

Federal Legislation to Jumpstart Space Solar Power

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The United States is transitioning from a primary reliance on fossil fuels to greater use of sustainable natural and nuclear energy sources. There are two reasons for this transition. The first reason is that the abnormally high and increasing level of atmospheric carbon dioxide has created scientific uncertainty and concern as to the detrimental impact this may have on the environment and, consequentially, human civilization. Almost certainly, this abnormal level is due to anthropogenic causes linked to the tremendous expansion in the human population since the early 1700s, the growth of human civilization (e.g., agriculture and industrialization), and the increasing use of fossil fuels. Although fossil fuels have enabled worldwide progress in elevating the standard of living, most of the world's nations have reached the conclusion that the world should transition entirely to sustainable energy by 2100 (see [“The Paris climate agreement and space solar power”](#), The Space Review, February 29, 2016). It is, however, very important to manage this transition carefully to avoid economic hardship or energy deprivation.

While the United States has large remaining fossil fuel resources, only some are technically recoverable with current safe, legal, and profitable extraction methods. The remaining known and yet-to-be-discovered domestic technically recoverable fossil fuels are inadequate to sustain US fossil fuel energy needs to the end of this century, especially given likely continued immigration-driven US population growth (see [“US fossil fuel energy insecurity and space solar power”](#), The Space Review, March 7, 2016). While the United States has an ethical environmental obligation to end its use of fossil fuels by the end of the century, the reality of having inadequate oil and natural gas resources makes the urgency of transitioning successfully to new sustainable energy sources a clear matter of national energy security. This warrants federal government leadership and strong American private sector engagement.

Congress must now respond proactively, through enabling legislation, to chart America's path forward to transition from fossil fuels to predominantly space-based sustainable energy by the end of this century.

Unfortunately, due to its large and growing population and per capita energy needs, the United States lacks sufficient suitable land to utilize terrestrial renewable energy to replace fossil fuels. (see [“US terrestrial non-fossil fuel energy vs. space solar power”](#), The Space Review, March 14, 2016). While the United States will utilize terrestrial domestic renewable energy to the extent it is politically acceptable, many factors will likely limit their scale-up. The expansion of nuclear fission energy is also not a satisfactory approach, given the large number of reactors needed. These factors lead to the conclusion that only space-based sustainable energy, such as space solar power, will enable the United States to practically transition away from fossil fuels.

The economic effort to transition to space-based energy will be substantial, perhaps requiring five to ten percent of the US gross domestic product for the remainder of this century. Three new large American industries must be established: space-based sustainable energy production and delivery, space mining, and spacefaring logistics. The combination of scale of effort and criticality of success indicates that carefully structured public-private partnerships provide the best approach. With this in mind, Congress must now respond proactively, through enabling legislation, to chart America’s path forward to transition from fossil fuels to predominantly space-based sustainable energy by the end of this century. What follows is an initial draft of authorizing legislation establishing these three new American spacefaring industries and identifying associated activities by other departments and agencies.

The United States Space-based Sustainable Energy Security Act

Goal

To ensure national energy security in the post-fossil fuel age, the United States shall establish commercial space-based energy, space mining, and spacefaring logistics industries to provide the United States, and its allies and favored trading partners, with space-based sustainable energy.

Specific Objectives

1. Establish an American space-based sustainable energy industry capable of providing the majority of US energy needs from space by 2100.
2. Establish an American commercial human spacefaring logistics industry capable of supporting the development, production, and operation of space-based energy systems and space mining capabilities.

3. Establish an American commercial space mining industry capable of providing extraterrestrial resources to support the operations of the space-based energy industry and the spacefaring logistics capabilities.
4. Provide for commercial airworthiness-certified passenger and crew spaceflight to, from, and within the central solar system. Spaceflight includes occupation of permanent human habitats in space as well as transport on spaceships and transatmospheric vehicles.
5. Reinvigorate national scholastic interest by America's youth in science, mathematics, engineering, technology, manufacturing, and spacefaring entrepreneurship as the United States becomes a true commercial human spacefaring nation.
6. Encourage American research, innovation, invention, intellectual property, and new business formation related to the above.

Department of Space

The president shall create and organize a cabinet-level Department of Space having overall responsibility for the first four goals above. To emphasize the commercial focus for achieving these four goals, the following three Federal Government Corporations (FGC) shall be created with the primary functions listed below.

1. A Space Energy Federal Government Corporation (FGC) shall be established to plan, organize, and initiate a competitive United States commercial space-based sustainable energy industry. The president shall appoint, subject to Senate approval, the FGC's chairman, president, chief engineer, and five-member Board of Directors. The chief engineer shall be a registered professional engineer and shall have overall technical approval authority for the space-based sustainable energy system. The president and chief engineer shall be medically capable of spaceflight. The Space Energy FGC shall, within six months, provide Congress the initial plan and critical path timeline to achieve United States non-fossil fuel energy security by 2100 using primarily space-based sustainable energy. Consistent with the initial nature of this submittal, the plan and timeline shall include:
 - a. Estimate of the type and scale of space-based energy capabilities needed consistent with expected United States population growth through 2100 while maintaining US per capita energy consumption in 2100 equal to today.
 - b. The functional and physical architectures to be considered for establishing the space-based energy systems.
 - c. The critical path to achieve the first commercial space energy capability.
 - d. The public-private partnerships and key contracts likely to be implemented.
 - e. Estimate of the types and scale of space mining and spacefaring logistics operations needed to implement the roadmap and timeline.
 - f. Assessment of the readiness of US companies to undertake the initial roadmap and timeline objectives.

- k. Utilization of existing and planned US expendable launch vehicles for payload delivery to support the rapid establishment of on-orbit logistics capabilities in LEO.
 - l. Likely Federal Government incentives to encourage broad commercial participation throughout the many States with special emphasis on the nationwide creation of many new small and medium businesses.
 - m. Possible new legislation, regulations, and treaties required to efficiently and effectively implement its responsibilities.
 - n. Estimate of federal expenditures required over the next ten fiscal years to undertake the above.
3. A Space Mining FGC shall be established to plan, organize, and initiate a competitive United States commercial space mining industry. The president shall appoint, subject to Senate approval, the FGC's chairman, president, chief engineer, and five-member Board of Directors. The chief engineer shall be a registered professional engineer and shall have overall technical approval authority for the space mining system. The president and chief engineer shall be medically capable of spaceflight. This Space Mining FGC shall, within six months, provide Congress the initial plan and critical path timeline to establish a commercial space mining industry responsive to the extraterrestrial resource needs identified by the other two FGCs. Consistent with the initial nature of this submittal, the plan and timeline shall include:
- a. The initial extraterrestrial resources needed and where these will be obtained.
 - b. The functional and physical architectures for establishing the initial integrated commercial space mining industry.
 - c. Pathfinder missions to develop and demonstrate key enabling technologies and capabilities.
 - d. Assessment of the readiness of US companies to undertake the initial roadmap and timeline objectives.
 - e. The public-private partnerships and key contracts likely to be implemented.
 - f. The space energy and spacefaring logistics capabilities needed.
 - g. Likely Federal Government incentives to encourage broad commercial participation throughout the many States with special emphasis on the nationwide creation of many new small and medium businesses.
 - h. Possible new legislation, regulations, and treaties required to efficiently and effectively implement its responsibilities.
 - i. Estimate of federal expenditures required for the next ten fiscal years to undertake the above.

The Department of Space shall oversee and inspect the three FGCs to ensure the effective and efficient accomplishment of their responsibilities. The Department shall provide systems architecting guidance to the three FGCs. The Department shall coordinate with other departments and agencies and shall respond to Congress on their behalf.

Passenger Spaceflight

Passenger spaceflight supporting the operational missions of the above three FGCs shall be done only on airworthiness-certified spaceflight systems. Employees of the FGCs, its contractors, NASA, the US Space Guard, and space construction companies may use non-airworthiness-certified spaceflight systems, such as the Orion system or commercial counterparts, until such time as the airworthiness-certified replacements become available. For these exceptional circumstances, all spaceflight participants shall meet and abide by current federal non-passenger spaceflight participant requirements.

Satellite Launch

Until approved by Congress, the capabilities of the Spacefaring Logistics FGC shall only be used for the launch of satellites or payloads directly supporting the missions of these three FGCs or the US Space Guard.

US Space Guard

Under the initial command of the United States Coast Guard, a US Space Guard shall be established to extend the role and mission of the Coast Guard to outer space to support US governmental and commercial human spacefaring operations. Operational capabilities shall be provided and supported through the Spacefaring Logistics FGC. The US Coast Guard shall, within six months, provide an initial plan and timeline to Congress for the establishment of the US Space Guard and identification of its operational command structure.

Role of NASA

The National Aeronautics and Space Administration (NASA) shall continue to lead US Government efforts in space science, space technology research and development, and the robotic and human exploration of space. However, as the new integrated commercial spacefaring logistics infrastructure becomes operational, NASA shall utilize this infrastructure to meet its transportation and logistics support needs.

NASA scientists and research engineers will provide non-resident expertise to the three FGCs.

In cooperation with the Spacefaring Logistics and Space Mining FGCs, the Orion Spacecraft system may be used to conduct initial human space resource survey missions and to establish initial Earth orbit, lunar orbit, and Lagrangian logistics capabilities.

NASA and its contractors shall continue to develop and operate the Space Launch System, developing versions of this system to support the Spacefaring Logistics FGC's unmanned launch needs and on-orbit reuse needs.

NASA and its contractors shall provide the primary chemical rocket engine and advanced non-nuclear space propulsion development support to meet the needs of the Spacefaring Logistics FGC.

NASA will provide advice and consultation to the three FGCs and other government organizations regarding prior research into space solar power and its use.

Until such time as suitable commercial capabilities are available through the Spacefaring Logistics FGC, NASA shall continue to train all government and commercial astronauts travelling to orbital space, for other than tourist visits, to ensure a uniform standard of training. Thereafter, NASA shall remain responsible for US government astronaut training for non-standard space missions such as lunar and Mars exploration.

At this time, NASA shall remain the primary federal agency responsible for asteroid detection and defense. NASA will consult with the Space Mining FGC regarding the establishment of safety protocols for the conduct of space mining.

NASA shall, within six months, provide an initial plan to Congress for establishing a robust permanent lunar scientific settlement and an initial human exploration mission to Mars taking full advantage of the commercial spacefaring logistics infrastructure and space power capabilities provided by the Space Energy, Spacefaring Logistics, and Space Mining FGCs.

Role of the Department of Defense

The Department of Defense (DOD) shall be responsible for the defense and protection of the new commercial spacefaring capabilities from hostile threats. Within six months, the Department shall provide an initial plan to Congress on how this will be undertaken.

The DOD shall, within six months, provide Congress with an assessment of using elements of the planned spacefaring logistics capabilities to establish a Civil Reserve Space Fleet.

DOD scientists and research engineers will provide non-resident expertise to the three FGCs.

Role of the Department of Justice

The to, from, and in-space operations of these three FGCs and all associated US commercial operations shall be under the legal authority of the Federal Government. The Department of Justice shall, within six months, report to Congress on any required changes in existing federal law or needed new legislation.

Role of the Department of Energy

The Department of Energy (DOE), working with the US Census Bureau and the US Geological Survey, shall provide Congress, within six months, a quantitative estimate of the remaining US technically recoverable fossil fuels and how much oil, natural gas, and coal will be needed to maintain affordable fossil fuel energy supplies while the United States transitions to a non-fossil fuel energy infrastructure by 2100.

Working with NASA, DOE shall begin the development of nuclear space propulsion systems to enable advanced reusable spaceships to operate in support of the needs of the Spacefaring Logistics and Space Mining FGCs, the US Space Guard, and NASA space exploration missions. Within six months, an estimate of the additional DOE expenditures required over the next ten years shall be provided to Congress.

Within six months, DOE shall provide Congress with a quantitative estimate of the US endowment of technically recoverable uranium and a plan of how this can best be utilized to enable US nuclear energy production.

With the transition of the United States energy infrastructure from primarily using fossil fuels to the generation of electrical power and the production of synthetic fuels, a fundamental restructuring of the terrestrial energy infrastructure will be required. Within six months, DOE shall provide an initial roadmap identifying how this restructuring will be accomplished across the industrial, commercial, and residential

segments and how space-based power transmitted to ground receiving stations will be integrated into the energy infrastructure.

Role of the Department of Transportation

The Department of Transportation (DOT), through the Federal Aviation Agency (FAA), shall regulate the safety of fully-reusable, commercial passenger and crew spaceflight consistent with the approach now used for commercial air transportation. Working with the Spacefaring Logistics FGC, the FAA shall provide an independent airworthiness certification of these systems. Eventually, a new Federal Spacefaring Agency will be formed under this department to undertake these duties. The FAA administrator or an immediate senior subordinate shall fly on the initial operational mission of each type of airworthiness certified spaceflight system.

DOT shall, within six months, provide Congress with a list of concerns and issues regarding the significant expansion of reusable space access needed to execute the missions of the three new FGCs and the potential interference this may bring to commercial aviation.

Role of the Department of Commerce

Building a new American integrated spacefaring logistics infrastructure throughout the central solar system will be comparable to the development of the Interstate Highway System in the last century. The influence this will have on American commerce will be transformational. Within six months, the Department of Commerce shall provide Congress with an assessment of the potential impact undertaking the missions of the three new FGCs and, especially, new business enterprises utilizing the new infrastructure for ancillary uses, will have on America's economy. Further, the Department shall, within six months, advise Congress of the economic benefits of maintaining affordable energy supplies during the period of transition to sustainable energy by 2100 and of the potential economic consequences of a failure to accomplish this.

The Department of Commerce shall promote throughout the many States, and work to remove any barriers, to the formation of new and expanded small and medium businesses to take advantage of and to develop, build, operate, and maintain the new commercial spacefaring logistics infrastructure, the space-energy systems, and the space

mining capabilities. Through the use of the high-speed Internet and with appropriate methods for the protection of critical information, it is the will of Congress that American citizens, regardless of who they are and where they live, will have the ability to fairly compete to engage commercially in this transformation of the United States into a true commercial human spacefaring nation and in the associated restructuring of the US energy infrastructure. Becoming spacefaring is to be a nationwide endeavor.

Role of the Department of the Interior

The utilization of space-based energy to power the United States will require the use of up to approximately 100,000 square miles (260,000 square kilometers) of land within the contiguous United States to construct the ground receiving stations. Working with the many states, the Department of the Interior shall identify suitable locations within the contiguous United States for these ground receiving stations. Within six months, the Department shall provide a preliminary map of possible locations to Congress. It is the will of Congress that the need for national sustainable energy security shall be a priority in the selection of land suitable for this use.

Role of the Environmental Protection Agency

Within six months, the Environmental Protection Agency shall identify to Congress the environmental protection considerations to be addressed in the implementation of the missions of the three new FGCs and the location, construction, and operation of the ground receiving stations.

Role of the Department of Housing and Urban Development

The transition of the United States from the fossil fuel age to the sustainable energy age requires a fundamental new approach to housing for low and moderate income families. It is well recognized that investments in energy conservation are, quite often, more cost effective than investments in energy production. While it is important to provide the United States economy with affordable per capita energy supplies comparable to that provided currently, there is no reason to assume that the residential energy needs for low and moderate income families should not be substantially reduced as the new sustainable energy infrastructure is being built. Modern and emerging low-energy utilization construction methods may enable many existing low and moderate income housing to be updated or replaced with per capita investments lower than that required to furnish the existing housing with its needed sustainable energy supply. Thus, as the

nation invests in building its sustainable energy future, a portion of this investment may be best made in lowering the per capita residential energy needs for low and moderate income families. Within six months, the Department of Housing and Urban Development, working with the Department of Energy and the Department of Commerce, shall report to Congress the national energy security and economic benefits of balancing sustainable energy production investment with low and moderate income residential energy demand reductions accomplished through the updating or replacement of existing housing.

Building the space-based sustainable energy infrastructure may require the construction of upwards of 1,200 ground receiving power stations each providing 5 gigawatts of baseload electrical power. Each will provide roughly two and half times the power output of the Hoover Dam. During the last century when the United States significantly expanded hydroelectric power generation in the southern and western states, significant population movement and commercial development accompanied these efforts as low-cost electrical power became available. Due to their nature and existing land use, these ground receiving stations will likely be located remote from existing urban areas. Thus, noting that the population of the United States may double by 2100, it is likely that new urban areas will grow in proximity to these SSP power stations to take advantage of readily available sustainable electrical power. A twenty-first century sustainable living strategy for the development of these new urban areas is appropriate. Within six months, the Department shall report to Congress on urban development strategies appropriate to the location of ground stations in different parts of the contiguous United States.

Role of the Department of State

The United Nations Framework Convention on Climate Change identifies the environmental threat arising from the environmental impact uncertainty associated with the abnormally high and increasing atmospheric carbon dioxide level. The 2015 draft Paris climate agreement does not identify an effective means for the world to transition from fossil fuels to sustainable energy. This is due to the failure of that agreement to identify space-based sustainable energy as an important means for the world to undertake this critical transition. Within six months, the Department of State shall report to Congress on proposed changes to the draft agreement to incorporate

space-based sustainable energy and define a path forward to accomplish this by 2100 using commercial space energy systems.



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