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Power to the next generation

HELLO TOMORROW | genesis ENERGY

SCHOOLGEN ACTIVITIES

INVESTIGATING THE PERFORMANCE OF PHOTOVOLTAIC CELLS

Teachers' Answer Guide and Sample Data

With the support of

Ministry for the Environment
Manatū Mō Te Taiao
Sustainable Management Fund

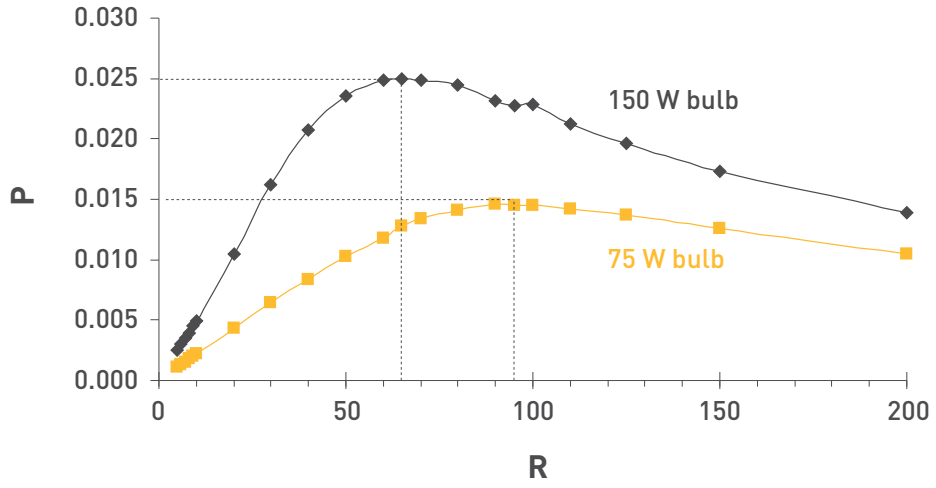
INVESTIGATING THE PERFORMANCE OF PHOTOVOLTAIC CELLS

EXPERIMENT 1

For our module (DSE cat. no. 02017), Quoted values: V_{oc} = 2V; I_{sc} = 550mA

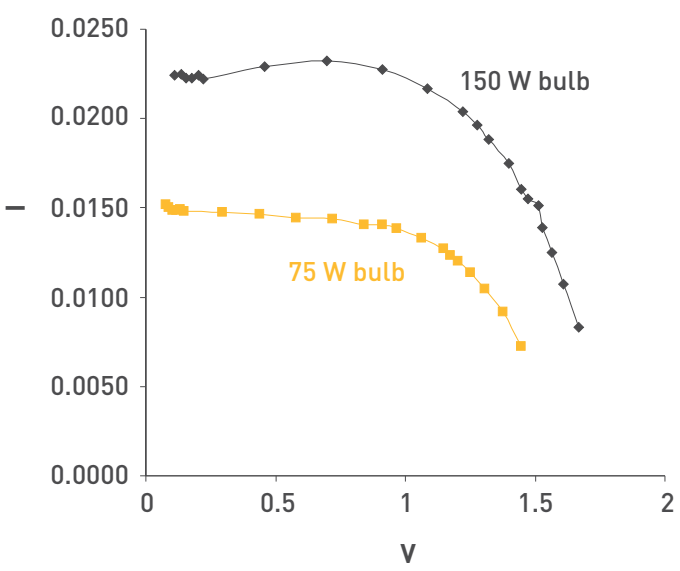
	150 W bulb, 50 cm from PV cell			75 W bulb, 50 cm from PV cell		
R (ohm)	V (volts)	I (amps)	P (watts)	V (volts)	I (amps)	P (watts)
5	0.112	0.0224	0.0025	0.076	0.0152	0.0012
6	0.135	0.0225	0.0030	0.09	0.0150	0.0014
7	0.156	0.0223	0.0035	0.104	0.0149	0.0015
8	0.178	0.0223	0.0040	0.119	0.0149	0.0018
9	0.202	0.0224	0.0045	0.134	0.0149	0.0020
10	0.222	0.0222	0.0049	0.148	0.0148	0.0022
20	0.458	0.0229	0.0105	0.295	0.0148	0.0044
30	0.697	0.0232	0.0162	0.44	0.0147	0.0065
40	0.91	0.0228	0.0207	0.578	0.0145	0.0084
50	1.085	0.0217	0.0235	0.718	0.0144	0.0103
60	1.222	0.0204	0.0249	0.842	0.0140	0.0118
65	1.275	0.0196	0.0250	0.912	0.0140	0.0128
70	1.32	0.0189	0.0249	0.968	0.0138	0.0134
80	1.4	0.0175	0.0245	1.063	0.0133	0.0141
90	1.445	0.0161	0.0232	1.146	0.0127	0.0146
95	1.471	0.0155	0.0228	1.174	0.0124	0.0145
100	1.513	0.0151	0.0229	1.203	0.0120	0.0145
110	1.529	0.0139	0.0213	1.251	0.0114	0.0142
125	1.565	0.0125	0.0196	1.306	0.0104	0.0136
150	1.61	0.0107	0.0173	1.376	0.0092	0.0126
200	1.668	0.0083	0.0139	1.448	0.0072	0.0105

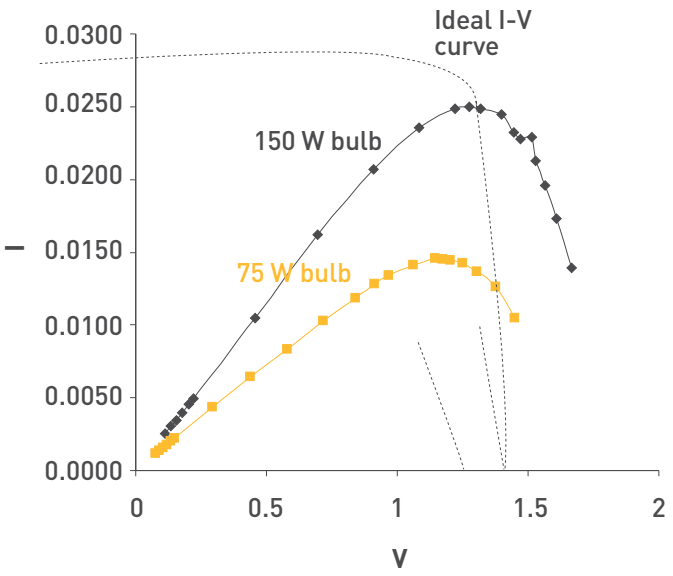
INVESTIGATING THE PERFORMANCE OF PHOTOVOLTAIC CELLS



For 150 W bulb, P_{max} = 0.025 ± 0.001 W; R_{opt} = 65 ± 5 Ω
For 75 W bulb, P_{max} = 0.015 ± 0.001 W; R_{opt} = 95 ± 5 Ω

Optimum resistances differ significantly. Maximum output powers do not change in proportion to the bulb powers.





INVESTIGATING THE PERFORMANCE OF PHOTOVOLTAIC CELLS

Estimate of efficiency:

(i) 150 W bulb: Power flux at 50 cm (d = 0.5 m) = $\frac{150}{4\pi d^2}$ = 47.75 W/m^2

Area of PV module, radius 5 cm (0.05 m) = πR^2 = 7.854 x 10^{-3} m^2

Power incident on PV module (input) = 47.75 x 7.854 x 10^{-3} = 0.375 W.

Maximum output, P_{max} = 0.025 $\pm$ 0.001 W

Efficiency = $\frac{output}{input}$ = $\frac{0.025}{0.375}$ = 0.0667 (6.67%)

(ii) 75 W bulb: Power flux at 50 cm (d = 0.5 m) = $\frac{75}{4\pi d^2}$ = 23.875 W/m^2

Area of PV module, radius 5 cm (0.05 m) = πR^2 = 7.854 x 10^{-3} m^2

Power incident on PV module (input) = 23.875 x 7.854 x 10^{-3} = 0.1875 W.

Maximum output, P_{max} = 0.015 $\pm$ 0.001 W

Efficiency = $\frac{output}{input}$ = $\frac{0.015}{0.1875}$ = 0.080 (8.0%)

EXPERIMENT 2:

Outdoors, in full sunshine, with R = 65 Ω, maximum output voltage = 2.10 V;

Output Power = $\frac{V^2}{R}$ = $\frac{2.10^2}{65}$ = 0.0678 W

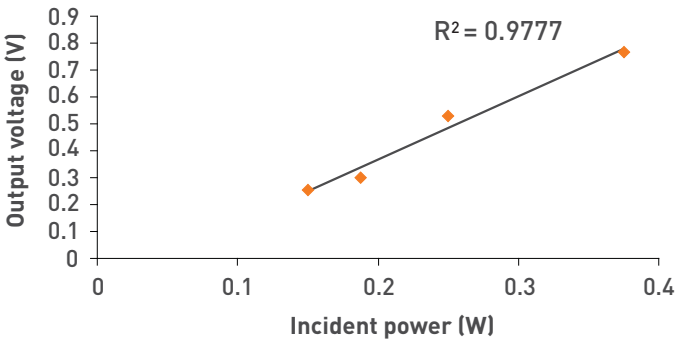
If efficiency = 6.67%, input power = $\frac{0.0678}{0.0667}$ = 1.017 W

Power flux = $\frac{power}{area}$ = $\frac{1.017}{7.854 \times 10^{-3}}$ =129.5 W/m^2

EXPERIMENT 3:

R = 65 ohms, d = 50 cm, Various bulbs in bulb-holder (no shade)

Bulb power (W)	Incident power (W)	Output (V)
150	0.375	0.765
100	0.25	0.53
75	0.1875	0.3
60	0.15	0.255

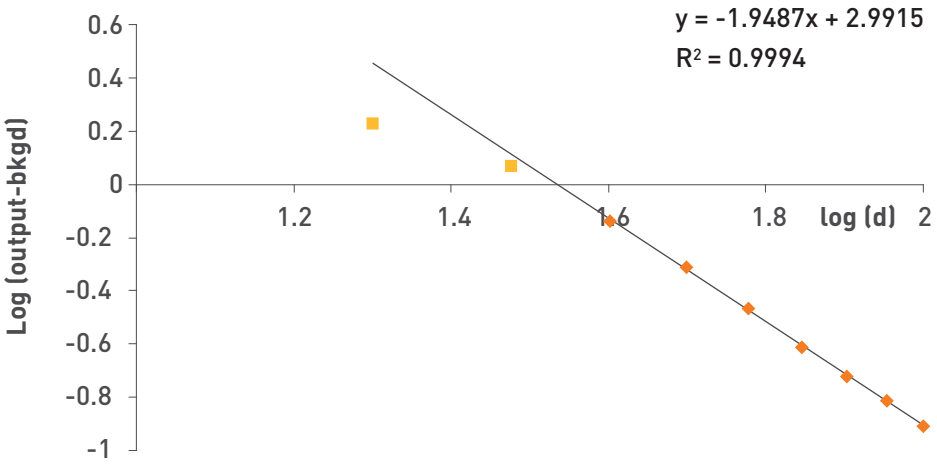


INVESTIGATING THE PERFORMANCE OF PHOTOVOLTAIC CELLS

Test of inverse square law 100 W bulb, R=65 ohms
Bkgd = 0.008

d (cm)	output voltage	trial 2	average-bkgd	log d	log V
20	1.693	1.693	1.685	1.30103	0.2266
30	1.168	1.168	1.16	1.477121	0.064458
40	0.742	0.734	0.73	1.60206	-0.13668
50	0.5	0.492	0.488	1.69897	-0.31158
60	0.354	0.346	0.342	1.778151	-0.46597
70	0.256	0.248	0.244	1.845098	-0.61261
80	0.202	0.194	0.19	1.90309	-0.72125
90	0.166	0.158	0.154	1.954243	-0.81248
100	0.136	0.128	0.124	2	-0.90658

20 cm and 30 cm measurements omitted from regression calculation



Uncertainty analysis on the gradient gives result grad = 1.95 ± 0.08, which is in agreement with the inverse square relationship.