## 1

States ought to apply the public trust doctrine to outer space while allowing limited private property rights through a system of tradeable development credits.

* CP solves 100% of the aff while encouraging the sustainable and equitable development of space.
* Their own solvency author goes neg and says that public trust doctrine is actively BAD unless it includes private property, so only the CP solves.
* Permutations are either severance or prove the aff is not topical since the CP requires private appropriation.

Babcock 21 [Hope M. Babcock (professor of law, Georgetown), “Using the Public Trust Doctrine to Manage Property on the Moon,” The Cambridge Handbook of Commons Research Innovations , pp. 264 – 272 (2021).] CT

There are various ways to manage property in outer space, which might work in a private or common property regime. However, any approach would have to allow the profitable development of outer space equitably and sustainably, as well as be efficient, fair, cost effective, and easy to implement and enforce. Above all, it must not run afoul of international law.

One idea is to establish economic development zones. Under this approach, international organizations would allocate areas on celestial bodies to various countries for the construction of structures, from which exclusive economic zones would radiate.54 Alternatively, an international organization might divide celestial bodies into shares for each country to exploit. Separating incompatible land uses in outer space might avoid negative spillovers from the co-location of conflicting uses,55 and could be used to exclude entities which might over-consume a common resource, leaving other users worse off. This latter feature of the proposal, however, conflicts with the OST’s free exploration and use principles.56

The proposal also requires an international institution to administer the system, which would be expensive to create and maintain.57 Spending money to create a new administrative authority, which might otherwise have helped poorer countries develop the capacity to participate in outer space. Additionally, it would be technically difficult to monitor and enforce what happens within these distant zones. And, depending on the perceived “fairness” of the zones and the allocation process, the proposal could lead to “discord“ among various countries, straining any civility norms previously established among spacefaring nations.

Having a lottery or an auction of “ownership rights,” or establishing a system of tradable credits might lessen the equity and technical problems with the economic zone management proposal. While an auction theoretically would open up the market in development rights to non spacefaring nations, in practice, only the wealthy nations would be able to effectively bid on and secure those rights.58 However, the idea of tradable credits might work.59

Under an outer space trading system, participant nations, regardless of their space faring capacity, would be allotted a fixed number of resource development credits, allowing the credit holder to extract a certain tonnage of materials or develop a fixed amount of celestial surface, during a specified time period.60 The credits could apply to the amount of the resource a participant was allowed to extract, regardless of location, or could be tied to a particular area of a celestial body. Participants could buy credits from and sell them to other participants.61 The proposal would allow developing nations to benefit from space exploration and exploitation, and participants would run the market reducing the need for an administering international agency.

Even though market participants would run the market, an international institution will be needed to allocate tradable credits and devise an allocation methodology that assures non-spacefaring nations receive some benefit. International oversight also will be needed to ensure that nations do not exceed their allotted credits. And tradable credits would need to be anchored by some form of authorization, like a permit, creating another need for a central administrative body.

While the idea of tradable development credits is consistent with international law, could assure equitable distribution of the benefits of space development, and provide sufficient incentives for development of these resources, the approach may be too administratively encumbered.

The public trust doctrine offers another approach for managing an open access commons. 62 Under this doctrine, the sovereign holds certain common properties in trust in perpetuity for the free and unimpeded use of the general public. The public’s right of access to and use of trust resources is never lost, and neither the government nor private individuals can alienate or otherwise adversely affect those resources unless for a comparable public purpose. Showing its adaptability, supporters of the doctrine are currently arguing in court that it applies to the atmosphere.63

The doctrine places on governments an affirmative, ongoing duty to safeguard the perpetual preservation of trust resources for the benefit of the general public, limiting the sovereign’s power on behalf of both present and future entities. It directs the government not to manage them for private gain and applies to private as well as public resources. Uses of trust resources that are inconsistent with the doctrine can be rescinded. The doctrine effectively places a permanent easement over trust resources that burdens their ownership with an overriding public interest in their preservation. Thus, the public trust doctrine protects the “people’s common heritage,”64 just as the Moon Treaty protects outer space as part of the common heritage of mankind.

A doctrine that imposes an enforceable perpetual duty on the sovereign to preserve trust resources, prevents their alienation for private benefit, and assures public access to them seems a particularly apt property management tool in outer space. The fact that public access to trust resources is so central to the doctrine65 is consistent with international space law’s open access principles. It avoids the problems of alienation and exclusion associated with private property management approaches and does not require the creation of a new administrative authority, as anyone can invoke the doctrine. Of all the management approaches discussed, the public trust doctrine seems the most suited to managing property in outer space.

However, the doctrine provides no incentives for development of trust resources.66 Its traditional use has been to curtail development, making it potentially a counter productive solution to the beneficial development of outer space. Allowing limited use of private property management approaches, like tradable development credits, might buffer that effect – a form of overlapping hybridity 67 between one type of property, a commons, and a management regime from another, private property, enabled by application of the public trust doctrine. This approach might allow development of outer space, while assuring that it will not just be profitable for a few; rather, space’s development will be sustainable and equitable, ideally for all.

Conclusion

Guided by the insights of Elinor Ostrom, this chapter proposes that viewing outer space as a commons will lead to a durable, equitable management regime where the wealthy are neither able to accumulate nor control the resources that space has to offer nor over exploit them. Using the public trust doctrine, supplemented by tradable development credits, as the preferred management approach will help assure that result and allow the development of space for the “benefit of all mankind.”

## 2

#### Space regulation scares investors away and spills over to other space activities. Freeland 05:

Steven Freeland (BCom, LLB, LLM, University of New South Wales; Senior Lecturer in International Law, University of Western Sydney, Australia; and a member of the Paris-based International Institute of Space Law). “Up, Up and … Back: The Emergence of Space Tourism and Its Impact on the International Law of Outer Space.” Chicago Journal of International Law: Vol. 6: No. 1, Article 4. 2005. JDN. <https://chicagounbound.uchicago.edu/cgi/viewcontent.cgi?article=1269&context=cjil>

V. THE NEED FOR CELESTIAL PROPERTY RIGHTS? ¶ The fundamental principle of "non-appropriation" upon which the international law of outer space is based stems from the desire of the international community to ensure that outer space remains an area beyond the jurisdiction of any state(s). Similar ideals emerge from UNCLOS (in relation to the High Seas) as well as the Antarctic Treaty, 42 although in the case of the latter treaty, it was finalised after a number of claims of sovereignty had already been made by various States and therefore was structured to "postpone" rather than prejudice or renounce those previously asserted claims.43 In the case of outer space, its exploitation and use is expressed in Article I of the Outer Space Treaty to be "the province of all mankind," a term whose meaning is not entirely clear but has been interpreted by most commentators as evincing the desire to ensure that any State is free to engage in space activities without reference to any sovereign claims of other States. This freedom is reinforced by other parts of the same Article and is repeated in the Moon Agreement (which also applies to "other celestial bodies within the solar system, other than the earth")." Even though both the scope for space activities and the number of private participants have expanded significantly since these treaties were finalised, it has still been suggested that the nonappropriation principle constitutes "an absolute barrier in the realization of every kind of space activity., 4 ' The amount of capital expenditure required to research, scope, trial, and implement a new space activity is significant. To bring this activity to the point where it can represent a viable "stand alone" commercial venture takes many years and almost limitless funding. From the perspective of a private enterprise contemplating such an activity, it would quite obviously be an important element in its decision to devote resources to this activity that it is able to secure the highest degree of legal rights in order to protect its investment. Security of patent and other intellectual property rights, for example, are vital prerequisites for private enterprise research activity on the ISS, and these rights are specifically addressed by the ISS Agreement between the partners to the project and were applicable to the experiments undertaken by Mark Shuttleworth when he was onboard the ISS.46

#### The private sector is essential for space exploration – competition is key and government development is not effective, efficient, or cheap enough. Thiessen 21:

Marc Thiessen, 6-1, 21, Washington Post, Opinion: SpaceX’s success is one small step for man, one giant leap for capitalism, https://www.washingtonpost.com/opinions/2020/06/01/spacexs-success-is-one-small-step-man-one-giant-leap-capitalism/

It was one small step for man, one giant leap for capitalism. Only three countries have ever launched human beings into orbit. This past weekend, SpaceX became the first private company ever to do so, when it sent its Crew Dragon capsule into space aboard its Falcon 9 rocket and docked with the International Space Station. This was accomplished by a company Elon Musk started in 2002 in a California strip mall warehouse with just a dozen employees and a mariachi band. At a time when our nation is debating the merits of socialism, SpaceX has given us an **incredible testament to the power of American free enterprise.** While the left is advocating unprecedented government intervention in almost every sector of the U.S. economy, from health care to energy, **today Americans are celebrating the successful privatization of space travel.** If you want to see the difference between what government and private enterprise can do, consider: It took a private company to give us the first space vehicle with touch-screen controls instead of antiquated knobs and buttons. It took a private company to give us a capsule that can fly entirely autonomously from launch to landing — including docking — without any participation by its human crew. It also took a private company to invent a reusable rocket that can not only take off but land as well. When the Apollo 11 crew reached the moon on July 20, 1969, Neil Armstrong declared “the Eagle has landed.” On Saturday, SpaceX was able to declare that the Falcon had landed when its rocket settled down on a barge in the Atlantic Ocean — ready to be used again. That last development will save the taxpayers incredible amounts of money. The cost to NASA for launching a man into space on the space shuttle orbiter was $170 million per seat, compared with just $60 million to $67 million on the Dragon capsule. The cost for the space shuttle to send a kilogram of cargo into to space was $54,500; with the Falcon rocket, the cost is just $2,720 — a decrease of 95 percent. And while the space shuttle cost $27.4 billion to develop, the Crew Dragon was designed and built for just $1.7 billion — making it the lowest-cost spacecraft developed in six decades. SpaceX did it in six years — far faster than the time it took to develop the space shuttle. ***The private sector does it better, cheaper, faster and more efficiently than government***. Why? Competition. Today, SpaceX has to compete with a constellation of private companies — including legacy aerospace firms such as Orbital ATK and United Launch Alliance and innovative start-ups such as Blue Origin (which is designing a Mars lander and whose owner, Jeff Bezos, also owns The Post) and Virgin Orbit (which is developing rockets than can launch satellites into space from the underside of a 747, avoiding the kinds of weather that delayed the Dragon launch). In the race to put the first privately launched man into orbit, upstart SpaceX had to beat aerospace behemoth Boeing and its Starliner capsule to the punch. It did so — for more than $1 billion less than its competitor. **That spirit of competition and innovation will revolutionize space travel in the years ahead.** Indeed, Musk has his sights set far beyond Earth orbit. Already, SpaceX is working on a much larger version of the Falcon 9 reusable rocket called Super Heavy that will carry a deep-space capsule named Starship capable of carrying up to 100 people to the moon and eventually to Mars. Musk’s goal — the reason he founded SpaceX — is to colonize Mars and make humanity a multiplanetary species. He has set a goal of founding a million-person city on Mars by 2050 complete with iron foundries and pizza joints. Can it be done? Who knows. But this much is certain: **Private-sector innovation is opening the door to a new era of space exploration**. Wouldn’t it be ironic if, just as capitalism is allowing us to explore the farthest reaches of our solar system, Americans decided to embrace socialism back here on Earth?

#### Continued private space development is the only way to make sustainable energy feasible – empirics prove. Autry 19:

Greg Autry {the director of the Southern California Commercial Spaceflight Initiative at the University of Southern California, vice president at the National Space Society, and chair of the International Space Development Conference, }, 19 - ("Space Research Can Save the Planet—Again," Foreign Policy, 7-20-2019, <https://foreignpolicy.com/2019/07/20/space-research-can-save-the-planet-again-climate-change-environment/)//marlborough-wr/>

Today conservationists and other critics are more likely to see space programs as militaristic splurges that squander billions of dollars better applied to solving problems on Earth. These well-meaning complaints are misguided, however. Earth’s problems—most urgently, climate change—can be solved only from space. That’s where the tools and data already being used to tackle these issues were forged and where the solutions of the future will be too. Space research has already been critical in averting one major environmental disaster. It was NASA satellite data that revealed a frightening and growing hole in the ozone layer over the South Pole, galvanizing public concern that, in 1987, produced the Montreal Protocol: the first international agreement addressing a global environmental problem. Since then, thanks to worldwide restrictions on damaging chlorofluorocarbons, the ozone situation has stabilized, and a full planetary recovery is expected. As this case showed, space can provide the vital information needed to understand a problem—and a surprising range of ways to solve it. Climate change is a poster child for the critical role of space data. Trekking across the globe to measure ice sheets with drills and gauge sea temperatures from the sides of ships is an expensive, slow, and insufficient way to assay the state of the planet. Satellites operated by NASA, the U.S. National Oceanic and Atmospheric Administration, and an increasing number of commercial firms provide a plethora of multispectral imaging and radar measurements of developments such as coral reef degradation, harmful plankton blooms, and polar bears negotiating thinning ice. Much of the technology involved in observing the Earth today was initially developed for probes sent to explore other planets in our solar system. Indeed, understanding the evolution of other planets’ climates is essential for modeling possible outcomes on Earth. NASA probes revealed how, roughly 4 billion years ago, a runaway greenhouse gas syndrome turned Venus into a hot, hellish, and uninhabitable planet of acid rain. Orbiters, landers, and rovers continue to unravel the processes that transformed a once warm and wet Mars into a frigid, dry dust ball—and scientists even to conceive of future scenarios that might terraform it back into a livable planet. Discovering other worlds’ history and imagining their future offers important visions for climate change mitigation strategies on Earth, such as mining helium from the moon itself for future clean energy. Spinoff technologies from space research, from GPS to semiconductor solar cells, are already helping to reduce emissions; the efficiency gains of GPS-guided navigation shrink fuel expenditures on sea, land, and air by between 15 and 21 percent—a greater reduction than better engines or fuel changes have so far provided. Modern solar photovoltaic power also owes its existence to space. The first real customer for solar energy was the U.S. space program; applications such as the giant solar wings that power the International Space Station have continually driven improvements in solar cell performance, and NASA first demonstrated the value of the sun for powering communities on Earth by using solar in its own facilities. Promisingly, space-based solar power stations could overcome the inconvenient truth that wind and solar will never get us anywhere near zero emissions because their output is inherently intermittent and there is, so far, no environmentally acceptable way to store their power at a global scale, even for one night. Orbital solar power stations, on the other hand, would continually face the sun, beaming clean power back through targeted radiation to Earth day or night, regardless of weather. They would also be free from clouds and atmospheric interference and therefore operate with many times the efficiency of current solar technology. Moving solar power generation away from Earth—already possible but held back by the current steep costs of lifting the materials into space—would preserve land and cultural resources from the blight of huge panel farms and save landfills from the growing problem of discarded old solar panels. Sustainable energy advocates in the U.S. military and the Chinese government are actively pursuing space-based solar power, but just making solar cells damages the environment due to the caustic chemicals employed. Space technology offers the possibility of freeing the Earth’s fragile biosphere and culturally important sites from the otherwise unavoidable damage caused by manufacturing and mining. The U.S. start-up Made in Space is currently taking the first steps toward manufacturing in orbit. The company’s fiber-optic cable, produced by machinery on the International Space Station, is orders of magnitude more efficient than anything made on Earth, where the heavy gravity creates tiny flaws in the material. Made in Space and others are eventually planning to build large structures, such as solar power stations, in space. As these technologies develop, they will augment each other, bringing costs down dramatically; space manufacturing, for instance, slashes the cost of solar installations in space. Eventually, firms will be able to supply endeavors in space with materials from the moon and asteroids, avoiding the cost and environmental impact of lifting them into orbit. Mining the solar system comes with its own potential impacts, but extracting resources from distant and lifeless worlds is clearly preferable to the continued degradation of the Earth.

#### Warming causes extinction – outweighs all aff impacts

Miller-McDonald, 18 – (Samuel, Master of Environmental Management at Yale University studying energy politics and grassroots innovations in the US. 5-2-2018. "Extinction vs. Collapse." Resilience. https://www.resilience.org/stories/2018-05-02/extinction-vs-collapse/)

Climate twitter – the most fun twitter – has recently been reigniting the debate between human extinction and mere civilizational collapse, between doom and gloom, despair and (kind of) hope. It was sparked by an interview in The Guardian with acclaimed scientist Mayer Hillman. He argues that we’re probably doomed, and confronting the likelihood that we’re rushing toward collective death may be necessary to save us. The headline alone provoked a lot of reactions, many angered by the ostensible defeatism embedded in Hillman’s comments. His stated view represents one defined camp that is mostly convinced of looming human extinction. It stands in contrast to another group that believes human extinction is highly unlikely, maybe impossible, and certainly will not occur due to climate change in our lifetimes. Collapse maybe, but not extinction. Who’s more right? Let’s take a closer look. First, the question of human extinction is totally bounded by uncertainty. There’s uncertainty in climate data, uncertainty in models and projections, and even more uncertainty in the behavior of human systems. We don’t know how we’ll respond to the myriad impacts climate change is beginning to spark, and we don’t know how sensitive industrial civilization will be to those impacts. We don’t really know if humans are like other apex predators highly sensitive to ecological collapse, or are among the most adaptable mammals to ever walk the earth. One may be inclined to lean toward the latter given that humans have colonized every ecological niche on the planet except Antarctica. That bands of people can survive in and around deserts as well as the Arctic as well as equatorial rainforests speaks to the resilience of small social groups. It’s why The Road is so disturbingly plausible; there could be a scenario in which basically everything is dead but people, lingering in the last grey waste of the world. On the other hand, we’ve never lived outside of the very favorable conditions of the Holocene, and past civilizational and population collapses suggest humans are in fact quite sensitive to climatic shifts. Famed climate scientist James Hansen has discussed the possibility of “Venus syndrome,” for instance, which sits at the far end of worst case scenarios. While a frightening thought experiment, it is easily dismissed as it’s based on so many uncertainties and doesn’t carry the weight of anything near consensus. What’s more frightening than potentially implausible uncertainties are the currently existing certainties. For example: Ecology + The atmosphere has proven more sensitive to GHG emissions than predicted by mainstream science, and we have a high chance of hitting 2oC of warming this century. Could hit 1.5C in the 2020s. Worst-case warming scenarios are probably the most likely. + Massive marine death is happening far faster than anyone predicted and we could be on the edge of an anoxic event. + Ice melt is happening far faster than mainstream predictions. Greenland’s ice sheet is threatening to collapse and already slowing ocean currents, which too could collapse. + Which also means predictions of sea level rise have doubled for this century. + Industrial agriculture is driving massive habitat loss and extinction. The insect collapse – population declines of 75% to 80% have been seen in some areas – is something no one predicted would happen so fast, and portends an ecological sensitivity beyond our fears. This is causing an unexpected and unprecedented bird collapse (1/8 of bird species are threatened) in Europe. + Forests, vital carbon sinks, are proving sensitive to climate impacts. + We’re living in the 6th mass extinction event, losing potentially dozens of species per day. We don’t know how this will impact us and our ability to feed ourselves. Energy + Energy transition is essential to mitigating 1.5+C warming. Energy is the single greatest contributor to anthro-GHG. And, by some estimates, transition is happening 400 years too slowly to avoid catastrophic warming. + Incumbent energy industries (that is, oil & gas) dominate governments all over the world. We live in an oil oligarchy – a petrostate, but for the globe. Every facet of the global economy is dependent on fossil fuels, and every sector – from construction to supply chains to transport to electricity to extraction to agriculture and on and on – is built around FF consumption. There’s good reason to believe FF will remain subsidized by governments beholden to their interests even if they become less economically viable than renewables, and so will maintain their dominance. + We are living in history’s largest oil & gas boom. + Kilocalorie to kilocalorie, FF is extremely dense and extremely cheap. Despite reports about solar getting cheaper than FF in some places, non-hydro/-carbon renewables are still a tiny minority (~2%) of global energy consumption and will simply always, by their nature, be less dense kcal to kcal than FF, and so will always be calorically more expensive. + Energy demand probably has to decrease globally to avoid 1.5C, and it’s projected to dramatically increase. Getting people to consume less is practically impossible, and efficiency measures have almost always resulted in increased consumption. + We’re still setting FF emissions records. Politics + Conditions today resemble those prior to the 20th century’s world wars: extreme wealth inequality, rampant economic insecurity, growing fascist parties/sentiment, and precarious geopolitical relations, and the Thucydides trap suggests war between Western hegemons and a rising China could be likely. These two factors could disrupt any kind of global cooperation on decarbonization and, to the contrary, will probably mean increased emissions (the US military is one of the world’s single largest consumers/emitters of FF). + Neoliberal ideology is so thoroughly embedded in our academic, political, and cultural institutions, and so endemic to discourse today, that the idea of degrowth – probably necessary to avoid collapse – and solidarity economics isn’t even close to discussion, much less realization, and, for self-evident reasons, probably never will be. + Living in a neoliberal culture also means we’ve all been trained not to sacrifice for the common good. But solving climate change, like paying more to achieve energy transition or voluntarily consuming less, will all entail sacrificing for the greater good. Humans sometimes are great at that; but the market fundamentalist ideology that pervades all social, commercial, and even self relations today stands against acting for the common good or in collective action. + There’s basically no government in the world today taking climate change seriously. There are many governments posturing and pretending to take it seriously, but none have substantially committed to a full decarbonization of their economies. (Iceland may be an exception, but Iceland is about 24 times smaller than NYC, so…) + Twenty-five years of governments knowing about climate change has resulted in essentially nothing being done about it, no emissions reductions, no substantive moves to decarbonize the economy. Politics have proven too strong for common sense, and there’s no good reason to suspect this will change anytime soon. + Wealth inequality is embedded in our economy so thoroughly – and so indigenously to FF economies – that it will probably continue either causing perpetual strife, as it has so far, or eventually cement a permanent underclass ruled by a small elite, similar to agrarian serfdom. There is a prominent view in left politics that greater wealth equality, some kind of ecosocialism, is a necessary ingredient in averting the kind of ecological collapse the economy is currently driving, given that global FF capitalism by its nature consumes beyond carrying capacities. At least according to one Nasa-funded study, the combination of inequality and ecological collapse is a likely cause for civilizational collapse. Even with this perfect storm of issues, it’s impossible to know how likely extinction is, and it’s impossible to judge how likely or extensive civilizational collapse may be. We just can’t predict how human beings and human systems will respond to the shocks that are already underway. We can make some good guesses based on history, but they’re no more than guesses. Maybe there’s a miracle energy source lurking in a hangar somewhere waiting to accelerate non-carbon transition. Maybe there’s a swelling political movement brewing under the surface that will soon build a more just, ecologically sane order into the world. Community energy programs are one reason to retain a shred of optimism; but also they’re still a tiny fraction of energy production and they are not growing fast, but they could accelerate any moment. We just don’t know how fast energy transition can happen, and we just don’t know how fast the world could descend into climate-driven chaos – either by human strife or physical storms. What we do know is that, given everything above, we are living through a confluence of events that will shake the foundations of civilization, and jeopardize our capacity to sustain large populations of humans. There is enough certainty around these issues to justify being existentially alarmed. At this point, whether we go extinct or all but a thousand of us go extinct (again), maybe that shouldn’t make much difference. Maybe the destruction of a few billion or 5 billion people is morally equivalent to the destruction of all 7 billion of us, and so should provoke equal degrees of urgency. Maybe this debate about whether we’ll go completely extinct rather than just mostly extinct is absurd. Or maybe not. I don’t know. What I do know is that, regardless of the answer, there’s no excuse to stop fighting for a world that sustains life.

## 3

#### The appropriation of outer space through the PTD is just, with the exception for space-based solar power projects.

#### SSP is viable and requires privatization.

Oberhaus 21 [DANIEL OBERHAUS, “Space Solar Power: An Extraterrestrial Energy Resource For The U.S.,” Innovation Frontier Project, August 18, 2021. <https://innovationfrontier.org/space-solar-power-an-extraterrestrial-energy-resource-for-the-u-s/>] CT

FUTURE OF SSP

The United States’ reluctance to pursue SSP can be attributed to a number of causes. In the 1970s and 80s, the exorbitant projected costs of an SSP station guaranteed that the project would not be pursued by NASA, the DOE, or the DOD. At the same time, the agency’s emphasis on developing nuclear space technologies — a trend that continues to this day — undermined enthusiasm for other ambitious energy projects like SSP. Finally, the fact that SSP is a space project meant to provide commercial levels of electrical power on Earth meant that it wasn’t obvious whether it fell within the purview of NASA or the DOE, and so both agencies were reluctant to allocate a substantial portion of their budget for its development. Today, the low cost of natural gas and renewables like wind and solar makes it seem challenging to justify a space energy project of this scale. But SSP offers several unique benefits as an energy resource, including its resiliency, its ability to provide flexible baseload power to geographically distant locations, its capacity to accelerate decarbonization directly by providing clean energy and indirectly by expediting the transition to off-world heavy industry, and its strategic benefits as a tool for diplomacy and national security. Given SSP’s benefits and the interest in the technology from most other space agencies, it’s puzzling that policymakers in the United States have not prioritized SSP R&D. The development of key technologies such as reusable rockets and thin film solar panels has finally made SSP economically and technically viable. But there is still a lot of fundamental research on SSP that needs to be done and it is in the United States’ national interest to begin this research program as soon as possible. So far, the only glimmer of hope for an American SSP program has come from the DOD’s efforts. In 2019, the Air Force Research Lab awarded a $100 million contract to Northrop Grumman as part of the new Space Solar Power Incremental Demonstrations and Research (SSPIDR) Project, which aims to develop hardware for in-orbit SSP experiments based on the design developed at Caltech.105 This is by far the United States’ largest federal expenditure on SSP R&D, but it is only a fraction of what will be required to build a large-scale SSP station and the specific technologies included in the SSPIDR program will not result in a system that could ever provide commercial power to civilians. SSP is a key tool for ensuring the prosperity and security of the United States in the latter half of the 21st century. It is imperative that NASA and the DOE prioritize the development of SSP. We believe the federal government should earmark approximately $1 billion for SSP research over the next five years with a special emphasis on advancing emerging technologies and in-space hardware demonstrations. Congress must take the first step in establishing a civilian SSP platform by directing NASA and the DOE to collaborate on a public-private initiative similar to NASA’s commercial crew program or its more recent commercial lunar payload services program. The directive must clearly delineate responsibilities between the agencies in order to avoid leadership paralysis that has stymied domestic SSP research in the past. Furthermore, a public-private program must be structured so that there is competition among multiple private companies, which must hit key milestones in order to continue receiving contracts. These contracts should be awarded with a fixed-price structure to avoid the massive cost overruns and delays that are typical of cost-plus contracts in the aerospace and defense sector. This is also an approach likely to find support among new launch providers and spacecraft manufacturers that have demonstrated the innovation that occurs when operating within the relative constraints of fixed price contracts. In fact, the main trade group for the aerospace sector has advocated for the increased use of fixed-price contracts in the past.106 Alternatively, it may be more efficient to establish a focused research organization (FRO) dedicated to SSP technologies to avoid delays associated with collaboration between two federal agencies on multi-year—and perhaps multi-decade—projects. FROs are independent entities that exist outside of national laboratories and universities. They are effectively a startup for basic research and deep technological development that requires large-scale engineering collaboration on technologies that may not yet have a market or are not readily monetizable.107 Recently, the U.S. Congress created five FRO-like centers in the DOE’s national labs as part of the National Quantum Initiative Act, which can serve as a framework for the creation of similar FROs dedicated to space solar power.108 While there are several approaches to a large-scale SSP system, we believe the most fruitful pathway is to focus on cost reduction over energy efficiency. This would prioritize highly modular systems similar to ALPHA, which benefit from the substantially reduced costs of mass manufacturing standardized components. We believe that it is possible to conduct a civilian SSP demonstration in low-Earth orbit within three years of the program’s start with less than $250 million in funding. The first phase of this program would involve conducting a series of ground tests with prototype systems over the course of about 18 months. Based on the results of this program, a system could be selected for an in-space demonstration capable of generating up to 300kw of power in low-Earth orbit. After a successful LEO demonstration mission, the next step would be to build a larger SSP system in mid-Earth orbit capable of producing commercial amounts of power (e.g., 1-10 MW). While this orbital altitude is not sufficient for maintaining the SSP system over a fixed spot on the Earth, it would stay on a fixed path so that it always passed over the same spots on the Earth. While the power from this MEO demonstrator would not be competitive with terrestrial electricity prices — we expect a cost of about $1/kwh — it would be a critical step toward proving the system’s ability to provide commercial power. We expect that the MEO demonstrator could be built and launched for approximately $1 billion. The success of the MEO demonstrator would lay the foundation for an SSP system in geostationary orbit that would be large enough to provide meaningful amounts of baseload power. We expect the initial version of this SSP system to be capable of delivering around 2 GW of solar energy to the surface. We expect that a 2 GW SSP system in geostationary orbit could be built for about $10 billion. Here we start to see the cost savings of mass manufacturing modular SSP components. This system would be capable of delivering more than 200 times more power than the MEO demonstrator for only 10 times the cost. We believe that a public-private SSP program jointly led by NASA and the DOE could result in a commercially viable SSP platform in geostationary orbit by the end of the decade. In addition to providing a critical pathway for SSP, it also has the potential to lead to substantial advancements in solar power and wireless power transmission technologies that would be useful on Earth. If policymakers do not take action on advancing domestic SSP capabilities soon, the United States will find itself losing its leadership position in space and increasingly vulnerable to natural and human-made disasters on the ground.

#### SSP solves warming. In the short term provides cheap, renewable, and flexible baseload power for on and off-world applications. It’s also key to transition heavy industry to space.

Oberhaus 21 [DANIEL OBERHAUS, “Space Solar Power: An Extraterrestrial Energy Resource For The U.S.,” Innovation Frontier Project, August 18, 2021. <https://innovationfrontier.org/space-solar-power-an-extraterrestrial-energy-resource-for-the-u-s/>] CT

What is often left unsaid in discussions about extraterrestrial industrialization and deep space settlement is how to supply the energy needed for large scale infrastructure projects. Nuclear energy has long been the power source of choice for deep space missions.2 This is largely because nuclear power systems can operate for decades without intervention and in locations where there is limited or non-existent sunlight. But nuclear energy is limited in its ability to scale and also creates serious health hazards for near-Earth operation.3 In this paper, we make the case for space-based solar power (SSP) megaprojects as relatively low-cost, scalable, renewable, and always-on power source for on-and-off world applications. Although SSP is a space-based energy asset, it has the potential to rapidly accelerate decarbonization on Earth while also fulfilling space exploration priorities. SSP is a decades-old idea that has only recently become economically viable due to the rapidly falling costs of space access and technological advancements such as higher efficiency electronics, low-cost mass-production of modular space systems like satellites, robotic in-space construction, and wireless power transmission. NASA, the Department of Energy, and several other research agencies have conducted in-depth studies and limited experiments on SSP, but the development of this energy resource was hindered by unfavorable economics. Things have changed and it is time to reconsider SSP as a valuable tool in the nation’s decarbonization strategy. This paper shows how the development of SSP can serve several national imperatives at once. In space, it can provide a renewable and cost-effective source of energy for moon bases and deep space missions. SSP can also provide a valuable source of energy — both electric and thermal — for industrial processes in cislunar space. This will facilitate the transition of heavy industry from Earth to space, which will mitigate carbon emissions in the medium-to-long term on Earth. Critically, SSP will have a massive impact on terrestrial greenhouse gas (GHG) emissions in the near term through wireless energy transfer from space to Earth. This is SSP’s original “killer app,” and multiple studies have shown that SSP can meet a substantial portion of Earth’s energy needs. Unlike terrestrial solar power, SSP is always on. It can provide solar power rain or shine, day or night. It is also flexible and can be quickly redirected to ground stations in geographically distant locations to meet rapidly changing energy needs. The dream for SSP is to have a source of clean baseload energy that’s available regardless of weather, location, or time of day. The baseload is the minimum electrical energy demand on a grid, which has historically been provided by power stations that are able to generate large and relatively constant amounts of energy. But as more renewables penetrate the grid and create fluctuations in electric supply, the base load power stations of the future must be flexible enough to rapidly ramp up and down to meet the evolving supply and demand dynamics of the grid. Much like the advent of GPS, a robust SSP capacity would have profound geopolitical implications. China is investing heavily in SSP and plans to have the first operating SSP plant in orbit by the end of the decade.4 The Department of Defense (DOD) is also pursuing SSP research for military applications. Notably, the Air Force Research Laboratory recently created a $100 million program to advance key SSP technologies.5 This paper concludes that the U.S. must allocate substantially more human and financial capital to SSP as part of its national security, domestic energy, and space exploration strategies.

#### Cooperation over SBSP acts as an olive branch that moderates aggressive Chinese behavior and prevents miscalculation from a space arms race.

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As China’s interests continue to expand outward from its shores, it seeks to build a military capable of protecting its economic interests overseas. For example, China has participated in counterpiracy operations in the Gulf of Aden since 2008 and recently established a permanent base in Djibouti to aid in this effort and serve as a PLA logistics hub for the region. This base will assist the PLA Navy in extending its reach while also securing sea lines of communication, through which much of China’s imports and exports transit. Beijing also has grand ambitions in space, many of which are economical and also require protection. These ambitions include projects to start lunar and asteroid mining, bring the BeiDou-2 Navigation Satellite System network into global service by 2020 and establish a Chinese space station by 2022. Beijing even has preliminary plans for an ambitious space-based solar energy network that will use microwaves to transmit power back to Earth by 2050.10 In the Strategic Studies Quarterly 12, no. 1 edition, Dr. Namrata Goswami argues that Chinese space exploration must be viewed through the broader framework of the Chinese economy’s expanding need for resources.11 She explains that President Xi sees space Counter and Cooperate AIR & SPACE POWER JOURNAL  SPRING 2019 73 as an environment for scientific innovation as well as an opportunity to revitalize stagnant state-owned enterprises. She goes on to state that “. . . these goals are unique as they indicate a completely different view of space. Rather than just an arena for conquest and showing off, China views space as an environment in which to live, work, and create wealth through habitation and resource extraction.”12 This begs the question: how will China protect its interests in space? Leadership in Beijing will increasingly have to consider how it will secure these important economic assets in a realm where there are few laws or agreed upon codes of conduct. Although this analysis is not exhaustive, it provides a basis for understanding China’s current space initiatives and ambitions. So what kind of policy should Washington adopt to accommodate China’s interests, advance our own, and dissuade Beijing from extending a potential conflict into space? An intelligent approach will be two-fold. On one hand, we should foster cooperation where our interests with the Chinese overlap. On the other, we should develop a comprehensive approach for defending our interests, especially in the SCS. The latter issue is of great importance because we must first confront Beijing’s transgressions here on Earth to deter China’s militaristic expansionism in space. Proposals for US Policy Cooperate China’s economic and military rise during the last several decades was made possible by the post-World War II economic order established by the US. However, as a great power, China is unsatisfied with the current US-led order that it did little to help shape. Beijing and Washington are increasingly at odds internationally as their competing interests and visions for the future begin to collide. New avenues for cooperation are desperately needed to foster mutual trust and create an environment where the US and China can coexist with minimal friction. Space presents an excellent opportunity for cooperation between Washington and Beijing. Our two nations will compete in this realm—there is no avoiding that. However, both parties will benefit greatly from having a standardized set of rules governing military and economic activities in space. Hopefully, if these two great powers establish a framework of behaviors and norms for space, the rest of the world will follow suit. To start, the US should extend an olive branch. As Brian Wee den and Xiao He point out in their article for War on the Rocks, “Washington still hopes that Beijing can be a constructive partner for greater international space security. While China still chafes at the largely American constructed rules-based order, it likewise has a clear interest in using its development of space capabilities to promote bilateral cooperation and to play a role the formation of new international regimes.”13 While Russia seeks to undermine international space initiatives, Beijing and Washington should look toward the future and create a bold plan for space governance. This does not mean intimate cooperation, but there should be norms and codes for how government entities and private corporations 74 AIR & SPACE POWER JOURNAL  SPRING 2019 Loftus should act in space. Weeden and He go on to say that both sides should seek to establish confidence-building mechanisms to help build trust as well as processes for cooperation and deconfliction. On the economic front, private companies crave stability and clear rules. If the world’s two preeminent military and economic powers establish clear guidelines early on, potential financiers will have greater confidence to invest the large up-front costs for expensive space-based projects. This leads to the next point that both sides should promote: private sector cooperation in the space domain. It would be advantageous for both sides if private corporations in the US and China pursue space exploration together. Space-lift capabilities, space stations, asteroid mining, lunar stations, and other endeavors all require significant initial costs. By partnering, American and Chinese corporations could call upon the support of both the Chinese and US governments in seeking out new resources such as solar power, rare elements, and numerous other fields for scientific discovery that would be of great benefit to people everywhere. A private-sector partnership should be plausible as long as intellectual property rights are respected and the governments involved don’t micromanage the projects. Deep US–Chinese economic integration is often cited as one reason war between our two nations is unthinkable. Why would the same logic not extend to space? Despite the potential space holds for cooperation, there is plenty of room for conflict. While high-ranking military officials in both China and the US believe the militarization of space is inevitable, it would be beneficial to agree upon one rule up front: no kinetic strikes.14 In 2007, China tested an antisatellite missile against one of its failing weather satellites, projecting debris that continues to threaten space-based assets to this day. A kinetic battle involving satellites would create clouds of space junk for which there is no current remedy. Both Beijing and Washington have reason to limit space warfare to nonkinetic means. If a conflict were to occur, there are a number of different ways to neutralize or affect satellites short of kinetic strikes. These methods include radio frequency jamming and lasers that can temporarily incapacitate or even completely destroy satellite-based sensors. It should be added that spy satellites are important to building trust. Spy satellites allow nation-states to have an understanding of what their rivals are doing, at least partially allaying suspicion of the other party. A similar terrestrial example is the Treaty on Open Skies, which is primarily based around the US and Russia but claims 32 other signatories. According to the Department of State, “the Treaty is designed to enhance mutual understanding and confidence by giving all participants, regardless of size, a direct role in gathering information through aerial imaging on military forces and activities of concern to them.”15 Both sides must recognize the importance of this technology in allaying suspicions and preventing paranoia. An agreement to not target spy satellites (through a kinetic strike, jamming, lasers, or any other means) would be a bitter pill to swallow but would foster greater openness while also mitigating the militarization of space.