Ray Beach (00:14):

Greetings. My name is Ray Beach, and I serve as the principal technologist for power and energy storage, and the space technology mission director at STMD. I will be addressing technologies associated with advanced power systems. I will start with a brief discussion of the thrust areas contained within the STMD strategic plan, a quick synopsis of power systems of interest, and an overview of the technology areas of interest for advanced power systems, including gaps in specific areas that need technology development for power generation, power management and distribution, PMED, and energy storage.

The space technology mission directorate at NASA headquarters has established a strategic technology plan, which includes the advanced power systems addressed here, and all other technical areas that support the science mission directorate in human exploration and operation mission directorate architectures. Four primary thrust areas have been defined to decompose and capture all technical areas needed to support the mission architectures and includes go, land, live, and explore. Within each of these thrust areas, there are power technology gaps associated with mission applications, as will be seen in subsequent slides.

NASA heritage power systems can be broken down into three major system types, solar power systems involving photovoltaics, energy storage, and power management and distributions such as the international space station are the most prolific type. Nuclear power systems using radio isotope power sources have flown on many NASA emissions. And fission reactors are under development, providing significant increased power generation with PMAD systems to enable control and distribution. Ancillary power systems provide the third type, and includes rovers, suits, landers with fuel cells, batteries, and PMAD elements. Each of these power system types are included in the following slides, which will provide a technology gap identification, cross reference with mission applications for power generation, power management and distribution, and energy storage for each of the thrust areas. So as you look at this table, you see down the column on the left that we again have decomposed the areas into the go, land, live, and explore thrust areas.

There is a mission identified in each of those areas associated with a power generation technology area of interest. And as you look at the power levels, again going down on the left column, you'll see various size power systems associated with power generation for each of those missions. Again, as you look across on the top row, you'll see that we have identified power levels again, as well as the different types of power generation sources. So you can see radio, isotope power supplies, fission, solar photovoltaic, and solar concentrators, primary batteries, as well as primary fuel cells. So if you look at the bottom of the chart, we have identified associated with green, yellow, and red areas that are of primary interest in terms of technology gaps that need to be closed in the power generation area in order to mount the mission. So what I'd like to do today is just to identify some of those.

So if I look at the human Mars nuclear electric propulsion in the go area, you can see that the power type is greater than one megawatt. And if you go across, you can see that in the fission area associated with that one megawatt system, we have a red box indicating that there is significant technology development that needs to occur. If you go into the land thrust area and you look at lunar clips, class missions, you'll see at the less than five kilowatt level and in the solar photovoltaic column associated with power generation, it's green indicating that we have most of those technologies well in hand in order to mount the mission. If you do again the same thing for the live thrust area, and you look at the lunar [inaudible 00:06:03], you'll see that in both the fission power generation area as well as the solar photovoltaic power generation, the columns, the boxes indicate yellow, indicating that there is still significant work, even though we have work underway to be able to mount those missions.

And if you go then to the explore area, again under the mission area, if you look at science probes, in this particular case, Jupiter, you could see it's a one kilowatt mission. And if you go all the way over to the far column associated with the chips technology, which is combined heat and integrated power, you'll see again a red box indicating significant work to be able to mount that mission. So this is a continuation again of the same information in the strategic technology development plan, but now associated with the area of power management and distribution technologies. So, again, the column on the left shows the different thrust areas, the different power levels associated with those missions. And then across the top, this has changed a little bit from the first slide. So although we still have power shown, we also include voltage levels associated with this category because of the need for different technologies in PMAD versus the power generation.

Again, just as for the earlier slides, we have used the same identification in terms of green, yellow, and red associated with technology areas that need to be worked in order to be able to mount the missions identified down the left hand column. So this is the third area, as indicated earlier, associated with energy storage technologies areas that need to be worked. Again, as the previous two slides, go, land, live, and explore, thrust areas are broken down along with the mission power levels.

And if you look across the top again, as with the PMAD area, it's changed slightly, and that now we are talking about energy storage. So we've defined the energy storage area, not the power as we had done earlier, but the total amount of energy storage needed. And just as with the previous slides, the green, yellow, and red areas indicate the areas that we will need to work again in order to be able to close for each of these mission architecture types. Thank you for your interest in advanced power systems. And I hope this will of help in understanding the technology gaps and NASA challenge needs for future space power systems.