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

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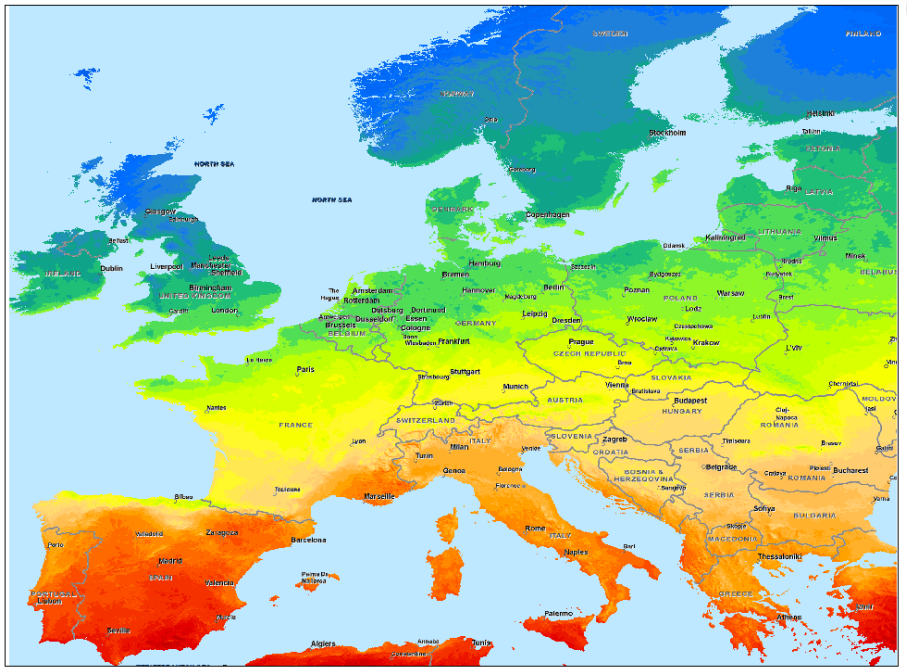
Motivation of the Research (1/3)



Solar radiation [kWh/m^2]

601 - 650	901 - 950	1.201 - 1.250	1.501 - 1.550	1.801 - 1.850
651 - 700	951 - 1.000	1.251 - 1.300	1.551 - 1.600	1.851 - 1.900
701 - 750	1.001 - 1.050	1.301 - 1.350	1.601 - 1.650	1.901 - 1.950
751 - 800	1.051 - 1.100	1.351 - 1.400	1.651 - 1.700	1.951 - 2.000
801 - 850	1.101 - 1.150	1.401 - 1.450	1.701 - 1.750	
851 - 900	1.151 - 1.200	1.451 - 1.500	1.751 - 1.800	

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Motivation of the Research (2/3)

Library *Tellus* at University of Oulu

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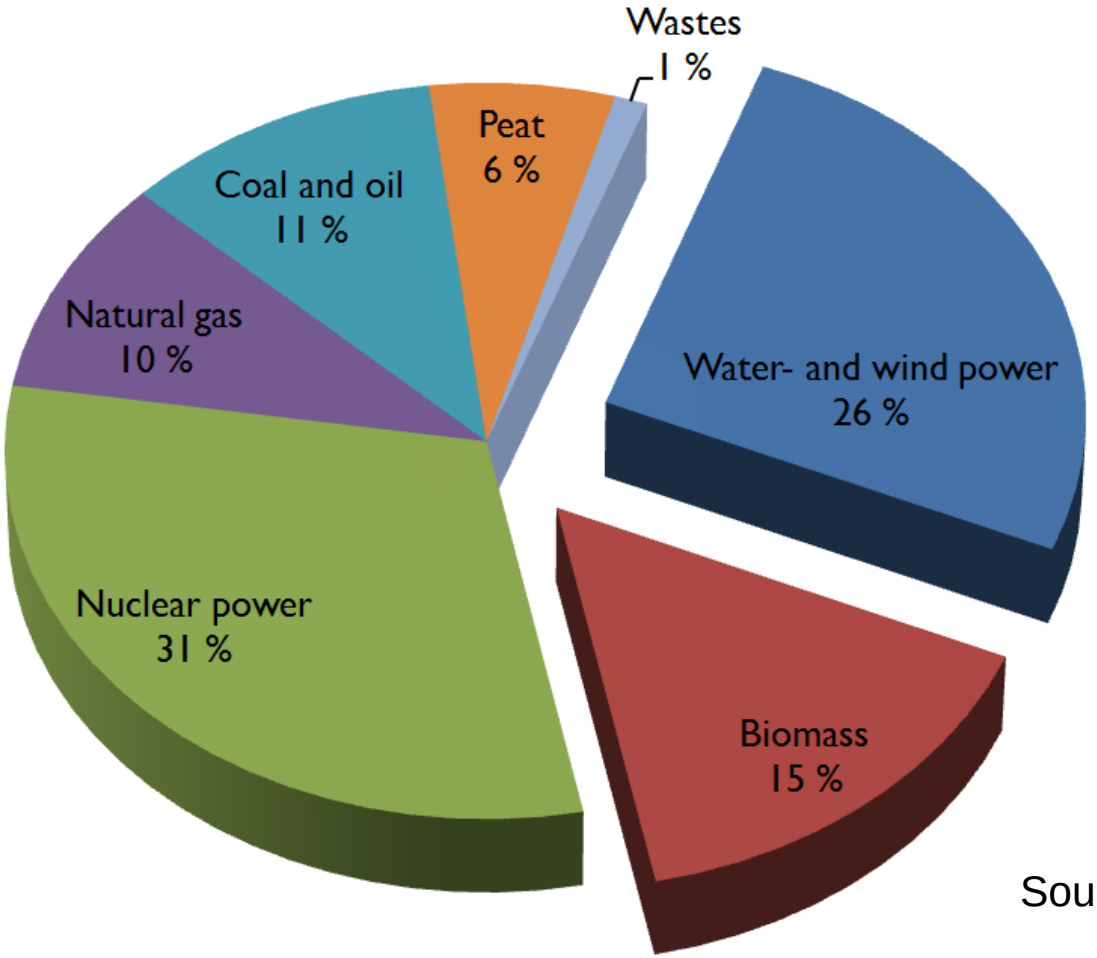
Motivation of the Research (3/3)



Electricity Production

36 % renewables

Source: Statistic Finland, 2012

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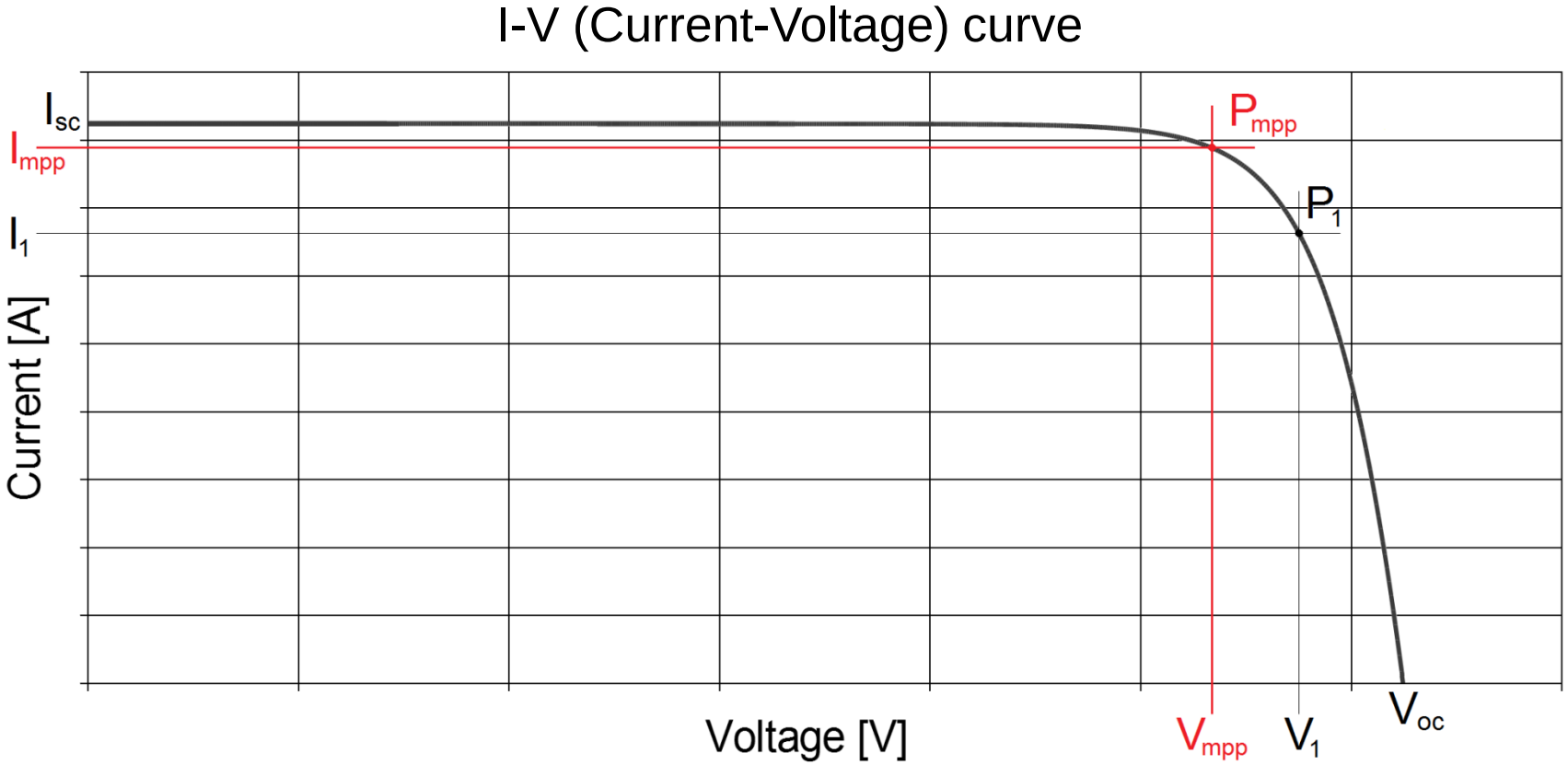
Solar Energy Behaviour (1/2)



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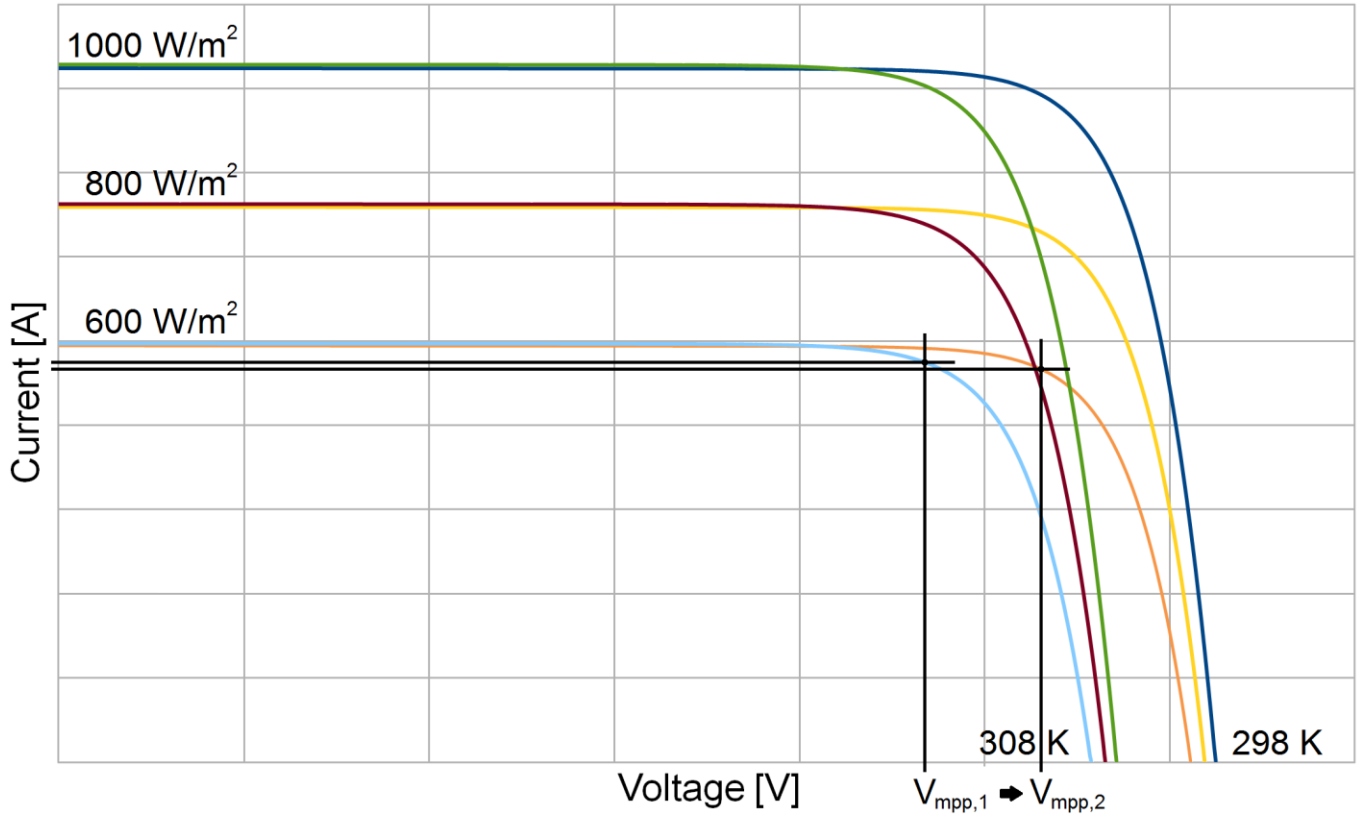
Solar Energy Behaviour (2/2)

I-V (Current-Voltage) curve



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Conventional PV Charger (1/3)

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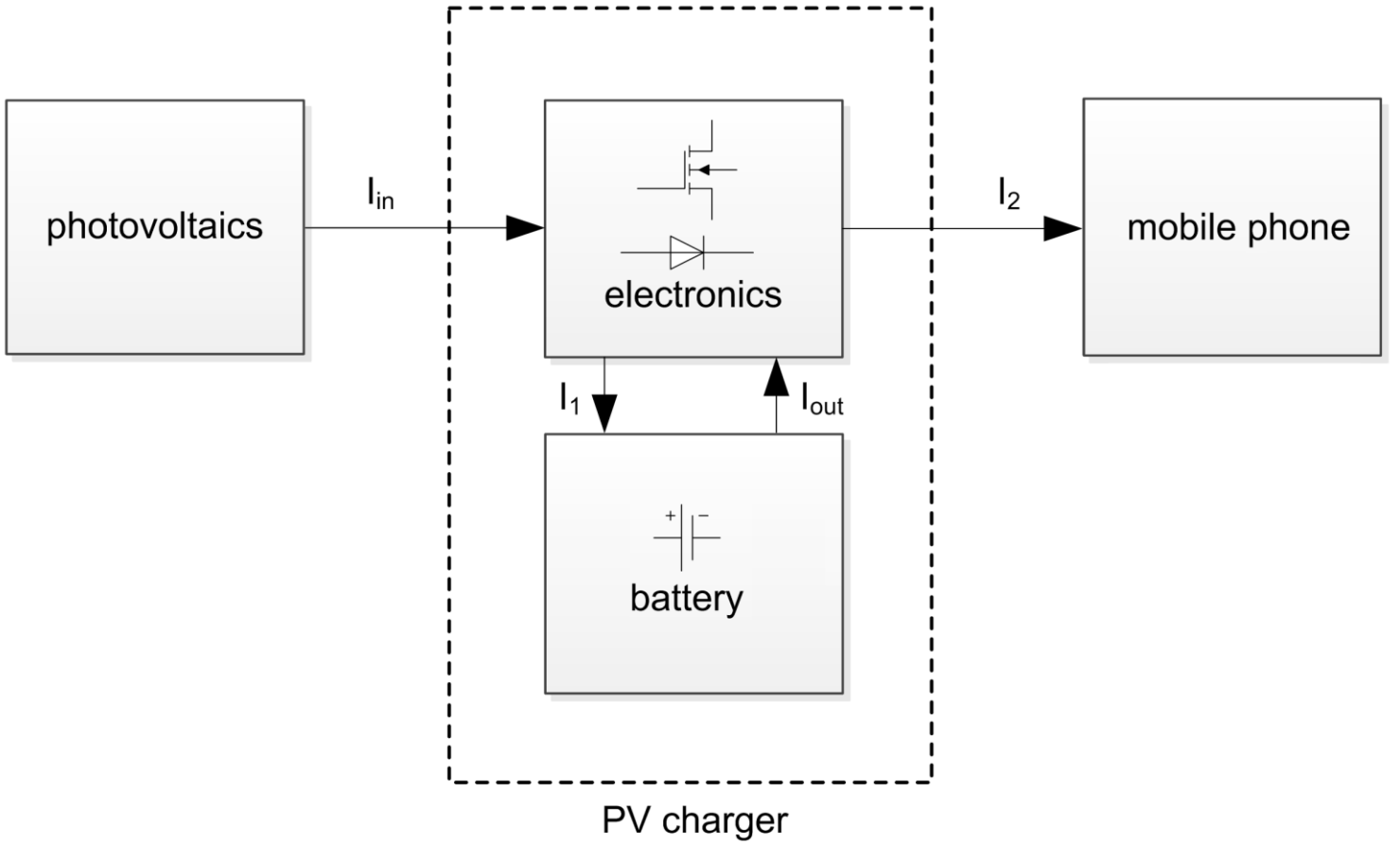
Conventional PV Charger (2/3)



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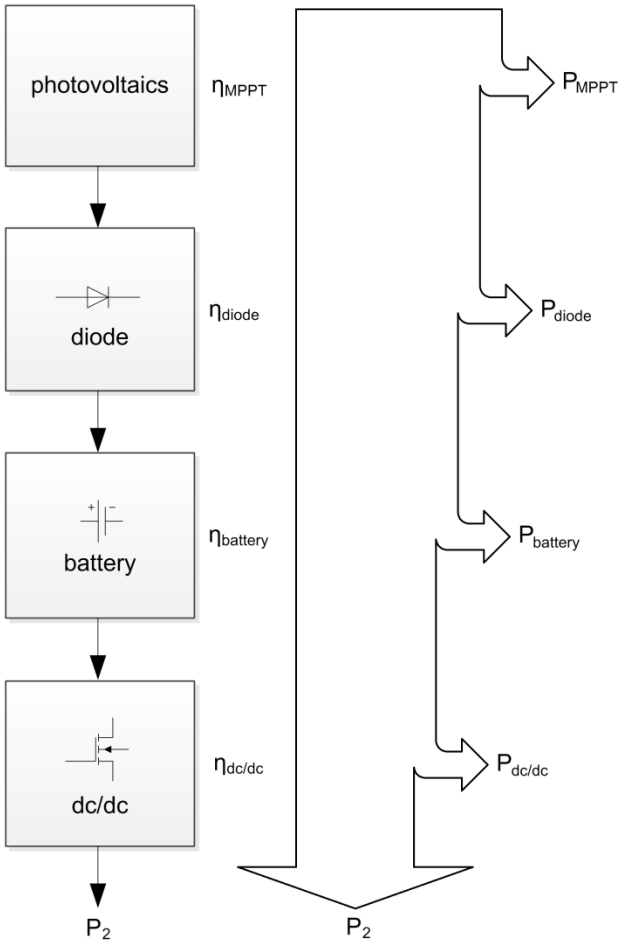
Conventional PV Charger (3/3)



$$E_1 = P_{in} \times \eta \times t_1$$

$$\begin{aligned} \eta &= \eta_{MPPT} \times \eta_{diode} \times \eta_{battery} \times \eta_{dc/dc} \\ \eta_{min} &= 0.97 \times 0.88 \times 0.80 \times 0.75 \\ &\approx 51\% \\ \eta_{max} &= 0.97 \times 0.88 \times 0.90 \times 0.95 \\ &\approx 73\% \end{aligned}$$

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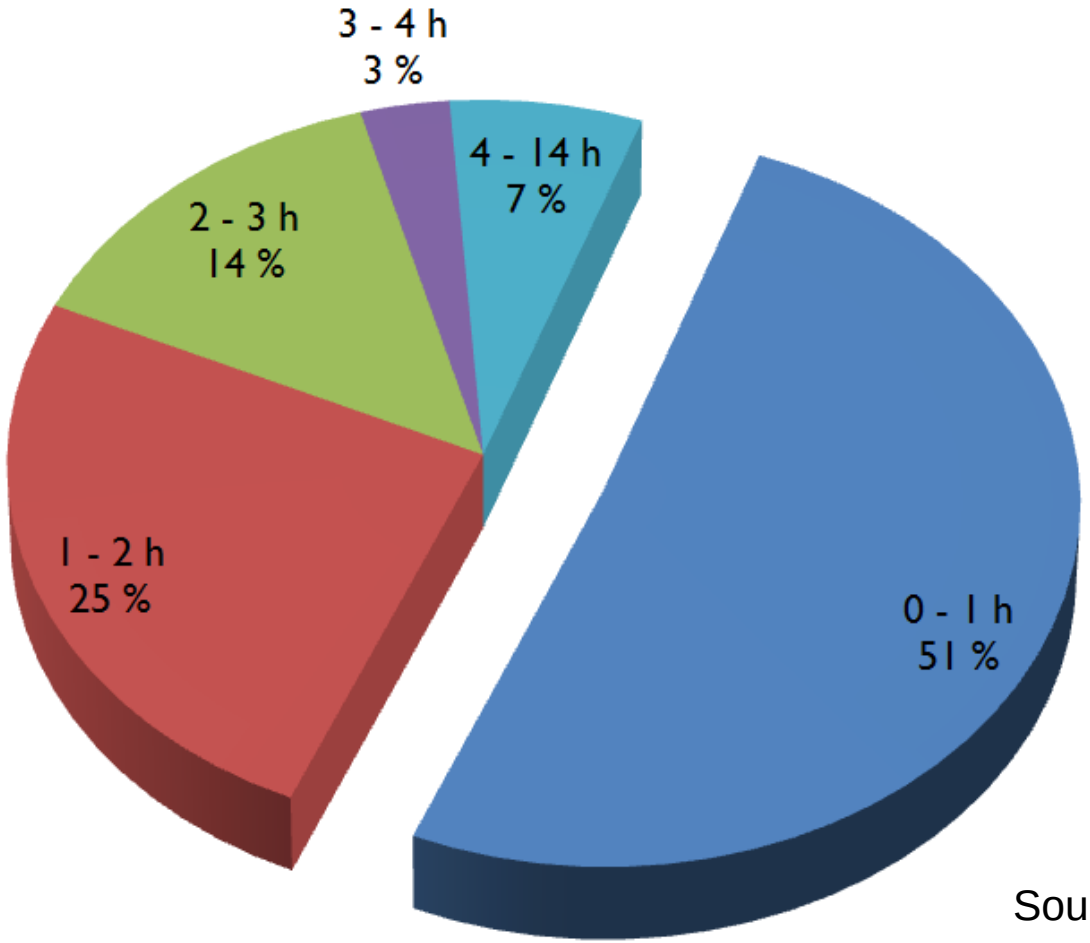
User Requirements



- 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 fulfilled
- solar charger needs to provide suitable amount of energy

$$E_2 = P_2 \times t_2 = P_{in} \times \eta \times t_1$$

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Design Requirements (2/3)

Size of photovoltaics:

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

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Design Requirements (3/3)

In the full paper:

- analysis of mobile phones as active or passive devices
- advantages and disavantages 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 conventioal solar chargers do not fulfil user requirements
- several prototypes of solar chargers built;

  current model works in indoor and outdoor environment

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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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