Future Power Electronics for Realizing Sustaining Society

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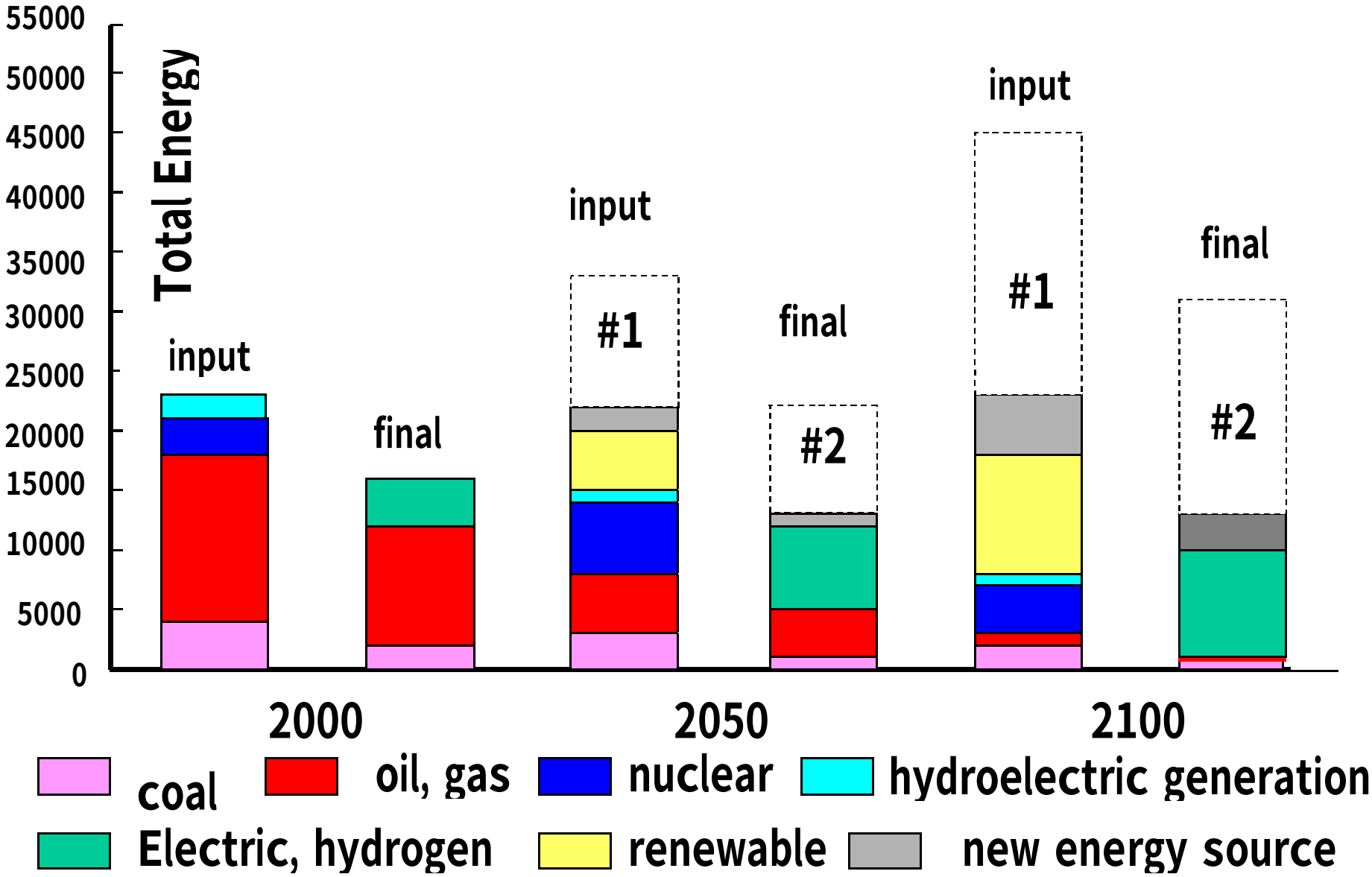
Outline

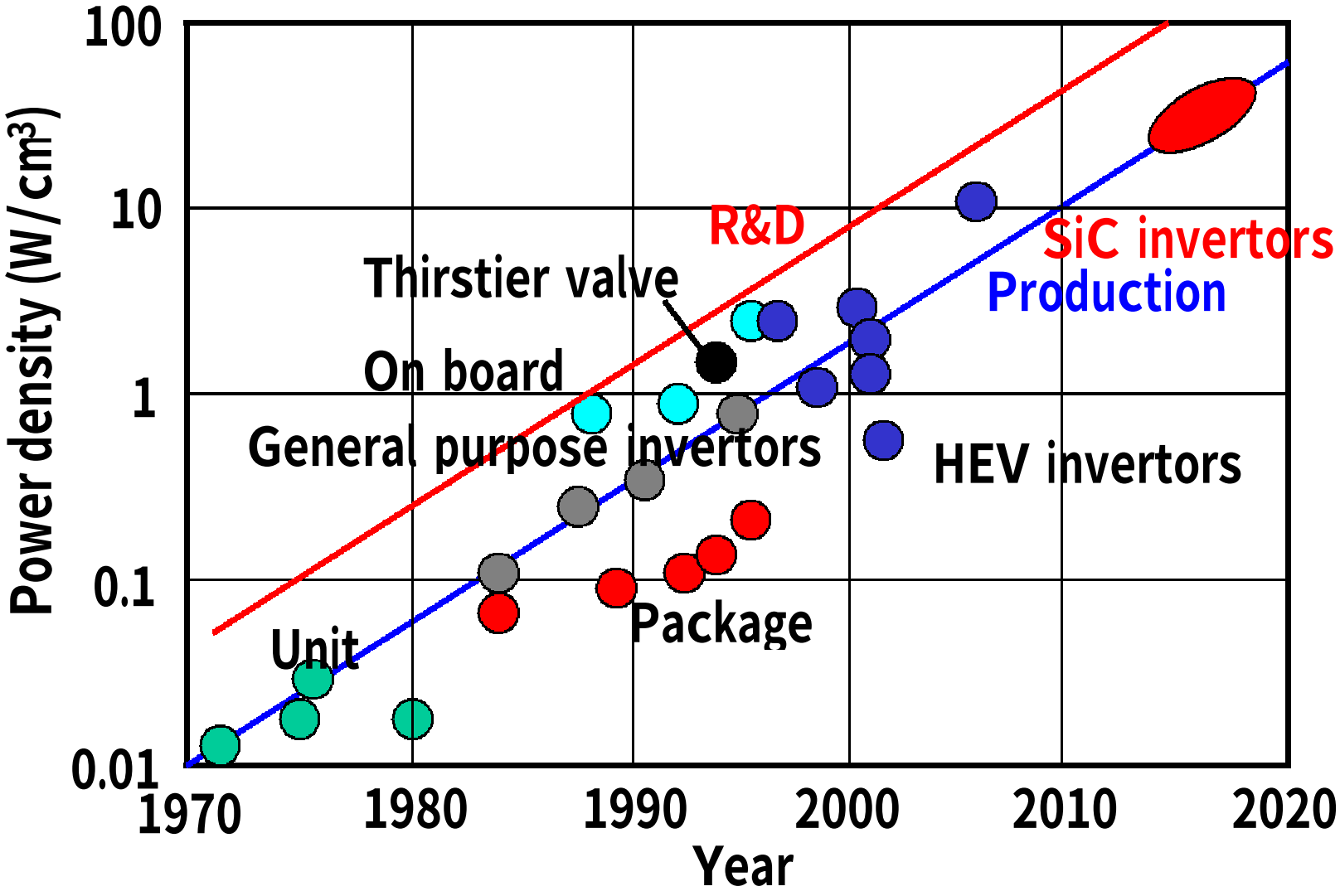
- Introduction
- Future power electronics
- Examples of effective use of the electrical energy using power supplies
  -photovoltaic module
- Platform technology
- Summary

Ultra long term energy strategy in Japan



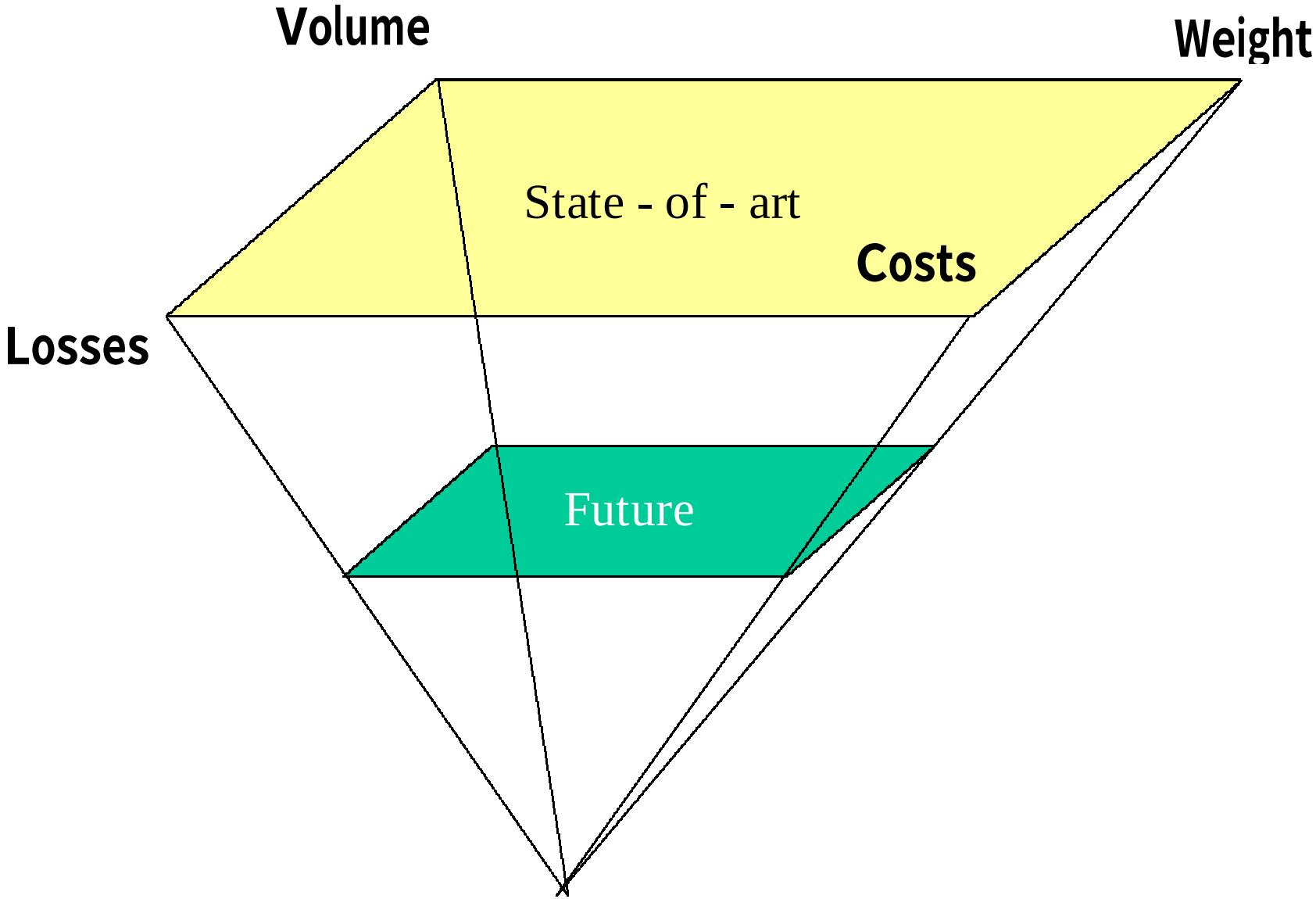
http://www.meti.go.jp/committee/materials/downloadfile g51013a41j.pdf

Trend of the power density



H. Ohashi, Trans. Of IEEJ, vol.12, no.3, pp.168-171, 2002.

Development trends in power electronics converters



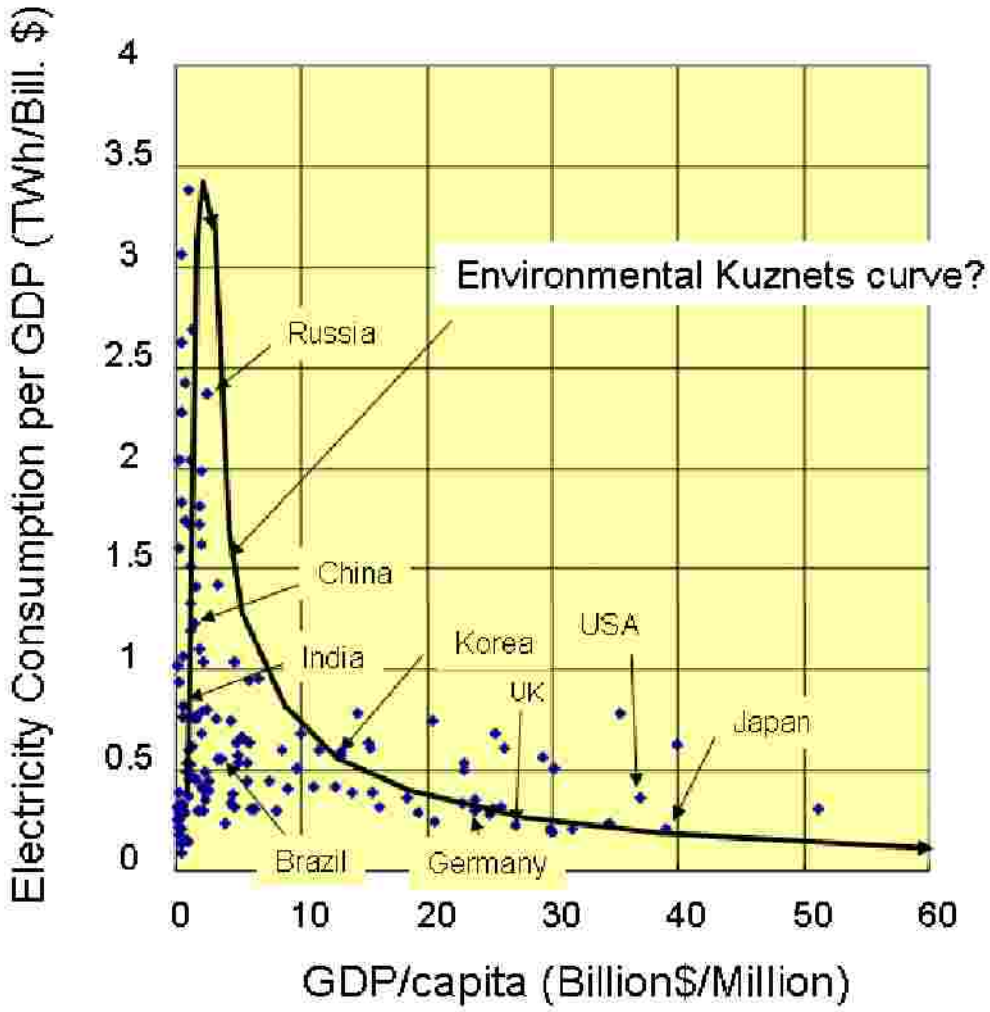
J. Kolar et al., PCC Nagoya, p.9, 2007

What is the future power electronics?

Effective use of the electrical energy aiming the low carbonized society by

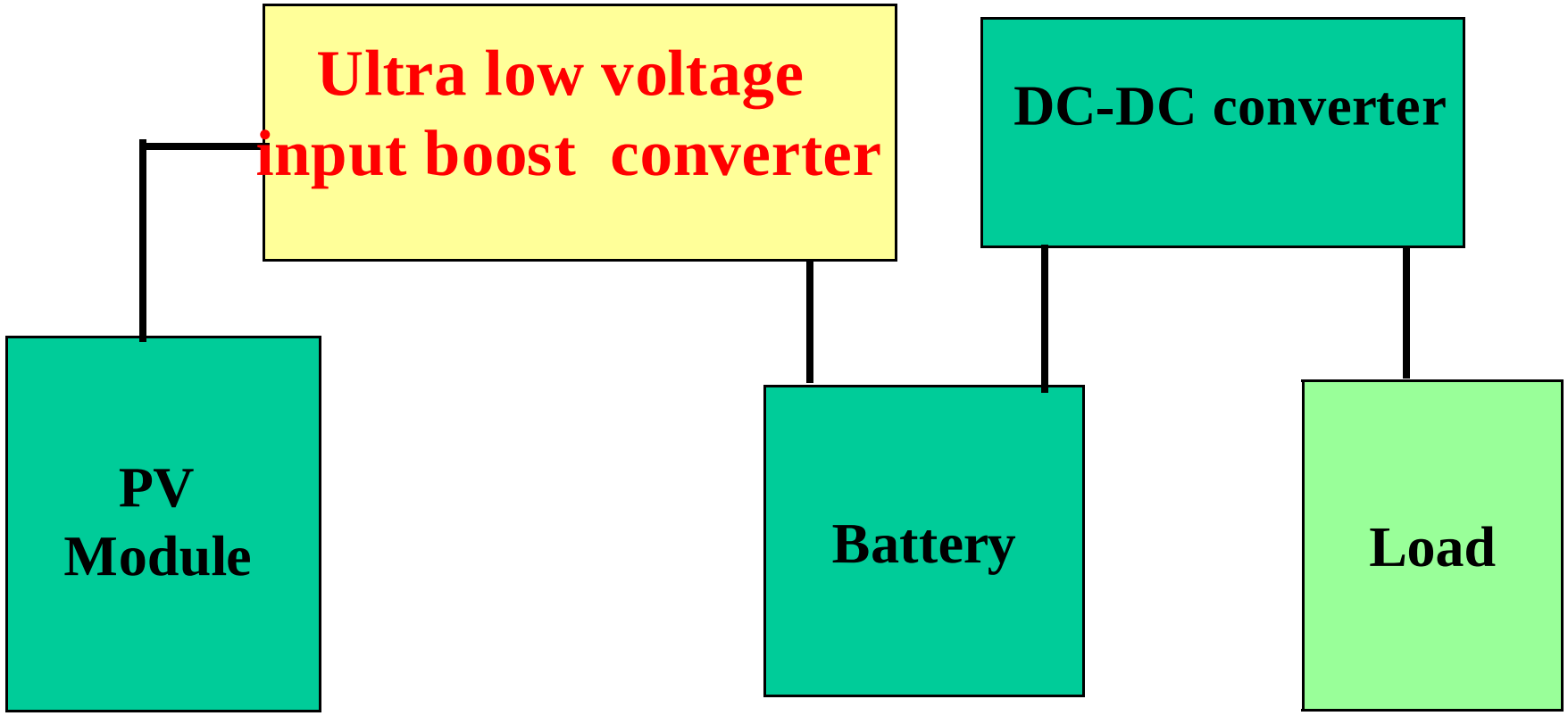
- power supply using not only outputting the required voltage but also power management and energy harvesting
- utilizing a lot miniaturized power supply (converter)

GDP/capita vs. Electricity consumption per GDP



2008 NEDO survey report：Green electronics technology of effective electrical power usage for sustainable soci y realization toward 2050」
http://www.nedo.go.jp/

Stand alone power supply system



S.Matsumoto et al.,ISPSD'09, p.180, 2009.

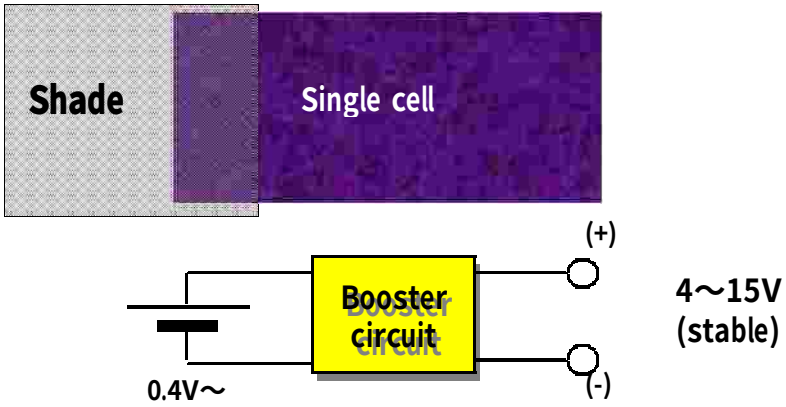
Stand alone power supply system

- -small capacity Solar systems—

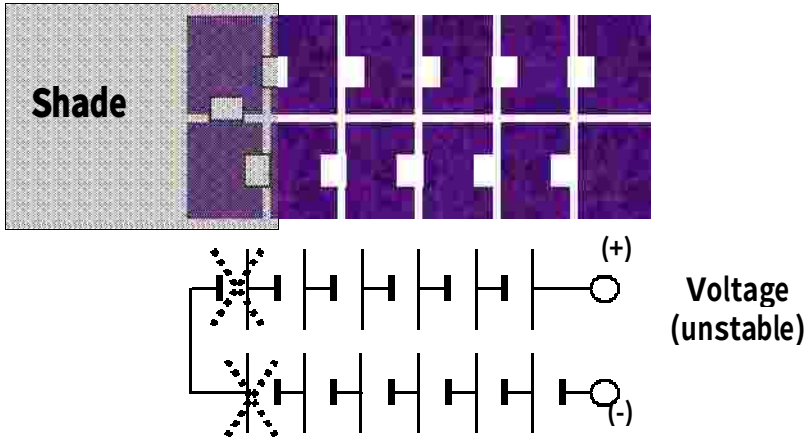
Comparisons of the photovoltaic modules

	High, Medium power	Small-power
Sun light irradiation	good	Not always good
partially shadow	bypass diode	critical
MPPT	micro controller DSP	No

Ultra low voltage input boost converter

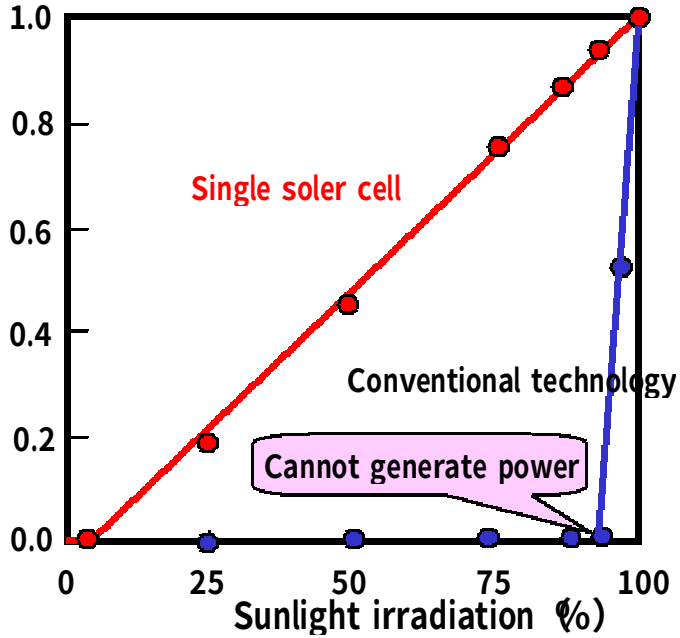


Proposed



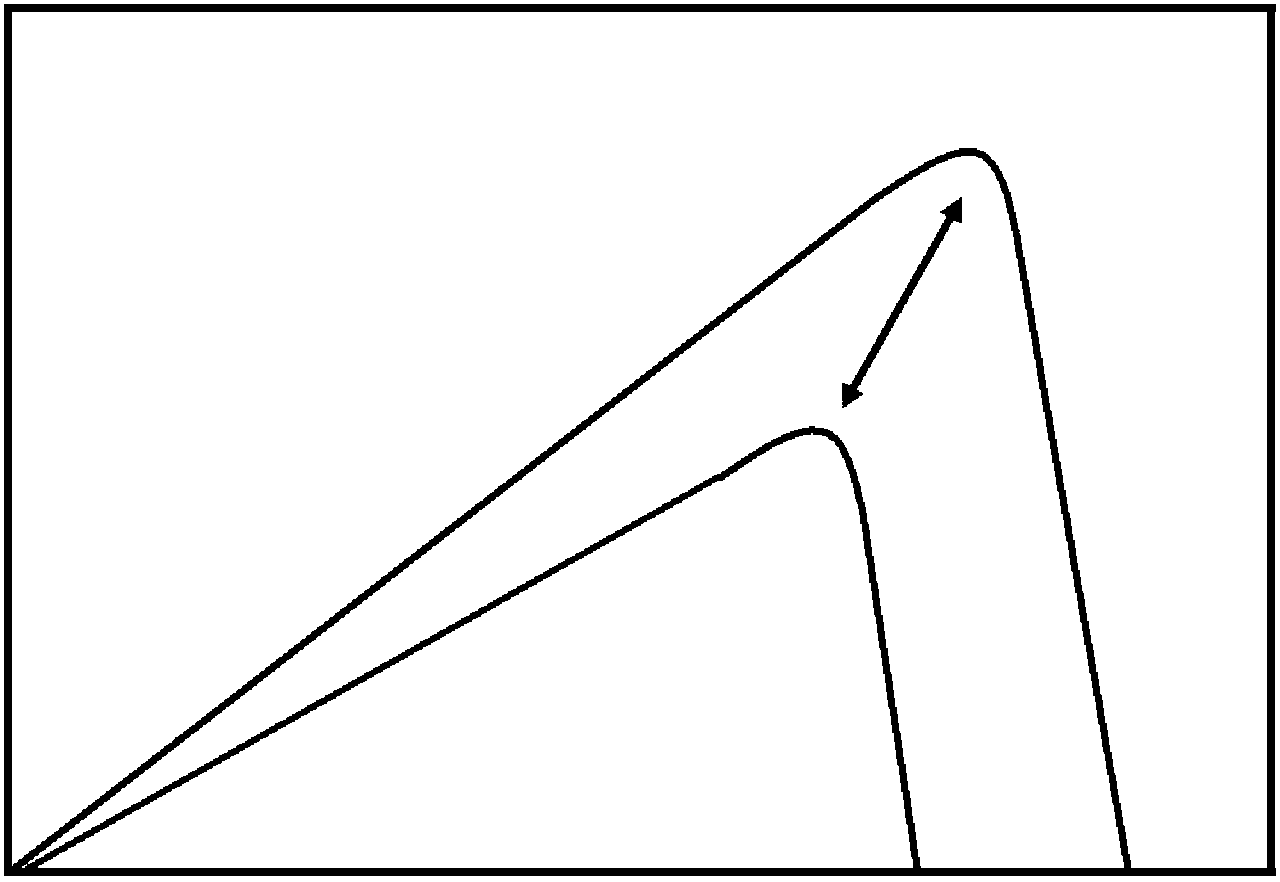
Conventional

Impact of single cell



S.Matsumoto et al.,ISPSD'09, p.180, 2009.

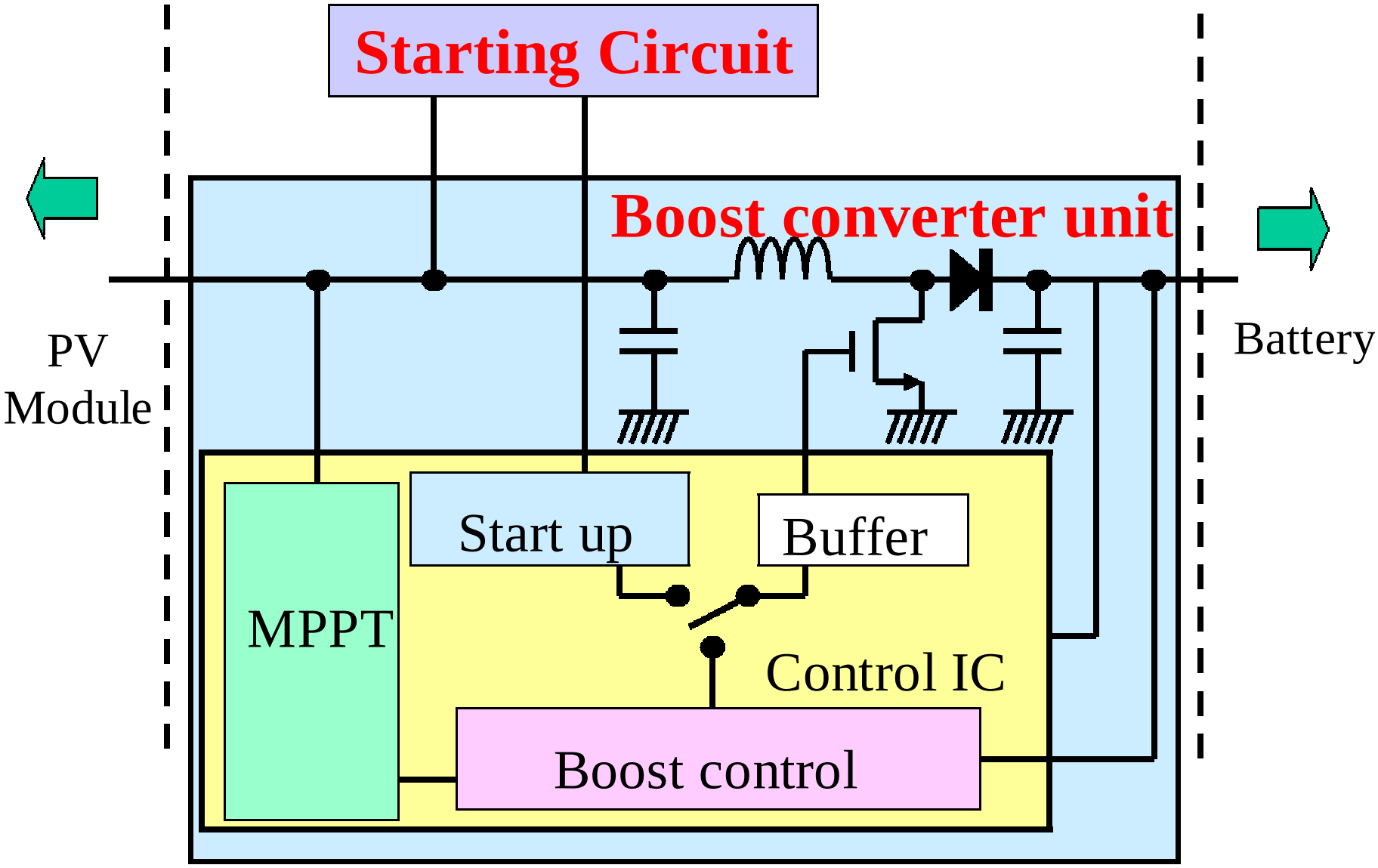
Maximum power point tracking



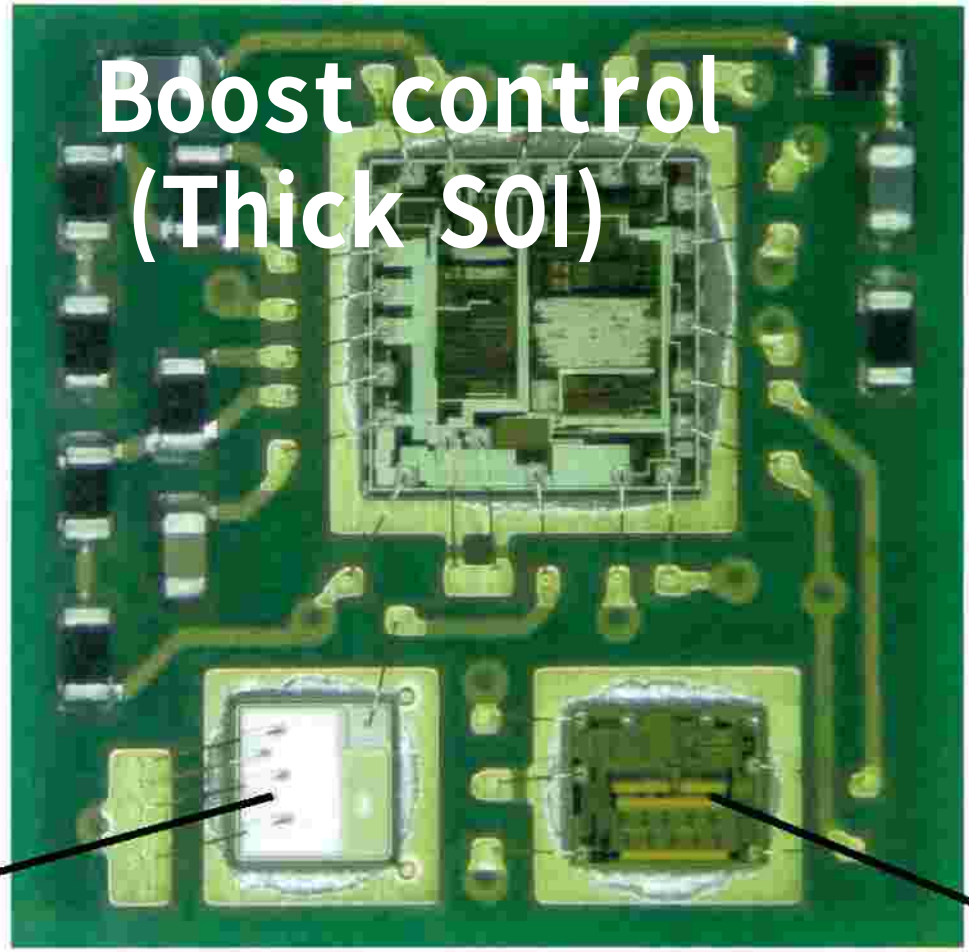
Features

- **Ultra low voltage input boost**
  ⇒ single solar cell applications
- **Low power consumption maximum power point tracking for small capacity systems**
  ⇒ increasing the generation power as high as possible
- **Powered by own input**
  ⇒ saving the battery power

Boost converter



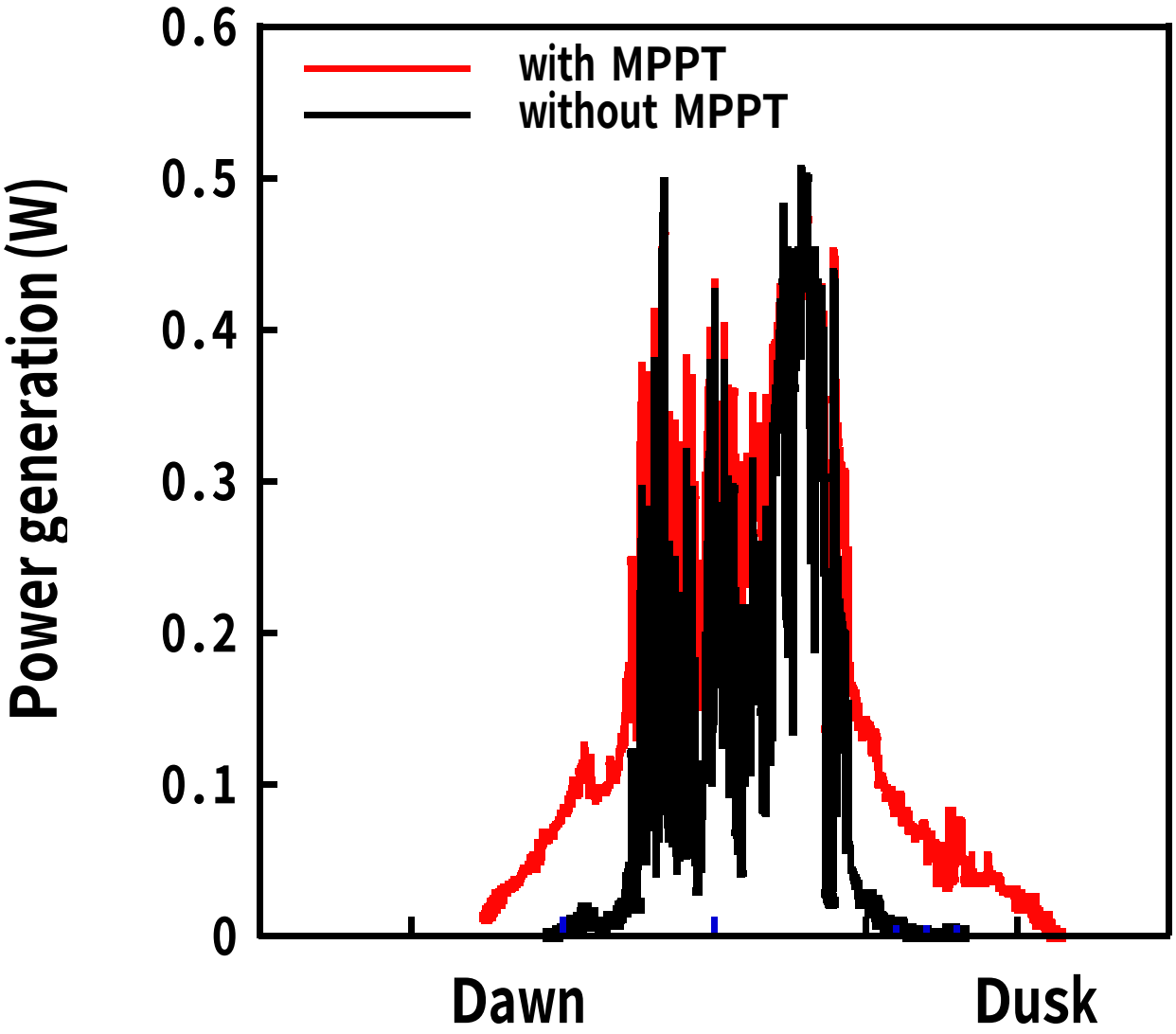
Power SIP



Trench MOS

Starting circuit
(Ultra-thin film SOI)

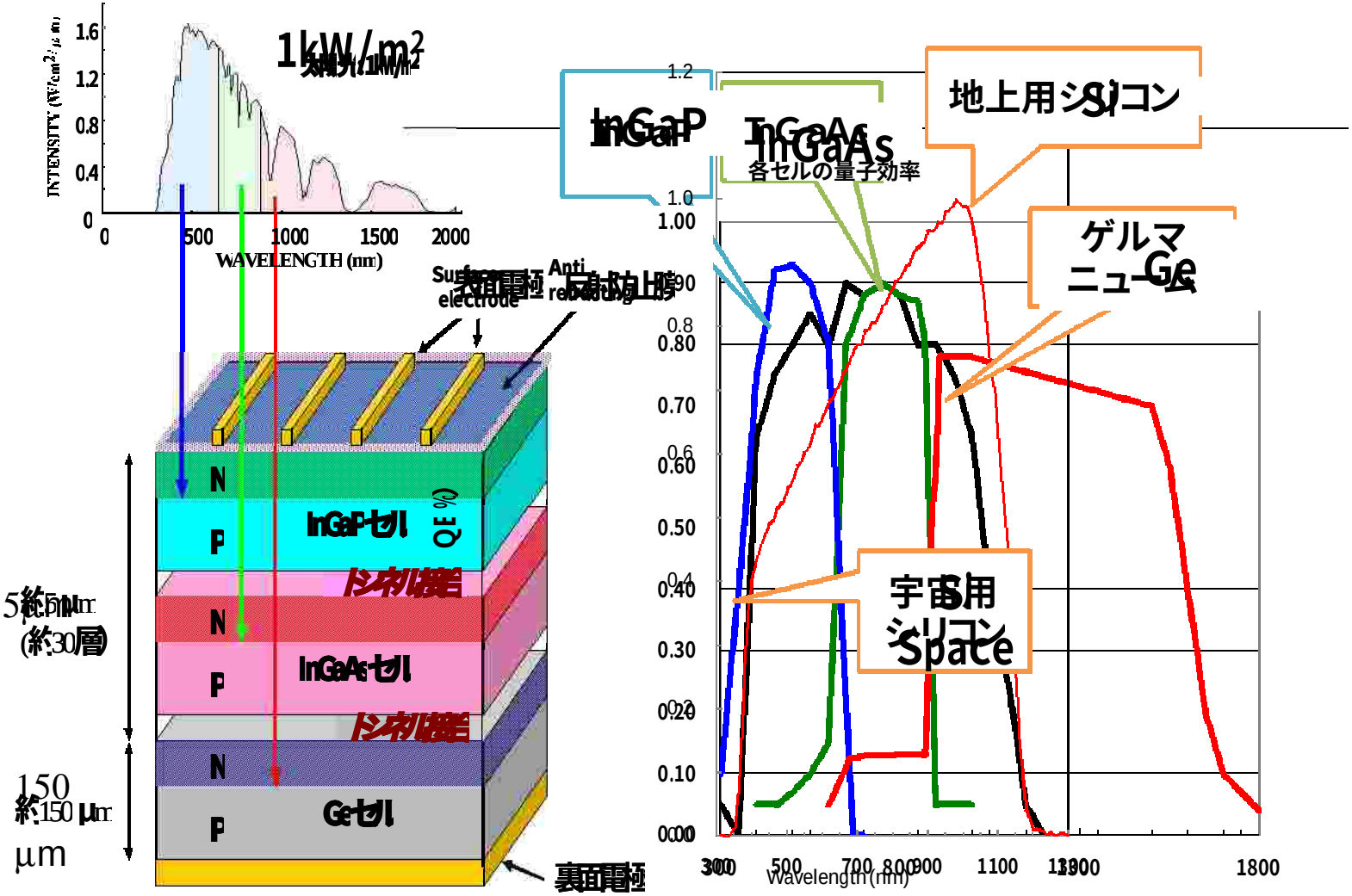
Impact of the MPPT



S.Matsumoto et al.,ISPSD’09, p.180, 2009.

Multi junction solar cell

Multi Junction for Satellite

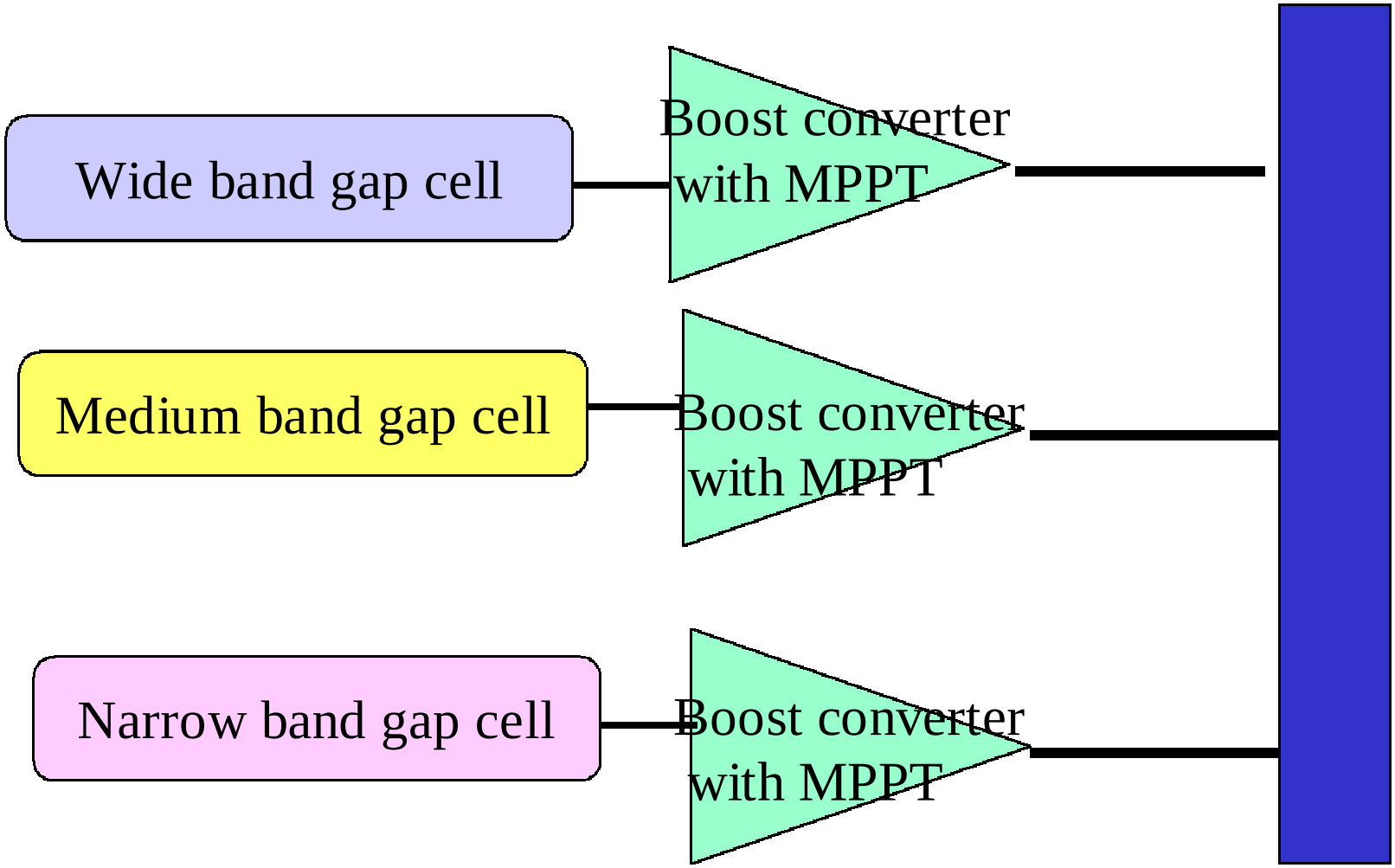


K. Tomita, Extended Abstract of the 2009 International Conference on Solid State Devices and Materials, pp.4-5, 2009

Challenges of multi junction solar cell

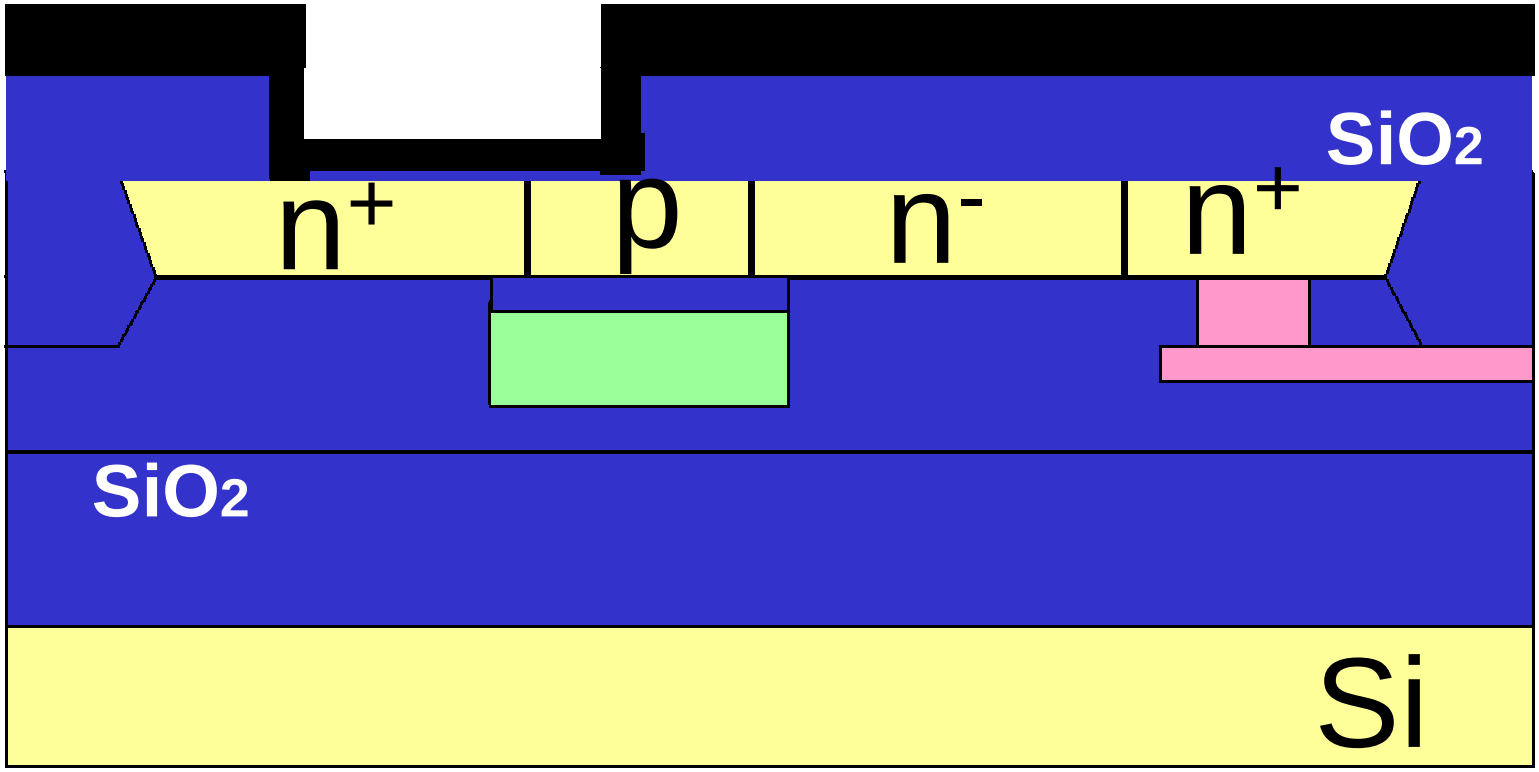
- **Lattice matching**
  - ⇨ **limitation of material choice**
- **Limitation of the thickness**
  - ⇨ **lower absorption efficiency of sunlight**
- **Current limitation**
  - ⇨ **seriesely connection of solar cells**

Smart solar architecture



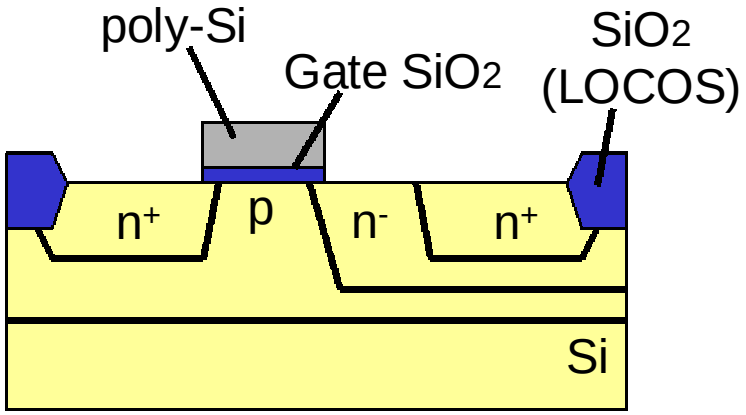
K. Tomita, Extended Abstract of the 2009 International onference on Solid State Devices and Materials, pp.4-5, 2009

Reversed Si Wafer Direct Bonding

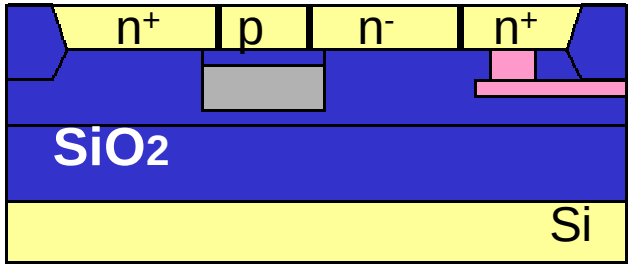


S. Matsumoto et al., IEDM'96, p.949, 1996

Main Steps in the Fabrication of RSDB

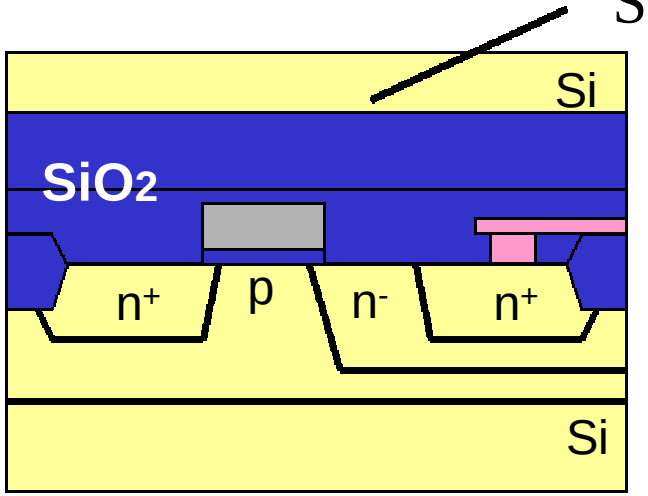


(a)

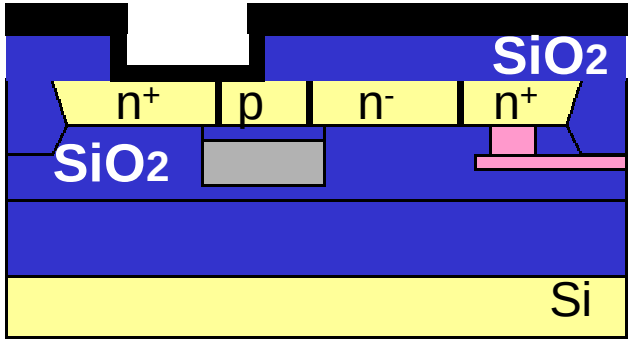


(c)

Supporting substrate



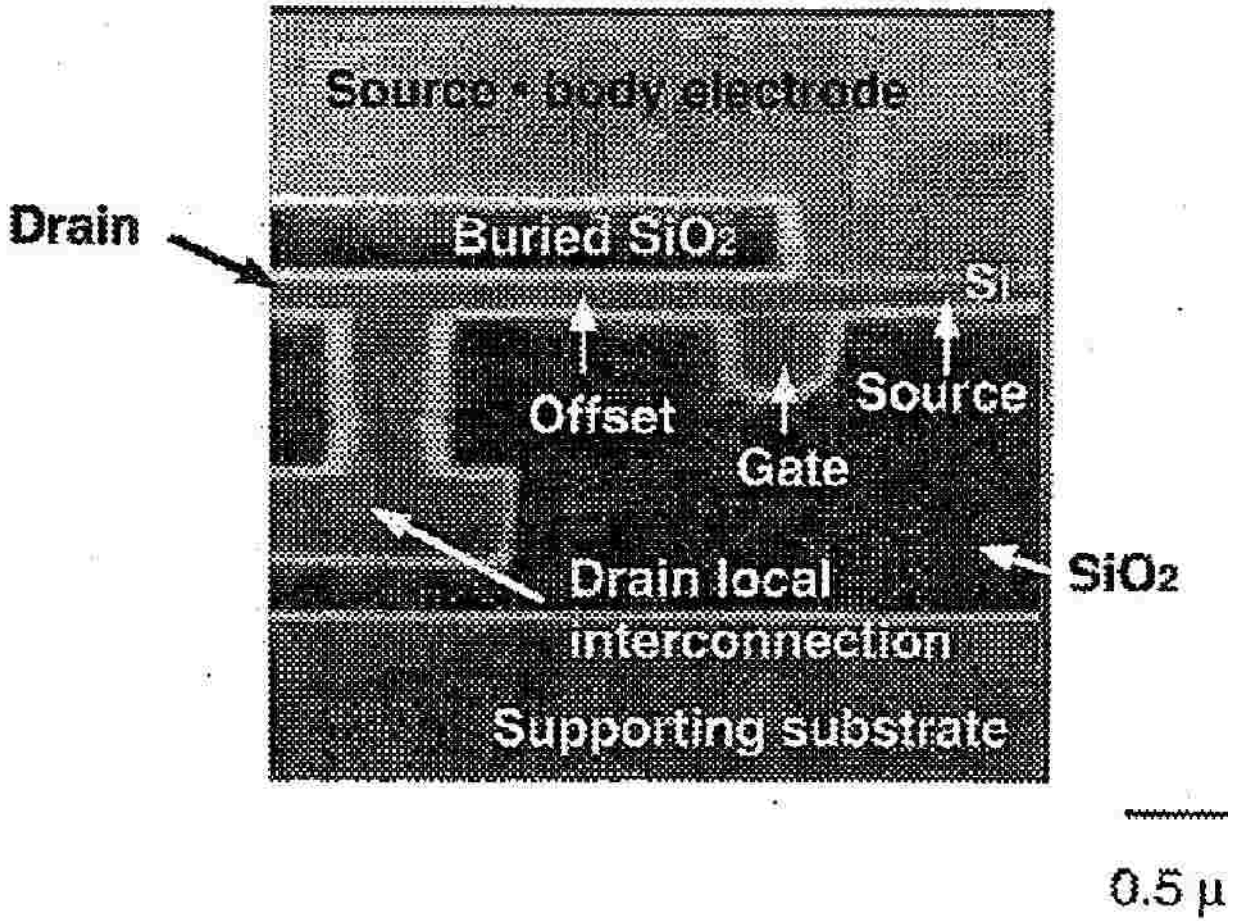
(b)



(d)

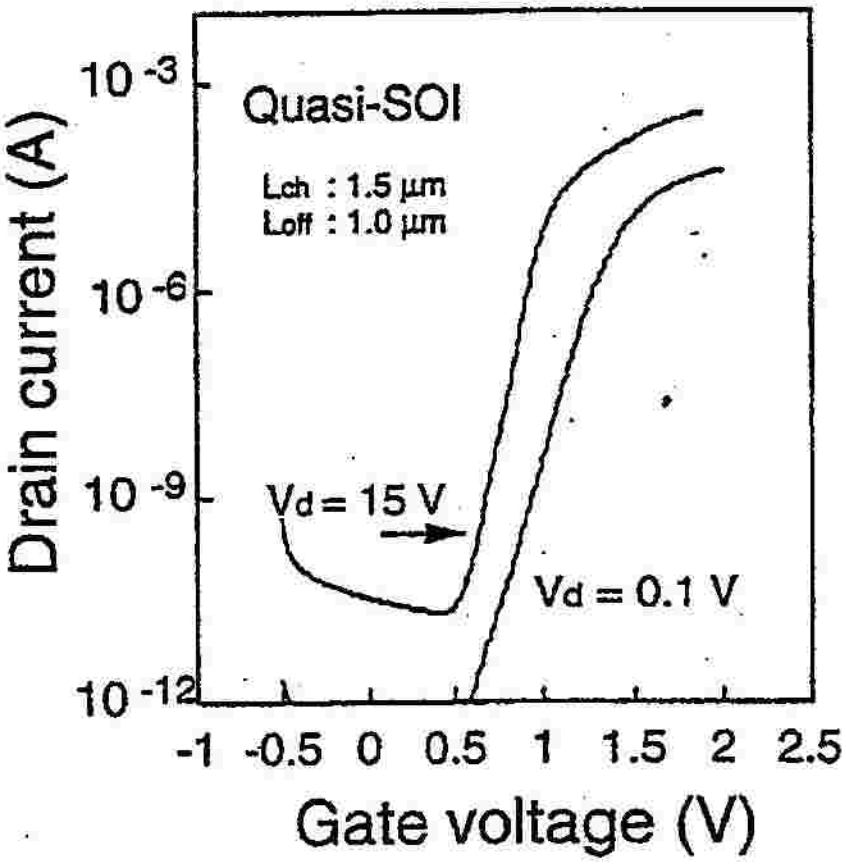
S. Matsumoto et al., IEDM'98, pp.945, 1998

Cross-sectional Photograph of RF Power MOSFET

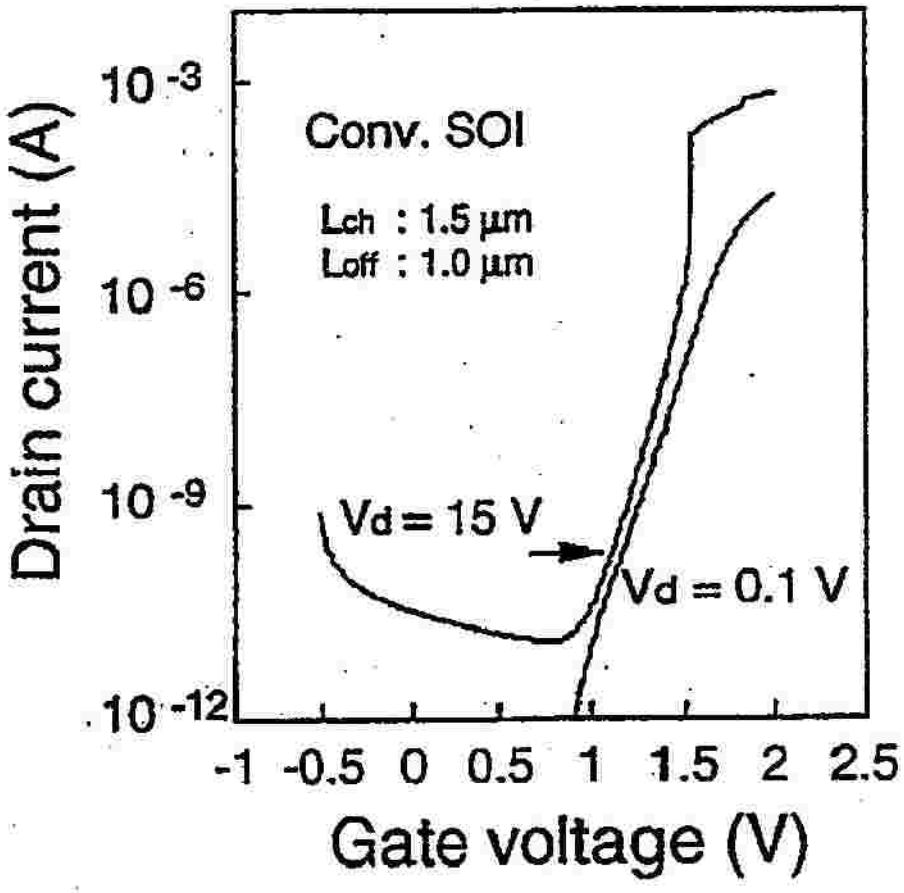


S. Matsumoto et al., IEEE Trans. Electron Devices, vol. ED-48, p.1448, 2001.

Subthreshold characteristics



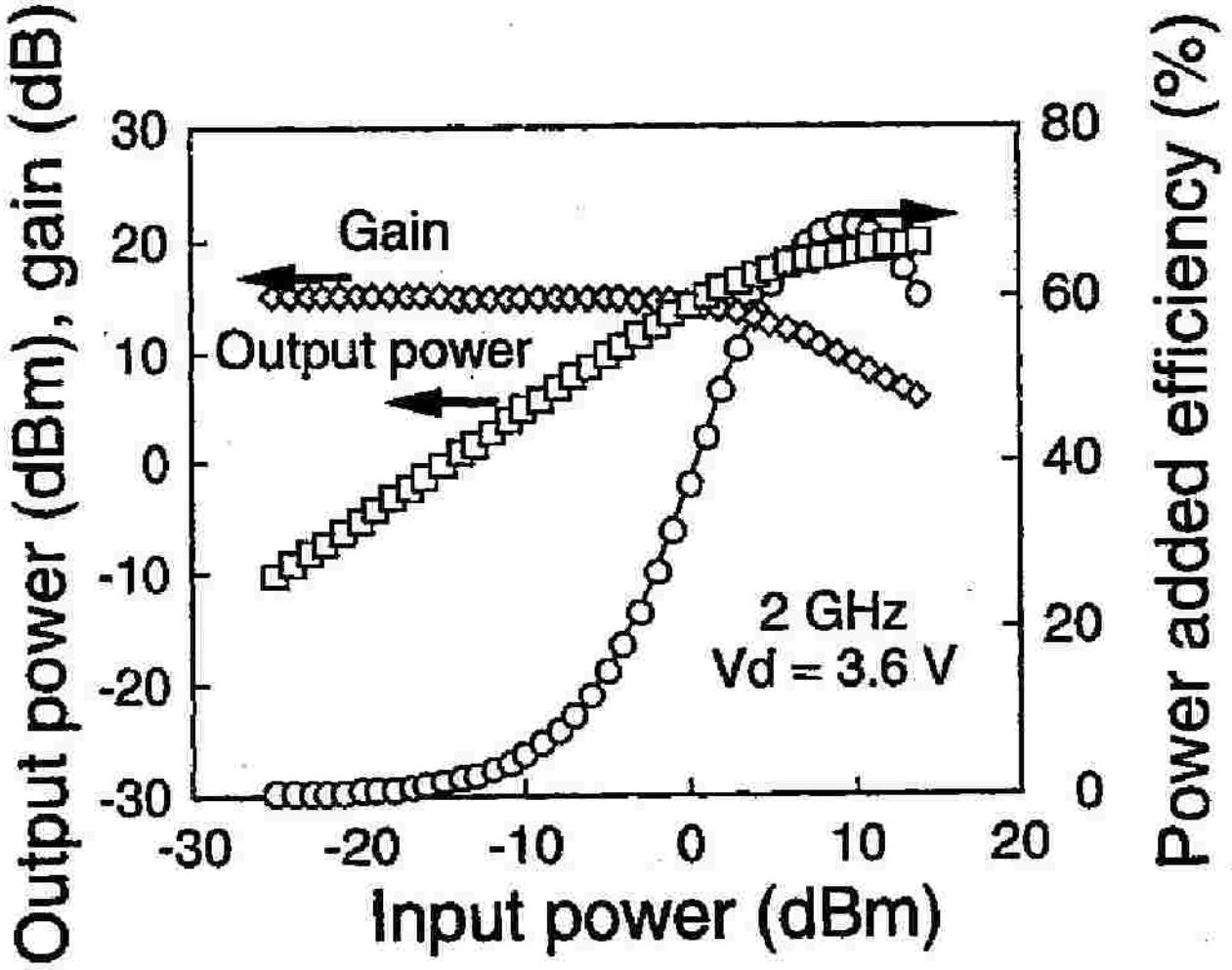
Quasi-SOI



SOI

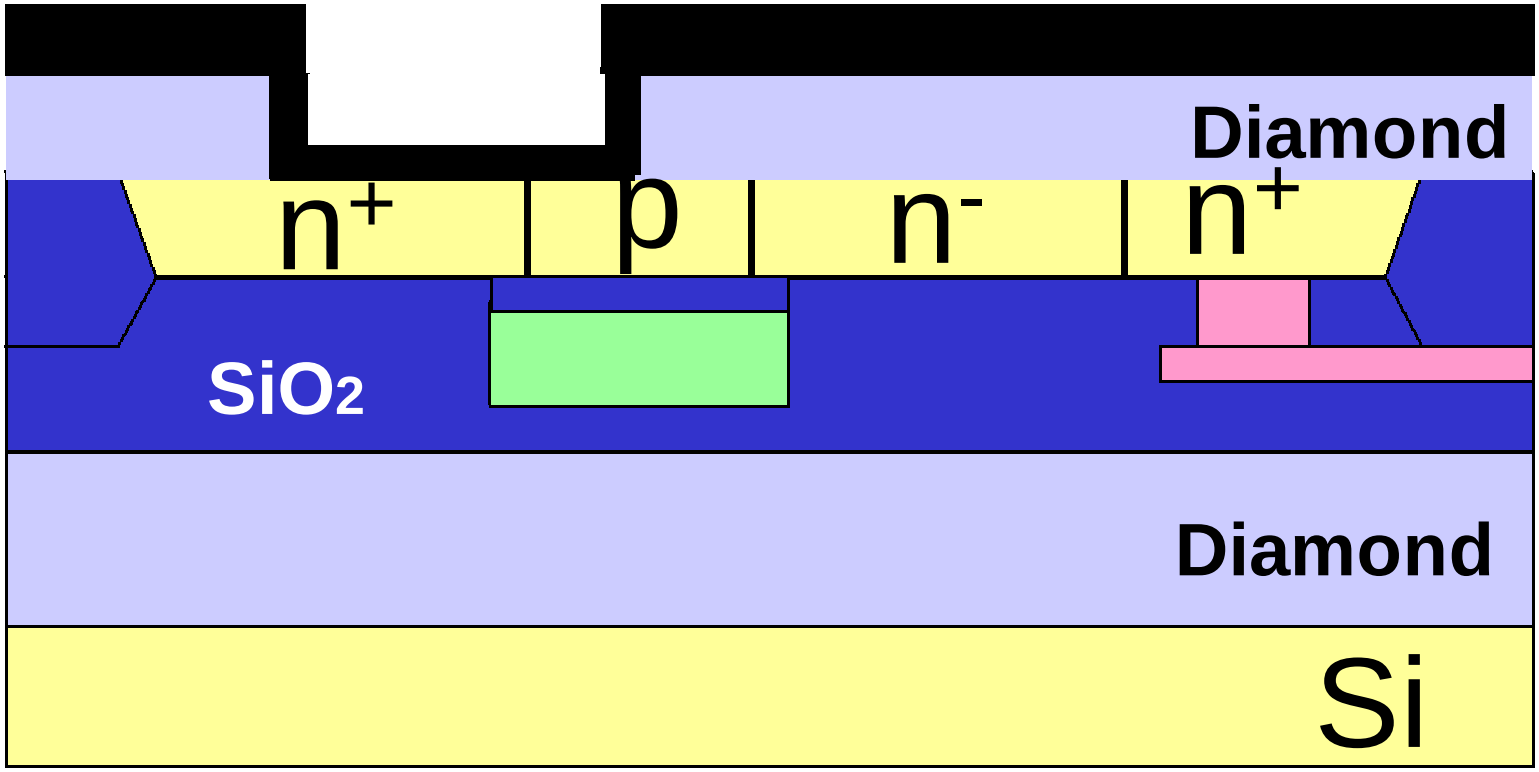
S. Matsumoto et al.,IEEE Trans. Electron Devices, vol.ED-45, p.105, 1998

RF Characteristics

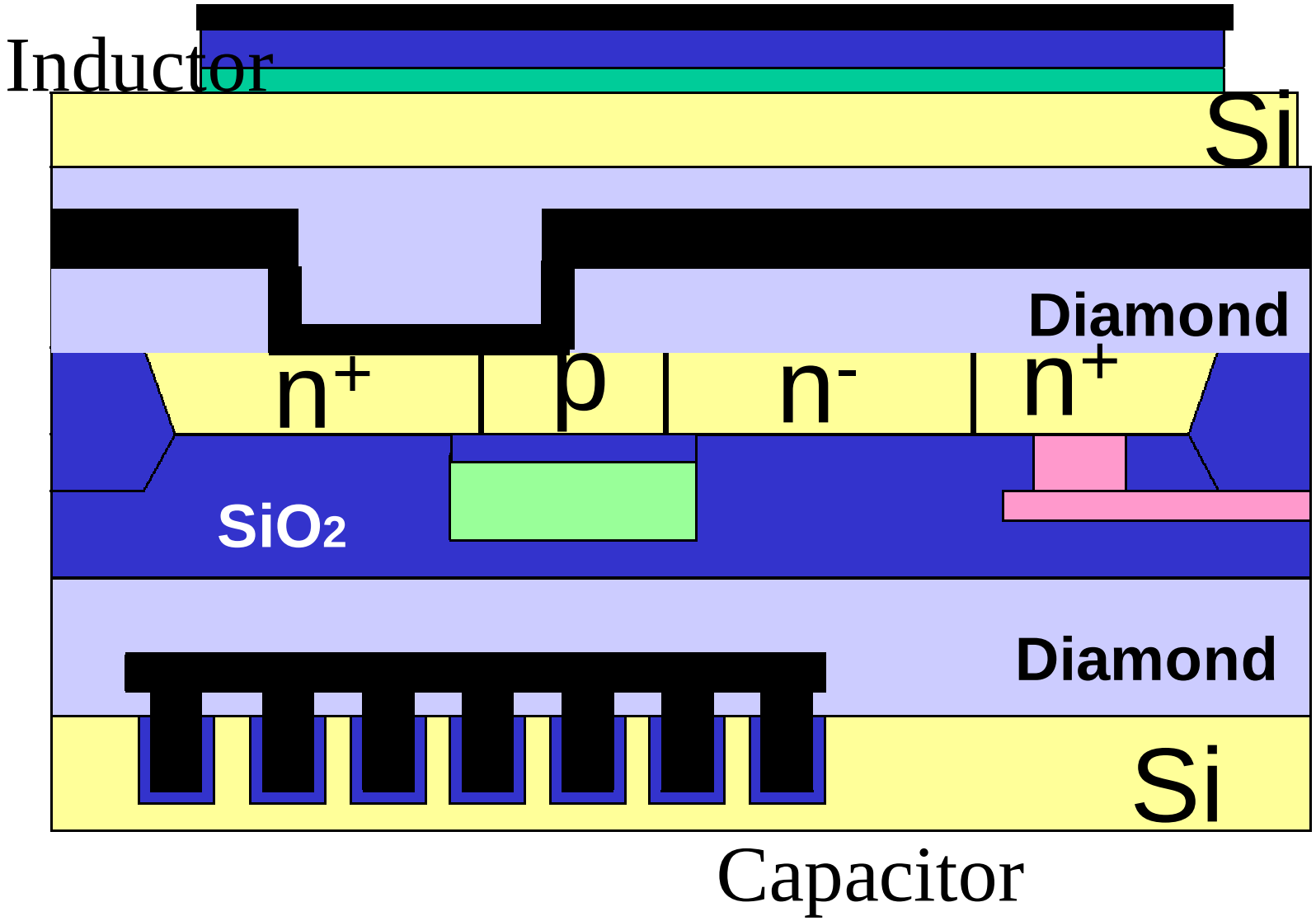


S. Matsumoto et al., IEEE Trans. Electron Devices, vol. ED-48, p.1448, 2001.

Extension of RSDB ex.1



Extension of RSDB ex.2



Summary

- Effective use of the electric energy is the key issue
  - ⇨ Power electronics
    - ⇨ **power supply**
- The miniaturization of power supply
  - ⇨ New concept
- Next generation power electronics
  - ⇨ Effective use of the electrical energy utilizing
- Reversed Silicon wafer direct bonding