C3PV
From Space Solar Cell to CPV Systems

Gerhard Strobl, Werner Bensch, Stephan Mayer

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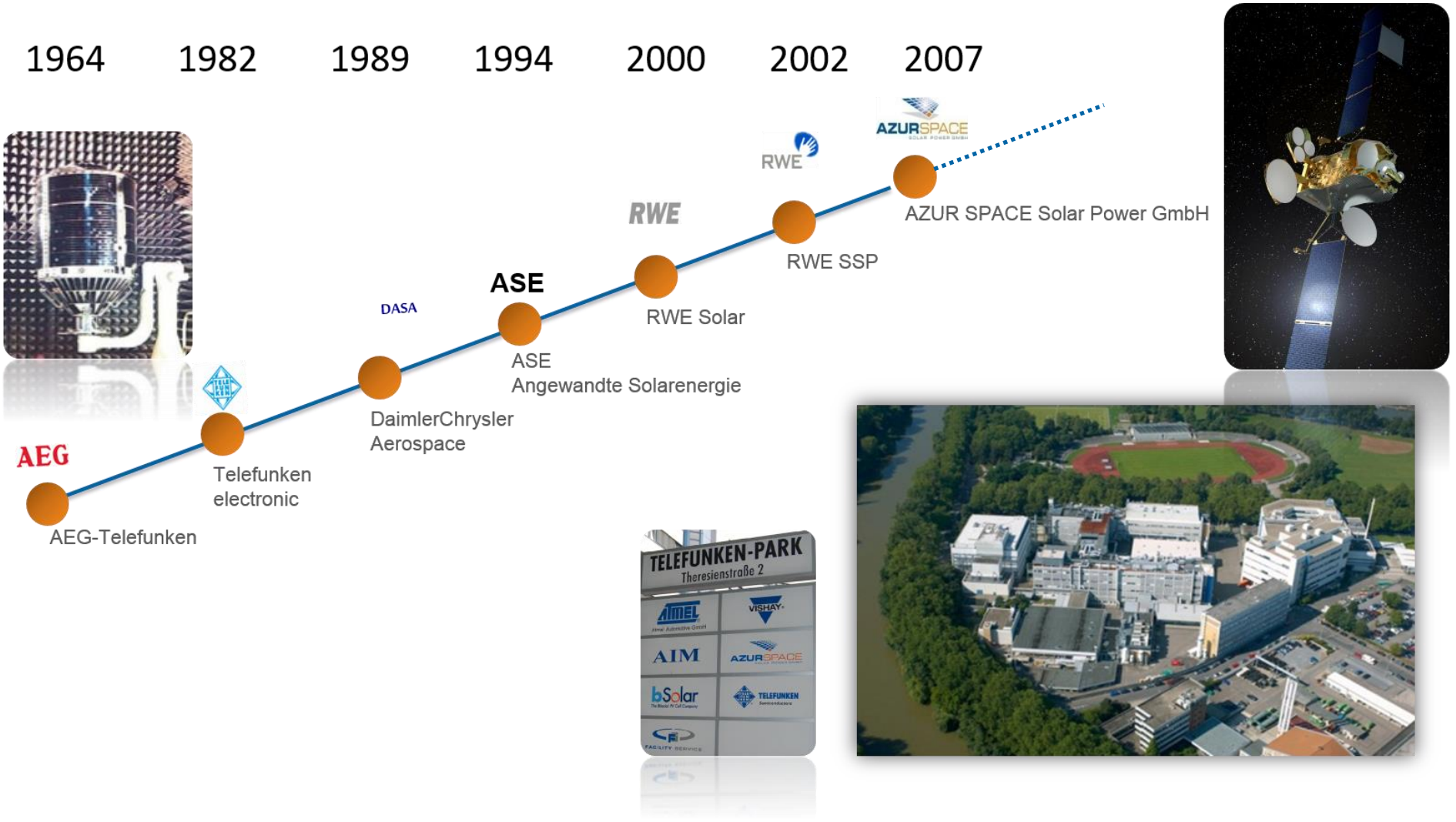
Agenda

1. AZUR SPACE Solar Power
2. Solar Cells for Satellites and Terrestrial CPV
3. C3PV - System and Business Model
4. Conclusion

1 – AZUR SPACE Solar Power GmbH Company Overview

AZUR SPACE
Company History



AZUR SPACE
Technical Milestones in PV

First generation: silicon photovoltaic – mono- and multicrystalline

1964 First silicon space solar cell in Germany

1974 First multicrystalline silicon solar cell for terrestrial application

1988 Fabrication of high efficiency silicon solar cells (18% AM0, 20% AM1.5)

Third generation: III-V photovoltaic & technology

2001 First European triple GaAs space solar cell

2008 First triple GaAs space solar cell with 30% efficiency

2012 Best EOL GaAs space solar cell on the market (patented)

2014 Terrestrial CPV solar cells with 44% (500x)

2017 C3PV system (partner programme)

Since 1964 AZUR SPACE has powered more than 500 Satellites …

AZUR (1968/69)

Hubble Telescope (1978/90)

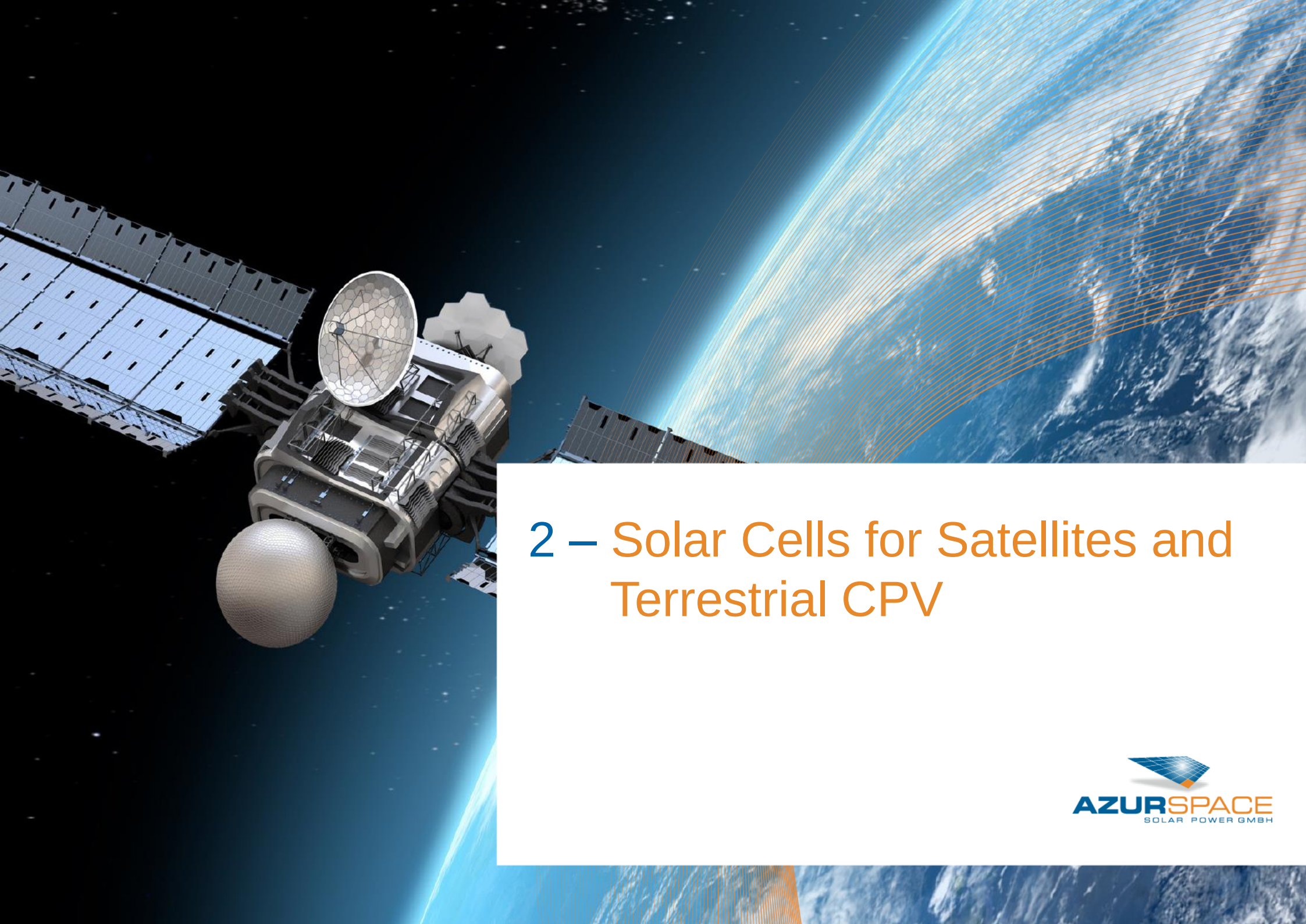
Intelsat (1996/98)

Venus Express (2005)

Rosetta Mission (2000)

Galileo Sats (2012)

Alphasat (2013)



2 – Solar Cells for Satellites and Terrestrial CPV

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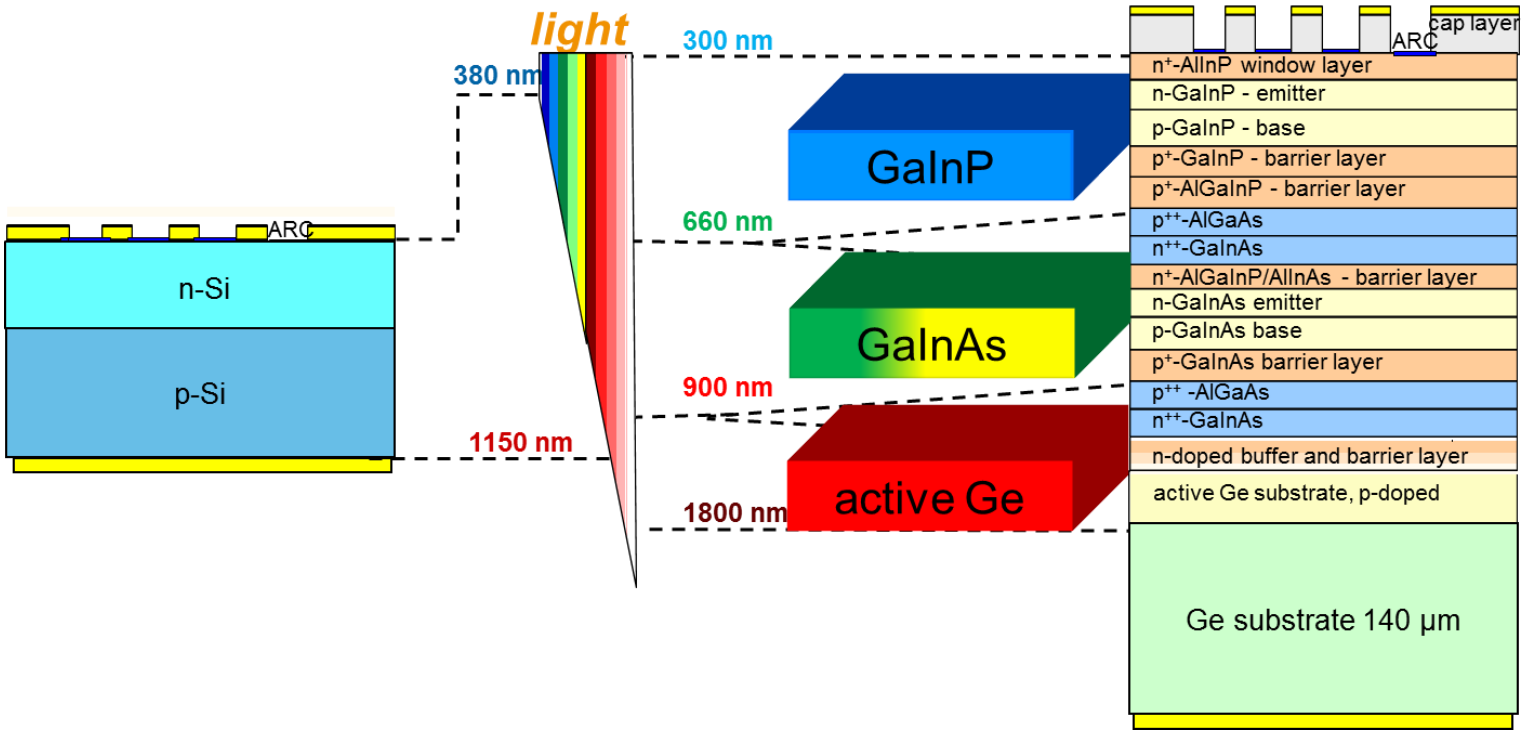
III/V Multijunction Solar Cells

Silicon **η~20% (AM1.5)**

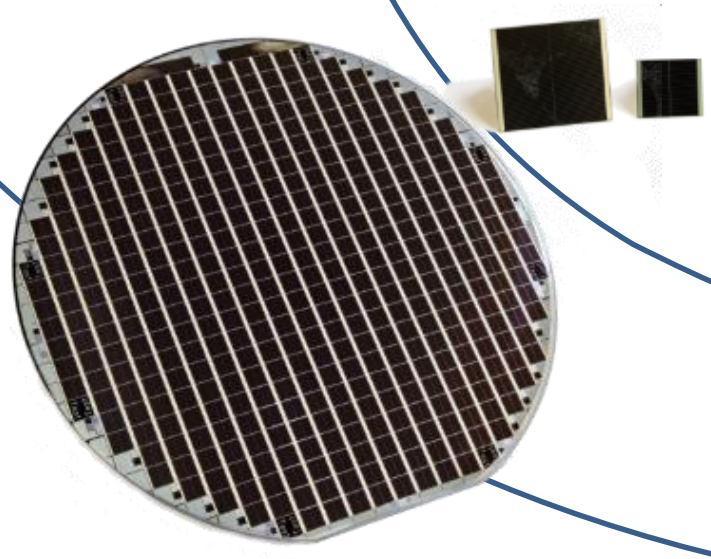
III/V triple junction **η~ 35% (AM1.5) >44% (500x)**



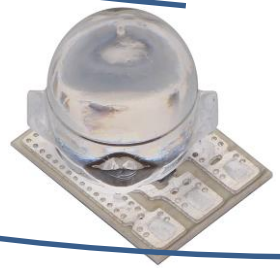
- Large wafer area (up to 150mm)
- Material engineering for As, P-based III-V semiconductors
- More than 40 layers, 3 cells and 2 tunnel diodes etc.
- Epitaxy on Ge

Terrestrial CPV Solar Cells
„From Space to Earth“

Space 3G30:
Large cell area,
Operation at 1x AM0,
Radiation hardness



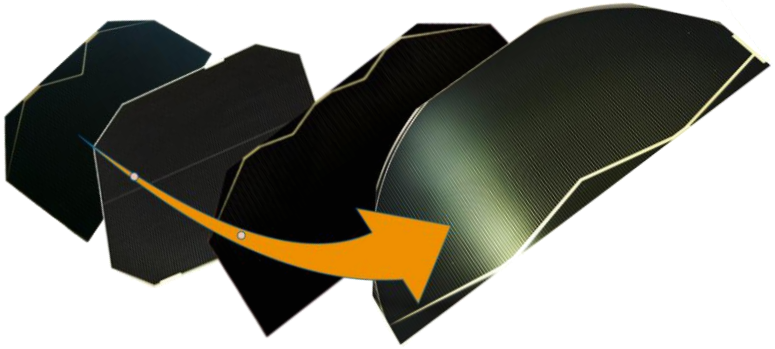
Terrestrial CPV 3C44:
Small cells (1,3x1,3mm^2 bis 10x10mm^2)
Operation at 500-1000x AM1.5
Humidity protection

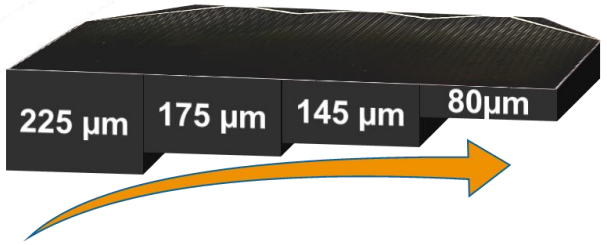


EFA®
Enhanced
Fresnel Assembly

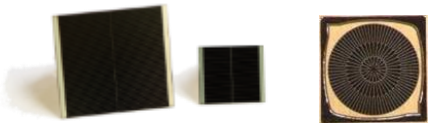
Solar Cell Production Status at AZUR

- AZUR‘s space solar cells (3G30) are the most radiation hard product in the market and currently represent our main product line.



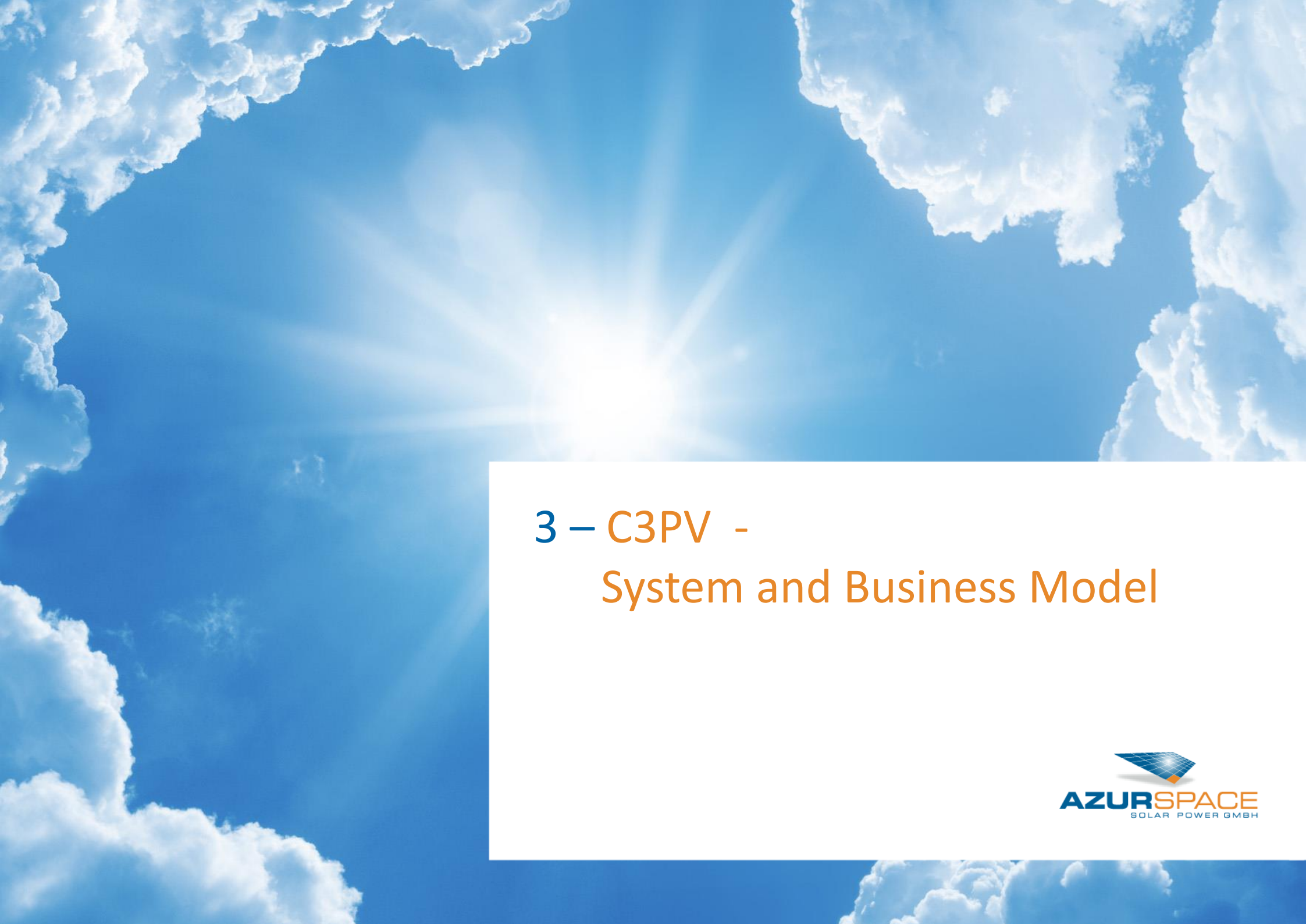


- AZUR‘s terrestrial CPV solar cells (3C44) are in volume production.



- AZUR currently has a production capacity of 500 000 Wafers / year which corresponds to 500 MW (assuming CPV cell production only).

- On request of a possible market demand, the production capacity can easily be expanded.



3 – C3PV -
System and Business Model

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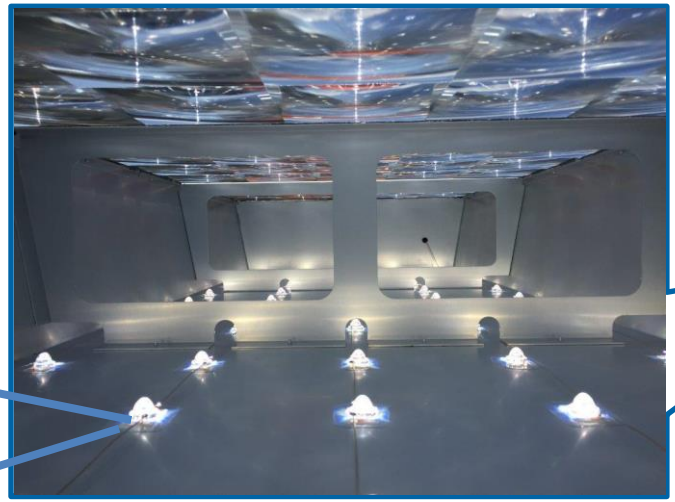
C3PV System

Concept:

C3PV System
3.5kW, 10.8m²

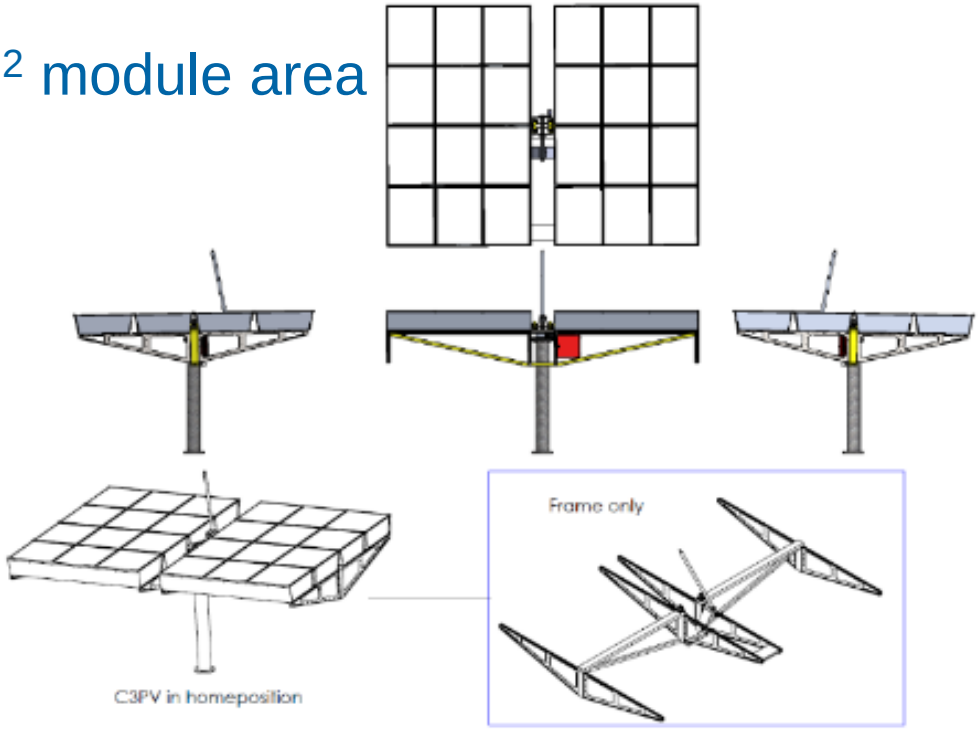
Interior View of the Module
30% Efficiency



EFA®
3C44 Cell

C3PV-System

- Equipped with most efficient solar cells on the market with 44%
- Module efficiency above 30% (STC)
- More competive price than standard PV (for regions with high direct insolation)
- Compact 3.5kW system with 10.8m^2 module area
- High local content



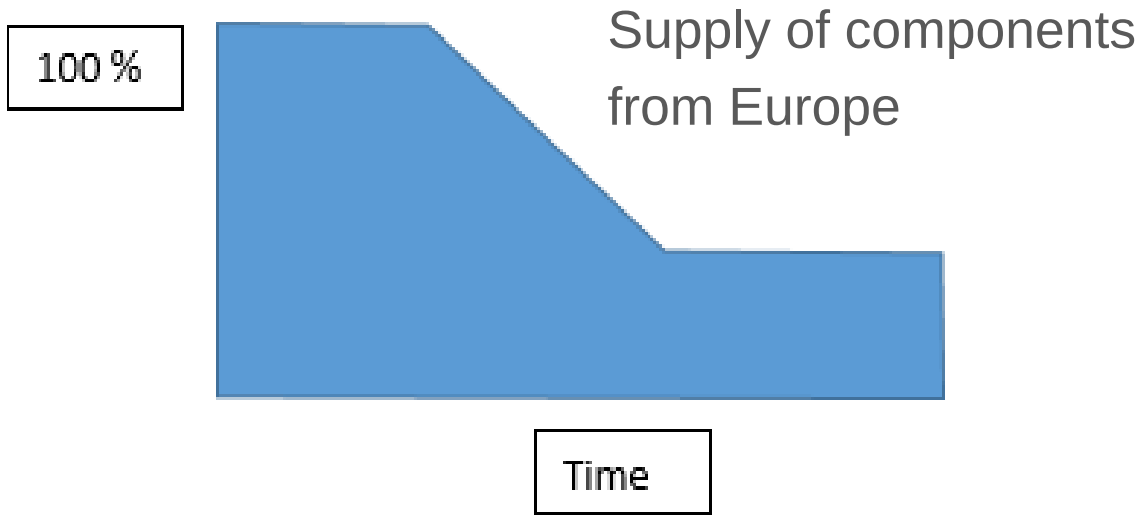
Hi-Tech in Europe, Low-Tech locally

Hi-Tech in Europe

1. Fresnel Lenses
2. EFA® - „Enhanced Fresnel Assembly“
   (solar cell, by-pass diode, secondary optics mounted on DCB ceramic)

Low-Tech locally

1. Module and tracker production with regional creation of value by local partners
2. Know-how transfer
3. Tasks of local partners
   - ⇨ Production
   - ⇨ Marketing & Sales
   - ⇨ Installation
   - ⇨ Maintenance



C3PV Production Status at AZUR

> EFA® (Enhanced Fresnel Assembly) production line – 50MW

> Module pilot production and demo line (blueprint and training) - 20MW

4 – Summary

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Conclusion

- AZUR is world market leader in space solar cells (3G30, 4G32) and in terrestrial CPV solar cells (3C44).
- AZUR wants to be a strong component supplier providing customers world-wide with solar cells (bare or assembled) as part of our core business.
- As far as customers want to manufacture complete CPV systems (C3PV), AZUR can provide the know-how for local module and tracker productions within the framework of its partner programme.
- CPV technology still has a significant cost reduction potential by future higher quantities in mass production and improved solar cell efficiency up to 50% (corresponding to a module efficiency above 35%).

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Thank you for your attention !

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