

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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TNC stands for: Solar Power and Building Efficiency
Our themes for more than 26 years

→ Development and Implementation

- 1989 first Photovoltaic system on a highway noise barrier (BFE P&D)
- 1996 developing the world's first solar power exchange model for the ewz, Elektrizitätswerk der Stadt Zürich
- Using bifacial technology (two-sided solar cells) as a noise barrier alongside roads 1994 and rail track 2008 (European patent)
- 1997/1999 responsible for the process development and implementation of the first national building renovation program by the Swiss federal government as part of Energy 2000 strategy.
- Implementation of the Swiss national building renovation program „Das Gebäudeprogramm“ for 16 States (Kantone) Mio €. 220/a
- Activity leader IEA PVPS Task 13 Performance & Reliability of PV Systems

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 project.
- Here are some considerations reflecting my 40 years of experience in solar power (PV and thermal), housing technology and building efficiency.
- I will make here my own proposal for the possible steps of the PV community and the industry to help improve energy and ecological wise the existing building stock in Europe.

«From PV Systems to Energy Solutions»



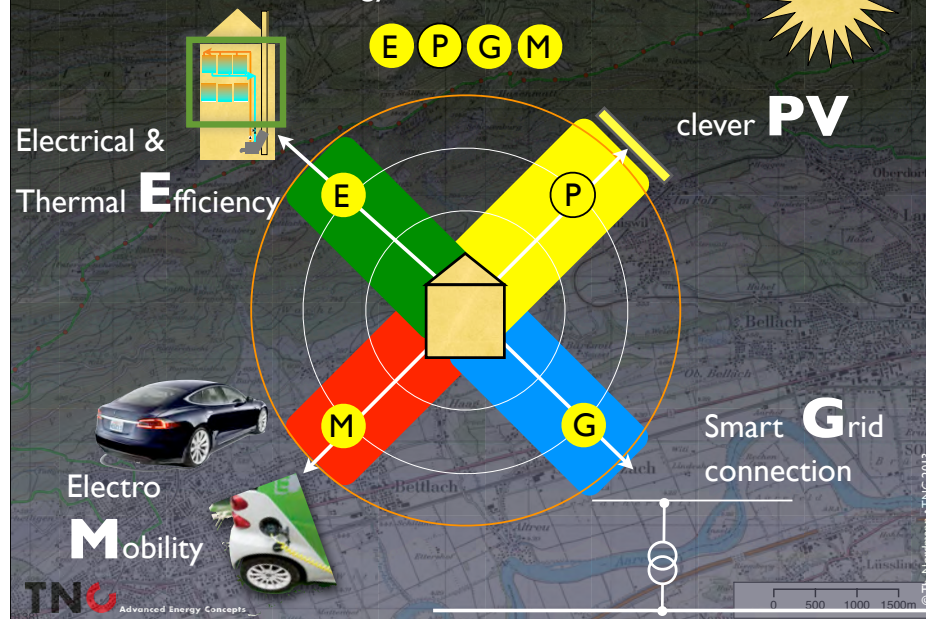
Agenda

- 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 emerge 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?

How do we develop from cost driven PV market [€/kWh] to a four dimensions Energy Solution Provider?



E Electrical Efficiency in buildings ...



E Thermal Efficiency in existing buildings ...



E Electrical & Thermal Efficiency in new buildings

Passive house, Minergie +

First really Zero-Energy Office-Building Switzerland – MINERGIE®-P-ECO-certified - healthy work
 – wood construction – roof-integrated PV – Energy Globe Award Switzerland 2008 – European Award for building-integrated solar energy technology 2008 Architecture

E Electrical & Thermal Efficiency

1 Appliance AAA+

2 Install: „Pullover“ < 50 kWh/m² ERA

3 Passive house, Minergie+

TNC Advanced Energy Concepts

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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 Price 1999

P Clever PV 100% of annual electrical demand

PV Park School Campus Erlenbach, Switzerland 192 kWp • 2009

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

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!

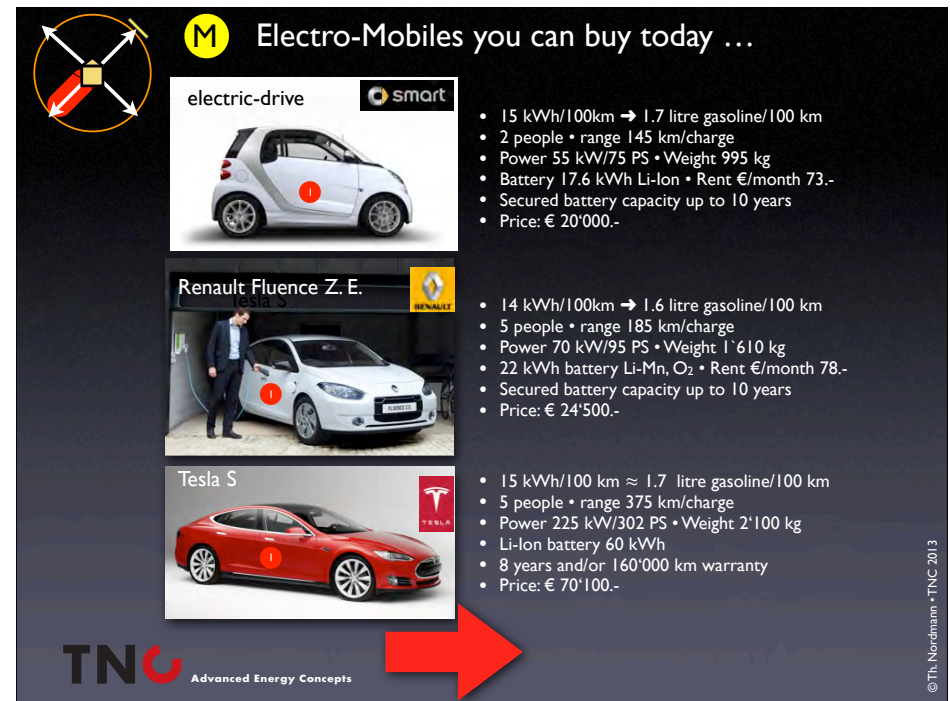
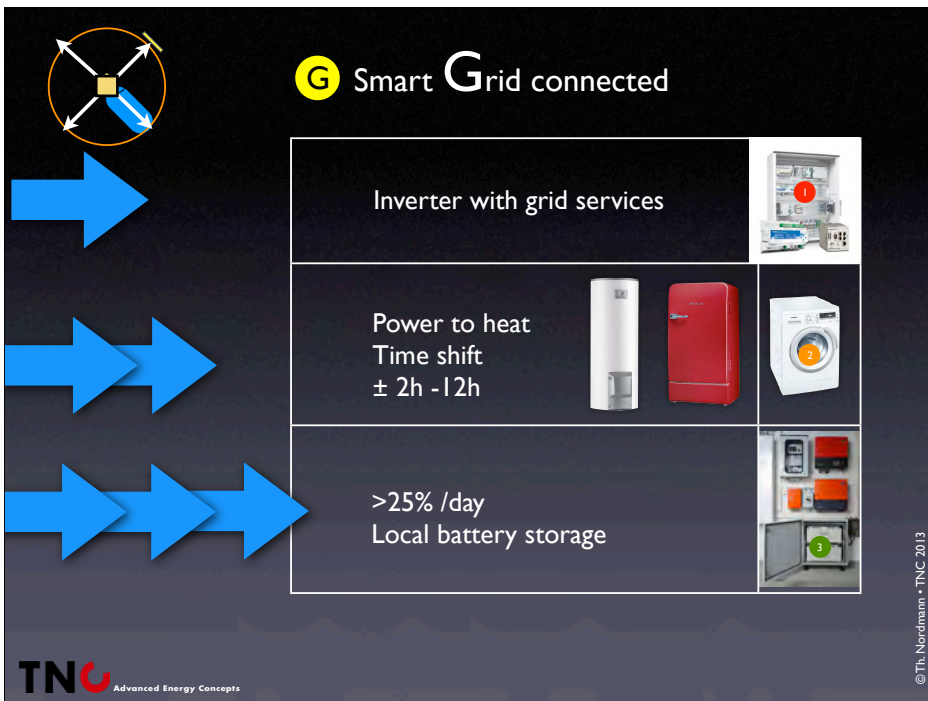
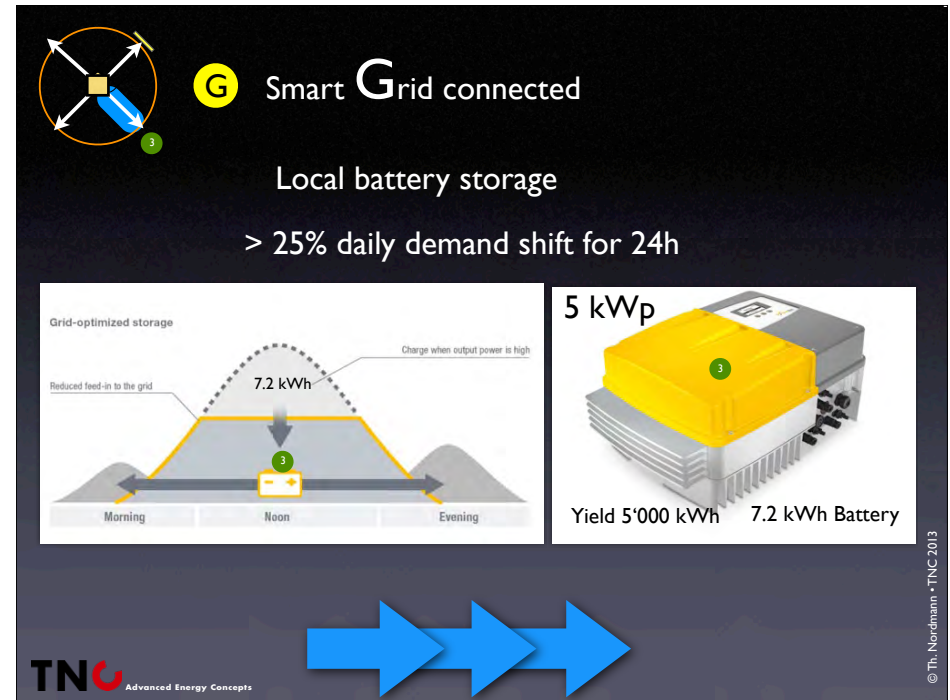
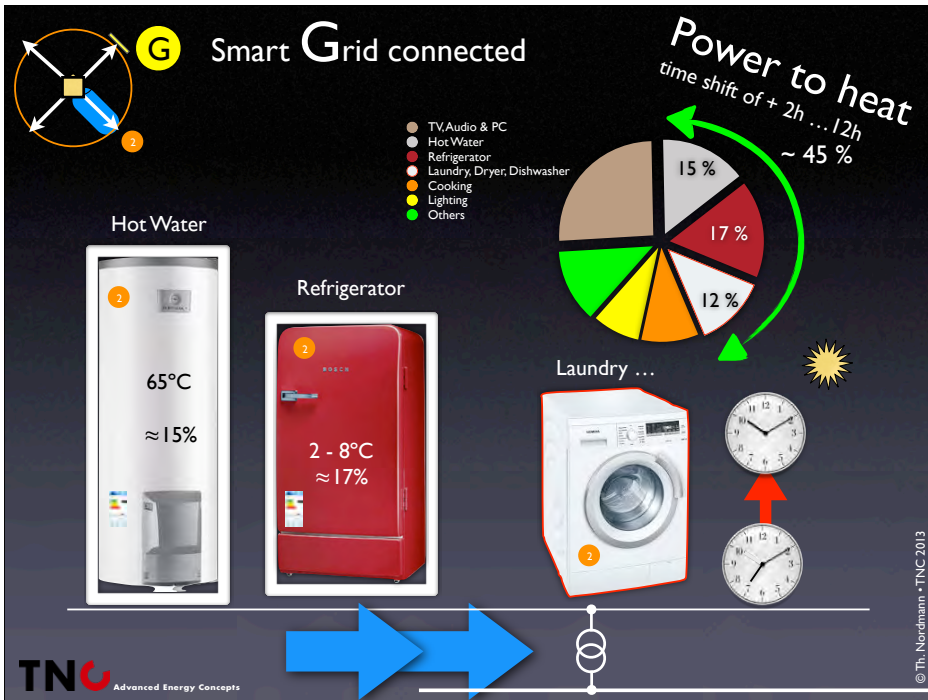
Principle of frequency-dependent active power reduction

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
$P_{max} \geq 100 \text{ kW}$	Energy management - remotely controlled	Energy management - remotely controlled
$30 \text{ kW} \leq P_{max} < 100 \text{ kW}$	No energy management requirements	Energy management - remotely controlled
$P_{max} < 30 \text{ kW}$	No energy management requirements	Either remotely controlled or fixed 70% feed-in limitation

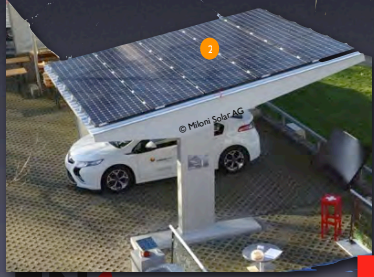
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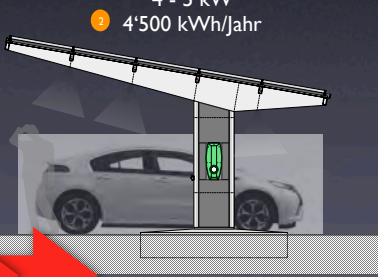
M Where do you charge your Electro-Mobile?



- 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!


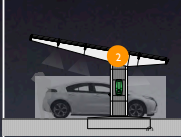




4 - 5 kW
4'500 kWh/Jahr



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M Electro Mobility

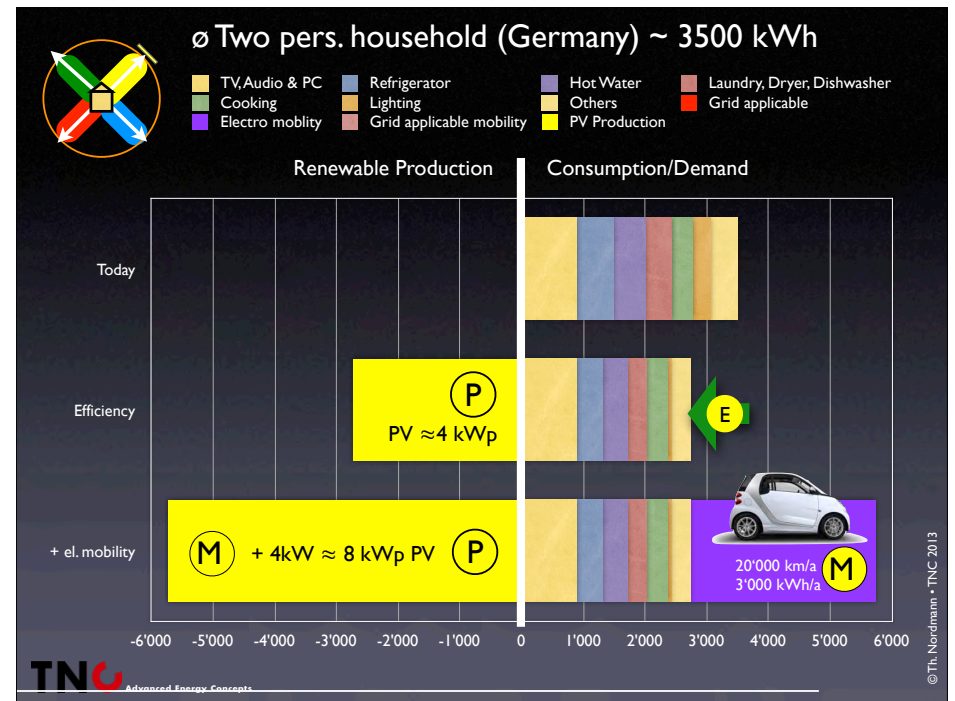
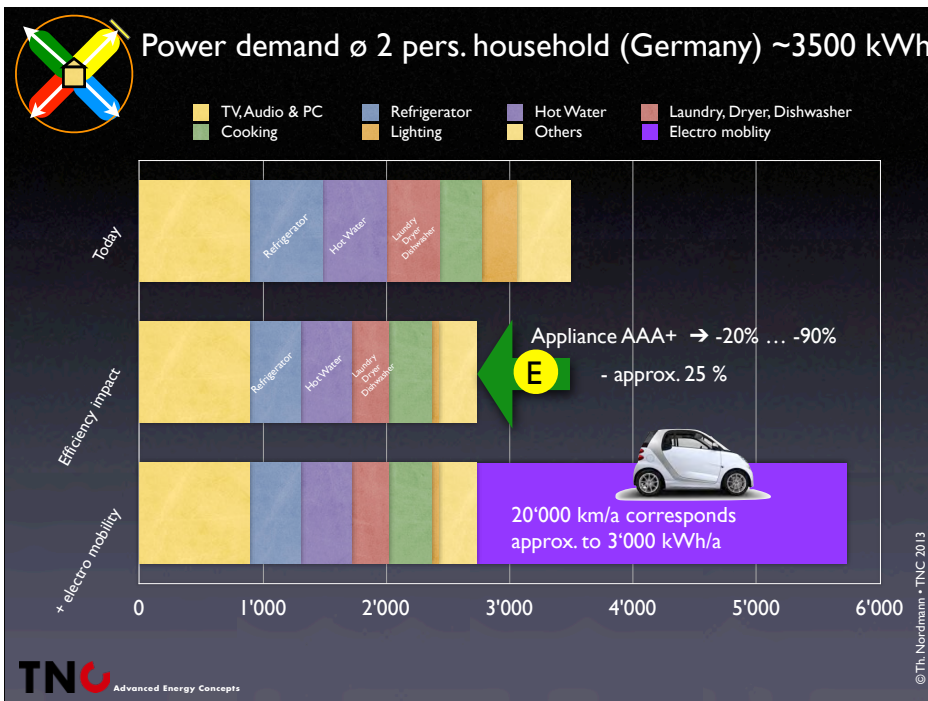
Buy your electro-mobile today!

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

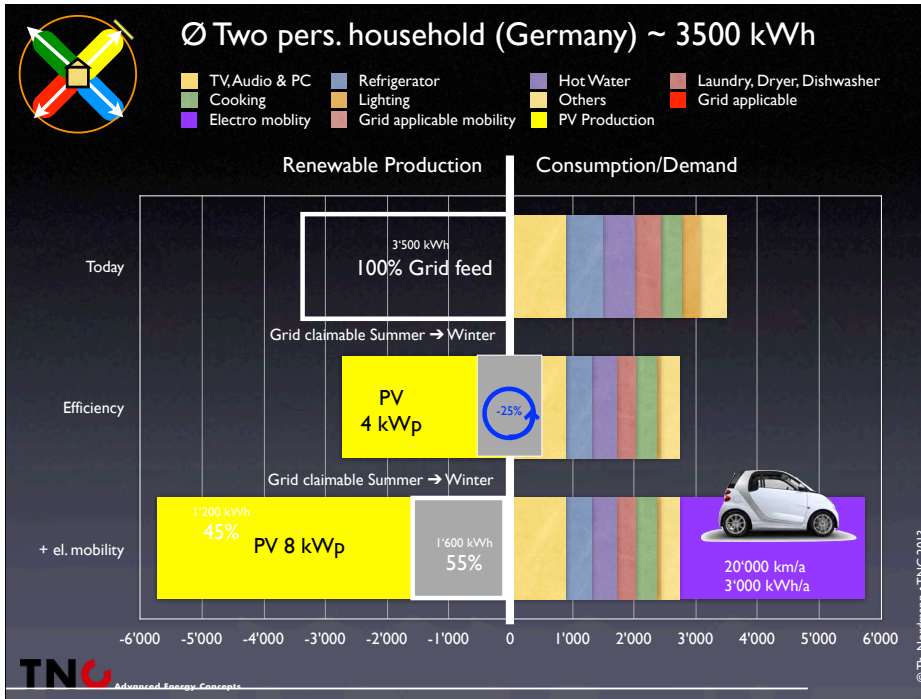
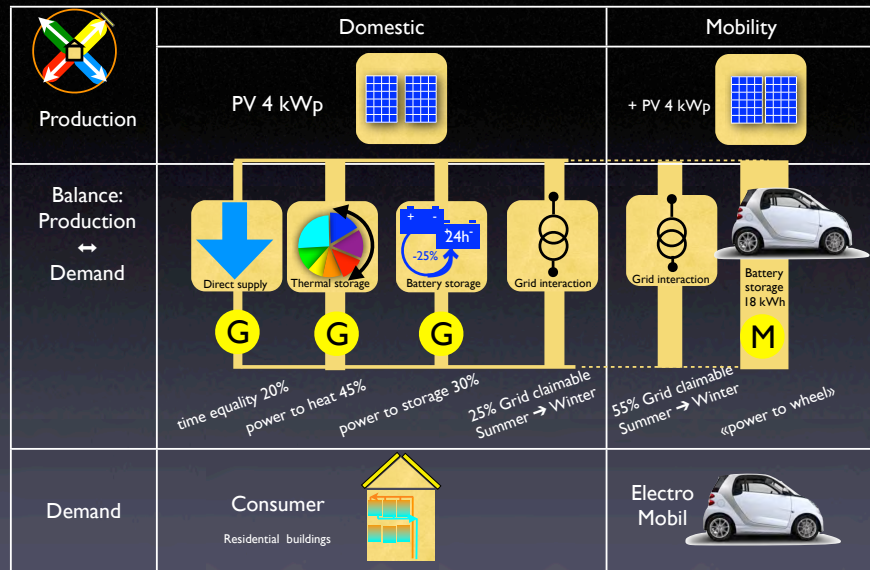
Double your PV self consumption

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

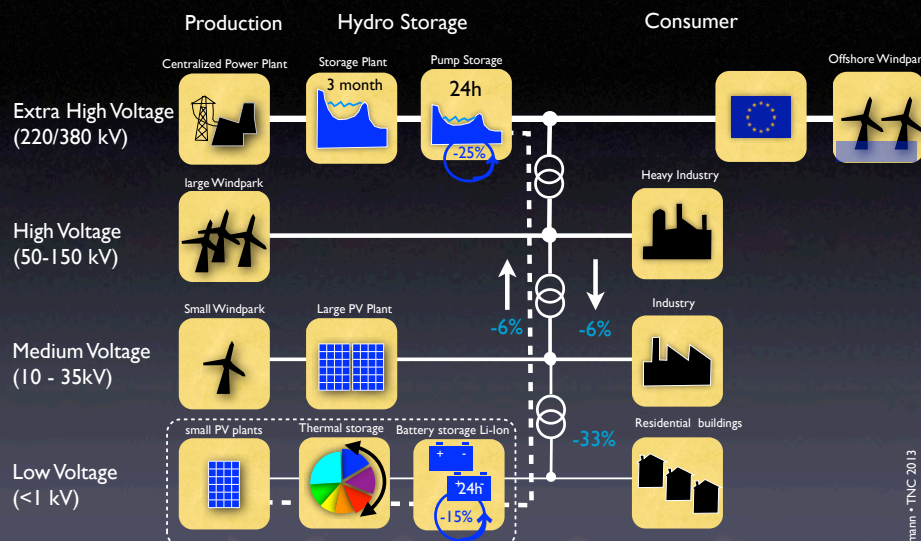
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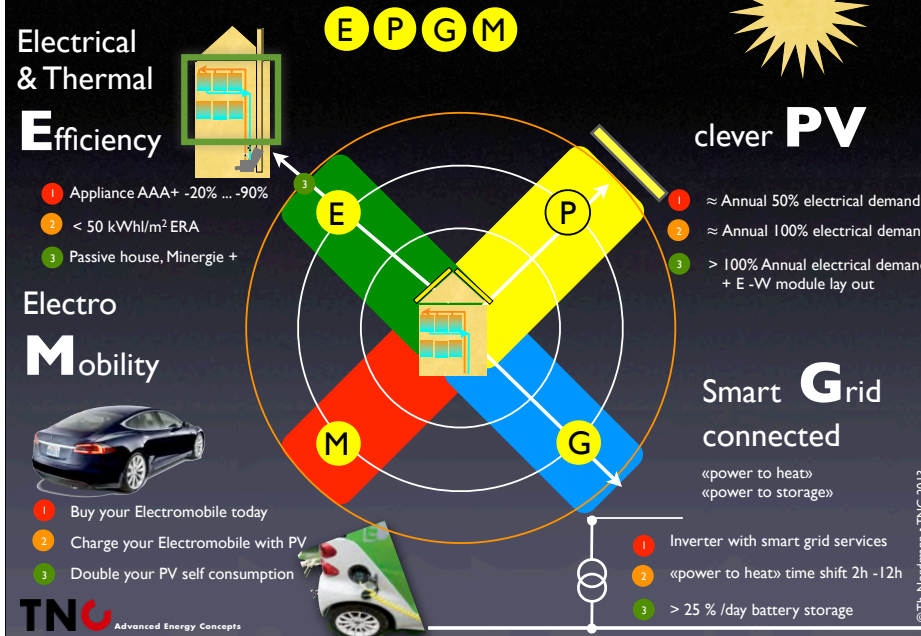
G PV self-consumption makes good technical & economical sense



Photovoltaic Storage Systems in the grid



Your four dimensions Energy Solution Provider



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.

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. can Enhance it by power to heat and power storage.
Inverters are able to provide further grid services.

Friday

Buy your electromobile today and charge it with PV → Power to wheel
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.

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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Stephanie Fehling

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Q & A