



Solar Power Satellite

- Autonomous Assembly of Ultra-Large Space Facility –
- Difference from building ISS -

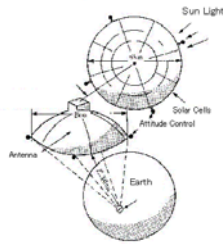
OOS workshop 2004

Dr Mitsushige Oda
Japan Aerospace Exploration Agency (JAXA)

Solar Power Satellite (SPS)

- SPS, being studied for decades by US and other countries.
- SPS will be one of the alternative energy source of future when the fossil fuels becomes scare.
 - Atomic energy becoming difficult
 - Wind, many other alternative options
- Many SPS concepts were proposed.

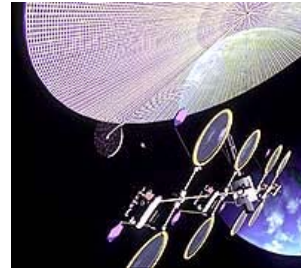
Various concepts



Dr. Peter Graser (1968)



NASA/DoE Reference model (1979)



NASA Solar Disc (1997)

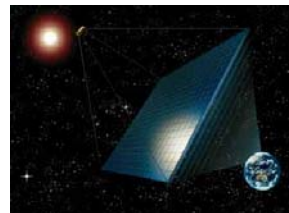
Various Concepts (2)



NASA Sun Tower (1997)

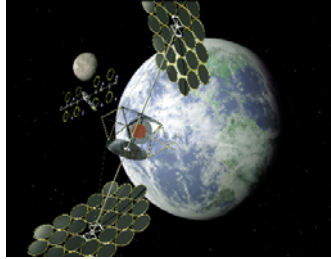


ISAS SPS2000 (1990)

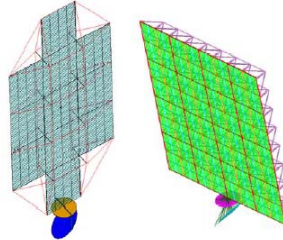


METI/USEF (2002)

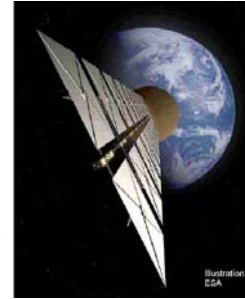
Recent SPS Concepts of NASA and ESA



Integrated Symmetric
Concentrator (NASA)



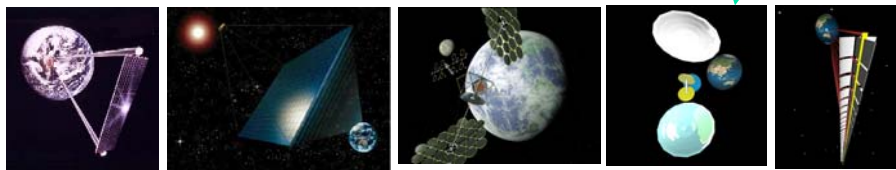
Abacus Reflector (NASA)



Sail Tower (ESA)

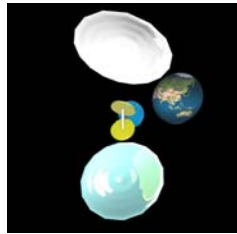
Difference of concepts

- Microwave power transmission (M-SPS)
 - Sun looking PV-cells + Earth looking antenna (Mechanical Gimbals are needed between PV-cells and antenna)
 - Static type (Earth oriented system: Low efficiency)
 - Sun looking mirror + Earth looking antenna
 - Gimbals for mirrors? Independently / formation flying mirrors
- Laser Power transmission (L-SPS)
 - Solid state laser with PV-cells (low efficiency)
 - Direct solar pumping laser power transmission

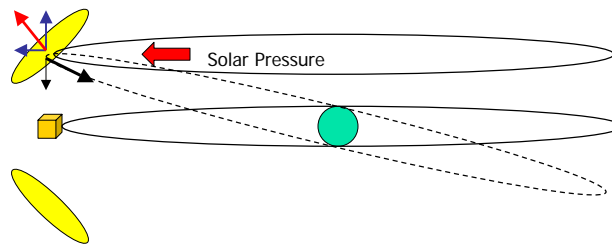


Solar Power Satellite; JAXA's concepts

- Microwave based system (M-SPS)
 - Formation Flying Solar concentration mirrors
 - Integrated Power generation / transmission module

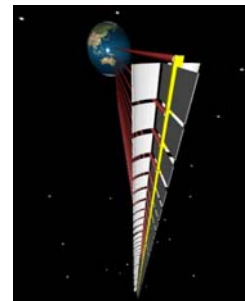


M-SPS



Laser based system (L-SPS)

- Direct Solar Pumping Laser
 - Highly concentrated solar energy excites laser generation within a laser medium such as Neodymium-doped yttrium aluminum garnet (Nd:YAG) crystal
 - Heat radiation is essential
- Cascaded system
 - Heat radiation
 - Easy to build
 - 200mX200mX100m X 100units



L-SPS

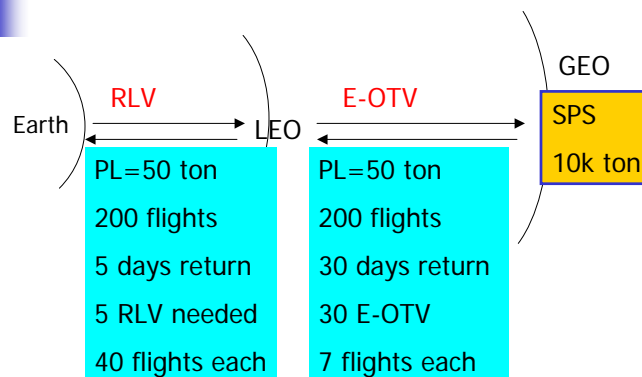
Needed Technologies

- Principal technologies
 - WPT (wireless Power Transmission)
 - Solar Pumping Laser

- Technologies for economical system
 - Ultra-Light Structure / Assembly by Robots
 - Low Cost Space Transportation systems
 - etc. etc.

- Space based energy in competitive price (0.08\$/kWh)

Cost model of SPS



Powerful & economical RLV & OTV are required.

Transportation cost must be far less than conventional vehicles.

Cost of SPS

- Development of SPS technologies - - - non recursive
 - WPT, Laser, Robot, etc., etc.
 - Technology demo + Proto-type SPS

- Development of Transportation system - - - non recursive
 - RLV(Earth – LEO), OTV(LEO-GEO)

- Transportation of SPS materials to space
 - Building RLV, OTV - - - - - partially recursive
 - Operating RLV, OTV - - - - - recursive

- Materials and assembly of SPS - - - - recursive

Cost Model of SPS

Develop SPS technology					
Develop RLV/OTV	?				
Build/operate RLV/OTV					
Build SPS					
Build 2nd SPS					
Build 2nd RLV/OTV & op.					
Build 3rd SPS					
Build 4 th SPS					

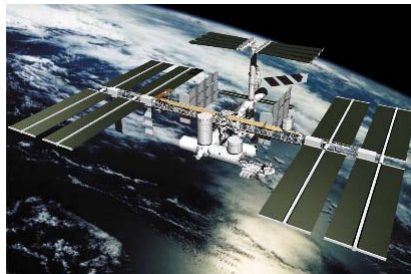
Who will develop RLV/OTV?

RLV, OTV

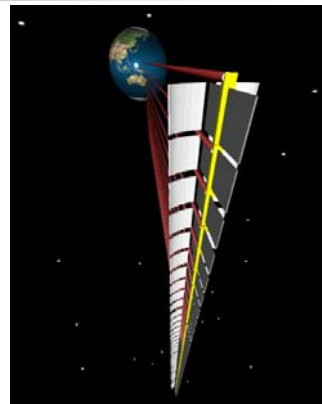
- Who can justify expense of developing heavy cargo carriers (RLV, OTV) ?
 - Are there cargo to carry ?
- Space tourism can only justify relatively small passenger carriers (manned RLV)
- Manned Mars exploration ?
- SPS can only justify RLV/OTV development cost ?

Robot

Building ultra-large space structure



- 110m X 75m
- By astronauts
- 10yrs

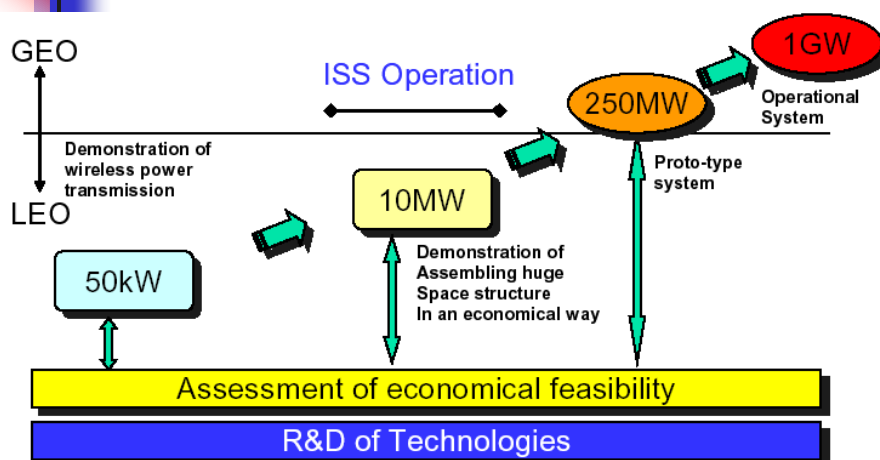


- 200m X 200m X 10km
- By robots
- 6 months ~ 1 year

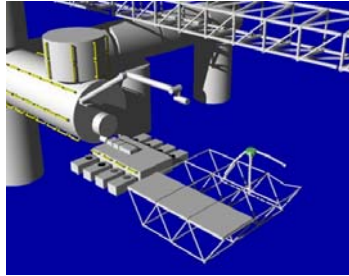
SPS roadmap of JAXA

- Stepwise development
 - Demonstration of WPT (Wireless Power Transmission) from space
 - Demonstration of solar pumping laser
 - Demonstration of building large space facility by robots
 - Demonstration of Proto-type SPS
 - Demonstration of Operational class SPS
 - Commercial launch & operation of SPS
- Realize above in 20 to 30 years

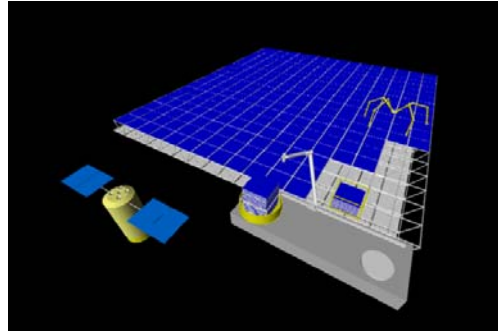
Roadmap of SPS (JAXA)



Robotic Assembly of Ultra-Light / Ultra-Large Space Facility, - Concepts of Technology Demonstration -



Technology development / demonstration on ISS/JEM
-Autonomous assembly
- Recovery from troubles



Assembly of a proto-type SPS by robots
- Supply of materials by unmanned carrier
- Autonomous robotic assembly