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Charakterisierung von Solar-Batterien durch Langzeituntersuchung nach IEC 61427

1. Internationale Konferenz zur Speicherung Erneuerbarer Energien

Characterisation of Solar-Batteries by longterm-tests according to IEC 61427

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Motivation:

Rural Electrification in Third World Countries by Systems basing on Renewable Energy Sources

- Basic Approach
  - Solarhome Systems
  - PV-Systems and or Hybridsystems in Micogrids
  - Hybridsystems in Minigrids

All concepts need storages!!

Today the only available storage
from the economical and technical point of view are
electrochemical batteries

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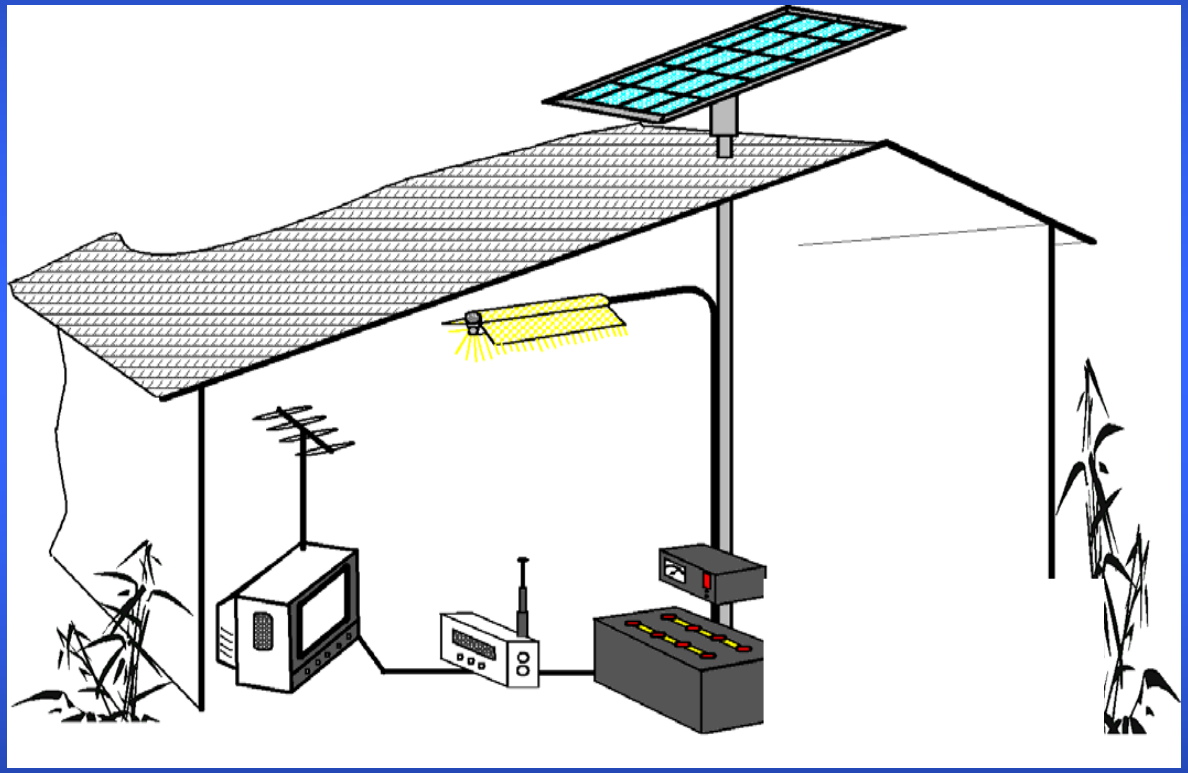
Definition of a Solar-Home-Systems



A Solar-Home has to full fill basic energy services or lighting and communication

A Solar-Home-Systeme consists of up to four PV Modules a battery and a charge regulator

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Where are SHS-Systems installed?

SHS in Indonesia

SHS in Bangladesh

SHS in Peru Titicaca-See

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Actual Situation:

- Two billion ($2 \cdot 10^9$) people without access to the grid
- Installed PV-Systems (grid independent) worldwide ? 1 to 2.2 GW[1)]
  - (Rough estimation 10% for SHS -> 2 to 5 million households)
- Main Obstacles:
  - Financing
  - Information
  - Confidence in the Technology

1)=REN21 Seite 17

Example: Peru[2)]

- Project surveyed by CER-UNI on Taquile and Amantaní islands

Total Number of Systems		425
	PV-Modul	Batteries
Failures after		
1 year	0,00%	0,70%
2 years	0,55%	8,30%
3 years	0,55%	17,60%
5 years	1,00%	65,00%

→ Need for (international Standards)

2) Mastertheses Stalin Ruiz ITT FH-Köln

Who is responsible for Standards ?

IEC
Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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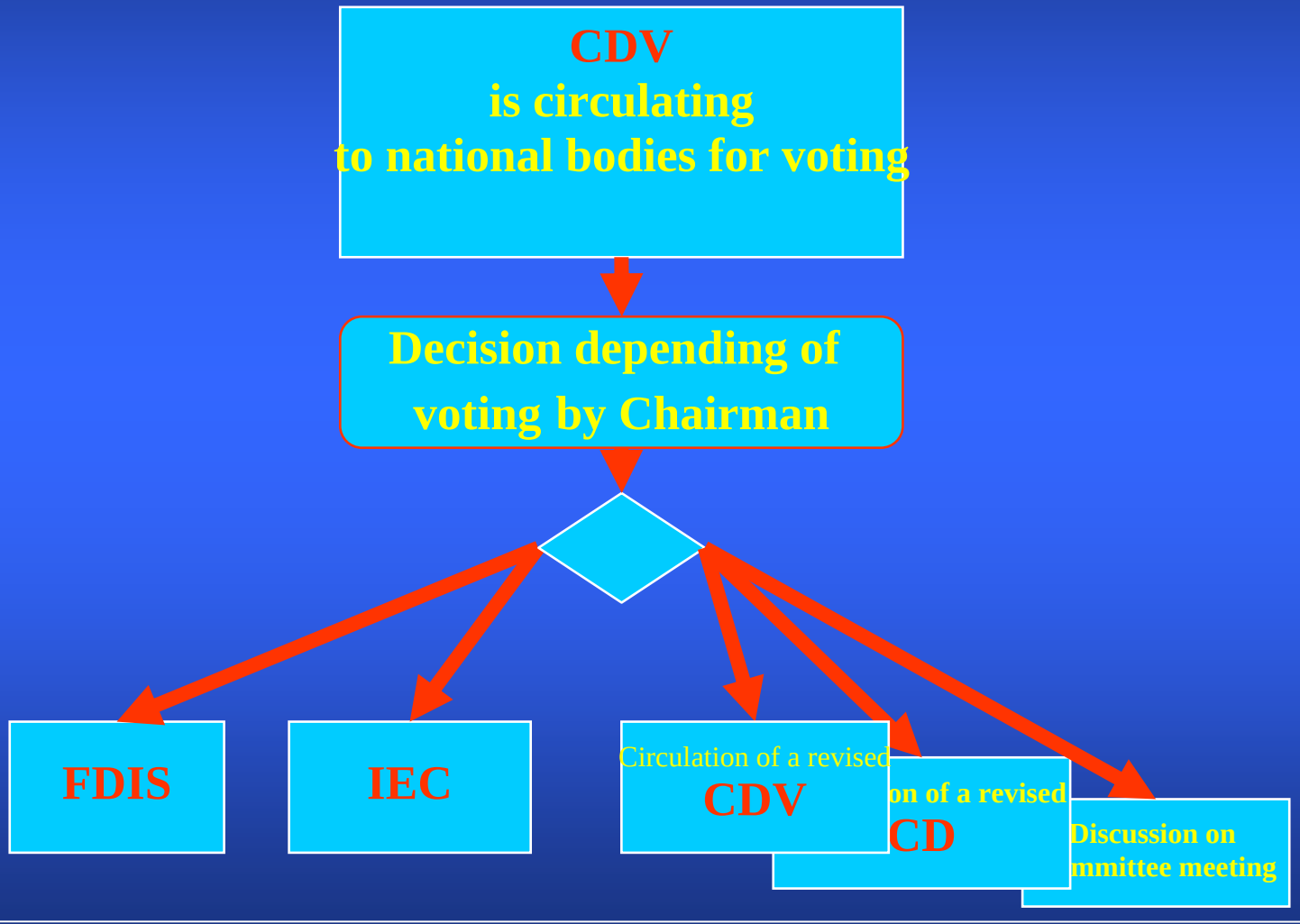
The drafting of Standards for Solar Batteries by IEC

- By whom
  - TC 21 supported by TC82 (responsible for PV-Systems in the case of Solar-Batteries
- Final decision by voting by National Committees

- Memberlist of TC 21

Participants (right for voting)			
INDIA	(IN)	DENMARK	(DK)
BELGIUM	(BE)	GREECE	(GR)
CANADA	(CA)	IRAN	(IR)
SWEDEN	(SE)	IRELAND	(IE)
POLAND	(PL)	HUNGARY	(HU)
GERMANY	(DE)	SLOVENIA	(SI)
LUXEMBOI	(LU)	SERBIA	(RS)
SWITZERLA	(CH)	SINGAPOR	(SG)
SOUTH AF	(ZA)	UKRAINE	(UA)
SPAIN	(ES)	MEXICO	(MX)
CHINA	(CN)	NETHERLA	(NL)
ROMANIA	(RO)	MALAYSIA	(MY)
FINLAND	(FI)	INDONESI	(ID)
RUSSIAN F	(RU)	BULGARIA	(BG)
FRANCE	(FR)	NORWAY	(NO)
CZECH REI	(CZ)		

How to produce Standards ?



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Result: IEC 61427 developed by IEC/TC21

Title:

SECONDARY CELLS AND BATTERIES FOR SOLAR PHOTOVOLTAIC ENERGY SYSTEMS – GENERAL REQUIREMENTS AND METHODS OF TEST

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Definition of Solar-Batteries by IEC 61427

- Operation Conditions
  - Daily Charging Cycle
    - Charging during the day
    - Discharging during the night
    - (Typical from 2 up to 20%related to nominal Capacity)
  - Seasonal Cycle
    - Periods with low radiation
    - Discharging down to 20% of nominal capacity
    - Periods of high radiation: Battery fully charged. Danger for Overcharging

Definition of Solar-Batteries by IEC 61427

- **Basic Operation Conditions**
  - Supply without Solar Radiation
    - From 3 up to 15 days
  - Typical charging current
    - Maximal charging current I_{20}
    - Average charging current I_{50}
  - Typical discharging current
    - Average Discharging current I_{120}

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Definition of Operation Conditions for Solar-Batteries by IEC 61427

Definition of charge and discharge currents in basic operation

	Lead Acid	Nickel Cadmium
Charge current generated by the PV generator		
Maximum charge current	$I_{20} = C_{20}/20$ (h)	$I_{20} = I_t/20$
Average charge current	$I_{50} = C_{50}/50$ (h)	$I_{50} = I_t/50$
Discharge current determined by the load		
Average discharge current	$I_{120} = C_{120}/120$ (h)	$I_{120} = I_t/120$

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Requirements for Solar-Batteries according to IEC 61427

- Mechanical endurance
- Charge-Discharge Efficiency

State of charge (SOC)	Efficiency lead-acid cells	Efficiency nickel-cadmium cells
90,00%	>85 %	>80 %
75,00%	>90 %	>90 %
<50 %	>95 %	>95 %

- Tiefentladespannung wird vom Hersteller angegeben

Testprocedures of IEC 61427 derived from operation conditions

- Capacity-Test
  - Accordant to IEC 60896 for lead acid batteries
- Permanent-Cycle Test
  - accordant IEC 60896 for lead acid batteries
- Permanent-Cycle Test for solar-applications
  - **Transformation of the operation conditions describes above**
    - Phase A – Shallow cycling at low state of charge
      - Volle Aufladung nach Angaben des Herstellers
    - Phase B – Shallow cycling at high state of charge

Phase A – shallow cycling at low state of charge

	Entladezeit [h]	Ladezeit [h]	Blei-Säure Batterien [A]	Nickel-Cadmium Batterien [A]
a)	9		I_{10}	$I_t/10$
			.or stopping at 1,75 V/cell	.or stopping at 1,00 V/cell
b)		3	$1{,}03 \cdot I_{10}$	$1{,}03 \cdot I_t/10$
c)	3		I_{10}	$I_t/10$

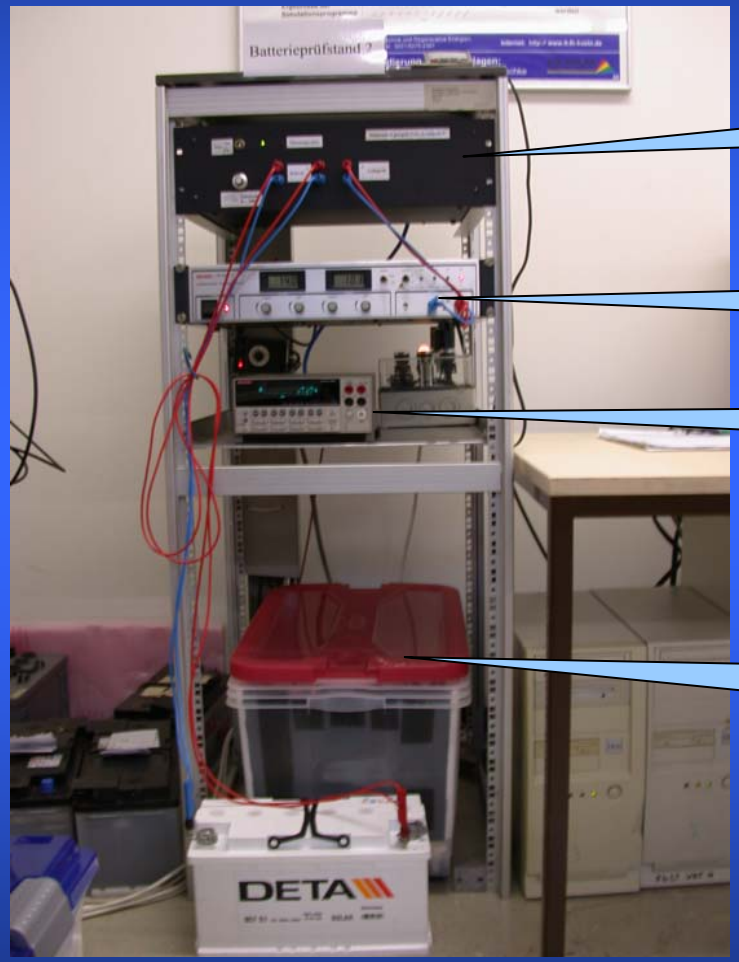
procedures b) and c) are repeated for 49 times

Phase B – Shallow cycling at high state of charge

	Entladezeit [h]	Ladezeit [h]	Blei-Säure Batterien [A]	Nickel-Cadmium Batterien [A]
a)	2		$1{,}25 \cdot I_{10}$	$1{,}25 \cdot I_t/10$
b)		6	I_{10}	$I_t/10$
			Bis max 2,4V/Zelle oder nach Hersteller	Bis max 1,55V/Zelle oder nach Hersteller

operations a) and b) are repeated 99 times

Batterieteststand



- Elektronische Last
- Konstantstromquelle
- Datenerfassung
- Thermostatisiertes Wasserbad

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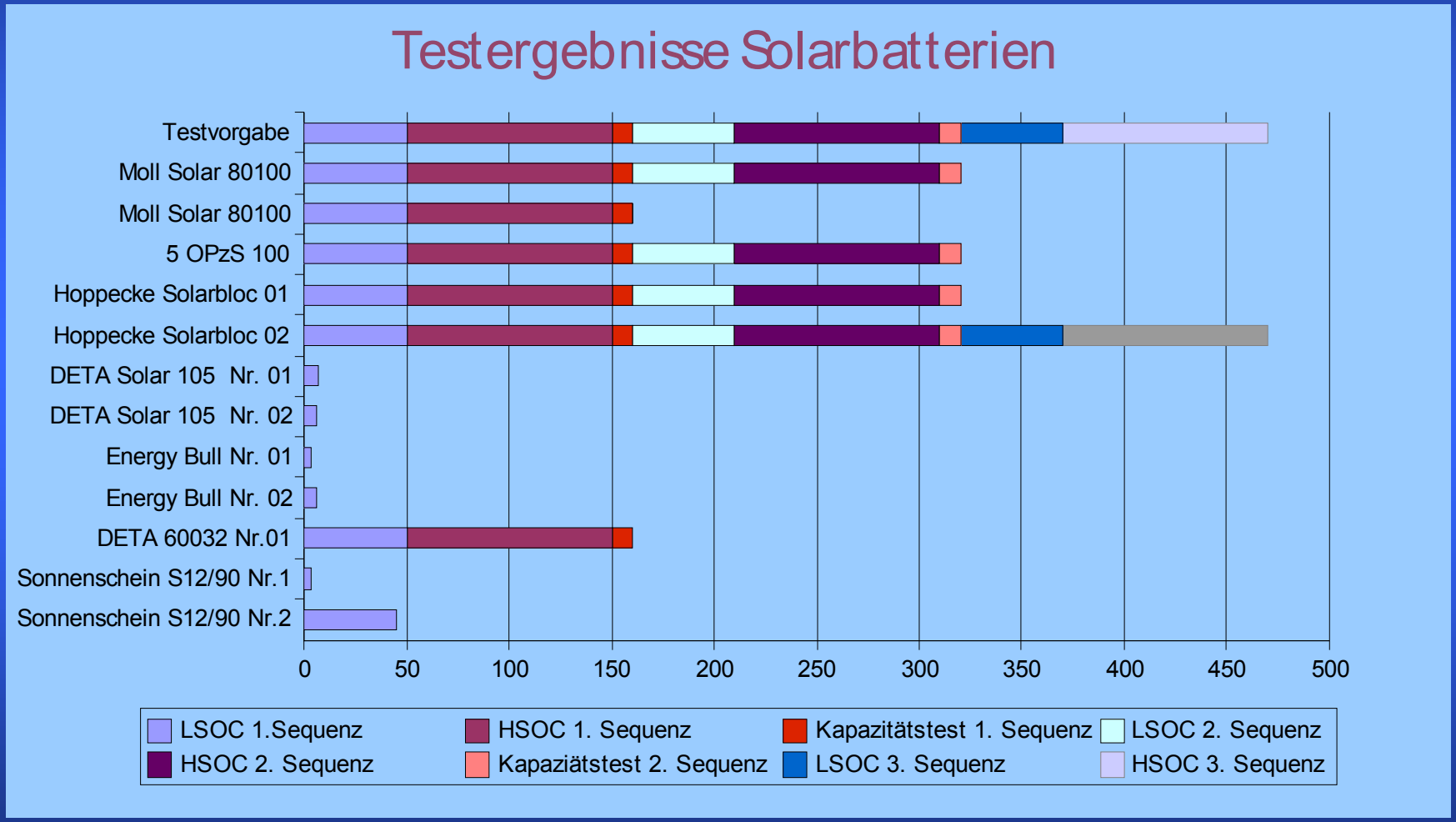
Previous Test-Results



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Results concerning Solar Batteriesn

- There are significant differences in qualities of Solar Batteries
- Obviously there is a progress in the development for special Solar Batteries
- Recommendations
- Batteries, for solar applications should be qualified according to IEC 61427
- The manufactures have to improve there data-sheets and there manuals.

Results regarding Teststandard

- With IEC61427 is a usable Teststandard for Solar Batteries
- Weak points:
  - There no clear relationship to the expected lifetime
  - There are discrepancies between the defined operation conditions and the test requirements
  - The Test is time-consuming
- Strong points
  - The Test enables to separate Batteries regarding to probable appropriateness for solar home systems

Open questions concerning the standard IEC 61427

- At present there is no definite pass fail criteria für Solar Cycle Test
- Testparameters are not in line with definition for operational conditions (e.g. I_{10} instead of I_{20})
- Conditions for complete loading
- Nebulous information by manufactures

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Solar Energy Association NRW www.ag-solar.de

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NRW.