



The role of Energy Storage in the future development of photovoltaic power

Winfried Hoffmann, EPIA president

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Winfried Hoffmann

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Chief Technology Officer (CTO), Solar Business Group of Applied Materials
President of the European Photovoltaic Industry Association (EPIA)



EPIA in short

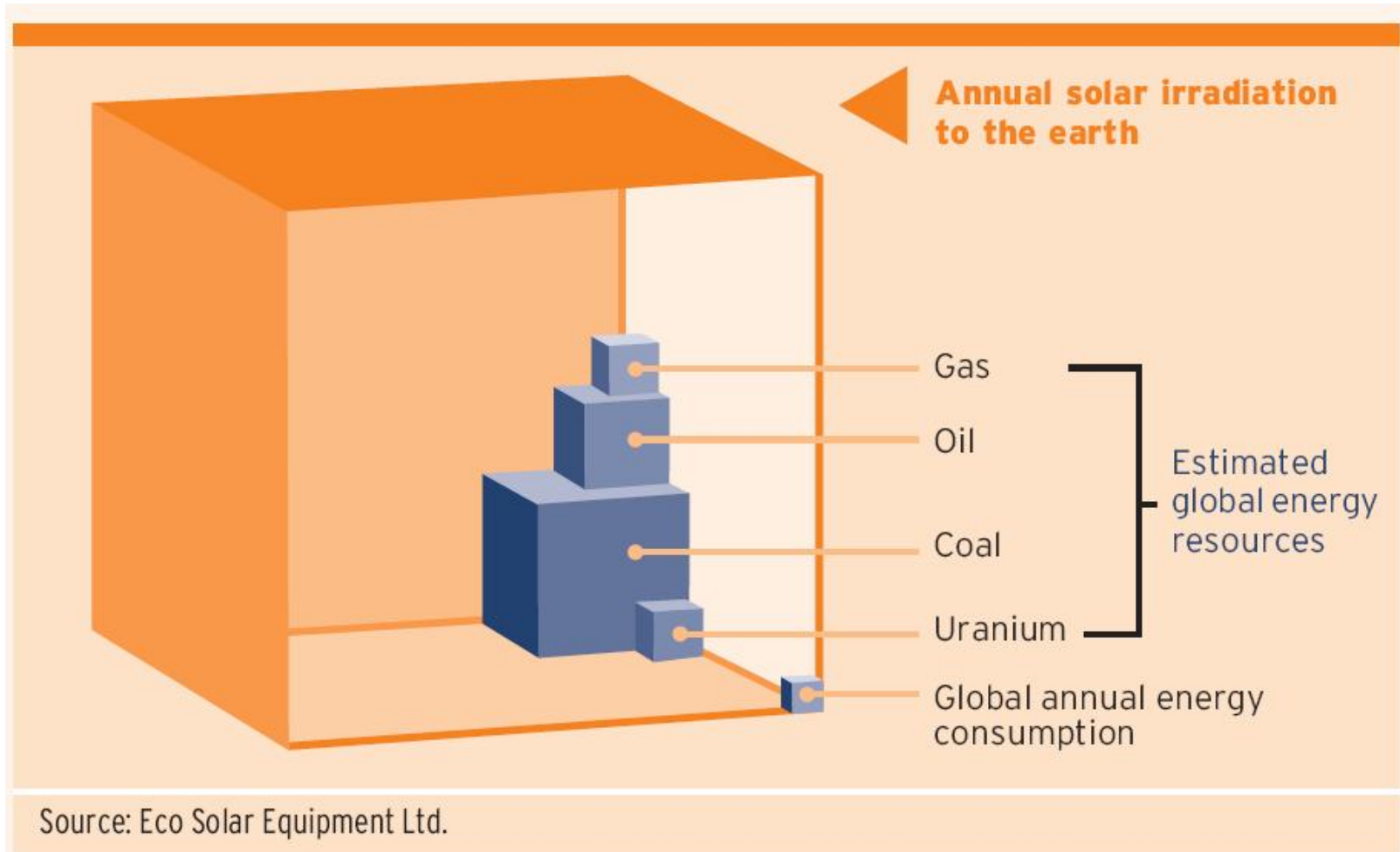
EPIA represents **95% of the photovoltaic European industry,**
and 80% of the Global photovoltaic industry

- Founded in 1985
- 165 Members, representing the whole Value Chain: Silicon feedstock, ingots & wafers, cells, modules, inverters & Bos, Systems Integrators.
- Budget 2008: 3,5 M€
- Secretariat in Brussels: 14 staff
- 8 Board members elected for 4 years
- 2 Years presidency:
 - 2006-2008 Dr. Winfried Hoffmann (DE)
 - 2008-2010 Mr Ernesto Macias (SP)
- **Member of EREC**
- **Renewable Energy House**

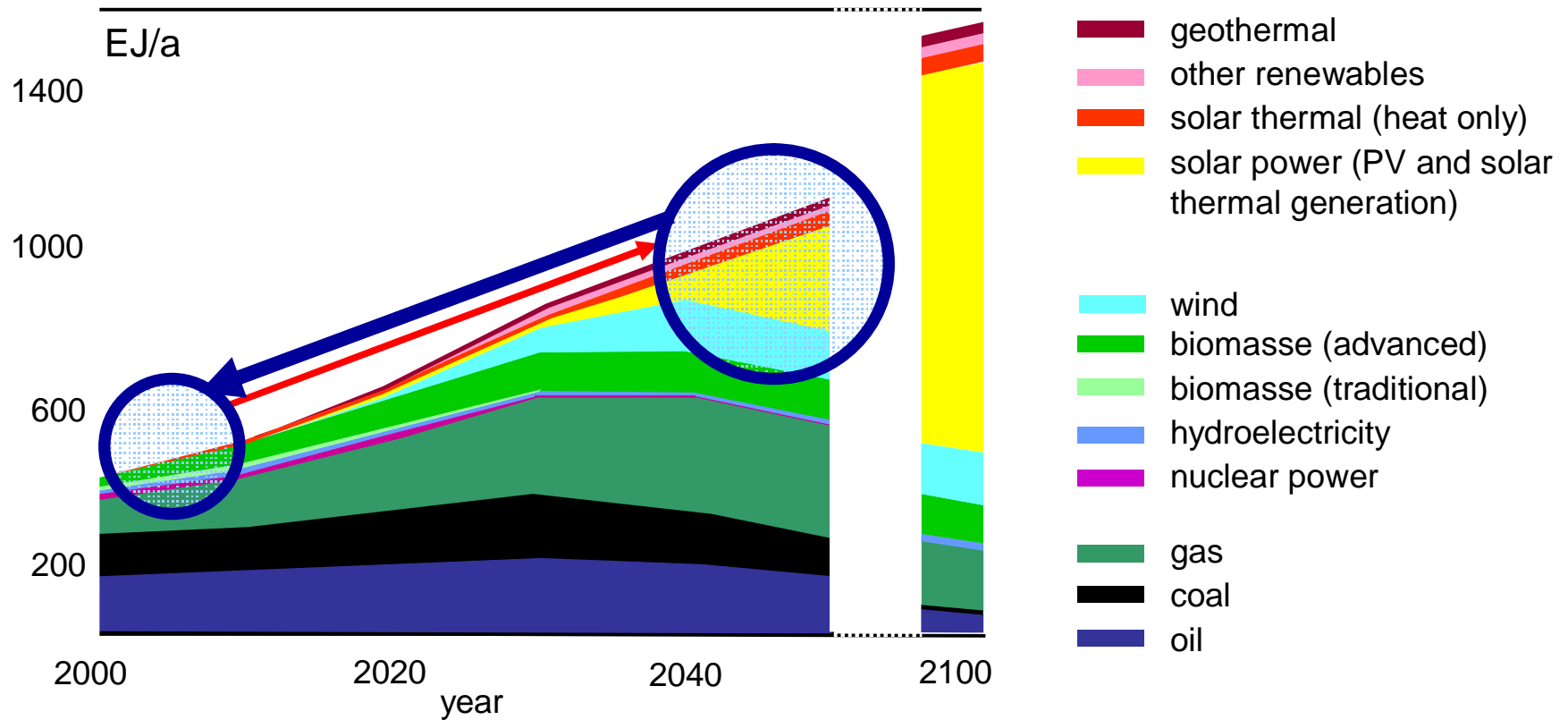
Components manufacturers (107)	Systems, Consulting, R&D (57)
Full Members (107)	Full Members (29)
<p>Aleo Solar (DE), Adept Technology (DE), AES Solar Energy BV (NL), AGC Flat Glass (BE), Applied Materials (DE), Atersa (NL), Arcelor (LU), Astra (KY), August Krempel (DE), Baoding Yingli (CN), Bangkok Solar (TAI), Belval (CH), Bisol (SI), BP Solar (ES), Canadian Solar Inc. (CA) Centrosolar (DE), Centrotherm (DE), China Sunergy (CN), Danfoss Solar Inverters (DK), DC Chemicals (DE), Dow Corning Europe (BE), DuPont (FR), Dyesol (UK), Edisun Power (CH), Elettronica Santerno (IT), Engcotec (DE), Elkem Solar (NW), eMat Technology (US), Energy Solutions (BG), Enersys (UK), EniPower (IT), EPV Solar (US), ErSol Solar Energy (DE), Evergreen Solar (DE), EverQ (DE), First Solar (DE), Fronius (AU), GE Solar (US), Guardian (US), Helianthos (NL), Heraeus Holding (DE), Hydro (NW), Isofoton (ES), Isovolta (AU), KACO Gerätetechnik (DE), Konarka (US), KPE (KR), Kyocera (DE), Leybold Optics (DE), Meyer + Burger (CH), Martifer (PT), Mistubishi Electric Europe (DE), Mondragon Assembly (ES), Multi-Contact (CH), OC Oerlikon Balzers Ltd. (LS), Optisolar Inc. (US), NPC Europe (DE), NPO QuintTech (RU), Photovoltech (BE), Photowatt Internatioal (FR), Pillar (UA), Piritium S.A. (GR), Podolsky Chemical (RU), PV Silicon (DE), Q-Cells (DE), REC Scanwafer (NW), RENA Sondermaschinen (DE), Renergies (IT), Saft (FR), Saint Gobain (FR), Samsung Deutschland (DE), Sanyo Component Europe (DE), Schott Solar (DE), Scheuten Solar (NL), Sharp Solar Systems (DE), SGL Carbon (DE), Siemens (DE), Silcio S.A. (GR), SHV (NL), Singulus Technologies (DE), Solar Cells Hellas (GR), Solaire Direct (FR), Solar Energy (RU), Solon AG (DE), Solsonica (IT), SMA Technologie (DE), Solar Century (UK), Solar Plus (PT), Solar World (DE), SolFocus (US), Solland Sollar Energy (NL), Solvay Solexis (BE), Sputnik Engineering (CH), Stangl Semiconductor Equipment (DE), Sunpower (US), Suntech Power (CN), Sunways (DE), Systaic (DE), Topsil (DK), Total (FR), Trina Solar (ES), Vesuvius (FR), Wacker-Chemie (DE), VON ARDENNE (DE), Umicore (BE), United Solar Ovonic Europe (DE), Würth Solar (DE)</p>	<p>3S Swiss Solar Systems (CH), Acciona Solar (ES), Carmanah (UK), City Solar (DE), Conergy (DE), Ecostream (NL), Ecotecnia (ES), Enfinity (BE), ESI (DE), Gaz de France (FR), Goldbeck Solar (DE), GP Solar (DE), IBC Solar (DE), IB Vogt (DE), Intrakat (GR), IT Power (UK), M+W Zander (DE), NAPS Systems (FI), NaRec Development Services (UK), Phönix SonnenStrom (DE), Saft Power Systems (FR), Solar Technologies (UAE), Solar Ventures (IT), Solar Electric (FR), Solaria Energia (ES), Tenesol (FR), Upsolar (CH), Wager & Co Solartechnik (DE), WIP (DE)</p>
	Associate Members (28)
	<p>ADEME (FR), Apollon Solar (FR), APREN (PT), ASIF (ES), Assosolare (IT), BSW (DE), CRES (GR), Dexia (FR), ECN (NL), EDF (FR), Enerplan (FR), Fraunhofer (DE), GIF I (IT), Helapco (GR), Holland Solar (NL), IM2 Systems (ES), IMEC (BE), INES (FR), Kosolco (DE), PV Cycle (BE), SEMI (US), SER (FR), SMBC (UK), Solar Promotion (DE), TNC (CH), Trama (ES), Yole (FR), Swissolar (CH)</p>

Total Turnover of EPIA members (2007): ~14.000 M€

Finite resources

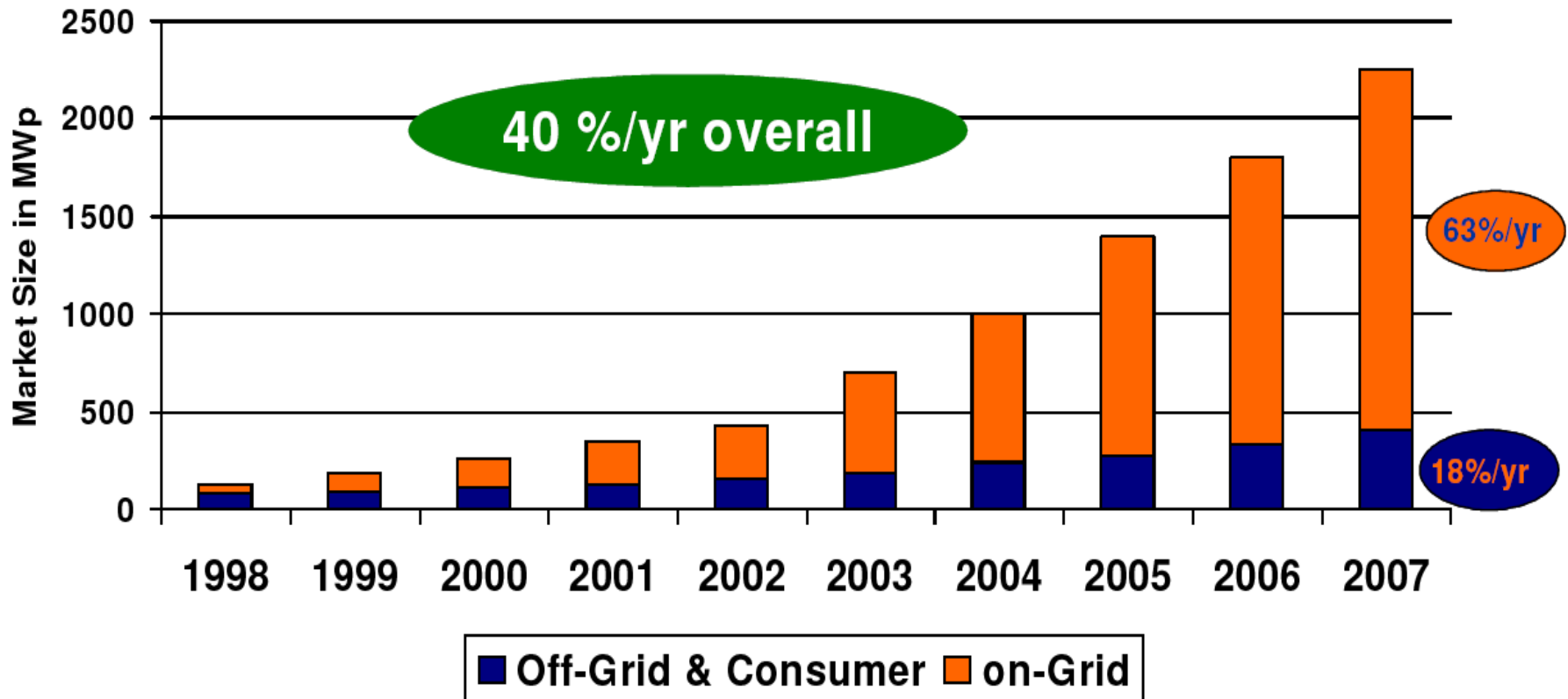


The challenge

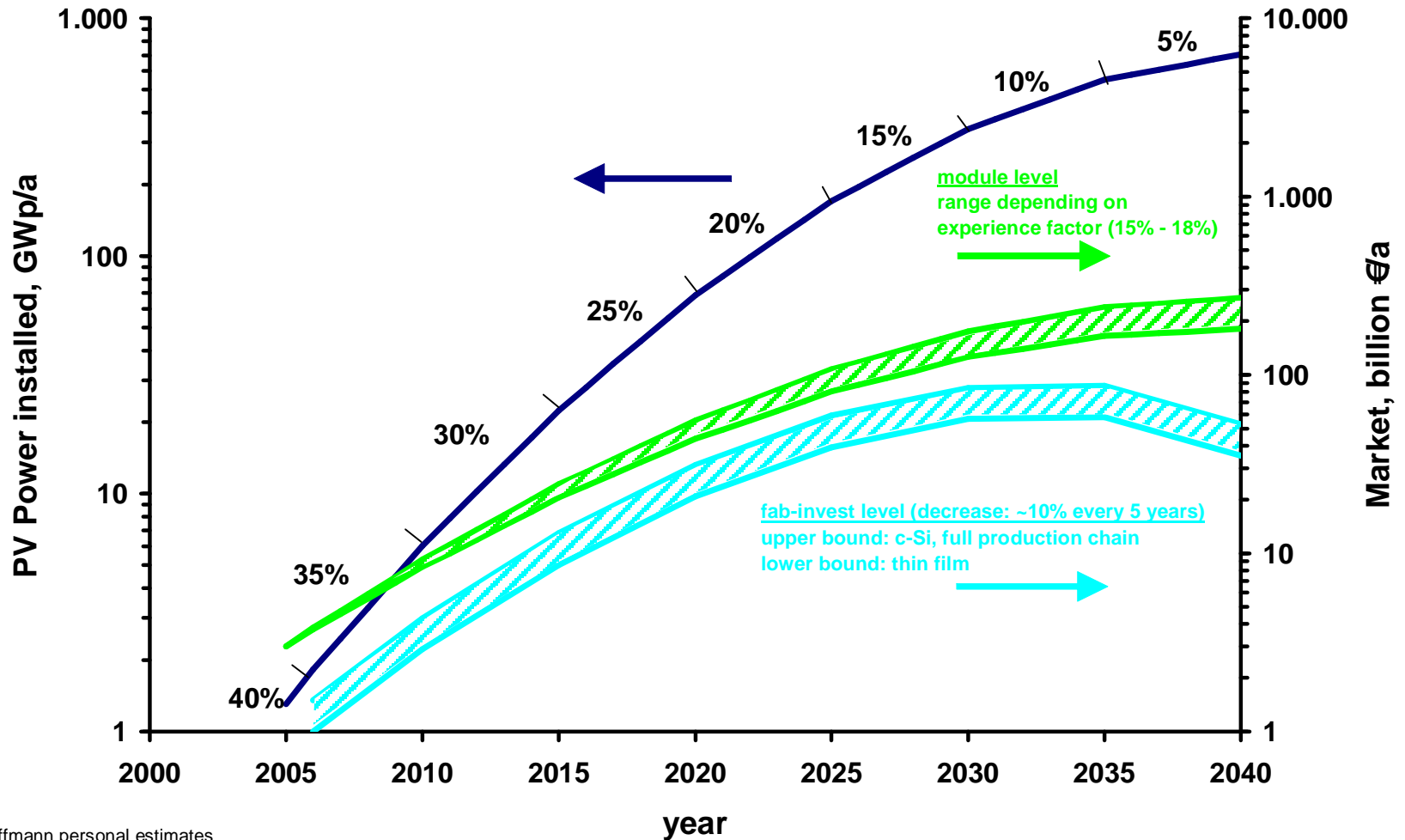


Source: German Advisory Council on Global Change, 2003, www.wbgu.de

Yearly installed market size in MW



Future Growth of the Global PV Solar Electricity Market in GWp and bn€ turnover

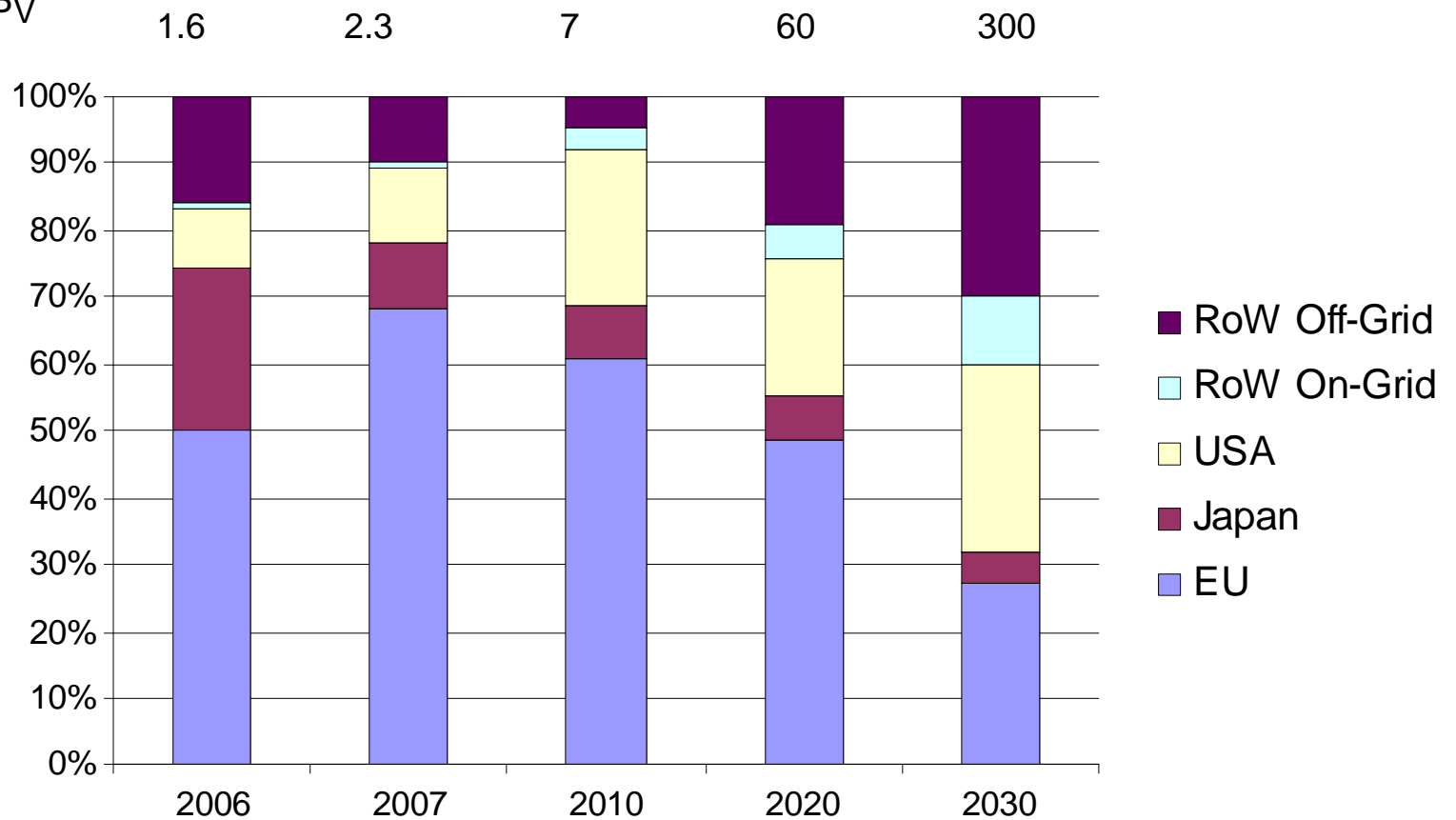


ref: W. Hoffmann personal estimates



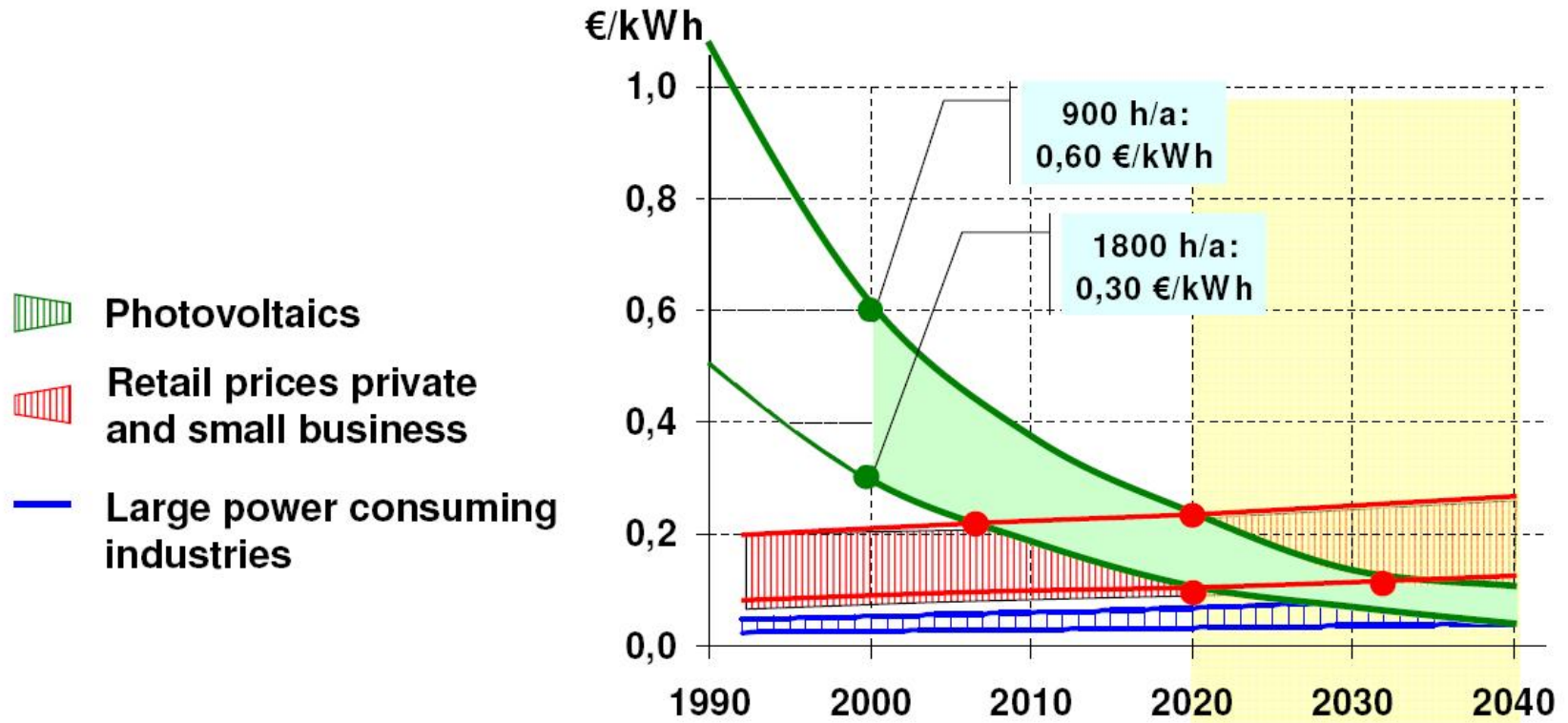
Development of the Various Market Segments (relative)

Yearly installed PV power (GWp)



Ref: W. Hoffmann, personal estimates

Grid Parity

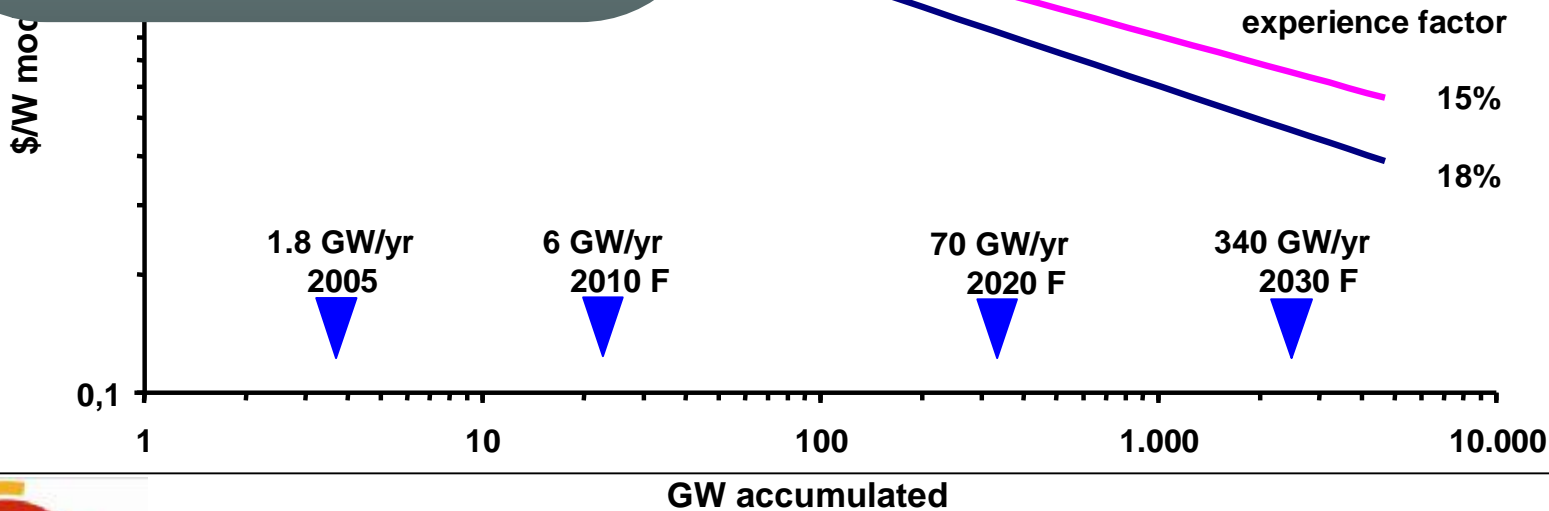
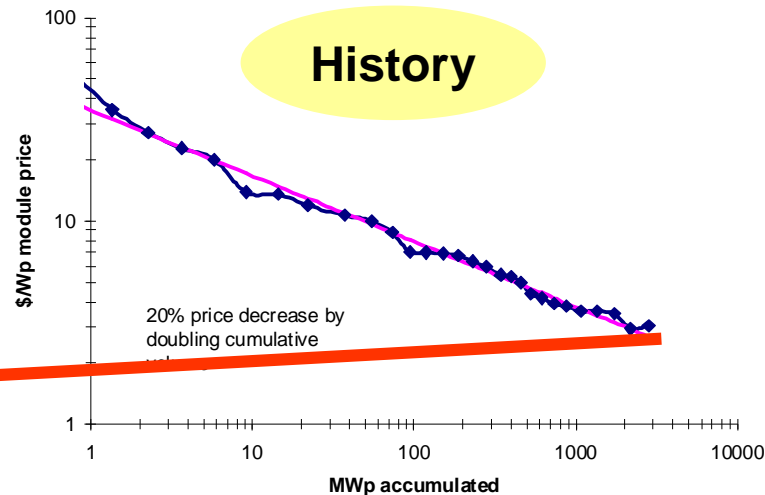
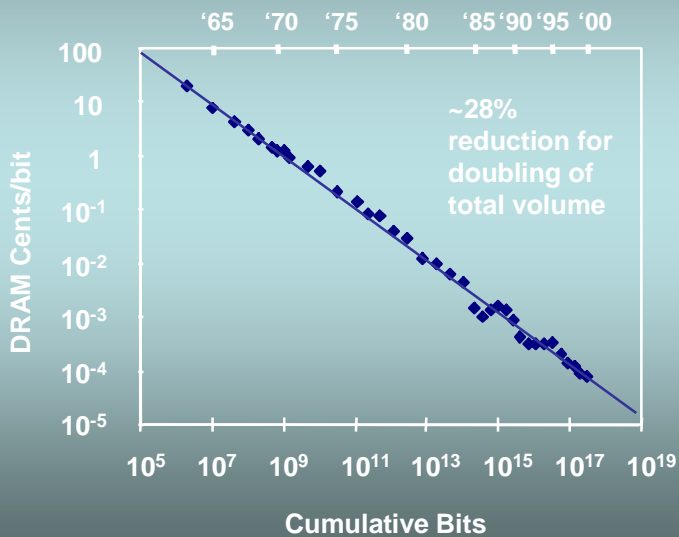


market support programs necessary:



Ref: W. Hoffmann, personal estimates, 1999

VLSI/DRAM



PV electricity cost

Electricity generating cost [€ct/kWh] Eurelectric / VGB Power Tech	Today 2005	Tomorrow 2030	Day after tomorrow 2050
Fossile (coal, gas)	4 - 4.5	6-7	6.5 - 9
Nuclear (PWR, HTR, FBR)	4 - 6	3.5 - 7	3.5 - 6
PV solar electricity (south/north)	20/40	5/10	3/6
+ Energy Storage	20/30	6/20	3/10

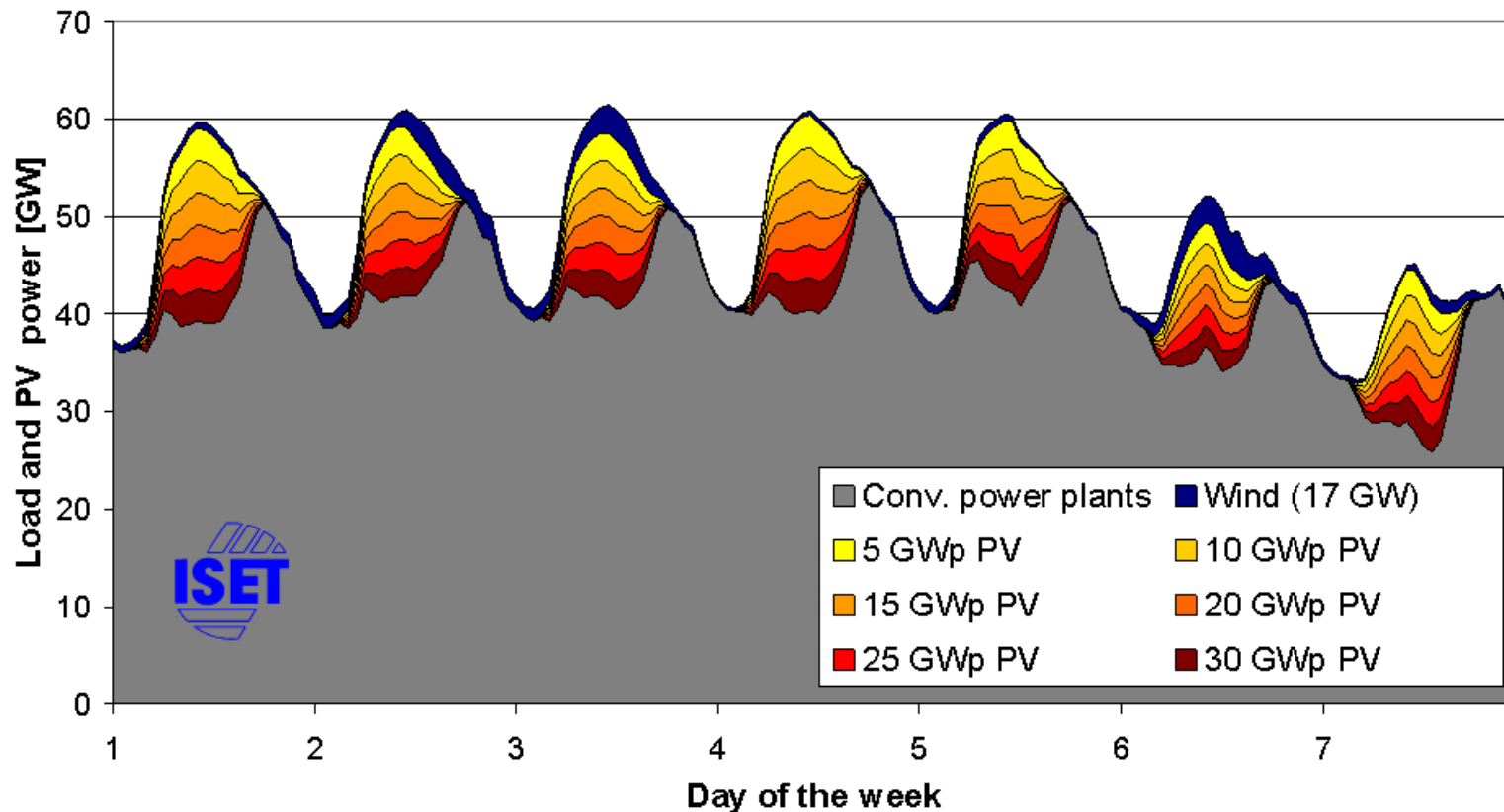
ref: EURELECTRIC and W. Hoffmann personal estimates



= own estimates

Impact of high levels of PV integration in Germany

Week of maximal PV generation (Week 26, Year 2005)



Source: ISET, 23. Symposium PV Solarenergie, Bad Staffelstein, March 5th 2008



Stretching the Sun

With Energy Storage

**Ray Kubis, President EUROBAT
President EnerSys Europe**

EUROBAT



Who is Eurobat?

- **EUROBAT represents the interests of the leading industrial battery manufacturers, providing expert information to consumers, political decision-makers, and the media**
- **Have worked for more than 20 years with European Commission, Parliament and Council on developing workable battery legislation such as REACH and RoHS**
- **EUROBAT structure**
 - **General Assembly of members** to shape the future of of the industry
 - **Board** of Eurobat is governed by 10 member representatives from the industry
 - **Committees:** Enviro (CEM); R&D (RTD); Automotive (ABC); Industrial (IBC)
 - **Permanent Secretariat in Brussels** run by highly qualified and dedicated staff



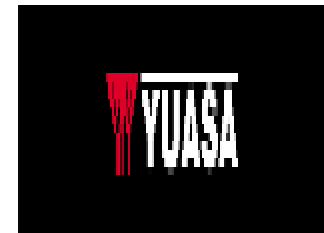
Eurobat Mission

To ensure that the ideal conditions are created for the responsible development of the automotive and industrial battery industry in Europe.

Acting in the common interests of all of its members Eurobat aims to sustain a competitive industry in an increasingly complex policy and legislative climate.



Eurobat Battery Company Members





PV and Energy Storage

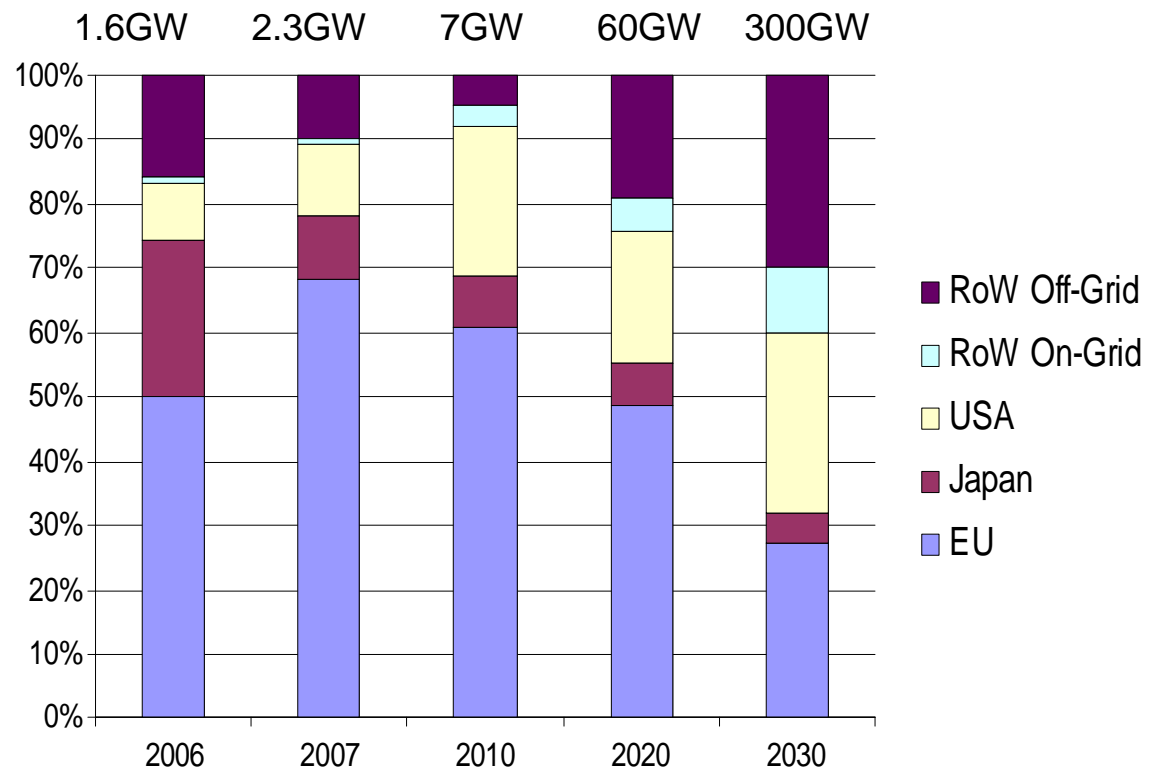
Purpose: Make PV energy available when it is needed (« dispatchable ») independent from time of production

- **Off grid:**
 - **Principle** - Energy Storage designed to provide hours, days or weeks of autonomy
 - **Challenge** - PV to become a reliable, sustainable alternative to grid electrification schemes in non-electrified areas.
- **On grid:**
 - **Principle** - Local storage of excess PV energy until it is needed
 - **Challenge** – Performance, efficiency and cost

On / Off Grid market evolution

- **Grid connected solar power**
 - Today mainly without storage
 - 1% on grid in 2010
 - 30% on grid 2030
- **Energy storage / batteries are generally included in Off Grid solutions:**
 - Industrial solutions are well established
 - Economically viable solutions are critical for the growth in Off-Grid demand

Yearly Installed PV Power





Market

A modest penetration of Energy Storage into PV will create a significant market

EPIA projections

high: « Policy Driven scenario »

low: « Pessimistic scenario »

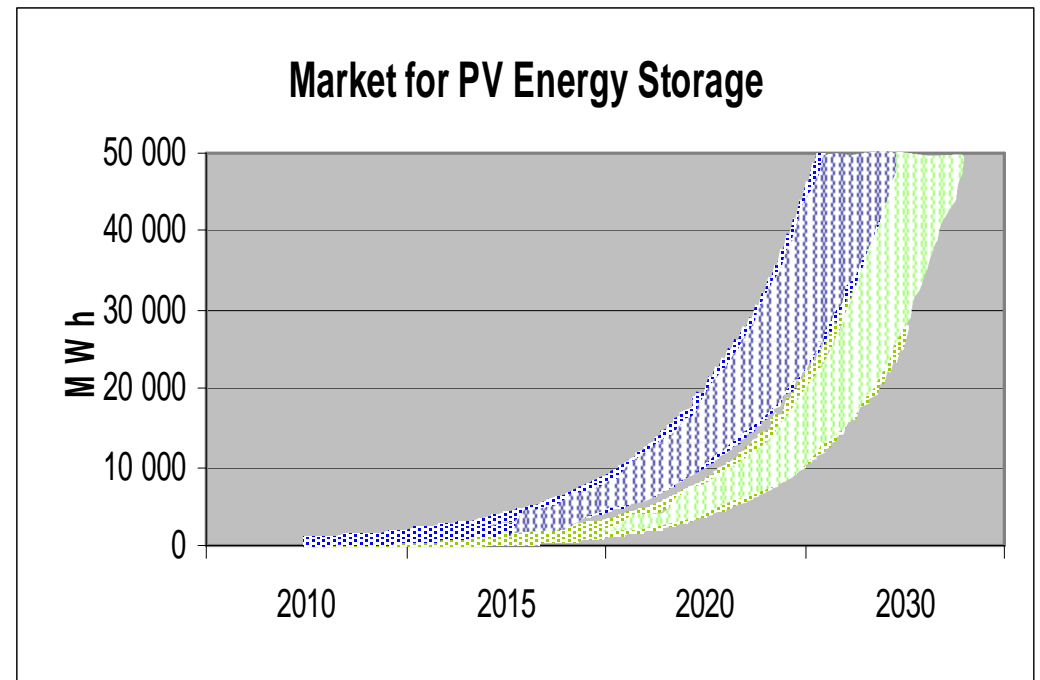
Market Split



On-grid 95% today

70% in 2030

Energy Storage

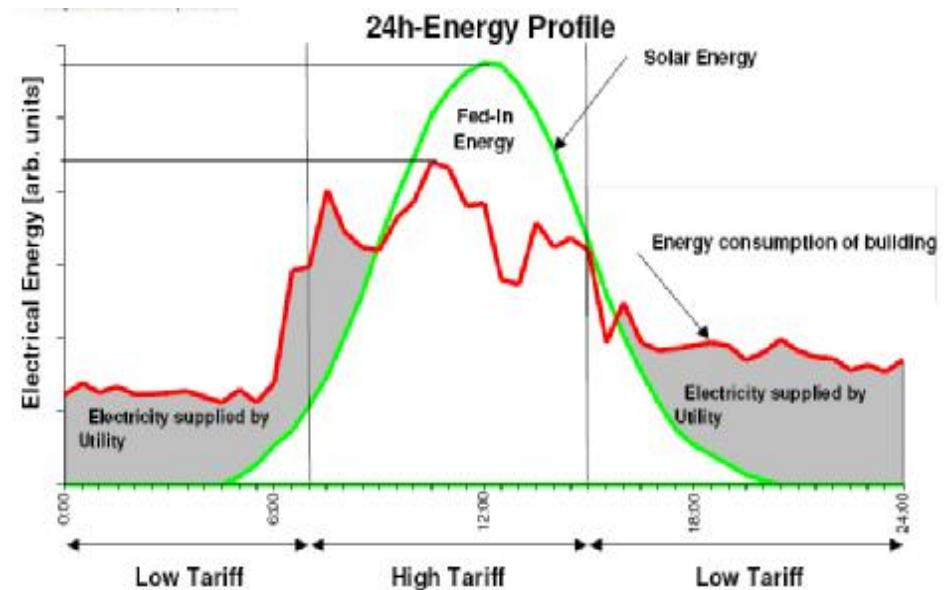
- **50% of off-grid systems**
- **1% of on-grid systems 2010**
- **30% of on-grid systems 2030**



-  Market Potential off-grid energy storage
-  Market Potential on-grid energy storage

Stretching the Sun

For grid connected, energy storage can stretch the sun's contribution to peak loads – extending the payoff of solar collectors – allowing for fewer peak power plants



On Grid Energy Storage

⊕

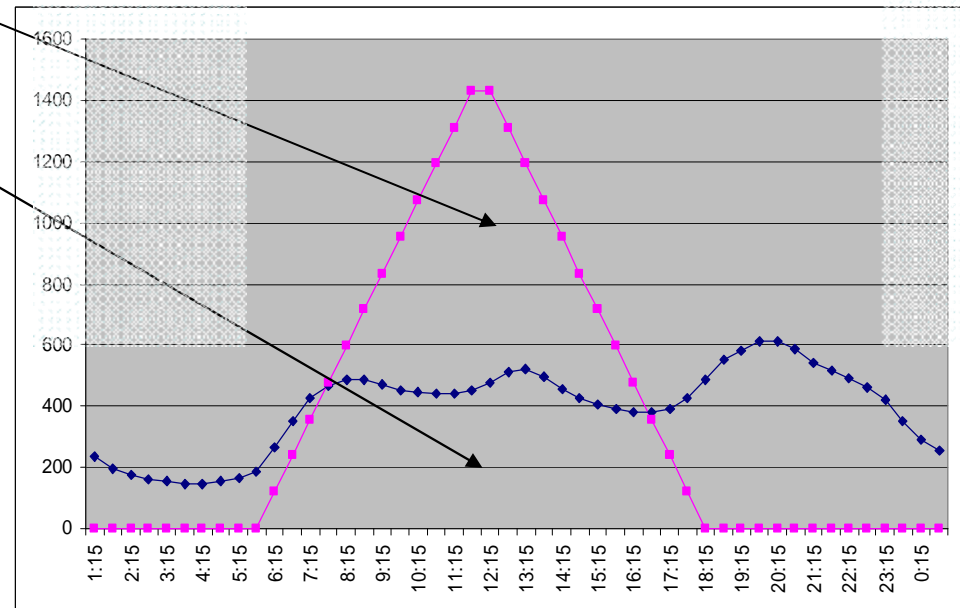
PV noon excess

•

PV direct use

1 + 2 = total PV generation

Household 24h consumption (blue)
PV production (pink)



Store « noon excess » until needed:

- In general evening peak around 7pm
- cover household local consumption in evening / night
- possibly inject surplus into grid when needed (upon demand)



All 3 major battery chemistries can contribute

Lithium based (Li)	Highest energy density, smaller, lighter
Nickel based (Ni)	Proven off-shore & harsh environments. Long life
Lead based (Pb)	Proven low cost, production and recycling



Conclusion

- **The industry can meet the challenge**
- **Suitable storage technologies exist**
- **System integration**
- **Global roadmap**
- **Cost of PV + Storage will be competitive**

A bright sun with a starburst effect is positioned in the upper left quadrant of a clear blue sky. Large, white, fluffy clouds are scattered across the lower half of the image, with a particularly large cloud on the right side. The overall scene is bright and positive.

Thank you