Subsidy free PV: Transforming the energy landscape

Future PV Roundtable

pv magazine group

Agenda

Part I

12:00	**Introduction & NEW pv magazine Future PV Roundtable Industry SnapShot Poll**
12:10	**Setting the economic benchmarks for subsidy free PV success**
12:20	**PANEL DISCUSSION: What technologies are available to manufacturers to help meet the subsidy-free business model?**

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Agenda

Part II

12:40 **Using functionality and digitalization to optimize self-consumption, and trade on the free market**

12:50 **PANEL DISCUSSION: Maximizing consumption onsite, and trading on the large and small scale**

13:10 **NEW pv magazine Future PV Roundtable Industry SnapShot Poll Results & Poster Session**

Networking

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Industry SnapShot Poll

1) SUBSIDY FREE PV: How soon will we achieve subsidy-free PV in Europe?

- 1 - 2 years
- 2 - 3 years
- 4 - 5 years
- Longer than 5 years

2) BENCHMARKING: What is the most important consideration to achieve subsidy-free PV?

- Business models which allow for a fair sharing of electricity price risks
- Another 20% drop in system prices
- Changes in legislation or regulations
- Availability of land

Industry SnapShot Poll

3) DIGITALIZATION: Where do you see digitization contributing to achieving PV

- Peer-2-peer trading platforms
- Aggregation of distributed solar & storage installations to offer grid services
- Blockchain technology for secure or cheaper transactions in the energy market
- Smart technology to improve the integration of solar into the grid

4) SUSTAINABILITY: Why do you think a sustainability initiative for the solar industry is important?

- To create positive PR by demonstrating holistic approach to reducing environmental damage
- To be part of a growing global consciousness of the climate crisis
- To help protect the planet for future generations
- To reduce costs or attract new investment into PV over the long term

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Setting the economic benchmarks for subsidy free PV success

Benedikt Ortmann

CEO

BayWa r.e.
renewable energy

The Don Rodrigo Project

Setting the economic benchmarks for subsidy free pv success

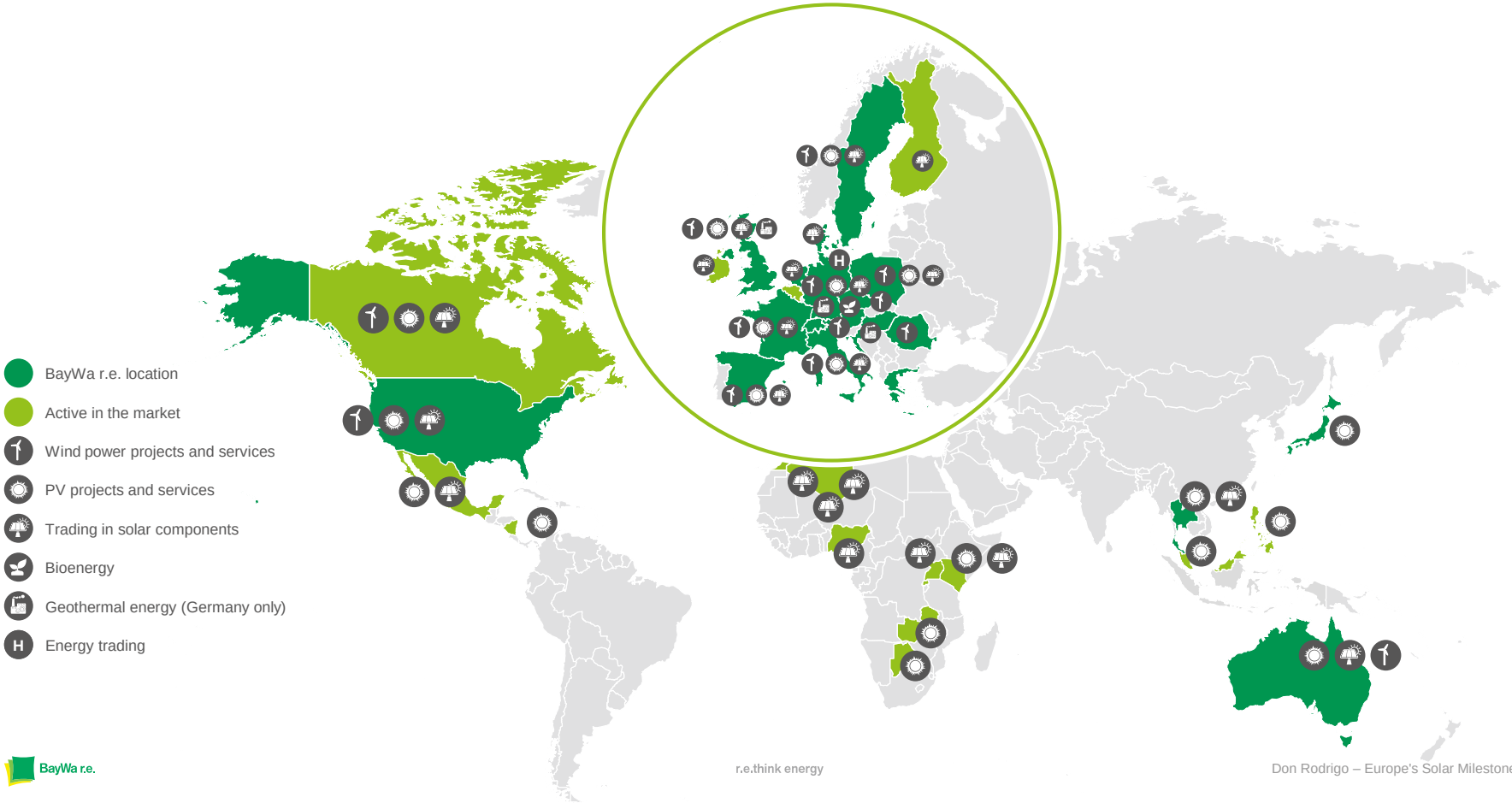
Dr. Benedikt Ortmann, Director Solar Projects

BayWa r.e.
renewable energy

r.e.think energy

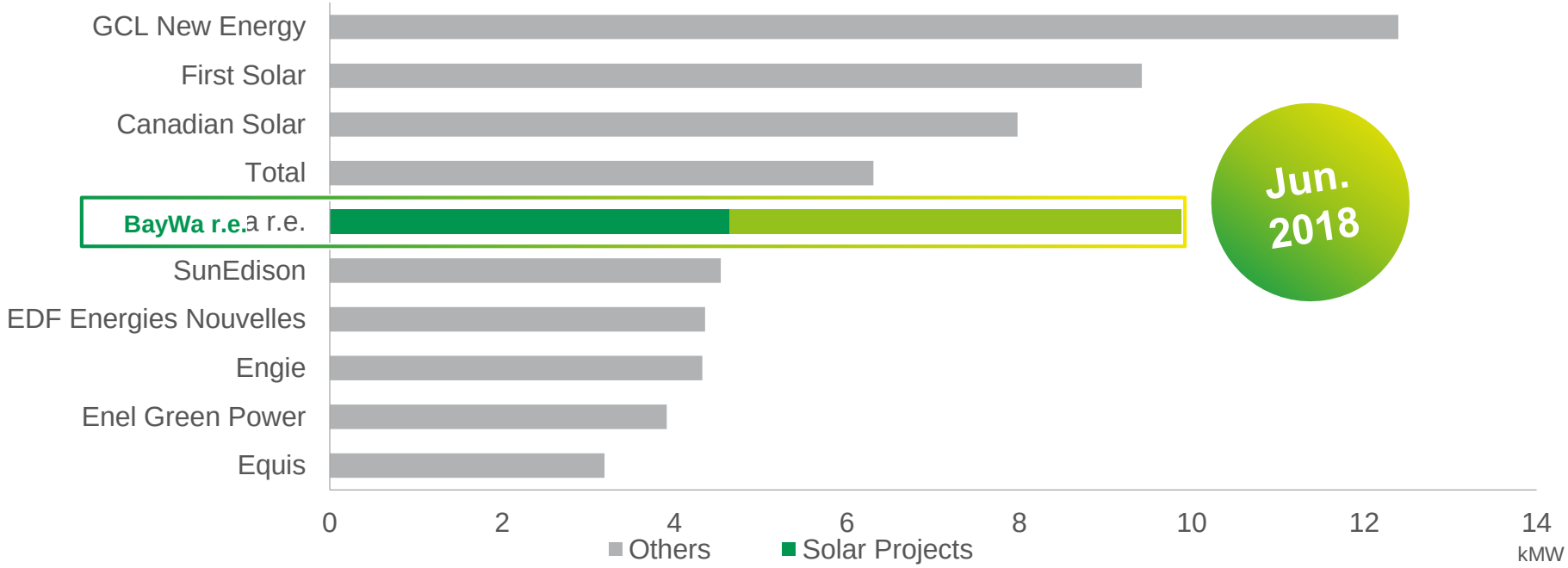
Introduction of BayWa

Our Global Footprint



We are the No.1 independent project developer worldwide

Realized projects as well as projects in the pipeline



Source: gtmresearch Dezember 2017

2

Grid Parity is happening

In 2012 we started Europe’s solar milestone project on a green field

The selection of the country

Why Spain?

Stable currency

Stable economy

OECD country

Ideal solar irradiation zone

As we planned to build this project unsubsidized, there was no concern major about politics in Spain

The selection of the site

Land Requirements

270 ha

Spatially coherent

Grid con-nection nearby

Relatively flat underground

Reasonable price for the lease

No environ-mental limits for flora and fauna

No major compensatory measures required

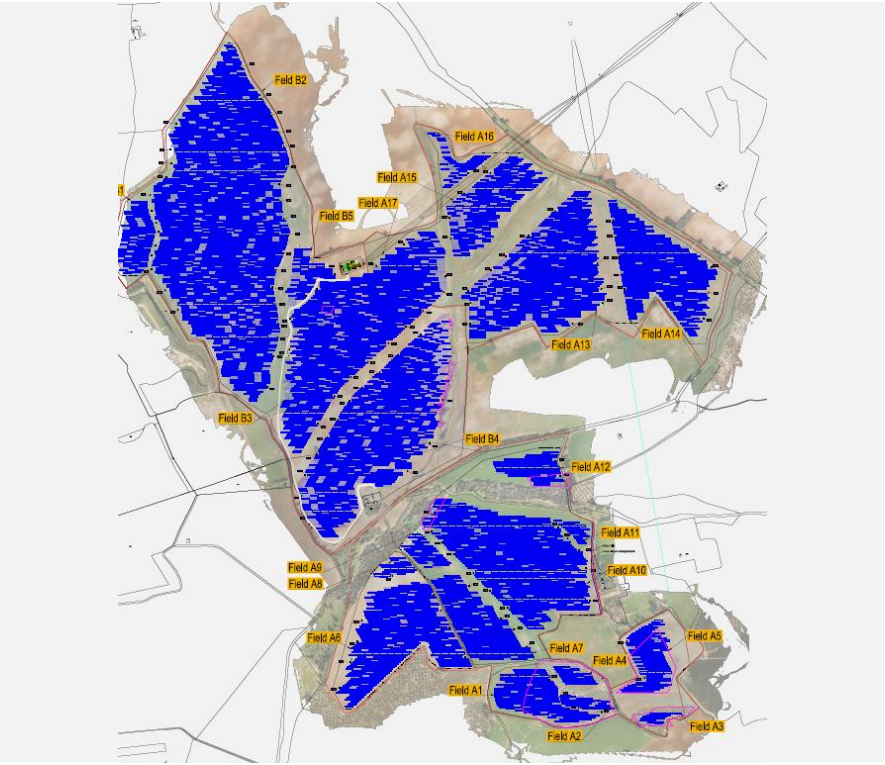
The decent site characteristics offered the optimal basis to build this extraordinary project.

Optimized technical planning process for most efficient use of land

String inverters and fixed-tilted technology

- Simple module exchange, simple maintenance
- Independency from the manufacturer for 20 years
- No standardized pavement needed, more flexibility for module tables
- 2,000 flexible string inverters adapting to the specific land conditions
- Flexibility, simplicity and independence means lower costs
- 1-axis would have brought less than 155 MW

➢ **Availability, performance and reliability of string inverters optimize the quality of the plant‘s production and lower the total costs of ownership significantly**



Overall state-of-the-art System Design

Module tables with 2 module rows each

27 – 29 panels assembled in strings

Strings deliver the produced electricity to a string inverter

Specific string construction in the lower row and one in the upper row minimizes shading losses at dusk and dawn

Decentral inverter concept leads to

- A maximum of availability on PV-plant-level
- Ease of maintenance, low risk for replacements
- Reduced cost

Overhead cable lines with an approx. length of 2.6 km will be connected to an existing substation owned by the transmission grid operator Red Eléctrica de España (REE)

The electricity are transformed on-site up to 220kV by its own substation

Panel manufacturer	Astronergy & GCL
Panel type	Crystallin
Inverters	Huawei 60 KTL and 100 KTL
Substructure	Zimmermann

We leveraged the full potential of our site’s advantages by designing a perfectly tailored system.

Don Rodrigo – Facts & Figures

Sevilla – Andalucía, Spain

- Europe’s 1st subsidy free Solar Project of its scale
- Capacity: 175 MWp
- Equivalent to the consumption of 93.000 average Spanish households
- 198.000t CO_2 emission reduction annually
- Largest subsidy-free project in Europe
- 1.500V DC and connection to REE’s substation at 220kV
- 3000km DC cable, 160km AC cable, 7,000 tons structure, more than 500,000 modules were processed (800 containers)
- Site has a size of approx. 270 ha, equivalent to 190 football fields
- First project in Spain with a long term PPA of 15 years together with Statkraft, one of Europe’s largest generators of renewable energy
- Commissioning is planned for Q2/2019

Being part of one of the first grid parity projects together with BayWa r.e. is a big milestone for us, showing that full market integration of renewables is possible.

”

Simon Kornek
Head of Continental long-term Portfolio at Statkraft

Don Rodgrigo:
Invest and operational cost

CAPEX	€/kWp
PV generator	567
Grid connection costs	32
Project development costs	50
Other costs (i.e. construction finance)	108
Total CAPEX grid connected	**758**
Due diligence, bank & share premium	**52**
Total invest	**810**

OPEX	€/kWp p.a.
Rent	1.46
Technical management	6.71
Business administration	5.02
Insurance	0.74
Other expenses	3.36
Total expenses	**17.29**

Solar yield:
1,730 kWh/kWp

Land lease:
961 €/hectar

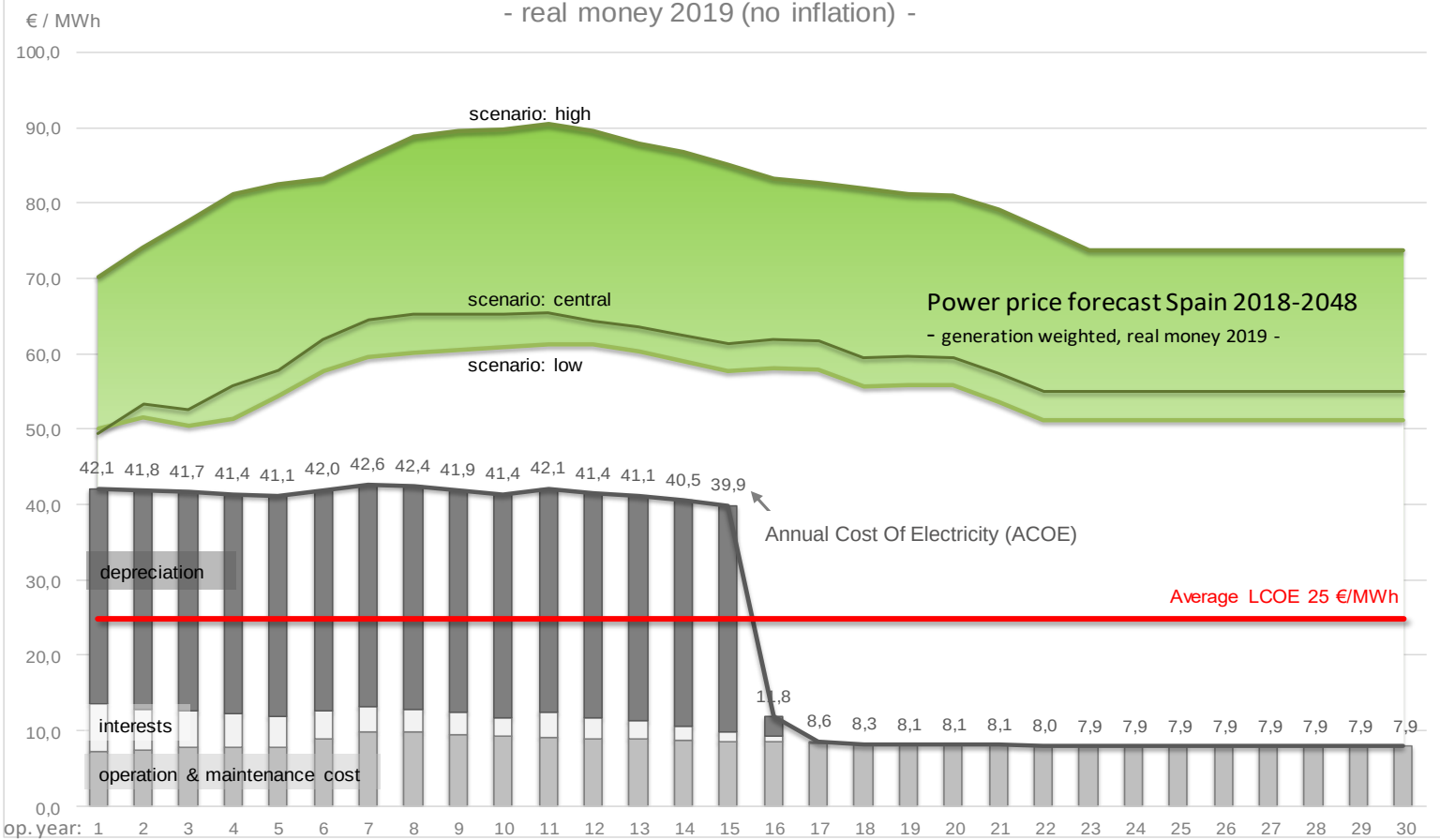
System: fixed tilted mono perc **310 Wp**, monofacial, string inverters
100 kW

Investor IRR (unlevered, 25y):
6.0%

Source: Bundesministerium für Wirtschaft und Energie (BMWi) (Hrsg.):
Projektbericht „Erneuerbare Energien-Vorhaben in den Tagebauregionen“ 10/2018

LCOE development Don Rodrigo

- real money 2019 (no inflation) -



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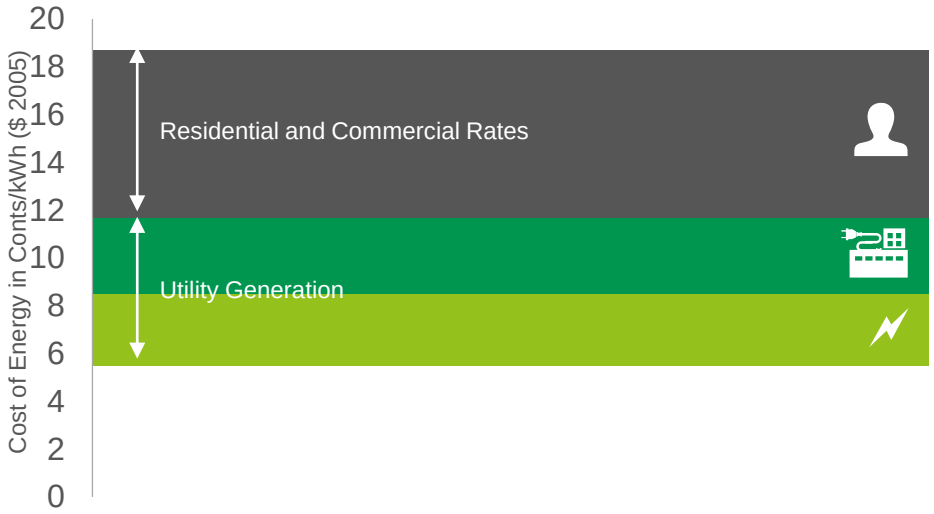
All about Grid Parity – and how Photovoltaic Energy is disrupting the market

What is grid parity?

The 3 levels of grid parity



Consumer price level

Easiest to achieve as cost of energy
are similar to high end-consumers prices

Wholesale price level

Comparable to the regular price,
to which municipal utilities purchase energy

Production price level

Same cost of energy production as classic
electricity utilities companies

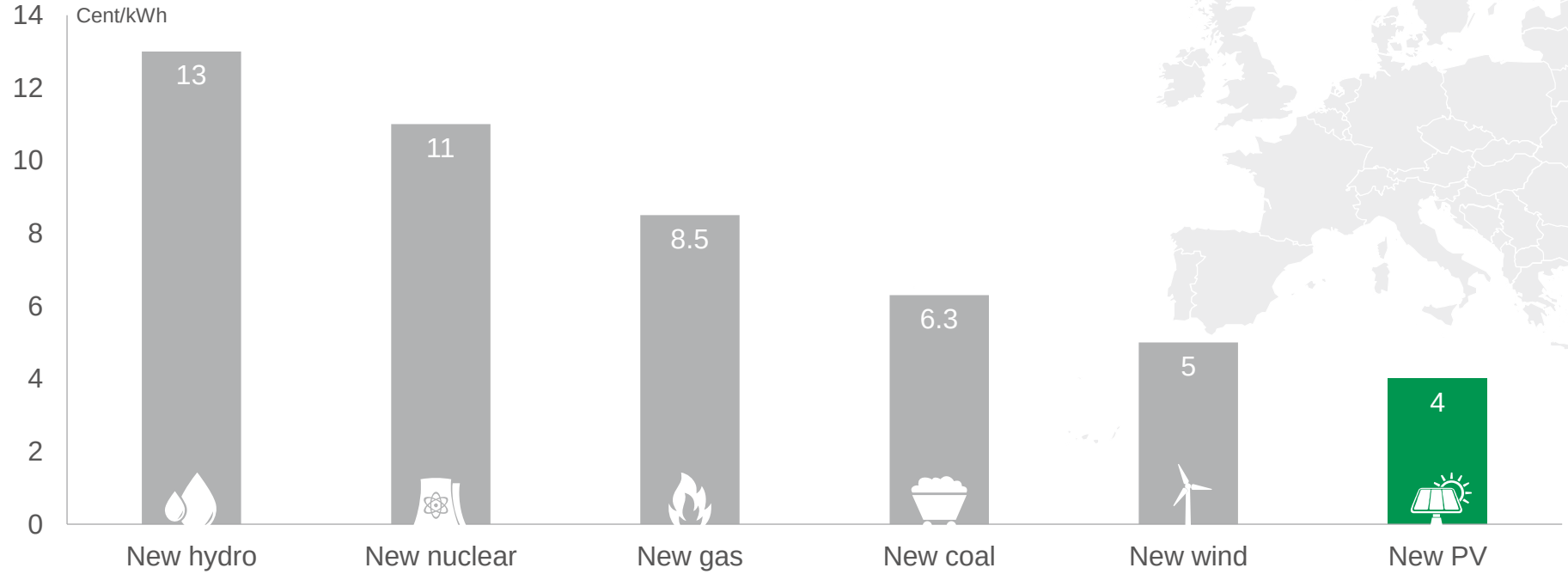
The ultimate goal – to produce Solar Energy cheaper than conventional energies – has now reached!

Source: US Department of Energy

Consumer price level Wholesale price level Production price level

Renewable Energy outperforms every other new energy form

LCOE Comparison of Energy Technologies in Europe



Source: EU reference scenario 2020

Renewable Energy outperforms every other new energy form

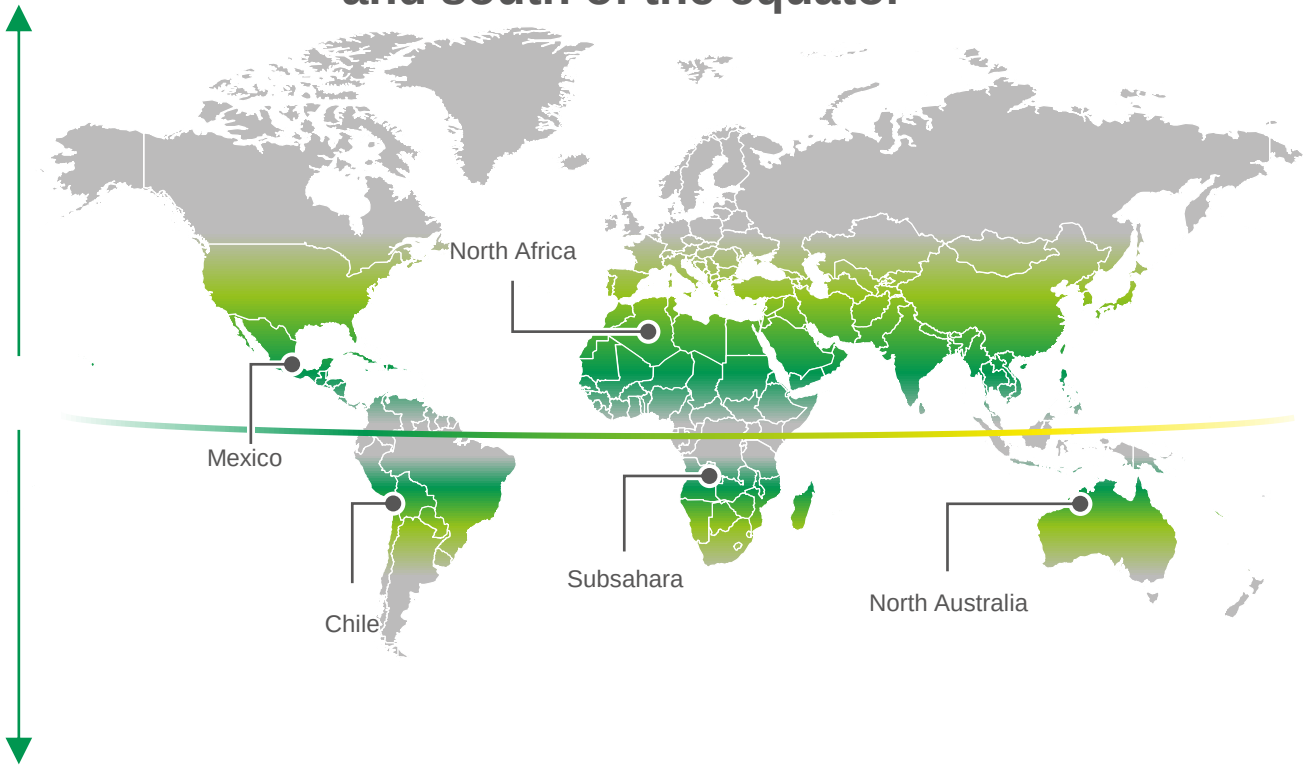
Photovoltaic is the

cheapest power source

in the history of mankind

Source: EU reference scenario 2020

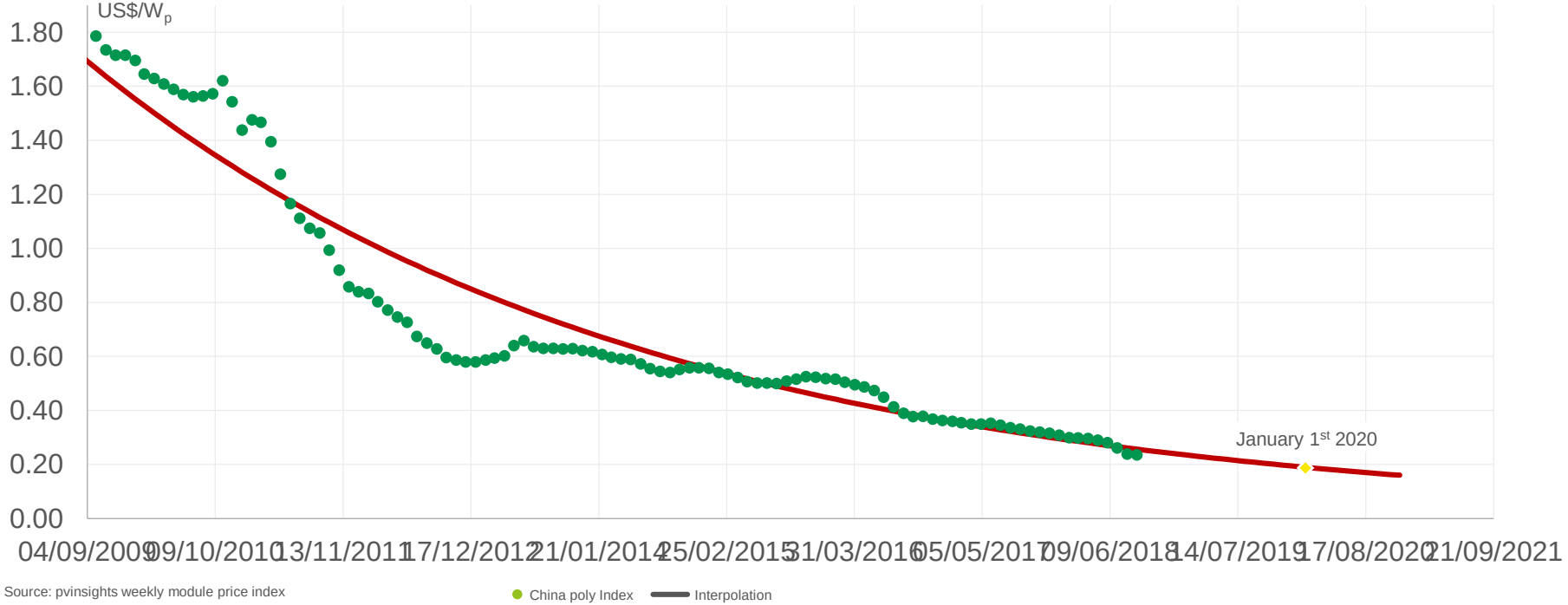
Ingredient No. 1: radiation
Zones with ideal grid parity conditions are spread north and south of the equator



Ingredient No. 2: panel cost

2020 : 20

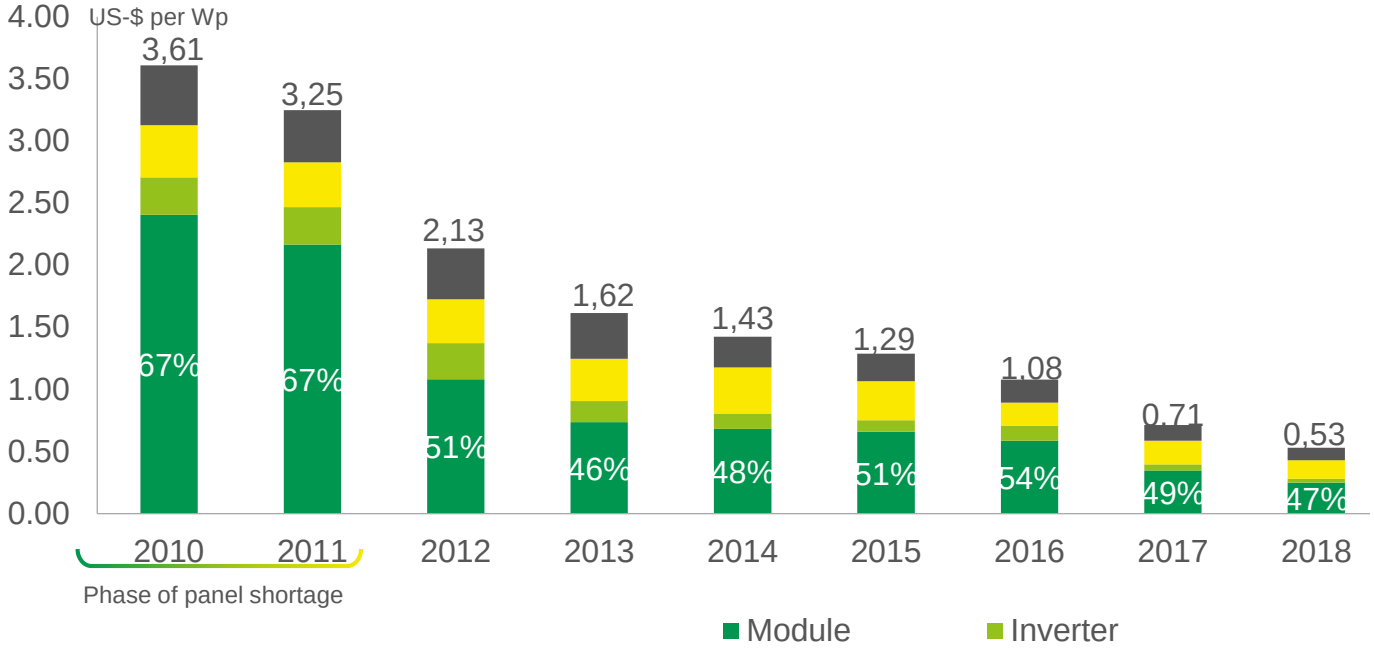
In 2020 panel prices will go below 20 Cent/Wp



Source: pvinsights weekly module price index

The panel remains at ~50% of construction costs

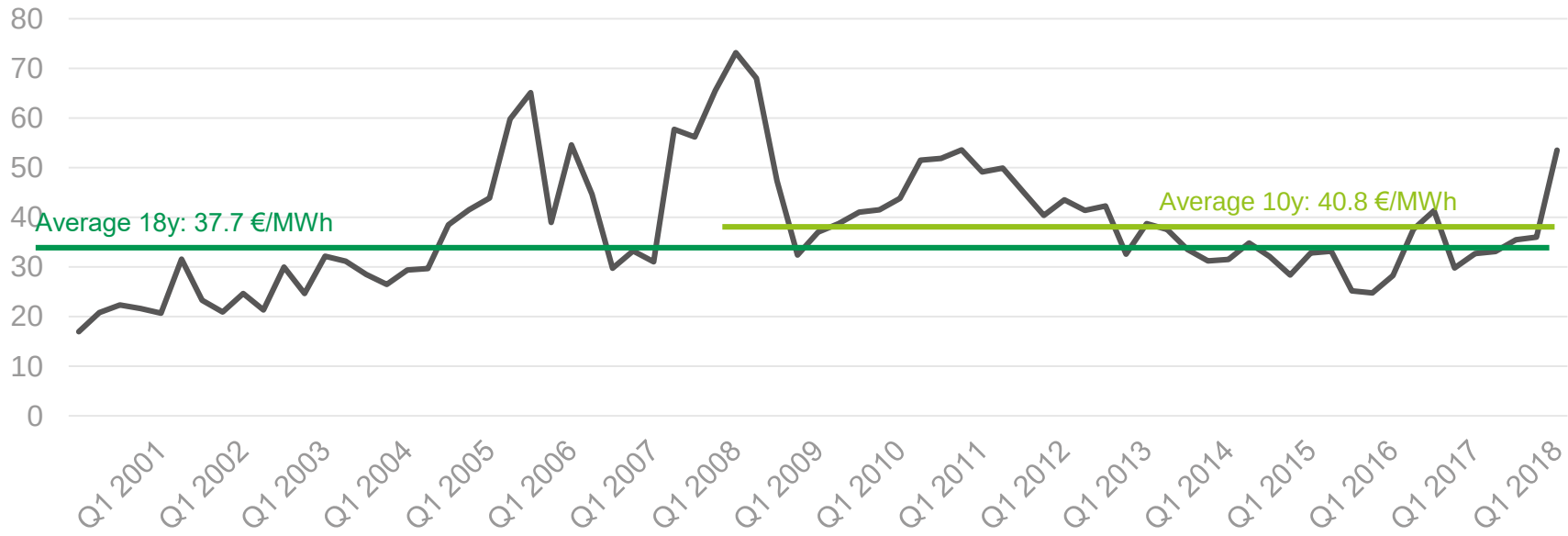
Comparison of the CAPEX Split for a PV installation



Source: NREL (utility-scale PV system costs benchmark summary (inflation adjusted), 2010 – 2017
2018ff: data projection BayWa

Ingredient No. 3: Sufficient electricity prices

Average Spot Power Price Germany (EUR/MWh, real prices)



Why Solar Energy will disrupt the energy markets

It is easy to install

It is easy to scale (every single cell is already a generator of its own)

It is easy adopt to the landscape

It does not harm the nature (green field or roof)

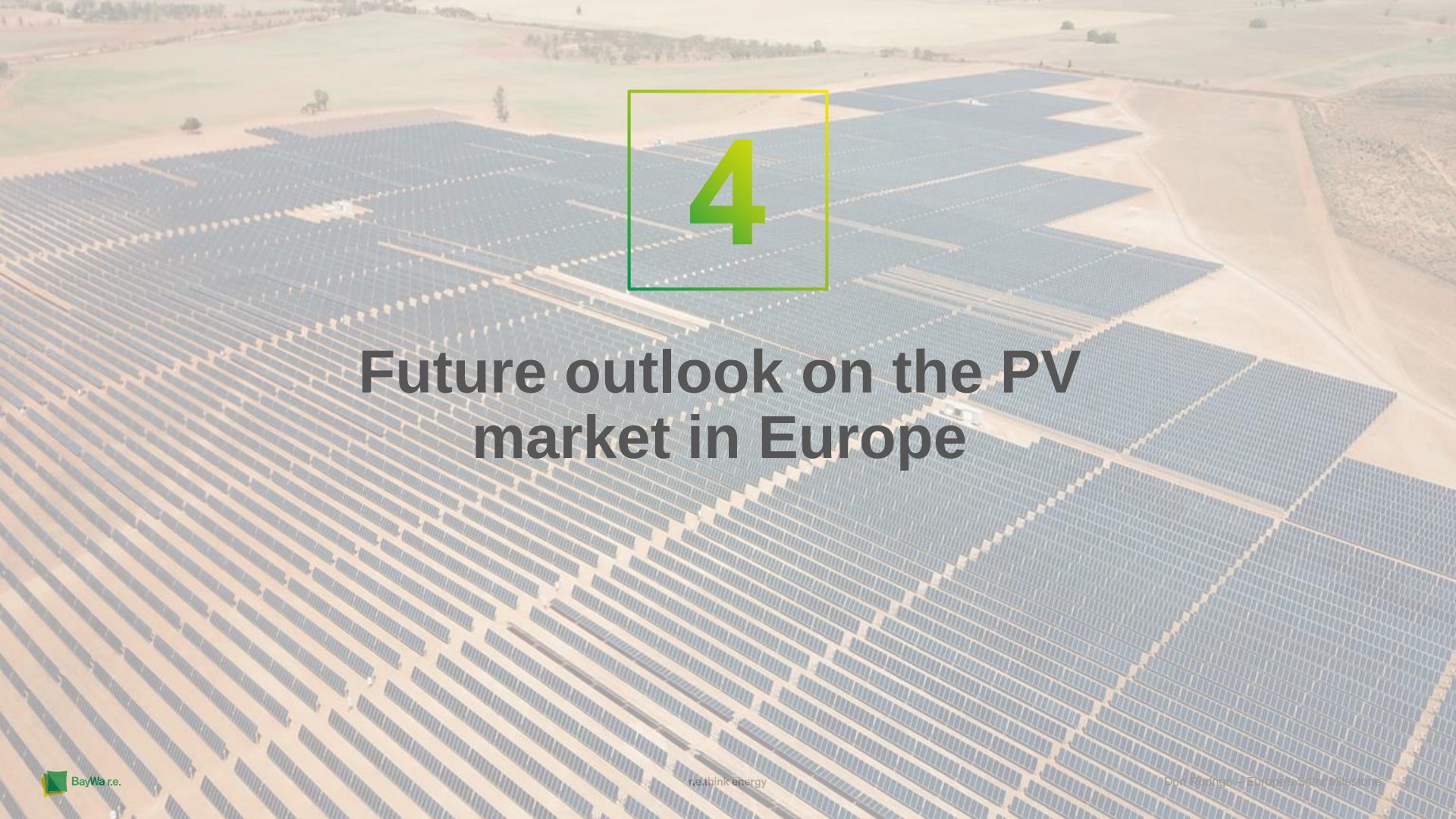
It does not effect people‘s life quality (no emissions, not even shadows etc.)

It is made for decentralized energy grids (rural electrification)

It is durable (40+ years of production)

It is reliable (very low volatility)

It is the cheapest!



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Future outlook on the PV market in Europe

Transition to fully merchant market is in progress

Grid Parity spreads across Europe

It based on

- The expected price developments of whole sale electricity in each country
- The solar irradiation map
- Expected price developments in EPC and material costs for photovoltaic

It does not contain

- Grid connection costs
- Possible differences in land and development costs

The study was performed 2016 by the Bequerel Institute, Brussels

r.e.levant

r.e.sponsible

r.e.duce

r.e.think

r.e.cycle

r.e.spect

r.e.flect

r.e.lation

r.e.newable

Dr. Benedikt Ortmann
BayWa r.e. Solar Projects

Benedikt.Ortmann@baywa-re.com

Panel discussion

What technologies are available to manufacturers to help meet the subsidy-free business model?

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Jenny Chase
Manager Solar Insight Service
Bloomberg New Energy Finance

Simon D. Meijer
CEO
COOLBACK COMPANY

Radu Roman
Product & Business Development Manager Europe
JinKO Solar
Building Your Trust in Solar

Paolo Tusa
Commercial Manager
DSM

Stefan Degener
Senior Director Business Development
First Solar

Using functionality & digitalization to optimize self-consumption, & trade on the free market

Lior Handelsman

VP Marketing and Product Strategy, Founder

solaredge

Using Functionality and Digitalization to Optimize Self-Consumption, and Trade on the Free Market

Lior Handelsman

May 16th, 2019

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End-to-End Smart Energy Provider

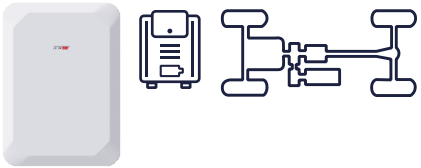
- One-stop-shop for smart energy solutions
- Established 2006 and NASDAQ IPO in 2015
- Global leader in smart solar inverters with installations in over 130 countries
- Award-winning innovative company with strong product portfolio and roadmap
- Ranked as top global inverter company
- Moving beyond solar
  - Gamatronic: Developer of uninterruptible power supply solutions
  - Kokam: A top-tier provider of Li-Ion cells, batteries, and energy storage solutions from South Korea
  - SMRE: Provider of innovative integrated powertrain technology and electronics for electric vehicles

One-Stop-Shop for Smart Energy Solutions

Smart Modules

Residential and
Commercial PV Inverters

Batteries, UPS, and EV Powertrains



EV Charging

Monitoring Platform and Grid Services

Smart Energy Management

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SolarEdge in Numbers

11.8GW
of our systems shipped worldwide

37.1M
power optimizers shipped

1.5M
inverters shipped

$271.9M
Q1 2019 revenue

Over **1M** monitored systems around the world

Presence in **26** countries

2,017 employees

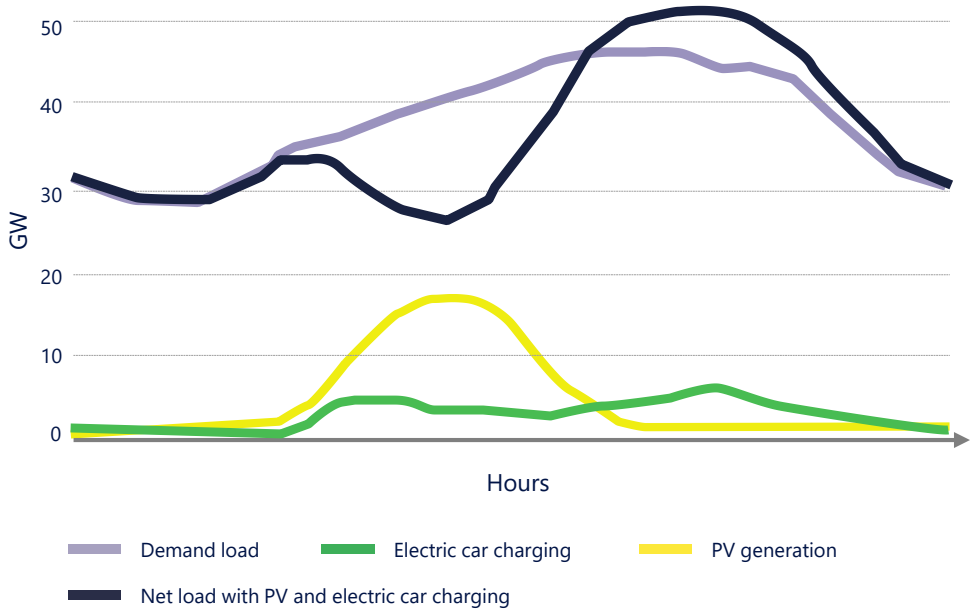
295 awarded patents and **219** additional patent applications

solaredge

Grid Status

PV and EV Impact on the Grid

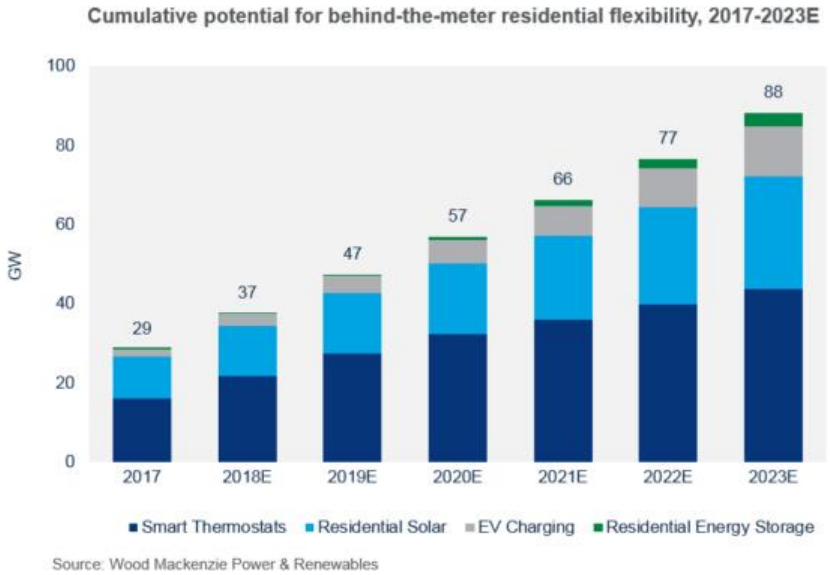
- PV and EV grid penetration is accelerating
  - PV at grid parity with reduced costs
  - EV demand created by IEA's EV30@30
- PV duck curve + EV charging causes steeper ramp up in evenings



Source: Smart EV Charging Systems for Zero Emission Neighbourhods, Research Centre on Zero Emission Neighbourhoods in Smart Cities

Potential for Demand-Flexible Grid

- Currently ~47 GW of demand-side flexibility exist solely in the U.S. residential sector
  - By 2030, 88 GW
- PV incentive structure moving towards self-consumption
- Need to smartly manage various DERs both locally and grid level

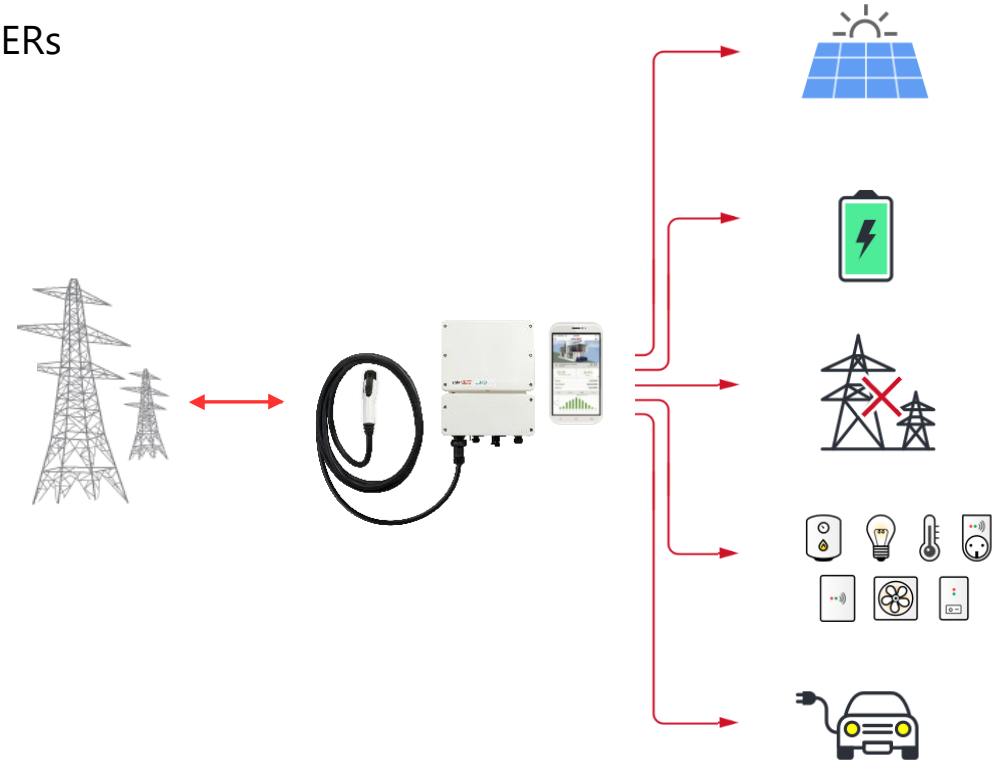


Source: https://pv-magazine-usa.com/2018/10/04/your-appliances-can-save-the-grid-and-allow-more-solar/

Demand-Side Flexibility

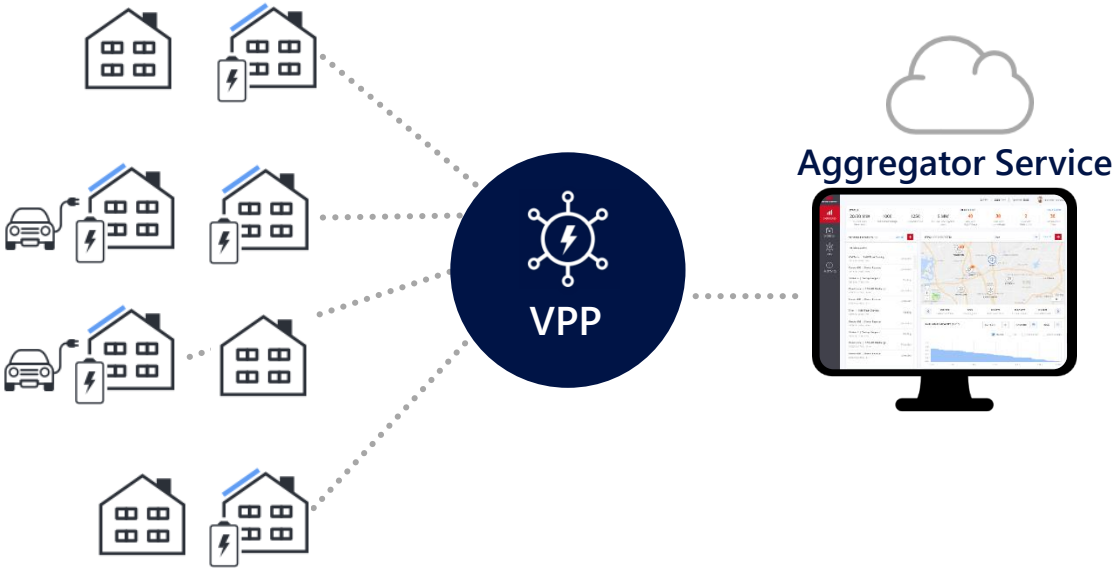
Smart Energy Manager

- Inverter manages multiple types of DERs
  - Storage
  - EV charging
  - Self-consumption
  - Home energy
- Manages and regulates smart grid
  - Takes aggregated commands and disaggregate them to underlying DERs

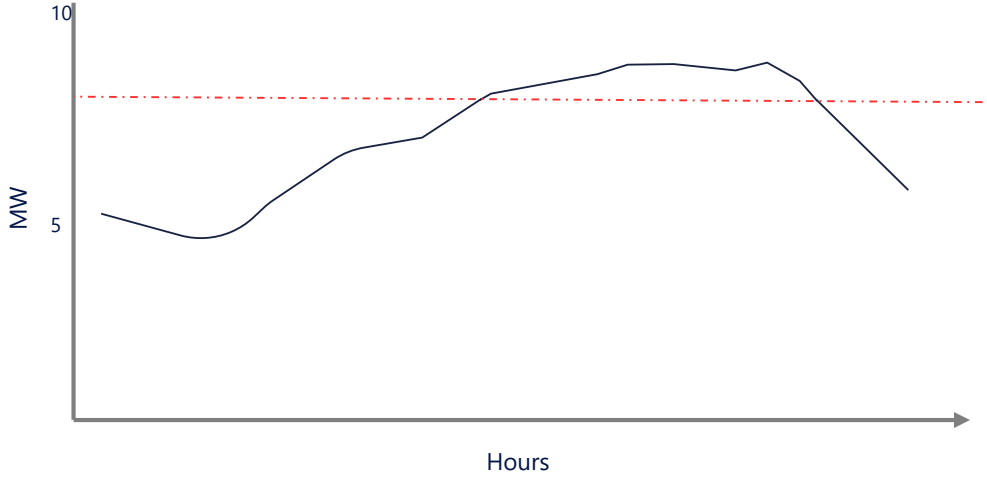


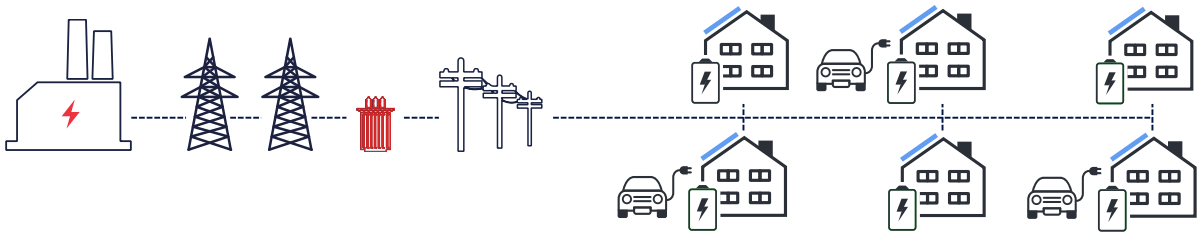
Virtual Power Plant

- Pooling DERs in the cloud enables to overcome local supply shortages
- Provide access to stored energy at a capped price during price peaks to hedge against price volatility
- Modify generation or consumption to stabilize grid frequency and voltage



Scenario: Energy Supply Shortage





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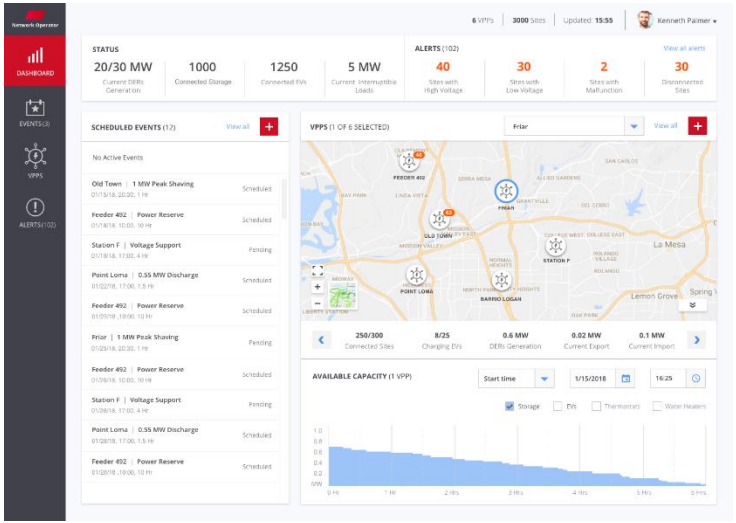

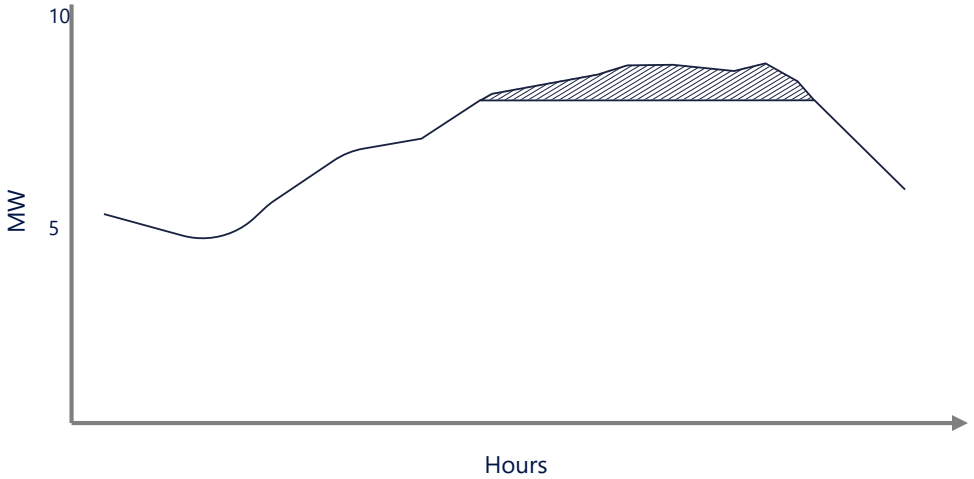

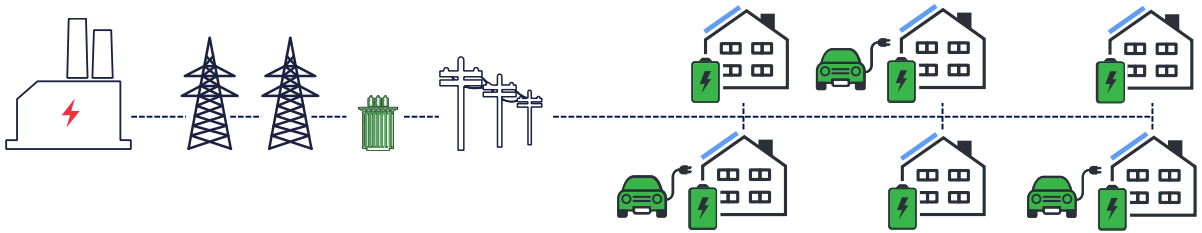

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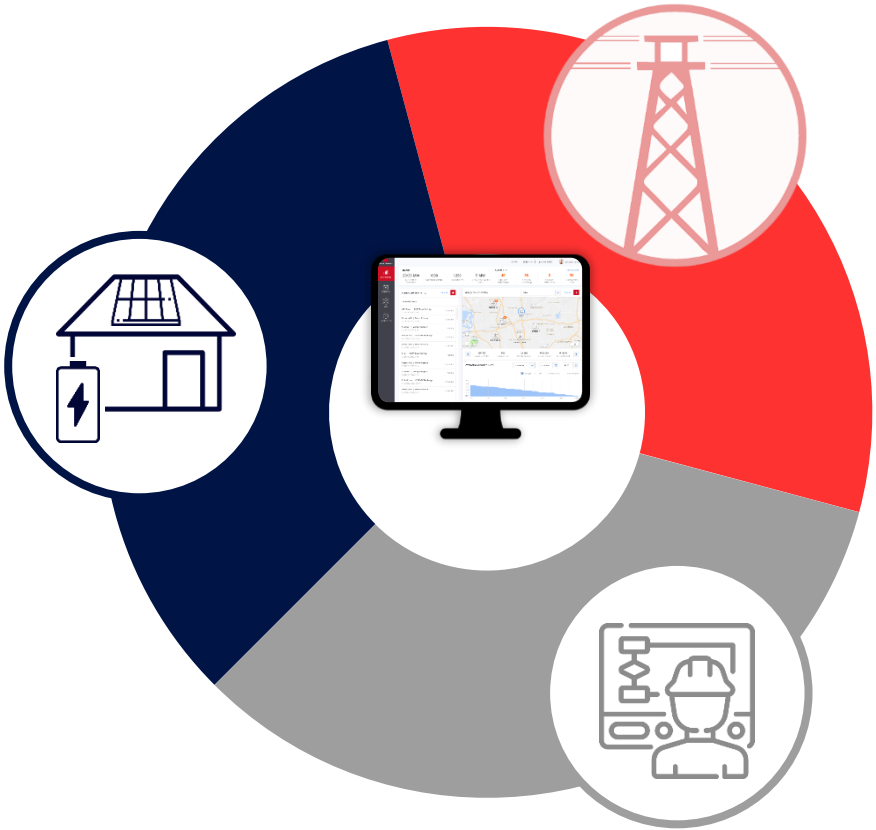
Value for All Stakeholders

Households

Upfront subsidy for hardware or monthly rebate for access to batteries and EV chargers



DNOs

Defer costly (~€10-20M) and underutilized upgrades or additions to substations/feeders

Eliminating some costly voltage regulator equipment, saving €K/feeder

Energy Suppliers

Protection from energy price peaks to save $30-80/kW$_{storage}$/year

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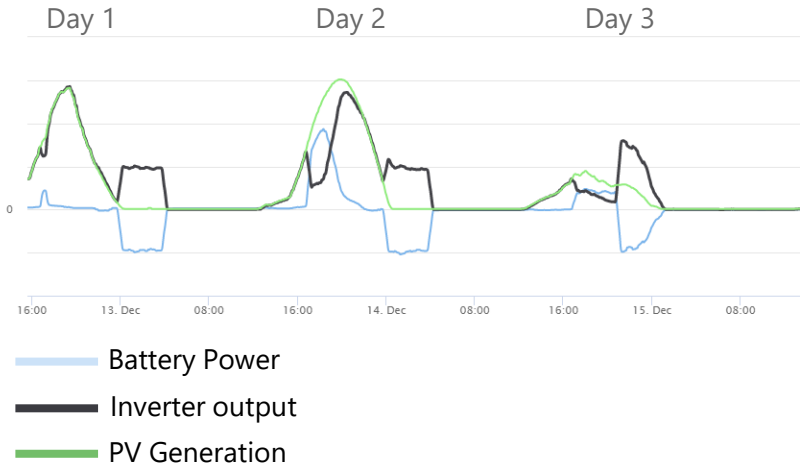
SolarEdge VPP Deployments

- VPPs providing demand response service in California and Massachusetts
- VPP capability for bring your own device (BYOD) program in Vermont and Australia
- Multiple VPPs for Energy Trading, Network Support, and Frequency Regulation in Australia
- Various new VPPs are expected to be deployed during 2019

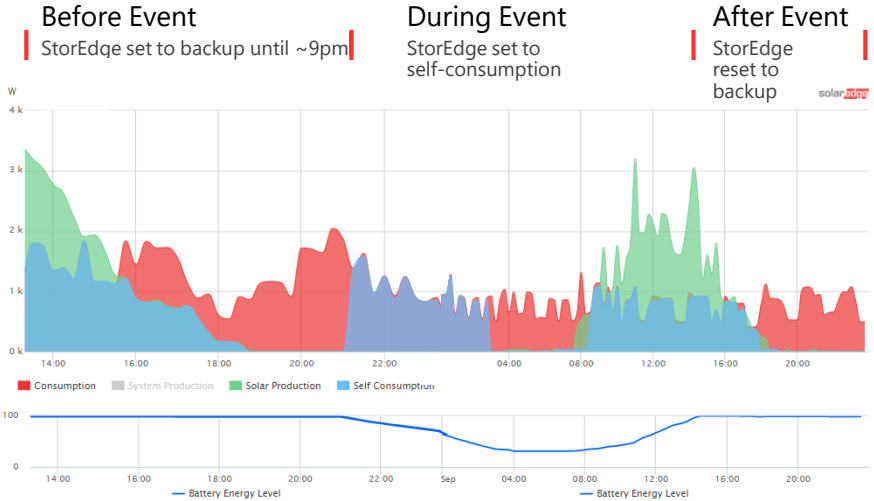
Field Proven Demand Response Events

- Californian utility required load shedding for a ISO-triggered demand response event
- SolarEdge provided VPP access to a fleet of residential StorEdge systems
  - 3 events pre-scheduled a day in advance for 3 consecutive days
  - Batteries discharge at desired power and duration to provide power to the grid over 4 hours
  - Batteries only charged from PV
    - Day 3 is distinctive due to decreased PV product in addition to discharge being pre-scheduled for an earlier time
  - Batteries were allowed to feed into the grid



Field Proven Demand Response Events

- Massachusetts utility required load shedding during 3 hours of peak demand
- SolarEdge provided VPP access to a fleet of pre-installed residential StorEdge systems
- During load shedding event, batteries provided site-level energy supply, with no grid export, to match site load



Thank You!

Cautionary Note Regarding Market Data & Industry Forecasts

This power point presentation contains market data and industry forecasts from certain third-party sources. This information is based on industry surveys and the preparer's expertise in the industry and there can be no assurance that any such market data is accurate or that any such industry forecasts will be achieved. Although we have not independently verified the accuracy of such market data and industry forecasts, we believe that the market data is reliable and that the industry forecasts are reasonable.

Version #: V.1.0

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Panel discussion

Maximizing consumption onsite, and trading on the large and small scale

Walburga Hemetsberger

CEO
SolarPower Europe

Alison Finch

VP Marketing
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Edmee Kelsey

Founder
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Cecilia L'Ecluse

Solar Analyst
Bloomberg
New Energy
Finance

Ike Inkwan Hong

President
Kokam

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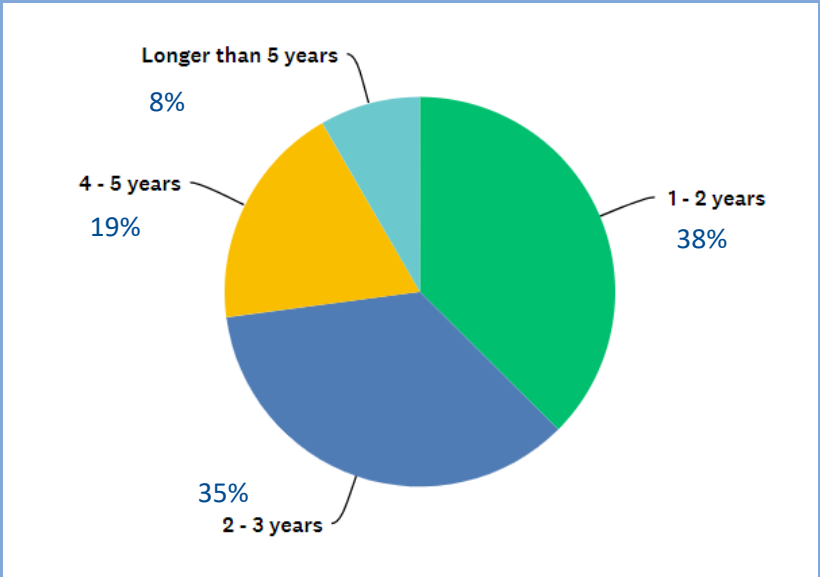
Industry SnapShot Poll

1) SUBSIDY FREE PV: How soon will we achieve subsidy-free PV in Europe?



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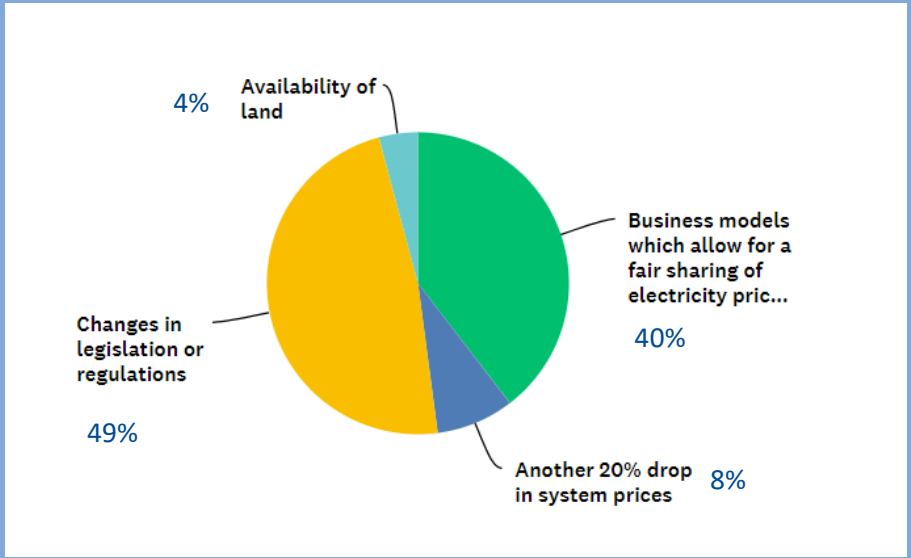
Industry SnapShot Poll

2) BENCHMARKING: What is the most important consideration to achieve subsidy-free PV?



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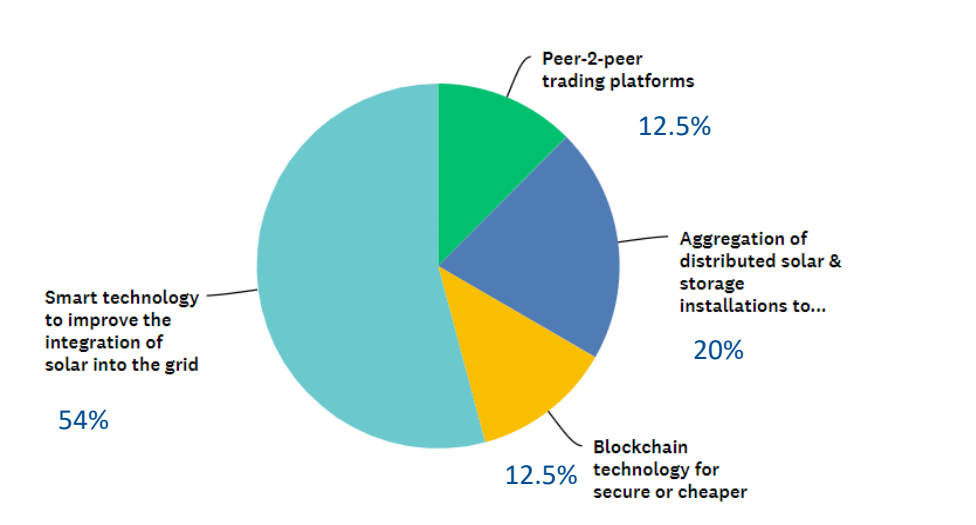
Industry SnapShot Poll

3) DIGITALIZATION: Where do you see digitization contributing to achieving PV



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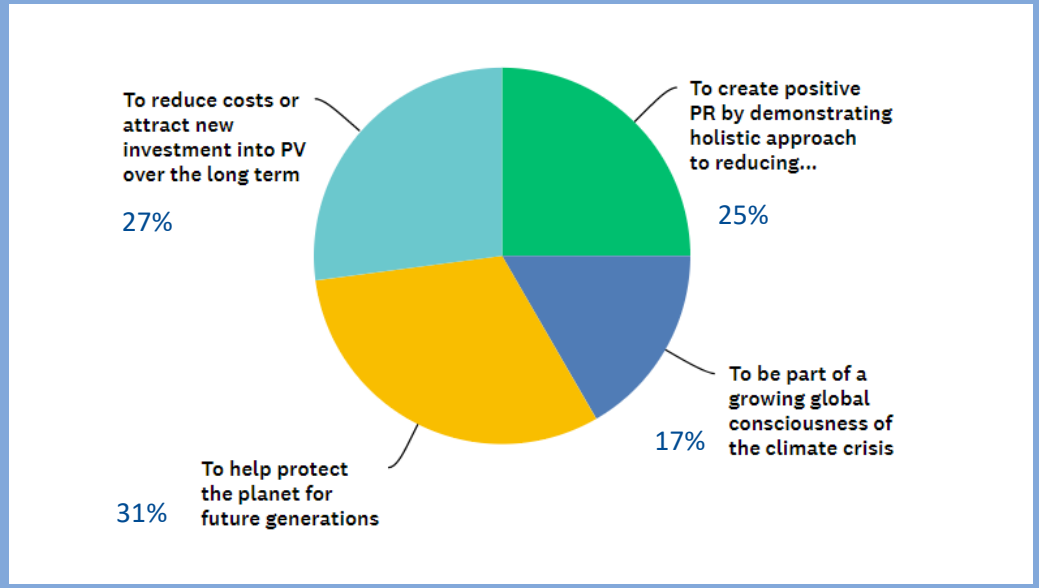
Industry SnapShot Poll

4) SUSTAINABILITY: Why do you think a sustainability initiative for the solar industry is important?



Subsidy free PV: Transforming the energy landscape

Future PV Roundtable

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JinKO Solar
Building Your Trust in Solar

First Solar

COOLBACK COMPANY

DSM

BayWa r.e.
renewable energy