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Jacques Vapillon
photographe de mer



CNR - ISMAR



Consiglio Nazionale delle Ricerche
Istituto di Scienze Marine

SOLBIAN

A new generation of PV panels

Integration of PV-Multifunctional Systems in Micro Electric Vehicles and Boats



Marco Bianucci, Luca Bonci
& Pietro Perlo

IDTechEx



**ENERGY
HARVESTING
& STORAGE USA**

Santa Barbara 2013

SOLBIAN.EU

ARE YOU READY
FOR A **new**
experience
OF **lightness
& power?**

Maserati boat official sponsor

SOLBIAN

MADE IN ITALY



**Develop winning, high-efficiency
technology for the future**



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Lightweight Powerful Flexible Photovoltaic Modules

- ✓ *Lightweight flexible solar modules*
- ✓ *Crystalline silicon cells (up to 23% efficiency)*
- ✓ *Patented encapsulation using technopolymers*
- ✓ *IEC 61215 certification for grid-connected*

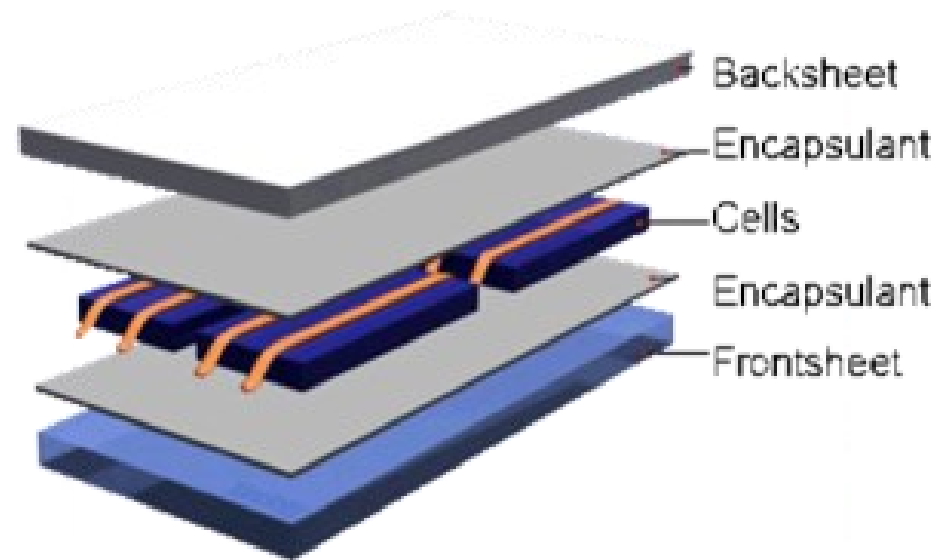


Solbian was born as a technological spin-off from the Italian National Research Council

Innovative Technology

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- ✓ *High Resistance Technopolymer (Special PE+ETFE+OLEFIN) instead of glass:*
 - *Lightness (2.1 kg/sqm)*
 - *Flexibility (thickness <2 mm)*
- ✓ *Highest efficiency crystalline silicon cells*
- ✓ ***Extensively tested under extreme conditions***



PATENT TRADEMARK AND CERTIFICATION

SollbianFLEX are the first crystalline flexible solar panels in the world that have successfully passed the test IEC

Certifications:

IEC 61215 Ed. 2
e IEC 61730

2011 - Certificazione IEC



•Tests

- 10.10 UV - test
- 10.11 Thermal cycling test
- 10.12 Humidity freeze test
- 10.13 Damp heat
- 10.17 Hail test
- 10.16 Mechanical load test
- MST 14 Impulse voltage test *
- MST 21 Temperature test
- MST 32 Module breakage test
-



The IEC 61215 and 61730 include very strict aging and resistance tests to ensure a life of the modules of at least twenty-years. Climatic chamber, thermal shock, electrical insulation, resistance to hail, exposure to high doses of ultraviolet rays ..

The production line and the company are certified ISO 9001 (Quality), ISO 18001 (Safety) e ISO 14000 (Environmental) i.

Giovanni Soldini & MASERATI



Extreme conditions

8



Extreme conditions

9





Emergency solutions



Military applications



From Europe to China



Building integrated PV

- Self consumption or grid-connected
- Lightweight modules
- Lightweight structure
- Architectural creativity
- High efficiency
- IEC 61215 certification



International Solar Decathlon - China 2013

Cuciuc - ITA556 - Mini Transat



Di Benedetto – TEAM PLASTIQUE



13 Race boats

Pedote PRYSMIAN ITA 747



Soldini - Telecom Italia



Soldini - MASERATI



WORLD SOLAR CHALLENGE

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THE COMPETITION

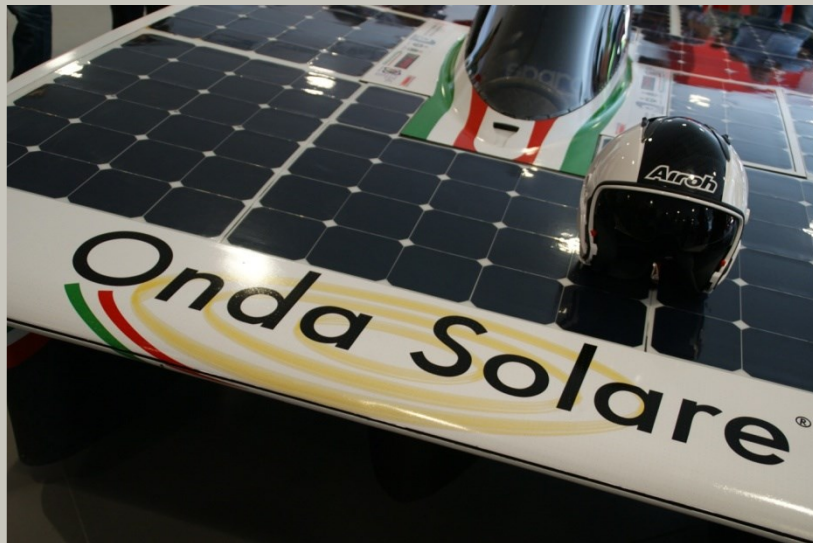
COMPETITORS FROM ALL OVER THE WORLD

THE COURSE

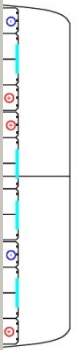
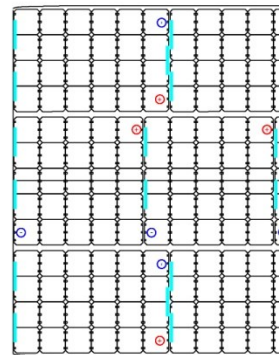


DISCOVER THE COURSE
ON GOOGLE MAPS

It is a friendly competition in which all the teams set off from **Darwin** with the aim of being the first team to arrive in **Adelaide**, around 3,000 km south.



Complessivo 390



Distributed control of PV panels for boats and sustainable mobility



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Energy consumption on board (12V)

Boat equipped for trans-oceanic trip

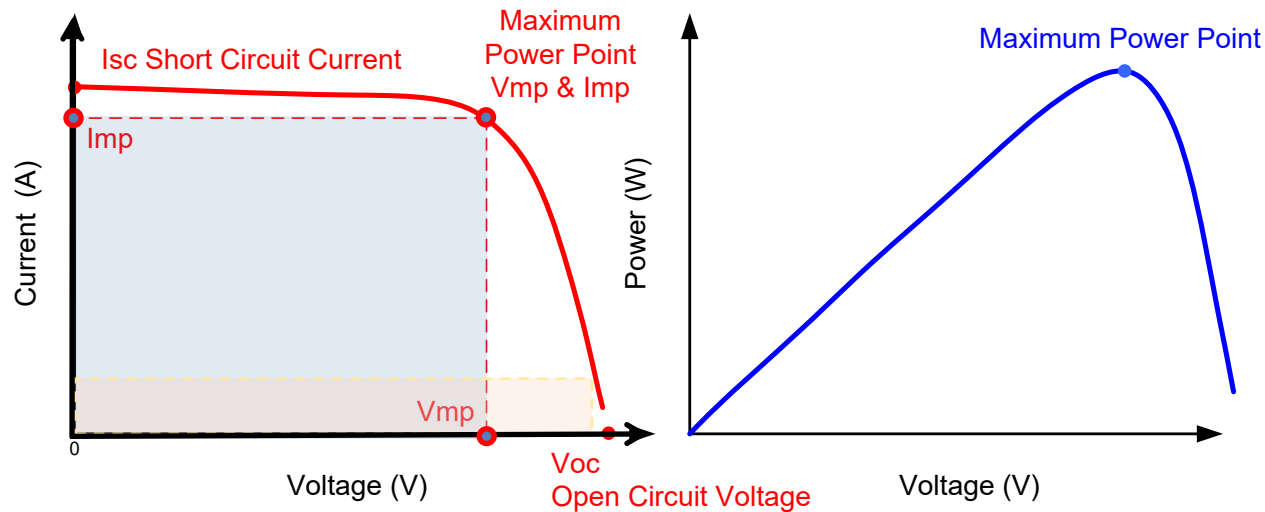
Using services, consumption during a typical day:

Utenza	A	watt	h/uso effett	Wh	Wh (LED)
Luci dx	2,0	25,2	5,0	126,0	21,0
Luci sx	2,0	25,2	5,0	126,0	21,0
Luce ponte	5,0	63,0	0,4	25,2	4,2
Luce fonda	1,6	20,2	5,0	100,8	16,8
Luce cuccetta	0,5	6,3	0,3	1,9	0,3
Luci cabina	3,0	37,8	1,0	37,8	18,9
Luce bussola	0,2	2,5	12,0	30,2	
Via Motore	1,6	20,2	0,1	2,0	
Strumenti	2,5	31,5	24,0	756,0	
Autopilota	5,0	63,0	10,0	630,0	
Radar	3,0	37,8	3,0	113,4	
VHF	2,0	25,2	2,0	50,4	
Frigo	4,0	50,4	17,0	856,8	
Autoclave	3,0	37,8	0,5	18,9	
Pompa doccia	6,0	75,6	0,1	7,6	
Pompa sentina	6,0	75,6	0,1	7,6	
Inverter	4,0	50,4	0,3	15,1	
prese 12 V	2,0	25,2	5,0	126,0	
Salpa Ancora	158,0	2000,0	0,3	600,0	
TOTALE 1				3632	3296

<i>Boiler acqua calda</i>	100,0	1260,0	2,0	2520,0	
<i>Microonde</i>	64,0	800,0	0,5	400,0	
<i>Dissalat. Pompa</i>	12	151,2	0,5	75,6	
TOTALE 2				6552	6216

Fast Maximum Power Point Tracking (MPPT)

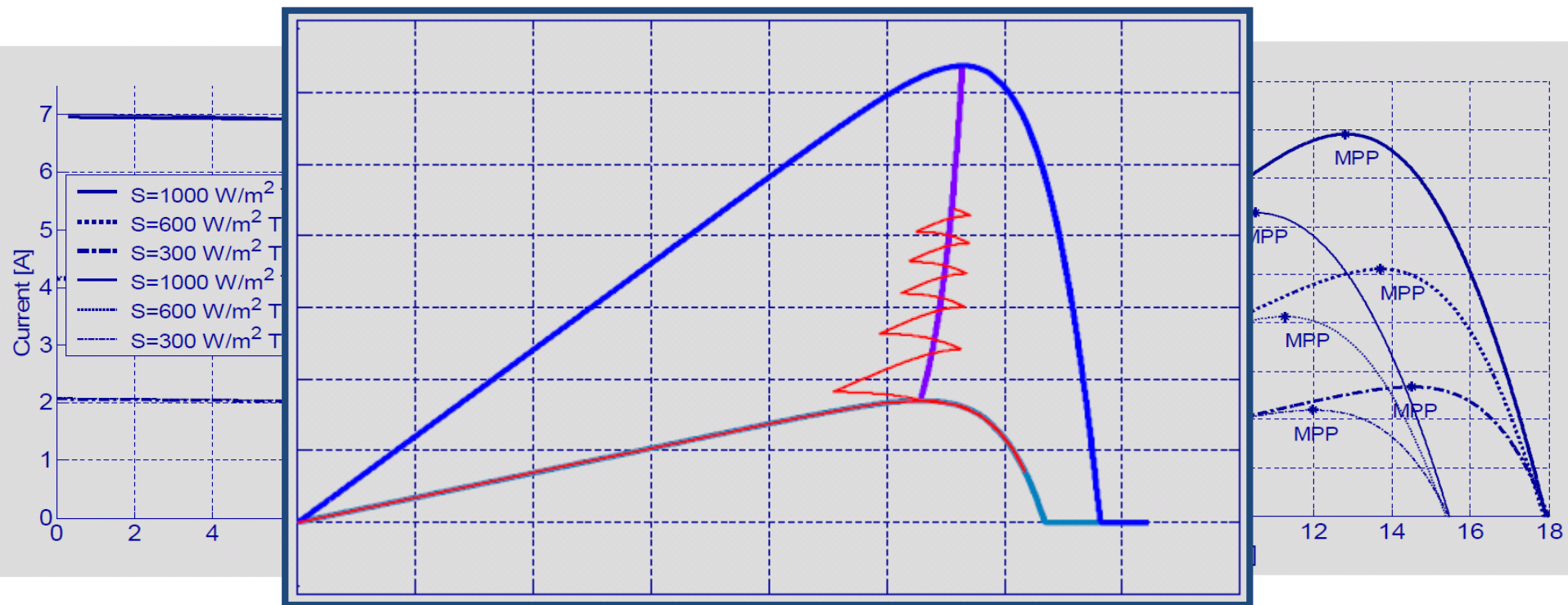
18



V-I and V-P characteristics under normal operating conditions, with no mismatch among the panel. The open circuit voltage (V_{oc}) is about 0.6V for a crystalline solar cell and it is relatively independent of the solar irradiation. The maximum power point (MPP) is the point at which the solar cell current (I_{mp}) and voltage (V_{mp}), produces the maximum power. At MPP of the curve, the voltage is about 80% of the V_{oc}

Fast Maximum Power Point Tracking (MPPT)

19



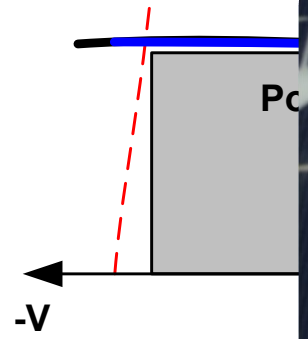
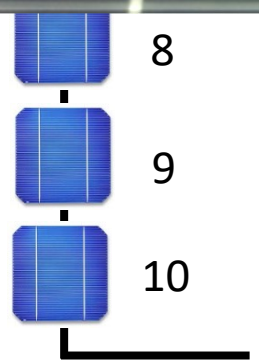
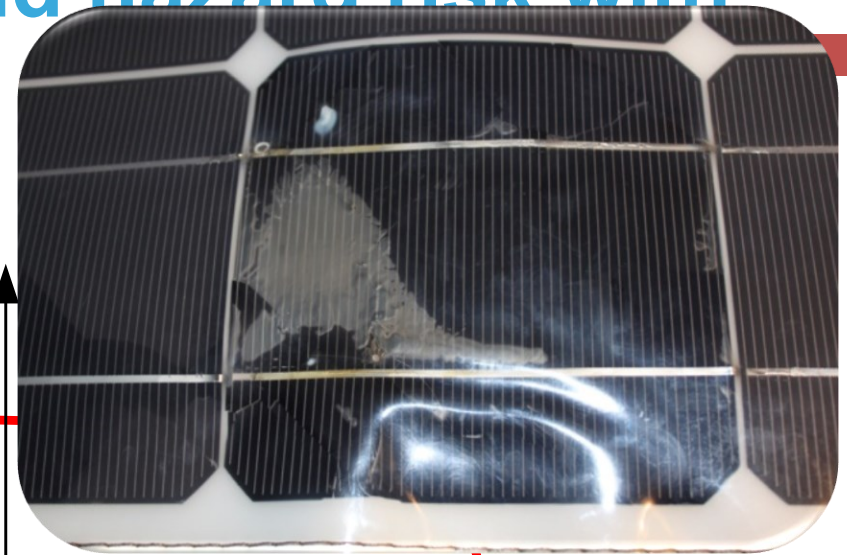
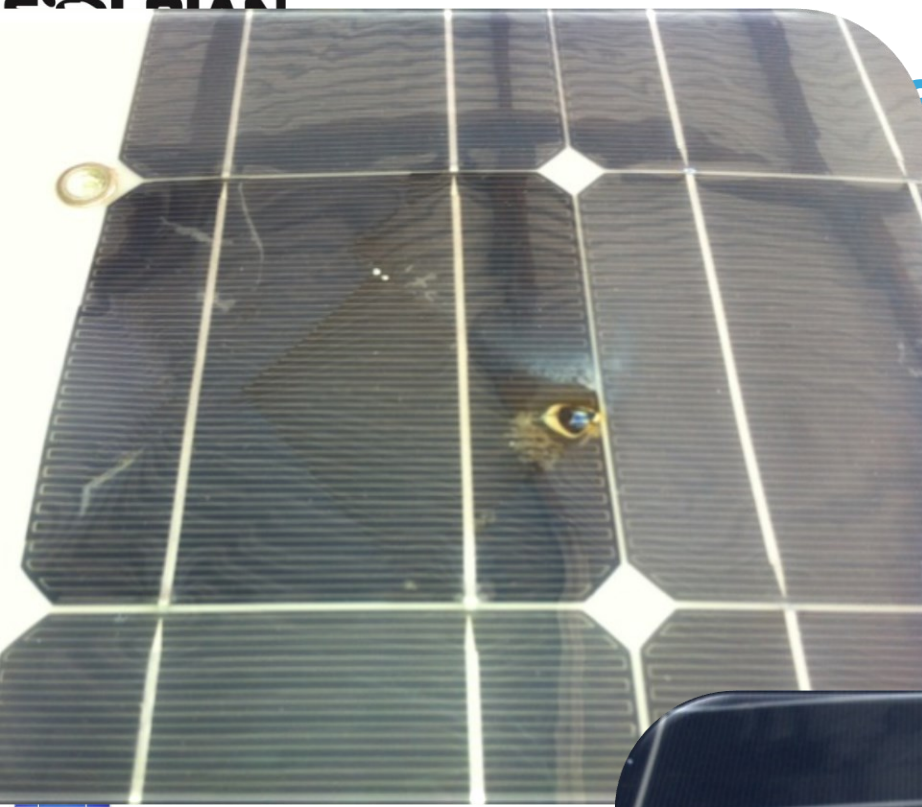
Dynamically, with a fast sampling, while the graph changes, the MPPT system continuously searches for the maximum on the curve.

Mismatching by shadows

20



and hazard risk with

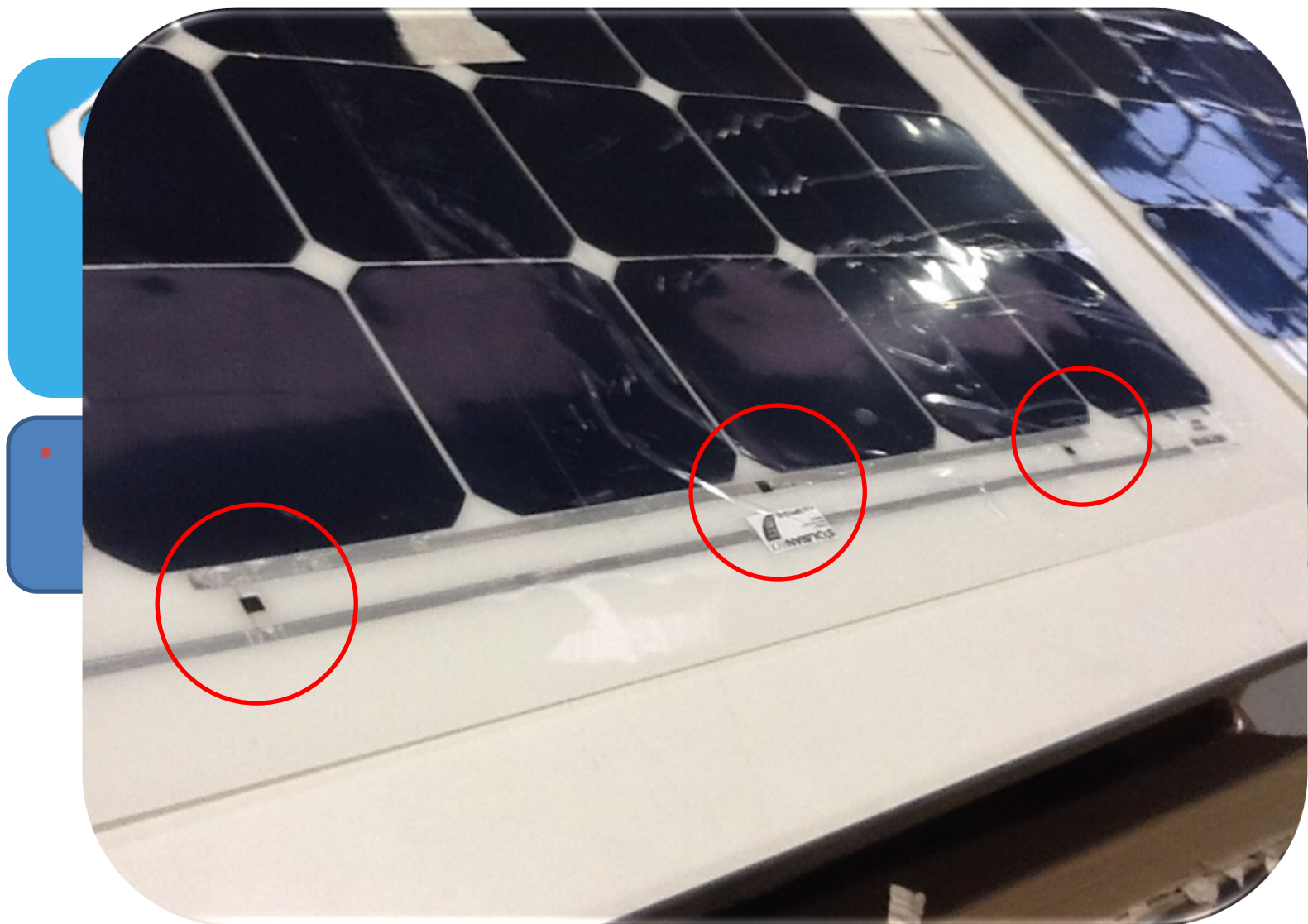


Combined I-V curve

I-V curve of 10 cells with

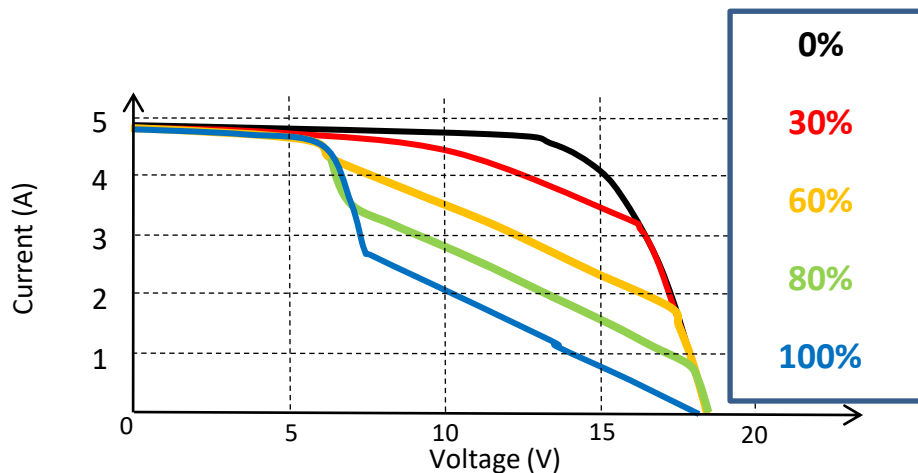
From Hot Spot to Energy harvesting

22

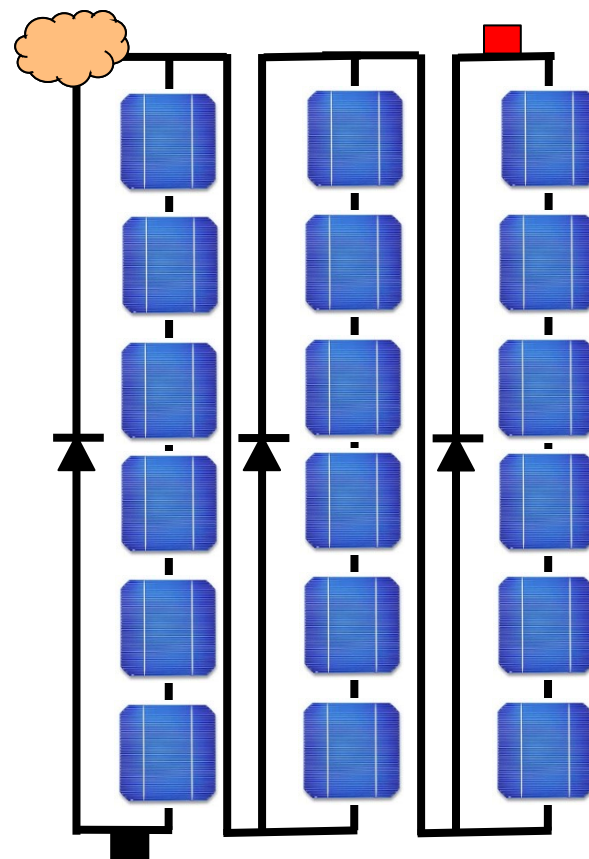
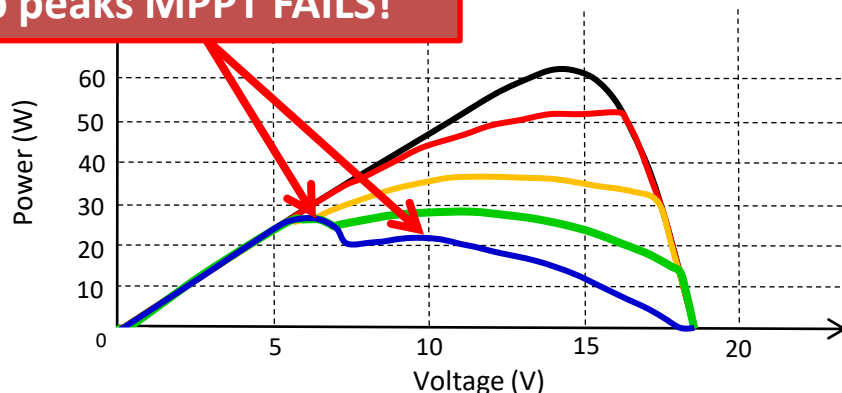


Partially shaded panel

23

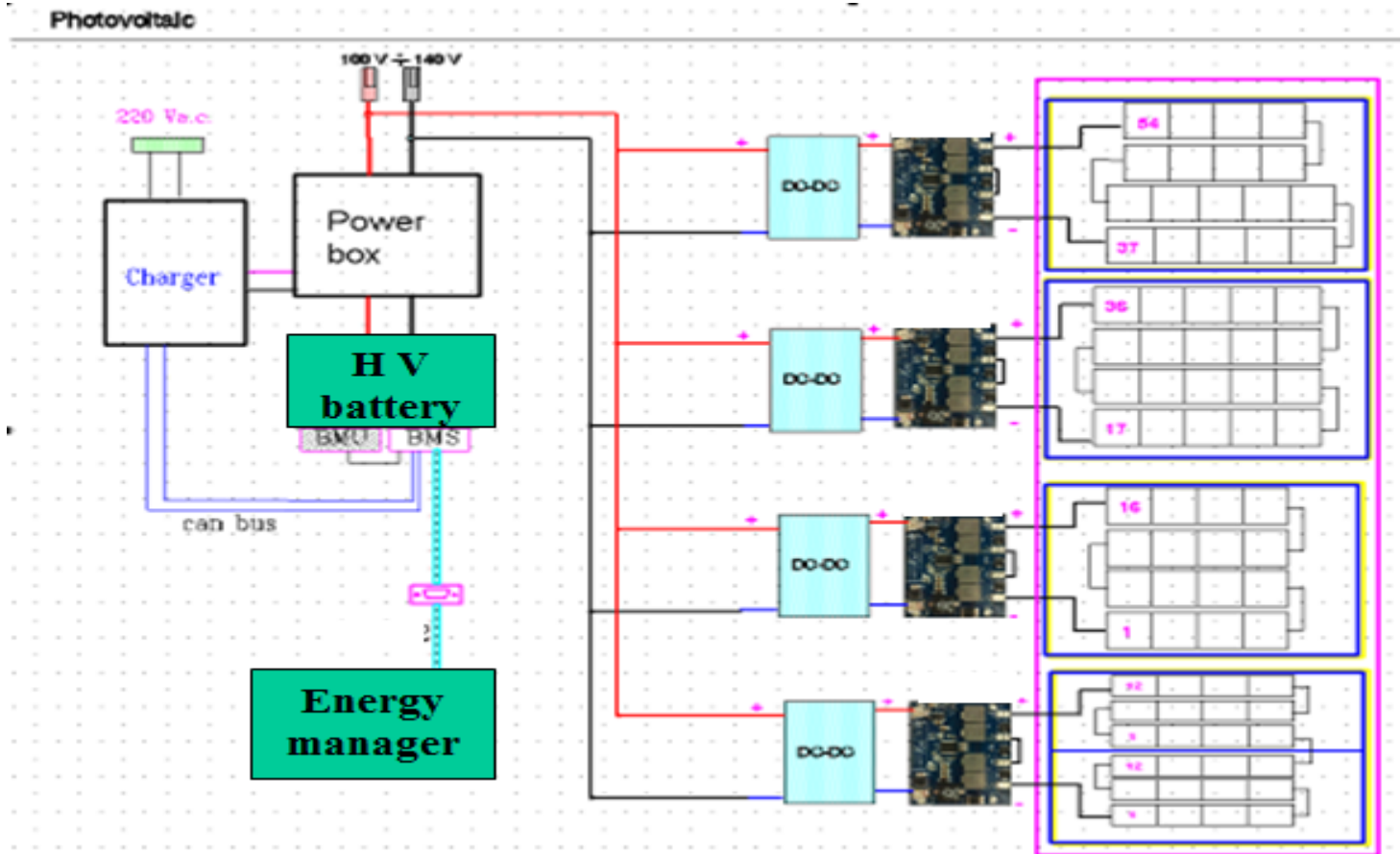


Two peaks MPPT FAILS!



70Wp panel with 60 cells and three bypass diodes irradiated with $1000\text{W}/\text{m}^2$ but **ONE CELL is partially shaded** from 0% to 100.

Smart Photovoltaic



Smart Photovoltaic employing system partition, small PV panels, lamination of cold diodes, distributed MPPT with adaptable boost electronics. From four independent modules with four boards to one single board performing four independent MPPT and DC-DC stage.

Positioning of the EU-MOBY Variable Platform

Type	Light EVs (e-Bike)	LightE VS (other)	Micro e-Cars light-heavy Q-cycles	City e-Cars NEDC	Small e-Cars NEDC	Mid size e-Cars NEDC	Large e-Cars NEDC
Weight kg	15-50	50-350	350-700	700 -1100	1100-1350	1350-1600	1600-2000
Energy kWh/100km	1-2	2-4	4-8	9-12	12-15	15-18	18-25
kg/100km of Li-ion b.pack (180Wh/kg)	6 -11	11-17	23-50	50-67	67-85	85-100	100 -150
DC link (V)	24-48	48-65	48-98	65-240	120-360	240-480	360-480++
Nominal Power (kW)	0.05-1.0	to 3	to 15	10-40	18-70	50-140	70-200+
Speed km/h	to 35	to 45	45-90+	By design			

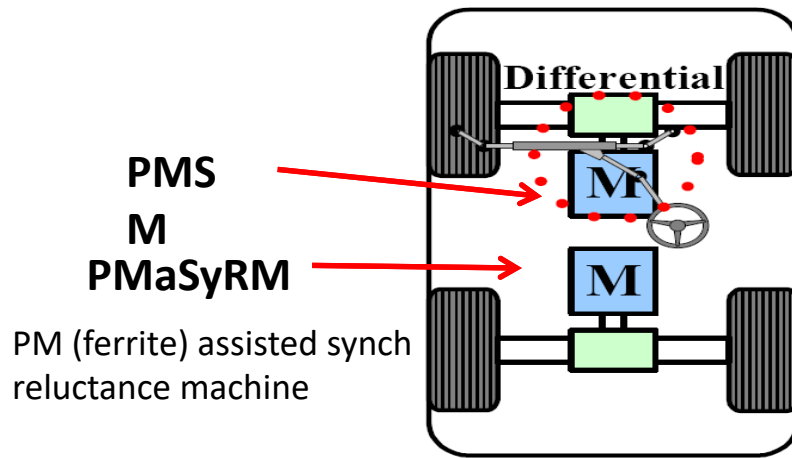
**E
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No driving licence/14years/16years/
No heavy safety restrictions

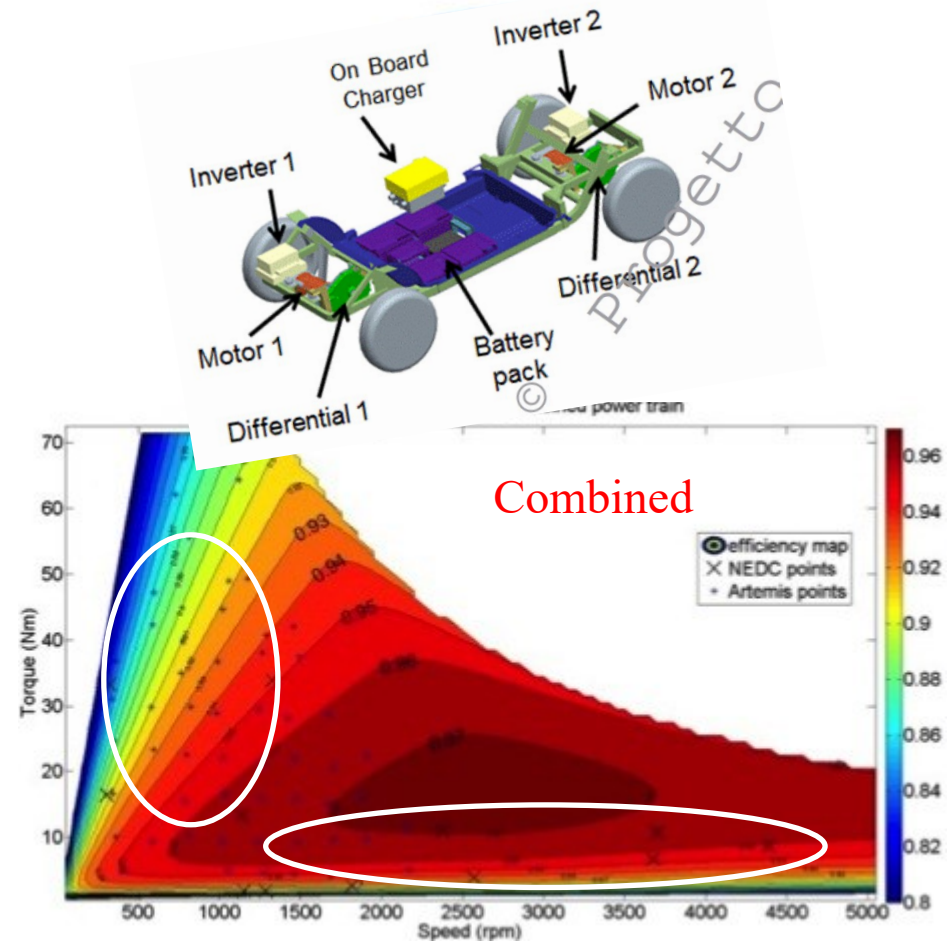
M1 passenger cars: ABS, EPS...mandatory.
NCAP 5 Safety almost a must.

Efficiency gains of the two motor powertrain

- ❑ The distributed power train reduces energy consumption in the tyre slip compared with the single motor drive scheme

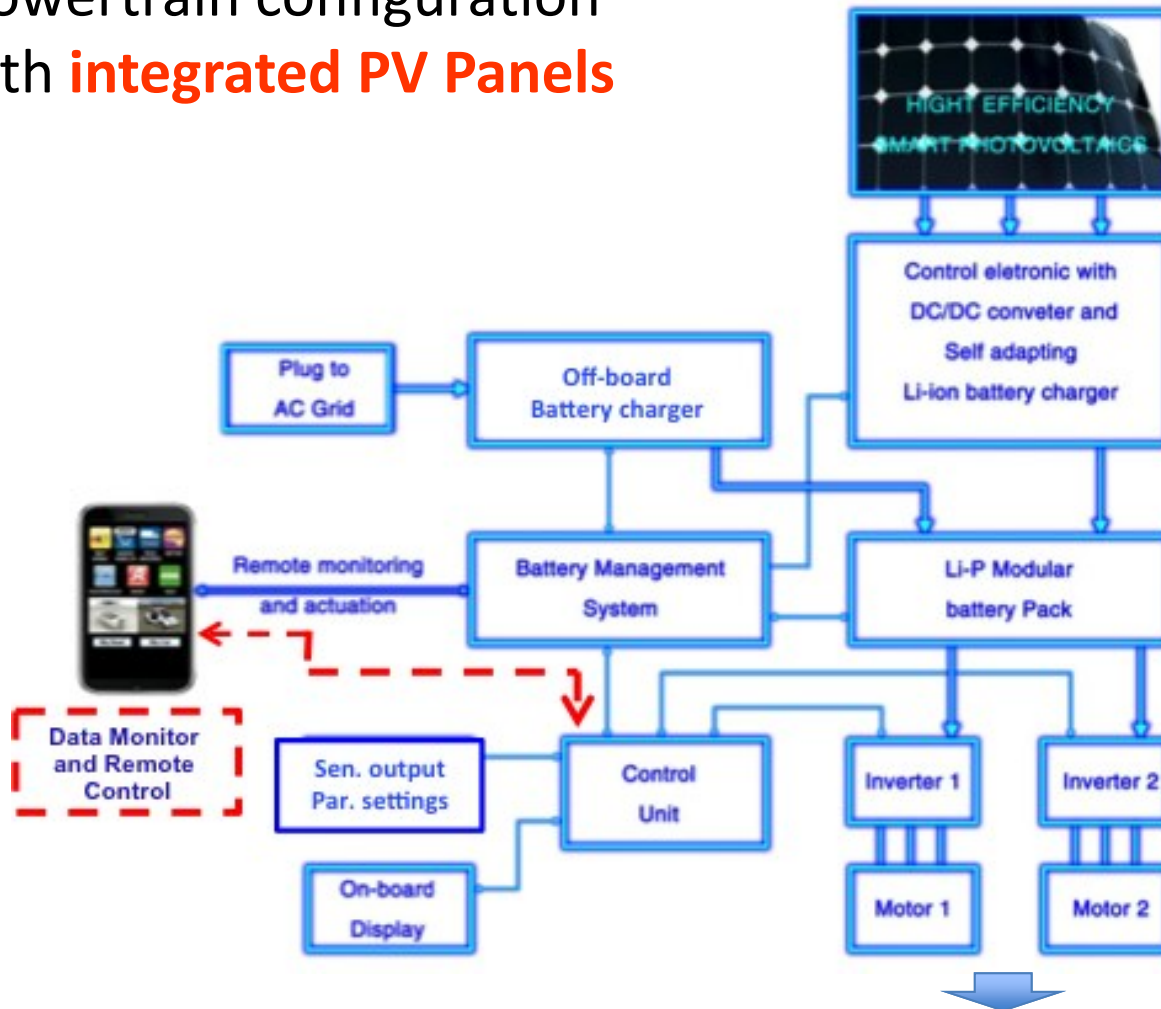


- ❑ Front motor optimised against **NEDC**, rear motor against **Artemis Urban** to achieve best overall efficiency
- ❑ Optimal torque distribution saves 4% -12% energy over NEDC
- ❑ **Higher perceived acceleration**



Technology implemented by Polimodel and his partner IFEVS in EU projects.

Universal two motors powertrain configuration with integrated PV Panels



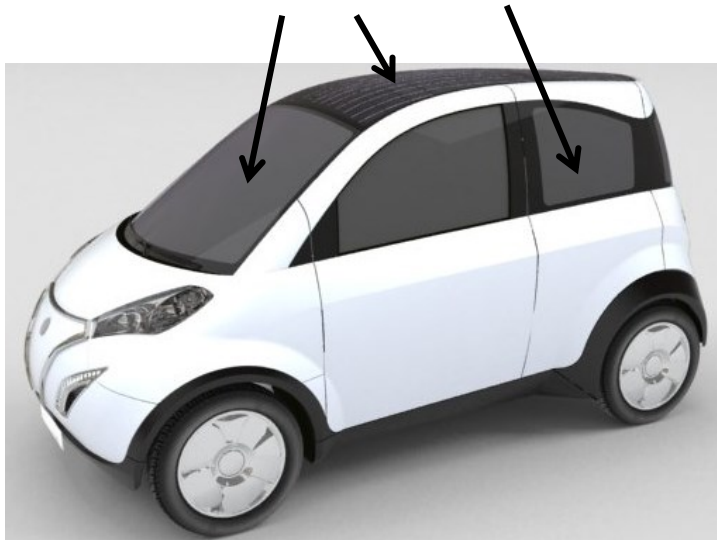
Experimented on
Cars, Boats, Airplanes

Solar energy harvesting

- ❑ Photovoltaic panels allow to harvest the solar energy when both driving and parked.
- ❑ Crystalline silicone has been used due to high efficiency.
- ❑ Double curvature is achieved by separating solar cells into small linear portions.
- ❑ High efficiency is achieved by connecting optimal number of cells in series with distributed electronic control

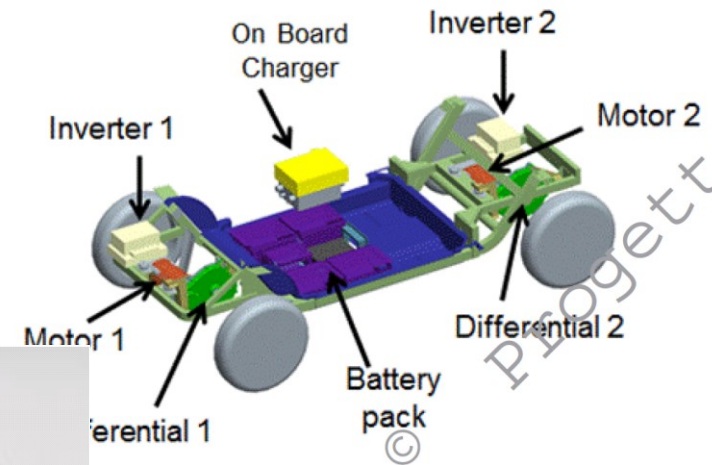


PV Surfaces

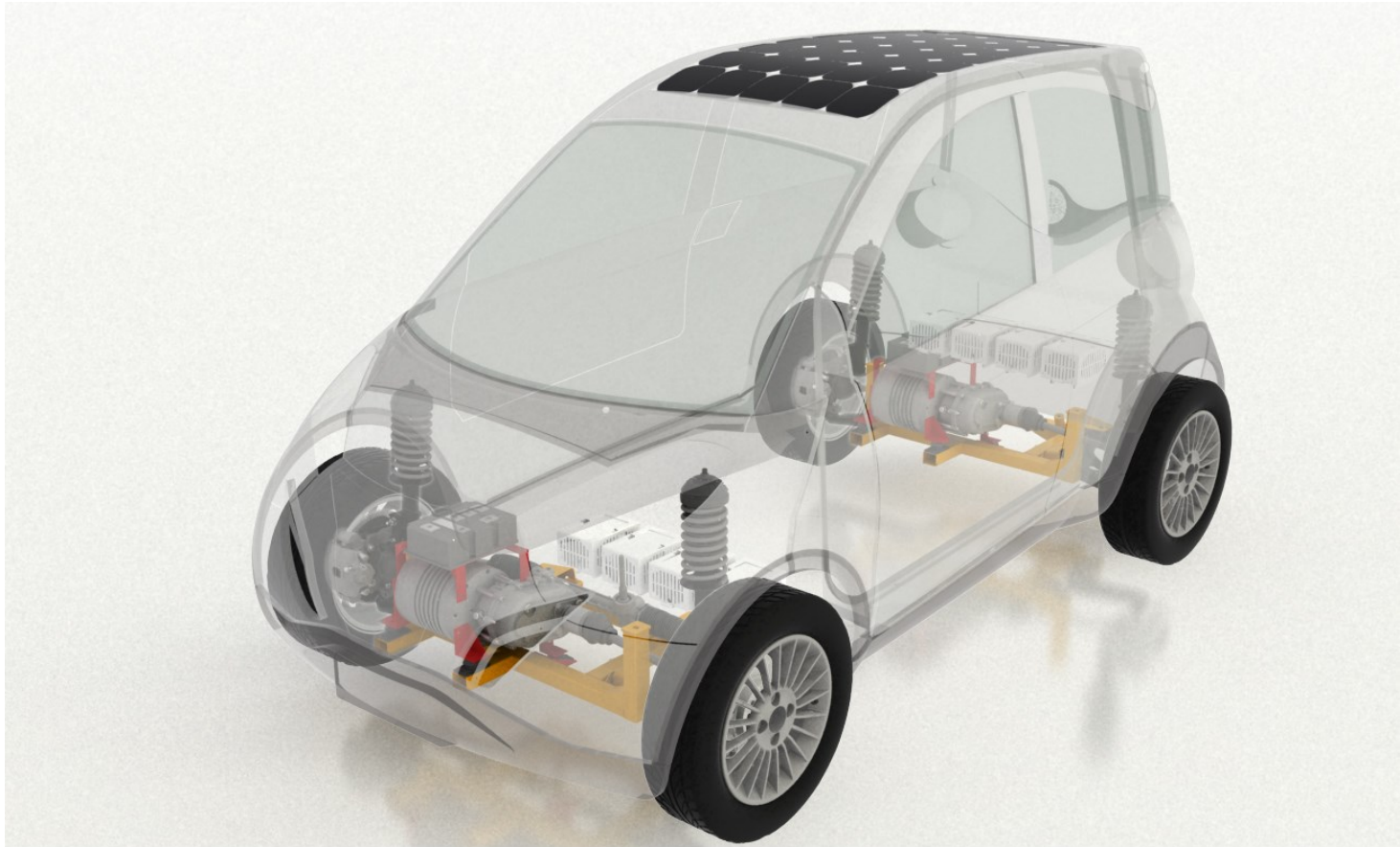


- ❑ At ambient temperature and with an irradiation of 1000 W/sqm average conversion efficiency measured at bench is > 20%
- ❑ Effective surface 1.9sqm (target 2.5 sqm)
- ❑ Target energy >1.2kWh/day average

PV ON E-CARS

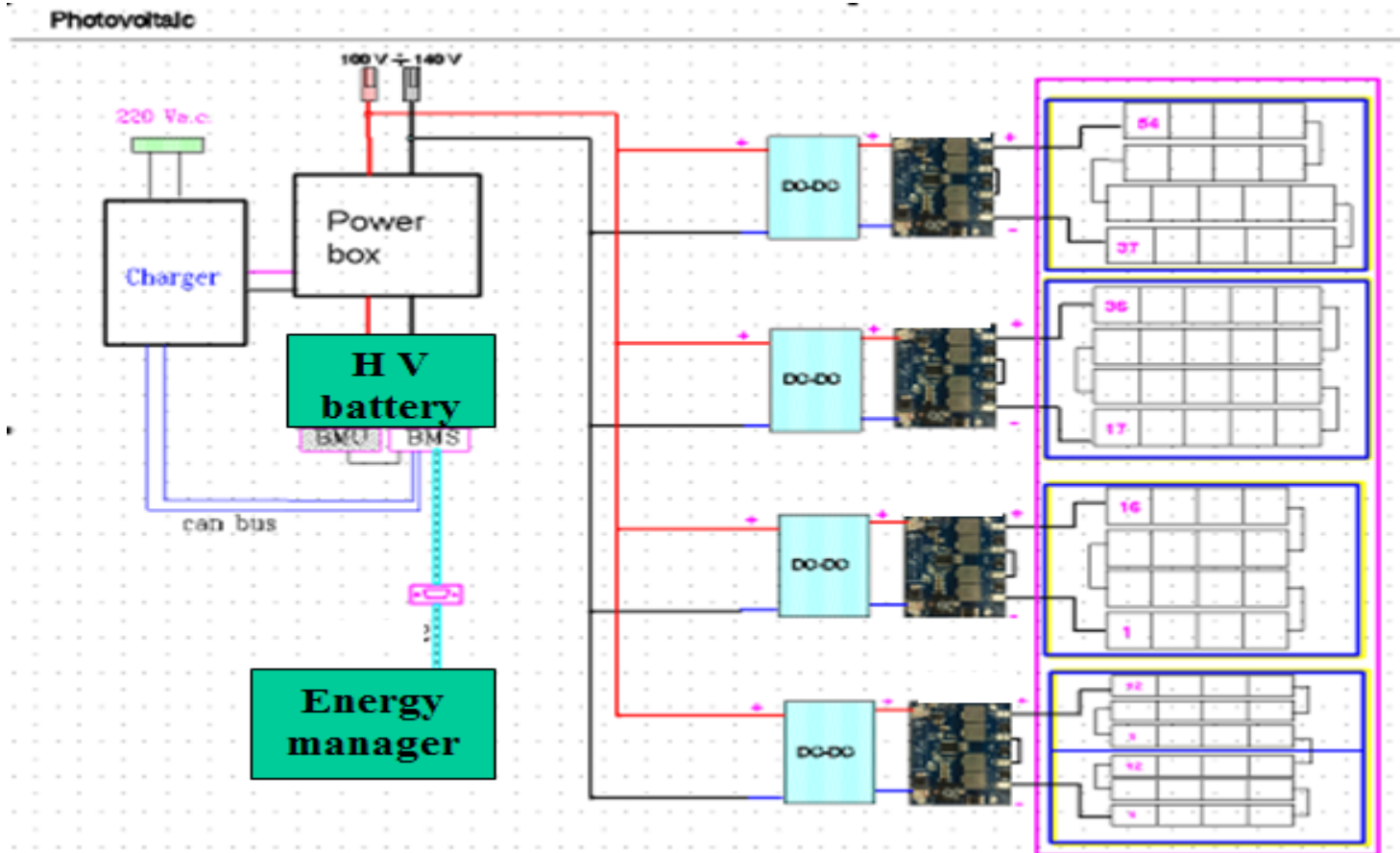


Direct photovoltaic panel to high voltage battery pack connection



Two motor powertrain with two independent battery packs. All photovoltaic modules are connected with the the battery pack on the front axle only. The rear battery modules can be partially swapped (IFEVS).

Smart Photovoltaic



Smart Photovoltaic employing system partition, lamination of cold diodes, distributed MPPT with adaptable boost electronics, second stage boost conversion with smart charging into the high voltage battery. From four independent modules with four boards to one single board performing four independent MPPT and one DC-DC stage.

TORINO

Annual irradiation deficit due to shadowing (horizontal): 0.0 %

Month	Hh	Hopt	H(90)	lopt	T24h	NDD
Jan	1540	2870	2970	66	4.0	406
Feb	2580	4280	4030	60	5.7	324
Mar	3900	5240	4110	48	9.2	217
Apr	4930	5530	3430	32	12.2	108
May	5880	5840	2980	18	17.2	10
Jun	6530	6180	2800	12	21.1	0
Jul	6810	6590	3060	15	23.0	0
Aug	5720	6120	3460	27	22.7	0
Sep	4350	5460	3930	42	18.6	39
Oct	2660	3850	3330	54	14.5	180
Nov	1620	2820	2810	64	8.6	347
Dec	1520	2790	2910	67	4.9	426
Year	4010	4800	3310	38	13.5	2057

Hh: Irradiation on horizontal plane (Wh/m²/day)

Hopt: Irradiation on optimally inclined plane (Wh/m²/day)

H(90): Irradiation on plane at angle: 90deg. (Wh/m²/day)

lopt: Optimal inclination (deg.)

T24h: 24 hour average of temperature (°C)

NDD: Number of heating degree-days (-)

PVGIS (c) European Communities, 2001-2012

Reproduction is authorised, provided the source is acknowledged.

<http://re.jrc.ec.europa.eu/pvgis/>

Average/y 4000 Wh/m²/day x 0.2 efficiency x
1.9m² effective surface = 1520Wh/day

Panel Efficiency Sunpower monocrystalline silicon 21%
Surface 2.2m² of which:

1.0m² Roof Horizontal 4010 Wh

0.65m² Windshield Optimal x 0.8 real 2496 Wh

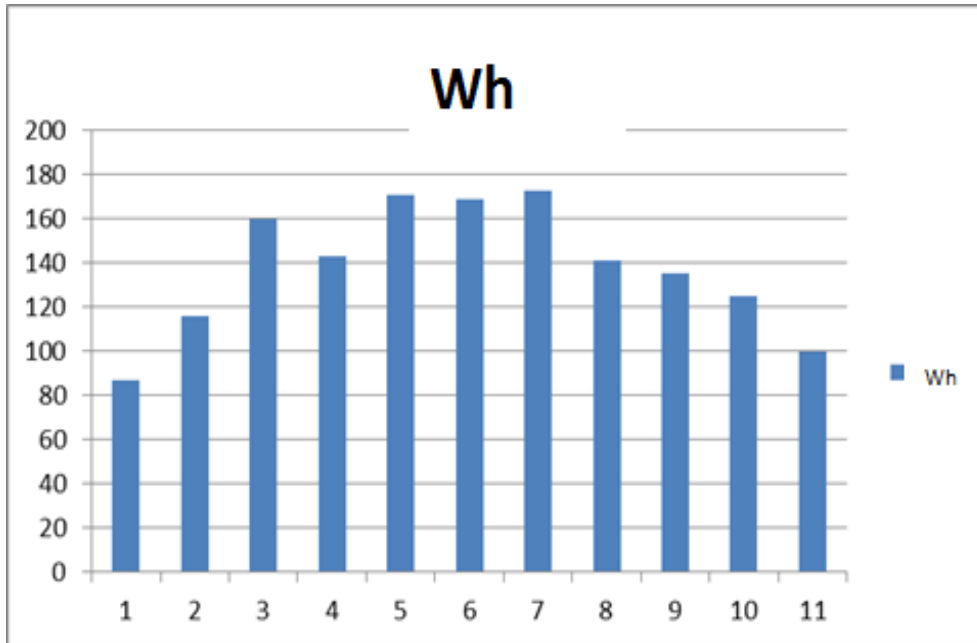
0.45m² Rear Side Windows vertical x 0.6 real 1137 Wh

4010Wh+2496Wh+1137Wh=7533Whx0.2= 1506Wh/day

On-board “Smart” Photovoltaic

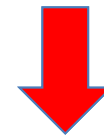


Measurements confirm that the EU-MOB can run the targeted 20km a day



Measured power consumption With full weight 800kg

- ❑ Constant speed
 - 50km/h: 48.37 Wh/km
 - 100km/h: 107.30 Wh/km
- ❑ NEDC
 - No energy recovery: 80 Wh/km
 - Energy recovery 100%: 70 Wh/km



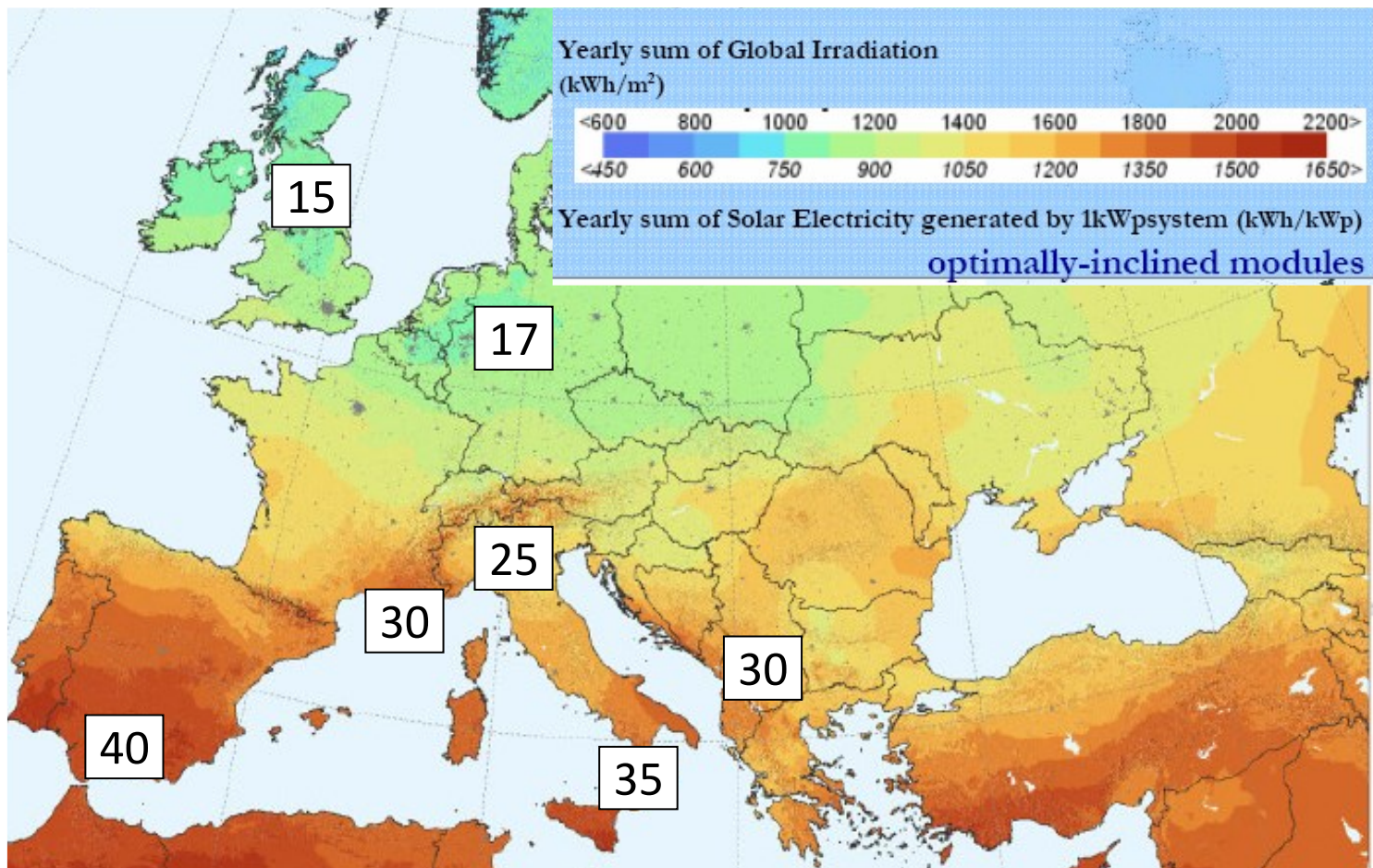
Torino June 2012: Stored energy in
the high voltage battery pack
1.6kWh/day month average



1600/75=21km/day
NEDC cycle

Potential of solar energy for mobility

- Average daily mileage potentially provided by solar energy harvested by a small e-car demonstrated with 2012 technology





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A new generation of PV panels

*Integration of PV-Multifunctional
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THANKS FOR ATTENTION!



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