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pv magazine Webinar: From innovative inverter to disruptive system design

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With

- Marco Trova, Global Product Manager, ABB
- Moderation: Emiliano Bellini, pv magazine

Content

- Cost breakdown trends in the utility-scale market
- Inverter evolution: Inverter + transformer Station
- Modular construction with detachable wiring box
- Power electronics and system-level cost savings outside of the inverter
- 1500Vdc and 800Vac combined to enable higher power density and cluster capacity
- Advantages of multi-MPPT technology

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There’s a new power in Solar

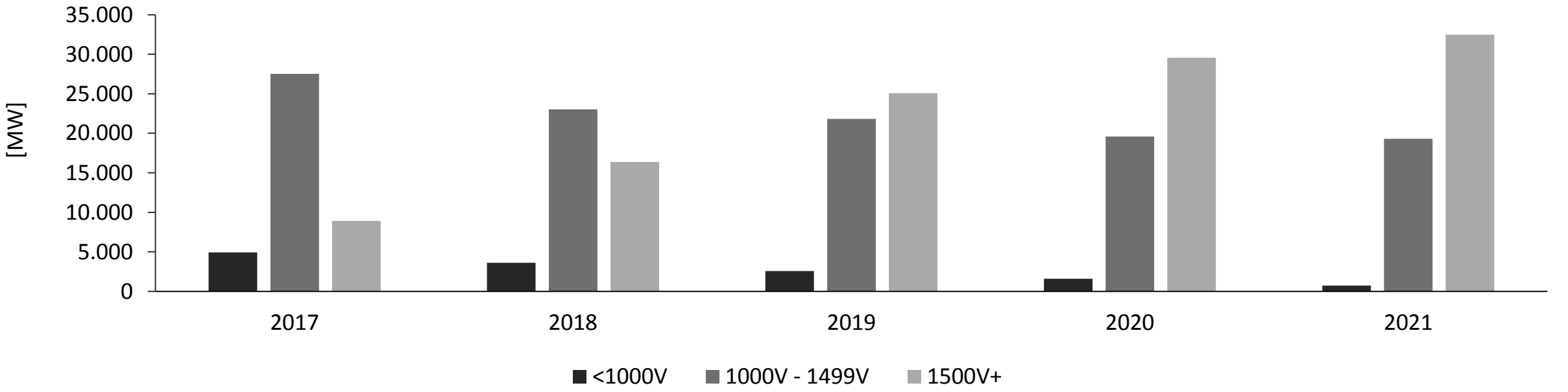
1500V ultra-high power string inverters for utility-scale PV applications

Andrea Genovesi, Gianluca Marri, Marco Trova

Utility-scale PV market trends

Technology is fast moving to 1500Vdc

WW Utility scale market by DC voltage

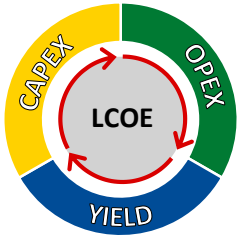


Utility scale projects are moving to 1500Vdc !

Sources: IHS Research, GTM, ABB Internal

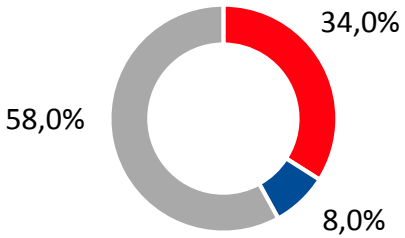
Utility-scale PV market trends

Outlook on CAPEX and OPEX evolution in the next years

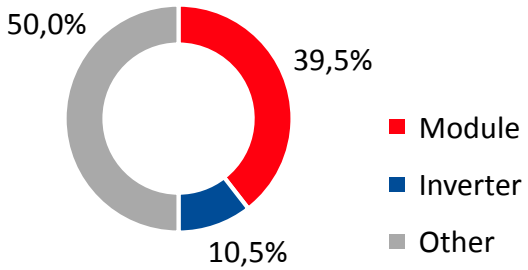


CAPEX repartition trend

2015 Capex repartition



2025 hypothetical scenario

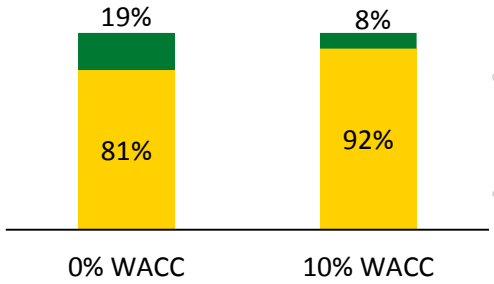


Cost trend over next coming years

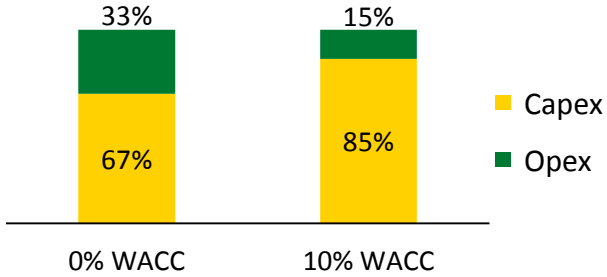
- PV Module: - 32% in 2025
- Inverter: - 25% in 2025
- **Other : - 50% in 2025**

Estimated OPEX and CAPEX share in the LCOE

2015 repartition



Expected situation in 2025



Capex
Opex

In 2025 the Opex can reach 33% of the Total LCOE!

Major cost savings will come from "other costs" (Soft Costs, Installation, Hardware)

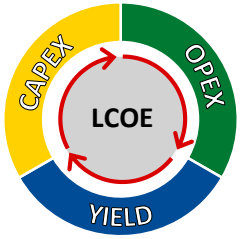
CAPEX reduction will increase the share of the OPEX in the LCOE

Inverter design targeting Total System Cost reduction is required!

Source: IRENA analysis and Photon consulting, 2016

ABB – PVS-175-TL

Setting a new trend in the solar inverter technology



System cost breakdown evolving towards an higher share of BoS and O&M

Identifying other areas for cost optimization while preserving the yield

$$LCOE = \frac{CAPEX + OPEX}{YIELD}$$

How inverters can support the solar industry to tackle these challenges?

	CAPEX	OPEX	YIELD
Evolving from component to a complete «all-in-one» solution Modular construction with detachable wiring box	↓	↓	
Power electronics enabling further system-level cost savings 1500Vdc/ 800Vac = highest power density and cluster capacity	↓	↓	
Multi-MPPT Technology, offering maximum energy yield Fuse & DC combiner free design, minimizing EBoS and O&M	↓	↓	↑

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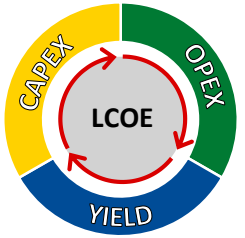
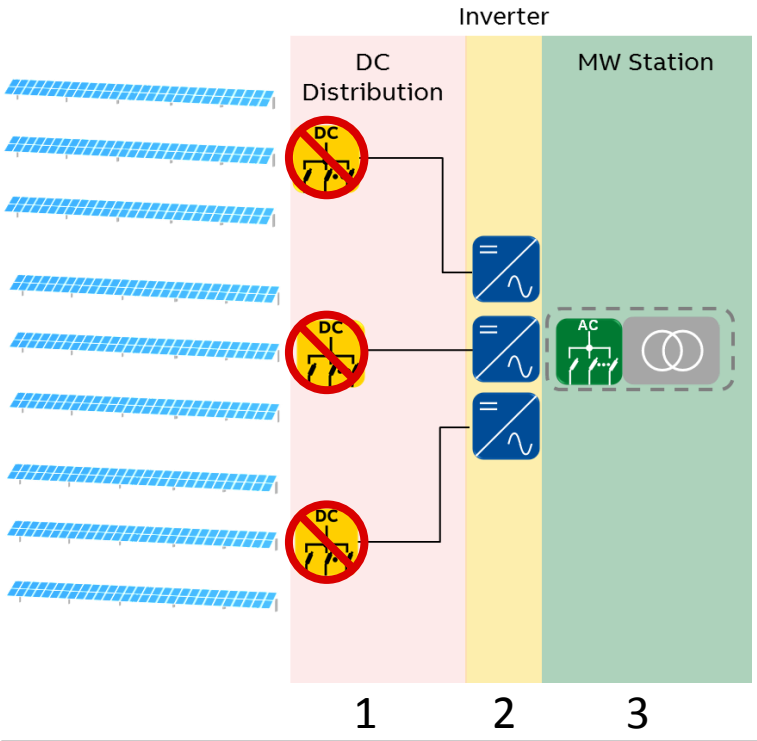
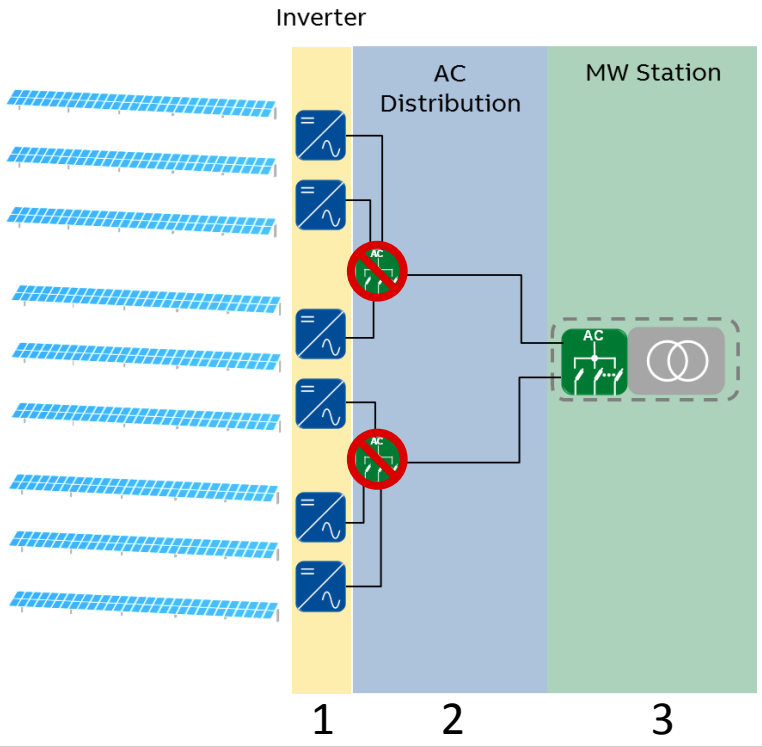
Evolving from component to a complete «all-in-one» solution



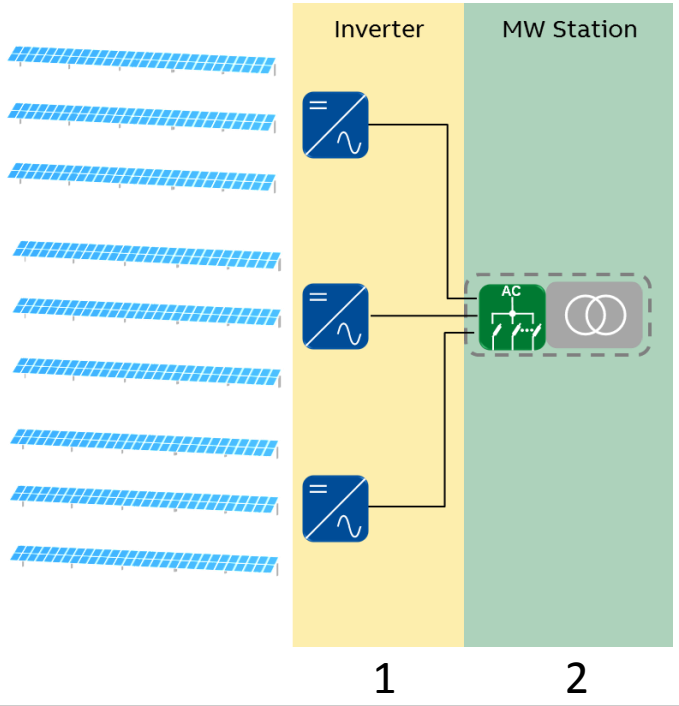
Virtual Central Inverter



String Inverter



"All-In-One" String Inverter



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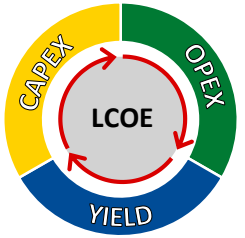
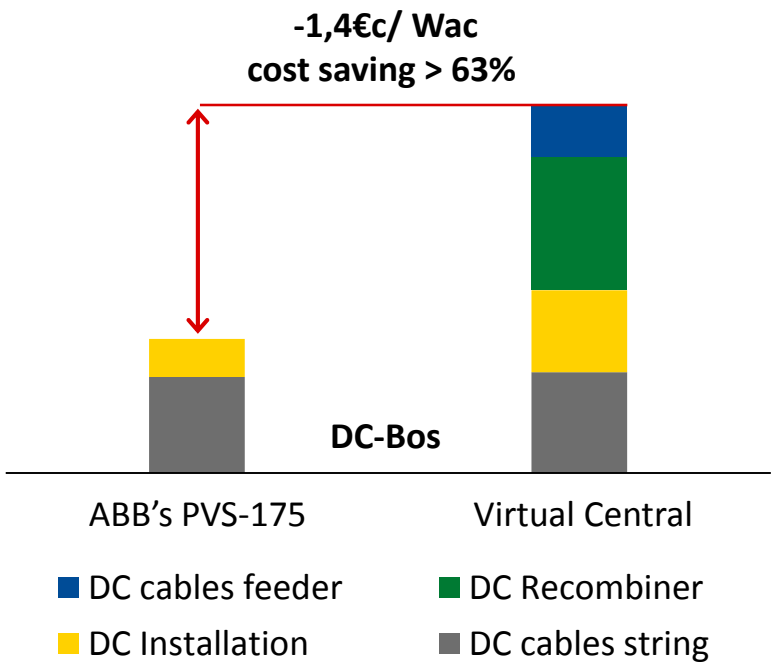
Evolving from component to a complete «all-in-one» solution

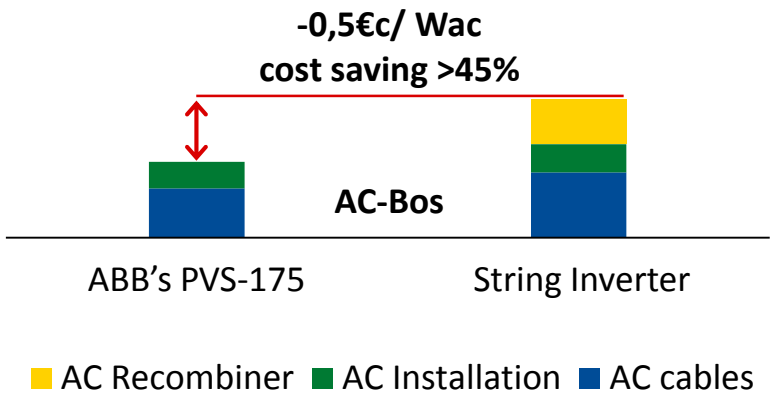


ABB's PVS-175 the «all in one solution» – BoS benefit

Virtual Central inverter



String inverter



PVS-175 additional cost savings

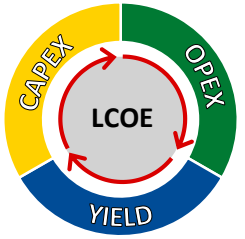
Logistic: Up to 65% less component to store onsite

MW Station: Enabling bigger cluster size

Civil works: Reduced basements and mechanical structures with respect to Virtual central solution

ABB – PVS-175-TL

Evolving from component to a complete «all-in-one» solution



ABB's PVS-175 the «all in one solution» – O&M benefit

Modular construction with detachable wiring box reducing installation and maintenance effort.

- Two box structure (power module ~76kg, wiring box ~77kg)

Benefits:

- **Two person can manage** the mounting of boxes
- **Power module can be easily replaced** without removing the wiring box.

Cost saving on logistics:

- Wiring box/ inverter box **can be stocked separately**
- **Future local variants** of wiring box possible

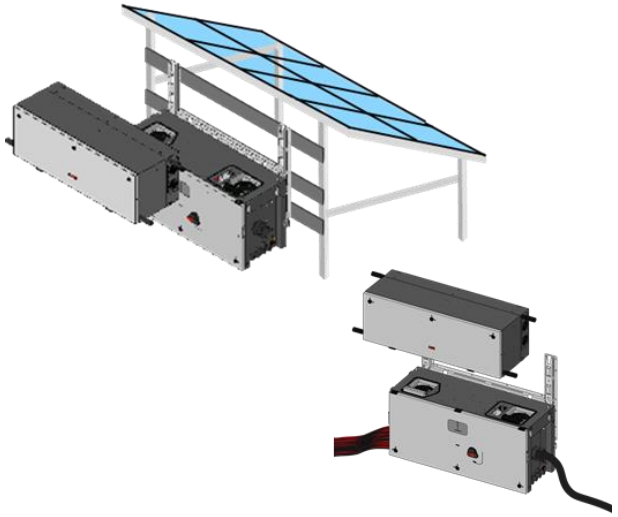
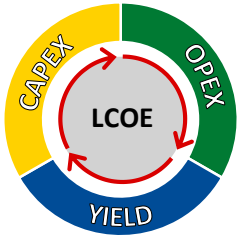


ABB – PVS-175-TL

Evolving from component to a complete «all-in-one» solution



ABB's PVS-175 the «all in one solution»

Reducing time spent on site: Commissioning, FW Upgrade, parameter's setting and troubleshooting may be performed either remotely via cloud or locally through a mobile App.

Minimum costs (both OPEX and CAPEX)

- Multi-inverter plant commissioning via Installer App
- Intelligent, remote monitoring and control

Protecting customer's investment

- TCP/IP as proven standard technology
- Cyber Security managed data transfer

Reduced plant complexity, improved reliability

- Integrated digitalization capabilities with ABB Ability™
- Direct transferring of telemetry data to cloud

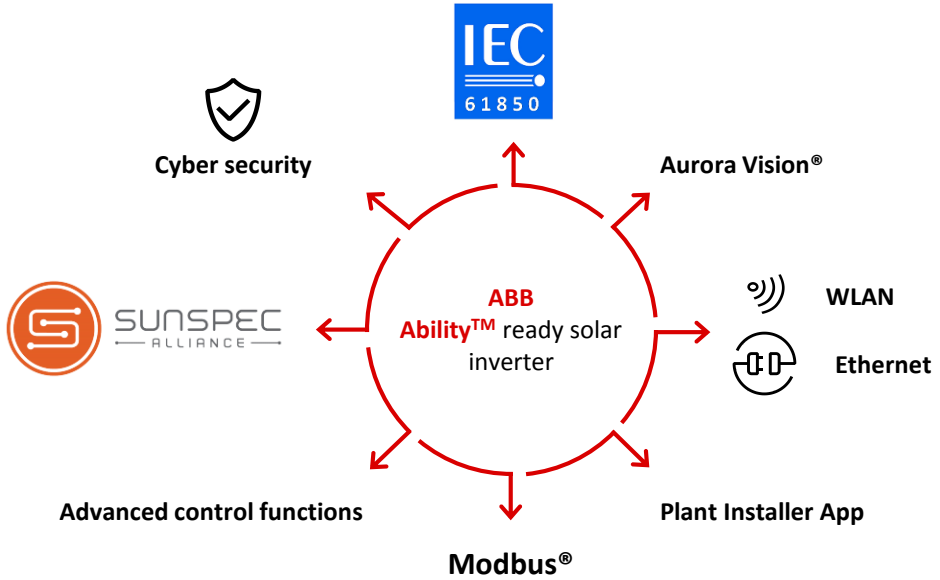


ABB – PVS-175-TL

ABB Ability™

ABB Ability™

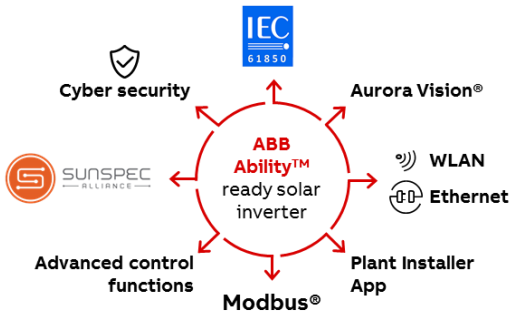
Improved user experience in large scale installations (Installer App for plant commissioning)

Self-consistent: advanced logging and control capabilities embedded into the inverter

Reduced time on site: Life time free remote cloud services (FW upgrade, asset management)

Proven technology: for better protecting customer' s investment (TCP/ IP, Modbus Sunspec certified, IEC 61850 information model,…)

Future-proof: meet current and future regulatory norms (like Rule 21- Step 2, EC61850, …)



Protecting customer investment

Off-the-Shelf TCP/ IP components

Standard technology: no need to educate people

IP protocol is the only one really suitable for IoT

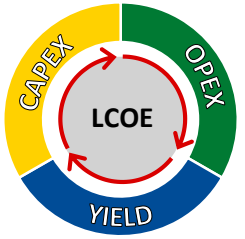
Modbus TCP Sunspec: trouble-free integration with third party devices

Multiple data streams and services can run at the same time:

- Remote monitoring
- Plant control (incl. dynamic feed-in)
- Remote FW update
- Remote parameter's setting

ABB – PVS-175-TL

Enabling further cost savings with the world's highest power inverter in the string category



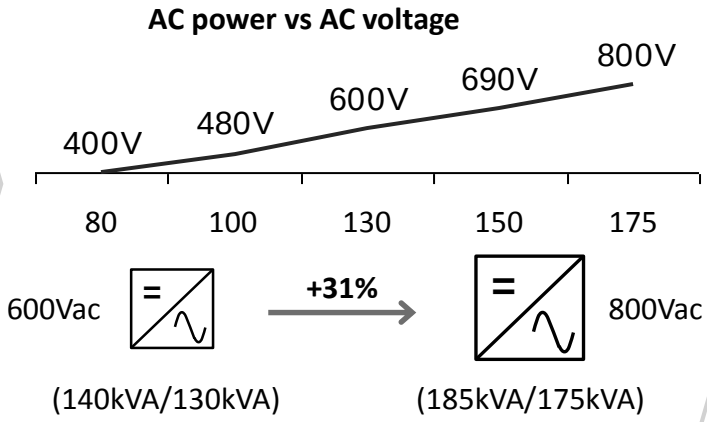
1500VDC allows high AC voltage!

High AC voltage is enabled with DC/DC boosters and 1500Vdc input voltage

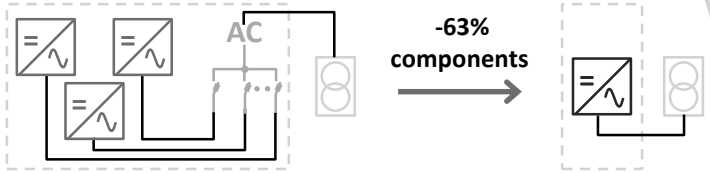
Single stage inverter reasonable max AC voltage ~ 600VAC, Dual stage inverter AC voltage can be increased to 800VAC

800VAC to reduce **Balance of System cost (i.e. AC side cabling)** and **enabling higher power units with same current (less units per power block)**

More power from the same enclosure



Less units and resources are needed

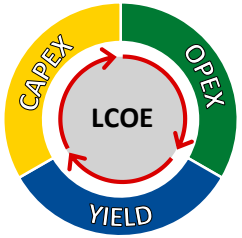


AC-BOS cost savings (LV distribution)

Bigger PV clusters may be designed

ABB – PVS-175-TL

Enabling further cost savings with the world's highest power inverter in the string category



1500VDC allows high AC voltage!

High AC voltage is enabled with DC/DC boosters and 1500Vdc input voltage

Main benefits

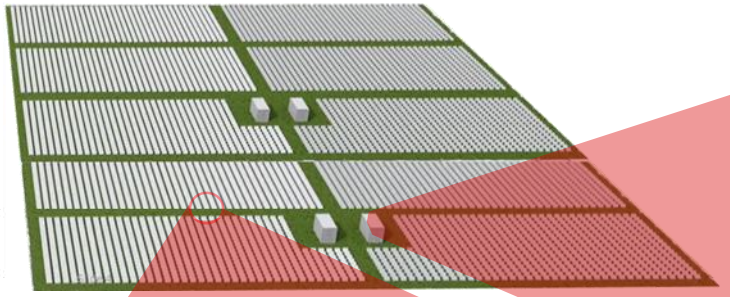
– Bigger PV clusters can be designed, reducing MV & AUX system costs, as well as installation costs!

100MWac project	Virtual Central (600Vac)	ABB's PVS-175 (800Vac)	Cost saving
N° of Cluster	27	20	Installation and Civil works → 26%
N° of MV/LV transformer	27 x (3,7MVA)	20 x (5MVA)	Equipment → 6%
N° of MV switchgear	27	20	Equipment → 26%
N° of LV switchgear	27	20	Equipment →19%
Total cost saving for equipments			**~ 0,3 €c/W**

ABB – PVS-175-TL

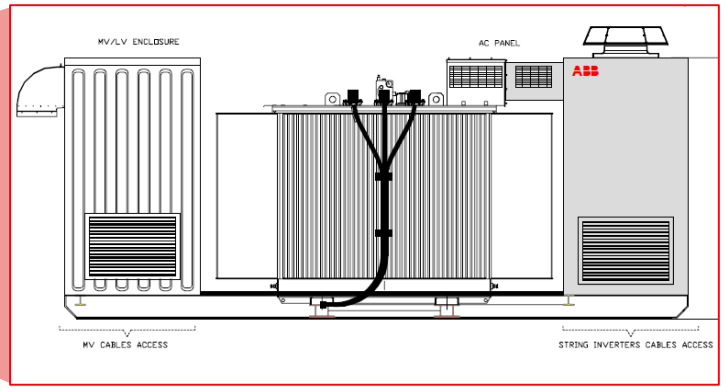
The ideal solution for decentralized utility-scale application

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 auxiliares included
- Oil Transformer
- Up to 6.7MVA
- Most cost efficient

OR

MVS (MV Station)

Containerazed 20ft solution

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

ABB – PVS-175-TL

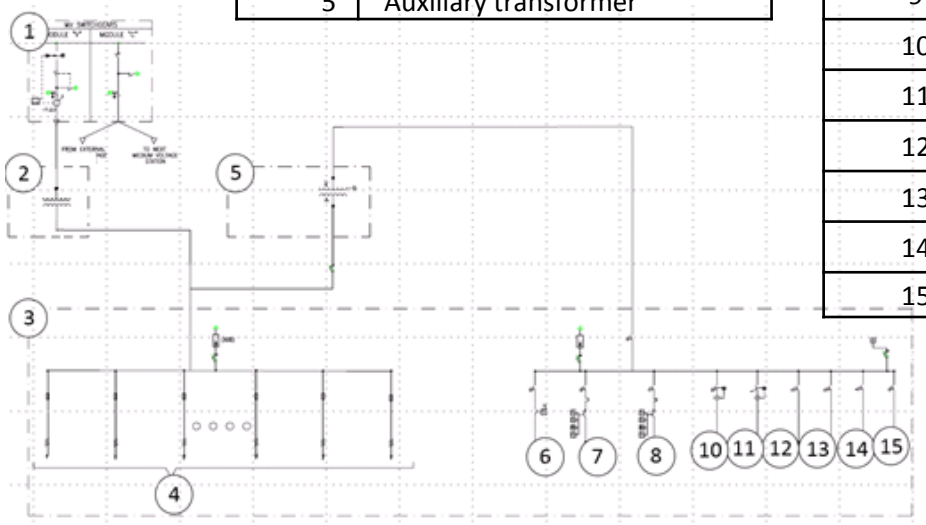
The ideal solution for decentralized utility-scale application

MVS main characteristics

Data-sheet

String-MVS 5180	
Output (AC)	
Compatible String Inverter type	PVS-175
Maximum AC output power ($S_{MAX(AC)}$) @30C	5180 kVA
Maximum inverters inputs	28
Medium voltage range ($U_{N(AC)}$)	12 kV to 36 kV
Output frequency	50/60 Hz
Power factor compensation (cosφ)	Yes
Transformer type	ABB Vacuum cast coil dry type
Medium voltage switchgear type	ABB SafeRing, SF6 insulated (CV, CCV, CCVV)
Power consumption	
Máximum Own consumption in operation	Maximum 5900 W/ 3800 W
Auxiliary voltage for customer use	3 ~ 400 V/50 Hz, up to 40kVA
Dimensions and weight	
Width/Height/Depth	2438 mm/6058 mm/2438 mm (20' HC container dimensions)
Weight approx.	< 20 t
Environmental limits	
Degree of protection	IP54
Ambient temperature range (nominal ratings)	-20C to +50C
Maximum altitude (above sea level)	1000 m
Relative humidity	5% to 90%
Civil Code/standard	Eurocode: Roof/wind/seismic 200kg/47ms/0,3g.

Item.	Description
1	MV Switchgear
2	MV Transformer
3	AC cabinet
4	Inverter outputs
5	Auxiliary transformer

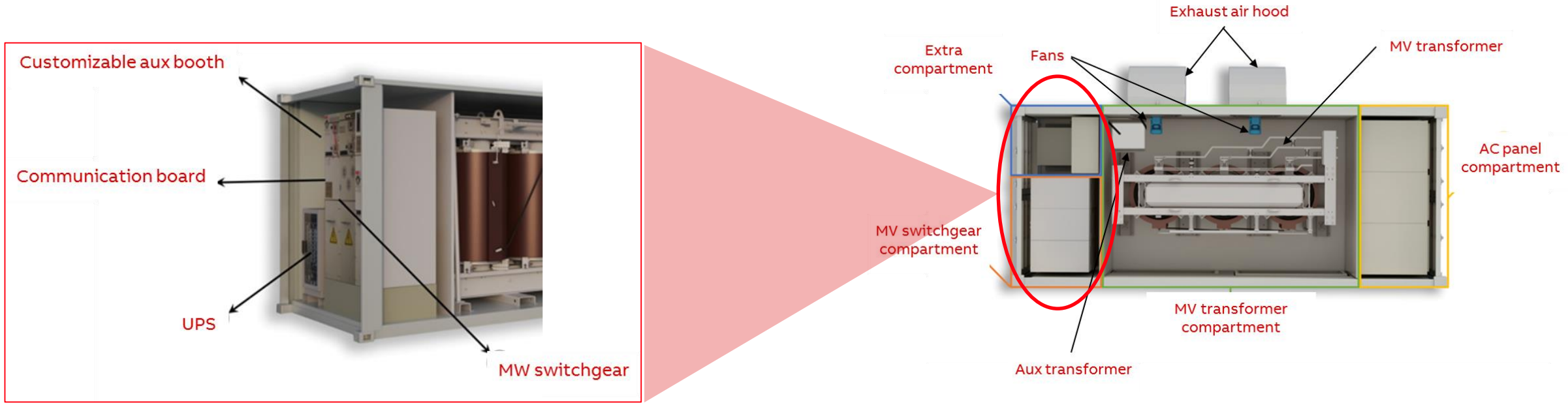


Item.	Description
	Auxiliary Services
6	AC cabinet heating
7	Transformers external fan1
8	Transformers external fan 2
9	External power socket
10	Lighting
11	Communication cabinet
12	MVS control equipment
13	AC cabinet control system
14	Spare
15	Spare

ABB – PVS-175-TL

The ideal solution for decentralized utility-scale application

MVS lay-out



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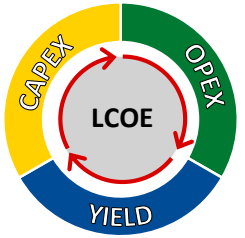
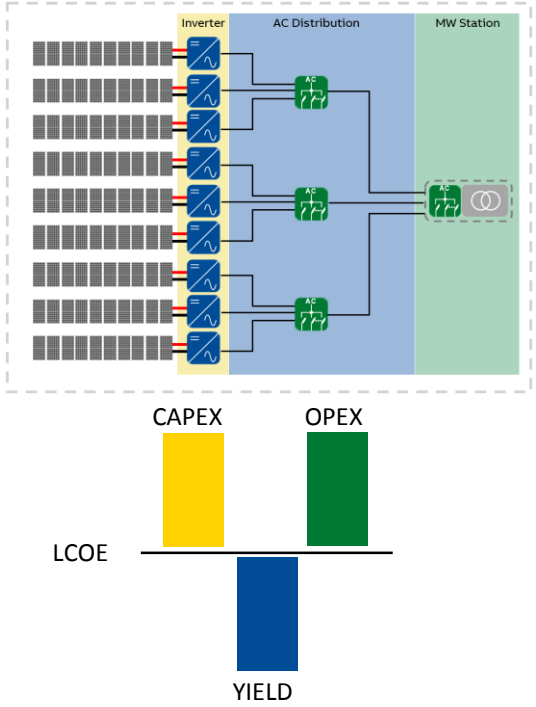
Preserving maximum energy yield while reducing CAPEX and OPEX of the system



Fully exploit the benefits of string inverters with Multi-MPPT and fuseless technology

String level Inverter



High YIELD and CAPEX

ABB – PVS-175-TL

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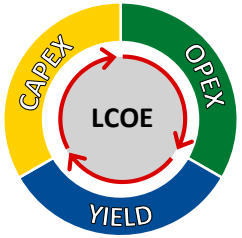

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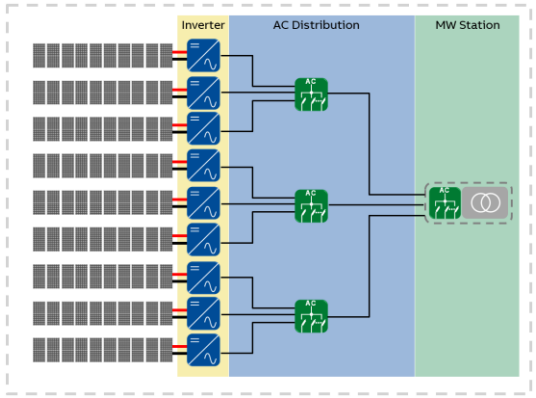
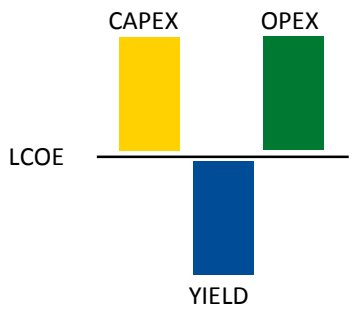
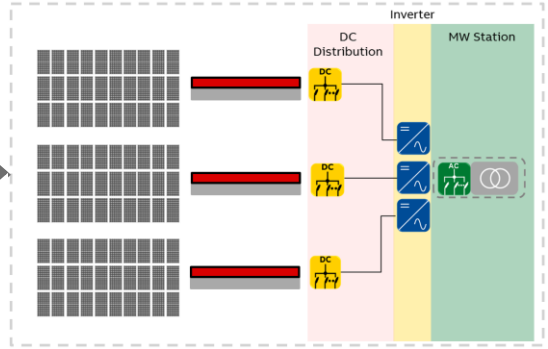
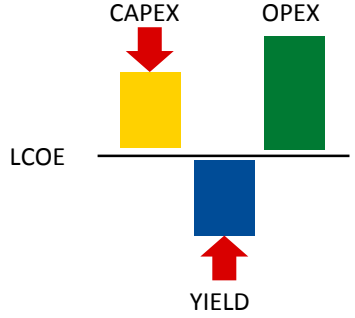




Virtual Central Inverter
(Single MPPT)

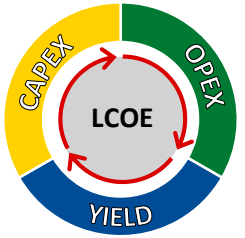




CAPEX reduction penalizing YIELD

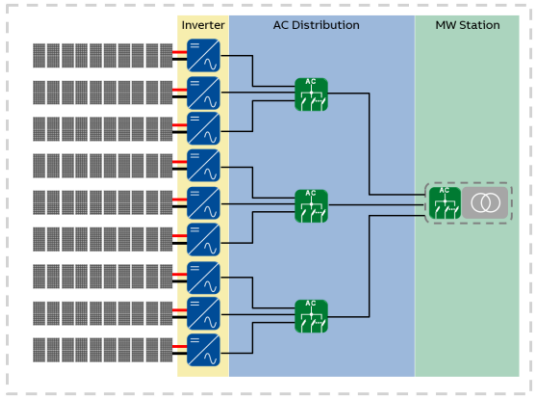
ABB – PVS-175-TL

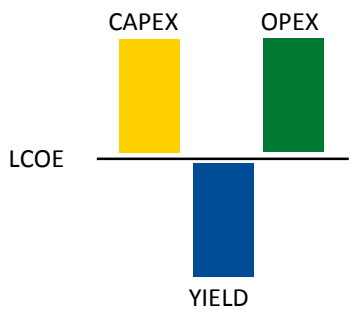
Preserving maximum energy yield while reducing CAPEX and OPEX of the system



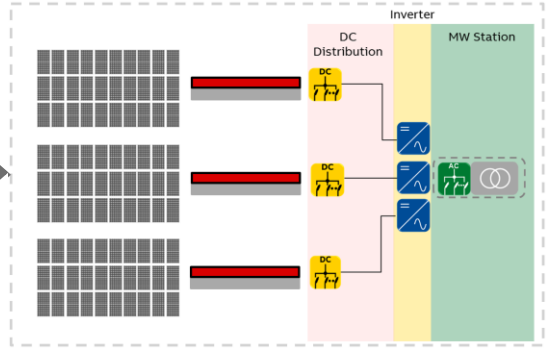
Fully exploit the benefits of string inverters with Multi-MPPT and fuseless technology

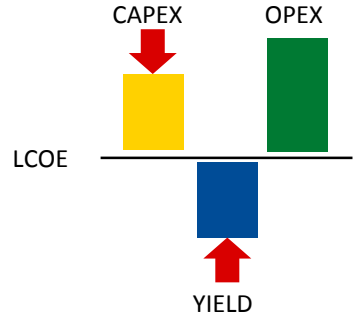
String level Inverter



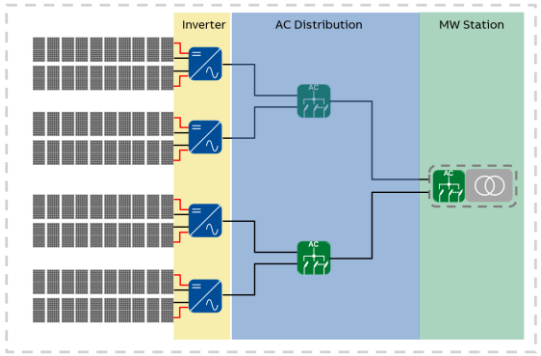


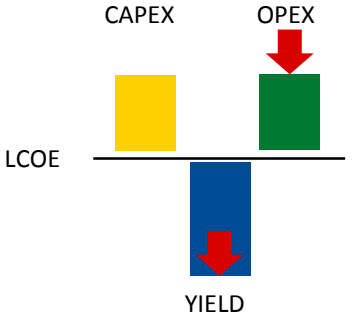
Virtual Central Inverter
(Single MPPT)





Multi MPPT String Inverter
(2 Strings x MPPT)

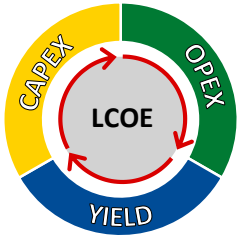




Maximizing YIELD while reducing OPEX

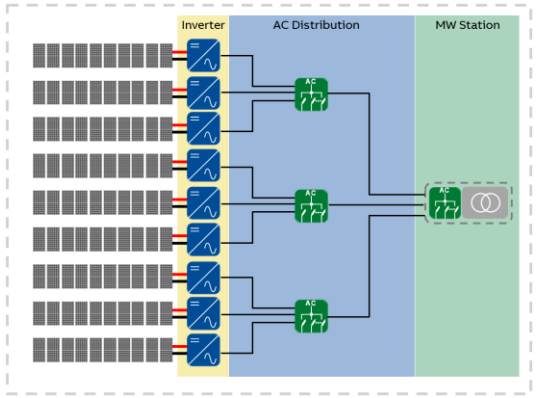
ABB – PVS-175-TL

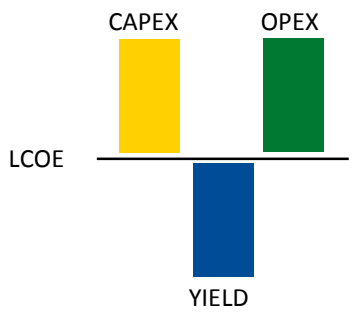
Preserving maximum energy yield while reducing CAPEX and OPEX of the system



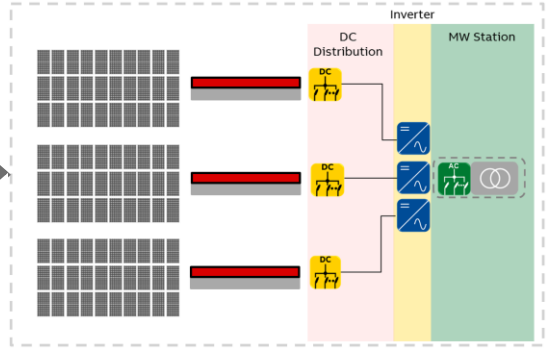
Fully exploit the benefits of string inverters with Multi-MPPT and fuseless technology

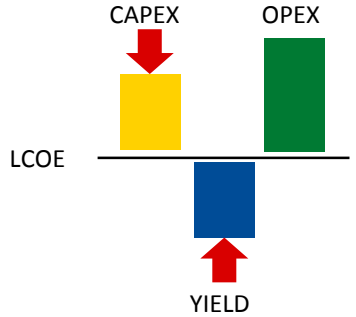
String level Inverter



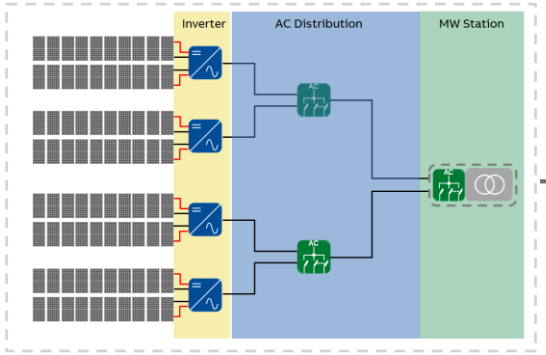


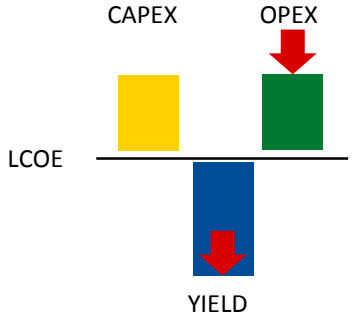
Virtual Central Inverter
(Single MPPT)



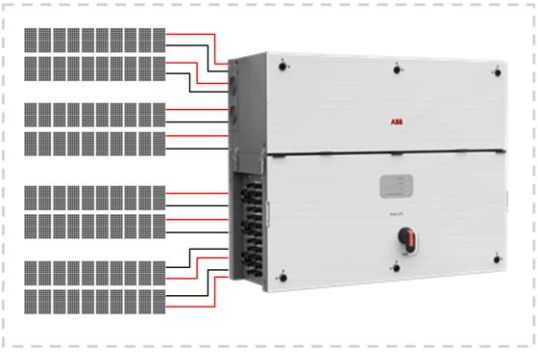


Multi MPPT String Inverter
(2 Strings x MPPT)





ABB's PVS-175
(12 MPPT/ fuseless/ detachable WB)



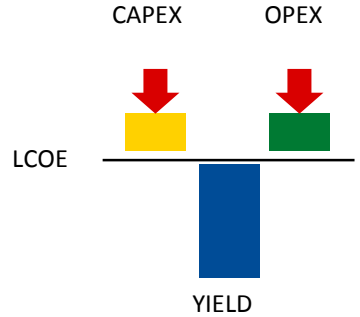
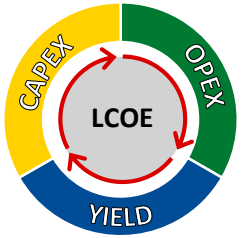


ABB – PVS-175-TL

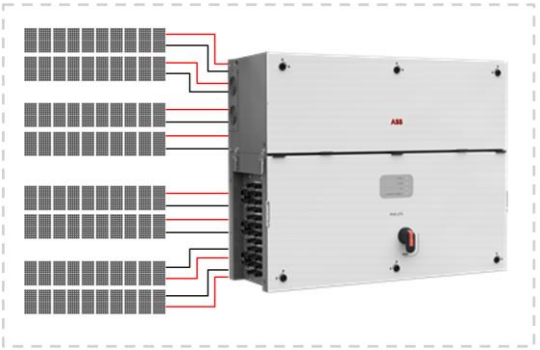
Preserving maximum energy yield while reducing CAPEX and OPEX of the system



Fully exploit the benefits of string inverters with Multi-MPPT and fuseless technology

Preserving maximum energy Yield while reducing CAPEX and OPEX

ABB's PVS-175
(12 MPPT/ fuseless/ detachable WB)



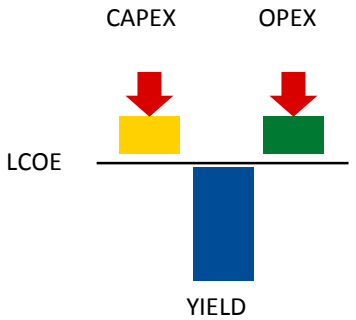
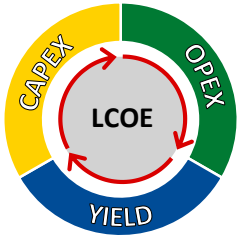


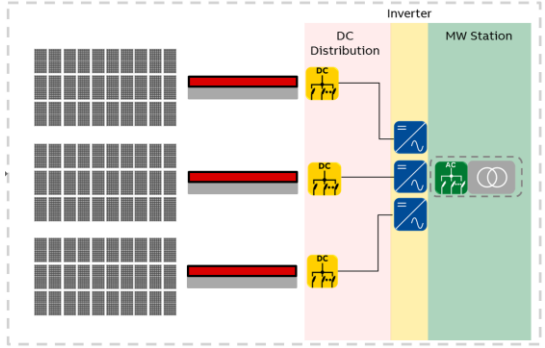
ABB – PVS-175-TL

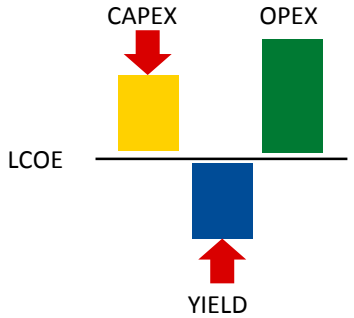
Preserving maximum energy yield while reducing CAPEX and OPEX of the system



Fully exploit the benefits of string inverters with Multi-MPPT and fuseless technology

Virtual Central Inverter
(Single MPPT)





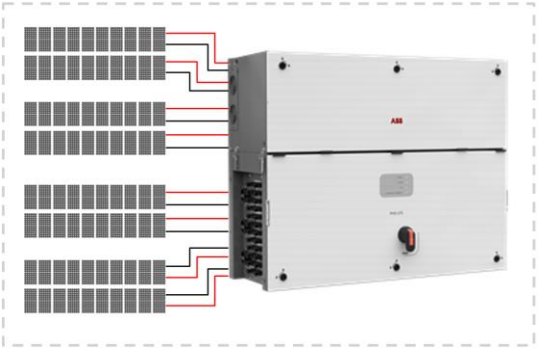
More power generation by	Multi-MPPT vs Virtual Central
Mismatch & Shading Losses (12 MPPT)	+0,3% ÷ +0,7%
Higher system availability (fuseless technology)	+0,1%
Overall Benefit using ABB's PVS-175	**+0,4% ÷ +0,8%**

Assumptions

- 2200 equivalent hours
- PPA @ 3€c/kWh
- (100MWac/20y)

Up to €1,1 Million additional income over 20 years !

ABB's PVS-175
(12 MPPT/ fuseless/ detachable WB)



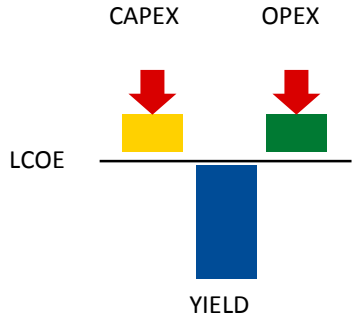
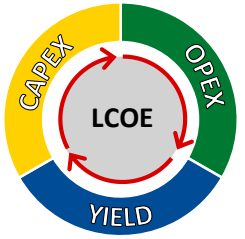
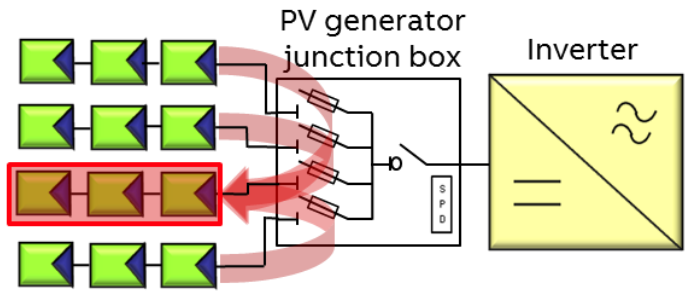


ABB – PVS-175-TL

Preserving maximum energy yield while reducing CAPEX and OPEX of the system



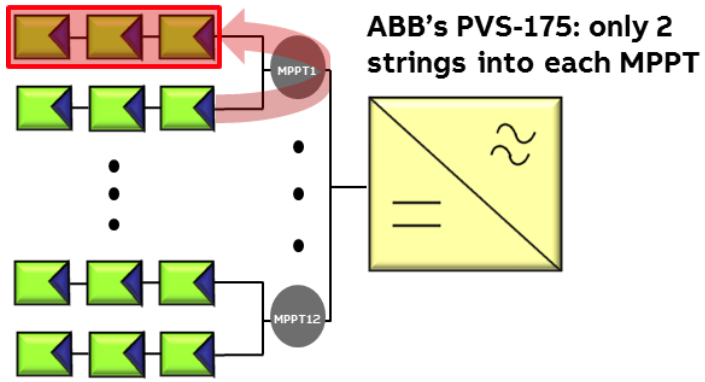
Fuseless technology benefit



The PV panels must be protected by reverse current according to manufacturer data-sheet.
Generally, if 3 or more strings are connected in parallel, a reverse current protection must be used.

Fuses are prone to nuisance tripping over the years and this increase:

- **O&M cost** → Site inspections are needed to check and replace fuses
- **Energy yield losses**



ABB's PVS-175 with 12 MPPTs and only 2 strings into each MPPT no need fuses:

- **Simplify O&M → Cost Saving**
- **Avoid energy yield losses**

ABB – PVS-175-TL

Overview

PVS-175 1500Vdc/800Vac a unique, six-in-one product

- **185kVA @30°C/ 175kVA @40°C:** The World's **Highest Power Inverter** in the String Category
- **Modular Construction:** with detachable wiring box
- **Remote Fw update & parameters setting**
- **Fuse-free design:** Minimize EBoS and O&M
- **12 independent MPPTs** for the highest yield and configurability in all ground conditions
- **Installer App:** 70% faster wireless plant commissioning

ABB – PVS-175-TL

Data-sheet

Inverter key parameters

- 185kW@30°C, 175kW @40°C
- Max Input Voltage 1500Vdc
- **Vac = 800Vrms 3-ph/ 3 wire, 50/ 60Hz**
- **12 Independent MPP/ 24 strings**
- Fuseless DC combiner design
- VMPPT = 850 – 1350 Vdc, full power

User Interface

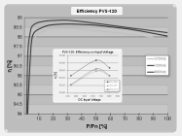
- Standard LEDs
- Integrated Web User Interface for managing inverter
- IOS and Android installation app for multiple inverter commissioning
- Standard level access to Aurora Vision remote monitoring service

Construction, weight, volume

- IP65
- Forced Air cooling
- Two box construction
- Overall weight ≈ 153kg (76kg + 77kg)

Communication

- 2 x Ethernet;
- Wi-Fi Channel
- 1 x RS485;
- Modbus RTU/ TCP (Sunspec compliant);
- Integrated datalogger and direct connection to Aurora Vision remote portal



Efficiency

- Max. Efficiency: 98,7%
- EU Efficiency: 98,4%
- CEC Efficiency: 98,4%

In/ Out protections

- Type 2 Surge arrester (both DC and AC)
- Insulation monitoring control per IEC 62109-2
- **DC Series Arc Fault Circuit Interrupter (optional)**

ABB – PVS-175-TL

Evolving from component to a complete «all-in-one» solution

ABB's PVS-175 the «all in one solution» – Benefit:

Lower CapEx

- **> 63% saving** on DC-BoS compared to Virtual Central
- **> 45% saving** on AC-BoS compared to conventional String Solution
- **Up to 65% less components** to install
- **20% to 40% saving** on AC cables and components versus 600Vac string inverters

Better OpEx

- **28% to 43% less inverter** to manage versus all other string proposals
- **up to 65% less components** to commission onsite
- **Multi inverter commissioning** thanks to installer app
- **30-50% less field interventions** for fuses replacement

Maximum Yield

- **0,3-0,7% lower losses** on the harvesting versus to Virtual Central solution
- **0,1% increase** on availability thanks to fuse free design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pv magazine Webinar: From innovative inverter to disruptive system design

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Discussion and Q&A

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Next webinars

Tuesday, December 4
8am to 9am (CET)

From innovative inverter to disruptive system design – challenges and advantages in the APAC region
powered by ABB

Tuesday, December 18
5pm – 6pm (CET)

From innovative inverter to disruptive system design - challenges and advantages in the LATAM region
powered by ABB
(in Spanish)

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