

3-SUN TECHNOLOGY

PVTechnologies AUSTRIA

A ZERO COST PV REVOLUTION

ONE THIRD THE PV MODULE COST
ONE HALF THE PV COST TURN KEY
THREE TIMES UP PV INDUSTRY
ANNUAL PRODUCTION CAPACITY

**3-SUN TECHNOLOGY
PRESENTATION OF SYSTEM'S
TECHNOLOGY AND COMPONENTS**

PVTechnologies AUSTRIA

A LEADING EUROPEAN PV INDUSTRY

HELIOTRON INSTITUTE

SOLAR ENERGY SYSTEMSRESEARCH & DEVELOPMENT

OCTOBER 2017

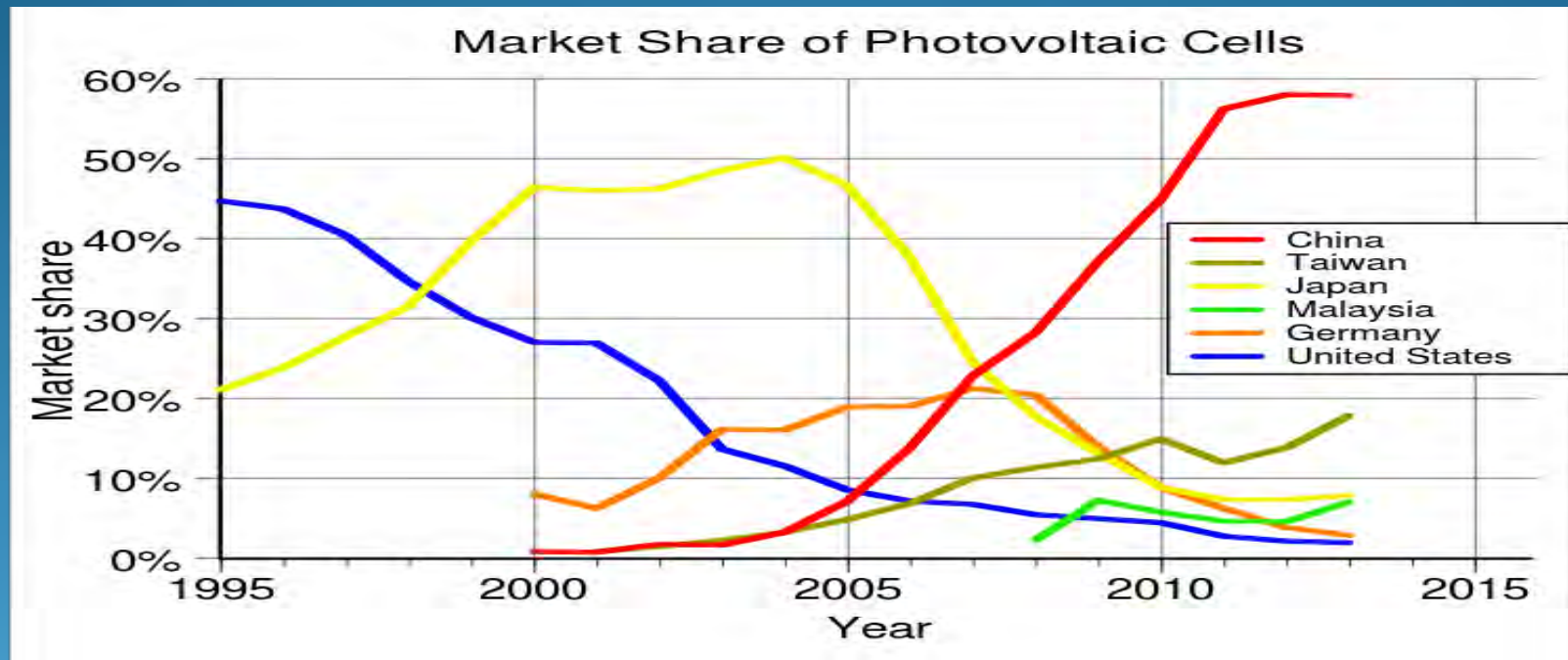
3-SUN TECHNOLOGY– PROFILE

- 3-SUN TECHNOLOGY is invented, patented and proposed in Research & Development programs by HELIOTRON INSTITUTE under the technical supervision of Alexandros Christos Papadopoulos, Mechanical – Electrical Engineer of NTUA.
- 3-SUN TECHNOLOGY utilizes conventional PV Cells of Monocrystalline or Polycrystalline Silicon which are operated under low concentration of 3 Suns thus producing three times more electricity at the same cost or the same annual electricity at one third the cost related to the PV Cells. The complete installed system cost is reduced to approx. 50% the relative cost of the conventional PV.
- 3-SUN TECHNOLOGY makes use of inexpensive plain reflectors which can be operated even without tracking, it is enough to adjust the tilt every two or three months in the year in order to keep high electricity production efficiency at high levels.
- In addition to electricity 3-SUN TECHNOLOGY can provide exploitation of the vast amounts of heat energy produced during the process of electricity generation within the PV Cells (5-6 times greater) which is otherwise rejected by the conventional one-Sun PV.
- 3-SUN TECHNOLOGY has therefore the capacity to use the Heat Energy generated for the production of chilled water for air-conditioning in cooperation with adsorption or absorption Heat Pumps, which during the process of production of Cooling Energy, they are returning an important part of the heat absorbed from the building by air-conditioning as domestic hot water with lower temperatures.
- This way 3-SUN TECHNOLOGY produces annually far greater Green Energy quantities compared to conventional PV (up to 10 times greater depending on the each time configuration).

➤

3-SUN TECHNOLOGY REVITALIZES THE EUROPEAN PV INDUSTRY BY REGAINING ITS LOST COMPETITIVITY AND TRIPLING ITS PRODUCTION CAPACITY AT NO COST

➤ Till 2008 the European PV industry had more than 35% of the World Market for the PV Cells and PV Modules ahead of China, Japan and USA. However in 2015 and 2016 the situation has been completely changed under the pressure of the Chinese competition. (1)

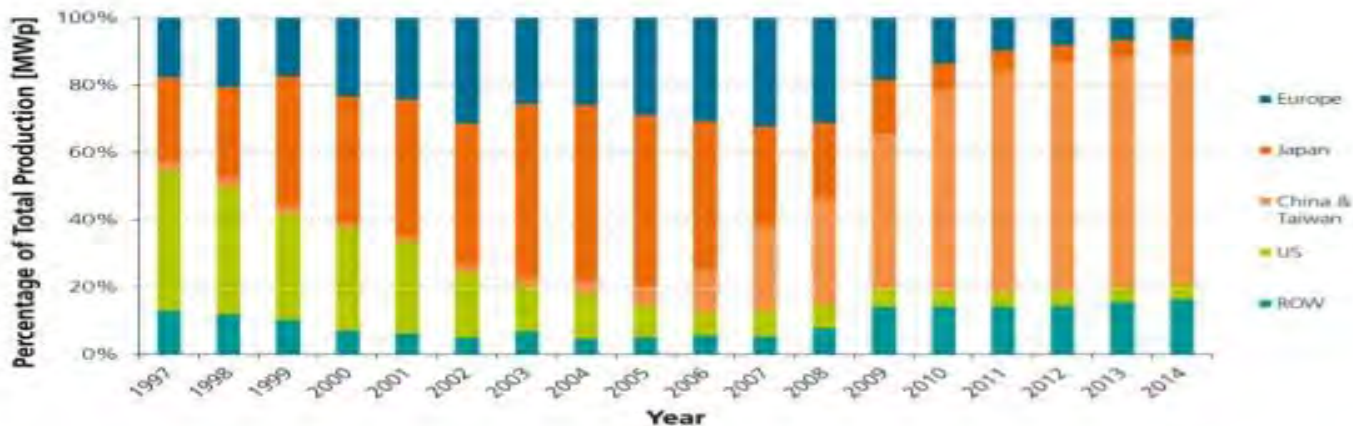


➤ 3-SUN TECHNOLOGY can revitalize the European PV Industry by not only regaining its lost competitive edge but most important by tripling its PRODUCTION capacity at practically no cost.

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PV Module Production by Region 1997-2014
Percentage of Total MWp Produced



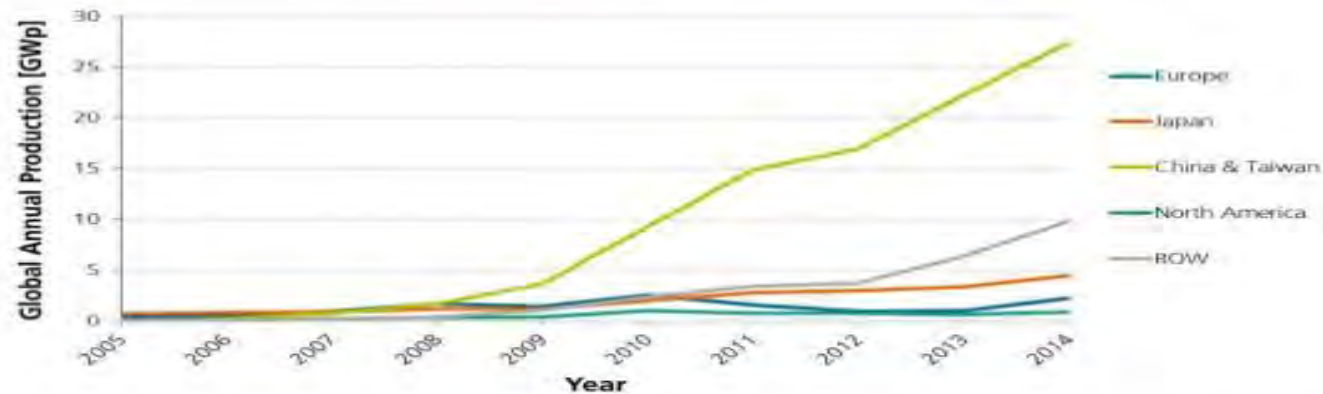
Data: Up to 2009: Navigant Consulting, since 2010: IHS. Graph: PSE AG 2015

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PV Industry Production by Region (2005-2014)
Global Annual Production

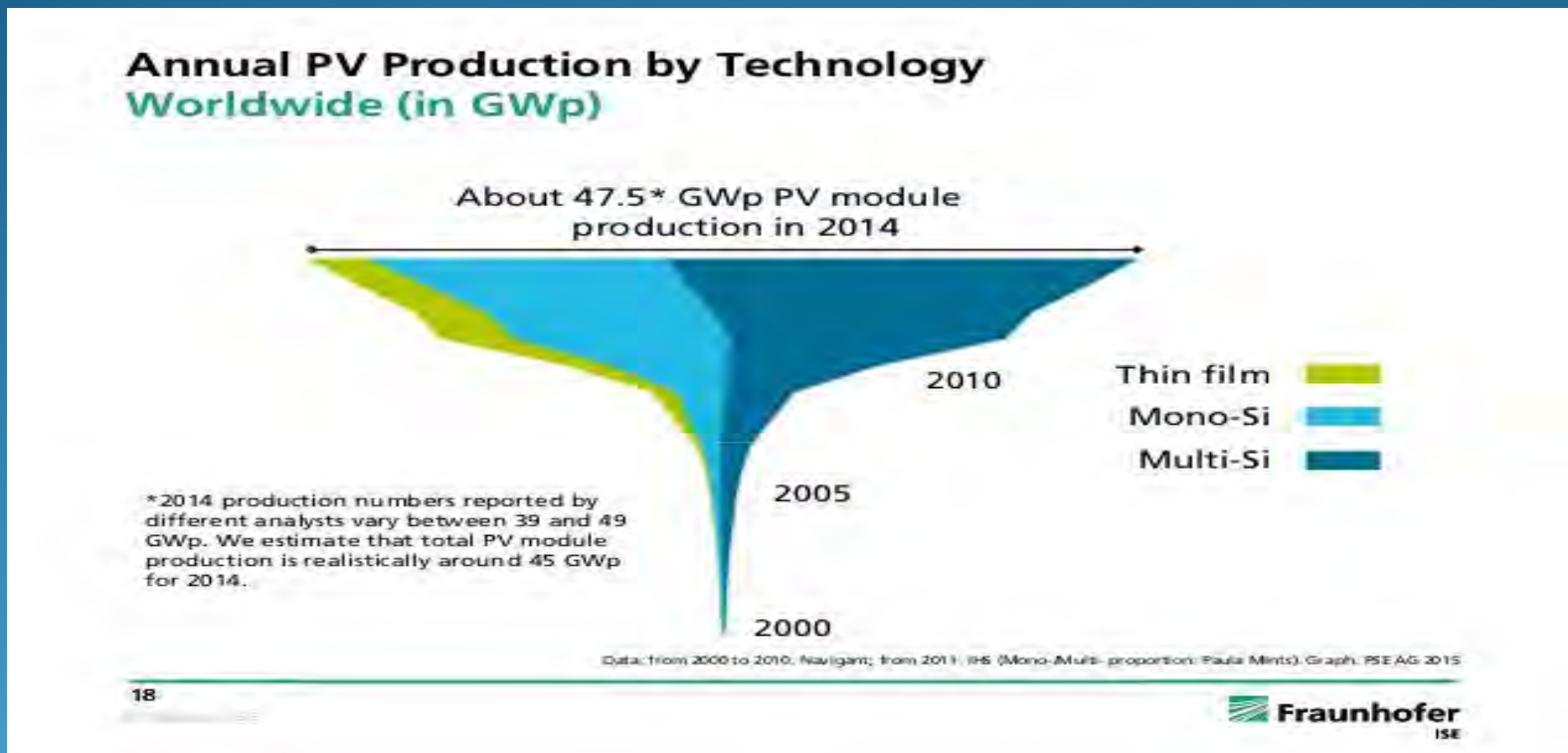


Data: Navigant Consulting and Paula Miris. Graph: PSE AG 2015

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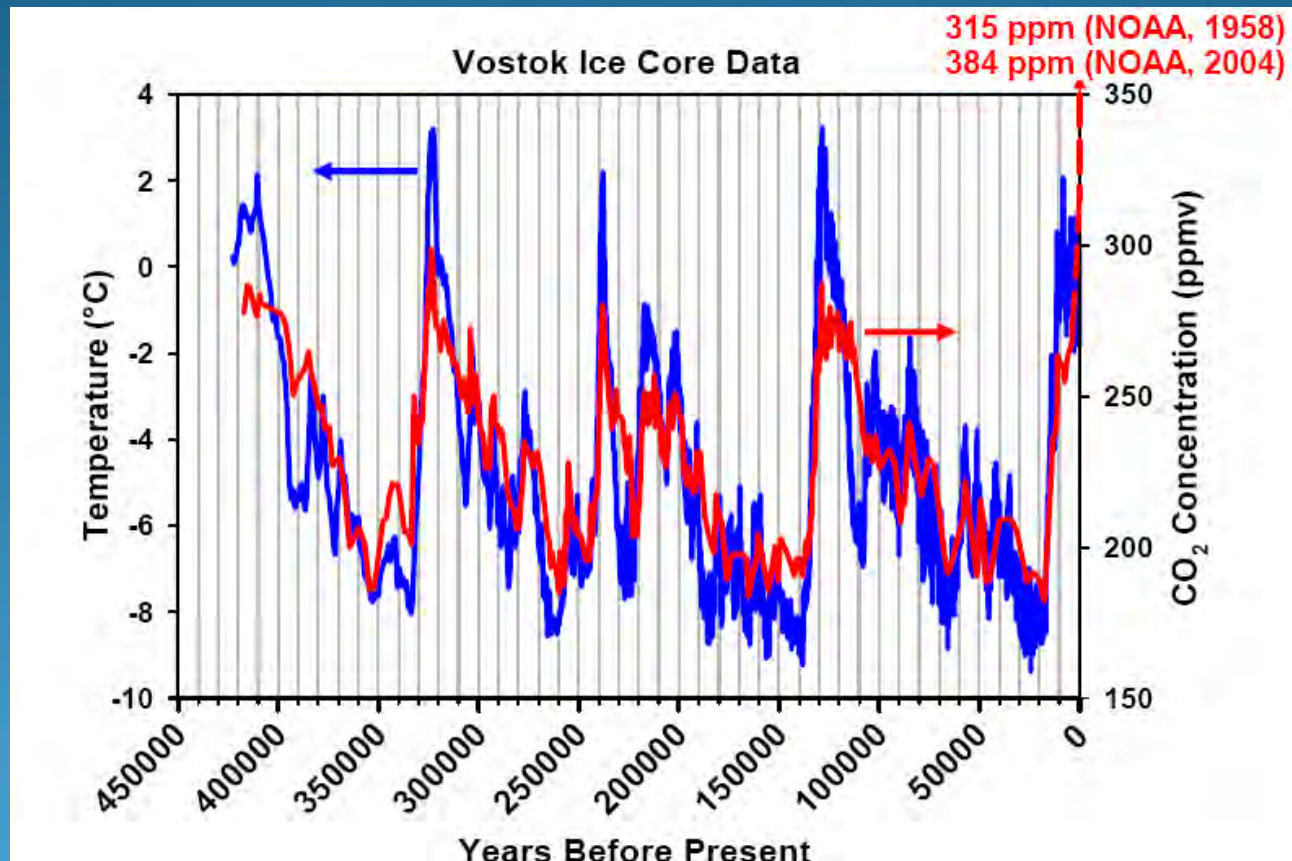
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Climate Change Diagram of last 450.000 Years



Antarctic Ice Core Data allows for Temperature and CO₂ Profiles Mapping of past hundreds of thousand years

Warning Facts I

Oceans Cooling Stream Velocity is reduced from 6.0 to 4.8 Miles/Hour. Climate Change is here! Too Late ? Why build-up of floating fresh water in Arctic as big as Lake Victoria could spell trouble for Britain and not only



Warning Facts II

- Last year's Arctic Ocean's ice thickness was minimal : 0.5 -1,5m
- In December 2015, middle of the 6-month Polar Night, in North Pole the temperature instead of minus 40 was several degrees over zero !
- First time ever in the history such difference, much earlier than foreseen.
- In previous years, the thickness of the polar ice reached up several meters above sea level and another 8-fold meters below the surface
- This ice consisted the stored cooling energy with which the gigantic Thermo - Haline Stream cooling the Pacific, Indian and Atlantic Oceans was cooled
- This year, maybe there will not exist enough ice storage for cooling the whole of the Thermo - Haline Stream for cooling the Oceans in order to avoid the Planet overheating.

Warning Facts III

- Oceans will overheat, maybe not in a year, they can store heat for a few years, but then they will burst out in form of Hyper Cyclones in order to be cooled, as in “The Day After Tomorrow” based on a US Army Study.
- Time to react before the Climate Change be irreversible is very short Maybe 15-20 years (some research institutes give even shorter time)
- 3-SUN TECHNOLOGY Technology with its self-financing capacity can achieve the UN Scenario to eliminate CO2 emissions instead of 35 years (till 2050) in only 15-20 years.
- Such a 15-20 years time gain can be the factor that will tip the scale to salvation from the Nightmare of Climate Change and by the way with a fantastic business profit for the Utilities, Industry and the Society

Consequences of the Haline Stream Interruption



“The Day After Tomorrow”, just a movie scenario for now, based on a Study as above financed by the American Army

3-SUN TECHNOLOGY INNOVATIVE DATA I

- CONVENTIONAL POLYCRYSTALLINE Si PV CELLS BE DIVIDED TO THREE CELLS IN SERIES
- THIS WAY RESULT TRIPPLE VOLTAGE AND ONE THIRD CURRENT GIVING SAME LOSSES
- HEAT DISSIPATION IS EFFECTED UNDER TRIPPLE BACK-SURFACE SAME TEMPERATURE
- 3-SUN PRODUCTION OF USEFUL HEAT EQUAL TO $5 \times P_{pv}$ WITH HIGH EFFICIENCY ($>70\%$)
- THIS IS DUE TO TRIPPLE RADIATION BUT SAME LOSSES UNDER SAME TEMPERATURES
- IT CAN BE REALIZED WITH REFLECTOR HEIGHTS FROM 10cm UP TO MORE THAN 4,0m
- 3-SUN TECHNOLOGY NEEDS NOT SUN - TRACKING, IT IS ENOUGH 1-2 TIMES/Y TILTING
- REFLECTORS CAN BE SILVERED GLASS, MIRROR FOIL OR POLISHED STAINLESS STEEL
- SOLAR CELL COST IS ONE THIRD DUE TO TRIPPLE ENERGY PRODUCTION WITH 3-SUNS
- REST COMPONENTS ADD REDUCED COST WITH INSTALED COST UNDER 50% PV COST
- THIS WAY EU PV MODULE INDUSTRY STAYING IDLE DUE TO PRICE CAN BE ACTIVATED
- 3-SUN TECHNOLOGY IS EQUIVALENT TO INCREASE OF INSTALLED PV EFFICIENCY 200%
- WITH 3-SUN PV LEVELIZED COST OF ELECTRICITY GOES UNDER ALL FOSSIL FUEL KWH
- 3-SUN PRODUCED HEAT CAPACITY CAN BE UTILIZED IN SEVERAL COST EFFECTIVE WAY

3-SUN TECHNOLOGY INNOVATIVE DATA II

- 3-SUN PRODUCED HEAT CAPACITY CAN BE COUPLED WITH HOTEL A/C HEAT PUMPS
- HOTELS CAN EXTEND THE TOURISTIC PERIOD BY 2-4 MONTHS (INCREASE OF PROFIT)
- LOW TEMPERATURE HEAT CAN BE UTILIZED FOR SWIMMING POOL / SPA HEATING
- IN CASE THAT 3-SUN A/C FOR HOTELS AND SIMILAR CLIENTS IS UTILITY OWNED, THEN:
- UTILITIES CAN AVOID THE INVESTMENT FOR 5-FOLD RESERVE CAPACITY FOR A/C LOADS
- THEY AVOID THE RELEVANT TRANSMISSION AND DISTRIBUTION LINES AND LOSSES, TOO
- IN MOST WESTERN COUNTRIES THE ABOVE MENTIONED AVOIDED COST IS 2x3-SUN COST
- IN CHINA, INDIA AND REST COAL FED ECONOMIES THE AVOIDED COST IS 3x3-SUN COST
- THAT MEANS FOR UTILITIES THE 3-SUN INVESTMENT IS MORE THAN 100% SELF-FINANCED
- IN ADDITION 3-SUN INVESTMENT ALTHOUGH FULLY AMORTIZED CONTINUES PROFITTING
- THE OBLIGATION OF UTILITIES TO 50% RES CHANGE TILL 2030 IS NOW A BIG OPPORTUNITY
- UTILITIES AND THE INTERNATIONAL BUSINESS COMMUNITY WILL INVEST BEYOND COP21
- WITH THE PROFITS OF 3-SUN UTILITY INVESTMENT, COP21 CAN BE READY IN 15-20 YEARS
- THIS MEANS A TIME GAIN OF 15-20 YEARS, A CRUCIAL FACTOR AGAINST CLIMATE CHANGE

3-SUN TECHNOLOGY INNOVATIVE DATA III

- ALL COMPONENTS OF THE 3-SUN TECHNOLOGY ARE ALREADY IN MASS PRODUCTION
- PV MODULE FACTORIES USING THE 3-SUN WILL TRIPPLE THEIR CAPACITY AT NO COST
- REST COMPONENTS SUCH AS REFLECTORS, INVERTERS, ELECTRICS EXIST IN MASS
- LAST YEAR (2016) THE WORLD INSTALLED PV CAPACITY WAS INCREASED BY 90.000 MW
- FOR THIS INCREASE THE (2016) PRODUCTION CAPACITY IS ESTIMATED AT 120.000 MW
- WITH 42% ANNUAL INCREASE IN LAST 6 YEARS, IN 2017 CAPACITY WILL BE 127.000 MW
- THE 2018 WORLD PV PRODUCTION CAPACITY IS ESTIMATED TO BE 180.000 MW / YEAR
- IN 2019 CAPACITY IS ESTIMATED AT 254.000 MW / YEAR AND 2020 AT 360.000 MW / YEAR
- CAPITAL COST TO INVEST FOR 1.000MW PV PRODUCTION CAPACITY IS 1.000 MILLION €
- TOTAL INVESTMENT FOR $360-120=240$ GW TILL 2020 IS ESTIMATED AT 240 BILLION EURO
- 3-SUN CAN INCREASE THE PRESENT PRODUCTION CAPACITY TO 360.000MW AT NO COST
- THIS IS A NO COST CAPITAL SAVING OF $240.000 \times 1.000 = 240.000$ MILLION EURO TILL 2020
- AND AN ADDITIONAL $720.000 \times 1.000 \times 2/3 = 480.000$ MILLION EURO TILL 2022 AND SO ON
- THIS IS A 720 BILLION € CAPITAL SAVING FOR THE PV PRODUCTION INDUSTRY TILL 2022

3-SUN TECHNOLOGY INNOVATIVE DATA IV

- OFFERING AT THE SAME TIME A 50% REDUCTION TO THE OVERALL INSTALLED PV COST
- PV INSTALLED CAPACITY TILL 2022 IS EXPECTED TO GROW FROM 320GW TO 2560GW
- THE PV INVESTMENT FOR THE ADDITIONAL 2240 GW IS ESTIMATED AT 2240 BILLION EURO
- 3-SUN OFFERING A 50% REDUCTION TO THE OVERALL INSTALLED PV COST ADDS 1120B €
- THE TOTAL 6-YEAR CAPITAL REDUCTION FOR THE PV INDUSTRY CAN BE 1840 BILLION €
- 3-SUN WITH THE UTILITY SCENARIO OF SELF-FINANCING CAN REVOLUTIONIZE PV GROW
- ELECTRICITY ONLY PRODUCTION COST OF 3-SUN PROJECTS IS ONLY 2 EUROCENT/KWH
- TACKLING THE CLIMATE CHANGE NEEDS 1.000 BILLION €/YEAR INSTEAD OF 320 TODAY
- 3-SUN PROVIDES BOTH THE REQUIRED FINANCING AND TRIPPLE CAPACITY TOGETHER
- 3-SUN TOGETHER WITH PROTEAS CAN BE THE “BIG IDEA” WANTED BY BAN KI-MOON
- WE CAN PROMOTE THIS POTENTIAL IN ADDITION TO THE PROTEAS ONE TO UNO G.S.
- IT IS OF UTMOST IMPORTANCE TO SUBMIT AND FULFILL THE ESPA DEMONSTRATIONS
- THEY SERVE BOTH AS PILOT PROJECTS AND CERTIFICATIONS UNDER EU PROGRAMS
- INTERREG WITH CYPRUS WITH A VALUE OF 3,2 MILLION EURO OPENS CYPRUS MARKET

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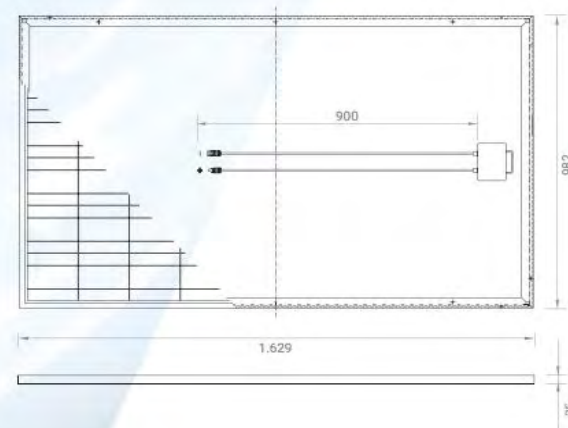
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PVT AUSTRIA High Efficiency Polycrystalline 3-SUN 180 Cell 300W Module Type PVT 3-SUN PRO P.180

**PVT 3-SUN PRO P.180 300
3-SUN POLYCRYSTALLINE
180 Cell Module**

PVT
AUSTRIA



3-SUN PVT MODULE TECHNICAL DATA

● Working Conditions

- MAX. SYSTEM VOLTAGE DC 1.000 V (TUV) VOLTAGE
- OPERATING TEMPERATURE -40°C / +85°C CURRENT
- MAX. REVERSE CURRENT 16 A
- MAX. WIND/SNOW LOAD 2.400 Pa / 6.000 Pa
- POWER TOLERANCE 0/+5 W
- IP PROTECTION LEVEL 65

-
-
-
-
-

● Electronical Parameters

- MAX. POWER* (PMPP) 300W
- VOLTAGE (VMPP) 93,20 V
- RATED CURRENT (IMPP) 3,03 A
- OPEN CIRCUIT VOLTAGE (VOC) 93,93 V
- SHORT CIRCUIT CURRENT 3,23 A
- POWER TOLERANCE 0/+3 %
- NOCT 48,3°C
- CONFIGURATION 25 pcs./pallet

Temperatur Coefficients

- TEMP. COEFF. (β) -0,35 %/K
- TEMP. COEFF. (α) +0,05 %/K
- POWER TEMP. COEFF. (δ) -0,39 %/K

Mechanical Parameters

- SAFETY CLASS II CELL SIZE 156 x 52 mm
- NUMBER OF CELLS 6 x 30 - 180
- FRONT/BACK GLASS 3, mm hardened solar glass
- WEIGHT 16 kg

PACKAGING

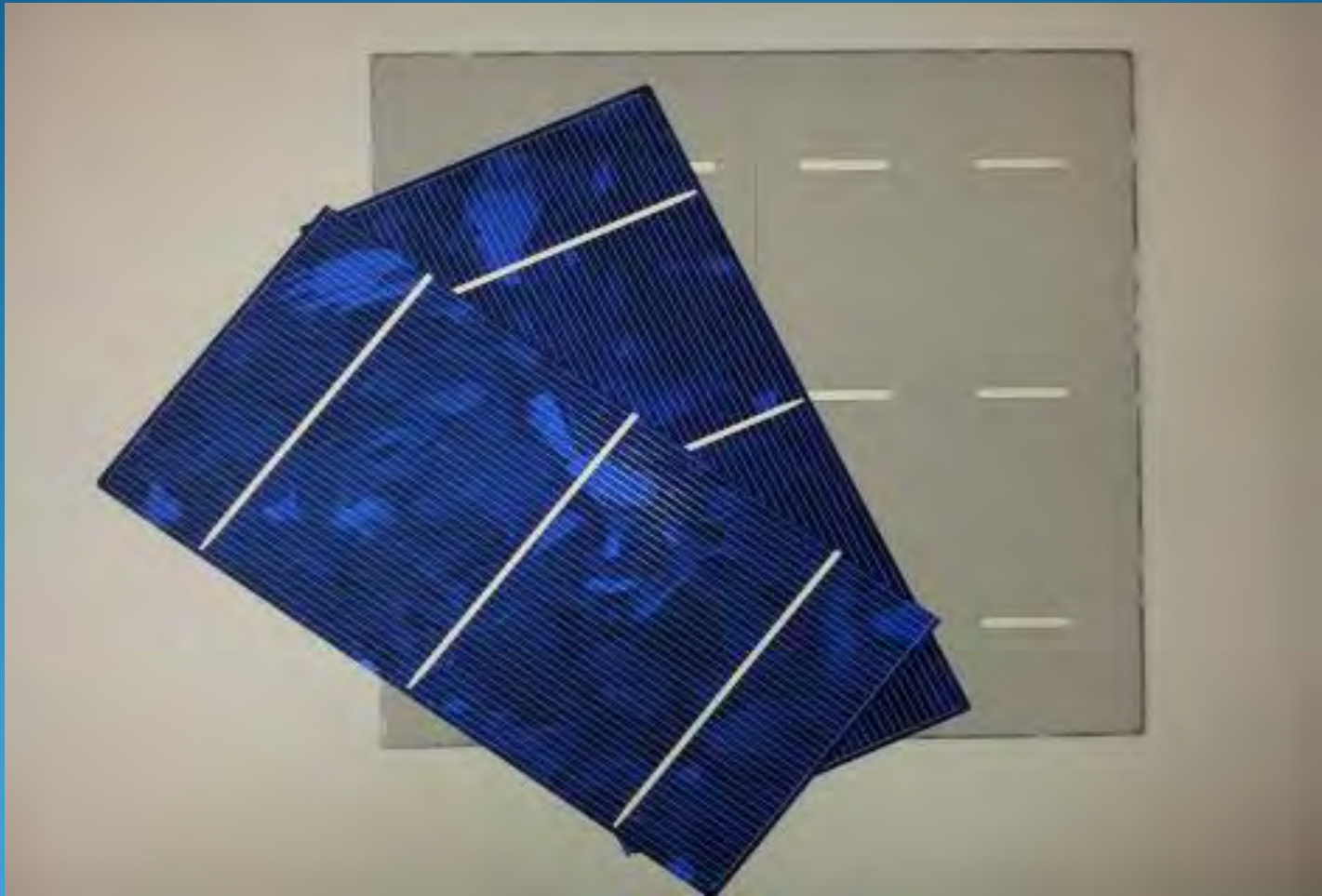
- WP DIMENSIONS (L X W X H MM) 1.645 x 986 x 7,1
- J-BOX TE Connectivity J-box IP67
- CABEL LENGTH 0,8–1,1 m
- CABEL CROSS SCTION SIZE 4 mm²
- NUMBER OF DIODES 3
- PLU-IN CONNECTION MC4 or equivalent
- FRAME Aluminiumframe

High Efficiency Polycrystalline Silicon Cell of Efficiency $\eta > 15\%$, with a 20 Years Warrantee



- Under 3-SUN Technology the PV Cell will operate with $3 \times 15 = 45\%$ equivalent 1- SUN Efficiency.
- The Power is the product of the voltage on the current. The Cell is split to 3 parts for same current
- Each part adds voltage, the current for connection in line remains the same (losses are the same)
- Heat dissipation surface is triple the Cell surface. So operating temperature remains the same.
- Suitable for heat collection via back surface cooling up to 85 degrees or higher is possible.
- The PV Cells are placed in front of plain reflectors securing 3-Sun concentration with no tracking.
- Tilting the reflectors 2-3 times per year is enough to secure near maximum concentration all the time

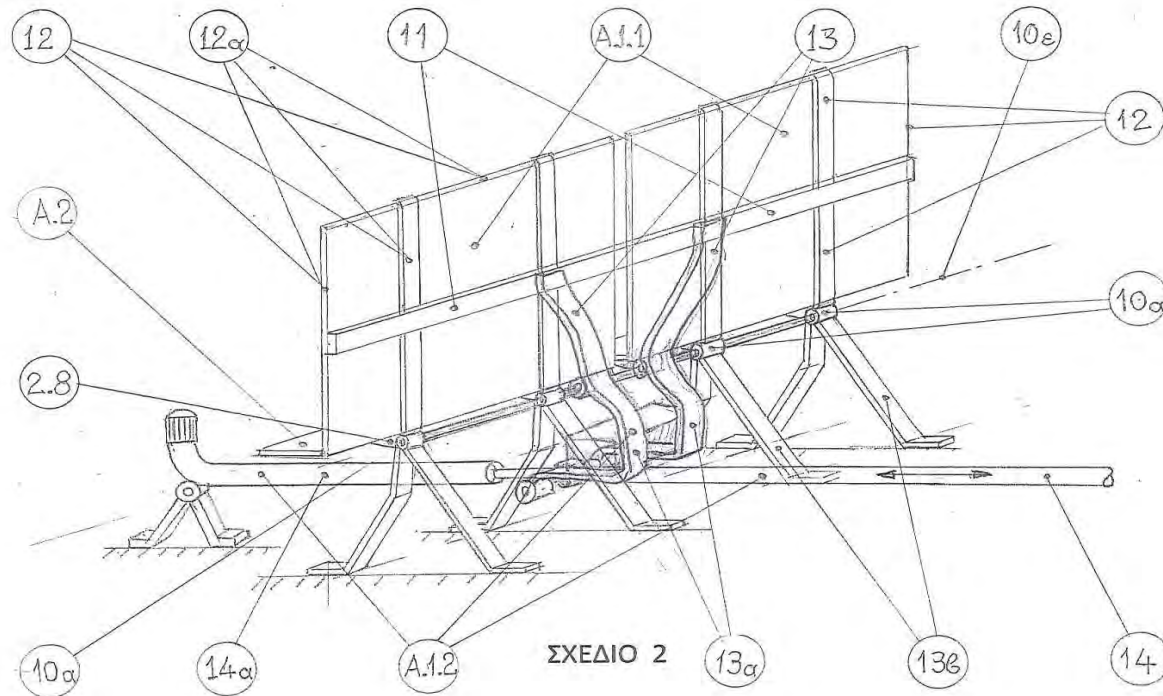
High Efficiency Polycrystalline Silicon Solar cell cut into two halves or three segments according to 3-Sun



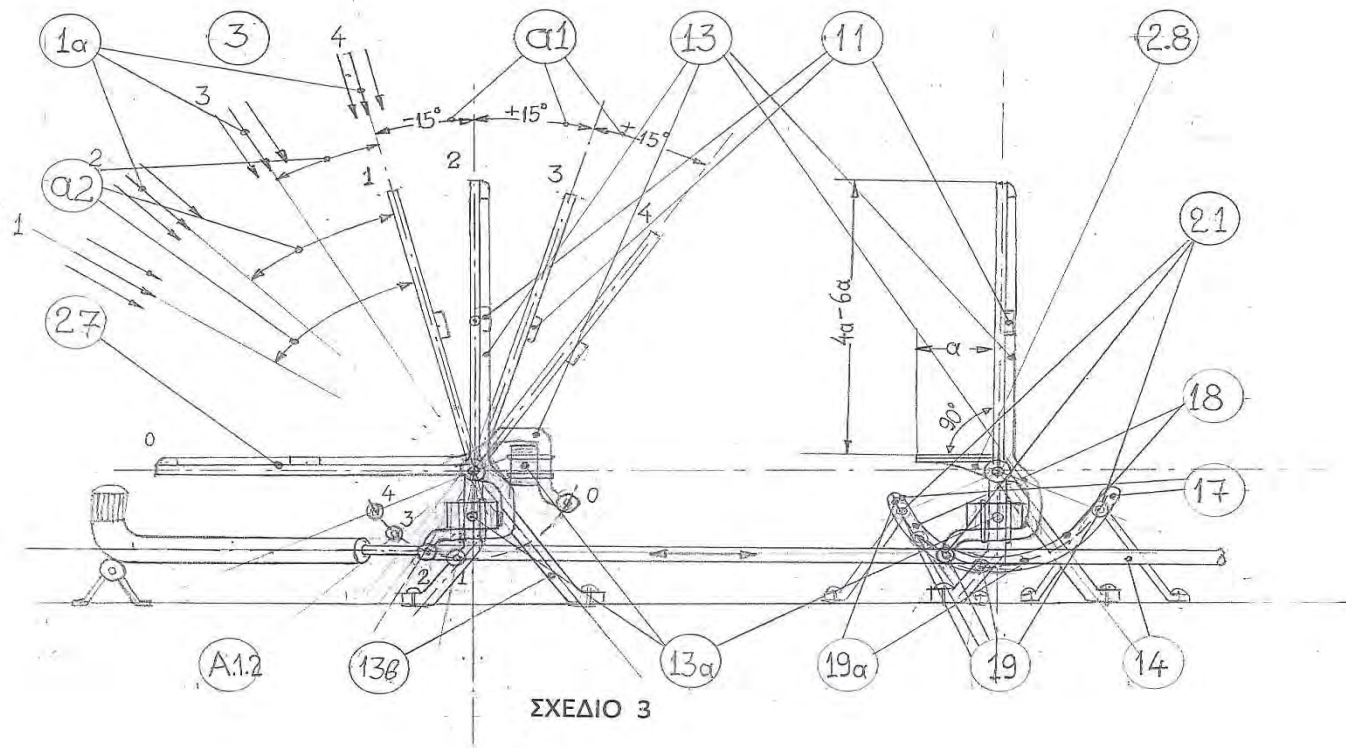
High Efficiency Polycrystalline Silicon Cell Cutting ILM-2 Production Machine



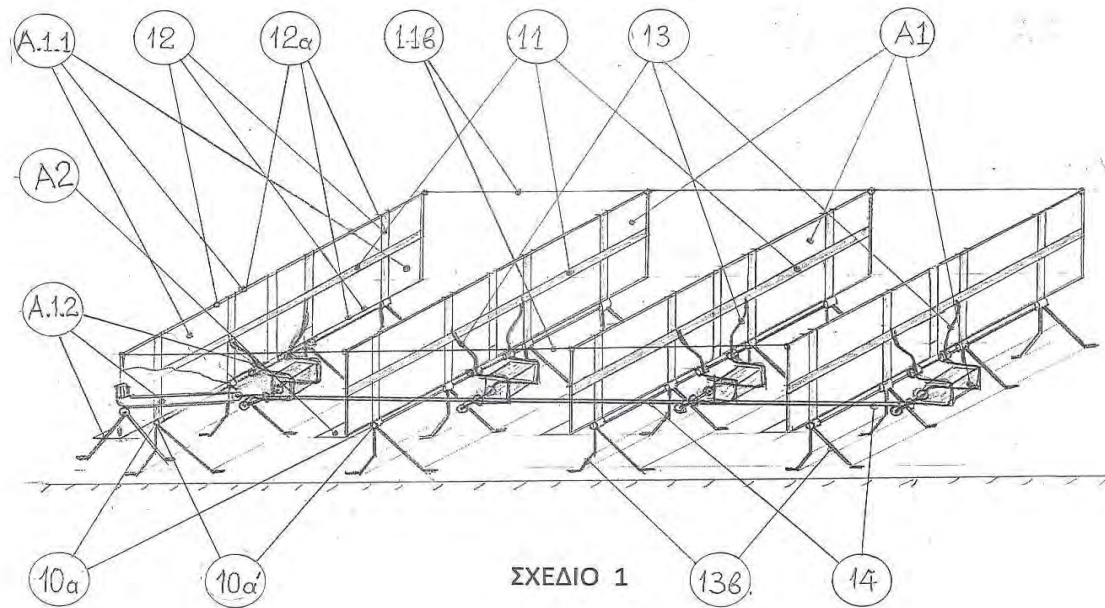
Basic 3-Sun Arrangement of PV Cells with the Reflector, Semi-Fixed Metal Support Base and Tilt Linear Actuator



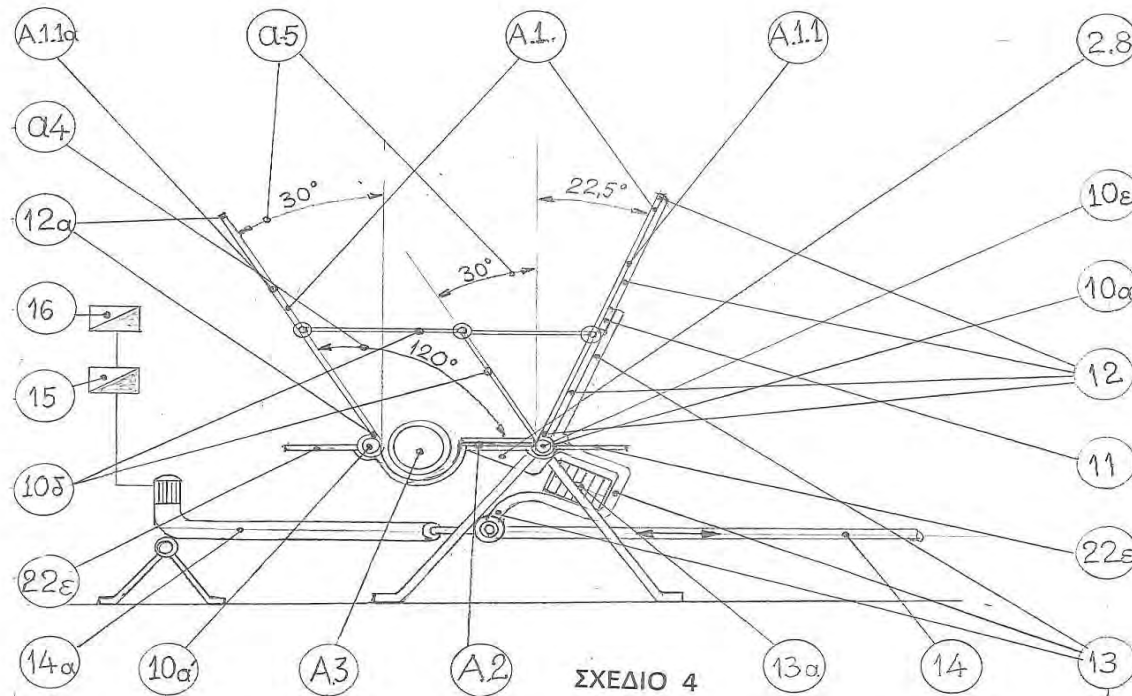
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Basic 3-Sun Arrangement of PV Cells with the Reflector, Semi-Fixed Metal Support Base and Tilt Linear Actuator



Hotel 3-Sun with the PV Cells, Reflector, Vacuum Tubes, Semi-Fixed Metal Support Base and Tilt Linear Actuator





Broad 4.5 RT Double Effect HW Chiller

HIGH POWER HEAT PUMPS FOR HOTELS



HEAT PUMPS IN COOPERATION WITH
3-SUN TECHNOLOGY SOLAR SYSTEMS
WITH A
P > 11000kW WITH HIGH COEFFICIENT
OF PERFORMANCE (COP > 1,63)

3-SUN UTILITY PV AT HALF THE COST



THANK YOU FOR YOUR ATTENTION