Sharp Energy Solutions

AIRWAVE



Energy Creation



Energy Storage



Energy Management



Energy Services

SHARP

Be Original.

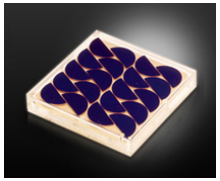
Sharp Corporation

- **Global electronics company**
- **More than 100 years of history**
- **41,898 employees worldwide**
- **18,390 bn U.S. $ net sales***
- **Strategic investment in Sharp by Foxconn in 2016**
- **Successful realignment: Sharp is profitable**
- **Risk diversification through various business segments**
- **Bloomberg Tier 1 Bankability**



*Annual report March 2017: 2050,6390 bn Yen net sales

Over 55 years of PV expertise



1959
Development of
solar cells begins



1970
Start producing
space-use PV cells



1976
First calculators with
solar cell batteries released



1980
Development of amorphous
thin-film technology



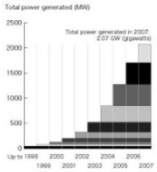
1992
Development of polycrystalline
and monocrystalline silicon cells



2000
Worldwide leading
manufacturer of solar
cells/modules



2005
Development of solar cells
that admit light



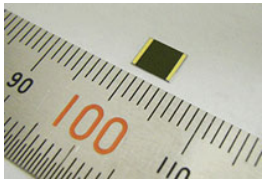
2008
First in the world with cumulative
production of 2GW



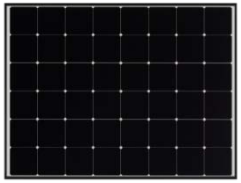
2010
International IEEE
Milestone Award



2011
Start of operation of one of
the largest solar power plants
(73MW)



2013
Development of a solar cell
with the world's highest
efficiency of 44,4%



2017
Launch of the innovative
Back Contact Technology
in EMEA

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Renewable energy

Global Outlook

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Bloomberg –New Energy Outlook 2017

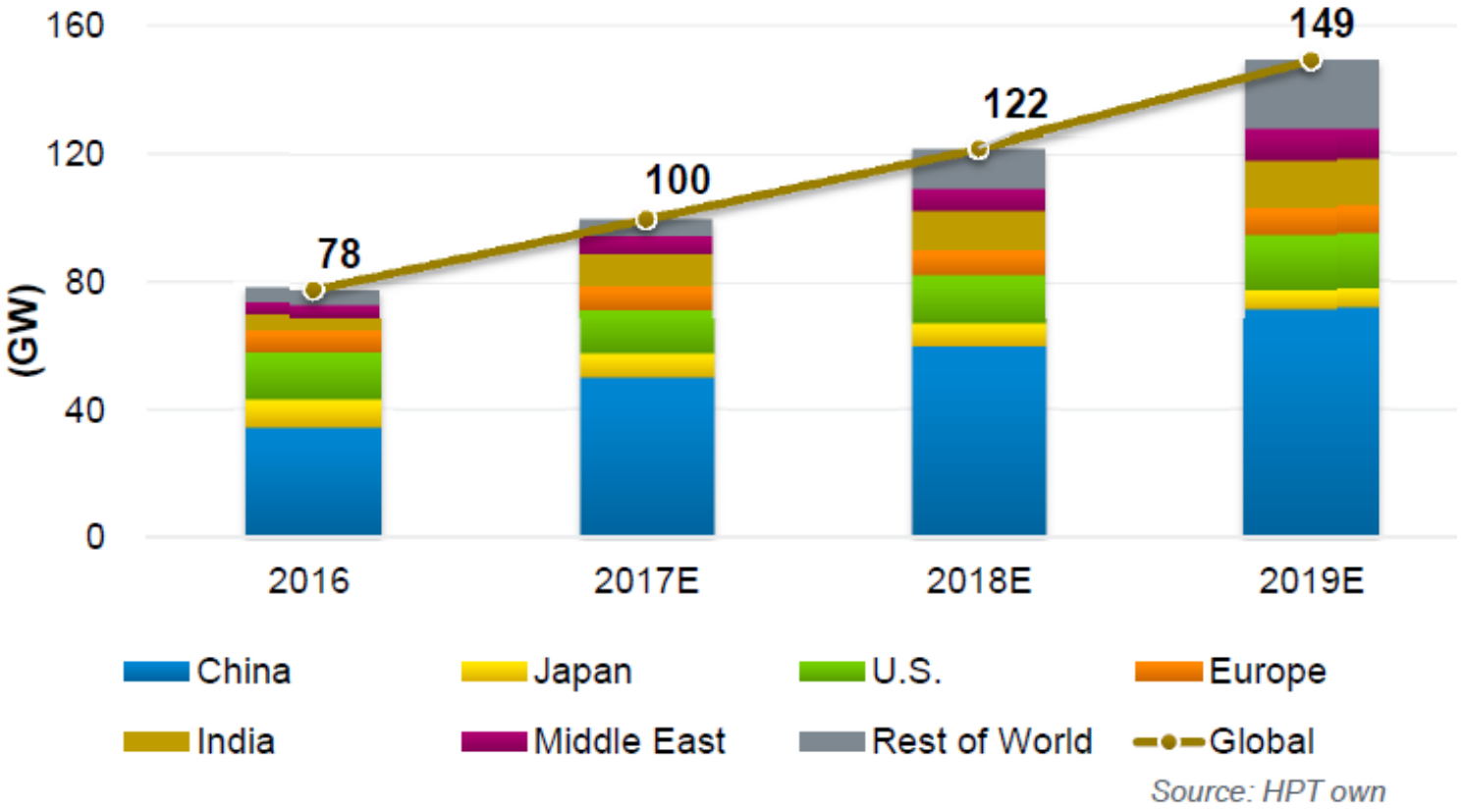
Until 2040 :

- Global Power demand grows by **58%**
- $10,2 Trillion to be invested into new power (72% RE) (EU $1 Trillion)
- PV and Wind accounts for 48% installed capacity and 34% electricity gen.
- Li Ion battery market: $20 billion
- 103GW of new flexible capacity, 53GW in batteries
- **Installed capacity in MENA moves from 93% fossils to 52% zero Carbon**
- Global Power Sector Emission Peak in 2026 with14 Gt, then decline1% / yr

Although the sector reach a peak in a decade, the rate of decline is not nearly enough for the climate! A further$5,3 Trillion investment in 3,9 TW zero Carbon capacity is needed to stay below the 2 deg C trajectory!

https://about.bnef.com/new-energy-outlook/#toc-download <June 2017, Bloomberg NEF>

Sunny scenario - Global PV Installation Forecast 2016-2019E



Source: HPT own

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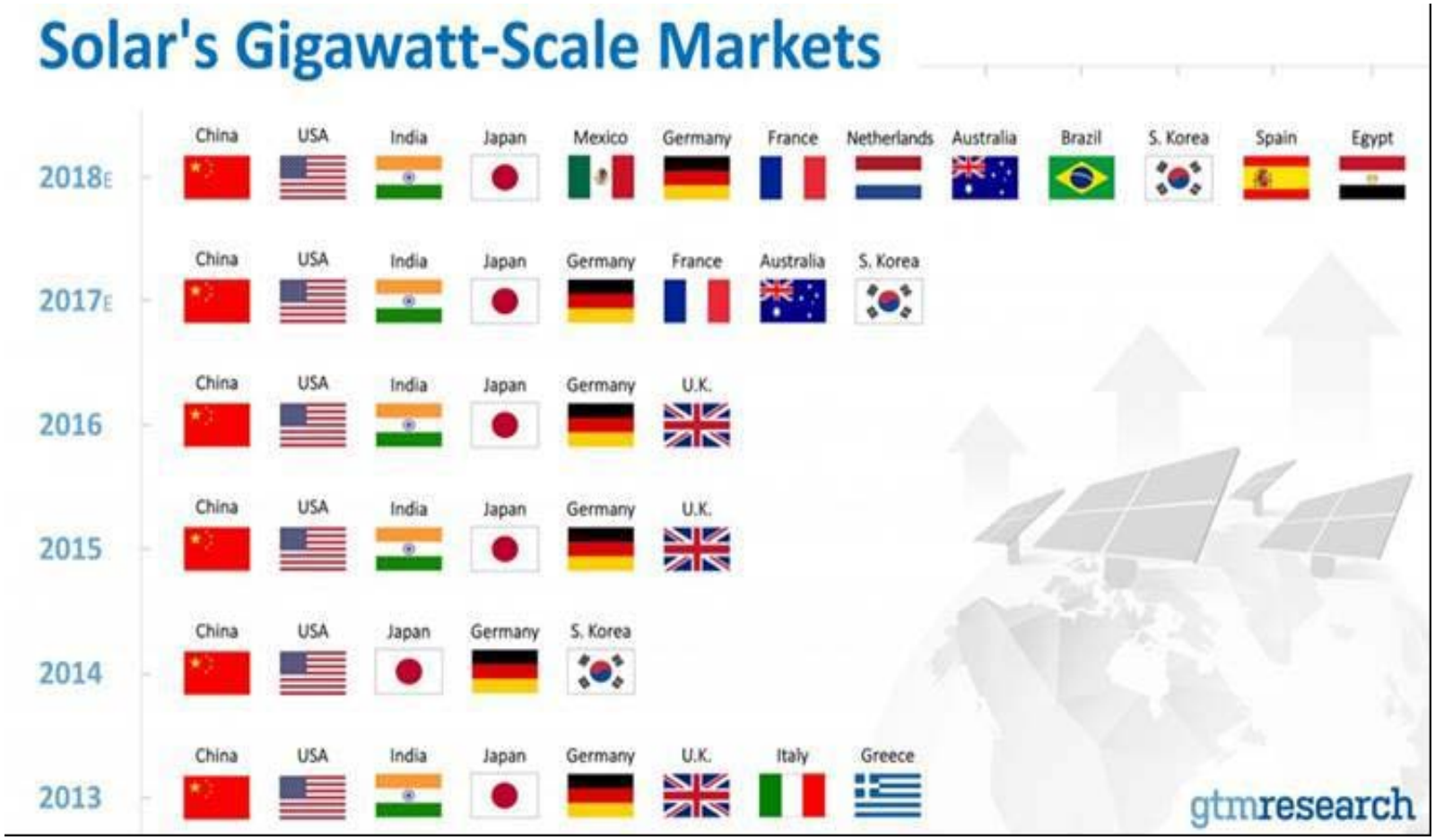
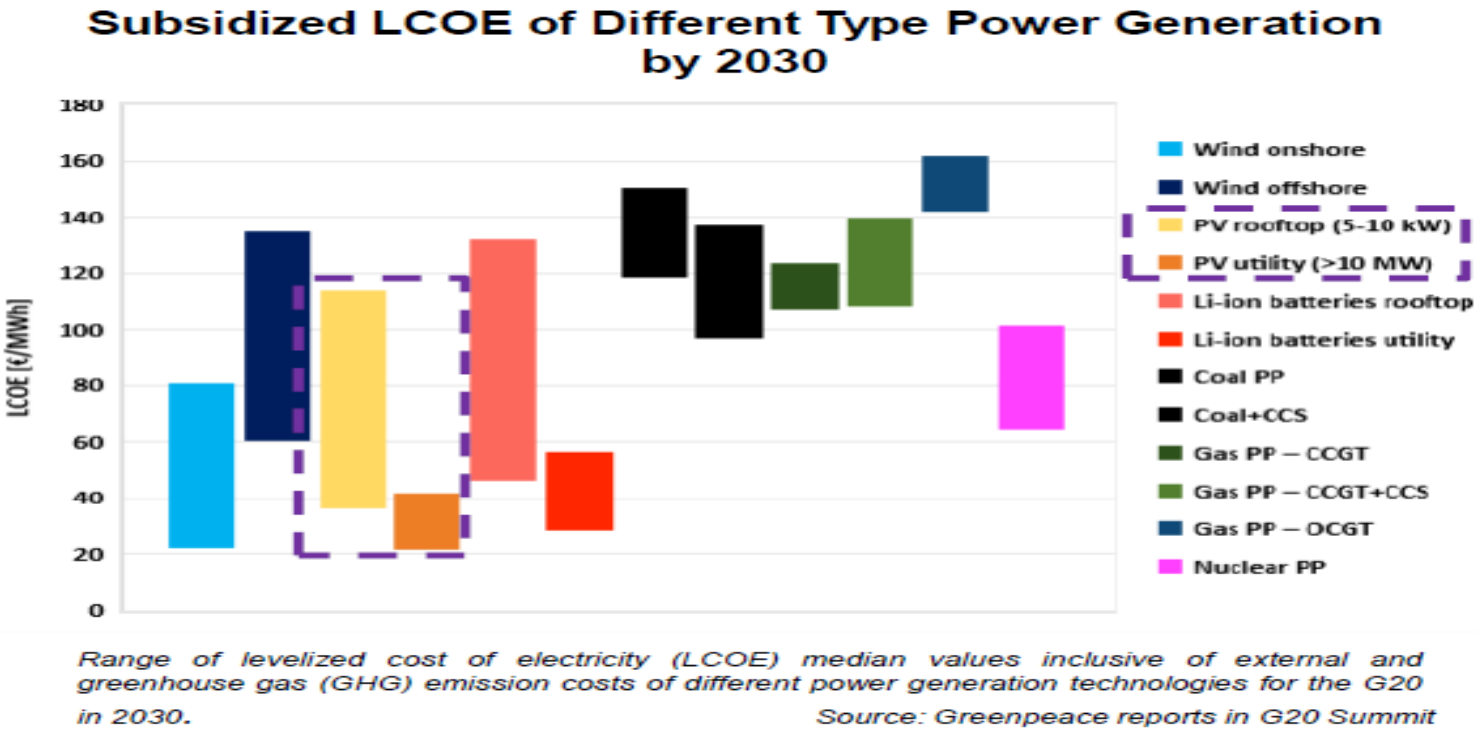
Solar's Gigawatt-Scale Markets



Levelised Cost of Electricity in 2030

Trend of LCOE



Range of levelized cost of electricity (LCOE) median values inclusive of external and greenhouse gas (GHG) emission costs of different power generation technologies for the G20 in 2030.

Source: Greenpeace reports in G20 Summit

Global PV installed capacity:
2016 : 308 GW
2017 : 405 GW

In 2030 the PV has the lowest LCOE !

PV is on track to become the cheapest way of generating power

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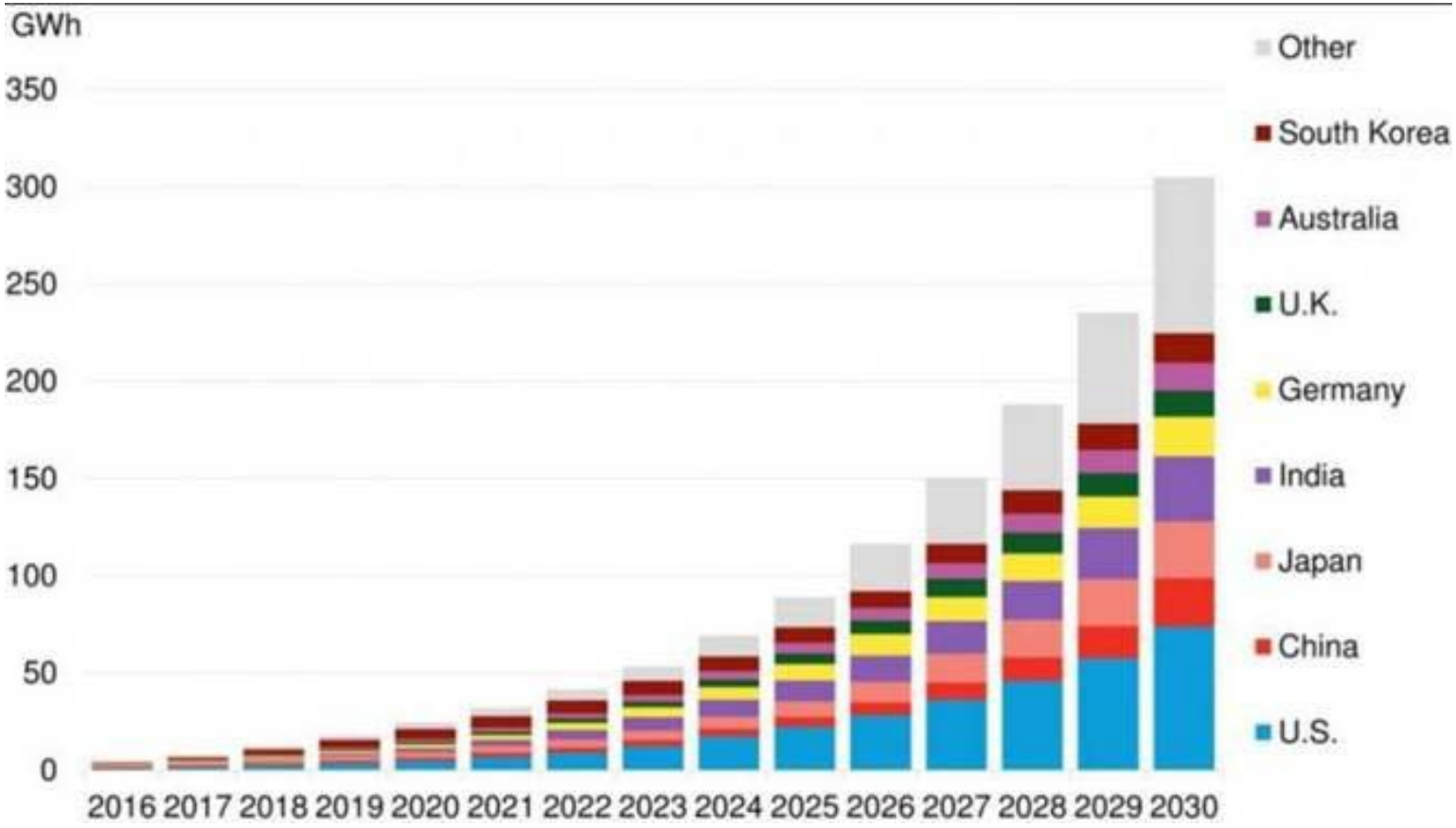
The global Storage (el. batt.) market



source : Bloomberg

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Highly efficient solar modules

Over 55 years of expertise



Energy Creation

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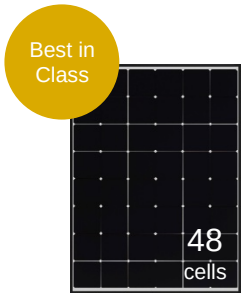
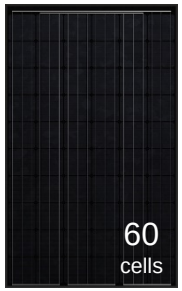
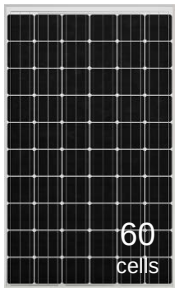
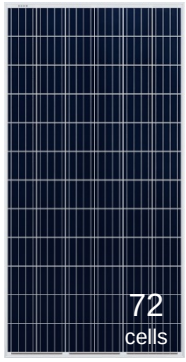
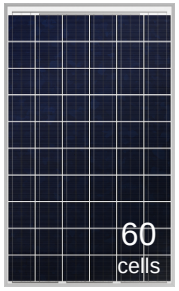
Large module range

For all kind of applications

	Monocrystalline				Polycrystalline	
						
	The innovative solution	The design solution	The high performer	The project solution	The reliable solution	The project solution*
Type	NQR256A	NU-RD300	NU-RC300	NU-SC360	ND-RB275 ND-RB270 ND-RJ270	ND-AH330 ND-AH325
Modul efficiency	19.8%	18.3%	18.3%	18.5%	16.8%	17.0%
Made in	Japan	Germany	Germany	Thailand	Germany (NDRJ) Thailand (NDRB)	China (* Outside EU only)

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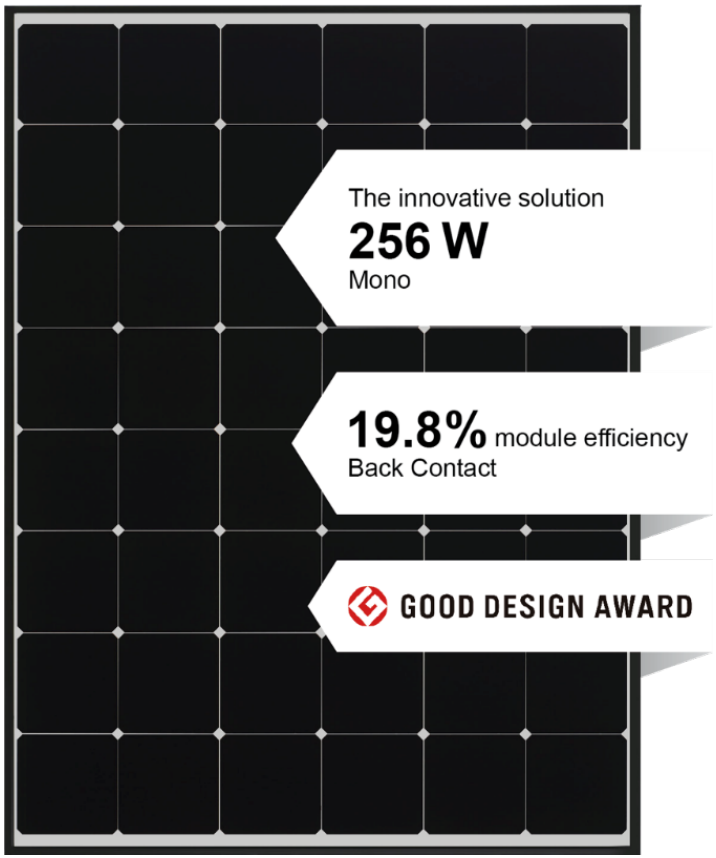
The most efficient 48-cell module

NQR256A



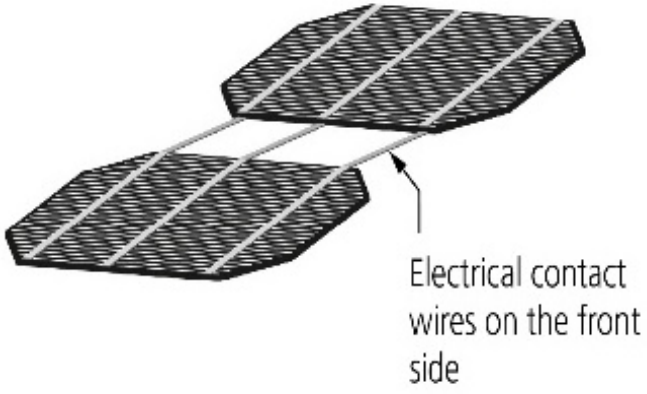
- Compact size for easy handling
- Portrait or landscape mounting
- Effective roof area utilisation
- Advanced technology developed by Sharp
- Back side connectivity for maximum performance
- Perfect Off-Grid-Solution

The most efficient 48-cell module

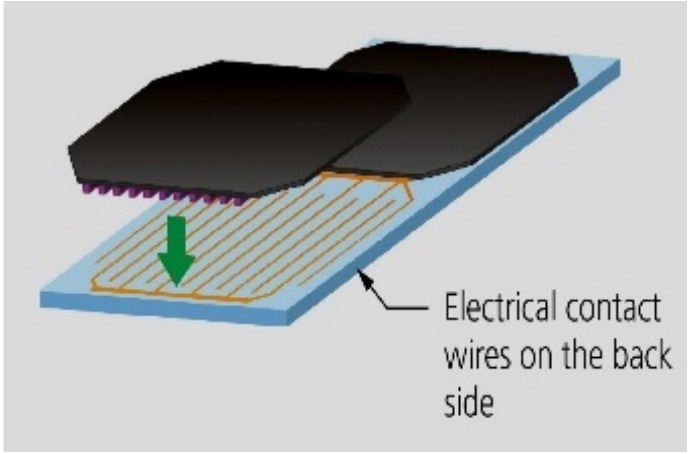
TECHNOLOGY

The most efficient 48-cell module

NQR256A



Standard Technology



Back Contact Technology

Standard Efficiency

- Front side contacts decrease the power generating area
- Bus bars cover the front side of the cell
- Front bus bars reflect sunlight, typical module **loses about 6%** of received light

Highest Efficiency

- Back side contacts increase the power generating area
- Bus bars don't cover the front side of the cell
- Antireflection coating for min. reflections
- Reduction of sunlight loss by **50%**

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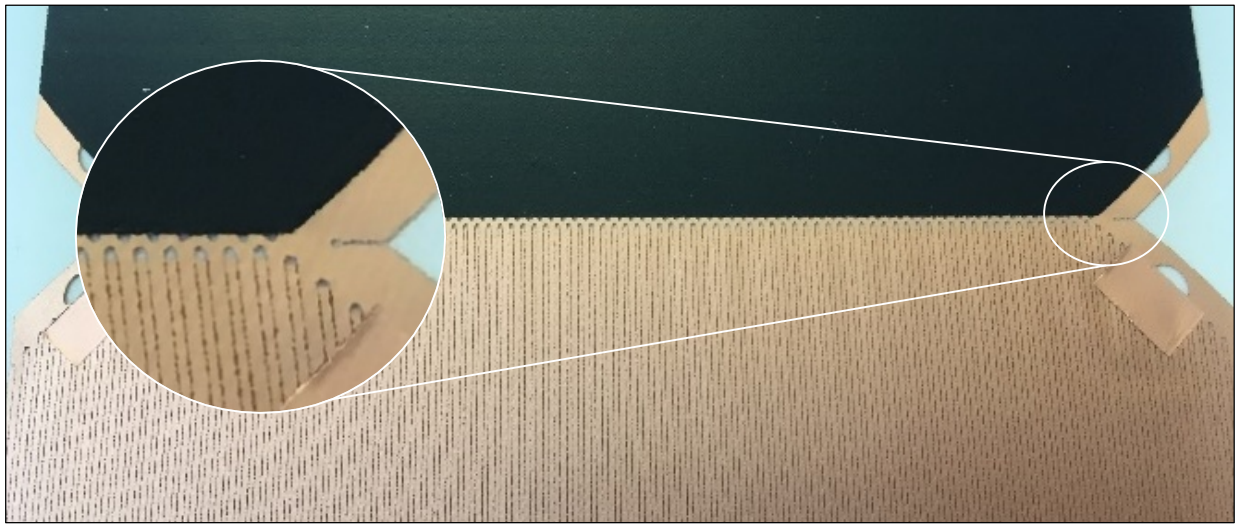
The most efficient 48-cell module

NQR256A



Min. Conductor Resistance

Larger conductor cross-section of the back conductor reduces power losses within the module.

By using the entire back surface, which we call **the wiring sheet method**, we were able to reduce the loss of electricity by about 3% during transmission.



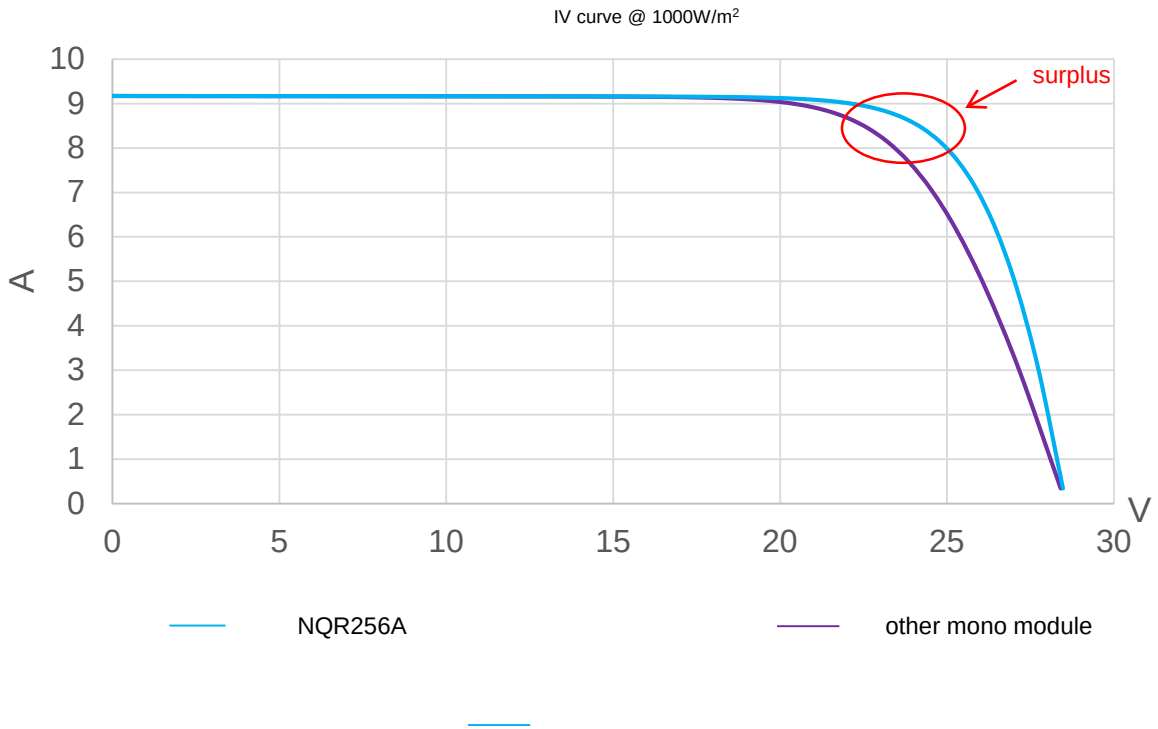
Cell based on copper foundation

The most efficient 48-cell module

NQR256A

Lower Internal Resistance

Improved internal resistance leads to more power and more total output.



The most efficient 48-cell module

NQR256A

Temperature coefficient

- ~ 10% ** better temperature coefficient
- Only -0.377% / ° C (Pmax)
- **Higher yields on hot days**

(** vs. 270W poly module ~ 0,42%/°C)

The most efficient 48-cell module

Best practise manufacturing technology creates highest quality

Fully Automatic Production

Produces an high efficient, robust module for the highest requirements.
Highest precision by automation and an innovative manufacturing process.



Back Contacts

Cell contacting at the highest quality level through proprietary Sharp procedures.

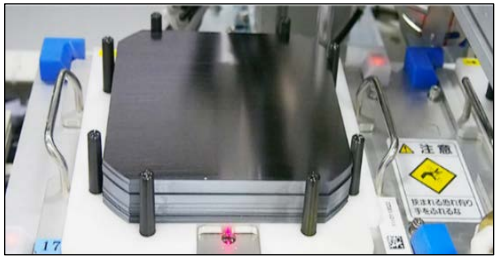
No Soldering in the Cell String

Solid copper back contact in between cells. Soldering omitted => defective soldering points etc. are omitted



Efficient Energy Flow

200 back contact lines for efficient energy flow. Inactive areas, such as in case of cell breakage in standard modules, can not occur.



Made in Japan

Production in Sharp main plant in Sakai.
http://www.sharp.co.jp/challenge_en/vol11/#solution



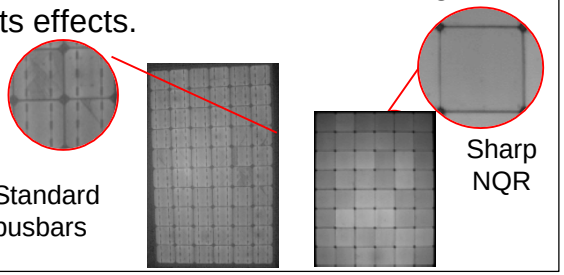
The most efficient 48-cell module

NQR256A

Convincing quality features

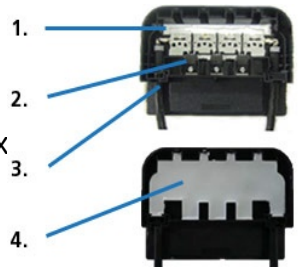
Reliable & Strong

Innovative manufacturing and stable construction reduces cell damage and its effects.



4x protected Connection Box

1. Contacts are soldered, not clamped
2. Diodes with additional heat sink
3. Connection cables are permanently connected to the socket
4. Connection box filled with resin



Hardest Testing

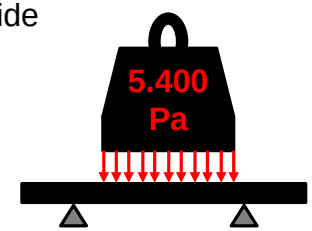
Strict Sharp test procedures QTSS (Quality Test Standard of Sharp).

Partly significantly more stringent than IEC. (International Electrotechnical Commission).

Tested Snow Load 5,400 Pa

The modules were tested according to IEC 61215 to a snow load of 5,400 Pa and are therefore also ideal for use in areas with higher snow loads.

In the many regions with heavy snowfall in Japan, the modules have often withstood the reality test outside the laboratory.





Long-Term Irradiation Test
Several 1000 hours of continuous testing simulate decades of operation



PID
Test under high voltages and extreme humidity (above IEC)



Wind&Load Change
Repeated pressure change simulates wind at storm range (not part of IEC testing)



Temperature and Humidity
Forced temperature and humidity change (above IEC)

The most efficient 48-cell module

NQR256A

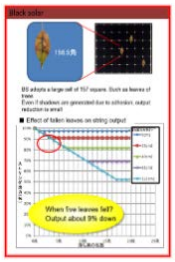
BENEFITS

The most efficient 48-cell module

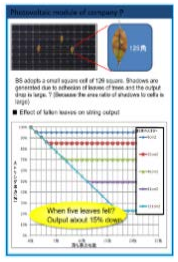
NQR256A

Cell Size Limits Shading Effects

Bigger cell size in comparison to other high-performance modules. Therefore, more output also at partial cell shading!



6 inch/15,65cm



5 inch/12,5cm

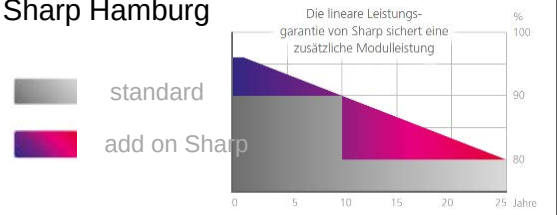
Positive Power Tolerance

- Only "plus-sorted" modules
- Up to 5% plus tolerance
- Module power from 256 W up to 269W

(depending on production output)

Guarantees

- 10 Years: Product guarantee
- 25 Years: Linear power output guarantee
- Guarantee provider in Germany: Sharp Hamburg



Impressive Appearance

- Looks perfect on every roof
- Black frame
- Antireflective surface
- Awarded with one of the most important design awards in Asia

GOOD DESIGN AWARD 2015

Most powerful module*

198 W / m² for maximum yields on each roof.

Highest spec. yield kWh / m²*.

*PV Sol premium (2017/R9): 48 cell modules June 8th 2017

Specification

Nominal power	**256 W**
Efficiency	**19,82 %**
No. of cells	**48**
Vmpp	**27,53 V**
Impp	**9,30 A**
Voc	**32,49 V**
Isc	**9,95 A**
Weight	**17 kg**
Dimensions	**1318 * 980 * 46 mm**

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The most efficient 48-cell module

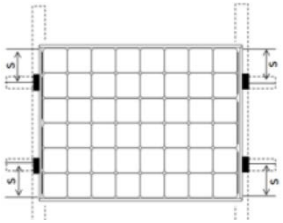
NQR256A

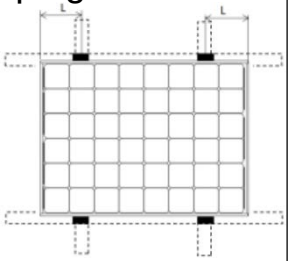
Flexible and easy installation – great handling

Save installation time. **Save costs.** **Stable and high value module.**

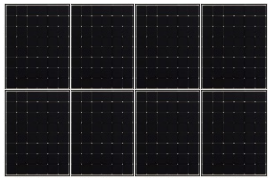
Flexible Installation

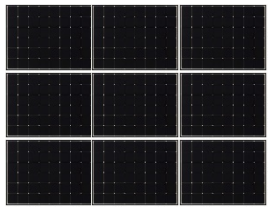
Long or short side clamping





Portrait or landscape





Cross rails or single rail layer





Advantages NQR256A

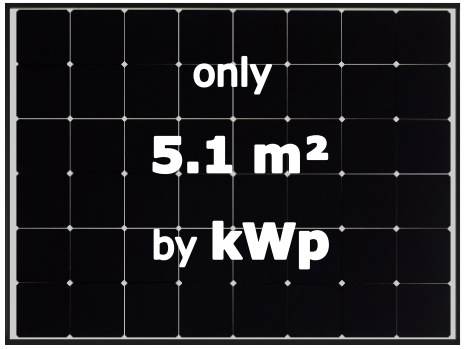
Covers any roof the best

= easy to handle

= robust

= flexible use

= easy to install



Super Handling at all Conditions

Only 17 kg (15% less than standard 60-cell module).

Easy and save installation. On the roof, resp. scaffolding or ladder, even at windy conditions.

= Less damages at installation

Robust & Stable

Resistant to damages

Cell based on Copper foundation



2 extra support bars



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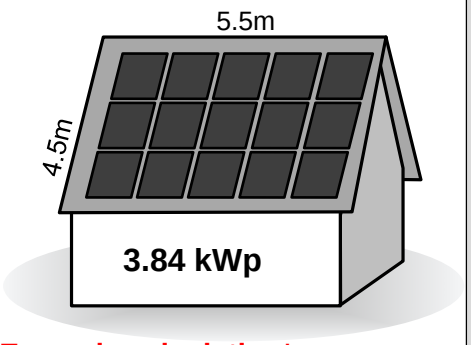
The most efficient 48-cell module

NQR256A

Comparison: Sharp NQR vs. 270W module vs. 245W high performance module

SHARP NQR256A



Example calculation*

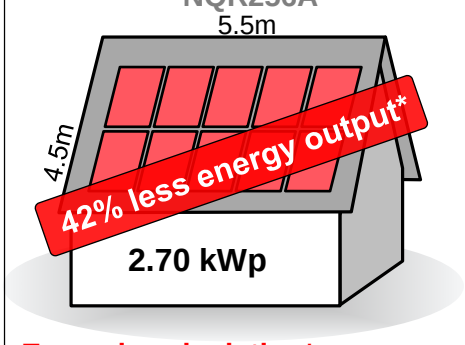
Annual yield (ttl.)	**4.332 kWh/a**
Annual yield / m²	**224 kWh**
Earnings	**13.253,- €**
Independency	**31%**

- \+ **Sharp quality**
- \+ **> 55 years experiences**
- \+ **Valuable guarantee**
- \+ **Strong company**

Advantages for plant operator

- \+ **Faster pay back**
- \+ **Happier customers**
  (Surplus income, increased output, increased revenue)
- \+ **Less material** by kwp**
- \+ **Quicker installation**
- \+ **Easy to handle**
- \+ **World record module**
  (48 cell module Oct. 2016)
- \+ **Great design**
- \+ **Sharp Team Europe**
  Service and support
- \+ **Quality: Made in Japan**

Standard Module 270 W vs. NQR256A

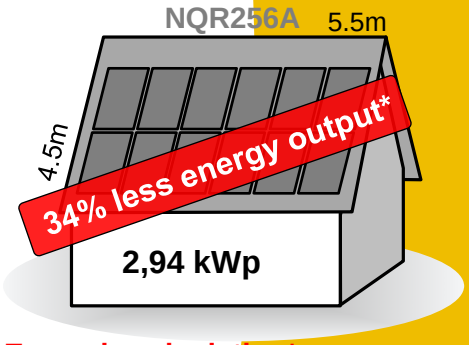


Example calculation*

Annual yield (ttl.)	**3,048 kWh/a**
Annual yield / m²	**186 kWh**
Earnings	**9,623,- €**
Independency	**28%**

- – 3,629€ less earnings (38%)
- – Losses by underperformance higher than system cost saving
- – Standard product

Manufacturer „P“ 245 W "high performance Module" vs. NQR256A



Example calculation*

Annual yield (ttl.)	**3,216 kWh/a**
Annual yield / m²	**213 kWh**
Earnings	**10,243,- €**
Independency	**29%**

- – 3,010€ less earnings (29%)
- – Higher system costs/kWp
- – Less roof space utilisation
- – Less power & production

* Same roof space 4,5m x 5,5m, Pvsol simulation Munich, consumption 3,500kWh/a, German feed in tariff 12.3ct/kWh, 25Y., average electr, price 30ct/kWh, independency: Quaschning, earnings from FIT & saving in 25Y. portrait installation. **Single rail layer parallel long side - short side clamping

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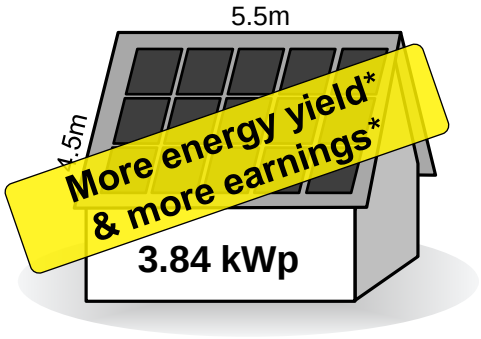
The most efficient 48-cell module

NQR256A

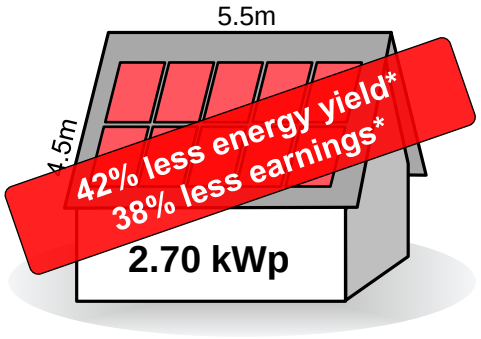
Comparison: Sharp NQR vs. 270 W module vs. 245W high performance module

SHARP NQR256A



- + **More turnover and margin**
- + **Great roof utilisation**
- + **Easy handling, quick installation**
- + **Aesthetic look**
- + **Happy customer (more earnings)**
- + **World record module**
- + **> 55 years experiences**
- + **Valuable guarantee**
- + **Strong global company**
- + **Sharp Team in Germany** (engl. speaking)

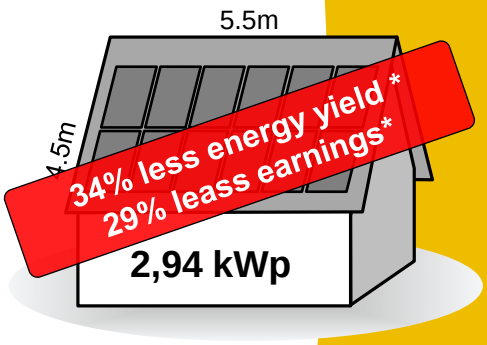
Standard Module 270 W



- Poor customer satisfaction
- Less turnover and margin
- Standard module: no sales story

Hersteller „P“ 245 W

"high performance module"



- Higher module price$_{/Wp}$ & system price$_{/kWp}$
- - Less roof utilisation
- - Less turnover and margin

Installer advantages with Sharp NQR256A*:

vs. 270W Standard module*:

- **+ 64% higher margin**
- **+ more than double turnover**
- **+ sales story: World record module**
- **+ offer different from competitors**
- **+ higher sales chances**

vs. 245W “high performance module”*:

- **- 20% lower module price****
- **+ 45% more margin**
- **+ mostly double turnover**
- **+ lower system costs**/kWp
- **+ higher sales chances**

* March 2017

SHARP Be Original.

Off-Grid with 12-Volt Battery

Comparison SHARP 48-cell module vs. standard 36-cell module

Sharp 48-cell module

Nominal power	256 W
Efficiency	19,82 %
No. of cells	48
Vmpp	27,53 V
Impp	9,30 A
Voc	32,49 V
Pmax	-0,377 %/°C
Isc	9,95 A
Dimensions	1318 * 980 * 46 mm

Standard 36-cell module

Nominal power	100 W
Efficiency	14,7 %
No. of cells	36
Vmpp	18,5 V
Impp	5,4 A
Voc	22,8 V
Pmax	-0,42%/°C
Isc	5,7 A
Dimensions	1315 * 518 * 35 mm

One Sharp 48-cell module can replace 2.5 standard 36-cell modules:



1.29m²



1.7m²
(30% more surface area!)

- To hit the same output of the SHARP 48-cell module (256W), 2.5 standard 36-cell modules are needed. The required area for the 36-cell modules is higher by the factor of 1.3.
- At high temperatures, the voltage of the 36-cell module may drop below the required battery charging voltage. The result is a lower battery charge over the year.
- Due to the higher Mpp voltage of the SHARP 48-cell module and the lower temperature coefficient, the SHARP module achieves higher yields in warmer environments.
- SHARP recommends using MPP trackers to charge 12V batteries. Mpp trackers are e.g. offered by Stecca und Phocos.

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Off-Grid with 24-Volt Battery

Most 60-cell modules are not usable for 24-volt systems

Sharp 48-cell module

Nominal power	256 W
Efficiency	19,82 %
No. of cells	48
Vmpp	27,53 V
Impp	9,30 A
Voc	32,49 V
Pmax	-0,377 %/°C
Isc	9,95 A
Dimensions	1318 * 980 * 46 mm

Standard 60-cell module

Nominal power	275 W
Efficiency	16,5 %
No. of cells	60
Vmpp	30,9 V
Impp	8,73 A
Voc	38,4 V
Pmax	-0,42%/°C
Isc	9,18 A
Dimensions	1650 * 941 * 46 mm

Two SHARP 48-cell modules charge a 24-volt battery to 100%:

100%  512 W

80-90%  270 W

- With a 60-cell module, a 24-volt battery is not fully charged to 100%. An off-grid system with a 24-volt battery requires a Mpp voltage of approx. 37 volts at least. However, a standard 60-cell module is only about 30 volts.
- Two SHARP 48-cell modules in series deliver 512 watts and a Mpp of 55 volts with an area of 2.6m². Two 60-cell modules are above 3.3 m². With two SHARP 48-cell modules, an off-grid 24V battery system can be properly charged.
- In combination with a MPP tracker, the highest efficiency is achieved. SHARP recommends using Mpp trackers to charge 24-volt systems. Various Mpp trackers are available on the market, among those Stecca oder Phocos.

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Conclusion

- The SHARP NQR256A 48-cell module is the ideal module for repowering existing 36-cell systems as well as for new installations in the 12-volt range.
- The 48-cell SHARP is suitable for 12- and 24-volt systems.
- In combination with a Mpp tracker it achieves the highest annual yields /m² in in off-grid systems.
- Due to the lower temperature coefficient compared to standard modules, the SHARP 48-cell module achieves higher output in the course of the year.
- Strong mechanical design: Two support bars on the back of the module withstand the strongest environmental conditions.

Innovative battery solutions

Solar energy day and night



Energy Storage

SHARP

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Battery solutions from leading manufacturers



LG Chem

Capacites:
3.3 kWh
6.5 kWh
9.8 kWh

Two batteries can
also be combined



BMZ

Free selection,
in 5 kWh steps,
up to maximum
30 kWh



Mercedes

Free selection,
in 2.5 kWh steps,
up to maximum
20 kWh

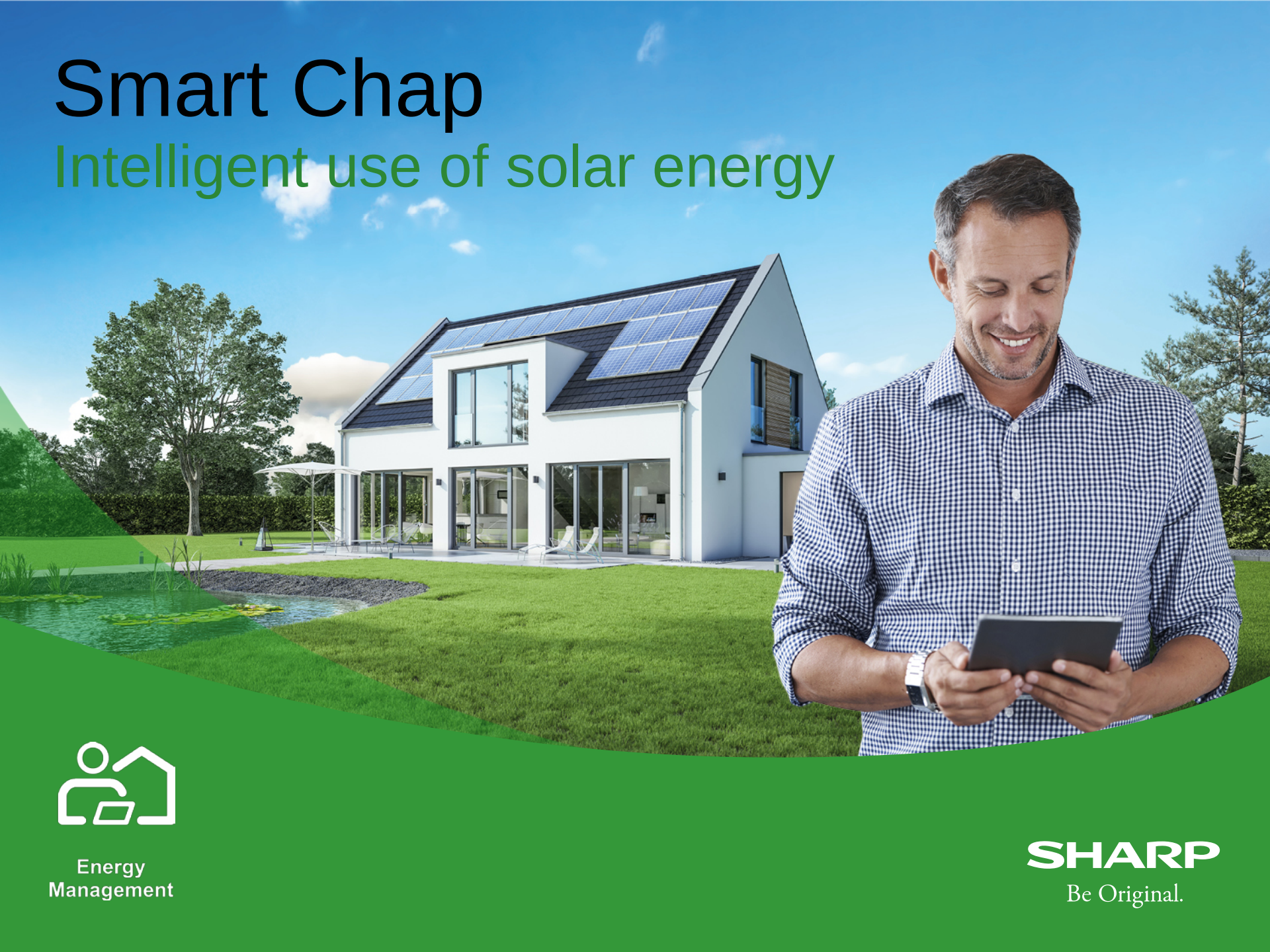


BYD

Free selection,
in 2.5 kWh steps,
up to maximum
10 kWh

Smart Chap

Intelligent use of solar energy



Energy Management

SHARP

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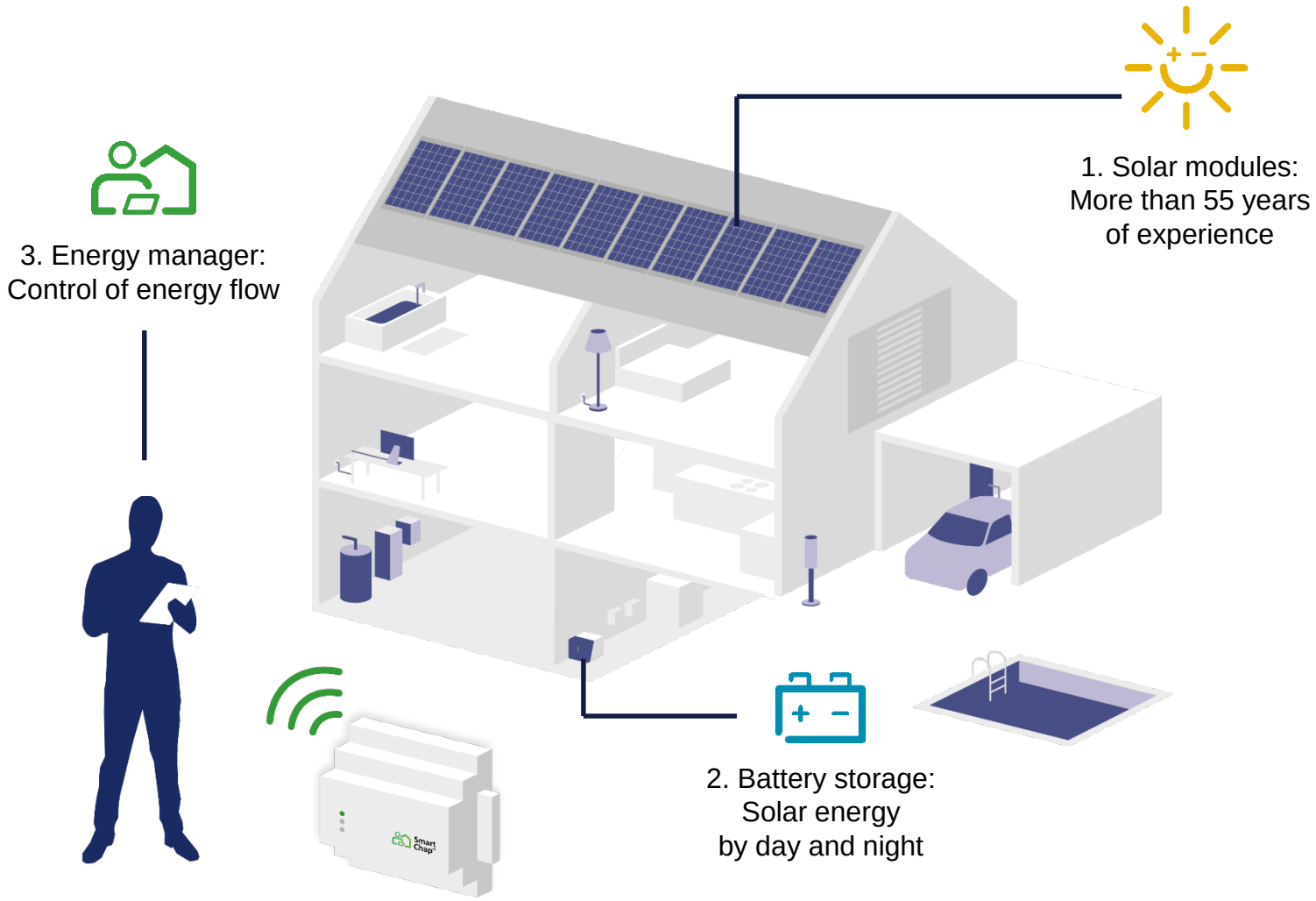
Home energy management from Sharp

Use devices when the sun shines



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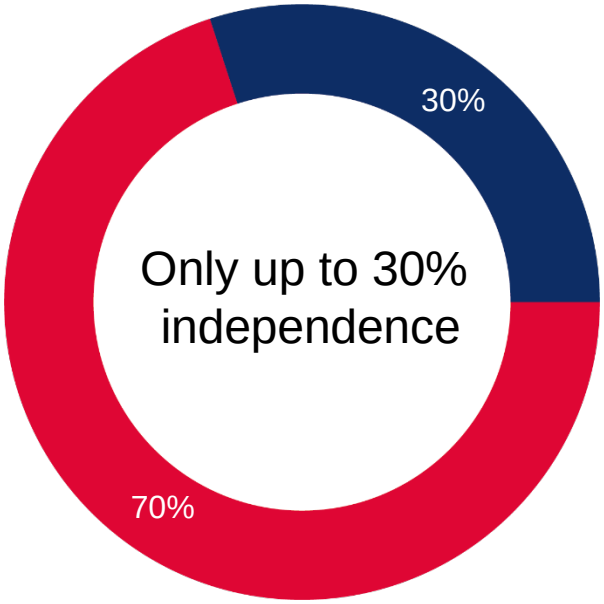
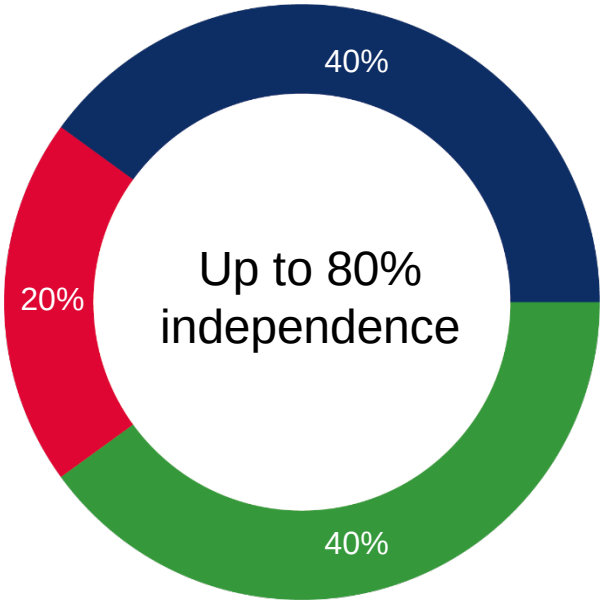
Maximum self-sufficiency with Smart Chap

Before
With a photovoltaic system only



After
With Smart Chap



Private consumption

- Direct consumption
- Battery consumption
- Grid consumption

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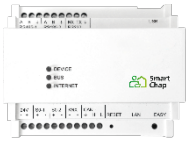
One platform, various options



Smart Chap™



PV system (Existing or new)

Battery + Inverter

Heat Pump (SG Ready)

Smart Plug

Heater

Grid

On request

Home Security

Lighting

Thermostat

Planned

Air Conditioning

eMobility

For utilities

Production and storage aggregation

Tariff structure

Smart Meter Gateway

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All benefits at a glance

Functions

- Comprehensive monitoring and analysis options
- Intelligent battery control based on weather and consumption projections
- Appliance management via smart plugs or switchable relays
- Direct connection to SG Ready heat pumps for solar-powered hot water
- Various Smart Home extensions (Fibaro)
- Emergency power capability

In the future:

- Network services
- Smart Meter Gateway

Sales partner benefits

- Open platform approach, ongoing development
- One system for different battery and inverter types
- Suitable for new installations and retrofitting
- New sales potential for installers and utilities (white label solution possible)

Benefits for the end customer

- Increased use of own solar power
- Electricity bill reduced by up to 80%
- Up to 99% self-sufficiency in the summer months
- Your shower and e-car can be powered by your own solar energy

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Modular solution for individual needs

The basic configuration of the system consists of an electronic control unit, a PV system, a battery storage device, a battery inverter and an electricity meter. The centrepiece of the system is the electronic control unit, which coordinates all the components.

Battery kit

Different manufacturers possible, e.g.



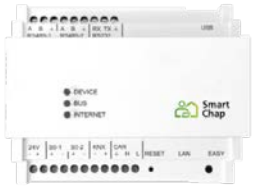
Batteries



- In preparation -

Battery Inverters

Smart Chap energy manager



Energy Manager



Easy Connect Box Victron



User Interface (App)

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Energy Services



Energy Services

After Sales Service

Training

Technical Support

Marketing Support

Energy Shop Order 24/7

Newsletter Registration

Latest News

2016

Feb.: Presentation of the Smart Chap HEMS system
Jul.: Launch of PV modules NU-RD300 and NU-RC300
Sep.: Start of MEA business
Dec.: Launch of PV module NQR256A

2017

Jan.: Launch of PV module ND-RJ270
Mar.: Launch of the Sharp Energy Shop
Sep.: Launch of PV module NU-SC360
Dec.: Launch of PV modules ND-AH325 and ND-AH330

2018

Increase PV module portfolio
Increase Smart Chap HEMS functions

Thank you

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