energies

MDPI

Supporting Information

Article

Photo-Rechargeable Electric Energy Storage Systems Based on Silicon Solar Cells and Supercapacitor-Engineering Concept

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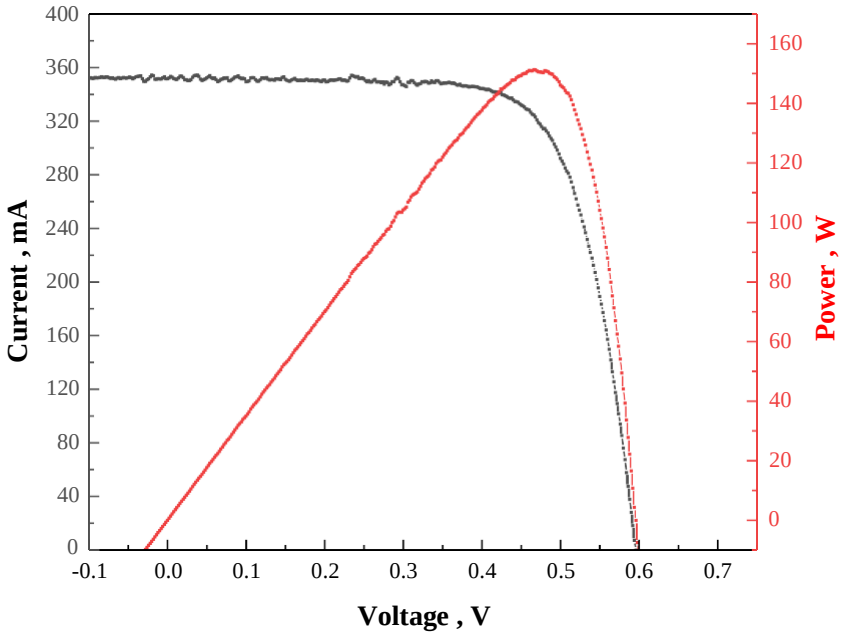
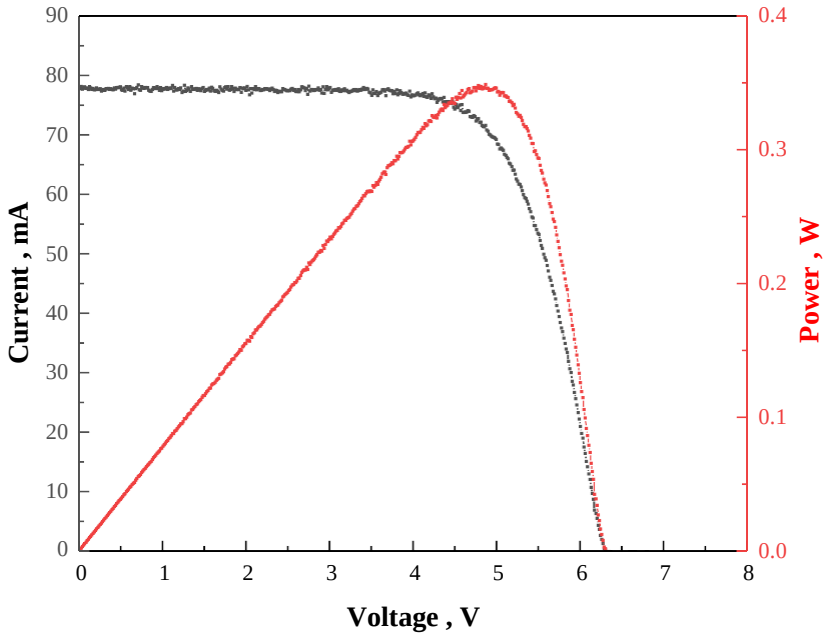
Table S1. A summary of crucial parameters of supercapacitors used in energy storage system.

Parameter		**Supercapacitor 1**	**Supercapacitor 2**	**Supercapacitor 3**
Brand Type		Eaton series XB	AXV Axial 850F	Eaton series XV
Symbol		XB3560-2R5407-R	SCCY1AB857SLBLE	XV3560-2R7407-R
dimensions		60mm × 35mm	115mm × 35mm	60mm × 35mm
Capasity of single capacitor	C_{sc}	400F	850F	400F
Operating potential of single supercapacitor	V_{sc}	2.5V	2.7V	2.7V
Storied energy	E_s	0.35Wh	0.86Wh	0.41Wh
Series resistance	R_s	4.5mΩ	1.3mΩ	3.2mΩ
Current of loss	I_u	0.45mA	2.2mA	0.85mA



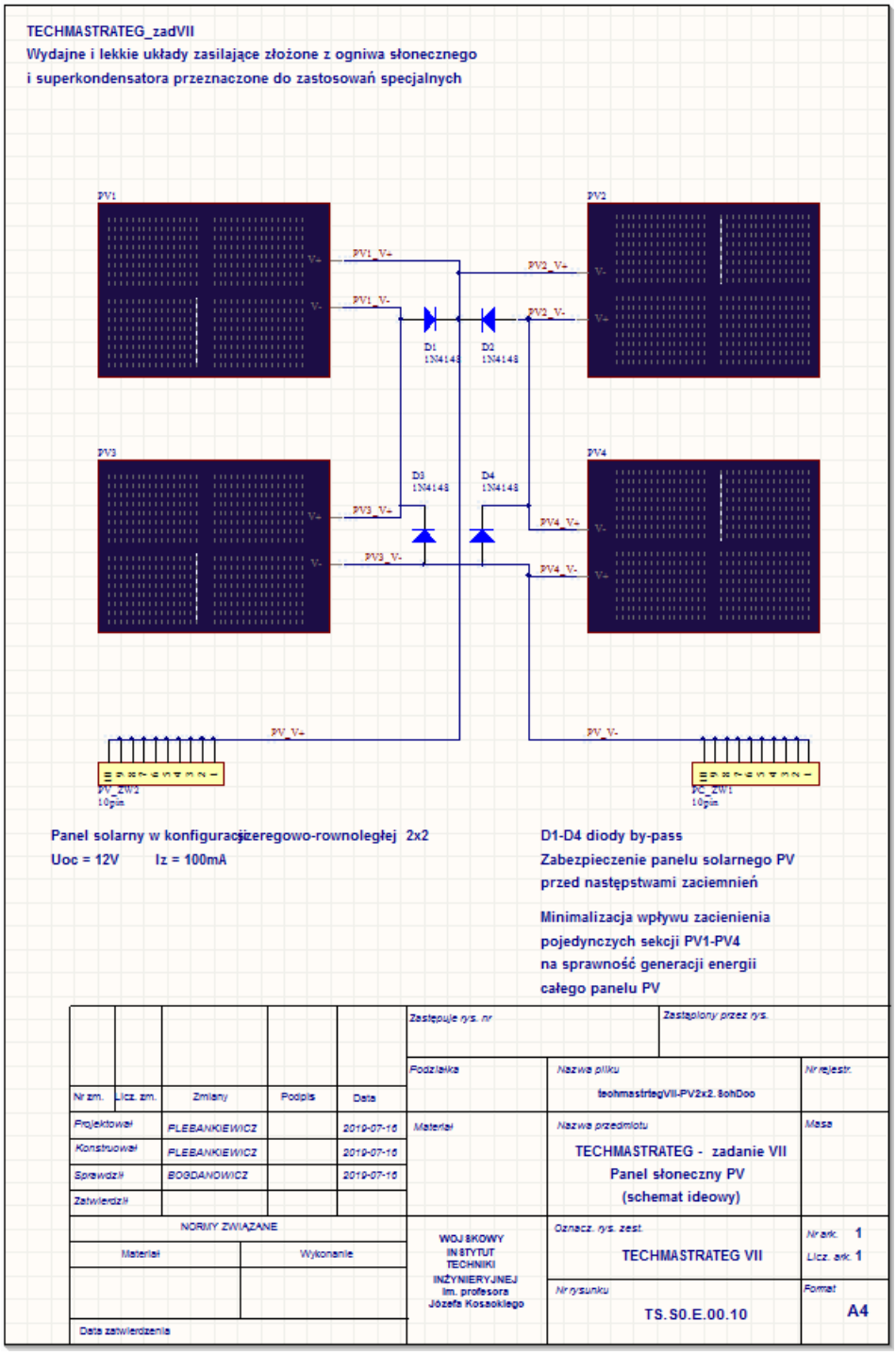
(a)



(b)

Figure S1. I-V characteristics of: (a) PV cell with size of 50 mm × 20 mm and (b) PV module with size of 65 mm × 65 mm.

(a)


TECHMASTRATEG_zadVII
Wydajne i lekkie układy zasilające złożone z ogniwa słonecznego
i superkondensatora przeznaczone do zastosowań specjalnych
PV1
PV2
PV3
PV4
PV1_V+
PV1_V-
PV2_V+
PV2_V-
PV3_V+
PV3_V-
PV4_V+
PV4_V-
D1 1N4148
D2 1N4148
D3 1N4148
D4 1N4148
PV_V+
PV_V-
PV_ZW1 10pin
PC_ZW1 10pin
Panel solarny w konfiguracji szeregowo-rownoległej 2x2
Uoc = 12V Iz = 100mA
D1-D4 diody by-pass
Zabezpieczenie panelu solarnego PV
przed następstwami zaciemnień
Minimalizacja wpływu zacienienia
pojedynczych sekcji PV1-PV4
na sprawność generacji energii
całego panelu PV
Zastępuje rys. nr
Zastąpiony przez rys.
Podziałka
Nazwa pliku
techmastrategVII-PV2x2. 8ohDoo
Nr rejestr.
Nr zm.
Licz. zm.
Zmiany
Podpis
Data
Projektował
PLEBANKIEWICZ
2019-07-16
Konstruował
PLEBANKIEWICZ
2019-07-16
Sprawdził
BOGDANOWICZ
2019-07-16
Zatwierdził
Materiał
Nazwa przedmiotu
TECHMASTRATEG - zadanie VII
Panel słoneczny PV
(schemat ideowy)
Masa
NORMY ZWIĄZANE
Materiał
Wykonanie
Data zatwierdzenia
WOJSKOWY INSTYTUT TECHNIKI INŻYNIERYJNEJ im. profesora Józefa Kosackiego
Oznacz. rys. zest.
TECHMASTRATEG VII
Nr arkusza 1
Licz. ark. 1
Nr rysunku
TS.S0.E.00.10
Format
A4

(b)

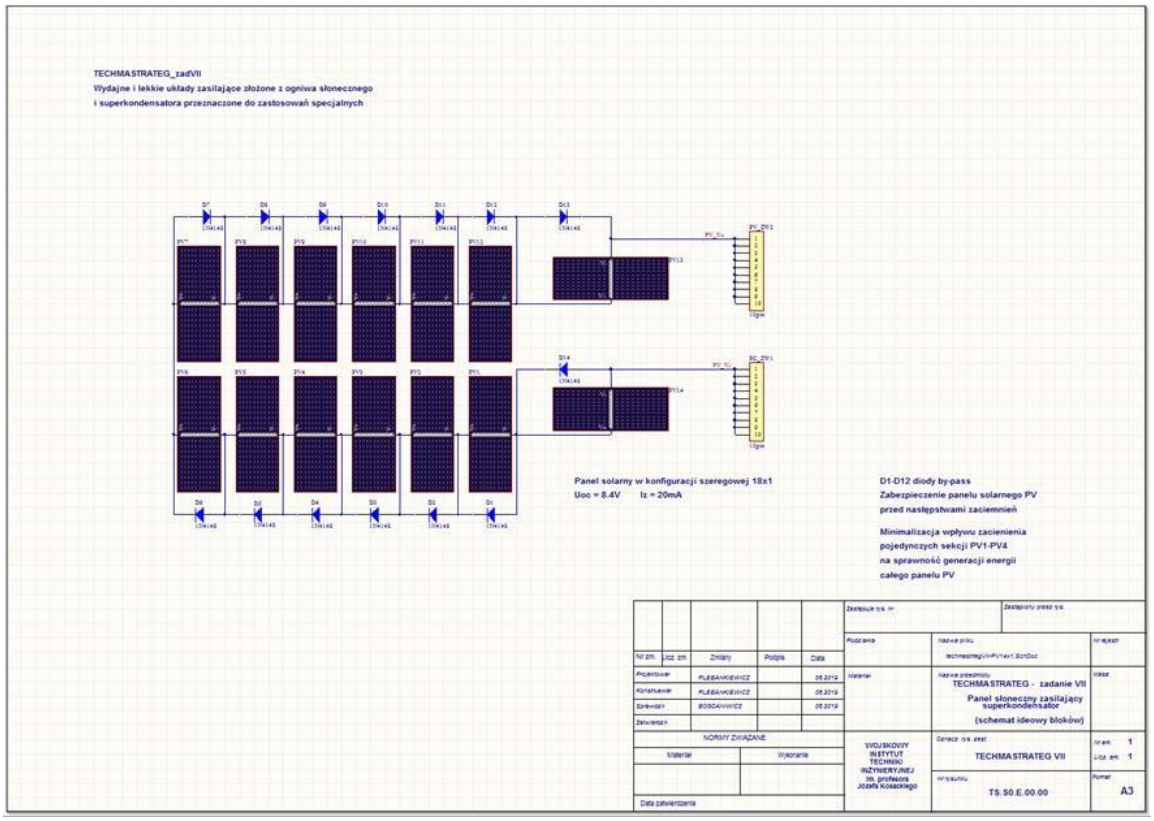


Figure S2. Schematic diagrams of PV panels: (a) photovoltaic cells in a 2 × 10 × 4 series- parallel arrangement; (b) 14 solar cells in series.

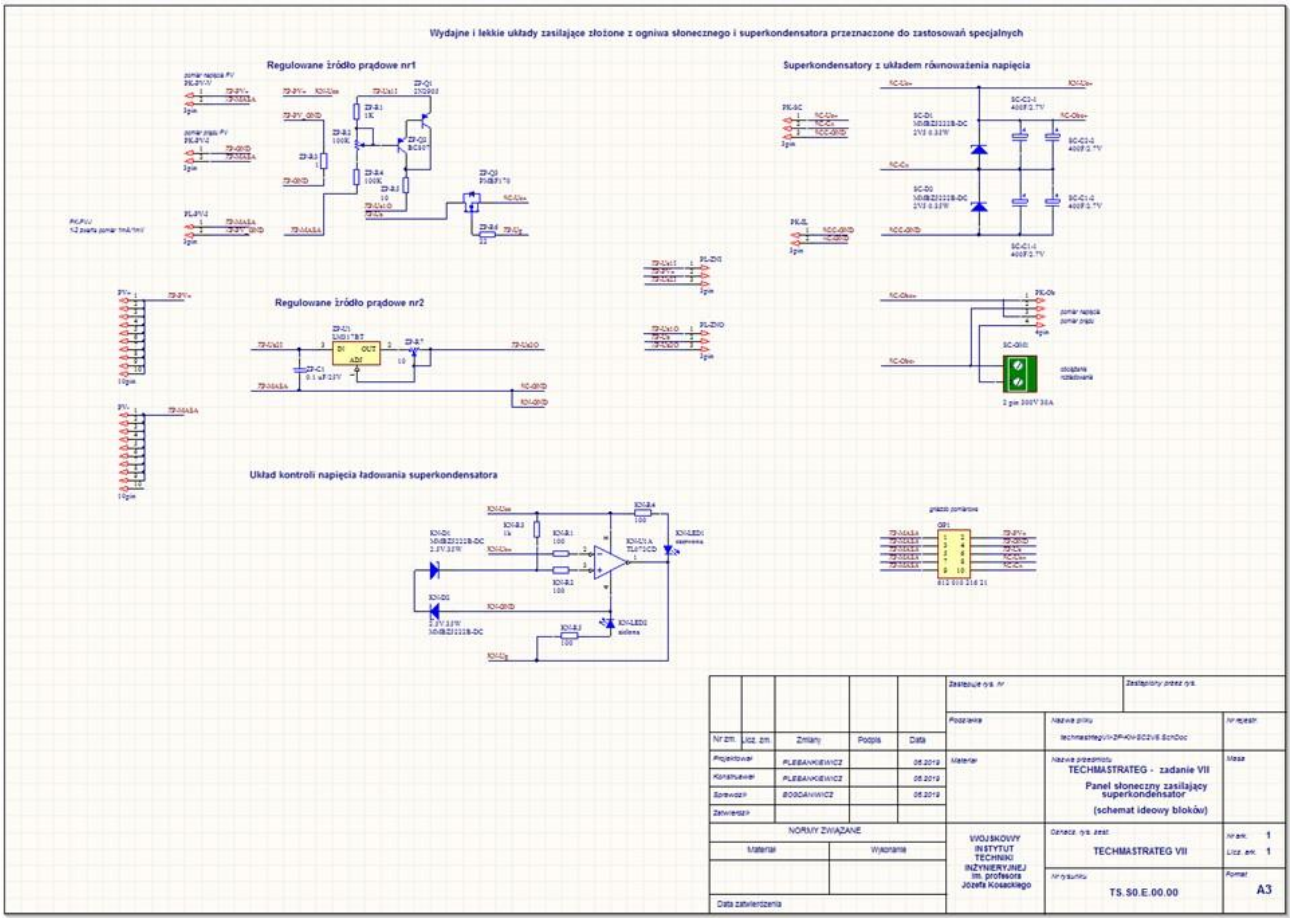
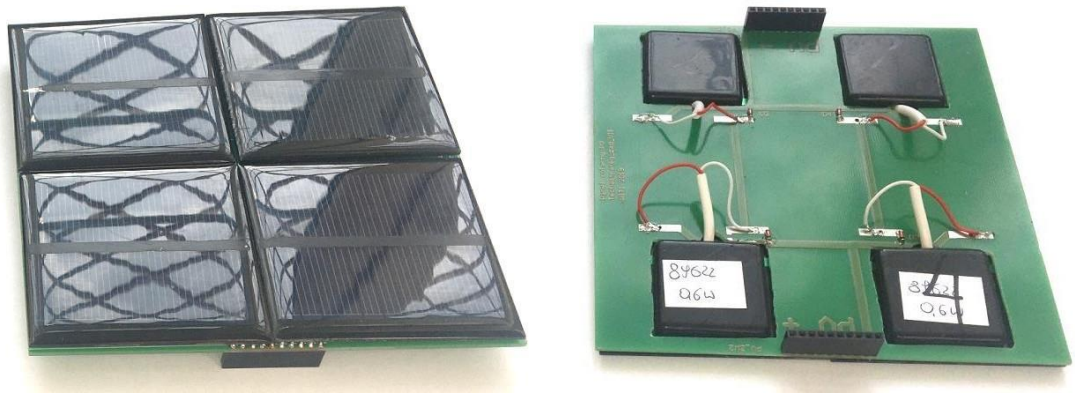
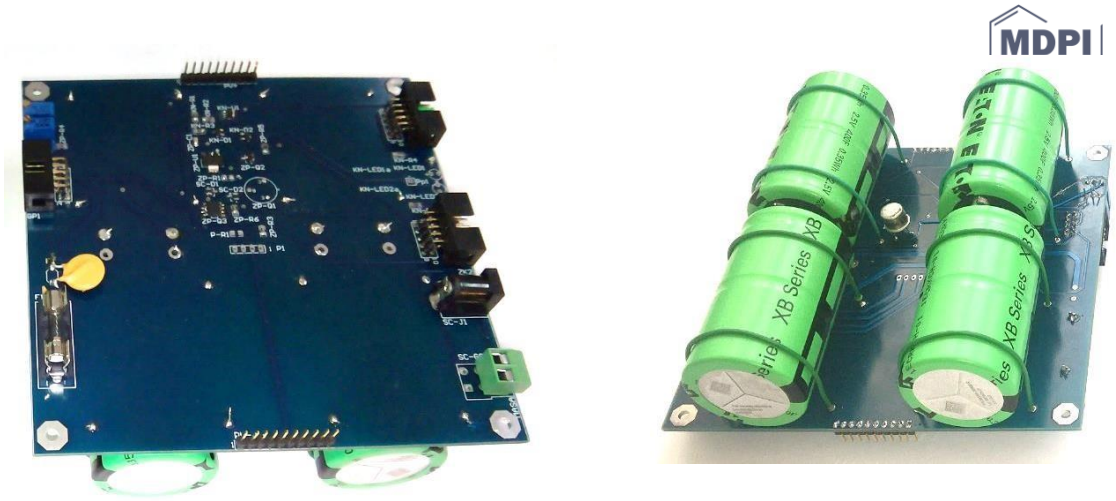


Figure S3. Schematic diagram of the power source block, voltage control system and supercapacitors.



(a) (b)

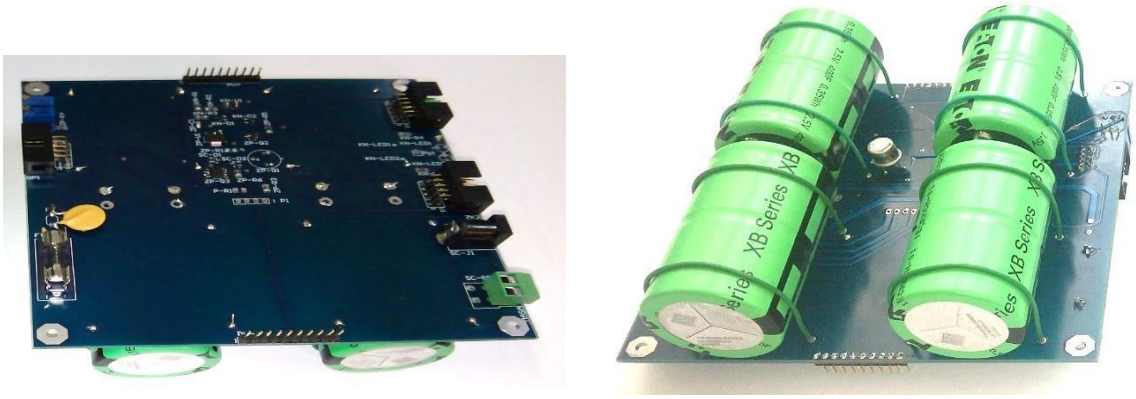
Figure S4. View of assembled PCB of first demonstrator- photovoltaic cells in a system of 40 cells connected in series in parallel in a 2 × 10 × 2 system: (a) page of elements; (b) print page.



(a) (b)

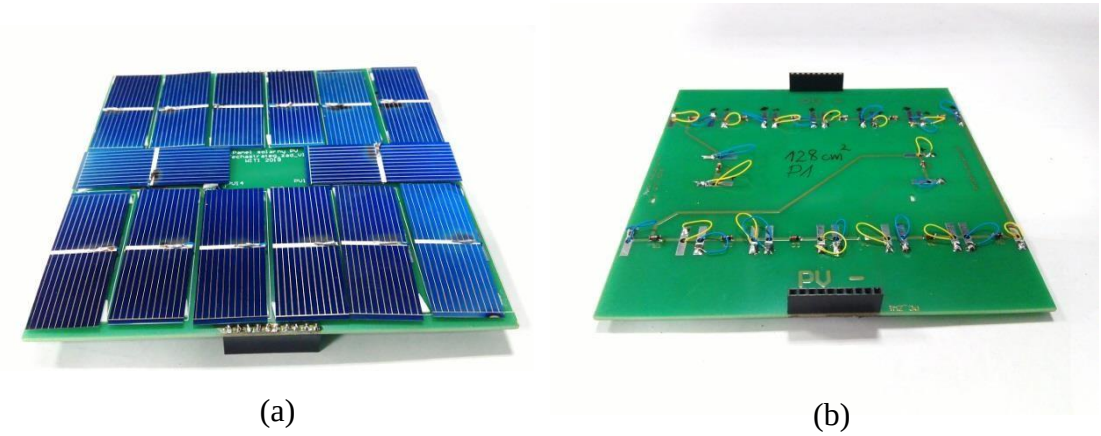
Figure S5. View of assembled elements: (a) a block of a power source, a voltage control system and (b) four supercapacitors with a capacity of C_{SC} = 400 F, operating voltage V_{SC} = 2.5 V

Figure S6. View of assembled PCB of second demonstrator - photovoltaic cells in a system of 40 cells connected in series in parallel in a 2 × 10 × 2 system: (a) page of elements; (b) print page



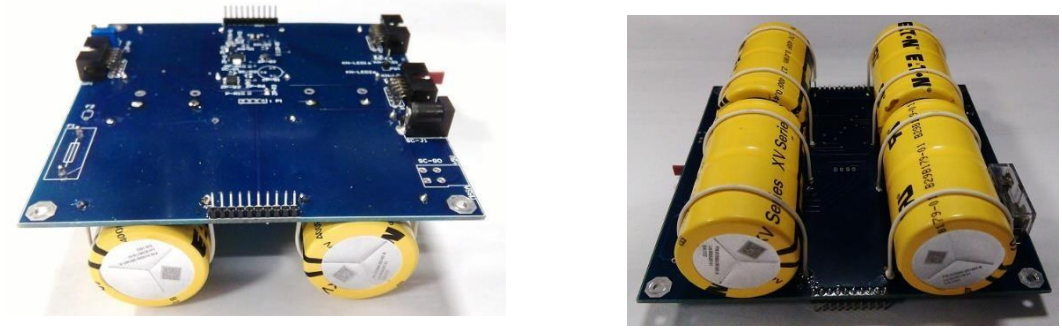
(a) (b)

Figure S7. View of assembled PCB of second demonstrator: power source block, voltage control system and two supercapacitors with capacity C_{SC} = 850 F and operating voltage V_{SC} = 2.7 V,
(a) page of elements; (b) print page



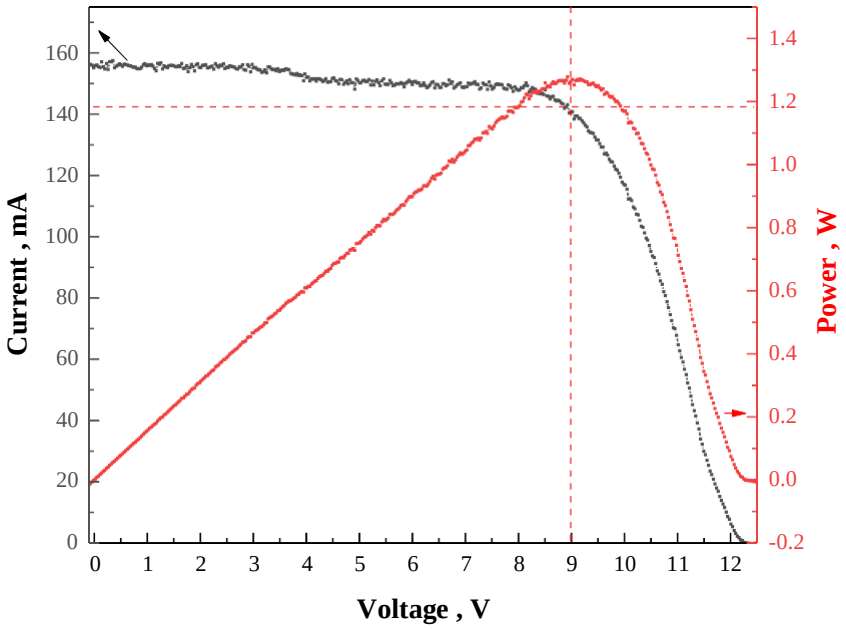
(a) (b)

Figure S8. View of assembled PCB of third demonstrator - photovoltaic cells in a system of 14 cells connected in series in a 14 × 1 system: (a) page of elements; (b) print page

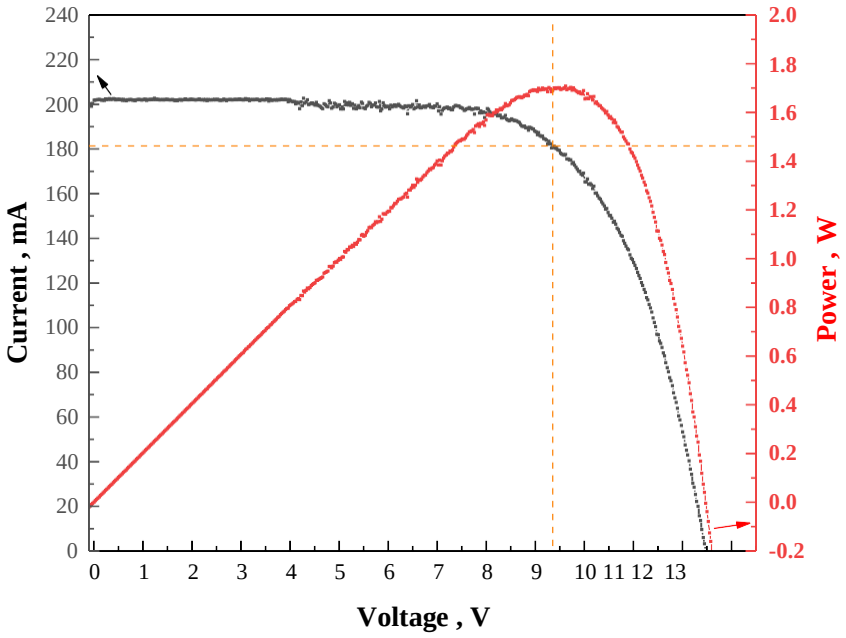


(a) (b)

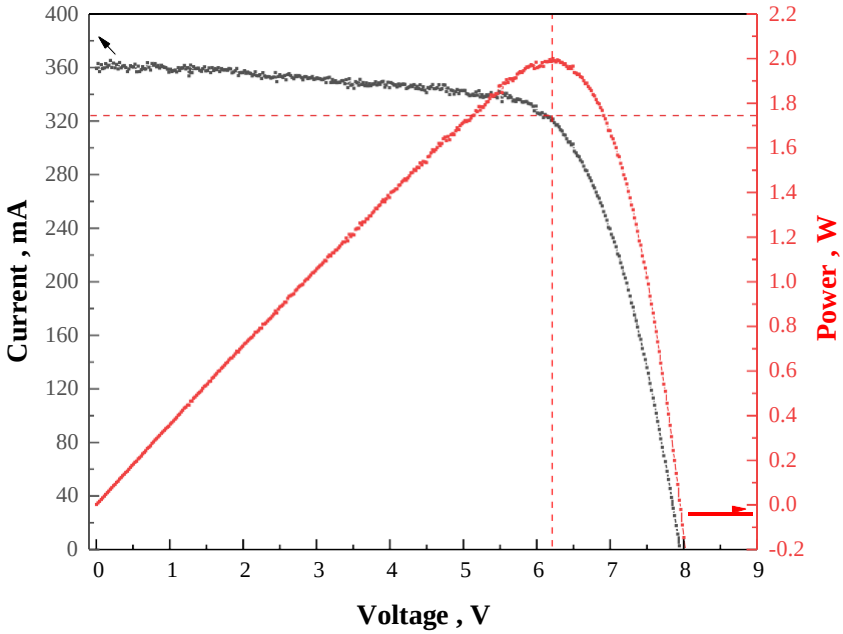
Figure S9. View of assembled PCB of third demonstrator - current source block, voltage control system and four supercapacitors with C_{SC} = 400 F capacity and V_{SC} = 2.7 V operating voltage: (a) page of elements; (b) print page


Current , mA
Power , W
Voltage , V
0
20
40
60
80
100
120
140
160
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0 1 2 3 4 5 6 7 8 9 10 11 12

(a)


Current , mA
Power , W
Voltage , V
0
20
40
60
80
100
120
140
160
180
200
220
240
-0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13

(b)



(c)

Fig. S10. Average voltage and current characteristics of a PV panel with the MPP optimal operating point marked at illumination ~ 990W/m^2 and ~ 21 °C for: (a) demonstrator no. 1 (V_{oc} = 12.45 V, I_{sc} = 155.76 mA, FF = 65%, PCE = 8.94%), (b) demonstrator no. 2 (V_{oc} = 12.34 V, I_{sc} = 212.67 mA, FF = 65%, PCE = 11.85%), (c) demonstrator no. 3 (V_{oc} = 7.95 V, I_{sc} = 359.33 mA, FF = 69%, PCE = 14.65 %).