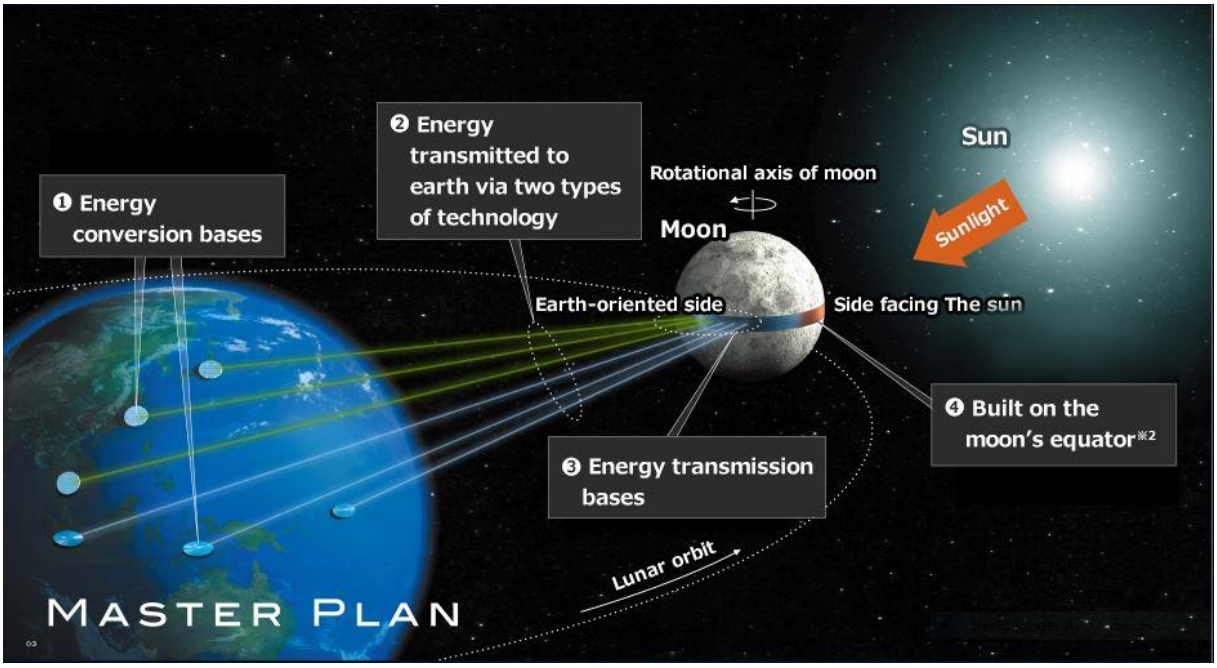
Solar energy from space

The solution to the energy question is drawing near - with a new fear of war

A technological breakthrough in energy supply is on the horizon:

Solar energy "captured" in space by satellites will be available around the clock in almost unlimited quantities, regardless of the weather - clean, sustainable and, after an initial phase, also very cost-effective, cheaper than today. The energy will be sent in the form of microwaves, harmless to humans and animals, to receiving antennas on earth (so-called rectennas). It will be the solution to our energy problems - and the beginning of a new nightmare. Environmental and security policy-makers urgently need to take a closer look at this prospect.



Source: Shimizu Corporation: https://www.shimz.co.jp/en/topics/dream/content02/

From Karl Marx comes the optimistic phrase: "Mankind sets itself no tasks for which it does not already have the means to solve." With regard to the problem of sustainable energy production, this seems to apply. Largely unobserved by the public, China, Russia, India, the USA and Japan have been working for a long time to collect the sun's energy not only on Earth, but already in space and then beam it back to Earth in concentrated form. Only the European states and the European Space Agency (ESA) seem to be sleeping through this "basic innovation". The consequence will be that the European economies will have to largely write off their investments in renewable energies (because they are no longer competitive). And they will have to pay high patent fees to the respective technology leader(s) if they want to participate in the new, economically superior technology. As if by a gigantic hoover, wealth will be drained from the countries lagging behind in technology. The first use of this innovation should be expected from 2027, at the latest from 2035.

The most advanced in space-based solar power generation (SbSP Space-based Solar Power; SSPS Space Solar Power System) seem to be the Japanese. After extensive preliminary scientific studies, they launched a $21 billion project in 2009 under the leadership of their space agency JAXA and the industry ministry METI.[1] The 16 largest Japanese industrial companies are involved, led by Mitsubishi Heavy Industries, the largest industrial conglomerate in the world. Since then, the Japanese have been working quietly on this project, as is generally their way. Rarely does one hear anything about the progress. The last available official news dates back to 2015, when it was reported that wireless energy transmission over short distances had succeeded. At the same time, JAXA published a roadmap for the further planned progress of the project, which holds out the prospect of the start of commercial use of space solar power for the year 2035. In my opinion, however, one should be on one's guard: "When you are close to the enemy, make him think you are far away" is one of the stratagems of the Chinese military theorist SunTzu. His work "The Art of War" is widely read and respected throughout Asia. In an official brochure also published in 2015, METI announced that Japan would completely cover its energy needs through the space project in 2050. Given the importance of this project and SunTzu's advice, it would not be surprising if the Japanese were "ready" sooner, estimated as early as 2027.

As I said, little has been heard or read about it from Nippon since then.

(The following sources confirm this assumption).

In 2014, I asked the economic department of the Japanese Consulate General in Hamburg about this. I had once done the consulate a favour, so they owed me a kindness. But never since then have I experienced a diplomat who was more embarrassed: "I simply don't get any information on this from my foreign ministry," my contact had to admit.

As a member of the CNSS Clausewitz Network for Strategic Studies e. V. at the German Armed Forces Command and Staff College, I got to know the Bundeswehr's Asia expert and the German military attachèe, who had previously served in Tokyo for ten years, at about the same time. Both had never heard of the Japanese space project and did not want to believe it when I asked them about it (as did the head of the Bundeswehr's Space Situation Centre, who mainly observes space debris). I asked the former two to use their "sources". A few weeks later we met again: "There is indeed something to it", they reported to me. Unfortunately, I do not have the impression that this has led to any activity.

The same goes for many other more or less influential personalities to whom I have since told about this issue. Even the former Federal Minister of Research, Prof. Dr. Horst Riesenhuber, doubted the existence of the Japanese space programme as well as the seriousness of other countries' efforts. At the time of our contact, Horst Riesenhuber was busy designing the ESA's new five-year programme. He promised me to keep an eye on the issue. However, this does not seem to have triggered any ESA projects: Among 623 searchable papers in ESA's Advanced Technologies Initiative (ACT), only one text is devoted to space solar power. According to a report in Forbes magazine, the ESA is now at least looking into the topic. However, only critical comments on the economic feasibility have come to light.

Why do I, an economist who is not involved in technical questions and who professionally deals with financial services, think I know something important that more competent experts doubt? The reason is: because I apparently once asked a real question (and as a former journalist I am well practised in asking questions). In 2011, I had the task of chairing the Hamburg Economic Council's "Growth and Innovation" commission. Where and how should the commission's deliberations on this "all-world topic" begin? I decided to start deductively with the major challenges. In addition to the topic of "demography", two other aspects therefore came particularly to my attention

The greatest geopolitical challenge in the 21st century is the protection or control of the Pacific sea lanes, which now account for the largest share of world trade.

2. new solutions to the energy problem are being sought intensively all over the world, because neither fossil combustion (CO2 pollution) nor nuclear power (radiation risk) nor terrestrial wind and solar power (lack of reliability) are viable technologies in the long term. With such great efforts, there should be a technological breakthrough somewhere in the foreseeable future - the only question is where or how?

A well-known fact helped with the answer: fundamental technological innovations are most likely to take place where military issues are also involved. Because that is where the big money flows.

And this is where the megatrends of energy and seafaring come together: warfare in general and naval warfare in particular are increasingly based on the use of satellites, of space technology. After all, you need an "eye" from above to even find the enemy fleet on a large ocean. So the keywords for an internet search were there: "space" and "energy". It's astonishing how many results you can find...

Another source confirmed my thoughts: The founder of the private strategy institute STRATFOR, George Friedman, published his long-term future projection "The Next 100 Years" in 2009. Already on the title page is the headline: "Space-based Energy Powers Earth".

While most essays speak of satellites with large "solar sails" in low-Earth orbit, the Japanese company Shimizu Corporation has a completely different vision: Shimizu wants to plaster the lunar equator with solar collectors; robots are to take care of the automatic maintenance of the system (which would otherwise be much more difficult with satellites). This LUNA RING, Shimizu claims, could generate thirteen times the amount of energy needed by the USA in one year. Shimizu is, if not the largest, then at least the most traditional construction company in Japan. The company built the imperial palace in Kyoto in the 19th century [2].

But since one hears so little about the Japanese - could it not be that they have quietly abandoned their project without success and do not talk about it so as not to "lose face"? Yes, that could be the case. But it is not likely because other nations are now pursuing the same project:

India and the American NSS National Space Society have been cooperating in a ten billion US dollar SSP project since 2013. This might explain the increased space ambitions of the relatively poor India.

After all, India is the country that is currently still most dependent on coal-fired power plants. There are reports that China has joined this programme.

The fact is, however, that China has started its own programme. The "Chongqing Collaborative Innovation Research Institute for Civil-Military Integration" is in charge. Experts confirm that China has a long-term plan and that "serious institutions" are working on it.

Russia is said to be following the issue closely.

At times, the Russians may have wanted to join other nations....

In the USA, NASA had already devoted itself to space energy 30 years ago, but in the meantime put the projects on ice again due to the supposed lack of feasibility. It was private companies that first ventured into this field. The Californian energy company PG&E Pacific Gas & Electric made a grandiose announcement that it would supply the first solar power from space as early as 2016. To this end, it concluded a supply contract with the private company SolarenSpace Inc. Apparently, however, SolarenSpace was unable to raise enough venture capital to move forward on the timeline as planned. However, SolarenSpace has not given up on its project and now has numerous patents of its own that are valid worldwide. There is partial research cooperation with the Scottish University of Glasgow.

The US government has also been supporting research in this field again for some time. The driving force is the US Navy, which wants to "refuel" its aircraft carriers directly with solar energy irradiation on the ocean. The U.S. Naval Research Laboratory has entered into project research on this. And the renowned CalTech, the Californian technical university, recently received 178 million US dollars for this. As a project of the US Navy Research Laboratory (NRL), the first SSP test application on a satellite was launched into orbit on 17 May 2020.

For a long time now, it has not only been the thought of energy supply that drives all these projects and the race to their success. For besides transmission by harmless microwaves, there is a second way to beam sunlight to Earth: by concentrated laser light. And this enables the construction of a ray gun, as we know it from the James Bond film "The Man with the Golden Gun".

Oh, dear reader, now you think Leander Hollweg has finally landed in the realm of fairy tales and science fiction, right?

Wrong.

There is the US patent US9346563B1. This patent dates back to 2013 and describes the construction of a satellite-based beam weapon. The US Patent Office has specifically registered this design as a "weapon of mass destruction".

Patent US20100276547A describes the construction of a satellite system for energy generation. The patent holder is "Lawrence Livermore National Security LLC", which is commissioned and supervised by the "National Nuclear Security Administration".

Unlike nuclear weapons, such a technology would allow devastating point-precise deployment with spatially and temporally limited effect. Wars would become winnable again and - in the eyes of their protagonists - winnable again. "It is always the same," writes military historian Margaret Atwood: "Wars happen because those who start them believe they can win them." Already, the build-up of a "space army" announced by the US and, more recently, France, takes on an understandable rationality.

And that is why the solution of the energy question is at the same time the beginning of a new nightmare.

Which company or nation will have this technology? And above all: who will be the first to have it? This will cause a fundamental shift in the global security architecture.

If it is the Japanese: will they stick to the alliance imposed by the Americans after 1945? Probably not. Japan is not a "Western" country. Japan has long wanted to be "ichi ban", the "number one" in the world - as actually all Asians want to be. Today, they still need the protection of the USA against a blockade of their shipping lanes, against the threat from North Korea and against Chinese ambitions at sea. After all, despite the country's decades-long pacifist constitution (there has been a recent relaxation), Japan has the strongest navy after the US. Possession of superior power generation technology and a space-based radiation weapon would make the country economically and militarily independent. If I were a Japanese politician, I would do everything, just EVERYTHING, to realise this vision.

Incidentally, in an essay on the occasion of the opening of the JDZB Japanese German Centre Berlin, I already mentioned in 1985 that Japan will invent new weapons systems in the not too distant future.

On 18 May 2020, the Japanese Ministry of Defence announced the establishment of a "Space Operations Squadron" as part of the Japanese Self-Defence Air Force.

So what does it depend on whether these bold plans will become reality? According to numerous experts, it is no longer a question of whether carrierless energy transmission will succeed over long distances. That is apparently the assumption. More critical is the economic question: at what cost can the necessary equipment be transported into space? So far, the calculations say: too expensive,

the resulting electricity price will be higher than on the current technology basis. But are solutions emerging for this as well? And could Germany contribute something substantial to this solution?

If the answer is YES, we would have a trump card with which we could enter the big game, for example in cooperation with the Japanese, who are traditionally well-disposed towards Germany.

There are astonishing findings on this question as well.

These findings are now (= since 25.06.2020) published under the new navigation point "Space".

Leander L. Hollweg, Berlin, 19 January/ 12 June 2020

P.S.: I would like to add to the idea that, in the end, the realisation of a strategically significant weapons technology does not necessarily depend on the costs. Unless these costs are "astronomically high", military decision-makers

military decision-makers are unlikely to shy away from the effort and are happy to take the economic potential of energy production as a "contribution margin". Berlin, 11 June 2020

P.P.S.: The sources on which the statements in this text are based are extensive. Due to time constraints, I can only post them on my website step by step. In this respect, too, I ask the reader(s) to return from time to time to the website, which is still under construction.

1] The project has been officially announced by the government. The news agency Bloomberg has reported on it. You can find this news in the sources.

[2] Shimizu provides a detailed description of his vision with vivid graphics on the internet. The link to it can be found here.

Dr David Criswell, former Director of the Institute for Space Systems Operations at the University of Houston, who died in September 2019, presented a technical study on the establishment of an SSP (LSP Lunar Space Power) moon base to the 17th and 18th World Energy Council Congresses back in 1998 and 2001. He estimated at the time that a 1-gigawatt demonstration lunar solar power generation system could be built over a 10-year period for about $60 billion. (By comparison, the 1.65 GW Benban solar farm in Egypt cost $4 billion in 2019; however, the power delivered by Benban is 430 MW, while the 1 GW demonstration delivers a full 1 GW).

Sources for the statements made in the essay "Solar power from space":

Japan

The original news story published by the Bloomberg agency on the launch for the Japanese Space-based Solar Power System in 2009.

The Japanese space agency JAXA's 2014 roadmap for realising the solar power project read here:

Around the same time (April 2014), the Japanese "Professor Emeritus of Space Research", Susumu Sasaki, gave an explanatory outlook on the challenges to be overcome in the course of the roadmap in the journal SPECTRUM of the International Engineering Society IEEE. You can read this outlook here.

A year later, in March 2015, JAXA and Mitsubishi reported that, for the first time, 10 KW was transmitted with pinpoint accuracy over a distance of 500 metres on a receiving antenna. The publication was again in the IEEE journal and can be read here.

The Japanese government likes to publish information about the prospects associated with new technologies for Nippon. Here I present an official METI brochure with visions for the year 2050.

Jaxa has become more informative in the meantime, as I could see recently when looking at their website. The state of research is documented here with numerous keywords and a FAQ catalogue.

Question 1 (Q1) is particularly interesting:

"Q1: When do you think we will be able to see the SSPS operating in space?

A1: We had so far proposed the development of a 1-GW (1-million kW) SSPS by the 2030s. We will update the development scenarios and technology roadmaps based on research results and recommendations from outside experts of the SSPS Economic Feasibility Committee and SSPS Technical Committee.

In addition to the 1-GW SSPS, we are also making concepts of a small SSPS system that may be deployable sooner, as well as immediately available practical applications of the technologies developed for the SSPS."

The IISS International Institute of Strategic Studies in London hosted a webinar on "Japan`s Grand Strategy in the Reiwa Era" on 18 June 2020. The expert and discussion partner was Kanehara Nobukatsu, a long-time senior government official. He spoke eloquently about Japan`s short- and medium-term intentions. But although he spoke of an urgent need for action in the ten to twenty year perspective with regard to the rise of China, he left Japan's strategic plans for this time horizon completely in the dark. Robert Ward, the Japan expert at the IISS, whom I approached about this

"critical gap", concluded: "The Japanese have no long-term strategy. They are just as pragmatic and short-term in their approach as other nations."

In my view, this is precisely what denotes the blind spot of European thinking: Because WE think and act so short-term, other nations would supposedly do the same.

United Arab Emirates - hand in hand with Japan

Few will have the VAR in mind as a "space nation". The fact is, however, that the VAR founded the Emirates Institution for Advanced Science and Technology (EIAST) in 2006 and launched its own satellite in 2009 with help from South Korea (Assembly) and Russia (Launch). Since 2018, the UAR have been able to manufacture satellites themselves. The EIAST became the Mohammed bin Rashid Space Centre (MBRSC).

From then on, things progressed in rapid steps: in 2019, the first VAR astronaut reached the International Space Station (ISS). On 14 July 2020, the VAR will launch their Mars mission "HOPE", which will explore the climate on the red planet. By 2117, the VAR want to establish a permanent habitat on Mars.

In their space plans, the Arabs have help from Japan, which is still heavily dependent on oil supplies from the VAR. To consolidate supply security, Japan offered VAR extensive space cooperation in 2015. At the Oil & Gas Expo in November 2015, Japan set up a pavilion that presented Japan's space visions including "Space Solar Power". A graphic presented there shows not only SSP satellites, but also the lunar base "Lunar Ring". It is the first evidence I know of so far that Japan has included the Lunar Ring vision in official government planning. The image element used for this in the graphic comes from the Shimizu presentation. The Japanese Dentsu Group reports in an (undated) background report: "Following on from this, to coincide with the World Future Energy Summit 2016 in January, several diplomatic events were organised by Japan's Office of National Space Policy, Cabinet Office; the Embassy of Japan in the UAE; the Japan Aerospace Exploration Agency (JAXA); and the UAE Space Agency. These included a Japan-UAE space symposium and a space cooperation conference. Such efforts were a step towards advancing the relationship between the UAE and Japan, through cooperation in space industries." The VAR Mars rocket lifts off from Japan's Tanegashima Space Center.

In February 2019, the VAR also agreed to a closer space partnership with Australia. The International Astronautical Congress, the world's largest space business event, will be held in the VAR in 2021.

Private companies from the VAR have started systematically buying up SSP patents.

India: Cooperation with the American NSS

Since 2013, the Indian government has been collaborating with the NSS National Space Society of the US in a space solar power project, initially funded to the tune of USD 10 billion. Read this.

India has so far relied more heavily on fossil fuel combustion than most countries. An alleged mission to Mars by Indians has puzzled outside observers: what does such a poor country want on Mars? Isn't it more plausible that Indian space activities are meant to solve the energy problem?

The National Space Society is an American international nonprofit 501 educational and scientific organisation specializing in space advocacy. It is a member of the Independent Charities of America Campaign. Founder: Wernher von Braun

Founded: 1987

State SSPS activities in the USA

In the USA, research has been underway since the 1970s to capture the sun's energy in space and radiate it to Earth. The last technically feasible solutions were conceived in a NASA research project from 1999 to 2004, but they could not be implemented for economic reasons.

After a good ten years of research standstill, government interest in this topic is now very lively. Renowned experts are pushing to make it a national priority. Not least the US Navy sees promising application possibilities and is again allocating considerable research funds to it.

The satellite launch of the first SSP test application was reported in the official US Navy News on 18 May 2020. It is not yet an actual test of remote power transmission, but a functional test of core technical elements under space conditions, as reported by the SpaceNews information service. In addition to the NRL, the following institutions are involved in the project:

Operational Energy Capability Improvement Fund in the Office of the Under Secretary of Defense for Research and Engineering,

the Department of the Air Force Rapid Capabilities Office,

the Department of Defense Space Test Program,

Boeing,

TSC Practice Operations,

Gulfview Research,

Odin Engineering,

SpaceQuest.

THE AMERICAN SSP-TEST WAS SUCCESSFUL. This was reported by the CNN news channel and the British newspaper The Independent at the end of February 2021. The source is a research report published in January 2021 in the IEEE Journal of Microwaves, in which five US researchers and a

Japanese scientist were involved. Apparently, energy transfer in the form of microwaves did take place during the test. The report notes that the results of the test flight are only preliminary, but nevertheless encouraging.

Among other things, the paper reports another successful Japanese SSP experiment in May 2019. As a result, the corresponding METI committee began developing a "sandwich structure with microwave phased array and solar cells", which is to be completed in 2024.

The report is, to my knowledge, the most comprehensive and detailed account of the technological status of SSP research to date. The paper summarises the findings as follows:

"The current acceleration in microwave and mmWave power beaming activity portends a new wave of innovations and progress, enabling major opportunities in civil power distribution and baseline alternative energy, as well as new architectures for military basing ... Research investments in space assembly and maintenance, deployable structures, thermal management, solar energy conversion, power management, and phased array control ... should lead to progressively increasing system capabilities, motivating the larger society to incrementally resolve economic, legal, and political challenges to widespread, large-scale adoption of this technology."

This source is also significant from my point of view because there is a worldwide scientific organisation for microwave research. A German scientist working at the KIT Karlsruhe Institute of Technology (University of Karlsruhe) has a leading position in this microwave organisation. I was able to ask him by phone in 2019 whether he thought the remote transmission of energy from space was physically feasible. The answer was an emphatic no, because this would allegedly be opposed by fundamental physical problems of heat conversion. The successful US test, on the other hand, arguably proves that the problem has been solved. The test thus also proves how far away German scientists are from knowledge of this new technology.

In my text I mention two important US patents. Here are the direct links to them:

- Space Solar Power Satellite System

- Space Solar Laser Power Weapon of Mass Destruction

China

According to a report in the renowned US journal "Nature", China wants to solve the economic problem of space transport costs by producing the essential components in 3D printers and thus making them considerably lighter. To this end, a test facility has been built in Chonquin, Bihan District. According to Forbes magazine, citing Chinese sources, the initial investment of USD 15 million is still small, however. While "Nature" sees the Chinese as successful space energy producers between 2021 and 2025, "Forbes" speaks of a perspective until 2050.

Australia

Australia entered the race for space energy in autumn 2019. To this end, a US-Australian joint venture was established, SST Solar Space Technologies. The company still appears to be a partnership looking for investors, but it stands out for its founder: former NASA physicist John Mankins is effectively the father of all space solar energy visions. Australia sees itself primarily in competition with China and wants to form an alliance with the other Pacific Rim countries Japan, New Zealand and Canada.

Incidentally, reference should be made to the partnership agreement signed in February 2019 between the Australian Space Agency (ASA) and the VAR.

Europe

The report "Future of the European Space Sector" prepared in 2019 by the EU Commission and the European Investitonsbank mentions "Solar Space Power" as one of several possible applications of space technology" as a small box within an overview chart. There, however, this technology is classified as a long-term project and no further attention is paid to it in the following document of about 140 pages.

In general, the report laments the lack of private funding opportunities for space projects and start-ups. Within the framework of the budget period 2021 to 2027, the EU Commission plans to spend around 16 billion euros on government space activities. However, no significant expenditures for SSP projects appear in it.

In December 2021, however, the tide turned. Based on initiatives from the British government, the European Space Agengy (ESA) finally woke up. It held a major international SSP congress and commissioned two feasibility studies in March 2022. Meanwhile, in London, the Space Energy Initiative was formed. A summary and commentary of these activities can be read on my personal Linkedin-account.