WIRELESS POWER TRANSMISSION VIA LASER

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Introduction:

There are many methods of wireless power transmission. In this article, we consider the method of energy transmission (heat or electricity) from one location to another, using a laser beam. The basic concept is the same as solar energy, where the sun shines on a photovoltaic cell that converts sunlight into energy. In the same way, the photovoltaic cell converts the laser light into energy. The main differences are that the laser light is more intense than the sun, so it can be directed in any desired position with high accuracy. Energy can be transmitted through the air or space or via optical fibers in the same manner as the communication signals are transmitted nowadays, so it could be potentially sent even to other planets, such as onto the Mars. The main advantages of the wireless power transmission include:

- Narrow beam provides a large concentration of energy over the long distances;
- Receiver' compact size makes it easily to be integrated into any small device\casing;
- No interference from other sources (e.g., Wi-Fi or cellular system);
- The laser power can be used for previously uneconomical or impractical applications.

For example for in-flight refueling of unmanned aerial vehicles and other aircraft vessels;

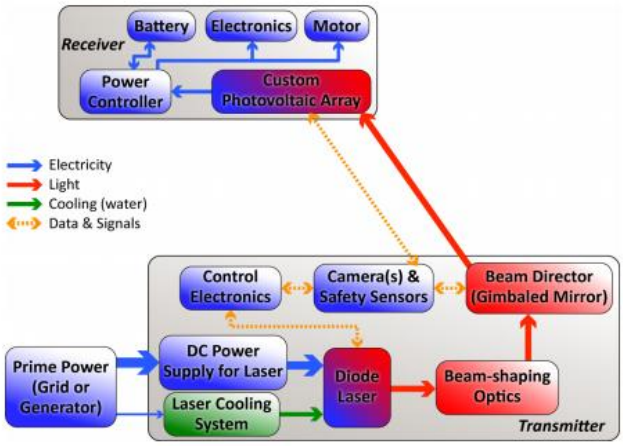
- Any power source could be used for the laser operation.
- Energy can be transferred via free space or through optical fiber

Main disadvantages:

- Low efficiency - approx. 30%.
- The inverse transforminto electricity is inefficient with photovoltaic cells achieving 40% -50% efficiency.
- Atmospheric absorption leads to losses.

The main problems and their solutions:

Empirically it has been proved that all lasers can be used to transfer energy. However not all of them are efficient. At this stage of development the transmission efficiency technology is about 30%. The conditions specifically applied for the lasers selection involve limitations related to the lasing process efficiency, the absorption efficiency and laser-electric conversion process.



Especially for direct generation of a photons beam, there are several types of materials suitable as the laser medium. Studies have shown that from the standpoint of resistance to thermal stress, the sapphire is the best material for laser among other materials. As large sapphire crystals are very difficult to produce, most concepts rely on the other crystals usage. In the end, the required energy density is several times smaller compared with the energy density, which is necessary for a more efficient transmission. Application of laser in space or from space to the Earth adds additional difficulties in the energy transfer:

The laser system use for the mass generation.

• High temperature requirements of the laser generation (high temperatures are preferable in order to ensure low mass discharge radiation);

• High quality beam, to avoid using the lenses and reach the small receiving surface;

• Control phase.

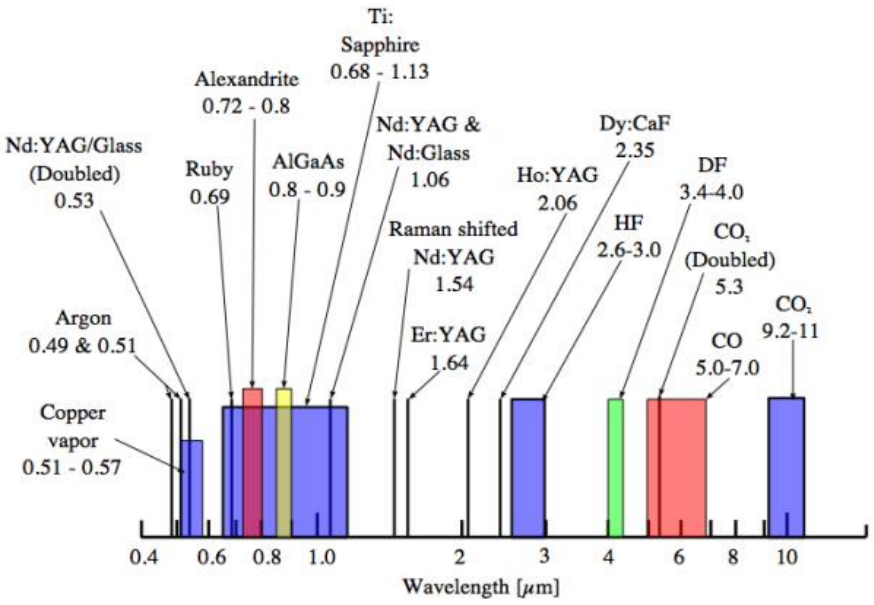


Fig1: spectral output of several types of lasers.

Laser different types compliance analysis has shown that the visible frequencies range, diode lasers are considered as the most promising lasers. At present, the scientists have achieved high level of power to kW and overcame some of the limitations of capacity due to the thermal gradients reduction in the material. In General, these lasers rely on a laser diode or materials, such as ND: YAG(neodymium-doped yttrium aluminium garnet; Nd:Y3Al5O12). Currently the laser diode is the most effective laser, up to 80% of the plug-in efficiency and the waves of light emitted in the range 795-850 nm.

Table. 1 Compare methods of energy transfer.

Technology	**Range**	**Directivity**	**Frequency**
Inductive coupling	Short	Low	Hz - MHz
Resonant inductive coupling	Mid-	Low	MHz - GHz
Capacitive coupling	Short	Low	kHz - MHz
Magneto dynamic	Short	Low	Hz
Microwaves	Long	High	GHz
Laser	Long	High	≥THz

However, the main problem is the thermal control of such diodes, namely panels to maintain optical coherence. In most cases, solid-state laser is manufactured on the basis of the crystal technology (ND:yag laser, ND:y2o3 at the temperature of liquid nitrogen, Ruby, etc). These lasers use optical pumping in the visible range. The use of ND:yag laser (1.064 μm) technology is the most widely applicable that part increases the efficiency of the laser. Overall system efficiency of diode pumped laser about 15%.

Conclusion:

The laser energy transfer from is one of the most energy transfer promising methods over long distances. However, the laser energy transfer systemsare still considered as less popular than the microwaves.

Among the most important challenges for this technology development for industrial applications in space are the thermal control, that is a key to large-scale laser power. Energy concentrations and the lasing efficiency require the removal of the significant amount of heat. Therefore, the material for the laser should be chosen in such a way as to balance the frequency, temperature, efficiency and modularity and stability requirements of space-based direct solar pumped laser.

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MIND MAPPING

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Visual images are one of the forms of communication, which play a vital role in ideas and material presentation. It is well-known that about 80 % of all information is perceived by a man by means of eyesight. Visual data and facts are perceived by a man better than any other types of information. One appropriate image can replace more than 100 words. Unique and original image can attract the attention of a large amount of audience.

There are various forms of information visualization ranging from simple tables to rather sophisticated mind maps used nowadays to deliver all necessary ideas clearly and efficiently. Each of the visual forms is used for certain purposes and has its advantages and disadvantages. Before using a certain way of information visualization it is necessary to analyze whether this kind of visualization will allow to simplify and intensify the perception or not. One of the most efficient ways to visualize and present information is a mind map. The use of mind maps facilitates to the development of critical thinking, organization skills (planning) and is a good mean for studying and projects.

The given paper is concerned with the application of mind maps. Moreover it considers the main rules to be followed when creating mind maps and shows the differences of mind maps from other forms of information presentation.

Visual images can be used in presentation, reports, books, articles and etc. They can be used to support some information or can be used separately from the text.

Term "mind map" was first popularized by British popular psychology author and television personality Tony Buzan and has become very popular among teachers, lectures, students, engineers and etc. However, the use of diagrams for visual "mapping" information using branching and radial maps traces back centuries.

A mind map is a diagram often created around a single concept used to visually organize information. An image is drawn in the center of a blank page, to which associated representations of ideas such as pictures, words and phrases are added. Major ideas are connected directly to the central concept, and other ideas branch out from those. There is a good idea to organize information as "rough notes" drawn by hand during a lecture, meeting or planning sessions. In some books, newspapers and magazines mind maps are organized as higher quality pictures.