MARCH 2019 CONNECTING THE FUTURE

Solar: Game changer of smart cities

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Agenda

- Solar Market: Overview and Trends
- Introduction to ABB Solar
- Utility Scale String Inverter
  - ✓ The award winning PVS 175
- Self Consumption Model
  - ✓ React 2: Supporting Independence

Long term energy market outlook

Solar growing more than all others

Massive expectations from Solar

Over $9 Trillion of new clean energy investments by 2040

Solar cost decline will make this technology as the most competitive by 2030

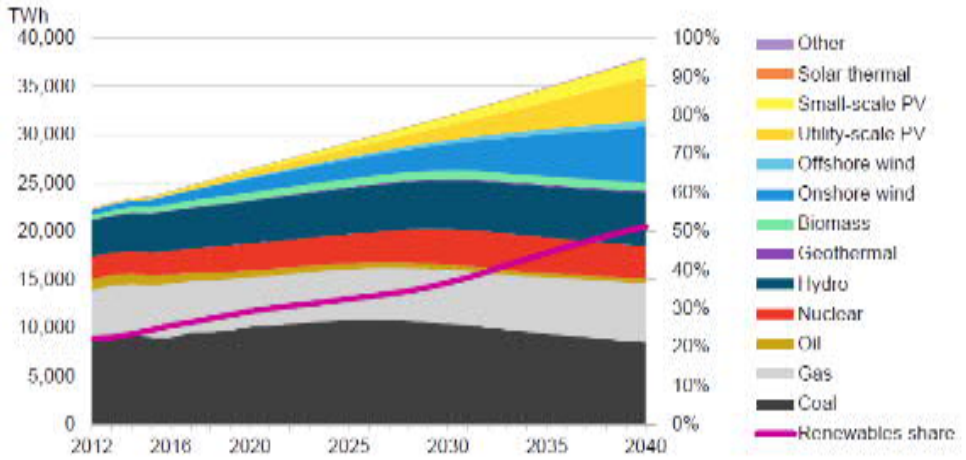
The Small-scale PV will reach socket parity by 2020

ASIA Pacific will experience a colossal growth across the coming 25 years

Europe will see a strong decarbonization

RE and gas will play the key role in Americas, based on the different countries

Electricity generation globally



Sources: BNEF

Business models evolving fast

Technology financially viable and competitive with other sources now

Unsubsidized

Self-consumption

Net metering

- Mature countries
- Electricity System focused on efficiency
- High price of electricity
- Willingness to become energy free
- Economy growing slowly
- Moving towards smart grids & buildings - VPP

Subsidized

PPA (Purchase Power Agreement)

FiT (Feed in tariff)

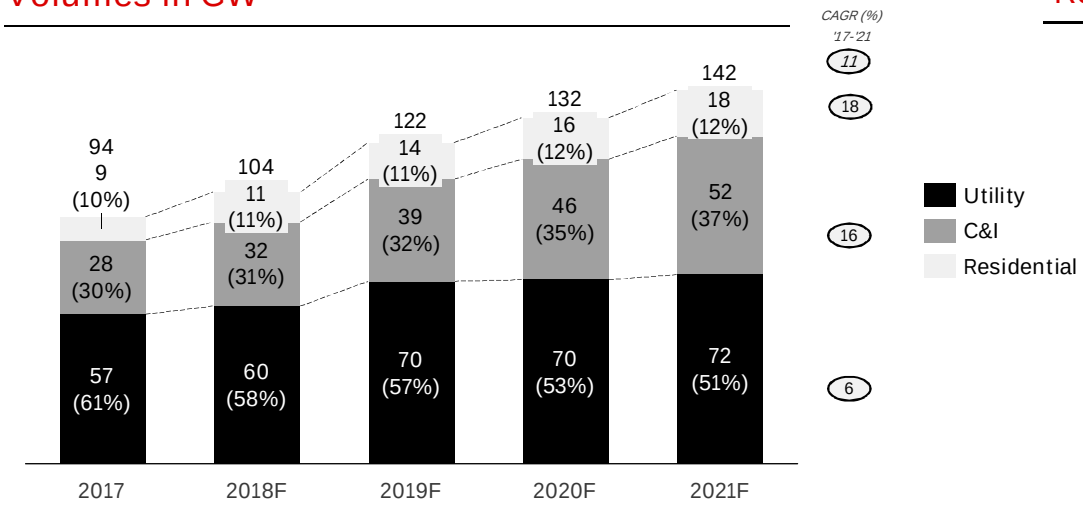
- Fast growing economies
- High energy demand - DER
- Emerging markets
- Poor energy infrastructures
- Easy and simple configuration/set-up
- Large land availability

Solar a leading contributor on all energy's system

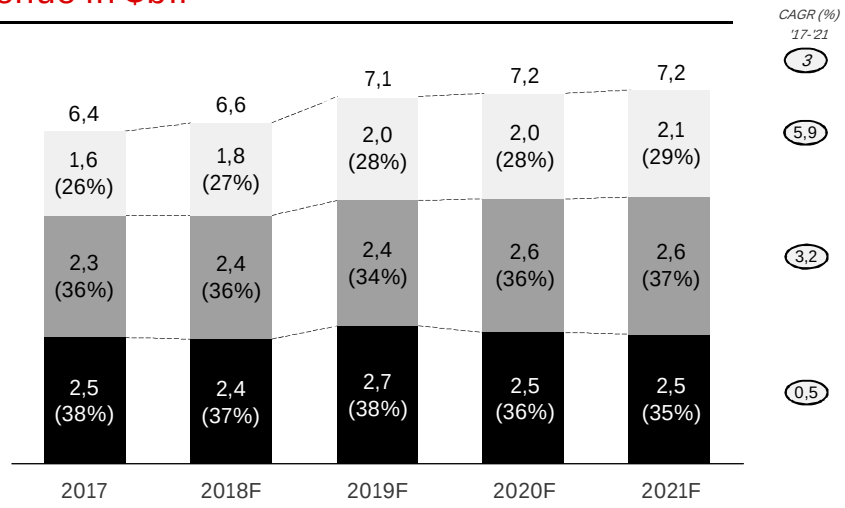
Solar market global outlook

Consistent growth in volume with CAGR 11%, lower in $ due to price erosion

Volumes in GW



Revenue in $bil



Sources: IHS Research, GTM, ABB Internal

Future market conditions are forecasted to be tough with aggressive leadership of Chinese players as the center of gravity is shifting to Asia (China is ~50% of the market).

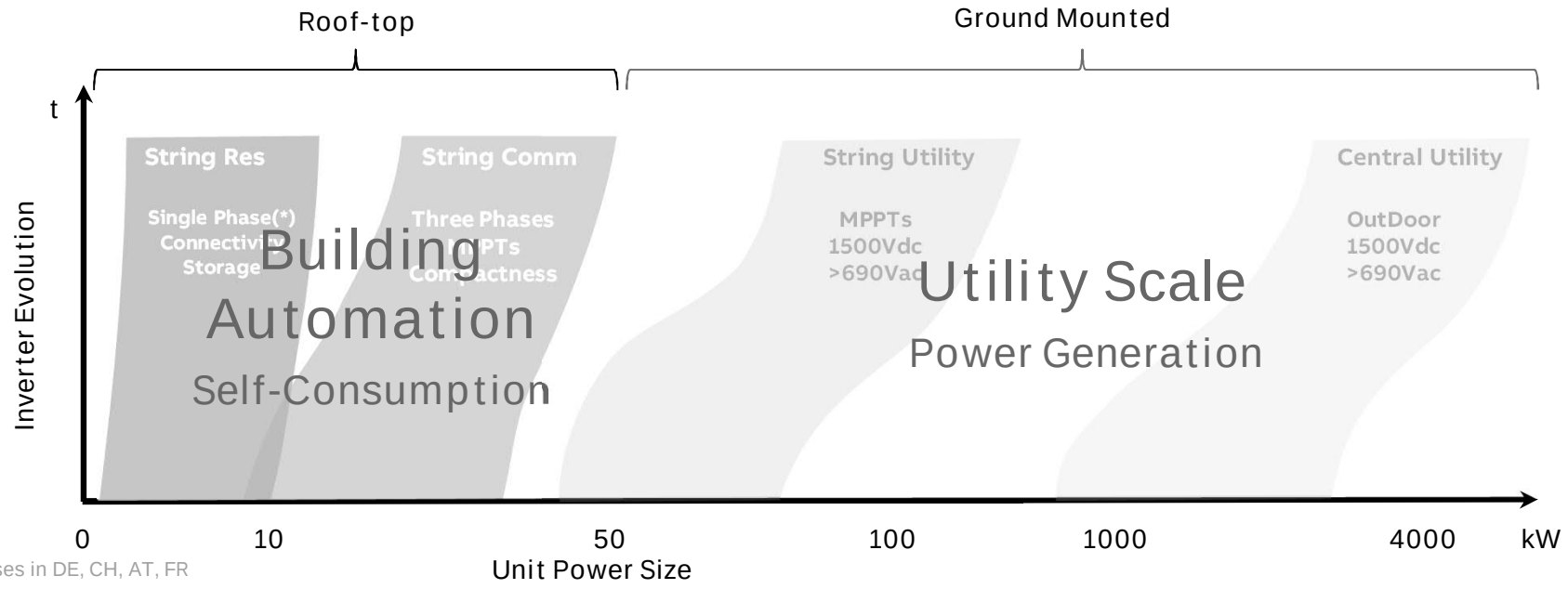
Uncertainty about new protective measures (import taxes) announced in US and similar ones which may come in other relevant markets as India.

In the Utility segment, in the past served with Central Inverters technology, string taking off replacing the previous ones

Product evolution expected

PV inverter technology close to maturity but still evolving

Two main applications going forward

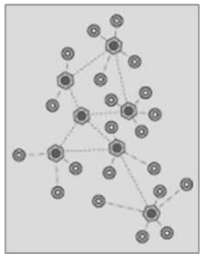


(*) Three Phases in DE, CH, AT, FR

Enabling grid digitalization

Minimizing wastage and meeting network needs

Full energy management system

Segment		New digital system platforms	
Res / Comm	Self-Consumption Roof-Top	• User friendly • Load management • Virtual Power Plant	
String Utility/Comm / Central Utility	Power generation Ground mounted	• Scalable • Easy upgrade • Full data reliability	

Enhancing the future energy market

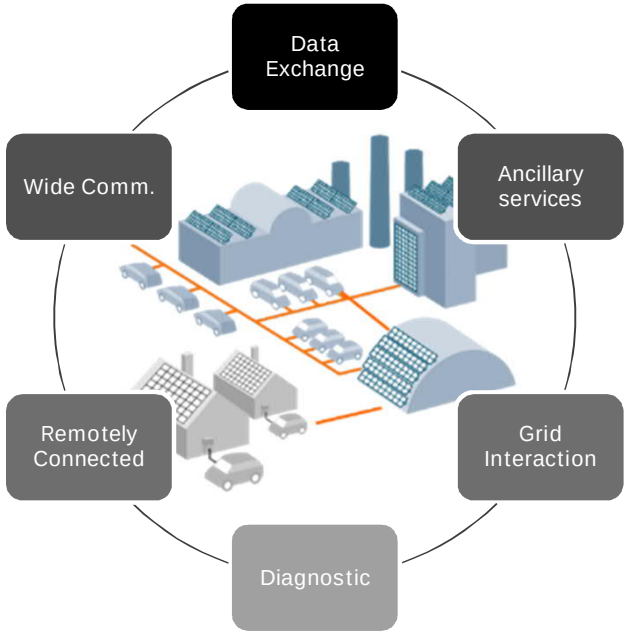


ABB Business Unit Solar

Count on our experience, expert knowledge and strong global footprint

- 40 years experience in power conversion
- Over 25 years in solar
- 30+ GW installed solar inverters base

- ~200 ABB solar service experts
- Optimized levelized costs of electricity and plant productivity

- Operate in +100 countries with dedicated solar specialists in 30+ countries

- 3 solar inverter operational facilities
- 6 new products and platforms in 2018
- ~2 million inverters worldwide shipped

ABB has the complete sun-to-socket offering from a single source

The market segments we operate in

From a single kilowatt to multi-megawatts

Residential

Usually projects below 10kW

- All about rooftop, typically single phase, one or very few inverters
- High value to connectivity, user friendly

Commercial & Industrial

Between 10 to 5000kW

- C&I roofs, all three phases, some or many inverters
- Flexibility, compactness and performances the keys

Utility

Above 5000kW

- Massively ground mounted
- From LV to MV, always big and many units
- $/W, performances and O&M on top

Microgrid

On/Off-grid projects

- From kw up to MW
- Rural installations primarily in Emerging countries

For on- and off-grid applications, across all power ranges and business models.

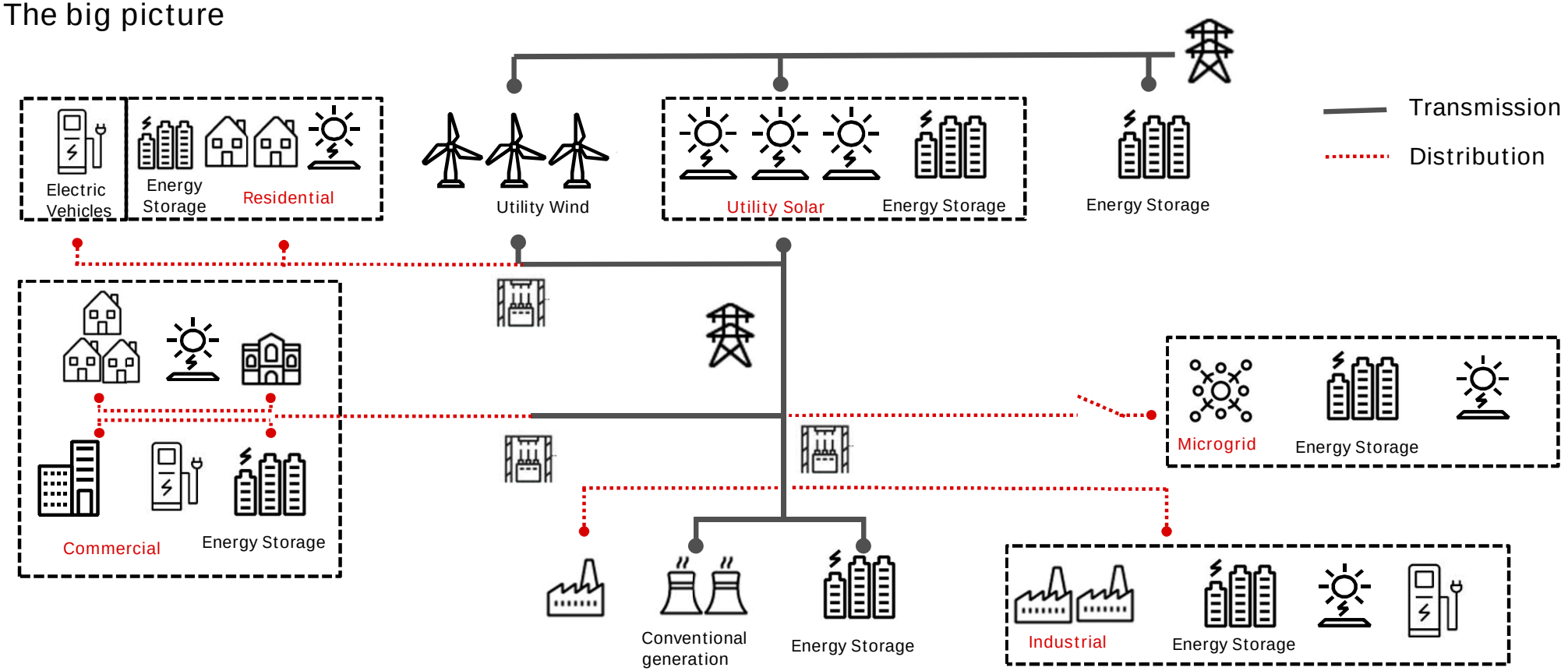
Our portfolio

Broadest inverter range in the industry

- For all power ranges, and all on- and off-grid applications and business models
- One-stop-shop with ABB‘s sun to socket portfolio
- Backed by a comprehensive package of communication, monitoring and control solutions and service across the complete plant lifetime

Macro electricity system

The big picture



Utility-scale PV

Creating new business with high power string inverters

PVS-175 for utility-scale applications

Ultra-high power, award-winning, 1500V three-phase string inverter

Evolving from component to an innovative, complete «all-in-one» solution

inter solar award 2018 WINNER

- Technological Advancement
- O&M friendly
- Advanced Communication for O&M
- Fuse-free design
- Maximized flexibility
- Easy to install

ABB – PVS-175-TL

Innovative unbeatable solution

Technological advancement

185kVA @30°C/ 175kVA @40°C:
The World's Highest Power Inverter in the String Category.

1500Vdc/ 800Vac to achieve up to 50% increase of exported power capacity compared with 400Vac systems.

Fuse-free design

2 inputs for single channel with MPPT-level current sense, minimizing mismatch and increasing energy harvesting.

All in one integrated string combiner reduces capex and opex costs.

O&M friendly

Minimized O&M costs thanks to modular construction & advanced cooling system.

Fuse free design to reduce failure rate and field intervention.

Maximized flexibility

12 independent MPPTs for the easiest configurability in all ground conditions.

Wide input voltage range 850-1350V for a large adoption.

Advanced communication for O&M

Remote FW update & Parameters upgrade.

Integrated datalogging with direct connection to ABB's cloud service.

Extremely easy commissioning and troubleshooting via a single access point (mobile device) for all units.

Easy to install

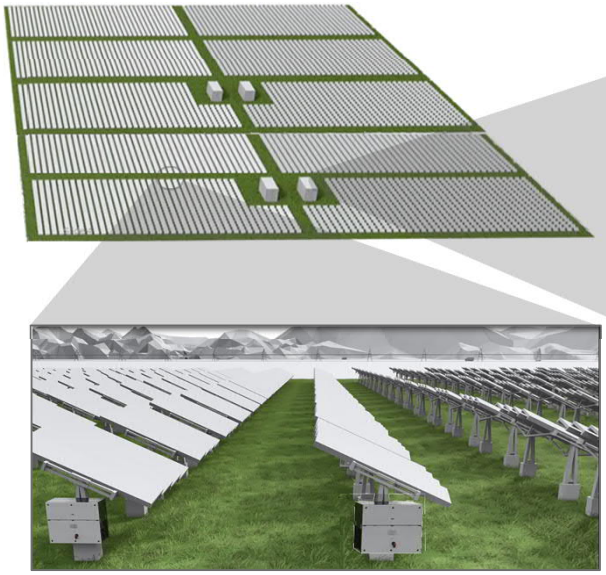
Save time and costs on site preparation and commissioning.

2 construction boxes. Two-men installation category inverter.

ABB – PVS-175-TL

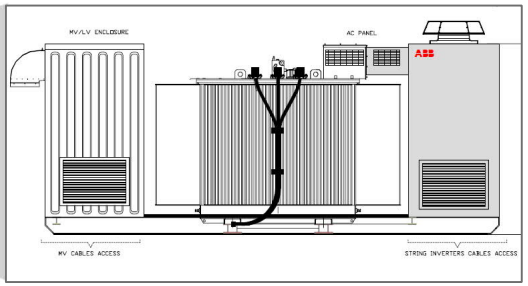
The ideal solution for decentralized utility-scale application

Integrated solution overview



All in one integrated string combiner

MVCS (MV Compact Skid)



Fits within a 20ft container

- Dedicated protected feeder for each inverter
- All auxiliaries included
- Oil Transformer
- Up to 6.7MVA
- Most cost efficient

OR

MVS (MV Station)

Containerized 20ft solution

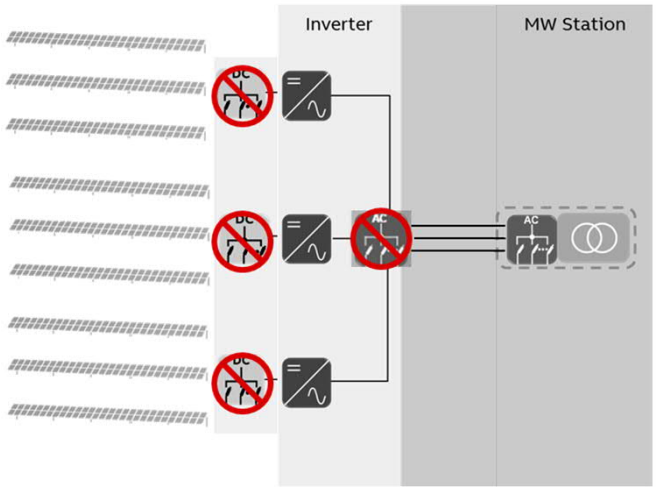
- Dedicated protected feeder for each inverter
- All auxiliaries included
- Dry Transformer
- Up to 6.7MVA
- Self-transportable solution

ABB – PVS-175-TL

The ideal solution for decentralized utility-scale application

PVS-175 the «all in one solution»

Designing inverters not only offering lower cost/ watt but also other system benefits will be required to further contribute to the overall system cost reduction:



Inverter & Station that's it!

CAPEX — Reduce the total number of components and avoid redundancies

- 1500Vdc/ 800Vac to deliver 185kVA per unit (the world record power capacity)
- All in one solution with integrated DC/ AC recombiners

OPEX — Minimize O&M costs avoiding time spent on site

- Fuse free design
- Modular construction with detachable power module
- Remote FW upgrade & parameter's setting (thanks to ABB Ability™)

YIELD — Preserving maximum energy Yield

- 12 independent MPPTs (2 inputs for single channel)
- Fuse free design

Solar integrated products

Various options for all combinations

Central inverters

PVS800 @1000Vdc

up to 4.2MVA

IS+MVP

PVS980 @1500Vdc

CS

up to 4.6MVA

Inverter(s) + MVP

String inverters

PVS-120 @1000Vdc

up to 3.1MVA

Inverters + MVS

PVS-175 @1500Vdc

up to 5.2MVA

Inverters + MVS

The new era of digital solar plants

ABB is ready for next generation of smart grid with ABB Ability™

Digital controls enabling digital grid and buildings

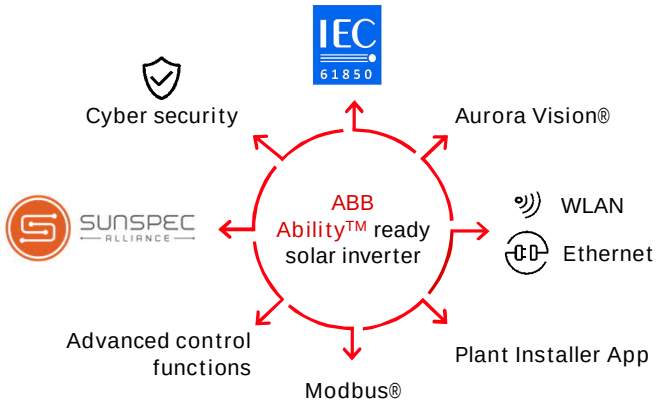
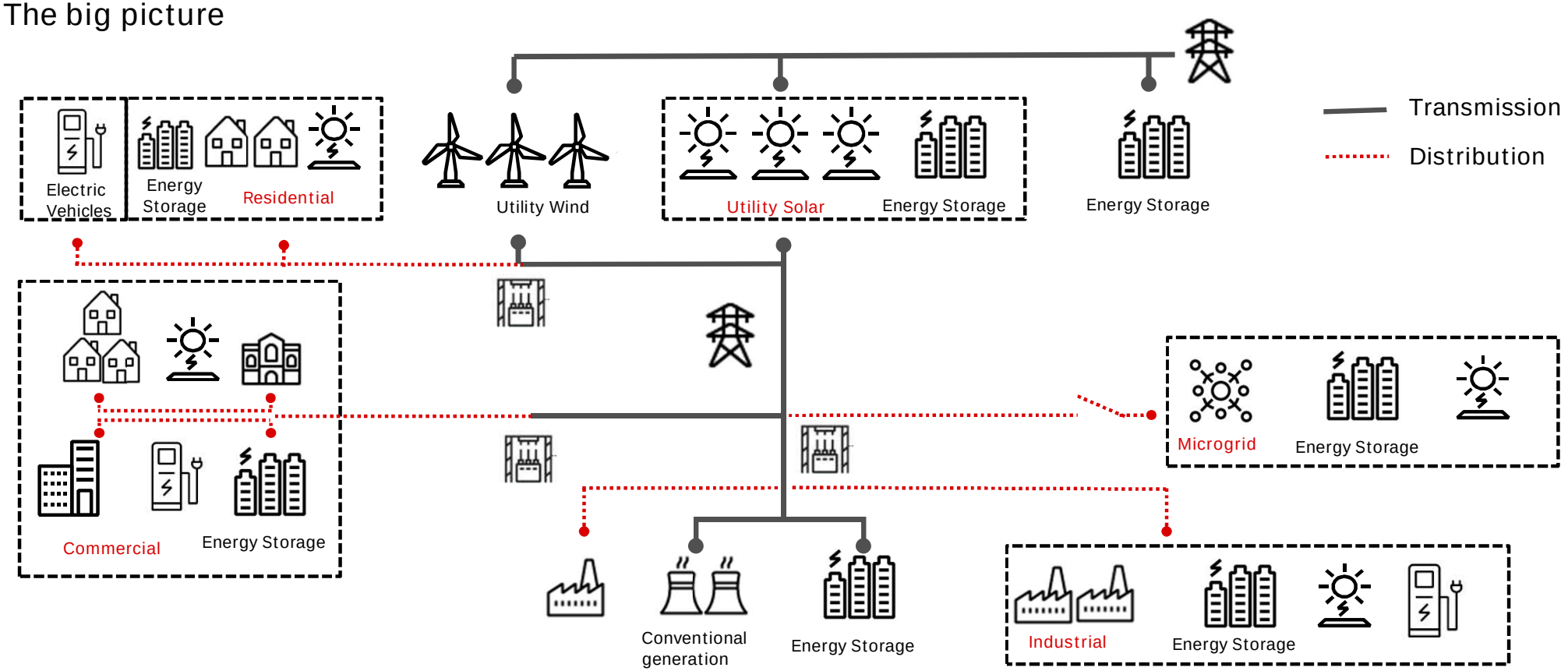


ABB Ability™ represents our complete portfolio of digital solutions

Macro electricity system

The big picture



Major shift towards self-consumption in the residential market

Storage technology will be the major game changer for energy systems

REACT 2

Single phase string inverter + Storage – 3.6kw to 5kW PV with 4 to 12kWh

Shaping the next generation of smarter homes

- Easy to install
- High energy self-reliance
- High energy efficiency
- Maximized flexibility
- High versatility
- Advanced Communication

REACT 2

Value proposition in detail

Easy and safe to install

Save time and costs on system installation thanks to plug and play battery and WUI

High energy self-reliance

Significantly reduce electricity charges thanks to an achievable energy self-reliance of up to 90%.

High energy efficiency

The inclusion of a high-voltage battery (200 V) delivers more reliability and up to 10% more system efficiency compared to lower voltage alternatives (48 V).

Maximized flexibility

The modular solution can grow with the needs of any household from 4 kWh to 12 kWh (up to 3 module).

Battery has not to be physically joint to the inverter

High versatility

Ability to be installed on both AC and DC sides, offers the perfect solution for new systems or the retrofitting of existing photovoltaic systems.

Advanced Communication

Thanks to native wireless and ethernet connectivity and the compatible with Free@home and other home automation systems, home owners can make the best use of the electricity generated by their photovoltaic system

REACT 2

ABB-Free@Home integration: End-to-end customer value creation

Customer needs

Home Owner

- Reduce energy consumption from the grid
- Increase energy self-consumption from solar
- More comfort

Installer

- Fast Installation
- Free and flexible

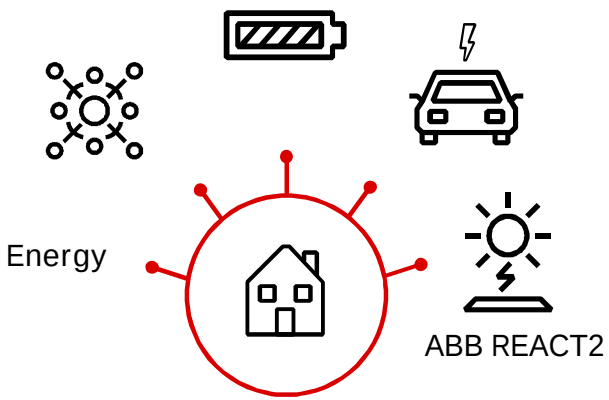


ABB Value proposition

Unified user interface allows to keep under control home consumption and solar production reducing energy consumption

- Up to 5% increase of self-sufficiency[1]

Load manager (via Actions configuration menu) allows to shift high power loads when there is high irradiation

- Up to 20% increase of self-consumption[1]
- Up to 15% increase of self-sufficiency[1]

Commissioning is particularly fast and saves valuable working hours.

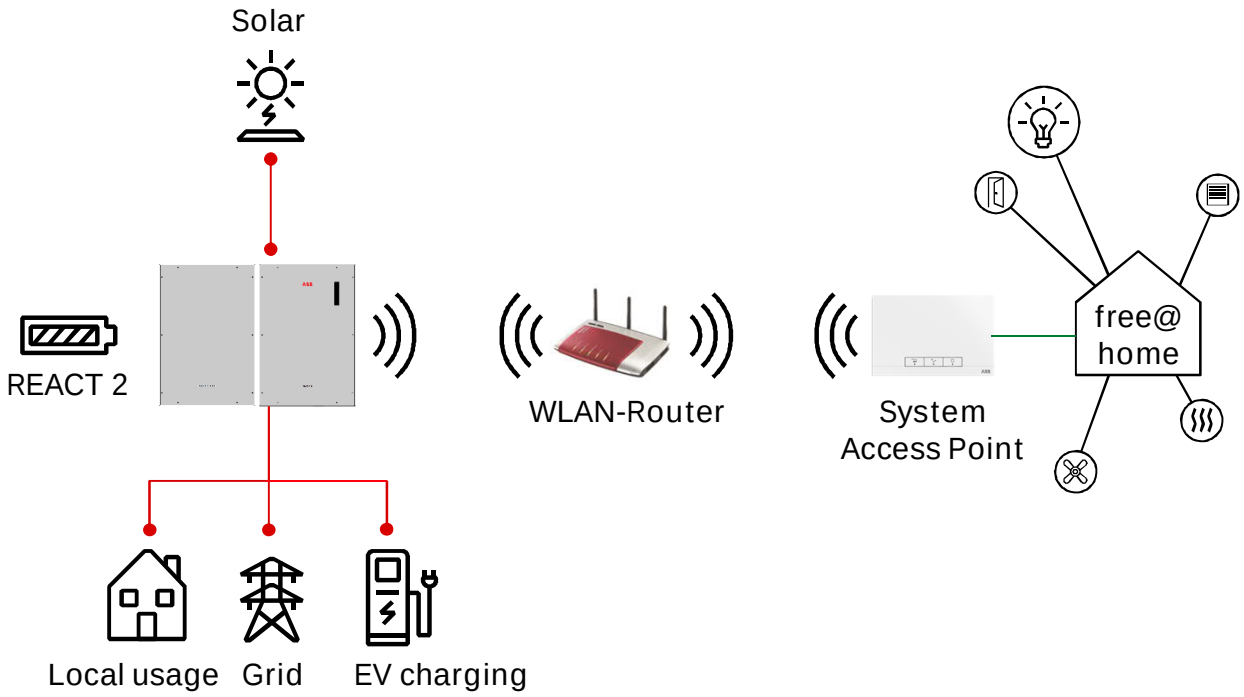
ABB-free@home and REACT 2

Shaping the next generation of smarter homes

Overview

The integration of the ABB REACT 2 into free@home is carried out thanks to the integration of ABB-free@home protocol into REACT 2. The data of REACT 2 are “compiled” and transmitted via the IP protocol to the ABB-free@home system access point, which in turn controls the other free@home devices.

Prerequisite for the integration of the REACT 2 into ABB-free@home is a REACT 2 (2), a router (1) and an operable free@home system (3)



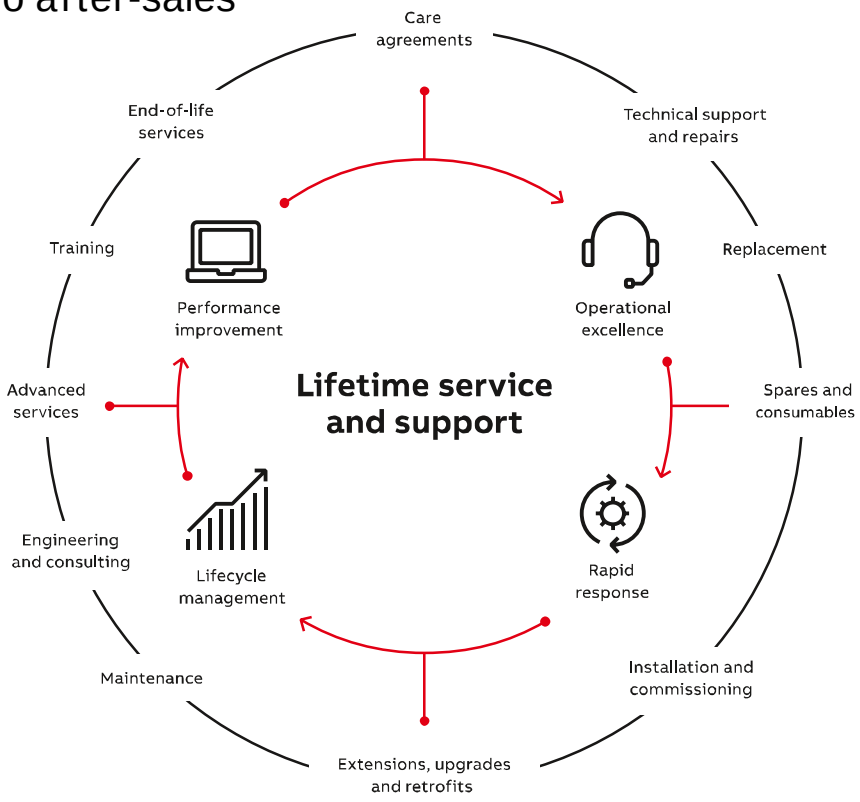
Services you can count on

Experts supporting the whole process from pre-sales to after-sales

Maximize uptime of inverters throughout their lifetime

Extensive global network enables local service delivery whenever and wherever you need it

Together, we can plan services which address your maintenance, training, technical support and service contract needs



Revitalizing farming in drought-hit rural areas

New solar initiative in South Australia gives farmers a boost

- Solar farms make use of disused agricultural land
- 28 sites have been installed, with another 34 on the way
- Farmers now have a second income stream and a stronger local economy

ABB technology helps SENA expand solar homes in Thailand

Residents can reduce the energy taken from the grid and lower the cost of electric bills

- ABB has provided 350 transformerless single-phase inverters, UNO-DM-PLUS 2.0
- Allow higher performance in a small space and enable integration with current and future devices for smart building automation
- Thanks to the proven advantages of residential solar power and ABB's high-performing and reliable technology, SENA expects to gain more consumer recognition.

Rural advances supporting national change

Reducing rural dependence on fossil fuels to help meet Malaysia's national energy targets.

- Malaysian government aiming to achieve total electrification by 2025
- Focus on replacing fossil fuel dependencies with renewables in rural areas
- Depending of ABB's MGS100 to provide reliable, off-grid solar power

Growing the business together

You want

- An attractive offering easy to sell into your project
- Value-add complete and easy solutions
- Marketing support and demand generation
- Simple, standardised configurations and tools to minimise your planning and transaction costs
- No after-sales trouble and good manufacturer support

We provide

- The broadest global portfolio of sun-to-socket solutions to deliver reliability, productivity and efficiency
- Integrated offerings for the different market segments
- Strong ABB brand and continuous promotional support
- Sales and technical tools making your business easier
- Strong sales and service footprint in all relevant solar markets
- Training for your sales teams and for your customers

How can we work with you to grow your solar business?