes  
(electricity, transportation, heating/cooling, industry)



2050

PROJECTED  
ENERGY MIX



### 40-Year Jobs Created


Number of jobs where a person is employed for 40 consecutive years

Operation jobs: 

76,897

Construction jobs: 

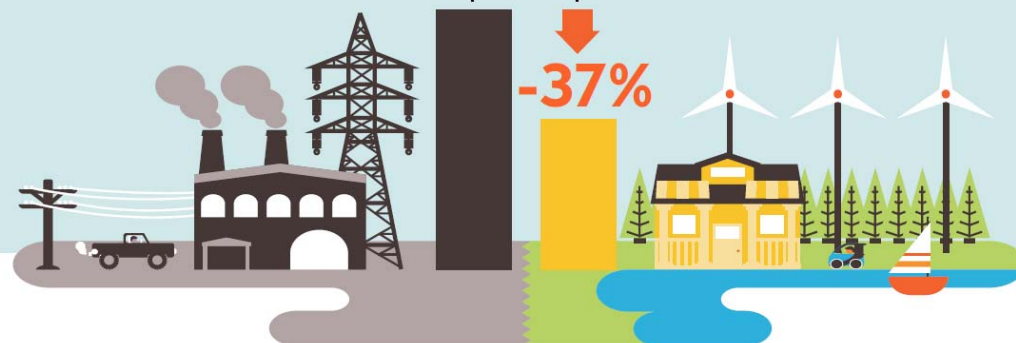
47,452

 = 10,000

Using WWS electricity for everything, instead of burning fuel, and improving energy efficiency means you need much less energy.

2050 Demand with BAU

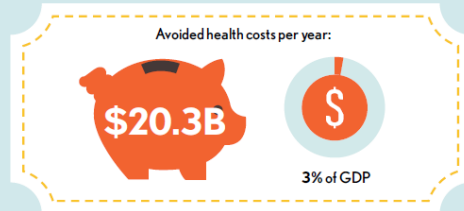
2050 Wind, Water, Solar



# 100% SWITZERLAND

Transition to 100% wind, water, and solar (WWS) for all purposes  
(electricity, transportation, heating/cooling, industry)

## Avoided Mortality and Illness Costs



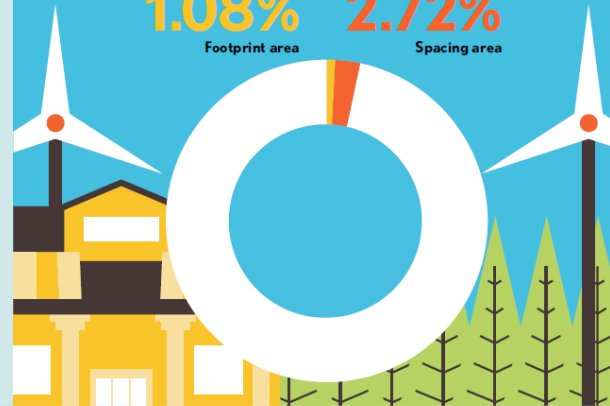
Air pollution deaths avoided every year: 1,539



Plan pays for itself in as little as 1.8 years from air pollution and climate cost savings alone.

## Percentage of Land Needed for All New WWS Generators

**1.08%** Footprint area  
**2.72%** Spacing area



## Future Energy Costs 2050

BAU (Business as usual)      WWS (Wind, water, solar)



Average fossil-fuel energy costs\*  
**8.2 c/kWh**

\*Health and climate external costs of fossil fuels are another 5.7 c/kWh



Average WWS electricity costs  
**6.2 c/kWh**

## Money in Your Pocket

€P = \$1,000

Annual energy, health, and climate cost savings per person in 2050: \$5,885



Annual energy cost savings per person in 2050: \$348



«100% Erneuerbar» ist der nächste Schritt!



Vielen Dank für die Aufmerksamkeit!

Professor Urs Muntwyler,  
PV Laboratory – [www.pvtest.ch](http://www.pvtest.ch)  
Institute for Energy and Mobility Research (IEM)  
BFH-TI Burgdorf, Switzerland

[urs.muntwyler@bfh.ch](mailto:urs.muntwyler@bfh.ch)

