

28th European Photovoltaic Solar Energy Conference and Exhibition EU PVSEC 2013: Session 5DP.3 "PV Systems"
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From PV Systems to Energy Solutions

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Preliminary Remark:

From PV Systems to Energy Solutions ...



- This is not a bouquet of astonishing BIPV buildings which are implemented with 0.5% PV market share!
- This presentation is not a report of recent TNC projects.
- Here are some considerations reflecting 39 years of experience in solar power (PV and thermal), housing technology and building efficiency.
- I make here my own proposal for possible steps of the PV community and the industry to help improve the existing building stock in Europe.

«From PV Systems to Energy Solutions»

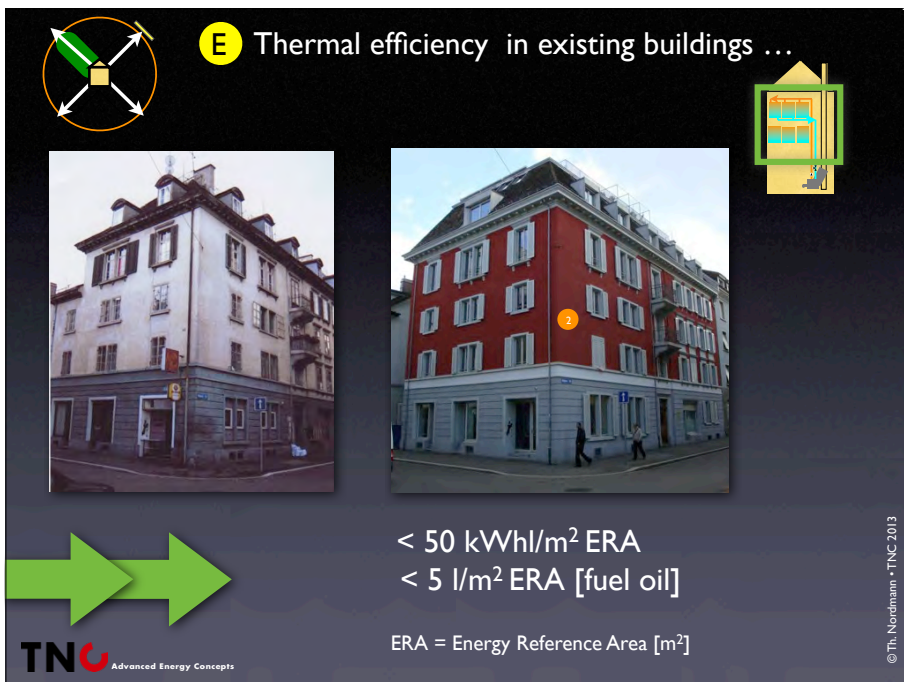
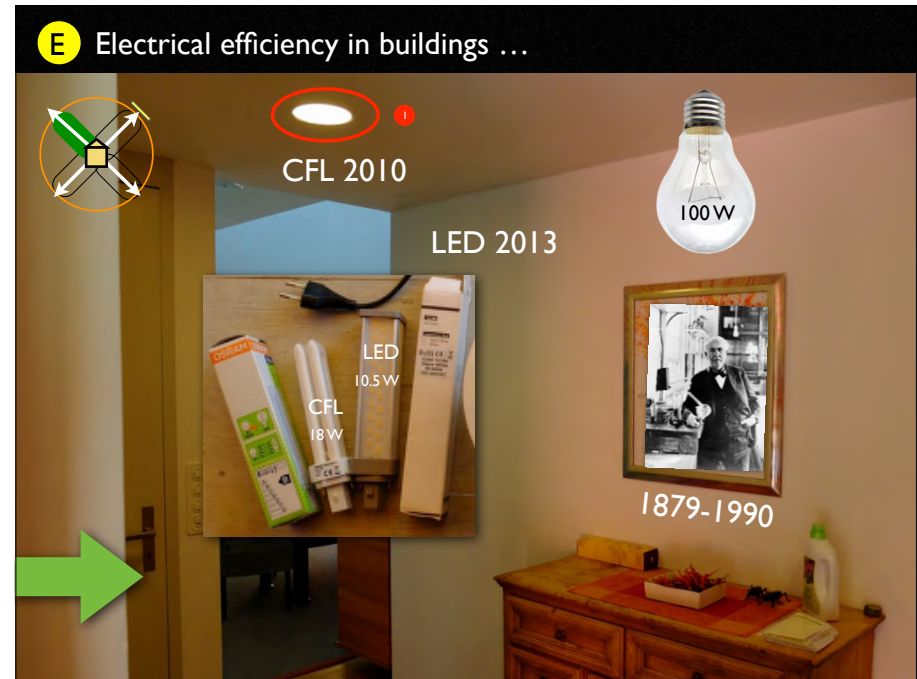
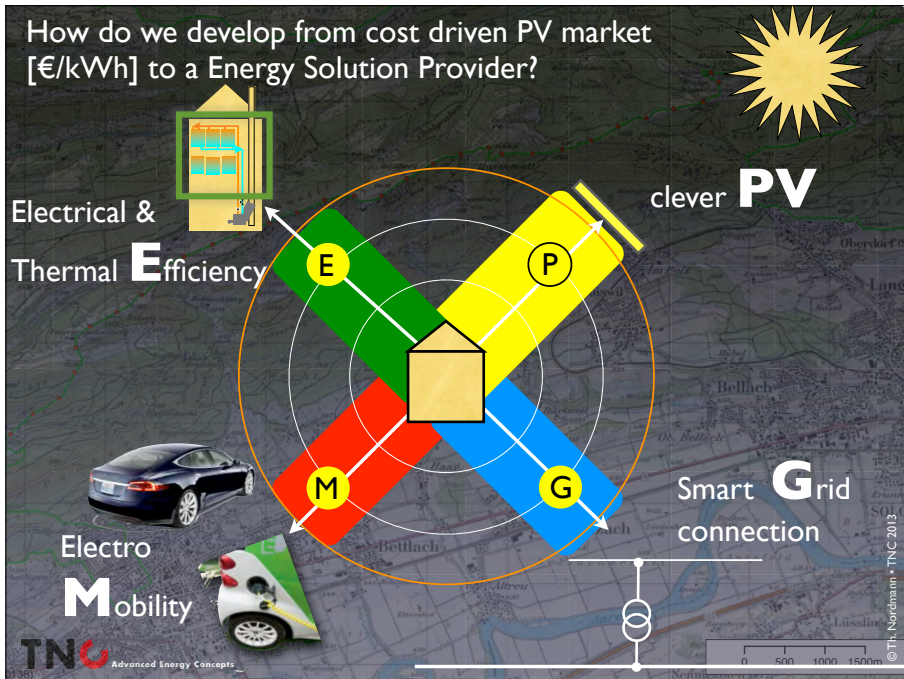


Agenda


- What makes Photovoltaic in buildings so important?
- Why do we need a joint European plan to allow high PV penetration in the power grid?
- How do we develop from lower cost PV [€/kWh] market to a Energy Solution Provider?
- Why power to heat, power to storage and power to wheel?
- Seven Conclusions ...

What makes Photovoltaic in buildings so important? Why should we start with the existing building stock?


- EU Buildings → ≈25% of power, ≈36% CO₂ emission!
- Buildings allows longterm investments 25+ years.
- Credible owners have access to low interest capital.
- Domestic buildings pay high electricity rates.
- The thermal and electrical improvement of European domestic building-stock is €100bn long-lasting decentralized market.
- PV modules are an important, but small part of the total investment.
- A important challenge:
how can the owner (legally) share the cost with the renting party?




E Electrical & Thermal Efficiency




1 Appliance AAA+



2 < 50 kWh/m² ERA



3 Passive house, Minergie+



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P Clever PV




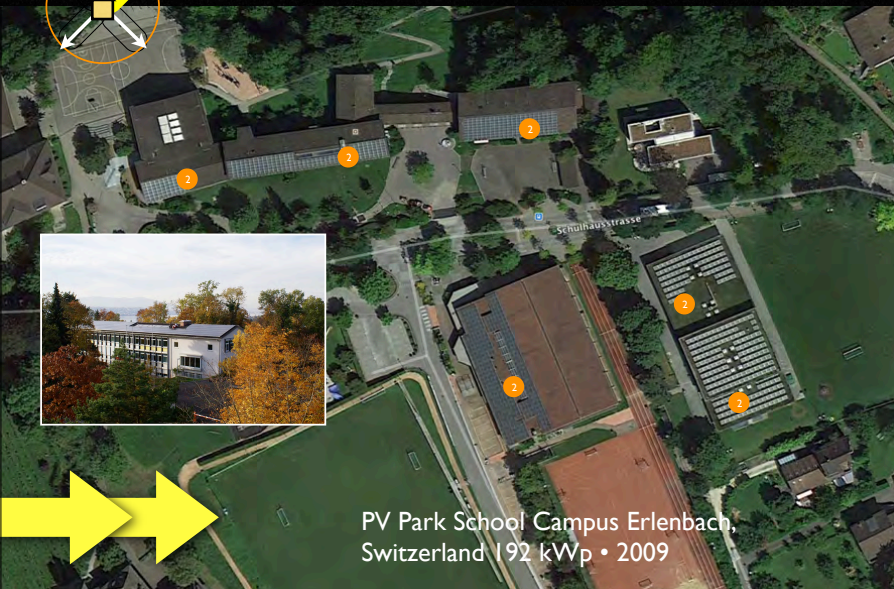
30 kWp > 25'000 kWh
≈ annual <10% electrical demand

30 kWp of BIPV in the
College of Zürich Stadelhofen,
Swiss Solar Prize 1999



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P Clever PV 100% of annual electrical demand

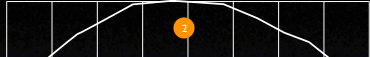
PV Park School Campus Erlenbach,
Switzerland 192 kWp • 2009

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P Clever PV > 100% Annual electrical demand incl. E-W module



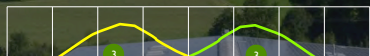
noon



north ← → south

roof-module fill factor = 30...50 %
yield = 100%

east ← → west



roof-module fill factor = 100 %
yield = 90%

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P Clever PV > 100% annual electrical demand plus O-W module lay out

© 2013 Reto Miloni

west east

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P Clever PV

1 < annual 50% electrical demand

2 ≈ annual 100% electrical demand

3 > 100% annual electrical demand incl. E-W module lay out

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G Smart Grid Connected

Inverter with grid services

50.2 Hz!

Principle of frequency-dependent active power reduction

Energy Management under the renewed EEG 2012

Inverter with grid services are already mandatory in some member states with high PV penetration (i.e. Germany, Italy).

Installed PV Capacity	EEG 2009	EEG 2012
P _{max} ≥ 100 kW	Energy management - remotely controlled	Energy management - remotely controlled
30kW ≤ P _{max} < 100 kW	No energy management requirements	Energy management - remotely controlled
P _{max} < 30 kW	No energy management requirements	Either remotely controlled or fixed 70% feed-in limitation

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G Smart Grid Connected

Power to heat time shift of + 2h ... 12h ~ 45%

Hot Water 65°C ≈ 15%

Refrigerator 2 - 8°C ≈ 17%

Laundry ...

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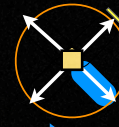
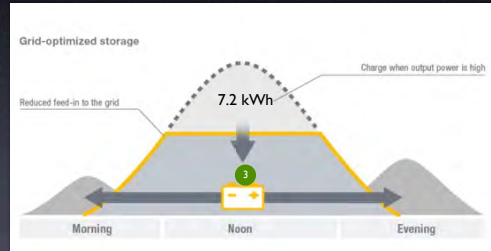
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G Smart Grid Connected

Local battery storage

> 25% daily demand shift for 24h



G Smart grid Connected

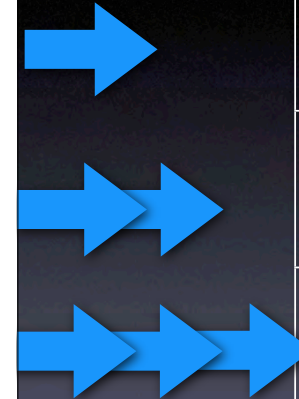
Inverter with grid services



Power to heat
Time shift
± 2h - 12h



>25% /day
Local battery storage



M Electro-Mobiles you can buy today ...

electric-drive



- 15 kWh/100km → 1.7 litre gasoline/100 km
- 2 people • range 145 km/charge
- Power 55 kW/75 PS • Weight 995 kg
- Battery 17.6 kWh Li-Ion • Rent €/month 73.-
- Secured battery capacity up to 10 years
- Price: € 20'000.-



Renault Fluence Z.E.



- 14 kWh/100km → 1.6 litre gasoline/100 km
- 5 people • range 185 km/charge
- Power 70 kW/95 PS • Weight 1'610 kg
- 22 kWh battery Li-Mn, O₂ • Rent €/month 78.-
- Secured battery capacity up to 10 years
- Price: € 24'500.-



Tesla S



- 15 kWh/100 km ≈ 1.7 litre gasoline/100 km
- 5 people • range 375 km/charge
- Power 225 kW/302 PS • Weight 2'100 kg
- Li-Ion battery 60 kWh
- 8 years and/or 160'000 km warranty
- Price: € 70'100.-



M

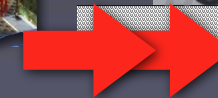
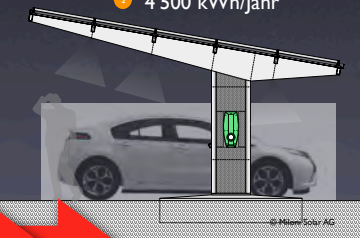
Where do you charge your Electro-Mobile?




- 15 kWh/100 km → 3'000 kWh/20'000 km
- Charging $\eta > 80\%$
- You need a PV installation with 3 - 4 kWp
Cost 2013 → € 7'000.- ... € 12'000.-
→ now you have a full tank for next 25 years!



4 - 5 kW
4'500 kWh/Jahr



M Smart grid Connected



Buy your electro-mobile today!


Charge your car battery storage (15 - 60 kWh)
Double your PV Installation

Double your PV self consumption

(PV) self-consumption makes good technical and economic sense.

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Power demand ø two pers. household (D) ~ 3500 kWh



TV, Audio & PC Refrigerator Hot Water Laundry, Dryer, Dishwasher
Cooking Lighting Others Electro mobility

Today

Efficiency impact


+ electro mobility

Appliance AAA+ → -20% ... -90%
- approx. 25%

20'000 km/a corresponds approx. to 3'000 kWh/a

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ø Two pers. household (D) ~ 3500 kWh



TV, Audio & PC Refrigerator Hot Water Laundry, Dryer, Dishwasher
Cooking Lighting Others Grid applicable
Electro mobility Grid applicable mobility PV Production

Renewable Production Consumption/Demand

Today

Efficiency

+ el. mobility

PV ≈ 4 kWp

PV ≈ 8 kWp

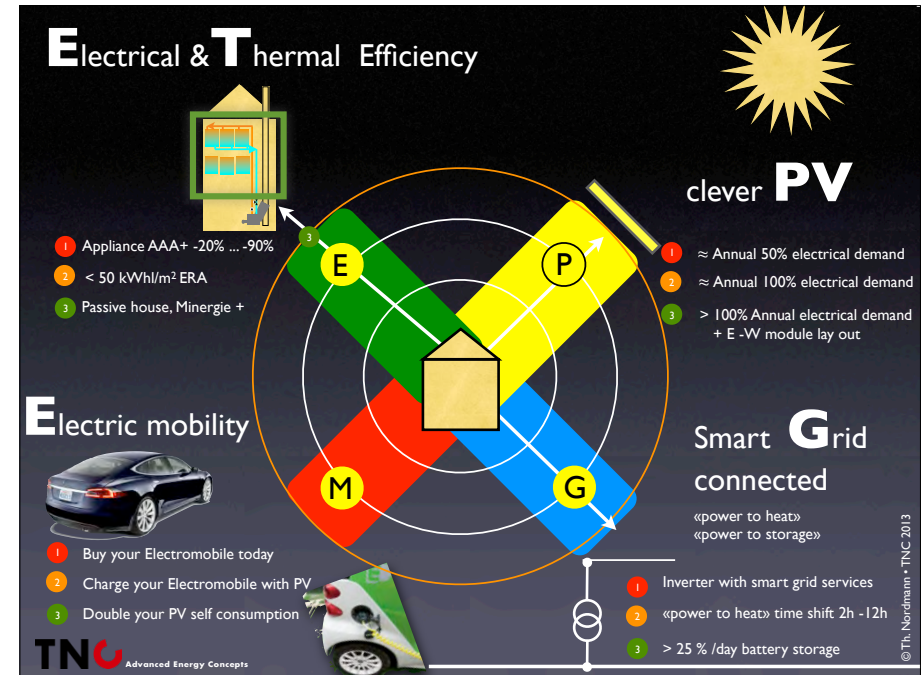
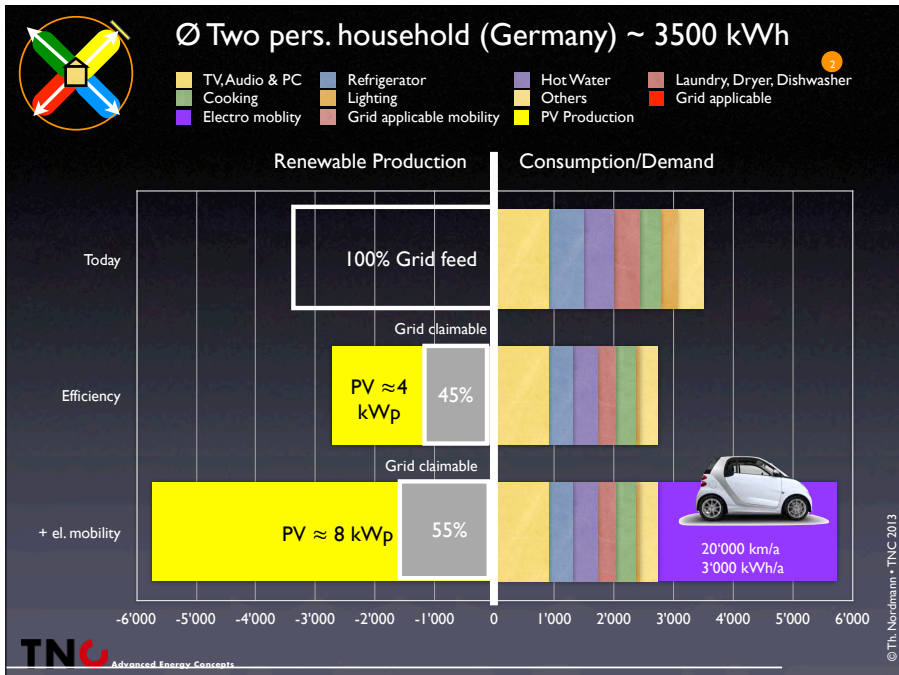
20'000 km/a
3'000 kWh/a

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PV self-consumption storage makes good technical & economical sense

Production	PV 4 kWp	PV 4 kWp
Consumer	Residential buildings	Electro Mobil
Power to heat, power to storage and power to wheel.	<p>Thermal storage</p> <p>Grid claimable «power to heat» 45%</p> <p>time equality 20%</p> <p>Battery storage 7.2 kWh Battery</p> <p>24h</p> <p>-25%</p> <p>«power to storage» 30%</p>	<p>Battery storage 18 kWh Battery</p> <p>Grid claimable «power to wheels»</p>

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Conclusions I

Monday
 We need PV when retrofitting the EU building stock.
 PV offers attractive solutions and processes to improve energy solutions for buildings and allows almost CO₂ free individual mobility.

Tuesday
 Successful energy solutions have to address the thermal **and** the electrical efficiency.

Wednesday
 For clever PV in buildings we aim to distribute PV uniformly over 6 hours by orienting modules east and west with marginal losses in yield.
 Thanks to the economical progress and self consumption we can use PV systems, which produce 100% and more of the annual electrical demand.

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Conclusions II

Thursday
 With market share of 5% – 20% of PV, the challenge is to provide smart grid connections of sustainable PV houses.
 PV self-consumption makes good technical and good economical sense and can be enhanced by power to heat and storage. Inverters are able to provide further grid services.

Friday
 Buy your electromobiles today and charge it with PV.
 20'000 km/a means additional 4 - 5 kWp of PV with high self consumption.
 Grid claimable services are in the same range as conventional buildings.

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Conclusions III



Saturday

The main challenge: we need a joint European plan to allow high PV penetration in the power grid.

The presented index may help develop such a common plan.

Sunday

Photovoltaic is part of the solution, and not a problem!

To keep PV attractive, we have to start developing today's PV systems into integrated parts of the energy solution.

Sustainable energy buildings with mobility can be a part of this solution.



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Q & A