Solar Energy Harvesting Strategies for Portable Devices such as Mobile Phones

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Outline

- Motivation of the research
- Solar (Photovoltaic, PV) energy
- Solar charger
  - performance of conventional PV chargers
  - user requirements and expectations
  - design requirements and specifications
- Conclusion and Future Work
Motivation of the Research (1/3)

Solar radiation [kWh/m²]

- 601 - 650
- 651 - 700
- 701 - 750
- 751 - 800
- 801 - 850
- 851 - 900

- 901 - 950
- 951 - 1.000
- 1.001 - 1.050
- 1.051 - 1.100
- 1.101 - 1.150
- 1.151 - 1.200

- 1.201 - 1.250
- 1.251 - 1.300
- 1.301 - 1.350
- 1.351 - 1.400
- 1.401 - 1.450
- 1.451 - 1.500

- 1.501 - 1.550
- 1.551 - 1.600
- 1.601 - 1.650
- 1.651 - 1.700
- 1.701 - 1.750
- 1.751 - 1.800

- 1.801 - 1.850
- 1.851 - 1.900
- 1.901 - 1.950
- 1.951 - 2.000

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Motivation of the Research (2/3)

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Motivation of the Research (3/3)

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- Coal and oil 11%
- Natural gas 10%
- Nuclear power 31%
- Peat 6%
- Wastes 1%
- Water- and wind power 26%
- Biomass 15%

Electricity Production

36% renewables

Source: Statistic Finland, 2012

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Solar Energy Behaviour (1/2)

I-V (Current-Voltage) curve

Current [A]

Voltage [V]

I_{sc}

I_{mpp}

I_1

P_{mpp}

V_{mpp}

V_1

V_{oc}

P_1

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Solar Energy Behaviour (2/2)

I-V (Current-Voltage) curve

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Conventional PV Charger (1/3)

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Conventional PV Charger (2/3)

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Conventional PV Charger (3/3)

\[ E_1 = P_{in} \times \eta \times t_1 \]

\[
\eta = \eta_{MPPT} \times \eta_{diode} \times \eta_{battery} \times \eta_{dc/dc}
\]

\[
\eta_{min} = 0.97 \times 0.88 \times 0.80 \times 0.75 \\
\approx 51\%
\]

\[
\eta_{max} = 0.97 \times 0.88 \times 0.90 \times 0.95 \\
\approx 73\%
\]
User Requirements

- USB interface as standard

\[ E_2 = P_2 \times t_2 \]

Source: Ferreira et al. 2011

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Design Requirements (1/3)

- user requirements need to be fulfilled
- solar charger needs to provide suitable amount of energy

\[ E_2 = P_2 \times t_2 = P_{in} \times \eta \times t_1 \]
Design Requirements (2/3)

Size of photovoltaics:

Connecting time: $t_2 = 1 \text{ h}$
USB output power: $P_2 = 2.5 \text{ W}$
Energy demand: $E_2 = 2.5 \text{ Wh}$
Time for the PV charger: $t_1 = 4 \text{ h}$
Required input power: $P_{in} = \frac{E_2}{(\eta \times t_1)}$
$P_{in} \approx 1.25 \text{ W (for } \eta_{min} \text{)}$
$P_{in} \approx 0.85 \text{ W (for } \eta_{max} \text{)}$
Design Requirements (3/3)

In the full paper:

- analysis of mobile phones as active or passive devices
- advantages and disadvantages between the two approaches
- dependence on the operating system
- available hardware
- access of hardware by software

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Conclusion and Future Work (1/2)

• possible to recharge mobile phones with solar energy
• current conventional solar chargers do not fulfil user requirements
• several prototypes of solar chargers built; current model works in indoor and outdoor environment
Conclusion and Future Work (2/2)

- battery capacity increases in future

Nokia Lumia 920
2000 mAh (BP-4GW)

Nokia Lumia 1520
3400 mAh (BV-4BW)

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Thank you for your attention.

Do you have any questions?

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