PV Generation Industry in China

Wang Jing

Global Climate Change Institute, Tsinghua Univ.

Email:jingwang03@mails.tsinghua.edu.cn

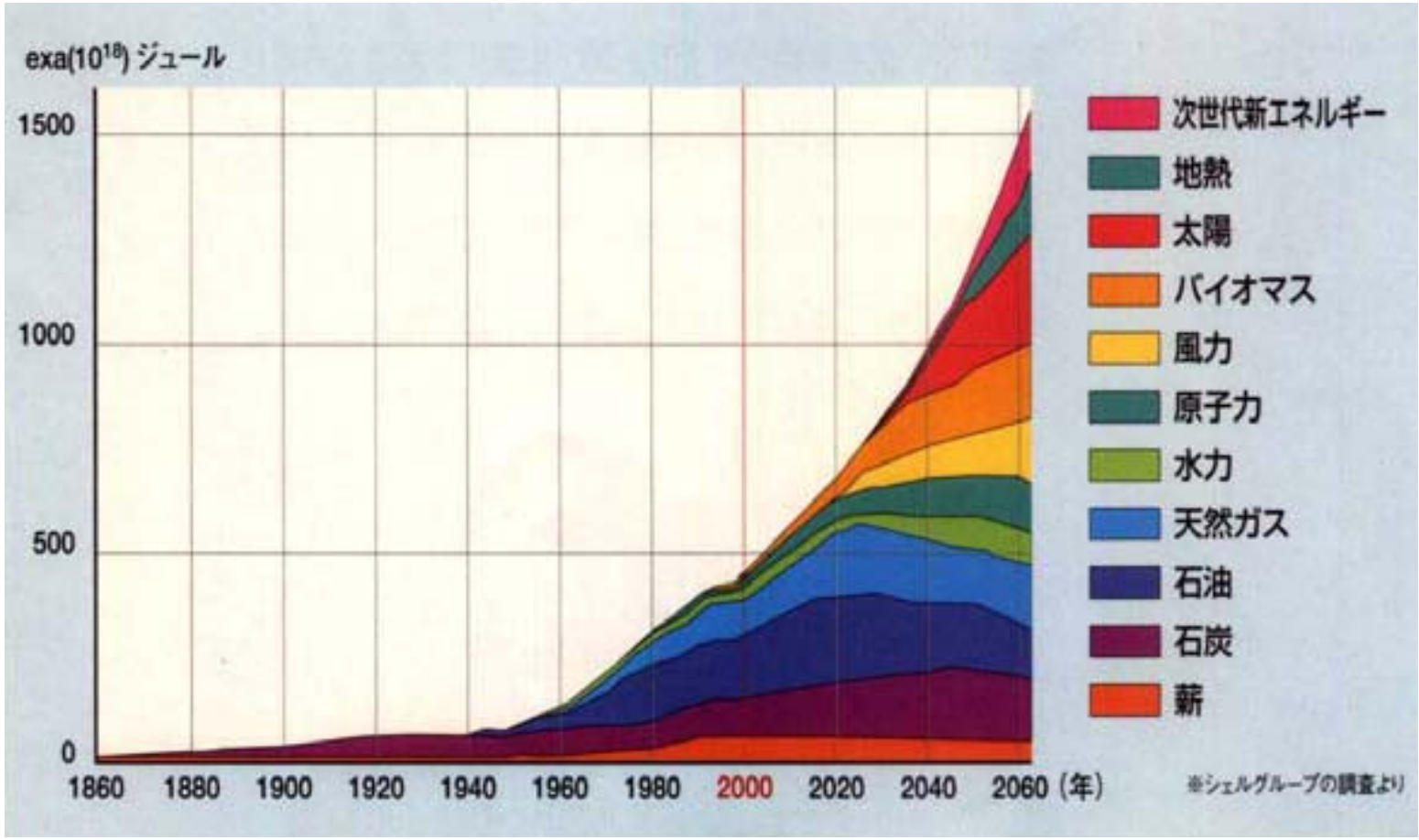
- Background
- PV generation technology
- Current status of PV in the World
- Current status of PV in China

Background

- Energy crisis
- Power shortage

Energy crisis

—— a problem the world has to face.



Expected global energy, Japan（1860～2060）

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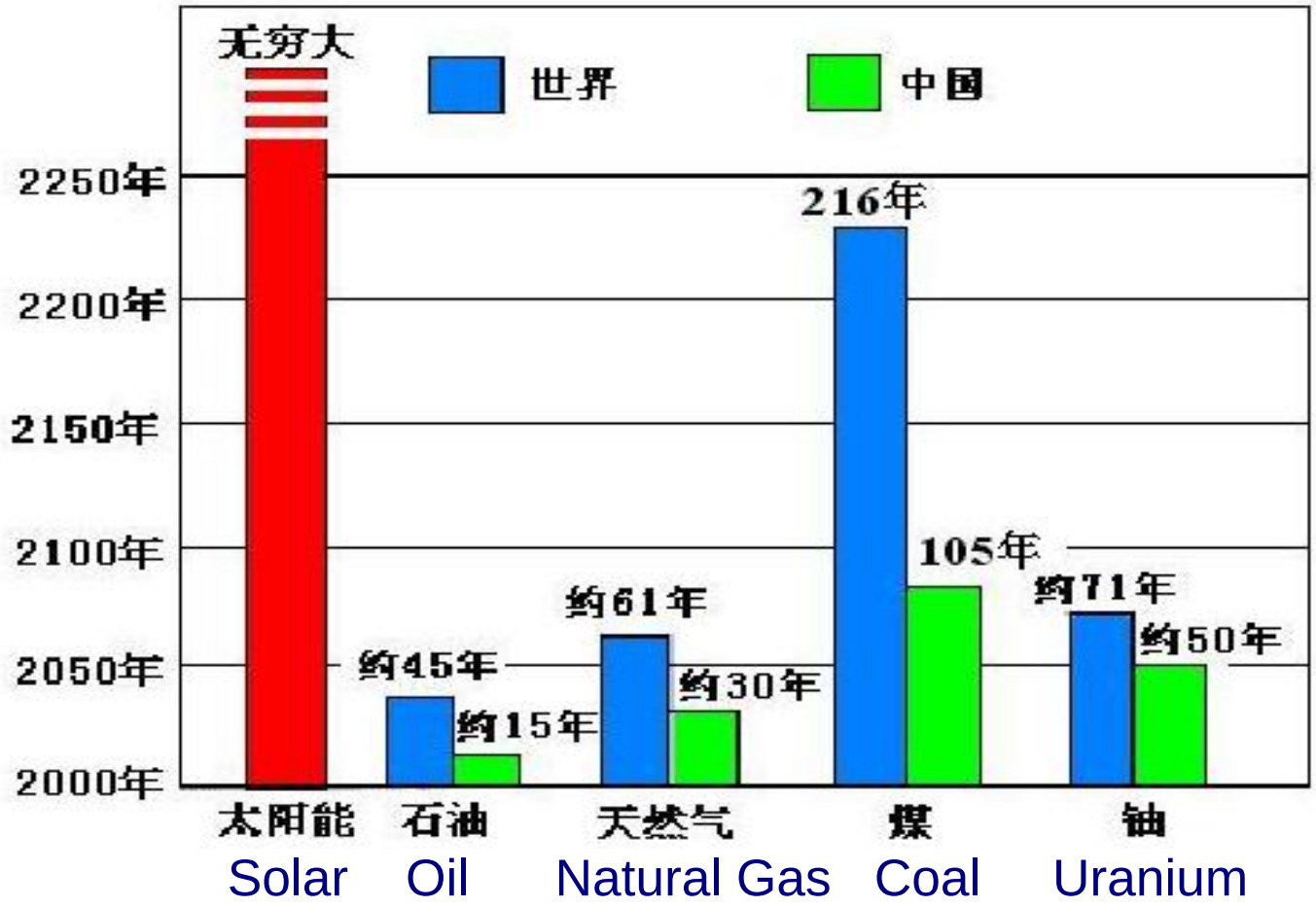
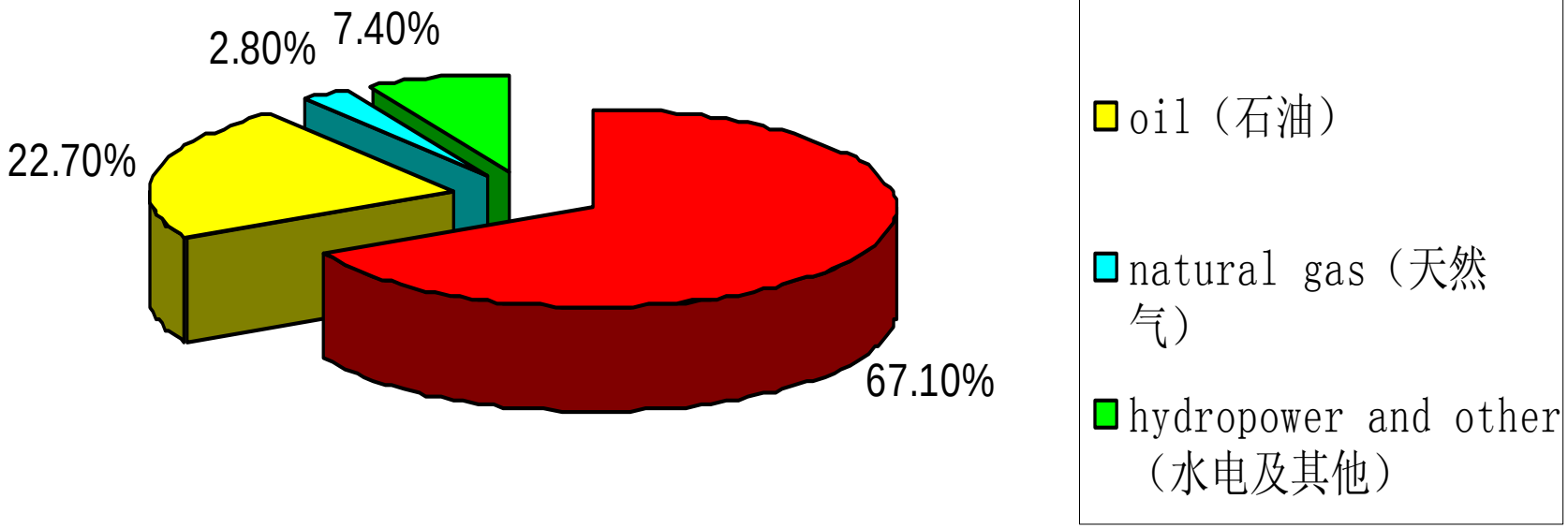
The fossil energy resources are very limited in China, solar energy is the future alternative resource.



Composition of Energy Consumption (2003)



Installed capacity and generation structure in China, 2002

	Installed Capacity/GW		Generation/TWh	
	Capacity /GW	Proportion /%	Generation /TWh	Proportion /%
Coal	265.54	74.5	1352.2	81.7
Hydro	86.07	24.1	274.6	16.6
Nuclear	4.46	1.25	26.5	1.6
Total	**356.57**	**100.0**	**1654.2**	**100.0**

- Some renewable energy generation such as wind with the capacity of 0.5GW (0.15%) are not included in the table above.

The future power shortage has to be filled up by RE power

It is foreseen that there will be a power shortage:

- 37 GW in 2010
- 102 GW in 2020

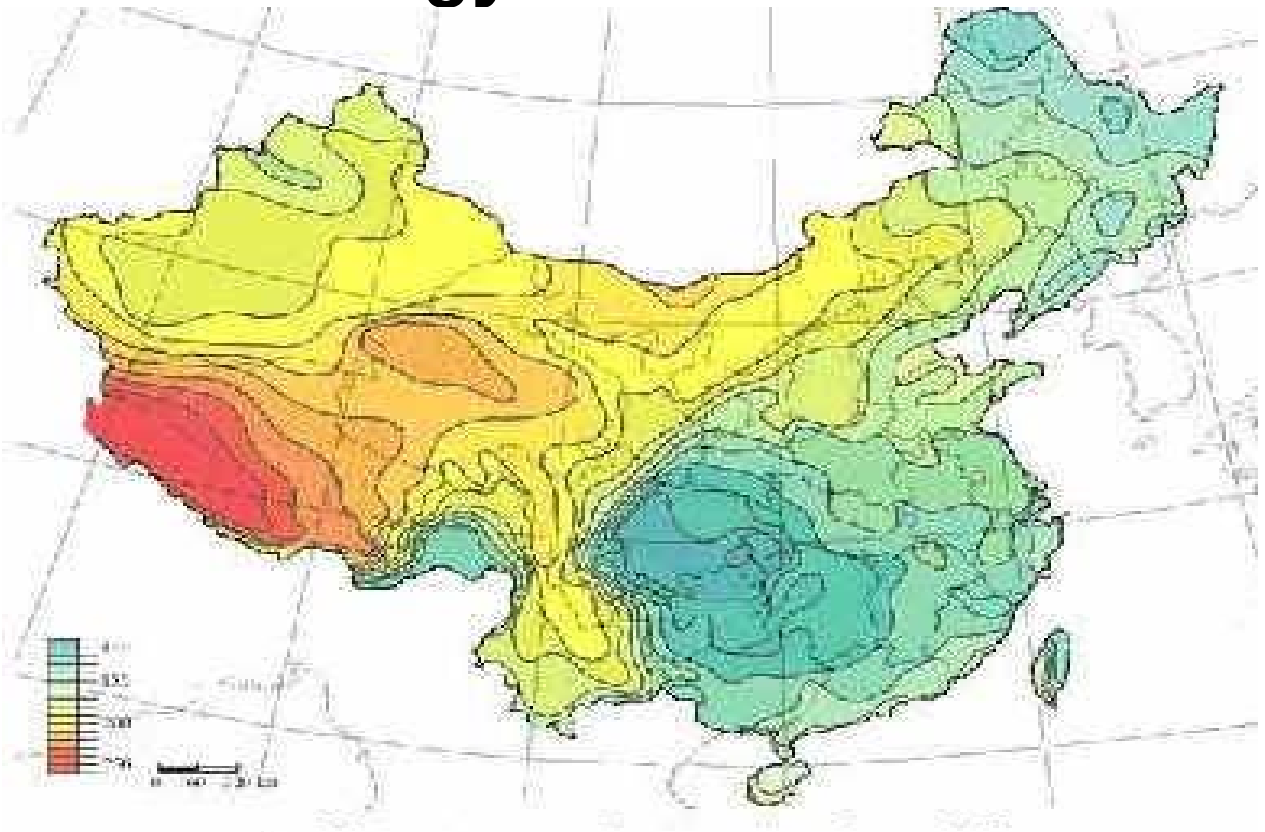
Considering the requirement and resources:

- The gap will not be filled up by coal, hydro and nuclear power
- The gap has to be supplied by RE

Solar Resource in China

- Criterion for measurement
  - Total radiation
  - Sunlight hours
- Annual Theoretical reserves：1.7×10^{6}Mtce
- Annual Radiation：3.3×10^{3}~8.4×10^{6}kJ/m^{2}
- Above two thirds area of the country where sunlight is more than 2000 hours a year.
  - Most of the solar resources are distributed in Tibet, Qinghai, Sinkiang, Gansu, Ningxia and Inner Mongolia.
  - Resources in the east, the South and the Northeast are ordinary.
  - Solar resources are poor in Sichuan Basin

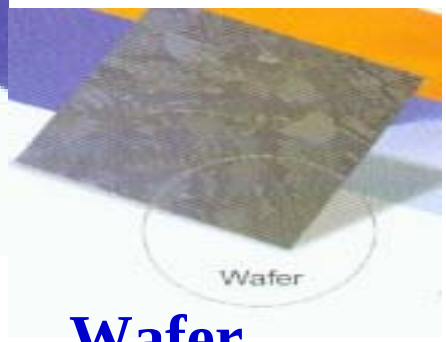
Solar Energy Distribution of China



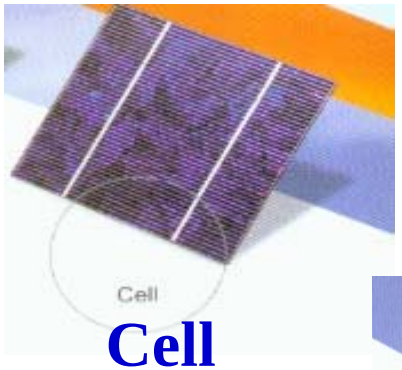
Color	Radiation Level	Annual Radiation/KWh/ m^2	Daily Radiation/KWh/m^2
Red	Best	**⩾ 1860**	**⩾ 5.1**
Orange	Good	**1500 – 1860**	**4.1 – 5.1**
Yellow	Ordinary	**1200 – 1500**	**3.3 – 4.1**
Blue	Poor	**< 1200**	**< 3.3**

PV Generation Technology

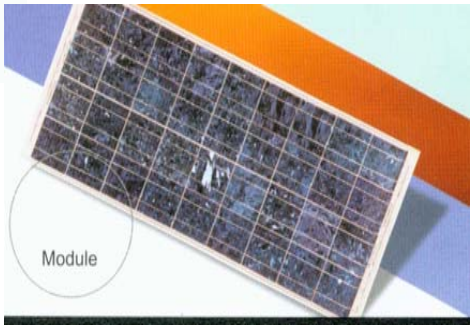
High purity silicon raw materials



Wafer

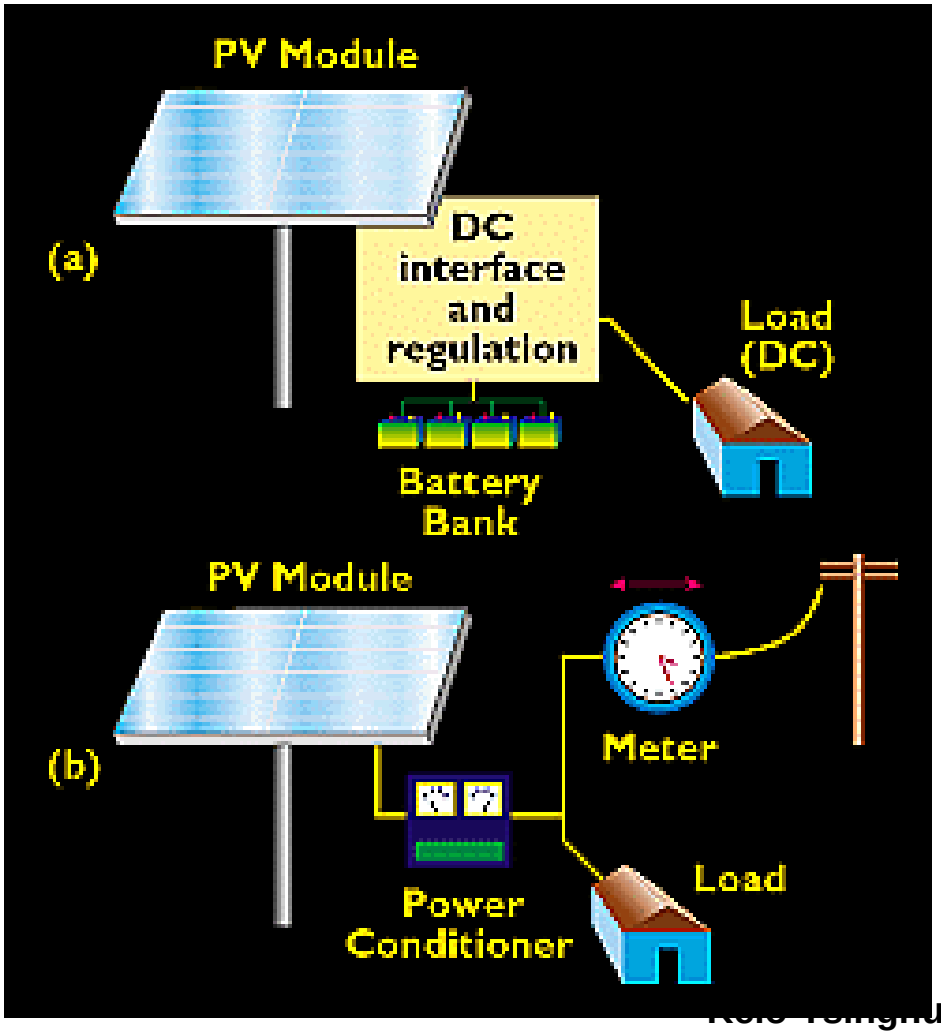


Cell



Module

PV Generation systems category



(a) Independent Supply System
- —PV components
- —Battery
- —Controller
  - DC Load
  - Inverter + AC Load

(b) Grid System
- —PV components
- —Inverter
- —Meter
- —Grid

Typical PV generation projects

- Independent system
  - **Independent village supply system**
- Grid system
  - **Building PV (BIPV)**
    - 1～5kW
    - promoted in many developed countries
  - **Very large scale PV (VLSPV)**
    - 100kW～100MW
    - Desert and Gobi in the West of China

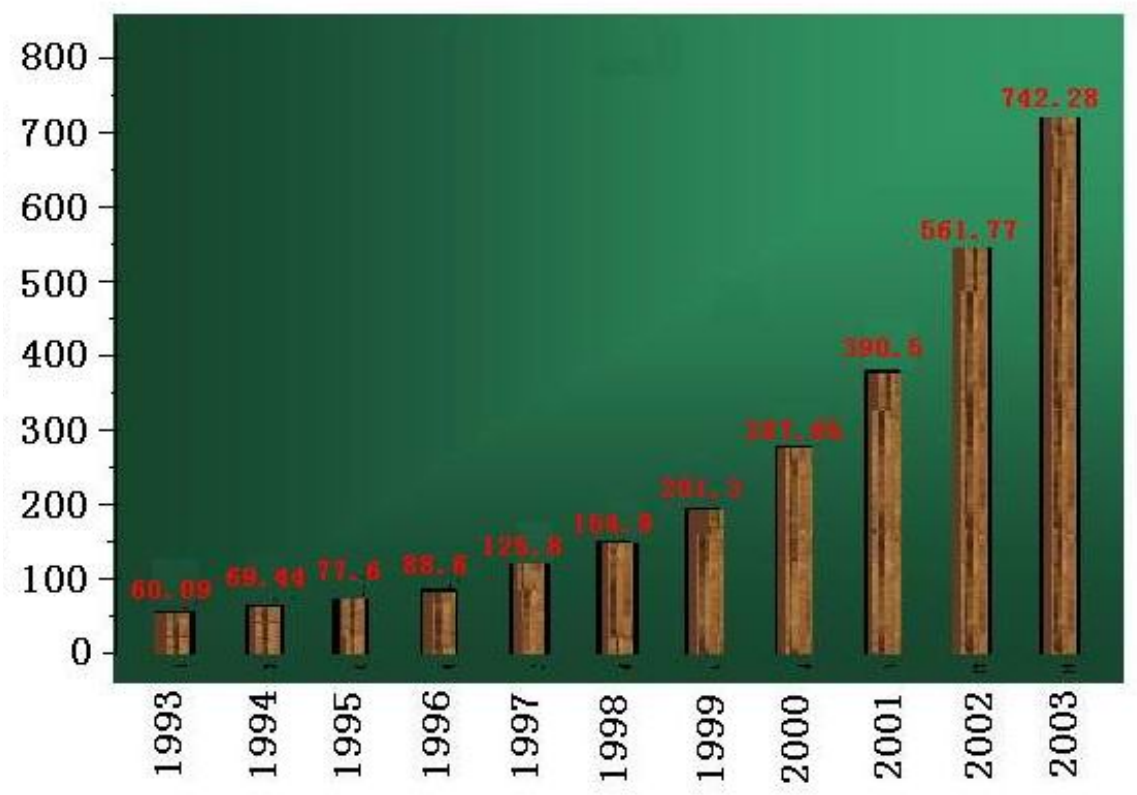
4 MW Solar Park, Hemau, Germany

Tokyo University of Agriculture and Technology

kurochan @TUAT

Global PV industry

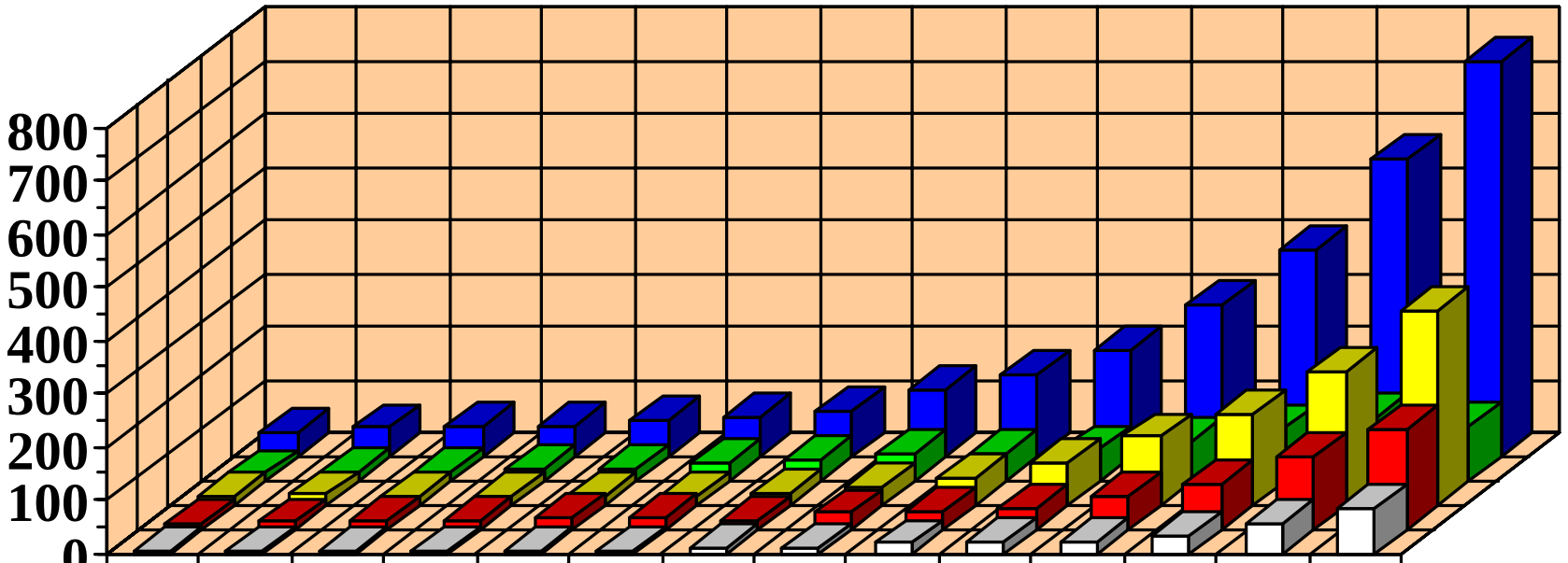
- Production scale expanding
  - 1980s **1~5MW/year**
  - 1990s **5~30MW/year**
  - 2001~2005 **50~500MW/year**，2003, **742.28MW**。



Production of solar cell/module in the World, MW

- Cell technology developing rapidly
  - Emergence of new technology
  - Rising of cell efficiency
    - Single crystal cell commercialization efficiency is 13%~18%.
- Cost and price of module decreasing
  - In 2002, cost of some important manufacturers in the world is $2～2.3/Wp，price is $2.5～3/Wp；
  - Expected cost of cells in 2010 may decline to $1/Wp，cost of PV system below $2/Wp.

PV Cell Production in the World (PVNET2003)



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Rest of World	4.7	5	4.6	4.4	5.6	6.35	9.75	9.4	18.7	20.5	23.42	32.6	55	83.8
Europe	10.2	13.4	16.4	16.55	21.7	20.1	18.8	30.4	33.5	40	60.66	86.38	135	190.4
Japan	16.8	19.9	18.8	16.7	16.5	16.4	21.2	35	49	80	128.6	171.2	251	363.9
United States	14.8	17.1	18.1	22.44	25.64	34.75	38.85	51	53.7	60.8	74.97	100.3	120	104.2
Total	46.5	55.4	57.9	60.09	69.44	77.6	88.6	125.8	154.9	201.3	287.7	390.5	561	742.3

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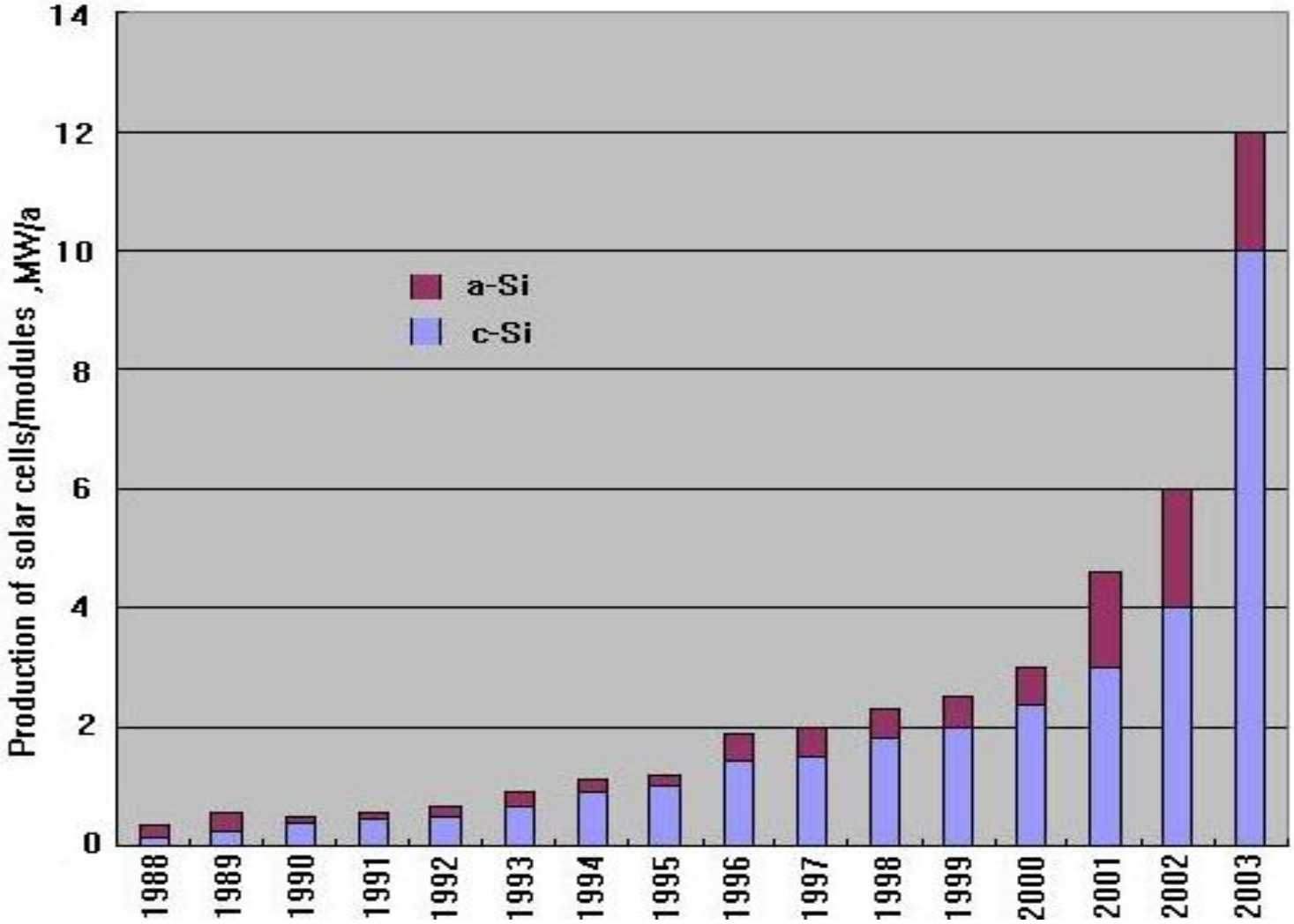
PV generation industry in China

- History
  - 1958: begin to study cell production
  - 1971: satellites
  - 1973: land use
  - 1980s: government involved, motivate fast development
  - 1990s: important government projects, ‘Bright project’, ‘deliver electricity to suburb’.
  - 2002: ‘the plan of sending electricity to the area without power in the west provinces’ sponsored by NRDC was incentive to the PV industry.

Current Status

- Production scale of cell/module expanding
  - 2003,12MW，about 2.2% all over the world；
  - 2004, expected 50MW，can be 5％ of all in the world.

  (above 90％ for exportation，national market in 2004 may be 3～5MW.)
- Cell/module cost continues to drive down.
  - From 65~80Yuan/Wp in 1980s to 25~28Yuan/Wp in 2003
- Improvements on industry chain and structure



Production of solar cells/modules in China, MW/a

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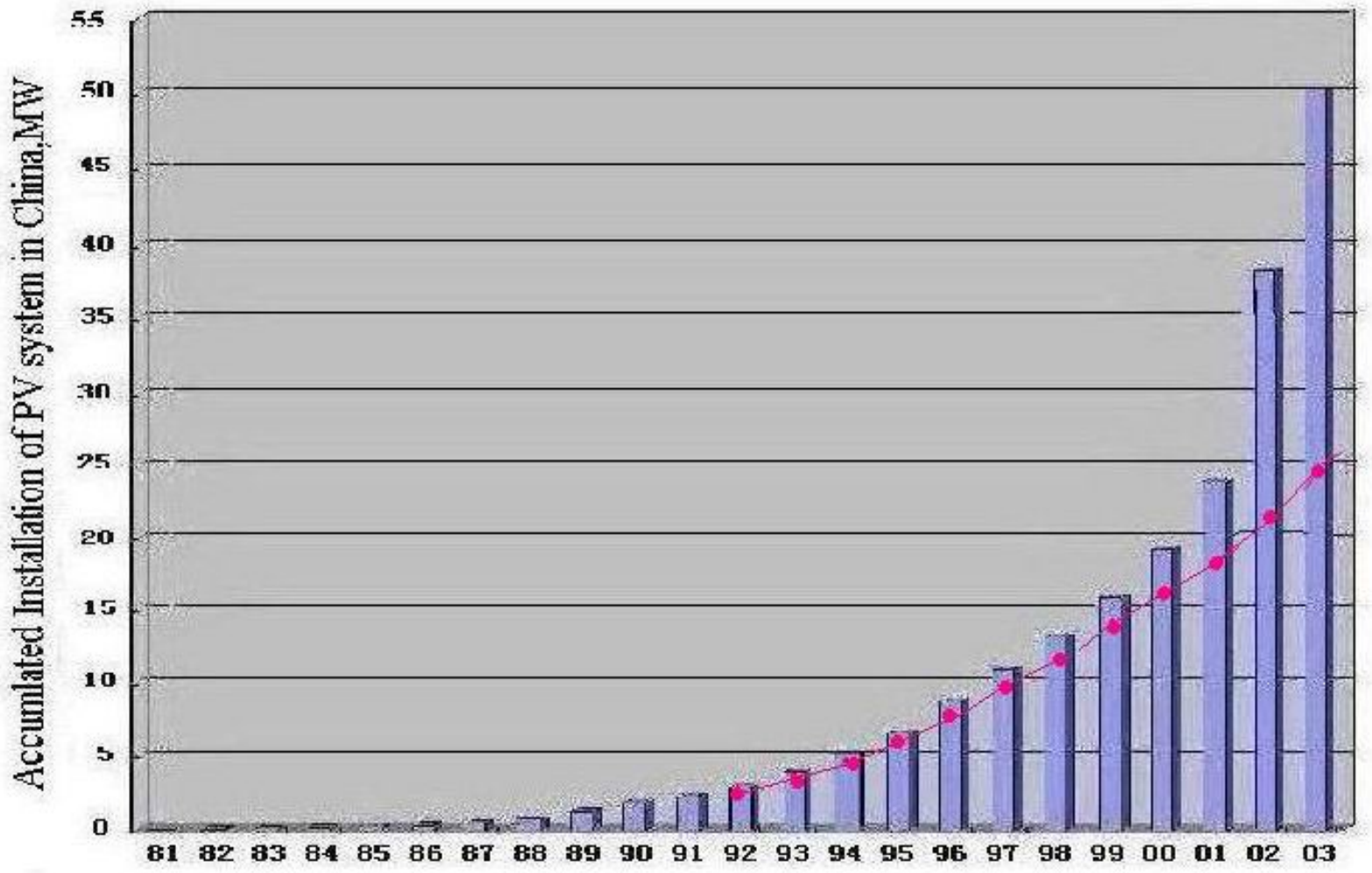

Accumulated installation of PV system in China, MW

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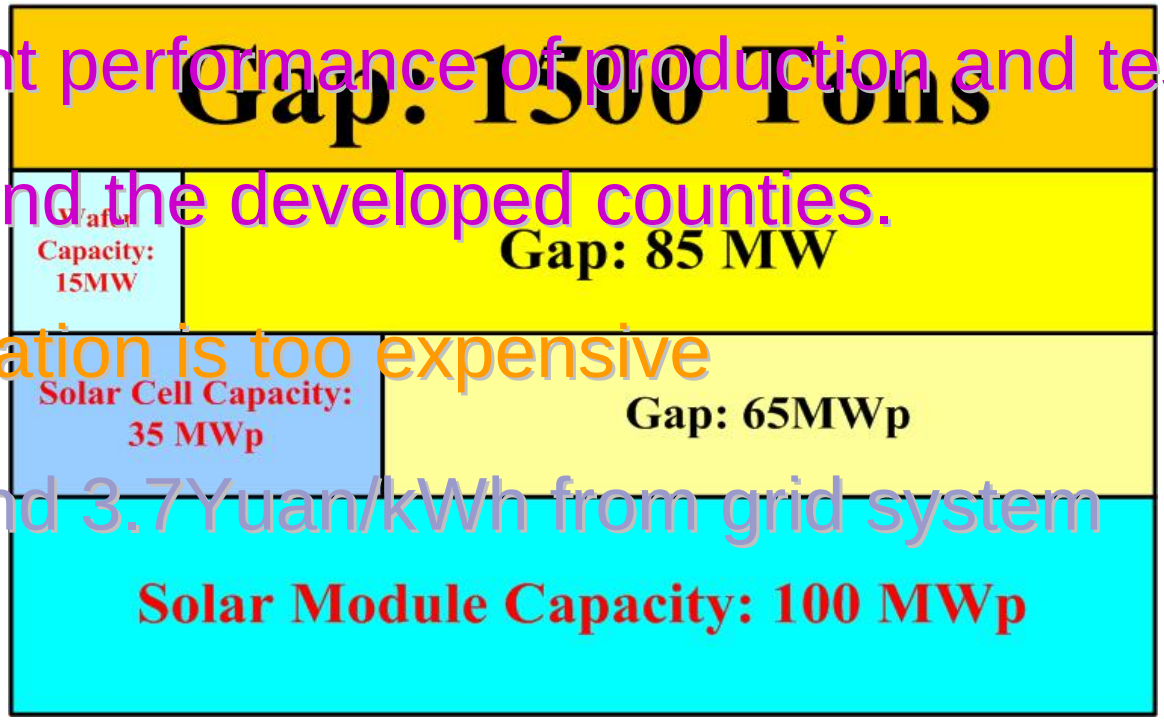
Issues of Chinese PV

Capacity imbalance of successive steps

- Silicon raw material: zero
- Wafer < Cell < Module

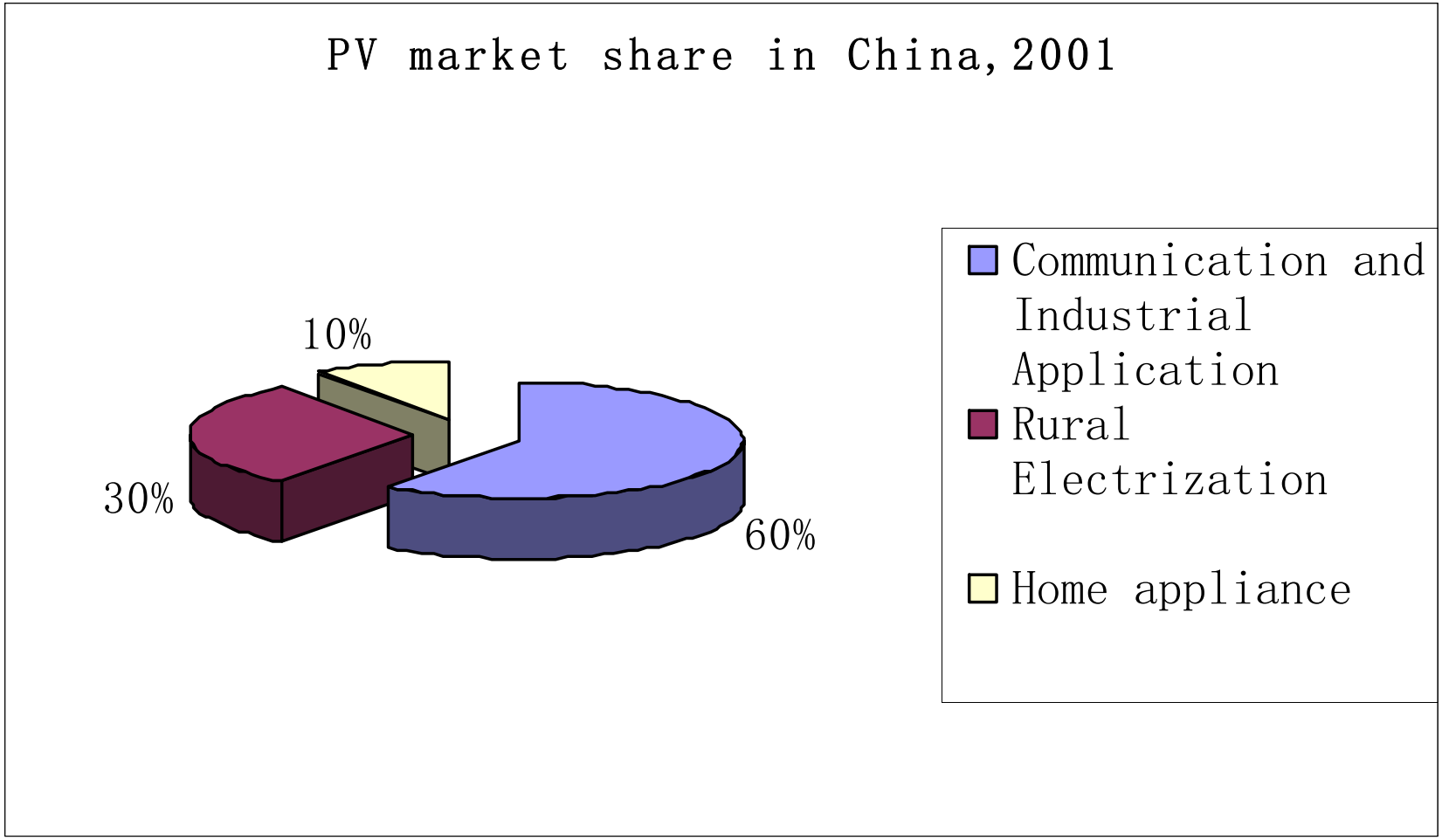


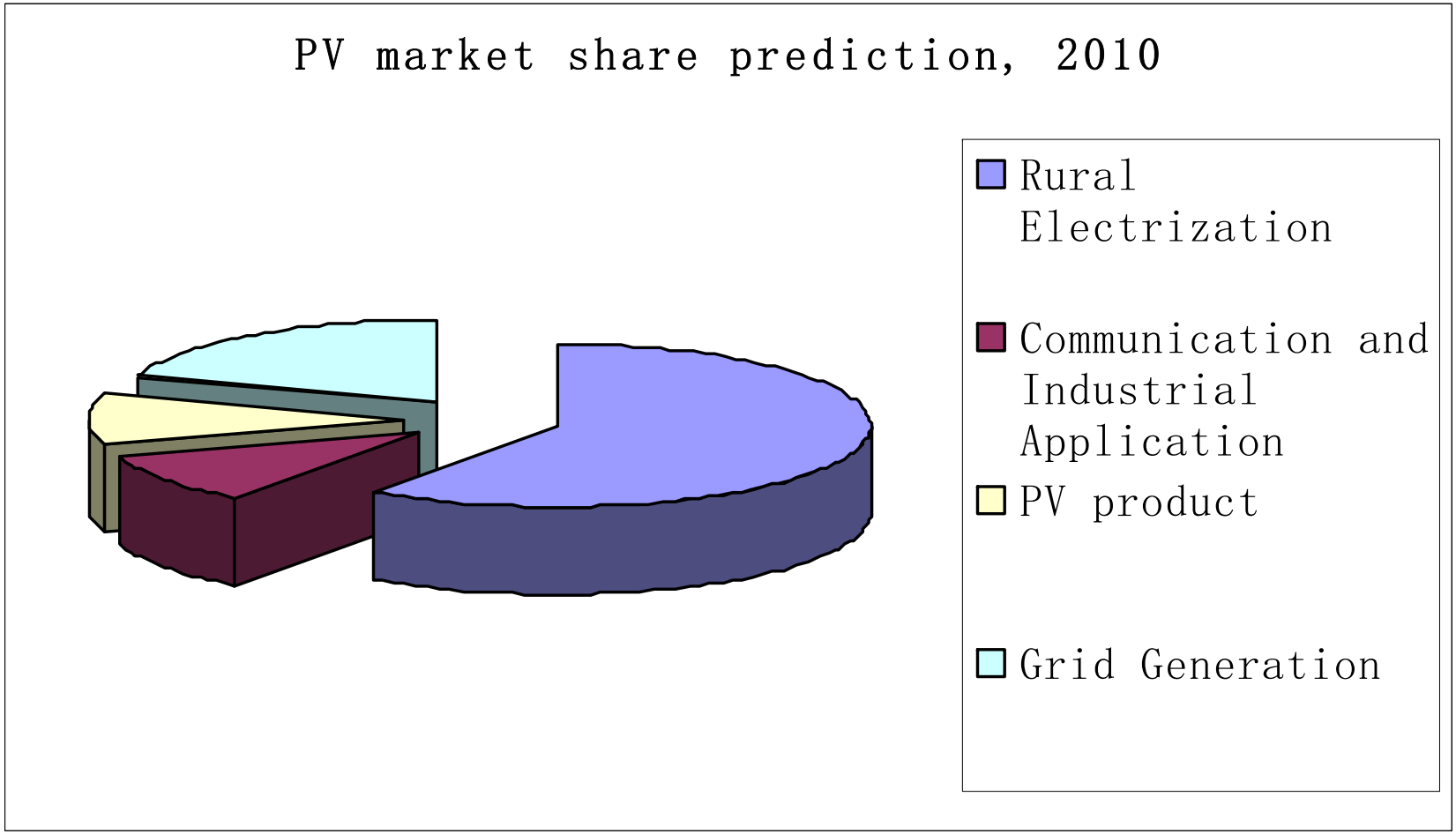
Equipment performance of production and testing trails behind the developed counties.

PV generation is too expensive

- Around 3.7Yuan/kWh from grid system

PV market in China




PV market share prediction, 2010
Rural Electrization
Communication and Industrial Application
PV product
Grid Generation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