

– Let's think about future energy- –

Power Generation in Space

For elementary school students

Lecturer Profiles

I was born in Hiroshima. I liked small animals and joined a club to take care of animals in elementary school days.



Club members



Birds in my home

I studied physics at university. After graduation, I was interested in the aurora .



Study of aurora in laboratory



Experiment to generate artificial aurora in space

Later, I was involved in lunar exploration.



Japanese lunar explorer "Kaguya"

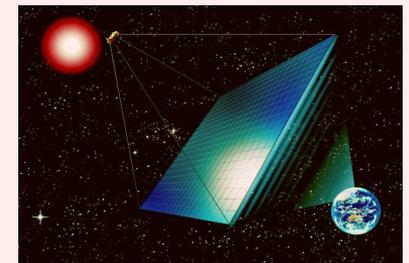


Earth observed from the Moon

Now I am interested in Solar Power Satellite.



Construction test on ground



Future Solar Power Satellite

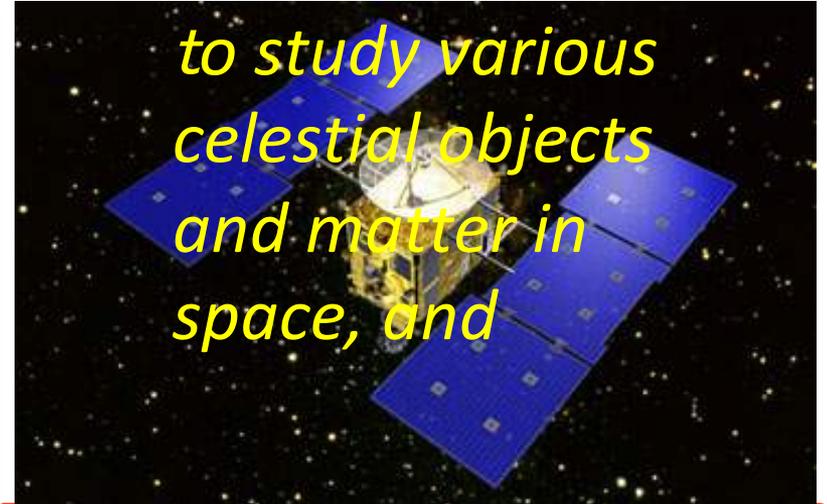
Today's subject

Japan Aerospace eXploration Agency (JAXA)

Launching satellites and explorers into space by rockets,



to study various celestial objects and matter in space, and



to utilize space environment for human beings.



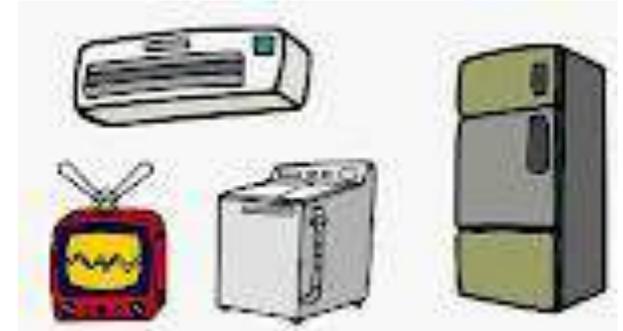
Precious Electric Power



in Factories



in Schools



at Home



for Electric Vehicles



for Trains

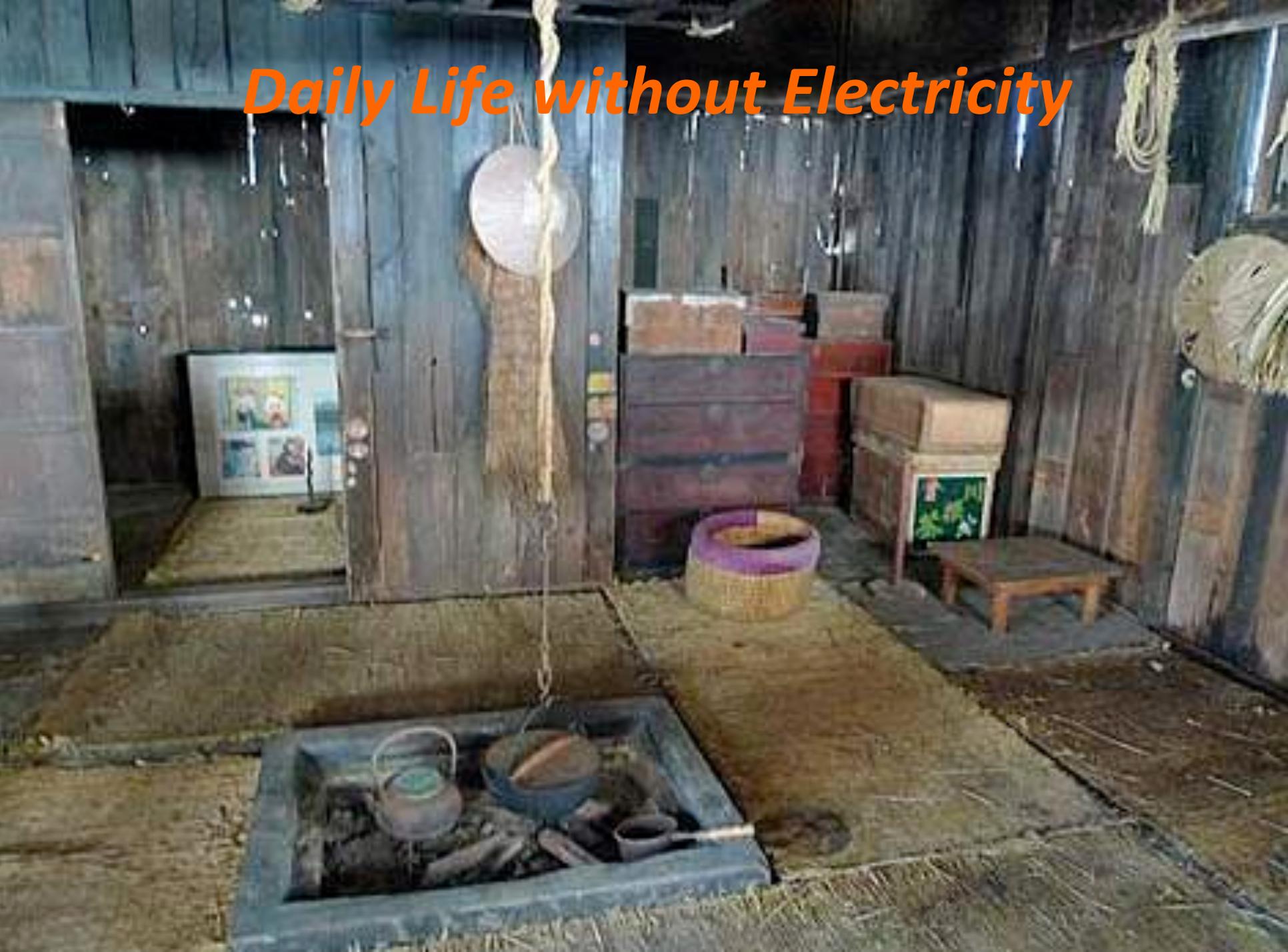


Illumination in town

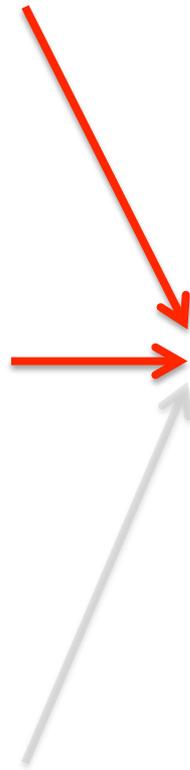
Daily Life with Electricity



Daily Life without Electricity



Where the electricity comes from?



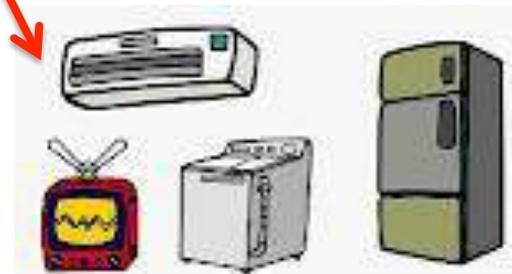
Transmission Line



Factories



Electric trains and vehicles



Home

Where the electricity comes from?

Power Station



Hydroelectric Power Station (20%)



Thermal Power Station (61%)



~~Nuclear Power Station (19%)~~



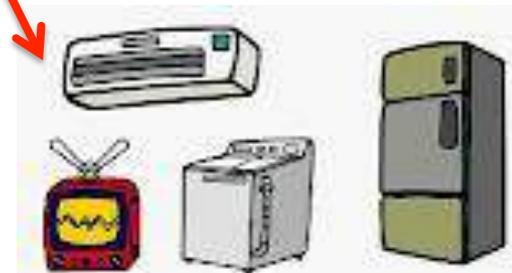
Transmission Line



Factories



Electric trains and vehicles

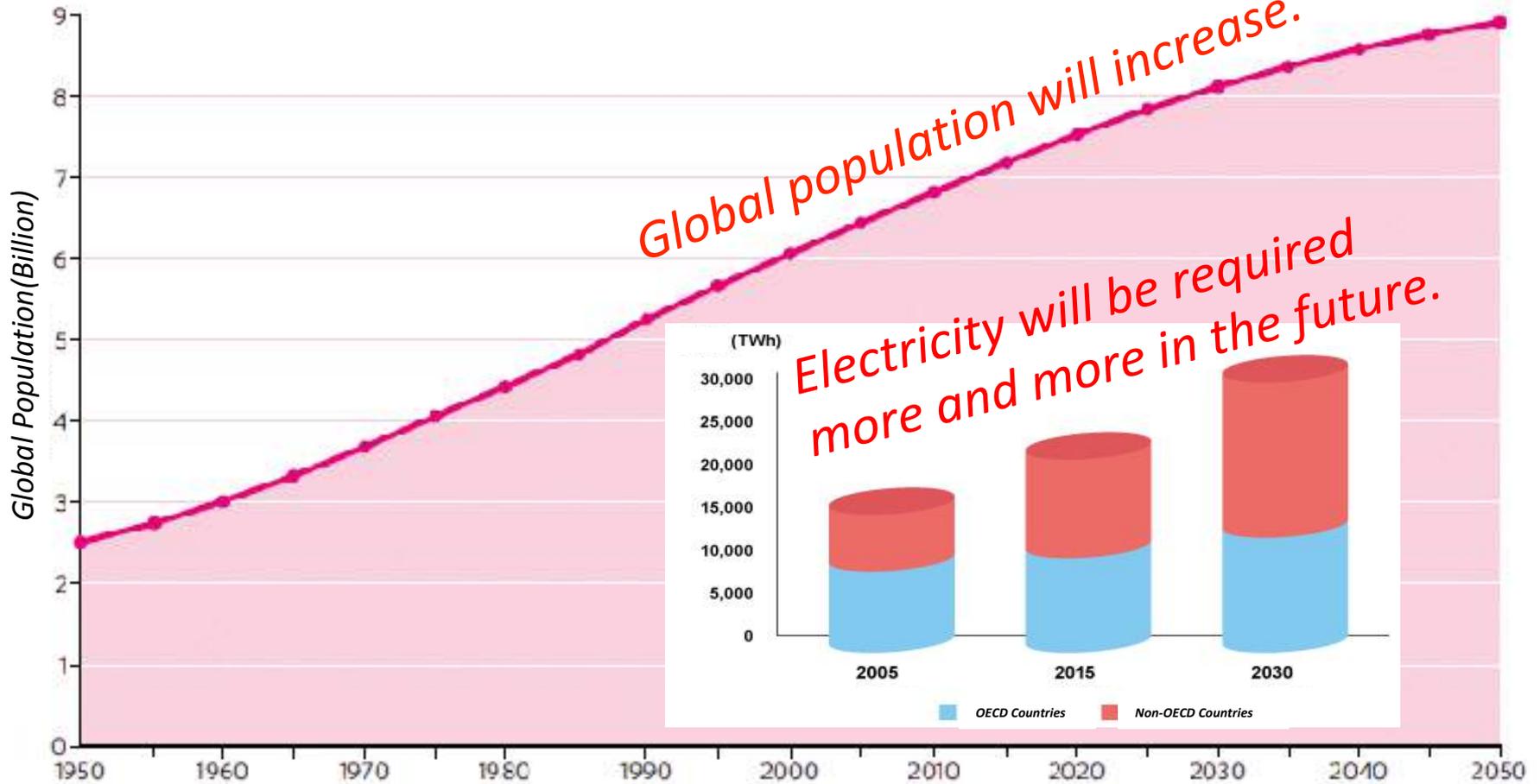


Home

Note: Ratio % are the figures before Fukushima nuclear power station incident.

Electricity consumption continues to increase.

Population Prospects (1950-2050)



Global population will increase.

Electricity will be required more and more in the future.

Source: UN Population Division

2018

Future of Power Stations



Hydroelectric Power Station (20%)



Thermal Power Station (61%)



Nuclear Power Station (19%)



Future of Power Stations



Hydroelectric Power Station (20%)

Both large area and water-rich river are required. Candidate sites are now limited.



Thermal Power Station(61%)

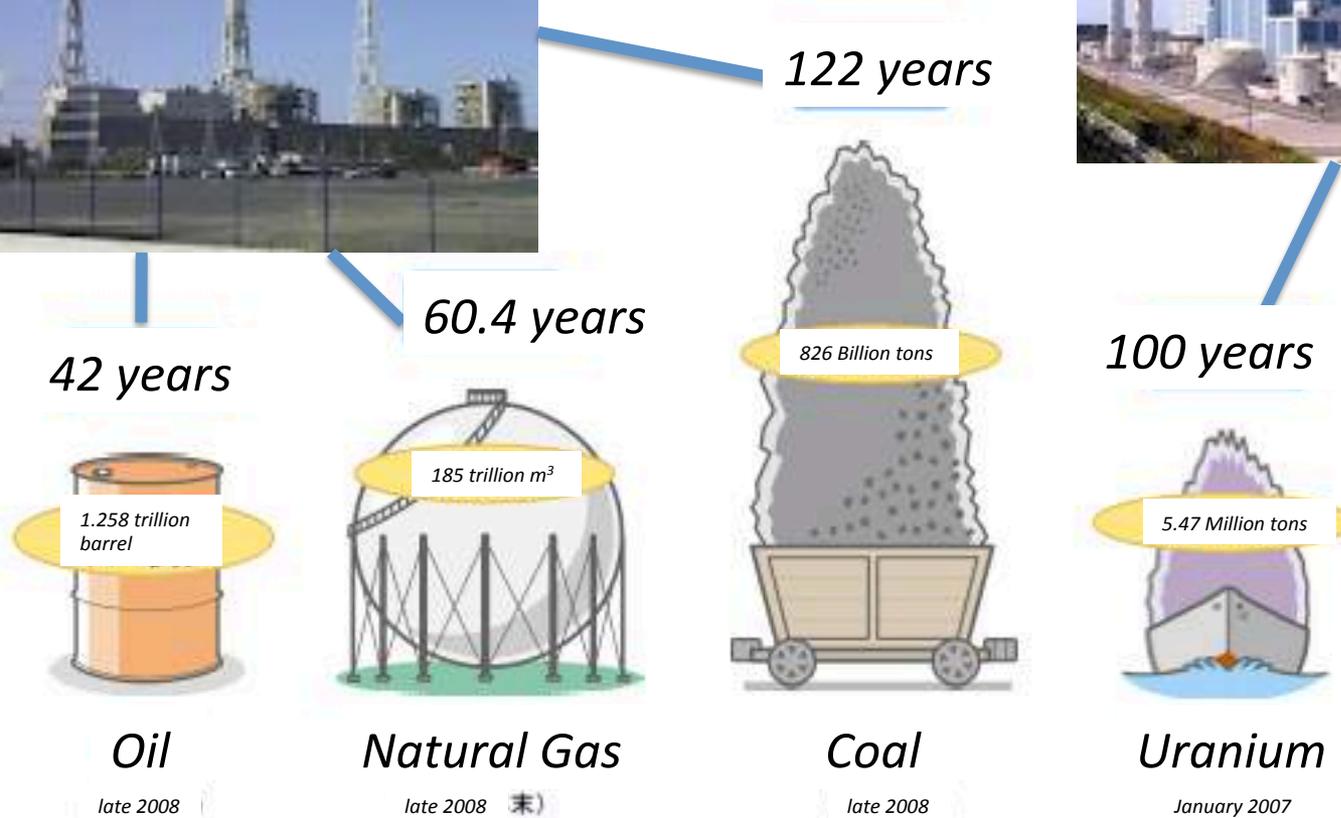
*Natural resources for the fuel are being depleted. Fossil fuel will be almost depleted within 100 years. Burning fossil fuels emits CO₂, that causes global warming. **Thermal power production needs to be reduced.***



~~Nuclear Power Station(19%)~~

*There are serious safety concerns about nuclear power station. **Nuclear power stations need to be reduced or terminated.***

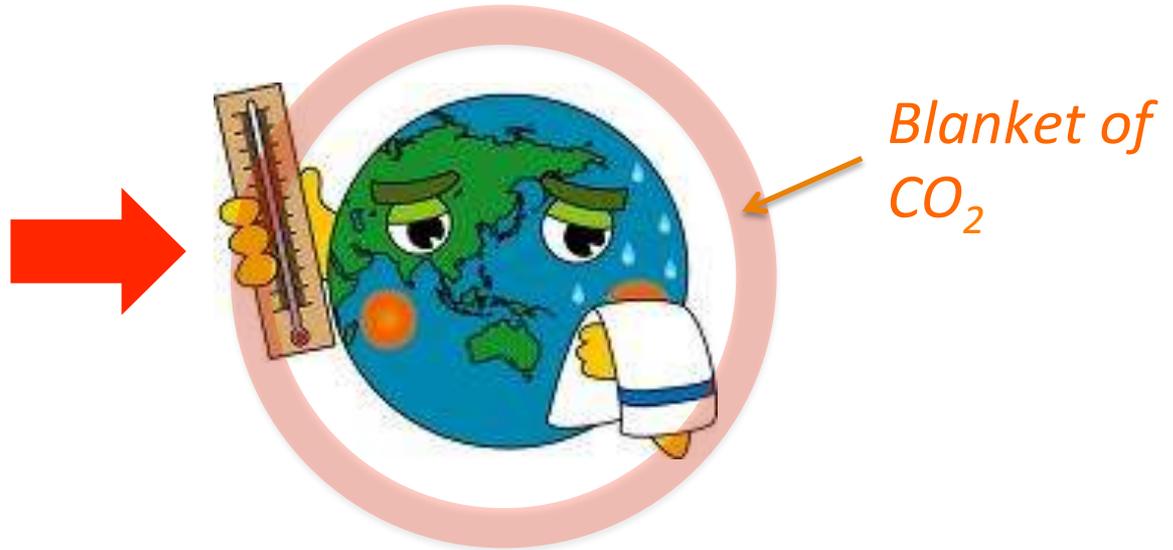
Fuels for thermal power generation will be depleted in 50-100 years.



Reference: Japanese Agency for Natural Resources and Energy (2010)

Problem of Global Warming

Burning fossil fuels for electricity creates carbon dioxide emissions.



Rising sea levels due to global warming

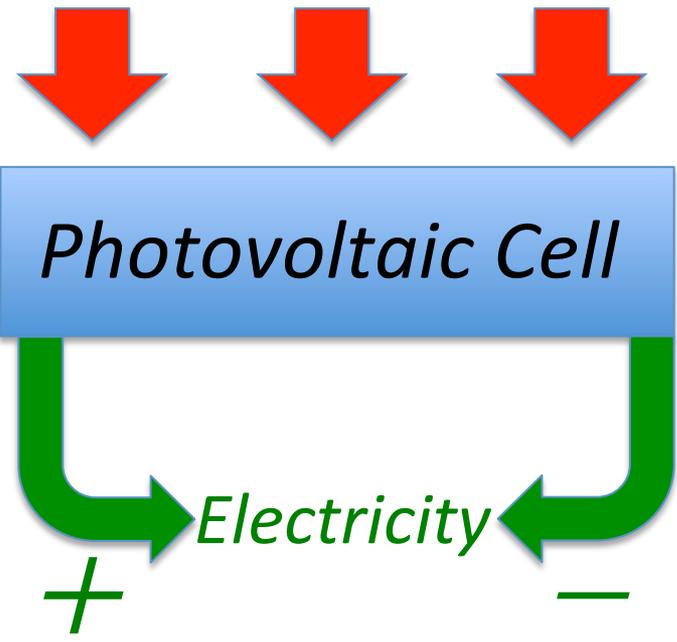


Desertification

Power Generation by Solar Light

Solar Light

Photovoltaic Cell



Calculator



Solar Watch

Photovoltaic cell needs no fuel. It does not generate CO₂ emission.

Solar Power Station on the Ground

Mega-solar plant (100 MWatt class)



Canada, 80MW



Kagoshima Japan, 70MW

One mega-solar plant generates energy to supply 20,000-30,000 homes.



***Why not build Solar Power Station
in Space (Solar Power Satellite) !***

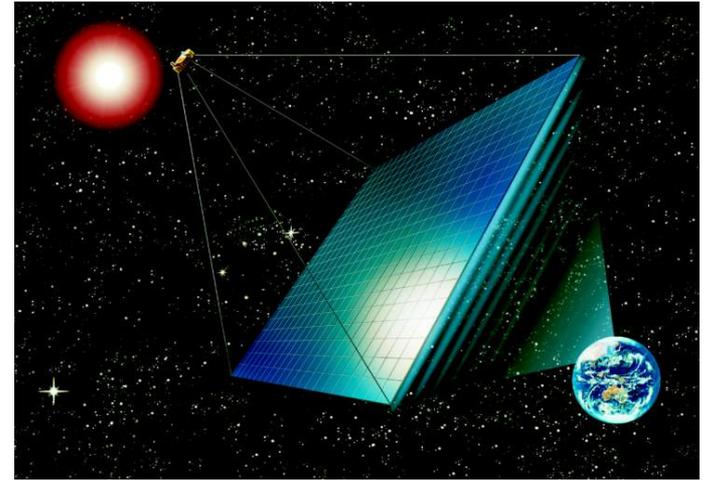


Solar Power Satellite (SPS) in Space

*Transportation to space
by reusable rockets*



*Solar power plant in space
(Solar Power Satellite)*



*Panels are folded and transported
to space. Generated power is
transmitted to the ground.*

Solar power plant on the ground

Advantages of Solar Power Satellite

Solar Power Station on ground



cloudy or rainy day



Night time



Land shortage

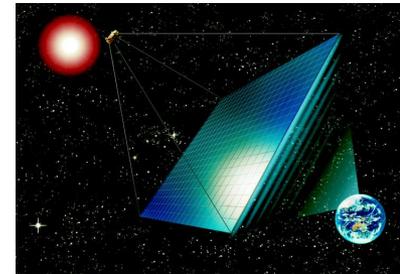
comparison



*Solar Power Station in space
(Solar Power Satellite)*



No cloud, no rain



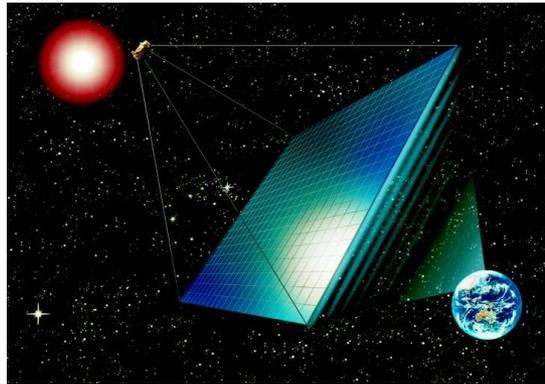
Sunny throughout the day



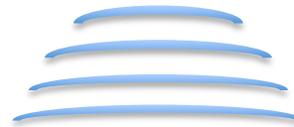
No land shortage

How to transmit electric power to ground from space? Using conductive wires ?

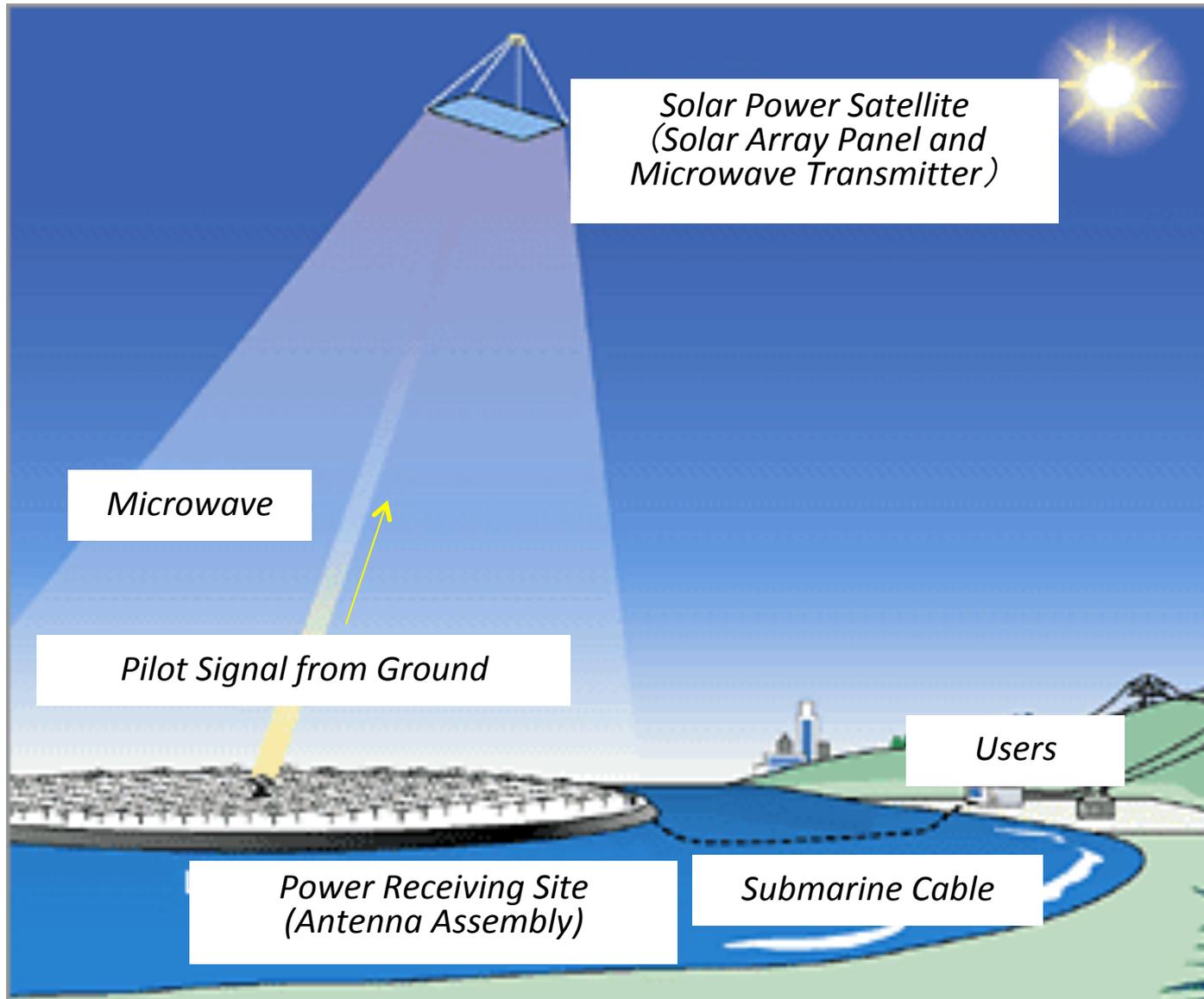
Microwaves in our daily life.



Electric power is transmitted to the ground using microwave (wireless power transmission).

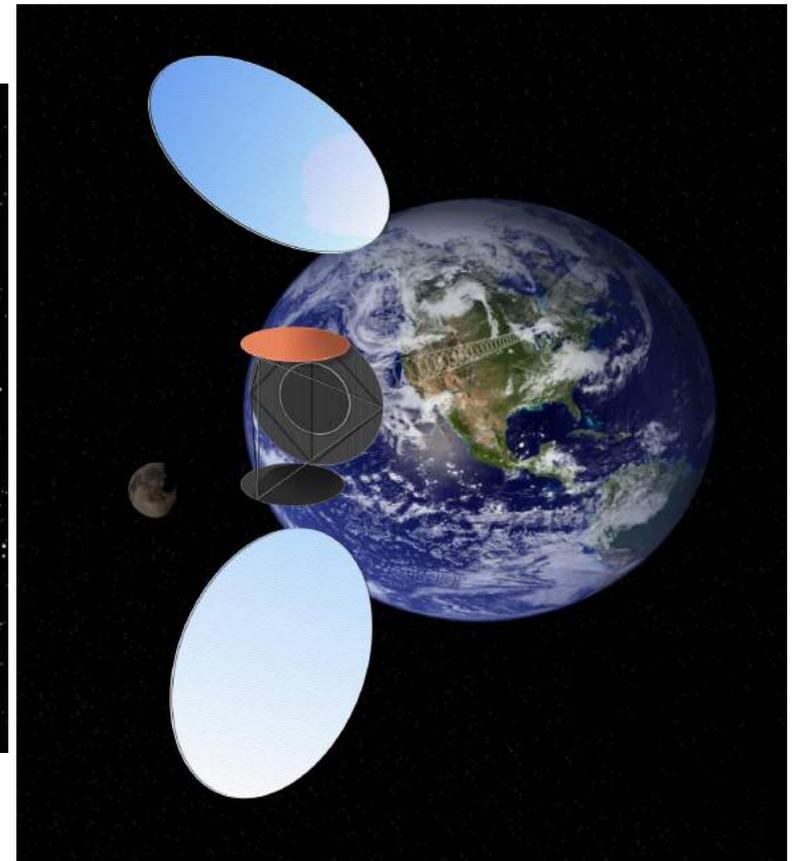
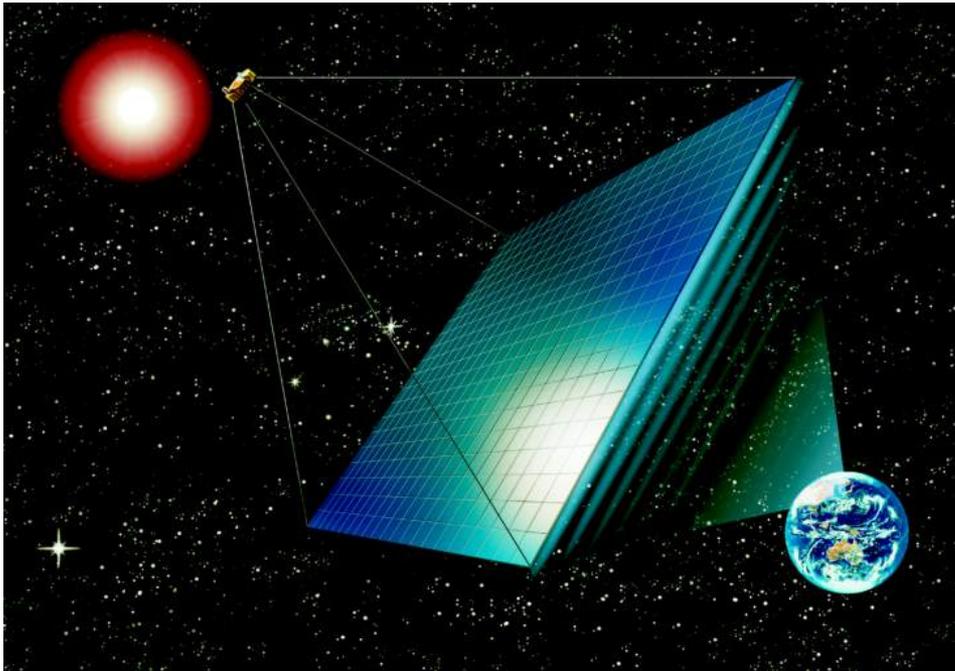


SPS Concept



JAXA Movie

Examples of Solar Power Satellites Designed in Japan



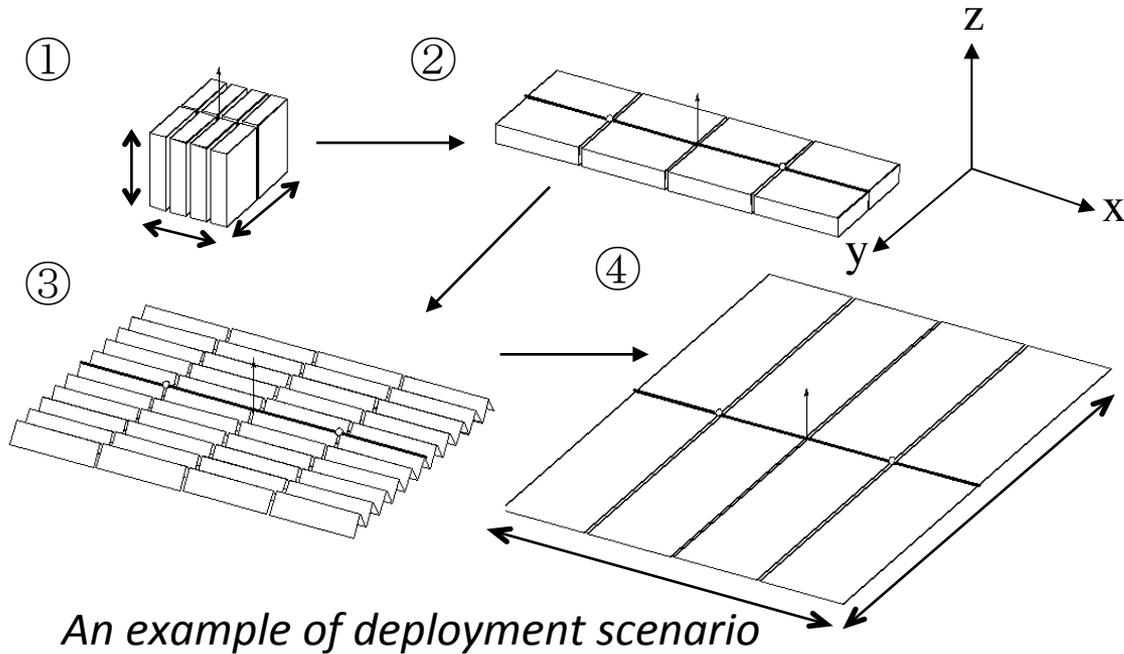
Size: 1-2km in Length (20-40 times the size of Tokyo Dome)

Weight: 10,000-20,000 tons (50-100 times the weight of large passenger plane)

Major Research Subjects to Realize Solar Power Satellite

- 1. Construction technologies to extend a large-scale solar panel in orbit.*
- 2. Wireless power transmission technologies.*
- 3. Long-life materials and structures that can be used in space more than 40 years.*
- 4. Low-cost reusable rockets just like airplanes.*

1. Construction technologies to extend a large-scale solar panel in orbit.



Experiment



Animation



Laboratory experiment to deploy a panel automatically

2. Wireless power transmission technologies

Receiver

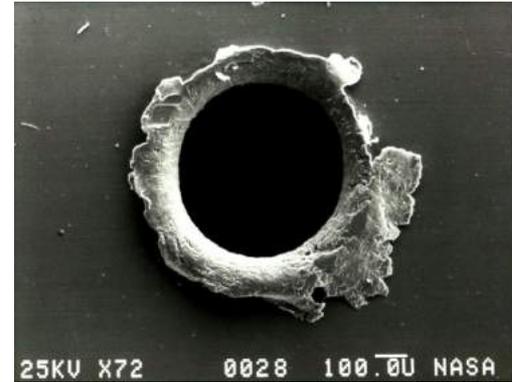
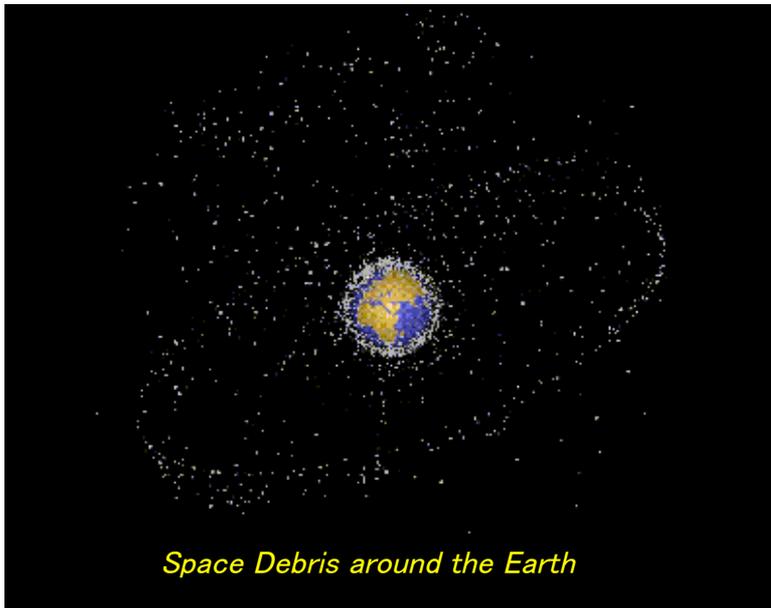
Ground Testing

Transmitter

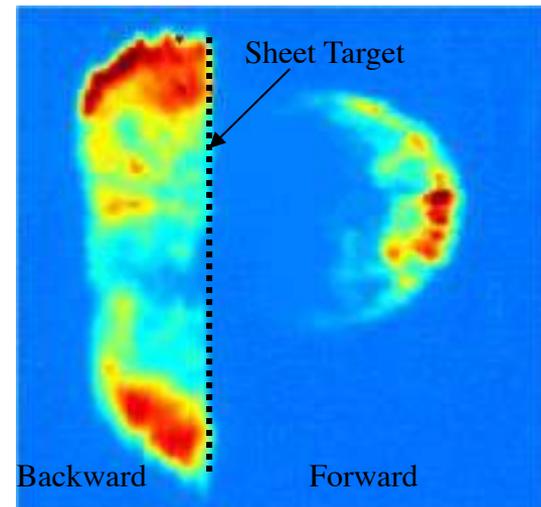


3. Long-life materials and structures that can be used in space more than 40 years

- There are a lot of space debris in orbit.
- Collision with space debris is unavoidable and serious.
- The measures are to find the structure and composition to minimize the collision damage.

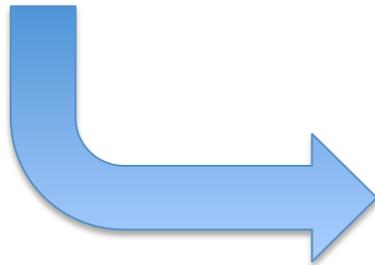
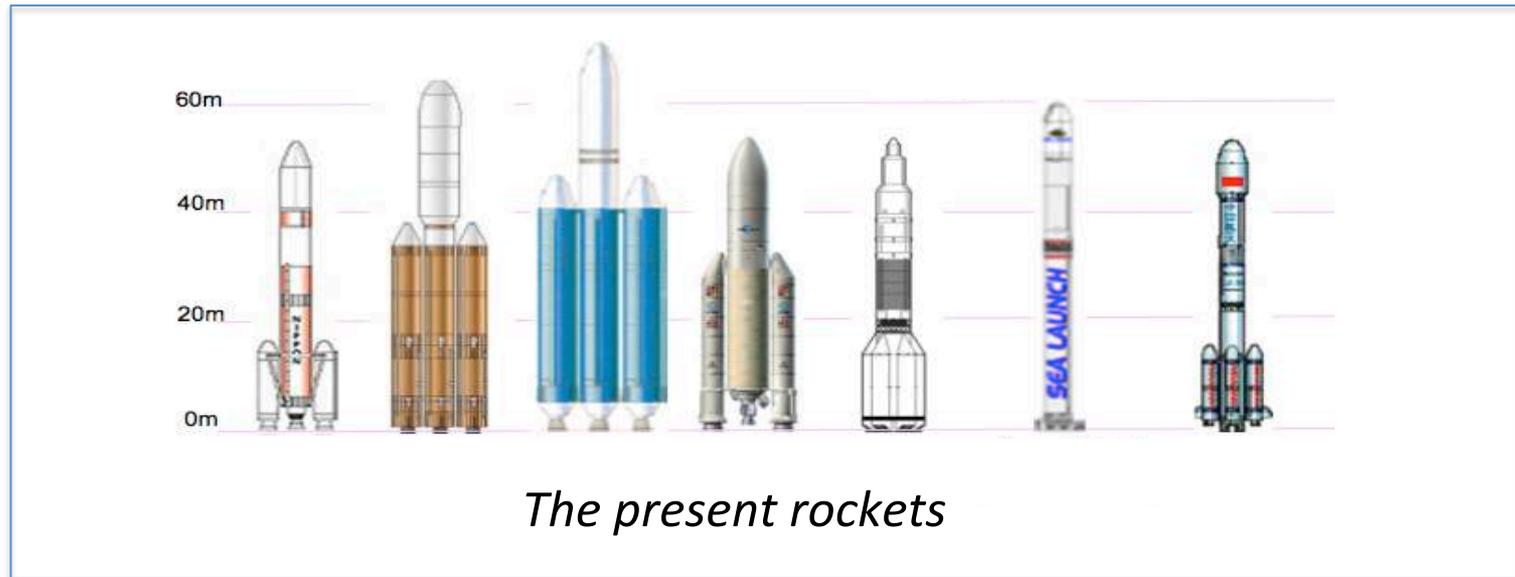


Damage in hypervelocity impact



Hypervelocity impact experiment to learn countermeasures

4. Low-cost reusable rockets just like airplanes



Reusable rockets in the future

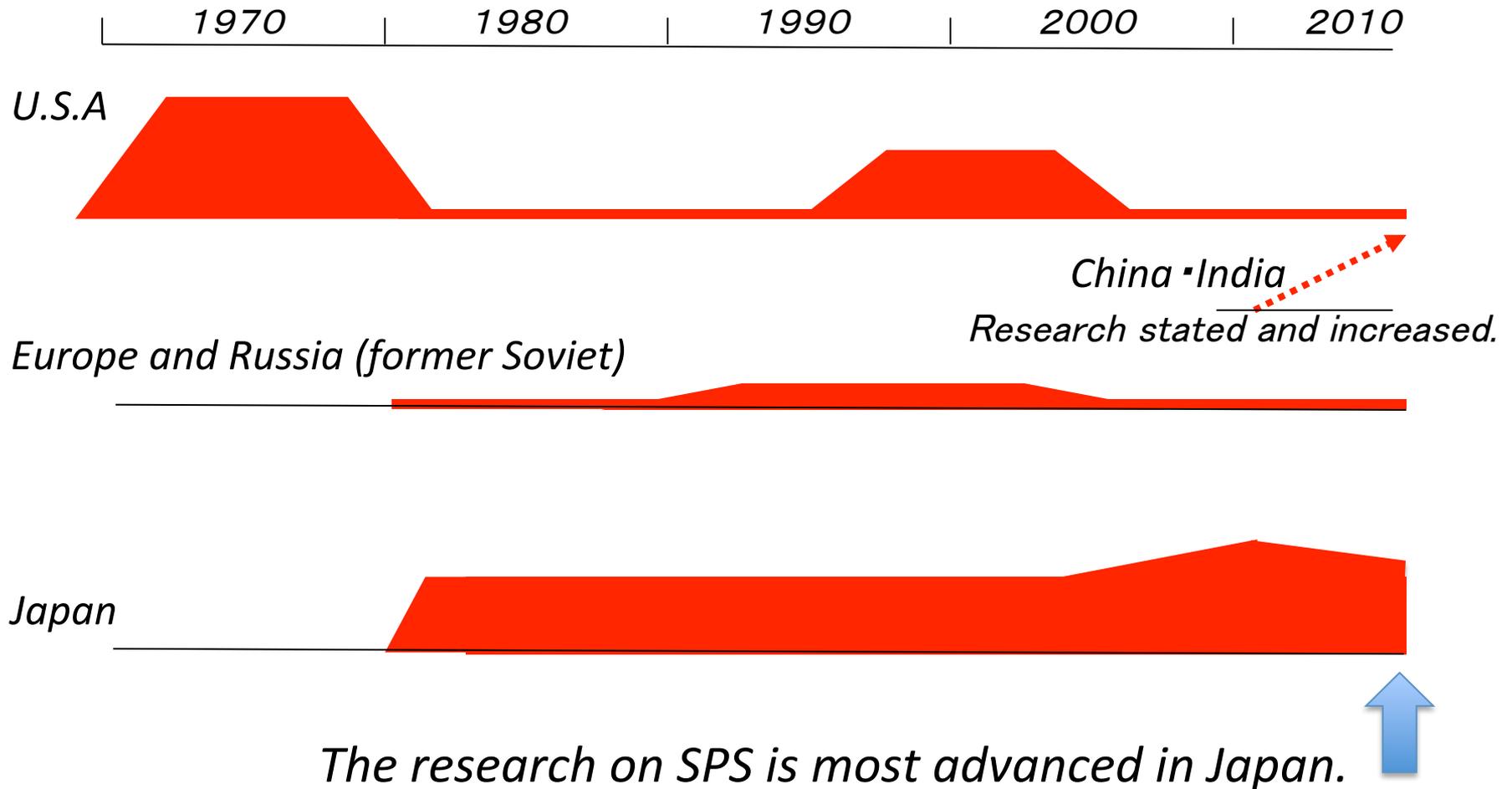


*Small scale reusable rocket experiment in JAXA
Weight : 500kg, Length : 3.5m*

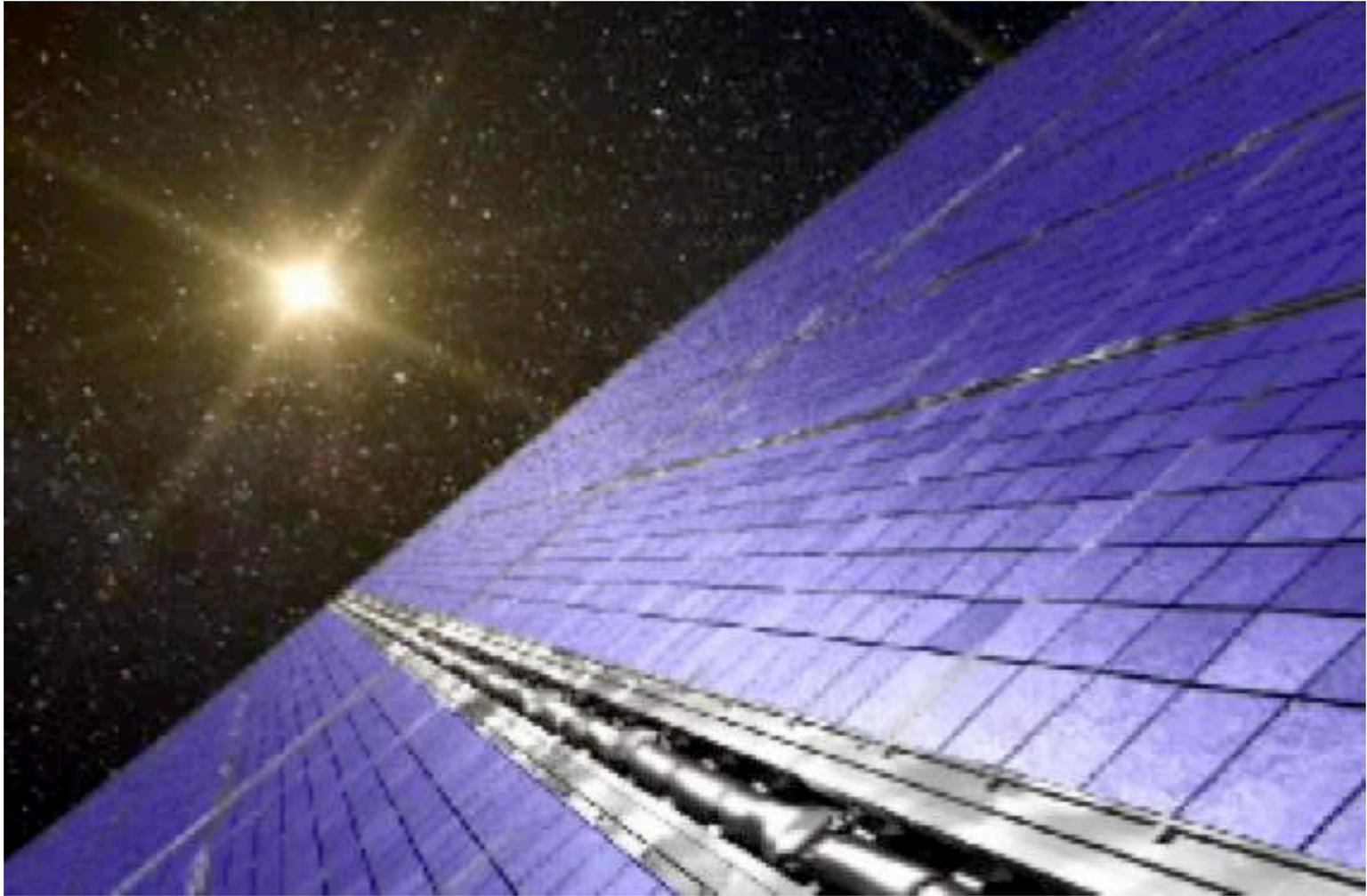
Most active country in SPS Research ?



Most active country in SPS Research ?



Early Stage Space Experiments to Study SPS Technologies



A proposal to conduct an SPS demonstration experiment at Olympic opening ceremony (not yet accepted, just a researcher's dream at present).



Ending Remarks

If we can realize Solar Power Satellite;

- limitless clean energy will be obtained,***
- global environment will be restored and preserved,***
- international conflicts over energy resources will be terminated,***
- creative and comfortable society will be established,***
- new civilization and culture will be developed in the creative and vigorous society expanding into space.***

