Written Public Comments Submitted to PCAST

January 11, 2022 to March 16, 2022

(Written Public Comments in order of date received)

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From: plaban biswas [redacted]
To: MBX OSTP PCAST MBX.OSTP.PCAST@ostp.eop.gov
Sent: Tue 1/25/2022 9:06 AM
Subject:

Sarah Domnitz, Designated Federal Officer, PCAST,

To
The Hon'ble -
The President of United States America, The White House.
1600 Pennsylvania Avenue NW Washinton, DC 20500. The USA.
[Through the -- Mr. Sarah Domnitz, Designated Federal Officer, PCAST of US Gov].

Subject ---- The world's most advanced technology has made it possible to innovate, --- It has become possible to " Established " the Sun as the entire Geographical space of USA by an ultra high - tach technology [Which is -- T/10 of USA], it will be possible to produce unimaginable amount of " Developmental forces" from these holy land of USA, like the Sun. The Government of USA will traditionally used these God technology - Socially,Environmentally, Militarily, Politically and Economically USA will be the most Almighty with developed country in all over the World . I've named these God of Developmental technology of great national interest of USA --- " The IEDAS C3D technology [The Ideal Economic Development by America's Service for all the Countries Citizens Career Development technology] ".

The ultimate source of the biggest thing ----The matters of the Universe are led by law. To search that law is the duty of science.
Acquiring those laws to make the path of society smoothly is the main object of science. Asking to wake up to know the secret of the source of creation , Asking gives birth to basic thoughts , Argument takes place in the world of thought , No action is done without cause and creator, this simple truth is established. How many problems and mysteries remain in the Universe ! There are more than hundred que stions against one question. It will be unbelievable and impossible if the answers come quickly. What seems impossible today is becom ing possible through various miracles of science and technology ! The truth which is established today, maybe perhaps practically truth. It will be the absolute and ultimate truth in little future. My idea is that it will be possible to unravel the mystery of the ultimate truth through -- The IEDAS research and development work .

I respect you with absolute devotion and Pranam Hon'ble US President Sir, -------

I wish you good health and overall success your US Government ,I 'm Shri Plaban Biswas, S/O - Late Anil krishna Biswas, 212/D- West Msunda P.O & P.S - New Barrackpore , North 24 Parganas , Kol - 131, W. B of INDIA .The Sun's massive destructive system could be transformed into the world's greatest human developmental services ---- One such conceptual thought came to my mind in January 1985 in a physics class . I was a ninth grader then . I was able to feel that little I of that day --- we are living or are living in every moment by the infinite grace of the human world or the animal world ----- He is our Sun [Humans God] and its underlying nuclear fission & fusion process --- This is the absolute truth , Back home that day, I prayed to my father [Shri Anil Krishna Biswas] to know the ultimate and absolute truth in a deep way------ My migrant worker father handed me his "The Vedas and The Vagbhata Geeta" with explaining his poverty. The path to truth, I began to walk
- - -

Sir, My IEDAS research preliminary work has recently been completed ,Now I have prepared a file for the Hon'ble US President a preliminary discussion of this IEDAS technology , The file is highly confidential and most important to Us Gov's national interests ,Which I am determined to send to the White House via Speed Post next week , And I will submit a tocopy of it to the Commercial Officer of Kolkata American Center , Please take

my humble submission file to the Honorable US Gov't Officers of PCAST very seriously , Because the file was just as important as a letter written in Albert Einstein , Sir Einstein wrote an important letter on 11 th October 1939 to then US President of the Hon,ble Franklin Delano Roosevelt ,Thank you with respect sir, Good evening. Yours faithfully ----- Shri Plaban Biswas.

January 31, 2022

Fusion Industry Association
800 Maine Ave SW
Suite 223
Washington, DC 20024

The U.S. will have stable, reliable fuel sources for fusion energy

To the Members of the President's Council of Advisors on Science and Technology (PCAST):

> *At the January 21 PCAST meeting, a commenter raised questions about the availability of two related resources that will be important for a roll-out of fusion energy power plants: tritium and lithium. This comment, from Andrew Holland, CEO of the Fusion Industry Association, provides a direct response to that comment.*

Private sector fusion approaches include a variety of fuel sources for fusion. Many, but not all, will require tritium and deuterium, isotopes of hydrogen. Deuterium can be distilled from all forms of water. It is a widely available, harmless, and virtually inexhaustible resource.

Tritium is a fast-decaying radioelement of hydrogen which occurs only in trace quantities in nature, which the U.S. has been working with since the 1940s. It is currently produced as a byproduct of certain fission reactions in nuclear power plants and can be created by intentional reactions. The primary US supply comes from the DOE Savannah River National Lab, while Canada is the largest supplier of civilian-use tritium.

The fusion industry estimates that global inventory for tritium will be sufficient for experimental fusion devices envisioned to be built in this decade, but when the industry is ready to scale-up, power plants will have to generate their own source of tritium as a byproduct of the fusion reaction in any large-scale fusion power plant.

Fortunately, tritium can be produced during the fusion reaction through contact with lithium. It is planned that tritium will be created when neutrons escaping the plasma interact with lithium contained in the blanket wall of the fusion power plant. These systems would benefit from a robust government science program to innovate around how to most efficiently engineer the lithium generating blanket.

There is currently a robust market for lithium, as the demands of the growing electric vehicle industry are testing global supplies. However, by the time commercial fusion power plants are ready for widespread deployment, there is likely to have been significant investments into

the lithium supply chain, including into battery recycling, as well as possible changes in battery needs as new minerals provide better energy storage capabilities. Finally, lithium can be extracted from ocean water, where reserves are practically unlimited.

I appreciate the committee's concern about fuel supplies for fusion energy. The current geopolitical moment is yet another reminder that adversarial countries will use their energy resources as a tool of foreign policy and national security. A fusion-powered economy would fundamentally end such concerns about the geopolitics of energy. Fusion turns energy from a resource that is mined or extracted to one that is *manufactured.* A fusion-powered future will be one where the only constraint on energy supplies and availability is the cost and availability of a manufactured good. For that reason and others laid out in my presentation to PCAST on January 21, I hope that the U.S. government engages in a serious effort to accelerate fusion energy.

I am happy to provide further information to the committee and its members directly.

Sincerely,

Andrew Holland
Chief Executive Officer
Fusion Industry Association

From: Norman Burton [redacted]
To: MBX OSTP PCAST MBX.OSTP.PCAST@ostp.eop.gov
Sent: Thu 2/10/2022 9:39 AM
Subject: New alien science, corrects the misconceptions, deceptions, and unknowns of our existence

Hello,

I am a social scientist, and I've made ground breaking scientific discoveries of a new science, the Metaphysical sciences, which mirror, complement the Physical sciences in every aspect.

The Physical sciences united all peoples of Mankind in one harmonious method for identifying, translating the physical realities of our existence. Science, the Physical sciences, eliminated the various conflicting religions false claims of domain over translating the physical realities of our existence, and eliminated half of our false reality created by the implementing the buffet of false data produced by the various conflicting religions.

My discovery of the Metaphysical sciences proves the metaphysical realities the various conflicting religions acknowledge, document, share are true realities of our existence, but are translated by Science. Just as the physical realities have proven to be translated by the method of science, eliminating half of our false reality, the Metaphysical translate the metaphysical realities of our existence, eliminating the false second half of our reality that is causing the chaos in which Mankind currently exist.

Religion is the originator of chaos in society, forcing itself onto society, through ritualistic brainwashing, enforced by blaspheme. Everyone recognizes the ritualistic brainwashing of the other religions congregations, but not their own, which is a characteristic of brainwashing. Everyone is right that everyone else 's religion is wrong.

Science, the Physical sciences identifies, translates the physical realities that identify, support the existence of the physical mortal animal Human species.

Science, the Metaphysical sciences identifies, translates the metaphysical realities that identify, support the existence of the metaphysical immortal alien Being species (soul, psyche, spirit, chakra, etc., the various failed, false method's names for the same acknowledged, documented metaphysical identity in a dormant symbiotic existence with the physical host Human species). The Human / Being is two species in a symbiotic existence.

Furthermore, the various interplanetary species (U.F.O.'s / U.A.P.'s) that the U.S. government recently acknowledged traveling unimpeded through Earth's skies, oceans are here acquiring knowledge about the metaphysical Being species in this dormant symbiotic existence with the physical animal host Human species, and not the Human species per se. The metaphysical Being species is the apex life consciousness of known existence.

Just as computer sciences, aeronautical sciences, and other sciences have been beyond Human comprehension at first introduction, so too are the Metaphysical sciences. The Physical sciences have allowed Mankind to evolve far beyond what was possible when religion was the accepted method for translating the realities of our existence, and the Metaphysical sciences will allow Mankind to socially evolve thousands of years seemingly overnight, eliminating the various individual mental imbalance disorders, and social disorders that currently plague Mankind.

All aspects of Human existence will change for the better once the Metaphysical sciences are implemented, completing the equation that proves Science is the method that unites all of Mankind in one harmonious method for identifying, translating All realities of our existence.

I've published a website, nburton.com, that further introduces the tip of my scientific discoveries, which was published long before the U.S. government's recognition of U.F.O.'s. The knowledge I have to share is the proof of my statements, which I encourage all to challenge, or implement, and science requires it, as self realization is the prime method for acquiring knowledge.

Sincerely,
Norman Burton
e-mail [redacted]

From: Urvishkumar Mehta [redacted]
To: MBX OSTP PCAST MBX.OSTP.PCAST@ostp.eop.gov
Sent: Sun 2/13/2022 3:27 AM
Subject: USA-India - International Relations: Cyber Treaty - Cyberspace and Cyber warfare and International Humanitarian

ATTN:
National Science and Technology Council
Office of Science and Technology Policy
Attn: FOIA Officer
1650 Pennsylvania Ave, NW
Washington, D.C., 20504
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Type: Cyber Treaty | International Humanitarian Law | Human Costs of Cyber | Humanitarian Action | Technology in Humanitarian Action

The letter is in reference with the cyber warfare and international humanitarian law, Tilman Rodenhäuser, to unpack for us what is at stake in the current peak in intergovernmental discussions on existing and potential threats in cyberspace, how applying international humanitarian law – also referred to as the laws of war or law of armed conflict – to military cyber operations can help avert the significant threats they pose to civilians, and why cyber questions concern all States.

Military Cyber Operations a Humanitarian Concern

Cyber-attacks and their consequences are on top of the agenda around the world. The concern, as a humanitarian organization, is that military cyber operations are also becoming part of today's armed conflicts and can disrupt the functioning of critical infrastructure and vital services to the civilian population.

For example, healthcare systems are increasingly digitized and connected but often unprotected, therefore particularly vulnerable to cyber-attacks. Too often, in armed conflict water and power infrastructure, or hospitals, are damaged by shelling and services are functioning only partially if at all: imagine a major cyber incident on top of it! This can have devastating consequences. Civilians caught in conflict and violence are already struggling enough as it is to see their hardships worsen.

We are also increasingly relying on new and digital technologies to support humanitarian programs, for instance by capturing and using information to inform and adjust responses or by facilitating two-way communication between humanitarian staff and civilians affected by conflict or violence. But this, too, makes us vulnerable to cyber operations that could impact our capacity to protect and assist during humanitarian emergencies.

We also see an increasing risk of intentional and unintentional harm to affected populations, notably through the (mis)use of data by warring parties and or the spread of misinformation, disinformation, and hate speech.

While few States have acknowledged publicly that they have used cyber means in support of their military operations, it is estimated that more than 100 States have developed—or are developing— military cyber capacities. Fortunately, cyber operations during armed conflicts do not occur in a legal vacuum: they are governed by international humanitarian law (IHL).

There are Gaps that are required to be filled:

A knowledge gap | A skill and literacy gap | An ethical gap | A governance gap | A financial gap

Cyber warfare' only concern technologically advanced States

It does not and it should not. Cyberspace is highly interconnected by nature. As such, attacks carried out in cyberspace against one State can affect many others, deliberately or incidentally, wherever they are located.

We saw this dynamic in recent years, when malware spread quickly and left hardly any country unaffected, freezing government agencies, paralyzing corporations and crippling logistics centers, costing billions in losses and fixes. In times of armed conflict, these indiscriminate and global effects of military cyber operations can be avoided, or at least limited, if IHL is respected.

Effectively regulating cyber operations during armed conflict is thus of concern for all States, whatever their level of technological development, their military cyber capabilities, or their involvement in armed conflicts.

Existing international humanitarian law adequate and sufficient to apply in cyberspace, or new cyber convention and amendments

One of the great strengths of international humanitarian law is – as pointed out by the International Court of Justice – that it is designed in such ways that it applies 'to all forms of warfare and to all kinds of weapons', including 'those of the future'.

The basic rules are straightforward: targeting civilians and civilian objects is forbidden; indiscriminate weapons and attacks must not be used; disproportionate attacks are prohibited; medical services must be respected and protected.

The same rules and principles – including the principles of humanity, military necessity, distinction, proportionality and precautions – apply to all military operations, be they kinetic or cyber, and must be respected.

However, there are questions that remain highly debated among States and other experts and need clarification. For example, there is disagreement whether civilian data – which are unique to cyberspace – enjoy the same protection as

civilian objects. Such disagreements on legal interpretations have always existed without questioning the applicability of the law as such.

Deciding whether a new convention is needed for cyberspace reaches far beyond the use of cyber operations during armed conflicts: it concerns a much larger spectrum of international law issues.

In our view, should new rules be developed to regulate cyber operations during armed conflict, they must build on and strengthen the existing legal framework, in particular IHL. And until any additional rules are developed, any cyber operations during armed conflict must comply with existing rules of IHL.

International Humanitarian Law Legitimize the Militarization of Cyberspace or Cyber warfare?

No. Affirming that international humanitarian law applies to cyber operations during armed conflicts does not legitimize cyber warfare, just as IHL does not legitimize any of the other forms of warfare.

In fact, this fear about a possible legitimization of warfare was repeatedly raised in intergovernmental discussions. But States addressed such a fear in 1977 by stating – in the preamble to First Additional Protocol to the 1949 Geneva Conventions – that international humanitarian law must not 'be construed as legitimizing or authorizing any act of aggression or any other use of force inconsistent with the Charter of the United Nations'.

International humanitarian law and the Charter of the United Nations are distinct but complementary. Concretely, the UN Charter prohibits the use of force other than in self-defence or when authorized by the UN Security Council. It also requires that international disputes be settled by peaceful means. If, however, an armed conflict breaks out, then international humanitarian law applies to set out essential protections for civilian objects and for persons who do not (civilians) or no longer (for example, wounded soldiers or detainees) participate in hostilities.

IHL does not replace or set aside the UN Charter, but rather adds a level of protection for all victims of war in the unfortunate event that a war breaks out.

Yours,

Auto Legislative Policy Director (Don M - International Military and Congressional Affairs)
Office of Urvishkumar Mehta
Commissioner, Federal Government, USA
@: [redacted]
Phone: [redacted]
Pronounce: (He|Him|His)

From: KD [redacted]
To: MBX OSTP PCAST MBX.OSTP.PCAST@ostp.eop.gov
Sent: Wed 2/16/2022 12:01 AM
Subject: United States Multi-Lateral Advanced Research Project for Space Inclusion

2/15/2022

Attention: Dr. Eric Lander; Dr. Maria Zuber; Dr. Frances Arnold; Dr. Marvin Adams; Dr. Dan E. Arvizu; Chief of Staff Kei Koizumi the Office of Science and Technology Policy; Deputy Administrator, Pam Melroy, NASA; Director Clayton P. Turner, Director, Langley Research Center, NASA; Director Dennis Andrucyk, Goddard Space Center, NASA; Thomas Zurbuchen, Associate Administrator for Science, NASA; James L. Reuter, Associate Administrator, Space Technology, NASA; members of NSTC and all PCAST:

I am a former classified analyst for the Department of State and Department of Homeland Security. My specialty is connecting things that will eventually come together (my focus is strategic defense.) I'm stating this with hope that you will allow me to take a bit of your time to read something important to Science and Technology, as well as to the United States. My goal is for this information to reach the hands of scientists who can and do advise the highest authorities on important projects for the country.

A number of concepts are forced out during this email, each important, though I am writing for the single reason stated: U.S. strategic planning.

Please remember that although strategic analysts do their best to communicate analysis of advanced connections, the jumps, for example, in base mathematics, may not be easily discernable at first. I ask for your understanding in this matter and request that you keep the following information in mind when making decisions for Science and Technology and specifically, United States interests. All information and maps are available very publicly, just not analyzed together, along with recent events and new technology.

My communication to you is this:

The Netherlands and eight other (free) countries currently have had major success in the creation and use of the largest low frequency array radio telescope on earth (LOFAR). The map (see map #2 from ACRON) below shows LOFAR participant country positions. As you may know, radio waves are emitted from many places on and off Earth (see Map #3 from NASA showing one single day of signals from Earth and our solar system.) I know this sounds elementary; please allow me to connect the dots. The whole is more than the sum of the parts.

Background: While we (U.S.) have our own radio telescopes, due to sheer size and concentrated focus, the Netherlands Low Frequency Array Radio Telescope has already picked up radio waves from numerous locations that start to put together a picture of communication (via radio wave spectrums) from not only our system, but our galaxy, other galaxies and the universe itself, especially during usually unknown information periods such as the popularly termed Dark Ages. Additionally, because the LOFAR is Low Frequency Altitude, it picks up *much larger areas of the radio sky* and unusual phenomena that may have future effects on this country or the planet, such as a recent transient that went to straight to our Polaris from a black hole in the universe. It is important to note that any *signals like this to near earth would affect the electromagnetic spectrum*, especially considering the copious numbers of signal transmitters already in local and near-earth orbit. Please keep reading...

Equally important, this is a **multi-lateral cooperative venture**. **All the countries currently participating have extremely close ties with the United States and all are members of the EU and NATO.** While some of the important public data above may seem pedestrian, I implore you to think strategically for the United States. Space remains a new venture when it comes to Earth/Space relationships. Though there are no military uses discussed, given our acknowledgement and recent demonstrations of the importance Space plays both in communications and as a possible theater, **it is not unthinkable to envision purposeful mobile transmitters or technology that emit signals beyond High Earth Orbit from heretofore unused regions.** Stars, planets, black holes, and combustion phenomena all emit radio and other spectrum frequencies. It is also not unthinkable to advance a defense against potential emissions from Low to High Earth Orbits. However, the purpose of this presentation is to acknowledge and act on the need to monitor new and different kinds of *communication*.

We, as a species, still cannot communicate with other species in their language. Over time, we have been able to identify that language exists within and among certain species, but that was not always the case and as we develop, we identify more and more types, methods, and qualities of language, communication and intelligence. We also use more between and among ourselves. The frequencies, right here on Earth may or may not be something in awareness (a common example of that is a dog whistle.) We have discovered the basic frequencies humans use verbally, audibly, and visually and are aware of more in the spectrums that we cannot detect without assistance; similarly, we are aware of the universe of the small, that we also cannot detect without assistance, as well as chemicals and other forms of energy or movement of energy.

Moving ahead and wider, analysis considers the types of opportunities and perhaps need for shielding regarding signals and spectrums that we know to be in existence as well as *innumerable connections* that physics and science both theorize and have proven, exist. The synced technology of a system like LOFAR discovers completely new data both terrestrially and from deep space due to the focus on low frequencies. LOFAR advanced technology also eliminated a significant amount of noise from the data when studying frequencies.

Using a simple yet encompassing analogy, LOFAR data, as well as advanced investigation of high frequencies creates the kind of map where the loss of one instrument (frequency) makes a difference in the outcome (because it's radio, it's waves, it's electromagnetic, etc., all at the same time); where two or more instruments (frequencies but beyond our current thinking and use together) *talk* together; where several signals (*from anywhere, using or accounting for time lag*) emitting together create *music* (or what we would identify as intelligent communication of some type); and where the full spectrum of instruments (frequencies from X, Y, and a different alphabet) create an orchestral language (critical to understand or defend against) but may also, conversely, create an EMP event. Think of a seemingly solid bridge collapsing from resonance frequency vibrations. Then think of the ability to not only detect the vibrational wave and rotational frequency to prevent collapse but to *speak* in the same language, thus moving the probability of collapse forward or backward. This may already be applied in certain industries, but it is not yet applied to major, critical infrastructure, (or in terms of communication, the topic of this message, this map is not yet understood, believed to be language, used, protected, or proven to be replicated in crucial ways. Yet the data is there, the movement is there, communication is there, the potential for harm is there, and the absence of critical elements change outcomes.)

This is why a strategic understanding of connections is crucial. Though they may seem disparate, under intense analysis over time, predictive outcomes and kinetically participating, influencing, dominating or changing outcomes are visible events, no matter where on the spectrum of signals/waves/language/communication they may exist, *or when* (for example, when LOFAR looks at change in deep space, and how physics applies. For other examples, apply the central properties of quantum physics.) *Strategic understanding may seem far out*, but it is not an outlier on the chart of probabilities; it predicts movements and change over time and analyzes the process and result. (Although the observer effect applies, for the purposes of this communication no details are necessary.) *Far out* may be **any advanced technology that becomes operational from any country or orbit. *Far out* may be an immediate surprise** to any country, individual, or lifeform that has not detected the correct signals and moved kinetically to increase or decrease that acceleration of movement or understood the type of language emitted to know to neither increase nor decrease the movement of energy at any point in time.

(Map #4, a very public map) shows the supposed current satellites in Earth orbit. The map is misleading because after culling for space debris the number of active satellites is reduced by almost 13k. (Space debris is an issue not addressed here but needs to be at high levels. The issue is known, but is there a government contract out yet for a company to actually meet specs to orbit and remove? Graveyard orbits...disposal orbits- very iffy and compliancy not-enforced...) This is simply pointing out that current terrestrial *noise*, versus what is actually new or newly discovered signal may reach a point, or already has, where it significantly hampers understanding. Additionally, because as mentioned, this email will force certain other things out, graveyards are good places to hide.

Also significant to this understanding is the well-known tale of the 52 hertz whale, (Map #1), whose song at 52 hertz is unheard by other whales and is projected to mean that his or her species will become extinct (though, as a positive long-term thought, it could be that another whale at that hertz has yet to be born *or within range* and could introduce a new species.) Please extrapolate the words about something in existence waiting for its parallel whose combination could create something new, to the gravity they should carry. However, the anecdote is to further support the reasoning for the United States to include itself in this significant multi-country partnership venture. Signals at any level, from anywhere, having unknown impact of importance may be missed without strict attention to all parts of the *perhaps infinite* spectrum. The more participants in sync, the better for all.

The United States has and continues to focus on detection of *certain thing*s, to the exclusion of other or entire fields of, for a random example, SONAR. **In other words, we reinforce our own weaknesses by concentrating on a certain area, creating to detect that area, and therefore only detecting that area.** This sounds similar to an old psychology adage, but in strategic analysis, it's become apparent that such a weakness exists in critical areas, both nationally and globally.

Also not dealt with here, though the gravity is fully known, is this type of monitoring and actions applied to electronic warfare. It already is and will become more important than ever to constantly monitor the full spectrum of frequencies and not to limit input to a priori conceptions, orders, or value of assets. Utilizing alliances to do so is an efficient and advantageous position. A drawback of entering into LOFAR as currently built, is that it only receives down to 10 megahertz. Due to electronic warfare engagement, though still nascent in its use on the masses, if the United States enters into the LOFAR group, OSTP, NSCT, and PCAST should recommend an additional advanced technical station that perceives down to 1 megahertz on the spectrum. This could easily become a populace necessity. Currently, as far as is known publicly, electronic attack and countermeasures are designed for conventional warfare regarding equipment on air, land and sea, and for Over the Horizon operations. Sensors or other advanced technology beyond missile defense are not deployed to protect civilians or soldiers from large group or citywide electronic attacks involving the spectrum, including but not limited to lasers, microwaves, particle beams, sonic targeting, focused energy, attack levels of UV rays, and attack levels of Gamma rays. Sensors for chemicals in the air should also be considered. The conjunction of hard science, capability, historical usage for conventional warfare, and current national and global conditions demand it. **This area will be the nuclear bomb of this century.** Preparation, research, development, deployment and continuous monitoring of all theaters on the now active four planes of land, air, water, and space, is essential.

Although the last paragraph is critical, please remember that the intent of this communication is to heavily advocate that the OSTP, NSTC, and PCAST recommend to President Biden of the United States to join the current international low frequency array radio telescope group of countries and commit to monitoring, reception and analysis of all geo, air, sky, orbital and space data or possible data (given noise reduction technology.)

To conclude: please recommend with the full force of your Office and councils that the United States join the Netherlands and other partner countries in LOFAR, an international low frequency array radio telescope to monitor low frequency emissions from all global regions, orbits, and space. Please also recommend with the full force of your Office and councils, in conjunction with the U.S. Space Command and other appropriate Commands to use advanced technology to build or orbit monitors or deploy sensors to detect and defend against frequencies as low as 1 mega-hertz, off the visible spectrum, and for high frequencies that penetrate the skin, for the purpose of general protection of the population.

I attest that I have nothing to profit from regarding this decision.

Sincerely,
K.D. Pillow
Virginia, USA

[redacted]

Maps, supporting information, and links below.

Map #1 straight from Wikipedia, as I've had to make do with very public information.

A 52 Hertz Frequency, as yet unanswered.

Link: LOFAR - ASTRON for all information.

Some info from LOFAR as well as a map of current positions, courtesy ASTRON:

LOFAR (Low Frequency Array) is currently the largest radio telescope operating at the lowest frequencies that can be observed from Earth. Unlike single-dish telescope, LOFAR is a multipurpose sensor network, with an innovative computer and network infrastructure that can handle extremely large data volumes.

An international telescope

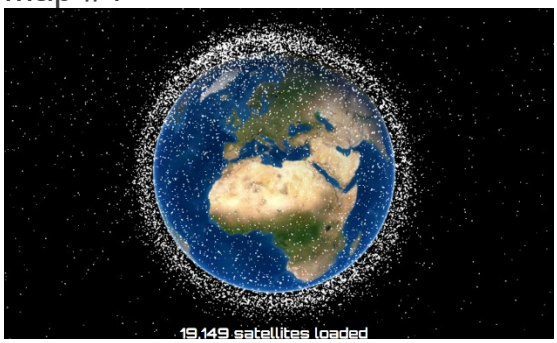
While LOFAR started as a national project in the Netherlands, consortia of institutes and researchers in several other countries soon placed orders to build one or more LOFAR antenna stations there. The enormous range of distances between the stations yield unique capabilities for detailed images of the sky.

The collaboration was consolidated with an MoU signed in 2010 in the presence of H.M. Queen Beatrix, and establishment of the International LOFAR Telescope (ILT) as a foundation under Dutch law. After a decade, the ILT has grown to encompass nine countries. Next to the Netherlands (38 stations), these are Germany (six stations), Poland (three stations), France, Ireland, Latvia, Sweden, and the United Kingdom (one station each); a station in Italy is funded to be built soon. Still more countries are considering joining as well. Here you find the interactive LOFAR map. Map #The LOFAR stations © Astron

LOFAR as a European Research Infrastructure Consortium.
LOFAR, designed and built by ASTRON in the Netherlands, is a distributed research infrastructure enabling world-leading radio astronomical research. During a decade of continuous operation, it has grown to a pan-European scale, with a diverse and expanding set of partners (presently in nine countries).

Map #3
© *NASA/GSFC Wind Waves Michael L. Kaiser*

Link: Satellite Map | Space Map Shows 19K+ Satellites Orbiting Earth (esri.com) (All countries)
Map #4



*13k of these are debris, including old satellites, rockets, and boosters.

Sincerely, K.D. Pillow

From: Urvishkumar Mehta [redacted]
To: MBX OSTP PCAST MBX.OSTP.PCAST@ostp.eop.gov
Sent: Sun 2/20/2022 4:39 PM
Subject: **The US is unprepared to face the challenge in the Arctic**

ATTN:
National Science and Technology Council
Office of Science and Technology Policy
Attn: FOIA Officer
1650 Pennsylvania Ave, NW
Washington, D.C., 20504
Phone: (202) 456-4444
Fax: (202) 395-1224

Subject: The US is unprepared to face the challenge in the Arctic

Type: Letter of Request on Arctic Mission

Dear Patrons

I am writing the letter with reference to the unprepared challenges in the Arctic Mission. I wanted to emphasize on the letter as a Science Agreement between Seven Countries and protecting and preserving the wildlife, sustainable water and renewable energy within the Arctic Region.

The melting Arctic is opening a new front in strategic competition, raising US security concerns in the once-uncontested frontier in a way that echoes the mid-twentieth century Space Race. But unlike the Soviet Union's Sputnik surprise, which jolted US politics and society, there has been no moment shocking enough to awaken Americans to the threats in, from, and over the Arctic region.

There are numerous externalities: The region opens up opportunities for increasing (or decreasing) the number of sea lines of communication, spying on Arctic nations, stoking competition for natural resources and rare-earth minerals, expanding nations' military presence, and even illegal fishing. These and other new possibilities may lead to an increased risk of pollution and gas or oil spills, potential sabotage to undersea cables, the displacement of indigenous people, and the disturbance of archeological sites.

Even worse: The United States is falling further behind as its allies and adversaries alike prepare for the new frontier more robustly. Russia and China, for example, have already heightened their activities and ambitions in the region beyond the traditional conceptions of defense, such as nuclear sub-surface power projection and deterrence. Their strategies already include plans to harness exponentially shorter sea lanes, meaning that China and Russia can reach global markets or military targets faster and much more cheaply. There is also the potential for a partnership between the two nations in developing the Northern Sea Route.

Just last week, Russian warships sailed through the Barents Sea as part of a massive naval exercise amid rising tensions between the Kremlin and NATO. To counter the Alliance, Russia has built approximately eight hundred military facilities in the Arctic since 2013. It is also reportedly building numerous airbases in the Arctic, where in July it tested a hypersonic cruise missile.

There is still time for US officials to increase operational capability and strategic effectiveness in the Arctic, and doing so is in the US interest. But in order to catch up to other countries' preparations, the United States must release a whole-of-government National Arctic Strategy based on an updated National Security Strategy (which is likely to come in early 2022).

Apart from establishing a truly interdepartmental approach to the Arctic—which is currently primarily a maritime domain—it should also draw on capabilities already developed by the United States and its allies for a parallel one: space. Because strategic competition in the Arctic region requires access to the location and more, leveraging technical means, such as commercial space-derived capabilities, is paramount.

Calibrating agencies' positioning

While the United States has had Arctic plans dating back to US President Richard Nixon's 1971 National Security Decision Memorandum, its current Arctic strategy was written in 2013—before Washington shifted its focus to strategic competition with Russia and China. Since then, the Arctic has been mentioned only once in the 2017 National Security Strategy, and not at all in the 2018 National Defense Strategy, the 2018 National Military Strategy, or the 2021 Interim National Security Strategic Guidance.

Yet because of its strategic implications for the United States, strategy and policy documents like these must account for the region. The United States must update its National Arctic Strategy to address the emerging realities and national-security interests, but it should not stop there: It must also break down the numerous operational verticals, integrate foreign allies and partners, and assimilate space capabilities for use in the Arctic when necessary.

In September 2021, the White House reactivated the Arctic Executive Steering Committee to advance US Arctic interests as they relate to conducting climate science, addressing the concerns of Indigenous peoples, and enhancing US national and economic security. In its 2016 Implementation Framework for the National Strategy for the Arctic Region, the committee pledged to review US actions in the Arctic, ensuring that they advance US security interests and strategies. But first, the Arctic Executive Steering Committee should look back at this document and assess whether it is still sufficient or relevant—and if not, the committee should explore how to boost its relevance given the changes in the Arctic.

At the cabinet level, the Department of Defense (DoD) has the federal government's largest Arctic-related budget. In addition to separate documents released by the Army, Navy, and Air Force, it released an updated Arctic strategy in 2019; while this is a noteworthy accomplishment for the DoD, which has long de-prioritized the region, none of these strategies were in any meaningful way coordinated (and thus integrated) with one another. Any update to a National Arctic Strategy should comprehensively bind these DoD documents.

The DoD is not the only department with its eyes on the Arctic: The departments of Homeland Security (DHS), State, the Interior, and Energy are all following developments in the region. Yet besides the DoD, only the DHS (and the Coast Guard, which falls under DHS) has a formal Arctic strategy. In fact, the whole-of-department approach behind the DHS strategy can be scaled up into a broader whole-of-government one by synchronizing interagency efforts and fully leveraging the capabilities, capacity, and partnerships across the entire federal government—not just one or a few departments or agencies.

This broader whole-of-government plan should also include State, Interior, and Energy, which must also begin to develop their Arctic strategies in coordination with the DoD and DHS given their important roles in the region.

Eyes on the stars

Any comprehensive Arctic strategy should also delve into the adjacent domain of space. The Arctic and space are inextricably linked—a fact the Air Force, which spends around six billion dollars per year on its Arctic goals and is the source of about 80 percent of the DoD's resources to the region, admits in its own Arctic Strategy.

For one, the Arctic's high latitudes could increase US capabilities to communicate with devices in polar orbits—where spacecraft and satellites already have a strategically advantageous viewpoint. At such heights, space assets can be more effective at everything from environmental and climate monitoring and defense surveillance to astronomical observation, including of those satellites in polar orbit.

But it is a two-way street: US space guidance—such as the National Space Policy, the National Space Strategy, and others—should also be updated to include the Arctic. These updates must consider how the ongoing commercial

space boom, along with the digital-infrastructure development it has fueled, can help solve challenges to sustained Arctic operations. For example, space-derived infrastructure can help monitor the operational environment of the Arctic, support climate research, and facilitate modern ways of living in the digital era for people living in Arctic regions.

Finding a north star

Developing an integrated, strategic blueprint aimed at advancing US Arctic interests is an important step—but only the first of several which the government should take. The United States should consider the value of designating an executive agent tasked with leading US Arctic activity. A primary US government lead would focus on planning for Arctic operations and supporting the execution of US Arctic policies, strategies, and plans across the federal government.

The United States is fully capable of increasing operational capability and strategic effectiveness in the Arctic. But to do so, there is an urgent need for a National Arctic Strategy that draws heavily on space-derived capabilities and encompasses a truly whole-of-government approach.

Yours,
Auto Legislative Policy Director (Don M - Intergovernmental and Congressional Affairs)
Office of Urvishkumar Mehta
Commissioner, Federal Government, USA
Phone: [redacted]
Pronounce: (He|Him|His)
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New Energy Times

Feb. 27, 2022

Dear Members of the President's Council of Advisors on Science and Technology,

Thank you for the opportunity to speak with you on Dec. 21, 2022. As I promised, I am enclosing scientific references to support my statement that the required fuel sources for commercial nuclear fusion do not exist.

There are a few other things that I'd like to point out.

1. FUSION FUNDING HISTORY

1.1 Congress, 1993

In 1993, the consensus of the American fusion research community was that the majority of efforts and funding for fusion should be focused on the ITER project. Thus, the fusion community convinced Sen. J. Bennett Johnston, chairman of the Senate's Committee on Energy and Natural Resources, to propose S. 646, the International Fusion Energy Act of 1993:

> The bill would establish within the Department of Energy (DOE) an international fusion energy program. DOE has been conducting a fusion research and development program for several years, but S. 646 would redirect and refocus this program towards the goals of designing, constructing, and operating the International Thermonuclear Experimental Reactor (ITER) by 2005 and operating a fusion demonstration reactor by 2025. The bill would eliminate current fusion program components that are not related to ITER.

Here's what Johnston told the committee members in his prepared statement to the committee on May 6, 1993:

> Over the last four decades we have spent almost $10 billion exploring ways to produce electricity from magnetic fusion. Many different approaches have been studied. The decades and billions of dollars of research have narrowed the magnetic fusion energy path to one approach — ITER. The purpose of ITER is to determine whether we can build a fusion demonstration reactor to generate electricity in commercial quantities. ITER will tell us whether fusion is the energy source of the 21st century.

And indeed, the wide variety of approaches were reduced, and ITER became the main focus.

1.2 President Bush, 2003

In the late 1990s, the U.S. pulled out of the ITER project because of objections to the cost. The international partners agreed a few years later to a scaled-down, lower-cost design, and the U.S. rejoined the international effort. A press release from the office of President George W. Bush on Jan. 30, 2003, announced the news and explained the primary measurable objective of the reactor:

> If successful, ITER would create the first fusion device capable of producing thermal energy comparable to the output of a power plant, making commercially viable fusion power available as soon as 2050.

The revised and current design of the ITER project is not capable of producing thermal energy comparable to the output of a working power plant.

The fusion scientists also convinced the president's office that "fusion is clean, safe, and renewable, using fuels that were readily available in seawater."

You'll see in that press release from President Bush's office that a blue-ribbon panel appointed by the National Academy of Sciences endorsed U.S. participation in the ITER program.

1.3 Phillipe Busquin, 2002

Over in Europe, fusion researchers told the European Commissioner for Research, Phillipe Busquin, that the purpose of ITER was to build a fusion reactor “capable of producing energy at an industrial scale, 1,500 MW.”

In turn, Busquin provided that information to the European Commission, the European Council of Ministers and European Parliament. European fusion researchers didn't bother to tell Busquin that, the year before, the planned gross thermal output of ITER had been reduced from 1,500 MW to 500 MW. I've spoken with Busquin on the phone, but his memories of the past have faded.

2. ITER FUSION POWER FACTS

2.1 No Net Power

In 2017, with the assistance of Daniel Jassby, a retired plasma physicist from the Princeton Plasma Physics Laboratory, Steven Cowley, who is now the director of PPPL, and Hartmut Zohm, the head of the Tokamak Scenario Development Division at the Max Planck Institute of Plasma Physics, I revealed publicly for the first time the facts about the planned power consumption for ITER. Those facts show that, if the reactor works correctly and accomplishes its scientific objective of a tenfold gain in plasma heating, the correlated result for the overall reactor will be a net loss of power.

2.2 The ITER Reactor Will Not Produce "Net Energy"

The ITER reactor was never designed to produce net energy or, more accurately, net power. Specifically, it was never designed to:

a) Produce 10 times the power the reactor would consume
b) Operate with only 50 megawatts of input electricity
c) Demonstrate that producing commercial energy from fusion is possible

Instead, if the reactor achieves its scientific objective:

a) The effective output of the overall reactor will be zero net power or less.
b) The reactor will consume hundreds of megawatts of electricity.
c) The reactor will fail to show that producing commercial energy from fusion is possible.

2.3 The Primary ITER Design Objective

If successful, the ITER fusion experiment will inject 50 million Watts of heating power into the fusion fuel and, in turn, produce fusion reactions with 500 million Watts of thermal power. This would be a tenfold power gain. But reaction power gain is not the same as reactor power gain.

If ITER succeeds in this reaction power gain — its primary scientific goal — then the correlated result for the overall reactor will be a loss, not a gain. The loss will be equivalent to 250 million Watts of thermal power. If the reactor were operated continuously and connected to the electric grid, that would translate to a loss of 100 megawatts of electric power.

All power-related references and sources are here: http://news.newenergytimes.net/iter-fusion-reactor-technical-references/

2.4 The False Power Claims

The power facts explained above stand in contrast to the widespread false claims made by representatives of the fusion community. Here are just a few recent examples.

On July 28, 2020, under the leadership of Director-General Bernard Bigot, the ITER organization issued a press release saying that, "If operated continuously and connected to the electric grid, [the 500 MW thermal output] would translate to about 200 megawatts of electric power, enough for about 200,000 homes." That math works only if the input power to the reactor is excluded.

In Spring 2020, under the leadership of Director Johannes Schwemmer, the ITER European domestic agency published a new Web page and said that "ITER will produce a significant amount of heat in the range of 500 MW for about 7 minutes — enough to satisfy the electricity needs of a medium-size town." That math works only if the input power to the reactor is excluded.

In 2012, the Princeton Plasma Physics Laboratory published a brochure saying that ITER was designed to produce 500 million Watts of power. The brochure said this would be enough for the "electrical needs for 200,000 average-size homes." That math works only if the input power to the reactor is excluded. You get the picture.

Bigot testified falsely before the French Senate in 2021. He testified falsely before the U.S. Congress in 2016.

In 2011, fusion scientists told the European Parliamentary Research Service, which in turn told members of the European Parliament that ITER was designed to "produce 500 megawatts of output power for 50 megawatts of input power" by 2027. They told the members that, as a result, ITER was designed to "demonstrate the commercial viability of fusion."

These are just a few of hundreds of examples of the persistent deceptive practices that have been going on for decades. The fusion scientists have even deceived prestigious science magazines like *Nature* and *Science*. Nobody wants to talk about this. Nobody likes to admit that they were deceived.

3. FUSION "PILOT PLANT"

3.1 Pilot Plant Concept

Now, before the first experiments have been performed in ITER, let alone before construction on the ITER reactor has finished, the U.S. fusion science community is proposing to design and build a fusion pilot plant.

By pushing for federal support for this fusion pilot plant, the U.S. fusion science community is telling us not to wait for the results of ITER. Everything that the fusion community had intended and claimed it needed to learn from ITER is moot. All of the reasons, as the fusion scientists insisted 30 years ago, that ITER had to be ten times larger than JET, are moot. All of the U.S. investment in ITER is moot. The message today is "skip ITER and build a fusion plant that will produce net electricity."

3.2 Pilot Plant Boondoggle

Now, some U.S. fusion scientists are becoming angry, and they have recently approached me. They are late in their careers and feel more confident about speaking out than their younger colleagues, whose livelihoods depend on the constant flow of federal fusion funding. The older scientists have provided me with information about one of the two U.S. pilot plant designs.

They object to unsupported assumptions in the design which lead to exaggerated power output claims. Wallace Manheimer provided me with an advance copy of a critical analysis that he has submitted to *Nuclear Fusion*, considered the most prestigious peer-reviewed journal on the

subject. [10] Since 1970, Manheimer has worked (initially employed full time, currently a consultant) with the Plasma Physics Division of the U.S. Naval Research Laboratory.

I cannot urge you strongly enough to read his paper when it becomes available. It is a comment about a paper published in *Nuclear Fusion* on the proposed fusion pilot plant by General Atomics, as described in a 2021 paper. [11] The lead author of that paper is Richard Buttery, the director and vice president of the DIII-D National Fusion Program at General Atomics.

Manheimer has provided me with an advance copy of his manuscript, but does not want it shared publicly until General Atomics provides its response. *Nuclear Fusion* asked Buttery for a response in January.

The Manheimer paper shows that the Buttery paper contains a number of overly optimistic assumptions for the proposed pilot plant design. Manheimer has allowed me to quote this part of his summary. I have edited it with bracketed text for clarity for non-fusion experts:

> In all of the cases General Atomics discusses, they assume that with a 4-meter [major radius] tokamak, they can get double or triple the power of ITER with its 6-meter [major radius] tokamak. Note that ITER has been designed by the largest, best, and most experienced team of designers in the world. Is it really likely that [the ITER team has] overlooked something that can double or triple the fusion power in a device [as proposed by General Atomics, that is one-third] ITER's volume, and thereby reduce the total cost and construction time very significantly? Does the ITER team agree that this is possible? In short, General Atomics is assuming that they have found a way operate in a [performance] regime [that is] far more advantageous than [either] ITER [or] other large tokamaks have found.

Manheimer also allowed me to quote his conclusion:

> The effort to build fusion pilot plants is largely funded in the private sector and the money involved is large. Helion brags that it has attracted $2.2 billion; Commonwealth fusion, $1.8B; and TAE, nearly $1B. ... Of course, these private entities can spend their money as they wish, and perhaps they will make some contributions to fusion. However, if their investors expect any payoff in the next decade, they are in for a big disappointment.
>
> The General Atomics proposal may be different. Are they proposing it to the government or to the private sector? If the latter, good luck to them. If the former, it is important that the government-sponsored magnetic fusion energy effort, and whomever else it can convince, unite against them. This vastly premature effort would be draining enormous resources from the American taxpayer to embark on a futile quest of tilting windmills. These fusion resources could be much better spent answering some of the issues brought up here on a smaller, much more affordable scale.

4. FUSION FUEL ILLUSION

4.1 The Fuel for Future Fusion Reactors Does Not Exist

These four bullet points encapsulate the issues regarding the deuterium-tritium fuel needed for fusion reactors. With the exception of deuterium, the fuels required for nuclear fusion are not abundant, virtually unlimited, or accessible everywhere. Specifically:

a) After ITER, there will not be enough tritium to operate any large fusion reactor. [1, 2]

b) The alternate plan — to make tritium from lithium, enriched in the lithium-6 isotope — is constrained by the absence of physics or technology that will allow a fusion reactor to make tritium from lithium-6 faster than it consumes tritium. [3]

c) There is no known technology that can produce enriched lithium-6 in the quantities needed (tons) for fusion reactors without using an environmentally hazardous and illegal mercury process. [5, 6, 9]

d) Aside from the military processing of lithium for nuclear weapons, there is no industrial source for the enriched lithium needed for future reactors. [7]

Thus, there will not be enough tritium after ITER to operate one fusion reactor. Peer-reviewed research published in *Nuclear Fusion* shows that we do not have a way to breed tritium fast enough in a fusion reactor to keep it self-sufficient. We do not have the technology, let alone the plants, to produce enriched lithium needed to produce the tritium. The only countries enriching lithium at industrial scale are China, Russia, and North Korea. They're processing lithium for their nuclear weapons.

5. ITER Reactor Assembly Halted

5.1 December 2021 Shutdown

Progress on the ITER reactor effectively came to a halt in December 2021. Two of the first sections of the reactor core that were delivered have sustained damage to elements of these sectors during manufacture. The French regulator Autorité de Sûreté Nucléaire (ASN) formally reported this damage to the ITER organization in July 2021. A number of questions arise about how this happened to both of the sectors that have been delivered. Seven more sectors are on the way. Unanswered questions include why delivery was accepted and why the director-general did not insist that the manufacturers provide replacements.

5.2 Impasse

All we know is that ASN has refused Bernard Bigot's proposed workaround. We don’t know how this impasse will be resolved, how long it will take, or whether it will be resolved. Building such an enormous device, setting up redundant manufacturing facilities in different countries to build

the same parts, shipping some of them halfway around the world, and needing to fit them together with millimeter-scale precision may not have been a good idea.

6. CONCLUSION

After I gave my brief presentation to PCAST on Jan 21, 2022, one member of PCAST asked me about my personal interest. This is a legitimate question. I have no business or investment involvement with any energy research, any company, any scientist.

When Manheimer contacted me to share his critique of the pilot plant, he expressed his dismay that I appeared to have an agenda to throw everything to do with fusion in the trashcan. I explained to Manheimer that that was not my intention, although I can understand why it could appear that way. As far as fusion, I am agnostic: I'm neither pro-fusion nor anti-fusion. Personally, I don't have much hope in fusion as an energy source. But that has nothing to do with my journalism and my activism.

I care a great deal about science. I also care a great deal about scientific integrity. Without trust, science is worthless. I'm also deeply aware of the dangers of false hope. Few things are as important to me as the trust that we, as a society, grant to and assume in the scientists who do their work on our behalf.

For those of you who are not nuclear experts, I am also enclosing references to the articles I've written about the fusion fuel issues. Below those are references to the scientific papers on which my articles are based.

I hope these comments will be useful to you. Overall, I wish you success in your support of President Biden, in service to the citizens of the United States.

Sincerely,

Steven Krivit

Steven B. Krivit
Publisher and Senior Editor, *New Energy Times*

References next page

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Submitted by Steven Krivit as attachment to letter to PCAST, February 27, 2022

President's Council of Advisors on Science and Technology (PCAST) Meeting

Oct. 19, 2021

Richard Hawryluk Presentation and Q&A

https://www.whitehouse.gov/pcast/meetings/2021-meetings/
Full Video: https://youtu.be/4Tc7hNM3_Zc?t=11764
Hawryluk Video Excerpt: https://youtu.be/VqgT5x3LTcM

MARIA ZUBER: I'm Maria Zuber and welcome to the second day of our second meeting, the topic of which is "climate change, energy, and the environment." Extremely important topics which President Biden has asked us explicitly to consider. I'd like to remind everyone that these proceedings are being recorded. I'd also like to remind the members that if you wish to ask a question or make a comment that you use the raised hand function. So today I'd like to welcome back our members, welcome the general public and also welcome our speaker's and now I'm going to turn it over for any opening statements to one of our other co-chairs, the President's science advisor, Eric Lander.

ERIC LANDER: Thank you very much Maria. We had a great meeting yesterday, we heard from a number of speakers about climate and energy and today were going to continue with some more wonderful speakers. PCAST is engaged in trying to wrap its mind around the topic and identify areas where we may be able to make useful contributions to the president's agenda here. And so were delighted to have these public sessions yesterday and today. And this afternoon's session is going to be chaired by our third co-chair. So I will pass over to Frances Arnold.

FRANCES ARNOLD: Thank you thank you Eric and I want to welcome everyone to this continuation of PCAST's dive into technologies for decarbonization and today we'll hear about the potential for integrating fusion into the U.S energy grid. Our speaker today is Dr. Rich Hawryluk who recently retired from his position as associate director for fusion at the Princeton Plasma Physics Laboratory which is a Department of Energy National Laboratory.

Among his many roles there he headed the Tokamak Fusion Test Reactor from 1991 to 1997 which was then the largest magnetic confinement fusion facility in the U.S. He also recently served as chair of the National Academy of Sciences Engineering and Medicine consensus study committee that wrote the report "Bringing Fusion to the U.S Grid." He'll have about 20 minutes for his remarks followed by discussion with the council. Dr. Hawryluk, please take it away.

00:03:02

RICH HAWRYLUK: Thank you very much for this wonderful opportunity. I'll put up some slides and we'll go from there.

I hope by now you can see the slides. This talk is going to be related to some of the talks you heard yesterday and also in your previous meeting: how to bring innovations and science and technology to the forefront and how to engage the private and the public in a partnership to advance fusion energy which is used to power their stars. So I'm going to talk about that today.

This is a, I'm going to give you the highlights from the National Academy of Science Engineering and Medicine report and I'll begin by giving the two key takeaway messages from that report.

First of all, the first recommendation is the United States be the leader in fusion and to make an impact on the transition to a low-carbon emissions electrical system by 2050. The Department of Energy and the private sector should produce net electricity in the fusion pilot plant in the United States by the 2035-2040 time frame.

The second recommendation was the United States, the DOE, should move forward now to foster the creation of national teams including public-private partnerships that will develop conceptual pilot plant designs and technology roadmaps that will lead to engineering design of a pilot plant to bring fusion to commercial viability.

And for this to be successful, for a pilot plant in 2035-2040 time frame, it requires urgent investments by the DOE and private industry to resolve the main technical and scientific issues to design, construct and commission a pilot plant. And this afternoon I'm going to try to go through the background for this as well as the reasons for these conclusions and recommendations.

So to put this in context, let me remind you of a previous NASEM study for a burning plasma research that motivated this one and in particular there are two key recommendations of that study.

The first, the United States should remain an ITER partner as the most cost-effective way to get experience with burning plasma at the scale of the power plant. And the figure on the right, you see, is a component that was recently delivered to ITER. Using low temperature superconducting coils will be part of 13-tesla magnet and it's about three and a half meters across to give you a sense of scale. This is a major accomplishment and the U.S. has been leading this effort and delivering on its commitments.

00: 05:52

The boxes in blue incidentally are updates since the Academy study uh to show you some recent developments.

The second recommendation, which is really what the focus of today's talk is about, is the United States should start a national program accompanying research and technology leading to the construction of a compact power plant producing electricity from fusion at the lowest possible capital cost.

So let's begin with the question, what is the role of a pilot plant? And we talked about that in the report. What we learned was the utilities foresee a transition to low-carbon electrical generation by 2050, and as you heard from this discussion yesterday there's a desire to accelerate this. We furthermore heard about the need for firm low-carbon non-carbon electrical energy from Jesse Jenkins yesterday and this has several important roles.

First of all, if you rely solely on renewables, which are very important, you can get fairly far along the path to carbon emission but then there's a risk of increased cost. To solve that problem you incorporate by firm low carbon technologies to decrease the cost and improve the grid stability. In addition to these motivations, a pilot plant must provide the technical economic information needed for utilities. We learned about this from utilities is a very important consideration both in construction costs and operating costs. This resulted in a set of goals for a fusion pilot plant. I will not go through all of them but to give you some of the highlights.

A pilot plant must produce an amount of fusion power and energy that is sufficiently representative of the market needs in order to meet the integrated performance and cost goals so that the utilities will know what the technical and cost information for first-of-a-kind power plant. Also to demonstrate net electrical production, Q greater than one, and produce net electrical power of greater than 50 megawatts. And we see this as occurring over frame starting the electrical production 2035-2040 and getting enough reliability information to be in a position to make a decision in the first-of-a-kind power plant by

The report also provides a national strategy for a fusion pilot plant for integrated fusion performance, electrical power to deal with the materials manufacturing components. You're exposed to radiation; to deal with the deuterium-tritium fuel cycle, if you use that to breed tritium, or consider alternate fuel cycles. The important issues are reliability and availability and environmental safety considerations. Regulatory framework will be needed for fusion. The NRC is holding some open meetings. I would like to report that the United Kingdom is moving ahead very rapidly in this and has already issued a report and is involved in the public consultation to finalize that by the end of the year.

00:09:17

They're also are looking for siting for their version of a pilot plant.

The report talks about the economic considerations for a pilot plant and we start off with looking at, in today's energy market, that the [inaudible] first of all kind power plant will need to have an overnight construction cost of less than five to six billion dollars considering the utilities in the United States. What that drove us to is a conclusion that the pilot plant even with a reduced generating power only 50 megawatts, we expect that first-of-a-kind will have much more than that we should also be constrained to construction cost of five to six billion dollars just to start the whole process of driving the costs down and realizing that cost is an important economic consideration.

Innovation and research investments are targeted to meet the technical economic goals they are needed to reduce the cost of pilot plant and accelerate the schedule. We also needed to improve the economics of the first-of-a-kind power plant to meet the challenge of having a viable design by 2028 and an initial pilot plant operations in time scale 2035-2040. Innovations in fusion confinement concepts of technology to extract the fusion power and close the fusion fuel cycle should be developed in parallel.

We can't do the science and then do the technology. We need to do both and as well as the design and this is going to be accelerated by a combination of government and private funding. There's been some important developments in the confinement of fusion.
A pilot plant will need to be based on a vetted well-established confinement physics basis for achieving net gain plasma gain well in excess of unity. On the left hand side you see results from magnetic fusion energy. You can, the so-called triple product is a metric to show how close you are to obtaining net energy gain. Experiments both in Europe at the United Kingdom as well as United States in my previous facility Tokamak Fusion Test Reactor, have demonstrated [inaudible] produced fusion power and achieved obtaining a net energy gain of about 0.6.

Most recently and this is exciting results we've gotten over the last month then and it was also the National Ignition Facility have shown a very important breakthrough in obtaining uh energy gained uh yields of about 1.3 mega joules and again an energy gain of about 0.6.

An important development in all of this in the use of computer simulations. They've been widely used in the tokamak program and the magnetic fusion program particularly accelerators that have optimized design. You can see that in some of the results from German facilities in the green hexagons as well as in the design of the capsules being used in [inaudible]

00:12:22

This is an area of strength the United States, to drive performance improvement and design.

There are important technical innovations, research opportunities that we need to exploit to make progress. One example is high temperatures conducting magnets and once again it's been a major development recently, Commonwealth Fusion Systems and MIT announced the achievement of a 20-tesla large bore high-temperature superconducting coil. The size of this is two and a half meters across. It's an important development in the pathway to magnetic fusion.

Development structural and functional materials and particularly assessing the neutron degradation.

Development of high heating plasma heating systems and actuators high efficiency.

Closing the fusion cycle for tritium processing developing the breeding blanket.

Many of these elements are still at a low-level technical readiness but as we have seen from the example of the development of the high-temperature superconducting coils, with appropriate investments they can result in rapid advancement.

In order to make, to develop the pilot plant, we believe that diverse participation is needed and in two different ways and both are equally important. We embrace the recommendation of the community planning process to embrace diversity, equity inclusion developed a multi-disciplinary workforce required to solve the challenges in fusion and plasma science and we believe that teams made up of private industries, national labs, and universities bring together important strengths.

Industry brings the focus and deployment and usable product by time frame of the market needs national lab and universities with innovation and deep technical expertise. We need to combine both to make the progress and accelerate the schedule.

We discussed public-private partnerships and we feel that the DOE needs to develop an appropriate model for fusion. The NASA commercial orbital transportation services program achieved remarkable success. You are all very familiar with that for commercially competitive space transportation has significantly less cost than government.

00:14:45

While the NASA COTS program holds promise in general the technical readiness level for space transportation is substantially higher than that for major fusion energy systems.

So we recommend that the Department of Energy to identify the best model to accelerate development and reduce the government costs of fusion pilot plan and note that for different phases different models may be needed and the government does have different models. The question is what's the appropriate one for fusion.

In our report we identified a strategy in the roadmap from where we are today to getting to the goals and obtaining fusion energy and put energy on the grid and to evaluate the whole fusion process.

We've discussed and I'm going to focus on the immediate actions what we need to do today. We need to form national teams and we talked in the report about two to four national teams to look at different concepts some of the concepts as we talked about in the previous slide a fairly high level of maturity but others are less to have engineering promise and we need to exploit.

So we need to evaluate those and to develop the conceptual design technology roadmap which will be different for different concepts. Different from magnetic fusion compared to say inertial fusion or different types of magnetic fusion. We need to demonstrate the physics basis to go to higher levels of performance increase the technological radius levels of the critical technologies as i mentioned earlier, define the regulatory framework and identify possible side options.

And perhaps most importantly we need to perform the preliminary design. This is critical to obtain a good cost of schedule basis and we want to do that by 2028 in order to have a decision to construct. If the preliminary design doesn't have a cost that's commensurate to what we talked about earlier and it doesn't have a pathway to a viable fusion project then we need to do even more innovations. But we feel that this plan if properly funded we can do the innovation but that clearly is a clear decision point that's needed to decide how to proceed with this.

With success we will then go on to the final design construction go into the operating phase with decision on the first-of-a-kind power plant in 2045.

00:17:14

cWe realize that this plan has risks and opportunities and we try to mitigate those risks. The risk obvious one is the schedule risk due to the level of scientific and technological readiness. The schedule there's another risk which is the flip side of that and we [inaudible] support the transition to low carbon electrical systems and clearly we would like to accelerate that.

We want to note that the United Kingdom and China have both wanted and stated that they'd like to be the first to put fusion on the grid. So there is a opportunity here but also a risk that others will be first. Obtaining public and private funding is always a concern. There are opportunities for instance the [inaudible] of the private sector over now a period of time worldwide the private sector has spent close to two billion dollars on developing a fusion energy.

We want to impact the transition to low carbon emission electricity both in the time scale of 2050 and beyond because the need for low carbon especially in the developing world will be great. We want to be a leader in development of fusion energy. We believe we can mitigate the risk but perform the R&D in parallel with the design and we've identified clear decision points to evaluate progress so we make the right decisions as we move forward. We believe that this plan has identified the goals innovation and timeline to put fusion on the grid. We recognize it's a bold plan and we also feel it's achievable.

The United States historically played a major role in development of the fundamental science for fusion. We the United States can take a lead in this technology or let other countries take the lead. Other countries are very much actively pursuing that. So this is an opportunity for us to move ahead and I hope uh with your support we will do so. I want to thank the committee members who participate in this. This is a very broad group of people with expertise not just in fusion but also energy systems, utilities, operators and fission and material science and it was very valuable very interesting discussion. You can find a lot more information on the website. With that I'd like to open it up for questions and uh and hope we have a good discussion thank you.

ARNOLD: Thank you very much. If we stop sharing then we can have a view of all the committee members. Eric would you like to open?

HORVITZ: Yes, sure, thanks. Thanks for the overview. I want to read the report from National Academy.

00:20:10

Sometimes things just take time and I'm curious at the current levels of funding for fusion research, how sensitive are likely breakthroughs and advances to get us much faster to the to the prize than 2050 with additional funding and if so where would that funding go? I was curious what you think about the sensitivity versus waiting around for the stochastics of breakthroughs?

HAWRYLUK: I think that we have focused in recent years in the United States largely on the scientific issues which are obviously important and there's more work to be done there. But it also there's opportunities on technical issues and it's important to do those in parallel and this also can be a great deal of synergy by working on the scientific issues with the technical, looking for clever technical solutions where you will end up having some scientific issues and some things do take time but we believe that with funding both of the technology which should be done in both in labs universities but also in private industry, combined with the scientific developments we can move forward on this.

HORVITZ: I just follow if we really believe 2050 is going to be a success, you know, you think we should we should fold that time over a bit and realize that we're way under invested right now potentially?

HAWRYLUK: We are under-invested. If we don't increase the investment we will not meet that timeline. On the time scale we're working with now that that will not be achieved. So you're absolutely correct

ARNOLD: Terence Tao you're muted sorry.

TERENCE TAO: Thank you for the very nice presentation um so I have a question about whether there's any sort of consolation prizes for this project. So clearly the primary goal is to get net energy generation um sustainably for um by a certain um target date but suppose the technology stalls um before it gets there. Are there any other economic benefits or environmental benefits that this technology could generate?

HAWRYLUK: Well the development of plasma science has many uh other benefits to society. For instance [inaudible] widely used in the other errors like micro circuit fabrication. Every one of your computer chips is using plasmas. In addition, the work that's being done in uh on ICF has national security implications and is part of the national stockpile stewardship program. So there are other aspects of this uh which are clearly important for society and for the United States um but you know this report really focused on as it was a statement of task the efforts associated with fusion development.
00:23:00

TAO: Okay, thank you

ARNOLD: Marvin Adams

MARVIN ADAMS: Hi, thanks, I'm going to ask a few questions if I may. So one starts with a kind of summary of the history of lessons learned from the fission industry and one of those lessons is that in the end the physics part turns out to be easy compared to the engineering and chemistry and safety realities which tend to be the drivers for cost and schedule. I'm just wondering how much that's been thought through so far in the fusion world so that's question number one.

Question number two. Is anything other than a deuterium-tritium fuel cycle viable on the time scale you've laid out for the pilot plant and if not, do you agree that it's important that the pilot plant demonstrate a sufficiently high tritium breeding ratio because if fusion's going to have a commercial impact with a DT cycle we're talking about breeding a lot of tritium, a lot of tritium, thanks

HAWRYLUK: Okay so these are excellent questions so let me uh work my way through them. I absolutely agree with you that you need to combine both physics and technology and when we do studies both in this country but also in other groups around the world the technology issues associated are extremely important. And the integration of the physics and technology and this is actually a theme throughout the report is necessary to really make the progress.

The work that we've been doing on ITER has given us a great deal of insight in some of these issues associated with systems integration, systems engineering that need to be done to uh develop fusion and uh you know it's you do need to combine both. We've also seen that recently in the NIT experiments.

Let me talk about the deuterium-tritium alternate fuels. The report uh was very specific that we were not to evaluate different uh concepts so we had to, we wrote the report to not only consider DT, but also alternate fuels as well as different fusion concepts.

If we do deuterium-tritium, one of the goals that was on the slides was to actually demonstrate uh the fact that you can breed tritium in sufficient quantities. That's an absolutely critical role for deuterium-tritium operation and it is something that needs to be done.

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We think it's doable but this is an area where frankly there are many different approaches um to breeding the tritium and they have to be demonstrated they have to be evaluated and that'll be an important technological undertaking associated with this.

The scientific requirements, you know so-called triple product, density, temperature, confinement time; that's a metric that we use, is higher for non DT fuels. So from a scientific standpoint you have to have a confinement system which is more confident and more capable than the deuterium-tritium one. On the other hand there are some engineering advantages. There are private investment companies which are actively pursuing uh non-DT fuels. People are at R&D level one [inaudible] they're also others using helium-3. That's actively going on in the United States but also in Europe. You know and we basically in our report show what requirements are for both and discuss that.

ARNOLD: Thank you Laura

LAURA: Thank you Richard that was very interesting I've been keeping an eye on fusion energy since I worked on Helios Antares a long time ago and of course that probably left me with negative feelings and I've been on a lot of panels looking at ITER etc. and I have uh one concern and then a second concern uh about that are really more global.

The first one is that this has been going on for a really long time and there's some very serious fundamental physics questions; whether it's plasma or ICF or whatever and you know if NIF can make that impressive 0.6 gain that's great but you can't build a reactor out of that for as far as ICF and do we know how we're going to get energy if we ever get a sustained reaction in something like ITER?

So I'm not quite sure what the pilot is going to be and so give me some hope that in 2028 we could actually have designs that we could move forward because this has been going on for so long.

The second one is I'd like to know more about — I'm a little concerned that the way NASA works with industry national laboratories and university would work on this. This is very expensive very complex and a lot of um gains uh monetary gains to be made and I think the U.S. government may have to play a fundamental role in making sure that this is all done evenly. And also how you would get these groups to work together would be pretty complex I think. So those are my two questions.

00:28:39

HAWRYLUK: Okay if I don't answer all of your questions please ask them again

LAURA: In a nutshell, one do you really think this, you're going to get a sustained reaction to get energy out of it by 2028? Number two, are you really going to get industry laboratories and universities to work together without trying to steal from each other to put it in generally.

HAWRYLUK: So let me begin with the first one. We agree with you. We made very clear in the report that if we don't have a fusion system that can produce more power out than the heating power that goes in, in terms of ITER, it would be nice if it is done with DT but even if it's done in deuterium you can make the extrapolation to deuterium-tritium – you should not go ahead with constructing a pilot plant. We think that is a metric showing the technical performance that's important.

Now you have to adjust that the parameters for non-DT fuels and all that but this is all doable all straightforward. The point here is you need to have the technical confidence that the physics is there. We believe that in some of these areas we're getting close. But we do need to demonstrate the scientific confidence and that's actually explicitly in the report and is explicitly actually one of my slides.

So I agree with that. And I think there's you know efforts underway um you know extensions of what we're saying done on NIF, extensions of what we're doing a magnetic fusion in terms of uh new uh concepts which are coming online new facilities online which uh we hope to bridge that gap.

The second one you talked about is the public-private partnerships and how we all play together and work together. I actually think you hit the nail on the head there. This is something that we as a community but also as a country need to work out the details on. You know what um we need to ensure that the government's investment is a wise investment. We also need to make sure that there's a sufficient um gain for the private investment to participate. There's work to be done there to how to develop these partnerships so partnerships only effective if both sides win. And I actually think that you know in the short period of time that we did this study which is about four months then one area that there's more work to be done on in my opinion is exactly how we structure public-private partnerships uh to be most effective to take advantage of this.

The opportunities are there. We heard from the private companies that they really want to work [inaudible] national labs and universities. We've heard from them that they want to work with the private but now let's figure out what the model is and how we do this.

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I'm not dismissing your question my action is completely supporting it.

LAURA: Well, we'll need your help on that.

HAWRYLUK: I'll be glad to participate anyway I can.

LAURA: Thanks.

ARNOLD: Bill Press

BILL PRESS: Yeah hello. I'm looking at your report actually on my screen and especially at the charge to your report and the charge is very clear that your report was not supposed to ask the question "Should we build a pilot plant?" but it says the Department of Energy is presuming to build a pilot plant, how should we do it?

It looks to me like the committee was a good committee to answer that question. It doesn't look to me like it was the right committee to answer the question "Should we go ahead and build a pilot plant?" For example such a committee in my mind would have people who would have more of an analysis of alternatives uh of other sources of energy that could be developed in that time scale and what the trade-offs would be.

So you know I think much of what we've heard from you had a flavor of "We should do this." That may be your personal opinion but I wonder if you could tease apart a little bit, what part of this is your or the committee's personal opinions versus what part of this do you think was really answering the charge which simply didn't ask that question.

HAWRYLUK: Well you're correct. The charge was very specific that we were to basically evaluate and provide guidance to the Department of Energy as well as to uh the participants in particular the private sector uh as to what's required to move ahead with a pilot plant to have a common base of discussion for both partners uh to have to move forward on this.

There's a much broader discussion. What is the role of fusion compared to other things. We talked about some of the things that fusion would have to achieve in order to be effective in terms of impacting uh energy and in particular also go to more non-carbon and other considerations but we did not do an analysis of, say, comparing fusion and fission and fusion and carbon sequestration. That was not part of our charge and so you know I have tried in my discussion not to give personal opinions but to adhere to what we've discussed as a committee and that as I think everything I have discussed except for

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the new items issue in blue boxes more things which are you will find actually in the report.

ARNOLD: Well we would love to hear your personal opinion and what would you recommend to the President if you had the opportunity.

HAWRYLUK: Well I actually am very supportive of our final conclusions. We need to set up these national teams. We need to basically address the question that was just asked of me. You know how do we work together to accelerate this process. That would enable us to more efficiently and effectively utilize the strengths of the national labs and universities as well as private industry to accelerate the development of fusion. The opportunity is there. I believe we can and should move ahead but we need to basically get on with it and I think you know that's the first step.

ARNOLD: Eric would you like to jump in?

ERIC LANDER: I would. Can I take another run at Eric Horvitz's question. So on the one hand you're saying we might have commercial fusion reactors in the 2050s sometime. On the other hand there are people in industry who are talking about having — selling commercial reactors by 2030 or so.

So you know you wonder is the NAS committee overly pessimistic, are the people from industry overly optimistic. I don't want to you know necessarily press that too hard, but I might ask suppose it was a national priority to have a vibrant commercial fusion industry by the 2030s, not the 2050s, what would you do? Could you do it or is this like incompressible or is that, you know, doable and what would it take?

HAWRYLUK: Let me try to answer it in the context of what we thought about and said in the report. We do know because we ordered us and some of the fusion companies want to do this faster than what we said in the report. We also know that other countries think it'll take longer. We basically thought took both of that into consideration. Having said that the first step is training these national teams to develop a technology roadmap. As a result of that some of the concepts may be able to be accelerated faster than what we said. It may also be as we really dig into it people will realize that if you want to do all of these things and in particular demonstrate reliability and operation it will take a bit longer.

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We talk in the report and talk about generating electricity in 2035 to 2040 time frame but we also felt that in order for industry to have utilities to have the confidence in technology we need to run it for a long enough period of time to demonstrate maintenance and operations costs. You can take a more aggressive perspective that you once you build this and once you have confidence in building it you can do these things in parallel. You can maybe move ahead at risk towards building some larger plants and move ahead. We did not examine all possible options and opportunities. We basically laid out what needed to be done in particular valuing technology for reliability and utility costs. Clearly as time goes on people can re-examine that and come to somewhat different conclusions. But this reflects our considered opinion of these topics.

LANDER: Thank you

ARNOLD: Maria

MARIA ZUBER: Thanks for that thanks for that good presentation. I have a I have a couple of questions. So first of all when the um the regulatory framework that the U.K. released um they made a statement with it that the U.K. aspires to lead the world in commercial fusion. So you know there there's a you know a fusion experiment going on in the U.K., experiments in China and a number of different um activities in in the U.S. one at my home institution MIT, one at Princeton [inaudible] institution and various others. Is there a risk that we could win at the technology and lose on the commercialization because of the short-sightedness or the bureaucracy of um or the public sentiment in developing an appropriate regulatory framework and if so what do we need to do about it?

HAWRYLUK: Well let me make a couple of comments. First of all the NRC is holding some public meetings on developing a regulatory framework in the United States. So they have begun that process and they have the lead in the United States on developing the regulatory framework. But the U.K. is moving ahead in some ways more briskly than the United States is in this topic. So that needs to that is an important consideration that needs to be dealt with.

The issue of commercialization is an area where I think if we carefully deal with this we can have an advantage by engaging the private companies along with the public early on we can perhaps accelerate this. This is you know venture capital and is a strength in the United States as well and moving into uh commercialization.

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The question is how to take advantage of that and I think you know we've already seen a fair amount of venture capital moving ahead in terms of supporting fusion. We I can see if there's a clearer effort meant to develop a strong partnership to the public and private sector, this could be symbiotic. It can help both sides and to accelerate. For instance the Fusion Energy Science Advisory Committee report which is very good report which came out identified the need for working with the private sector but did not incorporate how the private sector would actually accelerate the process uh because it's just done somewhat it was really focused on the public part. This is when opportunity to combine it to accelerate the development.

ZUBER: Yeah thank you yeah and um and my second question actually um actually relates to that somewhat so you're correct there's been you know quite a lot of funding that's going into commercial fusion right now which I think says in itself that fusion is probably not 40 you know years away anymore because uh companies would or venture capital would not be investing in it if it was.

HAWRYLUK: Correct.

ZUBER: But there but as you as you noted in your presentation you know there are still um well there are science questions but they're also you know engineering this there are still kind of fundamental investments to be made and to this point you know much of the U.S. fusion budget is being invested in ITER which is an excellent experiment um but is the investment in ITER going to be um adequate or appropriate to develop these other engineering um needs for uh you know the different fusion experiments.

They're not just tokamaks there's you know inertial confinement uh etc. and then there's the TAE approach. So um so is there is there enough fundamental investment in in maturing to the stage where um where you can accelerate this in the way that Eric is talking about.

HAWRYLUK: To accelerate this requires additional funding over above what we have today and that's very clear and important as I hope was clear in my presentation. We discussed in the report that even today ITER is providing very valuable information that will help in developing the pilot plants but to develop some of these concepts which are not especially those which are not tokamak specific this is going to require additional funding but even for the tokamak, in order to get the costs down we're going to have new innovations that are basically required and this is part of our plan to not just develop a platform that generates heat but to capture that heat breed tritium breed electricity and to reduce the cost.

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That's important these are very important technology engineering issues that need to be resolved along with the scientific issues.

ARNOLD: So actually I'd like to jump in and follow up on that. Is there a risk that going for a pilot plant given the cost too early would actually suppress innovation uh in these other concepts right? Because you will have to choose a technology to move forward with in the pilot plant. Is it possible that that would then pretty much cut off uh development of other technologies.

HAWRYLUK: I think not and the reason I say that is that our report talked about starting off with two to four national teams and basically capture different configurations different technologies different approaches to developing fusion. We did not it was not our charge nor our mandate to specify one specific technology and one configuration we did not but I think the advantage of doing this and we saw this in the COTS program at NASA is that not all technologies work out equally well. Not all uh approaches work out equally well having both competition but also recognizing that some things will be more successful than others is important elements of this.

ARNOLD: Ash Carter

ASH CARTER: Thank you a very good presentation. My question was gonna be uh the one that Eric asked which is why my hand went down but I'll ask another one instead. It is a strange - is a very good presentation, I thank you very much. As Bill said, it is a strange charge uh to task a demo um when one doesn't exactly know what is being demonstrated uh and a demonstration is itself kind of aspirational um and so it is a hard thing to get your arms around Richard and uh I commend you for doing well under that circumstance. But it is it is a very odd charge. The nugget that I get out of this that I think is most durable um is the public-private partnership one.

That seems like the clearest positive value proposition here um because as uh Maria was saying there is a certain amount of private money flowing in. I don't know Maria whether that proves anything about the ultimate wisdom of where that money's going but it but it's green um and so uh we might as well use it for this uh cause. And so I think the public-private partnership is the part of this that makes the most sense and that also doesn't require um something your committee wasn't charged to do but what the real world at large needs to do which is trade off between doing this and doing other things.

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That's certainly true for the DOE budget and to some extent it's true for the regulatory agencies as well and so we need to decide whether in those contexts it's worth the money and worth the trouble uh to go after a DEMO like this but if you can complement it with private sector effort and money then I think you really have something.

So I think that's the to me Richard that was this uh the most persuasive part of the report; the national teams uh on a public private basis that's where we're most likely to get some value out of the pursuit of this demo.

HAWRYLUK: Thank you I agree with the importance of the public-private partnerships. I also feel that this report maybe didn't explain uh all the work that's been done over years in terms of discussing and defining what a demonstration power plant would be or in this case a pilot plant which is somewhat less ambitious um but having said that it provides very clear guidelines to both the technology people and the scientists as to what they need to do to get there without being specific as you know you need to put this bolt n that hole um and you know it has to meet this nuclear grade or not nuclear grade material that's inappropriate.

On the other hand just the common view as to what's required to go ahead what the utilities are interested in I found to be on a personal level an illuminating discussion and I hope other people when they report can get that value from that as well.

CARTER: That's exactly what got out of it thank you that's a very good way of saying it.

ARNOLD: Maria.

ZUBER: One more question for me on um on education. So um so it's been a real um uphill battle developing the next generation of um fission plants okay, the low enrichment which I which I believe also we ought to be you know investigating carefully because we uh I think we're gonna need all the zero carbon options uh that we can in terms of evaluating what works best or maybe we'll even need them all. But you know the public perception the regulatory issues is there anything that we could learn um from the uh the process of um uh public engagement in the and regulation that can help us in the, I'll say, education process of trying to gain public acceptance for um for fusion as we move ahead here.

HAWRYLUK: Well let me give an example a personal example is I was responsible for the deuterium-tritium experiments at Princeton and as you all know Princeton is located between Philadelphia and New York.

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And so making sure that we did that properly was absolutely paramount importance but to get community acceptance and to engage the community was very important as well.

We had many meetings with the community. We had people coming in we gave them tours at the facility before we brought tritium on site um so they were confident in what we were doing and they understood what we were doing. So if we're going to go ahead with this technology and I hope we do engaging the public at all levels both from the high policy makers such as your committee but also from the person down the street who's working in the bakery or the supermarket we have to engage them all and they have to be confident and comfortable with this um and this is an important element this whole issue of outreach and education.

ZUBER: Great thank you

ARNOLD: Good timing well if there aren't any other questions, council, this is your last chance we'll pass it on now to Maria Zuber to introduce the next speaker.

Submitted by Steven Krivit as attachment to letter to PCAST, February 27, 2022

President's Council of Advisors on Science and Technology (PCAST) Meeting

Jan. 21, 2022

Fusion-Related Excerpts

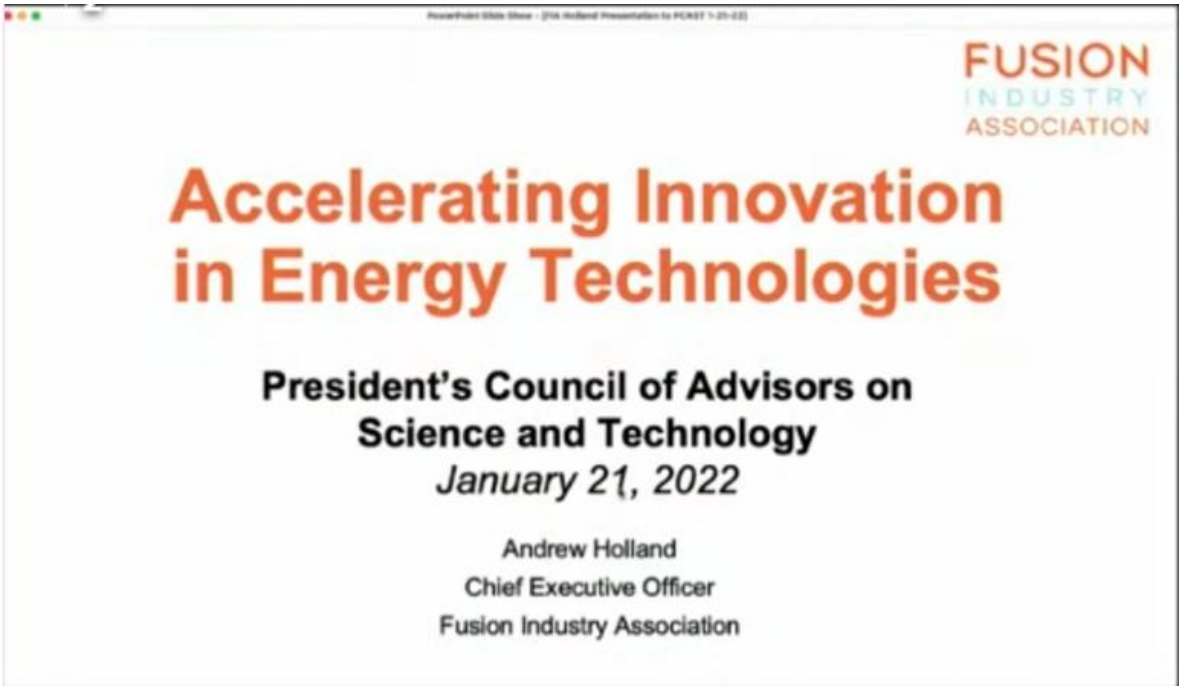
https://www.whitehouse.gov/pcast/meetings/2022-meetings/
Full Video: https://www.youtube.com/watch?v=8AIIj3F8ArE&t

Speakers Appearing in This Partial Transcript:
Andrew Holland, CEO, Fusion Industry Association
Frances Arnold, California Institute of Technology
Eric Horvitz, Microsoft
Jigar Shah, Department of Energy
Katie Rae, The Engine
Eric Lander, The White House
Steven Krivit, *New Energy Times*

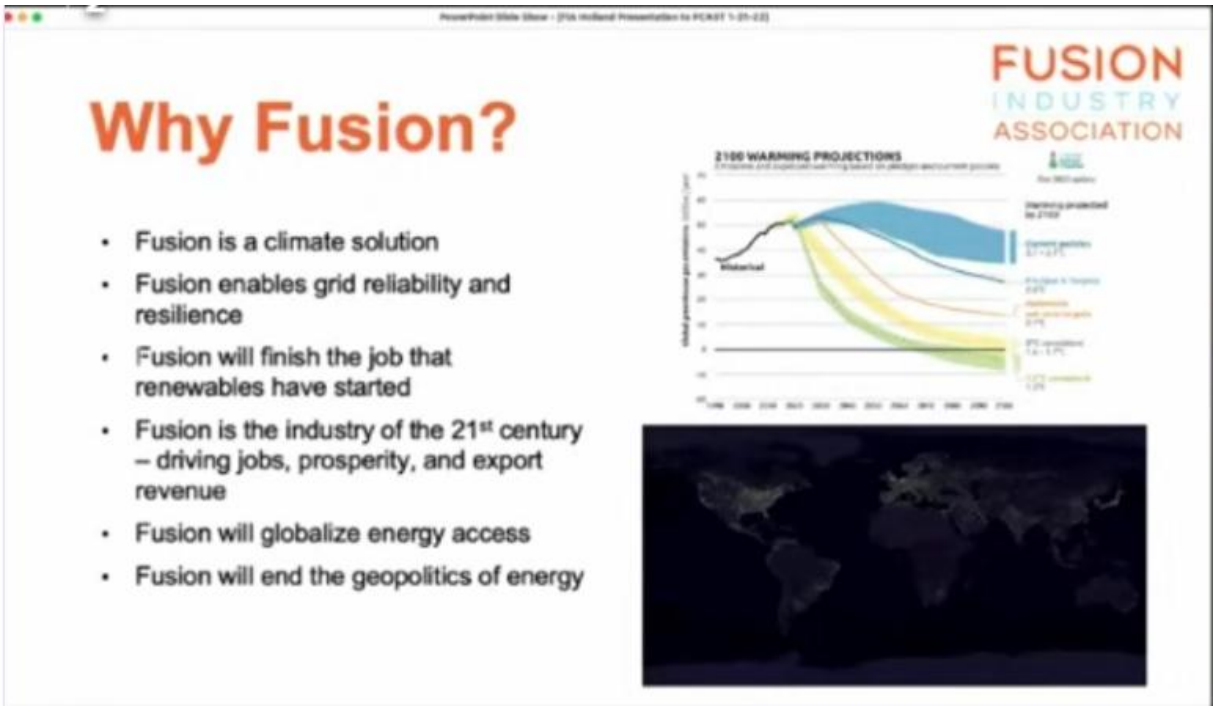
[Video Timecode: 00:17:10 — Holland Presentation Begins]
[Jump to Timecode: https://youtu.be/8AIIj3F8ArE?t=1030s]

ANDREW HOLLAND: Dr. Arnold, thank you. Let me get my slide set up here. Can you all see this?

Okay, great. Thank you all very much.



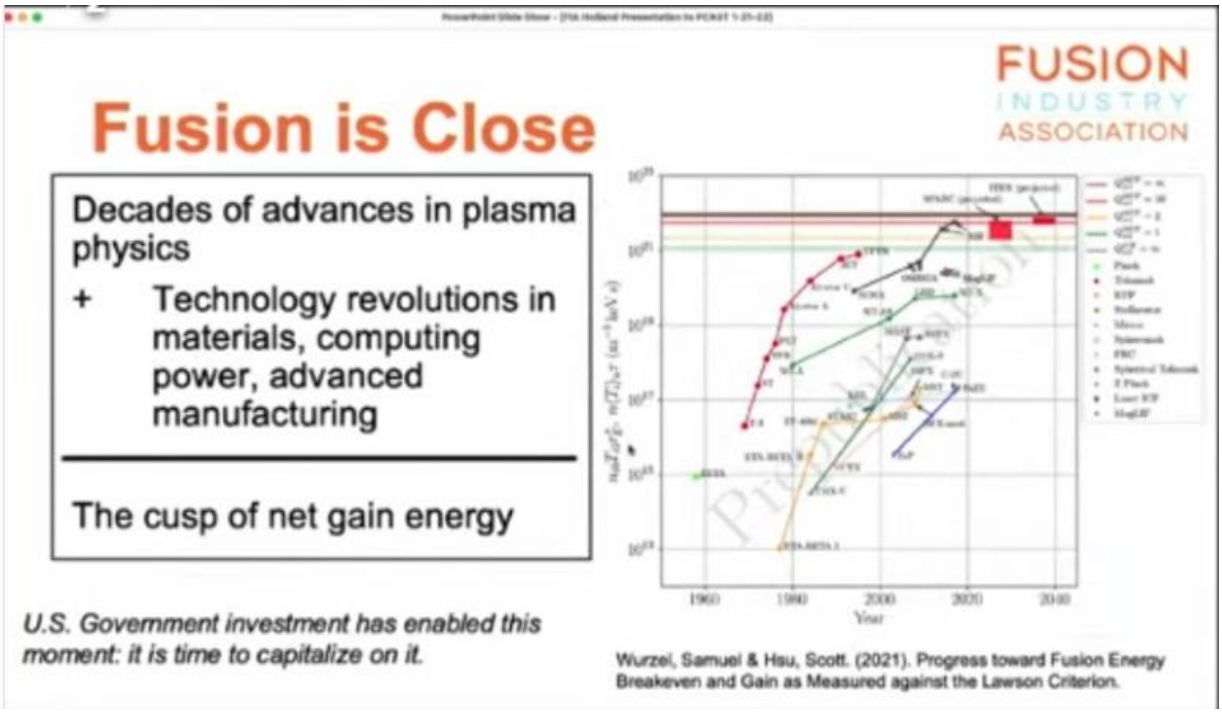
Good afternoon I'm really excited to be with you all today. This is a great opportunity. My name's Andrew Holland, CEO of the Fusion Industry Association. I'm not here as a scientist, I'm here as a policy expert and as the CEO of the Industry Association working to commercialize fusion energy at speed. So what that means is, if you have any scientific questions about anything I say here, I'm happy to set up briefings directly with the leaders of our member companies. I'll answer as best I can.



But let's start with the basics. Why fusion innovation? Don't we have the tools for decarbonizing energy now? We just heard a great slide deck about solar innovation, why do we need more clean energy options? Well, fusion is uniquely suited for the rapid scale-up that will be necessary to address climate change and bring affordable energy to the world. Fusion energy is reliable, firm power that will replace fossil energy sources such as coal and natural gas while acting as an excellent complement to renewables; the wind and solar that we know will dominate the grid of the future.

Fusion is generating green jobs, in science and manufacturing today, and these will only expand exponentially as the industry grows. Fusion can support growing economies and raise living standards around the world without environmental sacrifices. Finally, fusion will break the geopolitics of energy. So a country's destiny is not determined by the size of its hydrocarbon deposits or its mined rare-earth minerals.

So let me underline this: fusion will light the darkness, provide the jobs and industrial base for the 21st century, and make for a more peaceful world.



And fusion is closer than you think. Scientists have been working on fusion for more than half a century, enabled by Department of Energy [public] funding. You can see the real advances in this graph here put together by Sam Wurzel and Scott Hsu from ARPA-E. You see steady advances over time towards breakeven fusion energy across technology approaches. But, costs and complexity acted as a barrier to net energy.

Now, let's add the wider technology revolutions our society is seeing; advances in materials, computing power, and advanced manufacturing technologies, have resulted in new ideas of how to achieve commercial fusion energy. That puts us today on the cusp of a key milestone: net gain energy, more energy out than in, sometimes expressed as Q greater than 1. I believe we'll see that milestone hit soon, whether it's the National Ignition Facility, out at Lawrence Livermore California, or if it's a private approach. We're in the years, not decades, timeframe for net gain energy.

A combination of technology revolution and scientific understanding will enable us to put that milestone into a commercial package. That's why you've seen this explosive growth in the private fusion industry over the last few years. The skeptics who joke "30 years away and always will be" simply haven't tuned in. They haven't seen the advances in the last few years. As I'll show, FIA members believe we can get to fusion on the grid in a decade. It's time to capitalize on our long-standing investment in fusion science. U.S. government investment has gotten us this close but now we have to transition fusion from science to industry. The government must continue to invest in fusion, but the focus must be on the commercialization of fusion energy, not on basic science alone.

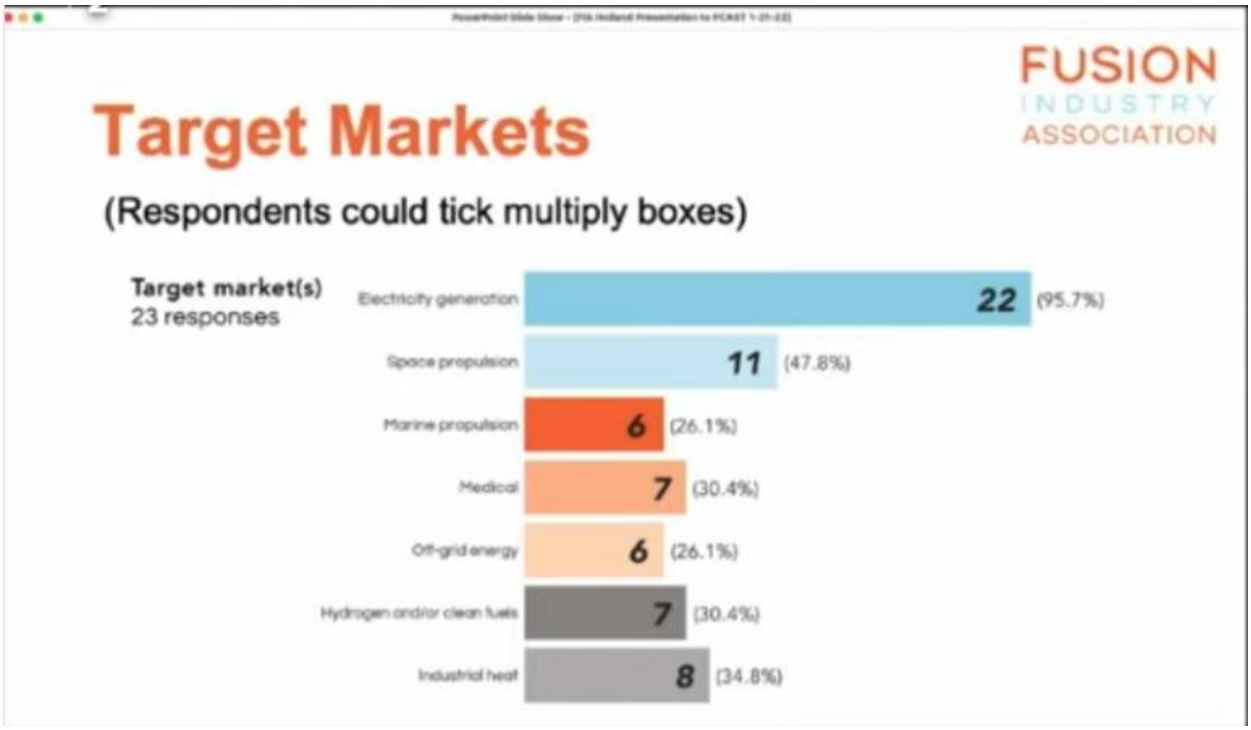
Let me be clear: if the U. S. does not act to accelerate fusion energy, the world won't wait. What's at stake is American leadership and competitiveness in the next great new industry of the 21st century. The U.K., right now is the leader, world leader in planning for fusion with both a plan for a government-operated pilot plant called STEP, by 2040, robust outreach to private partners, and a draft approach to the regulation of fusion energy under the lead of their environmental and occupational safety regulators, not their nuclear regulators.

Our global strategic competitor is moving too: China is beginning to rapidly scale up their fusion work after announcements of records in plasma confinement at their tokamak in Hefei. They're building a new campus for R&D of fusion power plant components, and last summer they approved building of a new burning plasma experiment they're calling [?] by 2027, moving toward their DEMO pilot plant in the 2030s. Other moves include the new Japanese Prime Minister announcing that they will determine their government's plan for commercialization of fusion this year. Likewise, the EU, the largest funder of ITER, is beginning the planning process to determine how to accelerate European fusion.

Meanwhile, sovereign wealth funds from key markets are making their bets on private fusion.

Now, let me talk some details about how fusion is moving from a science experiment into the marketplace. As of January 1st, I can verify 31 private fusion companies around the world. 27 of them are members of the FIA and 21 of the 31 are American companies. So this is, at this point, an American industry. In our survey from mid-2021, we found $1.87 billion in investment and that has grown rapidly to over $4.3 billion by December 2021. And I expect further growth this year at similar scale or even higher.

A few more key points that I'll expand on in the coming slides. Companies are focused on electricity generation and they largely expect commercialization by the 2030s. Let me go into those a little further.



While fusion energy will ultimately enable a revolution in all energy uses, the primary market that private fusion is aiming for is electricity generation. Notable other areas of interest include clean hydrogen and ammonia production and even zero-carbon shipping. So fusion will enable the deep decarbonization across the economy that we need.

And I want to note a surprise when we did this survey. The private sector approach has enabled the broad diversification of technological risk by having companies take multiple different approaches to fusion. Unlike the government-funded approach which has repeatedly cut technologies and move forward towards one way. Without any planning, there are no FIA members who are pursuing the exact same approach [as each other.] They are competing along multiple parallel pathways: magnetic, inertial, magneto-inertial, electrostatic and more. That's what happens when investors accept technological risk in the search for innovation and speed.

Let me just give acknowledgment to the broad membership of the FIA, as shown here. We exist to support our membership and accelerating towards commercial fusion energy. In practice what that means is government advocacy, regulatory support, building business connections through an affiliate membership of 40 companies and nonprofits, and building public awareness. In short, my job is to ensure that the road to commercialization is smooth so that when we do achieve breakeven, our member companies can expand rapidly without artificial constraints.

Now I want to touch on this slide because it's really important. I'm going to sit here for a second. This is a timeline that is relevant. Let me highlight the most important take away from our survey. This accelerated timeline is demanded by investment schedules but also is demanded by the increasingly urgent needs of the climate crisis. Timelines here are indicative and common across the industry but, of course, there is some variation.

Right now, thanks to decades of scientific research in fusion, the design and construction, of breakeven, breakthrough experiments is ongoing by private fusion companies. And this will result by the mid-2020s in fusion devices that will achieve a scientific proof of concept. Scientific breakeven or the equivalent proof needed to move forward. That's soon! The mid-2020s, we're talking three, four, five years from now. Once successful, companies will then move into building and operating pilot plants, scaling up support systems and the balance of plant, and ultimately a rapid global deployment of fusion energy by the middle of the next decade.

So let me acknowledge the skeptics here. This is fast! A decade or more faster than any competitor government programs. And to those who always accuse us of overpromising, let me make clear that fusion innovation is a function of both time and money. Fusion is hard. Fusion will always be 30 years away if no one invests in it. And that's why the catalyzing effect of private investment has been so critical.

Now with that introduction, I want to run through a few high-level policy recommendations. And I've got specifics on all these, and funding asks to Congress and such like that but today I'm going to give you the top line changes needed for a serious acceleration in fusion innovation.

As a representative of the private fusion industry, here are three goals that the U.S. government can do to meaningfully accelerate fusion energy.

First, the Department of Energy must become a partner in the pathway to fusion energy commercialization. Our fusion program, for decades, has lacked an energy mission. Our companies want to work closely with DOE labs and scientists.

Second, if you want to move fast, then the federal government should directly support those who are demonstrating the ability to move fast. We have a plan for a new public-private partnership program that would enable the best of both the public and private sector approaches to fusion.

Please note something here, something that I've noticed in these discussions, pilot plants are built by private industry for private industry, that's the purpose, of a pilot plant.

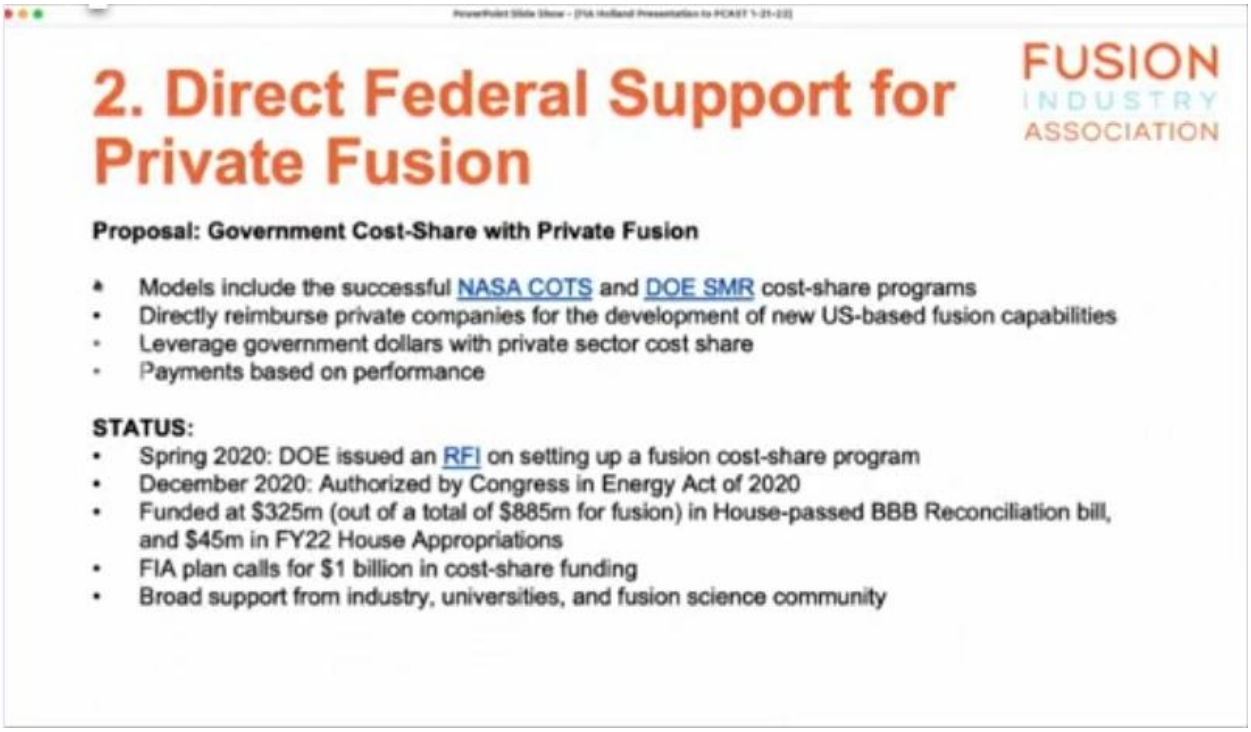
Finally, we need to be certain that regulations won't needlessly slow the rollout of fusion.

So, to start, this may seem obvious, but anyone who's interacted with the Office of Science understands the challenge. The fusion program must have an energy mission, not simply basic science. Fortunately, the outline of how to transition the U.S. fusion program from a scientific research program to an energy program was laid out by both the fusion scientific community and the National Academies of Sciences in reports published over a

year ago. These recommendations have now sat on the shelf for a year. They should be immediately implemented. I would especially note a few recommendations.

The National Academy said we must set up national teams, including public-private partnerships to develop pilot plant designs and technology roadmaps. The community said we can start immediately building new recommended facilities, like a fusion [inaudible] neutron source facility and high-heat flux testing facilities. We must significantly expand plasma-facing blanket and tritium R&D programs. So these new facilities and programs should be built and operated at American national labs, and finally, DOE must also strengthen the fusion research program with new programs in under-invested areas like stellarators, inertial fusion energy, and alternate concepts.

Major research universities are key partners in these programs today and they will create the backbone of the fusion workforce. We support these reports and believe that it's time to implement them. We think we can do them all much faster than even the reports say.

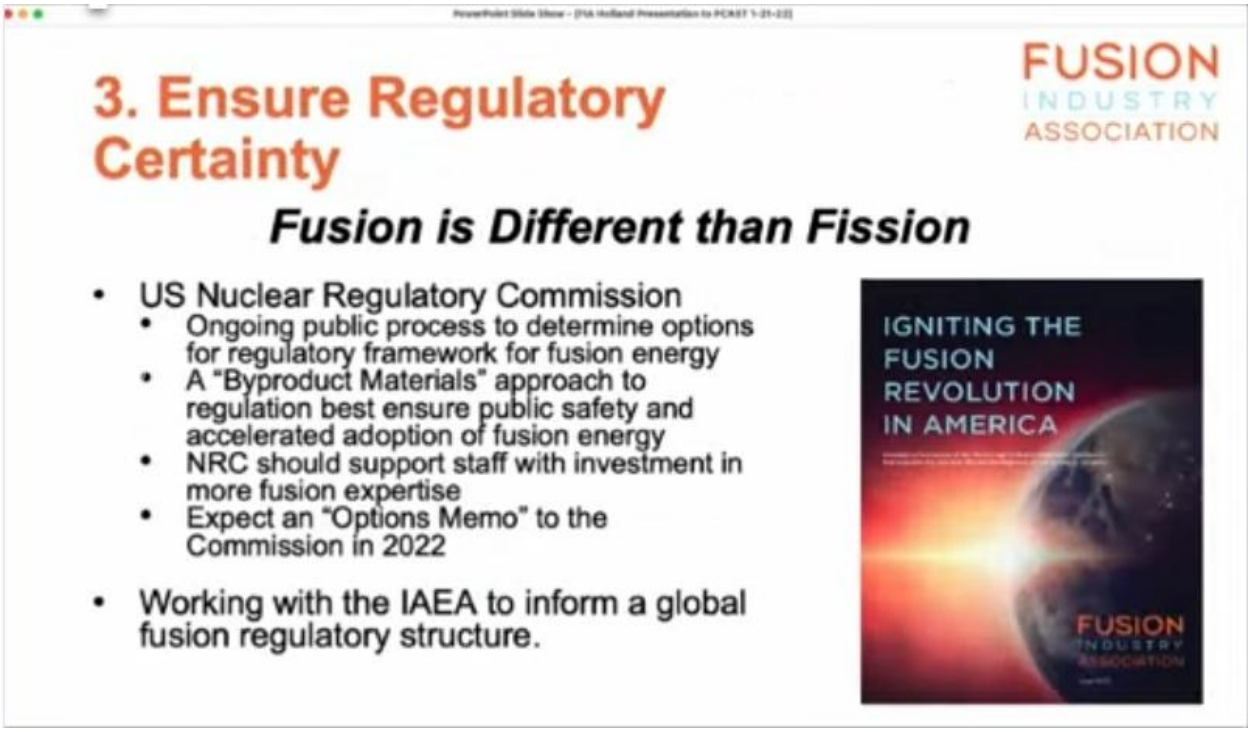


Second, the government must build a robust cost-share program with private industry. The details of how to set up a new cost-share program should be determined by DOE but the need for it should be clear. If you want to move fast, you place your investment with those who are already moving fast. Government funding of private fusion will ensure the industry is American-made and will attract leading talent, entrepreneurs, and investors to the U. S.

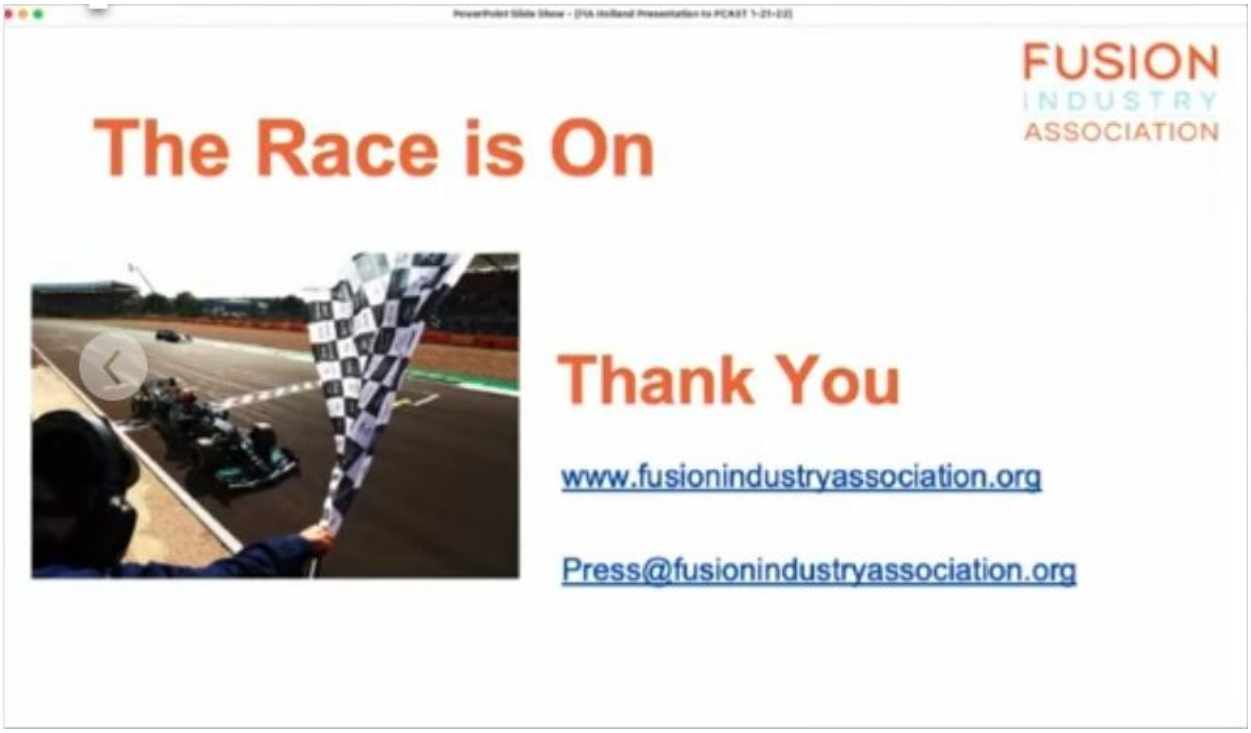
I think it's pretty clear, this will crowd in new investment. With sufficient funding, the result would be several new approaches to achieving breakthrough fusion. The FIA estimated that a $1 billion program would result in five or more new burning-plasma experiments in the U.S. this decade.

Now let's be clear, taking game-changing new technology to market is always a public-private partnership, whether nuclear power in the 1950s, military support for Silicon Valley chip-makers in the 1960s, commercial space in the last decade, even fracking and renewable energy. And this is not some unvetted proposal that the industry's putting out. In the spring of 2020, DOE issued an RFI on how to set up a fusion cost-share program. The support was notably broad. Congress authorized this program over a year ago in the Energy Act of 2020. Draft appropriations bills in Congress right now would fund it, whether Build Back Better or FY22 appropriations. We should not wait another budget cycle to initiate this program, we're ready to move right now.

ARNOLD: Andrew we have wrap up -



HOLLAND: And finally, on regulatory certainty, what I'd say is we need regulatory certainty and we're ready to go there, I'm working with the NRC on that.



And then finally, the race is on. As Director Lander said in comments to the AGU last month about fusion, the race is on, the time to act is now, I'm happy to take your questions. Thank you Dr. Arnold, back to you.

[General Discussion Begins]

[Laura H. Greene asks a question about carbon blasts]

[Video Timecode: 01:12:57 — Fusion-Related Discussion Begins]
[Jump to Timecode: https://youtu.be/8AIIj3F8ArE?t=4377]

ERIC HORVITZ: Thank you. Thanks for the fabulous talks. A comment, question to Katie and Jigar. Where are we with milestone-based programs with fusion? It's not clear to me that we have anything akin to private innovation of space, for example, with what was done with milestones there, for fusion.

HOLLAND: Can I jump on that too?

ARNOLD: Go for it Andrew.

HOLLAND: So that, yeah, that is exactly what we are actively pushing for in Build Back Better, in the House-passed Build Back Better bill there was $325 million for a milestone-

based program. It would largely be, the way we see it, it's kind of modeled on COTS or SMR program from DOE or various other, even ARDP. There's various models for doing it. We are excited for it, hoping it gets ramped up and set up soon. I think it is, this is the way of the future, to do public-private partnerships. It's, you know, doing it the way the private sector funds programs. You meet a milestone, then you go back and you raise more money to get to your next milestone. You don't commit to the whole thing at once and all of the dollars at once. This is a pay-for-performance and meet that there so it's a, our goal is a 50-50 cost share. You know, were ready to do it right now.

ARNOLD: Jigar, would you like to address that?

JIGAR SHAH: Yeah, I mean all of the loans at the Loan Programs Office are structured exactly that way. So, we already do that, we have milestone-based disbursements and as they meet the milestones, we put them out. And many of these technologies in a first-of-a-kind space may take two or three years to meet all of those milestones.

HORVITZ: Yeah, I just didn't see advanced nuclear including fusion.

SHAH: Well, I mean, fusion qualifies for our office. I'd say that fusion, you know, I appreciate all the progress fusion has made, right, but ultimately it's not a commercial product, right?

HORVITZ: Yeah

SHAH: So, even the word "commercial viability" is sort of a false flag in fusion. It means that it produces one kilowatt-hour over what it takes to make it. And so I think that when it actually really commercializes, we'll talk about milestones around deployment and integration inside the grid. And I'm a big fan of where were headed but, you know, I don't think we are planning yet for -

HOLLAND: Were not ready for you yet Jigar but, but we'll come when we are.

SHAH: I appreciate seeing the results.

[Joe Kiani asks a question about geothermal]

[Steve Pacala asks a question about solar spatial planning]

[William Press asks a question about investors and interest rates]

[Video Timecode: 01:28:20 — Fusion-Related Discussion Begins]
[Jump to Timecode: https://youtu.be/8AIIj3F8ArE?t=5301]

ERIC LANDER: I'll jump in. First, huge thanks. Those were an amazing series of talks, really really just great. I'm going to listen to them again on the Web site because they were really good. But, I did have a question for Jigar because, maybe, it made me appreciate, I don't quite understand the nature of things like the COTS program where you give milestones to people. You made a comment with fusion that I've been turning over in my head where you were saying "Well, I don't know if this is really commercial yet, etc." But in a milestone program one way to do it is to say "We'll pay you a real big milestone if you have a commercially relevant plant, demonstration plant that's net positive energy by a factor of whatever. Doesn't cost you a penny if they can't do it. But it changes the economics of the investors who know that they'll get a return when they reach that point. So why isn't, is that a kind of COTS program that you could make? You don't have to be a believer, in fact, you could say prove me wrong.

SHAH: Yeah, so we do that now, but there's a, but I think that, the point I was making on fusion and I'm a huge fan of fusion —

LANDER: Yeah, no, this is one [inaudible] structure of the program.

SHAH: But I do think that we grey things over at our peril, right? There are things that are actually commercial in the sense that I actually have a customer and a buyer and then there are things that I don't have that for. So, for instance, Lake Charles Methanol Plant, we provided a milestone agreement to in 2015. They still haven't met the milestone. And when you think about where Maersk is right now, where they've built a methanol ship and they're waiting to buy green methanol which they can't find to put into that thing, right? It would be great for Lake Charles Methanol to meet their milestone and build this facility so that Maersk can buy their green methanol. So we are doing that now. But, on fusion, right, what I need is an electric utility that is going to buy the fusion plant, even if it's for 2040, right? Put it into their integrated resource plan and say to their public service commissioners that we are going to do this because we're going to have a center of excellence on fusion here and all these other things and -

LANDER: I'm not getting it. I'm missing the point. I don't know exactly why the United States needs an electric utility that's going to buy it if you think there's a series of milestones that represent, in whatever technology we're talking about, major achievements that will move this along. You have the ability to change the economics of investment in risky technologies and it seems to me that you are tied rather tightly to "do I have a final commercial company right now who wants to go purchase it." Whereas I see

you sitting on money that can unlock innovation in different spaces and it sounds like you're being real conservative about that.

SHAH: Well, you know, I've been accused of worse so I appreciate that, right?

LANDER: I'm pushing you because I think -

SHAH: No, no, I appreciate that Eric and I'm happy to work with you to try to figure this out but I do think it's important for the Loan Programs Office to actually have a customer. And that customer could be, by the way, the U.S. government, it could be Idaho National Laboratory, it could be the Defense Department, right? But it can't be, we have, as Katie suggested in her slides, we have different valleys of death,, right? And fusion absolutely needs help today to demonstrate commercial viability and then to demonstrate that they can actually create actual commercial viability and that's wonderful, right? And we are talking to all the fusion folks already at the Loan Programs Office, including Commonwealth. And I think they are amazing, right? But if I were to say to Commonwealth, well, who's your first customer going to be, like, who would even theoretically would it be, what application would you do? Would you be selling the thermal off your plant, like, how would this even look in relation -

LANDER: Yeah -

HOLLAND: I can this question but -

ARNOLD: I'm so sorry, but Andrew -

LANDER: Let me speak with Jigar and then I'm going to give it back to you and Frances here. You know, why don't we take it off-line there -

SHAH: Yeah.

LANDER: I do want to understand how we make, you know, and I don't care whether it's fusion or anything else -

[Video Timecode: 01:45:11 — Fusion-Related Discussion Begins]
[Jump to Timecode: https://youtu.be/8AIIj3F8ArE?t=6311]

HOLLAND: I am here and you know, those inspiring words, I think, are right. You know, when she said "set targets," well fusion's ready, we are ready for ambitious targets. You know, ambitious targets that probably go faster than a lot of people think that we can do,

but we are ready. Give us a target and if you want to talk about jobs or manufacturing, just imagine what it's going to look like when we are building thousands of power plants, fusion power plants in factories in the United States. That's what the scale-up hear going to look like. It is rapid scale-up but it's factories and it's manufacturing; this is a jobs base for the 21st century and if it's not here it's going to be somewhere else. So let's make the investments now to do it. Now Director Lander had talked about the COTS program and Loan Program Office. What I'd say is FIA members are not looking at the Loan Program Office as the next step, the place where we're going to right now. We think, you know, something like the Clean Energy Demonstrations Office, just stood up in the Department of Energy, might be the right place for some sort of COTS program like this, some sort of outside office or even within the existing fusion energy sciences program. They just did a report on this a couple of years ago on what it would look like. We think that we can go much faster than this and we think it would need to be, you know, kind of set up with some, you know, go-fast people from outside to really accelerate it and move it but a milestone program, yes, let's do it, let's get it stood up. Honestly, we don't care where you put it, but we don't anticipate that it will be in the Loan Program Office which is really for the building of power plants. We are building the proof-of-concept plants, and then pilot plants, and then power plants. So, we can do those three steps in a decade, but we've got to move fast to do that and so we are ready and that, it's just kind of different boxes on the government org chart.

SHAH: Well-said Andrew.

LANDER: Let me just say that my interest is where the whole Department of Energy can use milestones. Whether it is in Jigar's office or elsewhere, I think the real question is just, you know, PCAST was talking a little while ago about all the levers we've got, the different ways to advance things and when you should use one or the other, and that's where my question comes from, I'd love to continue with the DOE, the range of financial levers that there are, and where they should sit, which technologies are ready for what, so let's take that off as a further conversation because I am enthusiastic that the DOE is leaning forward on being able to really accelerate industries by figuring out what are the steps that they need to go forward. So thank you both and I'm going to hand it back to Frances.

[Andrea Goldsmith asks Katie Rae about "Tough Tech.]

[Video Timecode: 01:53:29 — Fusion-Related Discussion Begins]
[Jump to Timecode: https://youtu.be/8AIIj3F8ArE?t=6808]

MARIA ZUBER: I'll try to be quick here so, for any of these technologies, and a bunch of fantastic talks here, if we wanted to put the pedal to the metal and accelerate these as

fast as we could, we talked about funding mechanisms and valleys of death, do we have the talent, if we had the funding, do we have adequate talent to do the acceleration? Are we talent-limited or are we funding-limited? And anybody could comment.

HOLLAND: Properly deployed, we have the amount of talent in the national labs to get going on fusion. Properly deployed, we are ready.

RAE: I would like to say

[Crosstalk]

ZUBER: National labs all working on ITER, though, right?

HOLLAND: Properly deployed. We have enough support to get going on this.

[Conversation changes to other topics]

[Video Timecode: 01:54:52 — Fusion-Related Discussion Begins]
[Jump to Timecode: https://youtu.be/8AIIj3F8ArE?t=6890]

RAE: And I would just say, in fusion for instance, if we are really going to develop that there will be thousands of incredible jobs made and were going to have to train that talent. I mean, Maria, we have talked about this, you're going to have to train talent in every one of these new industries which means very good jobs and that's music to everyone's ears..

[Phil asks question to Harry Atwater about resilience.]

[Video Timecode: 01:56:37 — Public Comment Session Begins]
[Jump to Timecode: https://youtu.be/8AIIj3F8ArE?t=6996]

ARNOLD: I'm now going to pass it on to Eric who will invite Steven Krivit in public comments.

LANDER: Great, thank you so much Frances. So, PCAST meetings include a public comment section for any member of the public who wants to make a two-minute comment and we have one individual who signed up in advance. I want to confirm that Steven Krivit is online and able to speak, is that right?

KRIVIT: Yes, I'm here.

LANDER: You are here! Excellent, I didn't see you there, thank you so much. So, we invite Steven Krivit from New Energy Times to speak.

KRIVIT: Thank you sir. Good afternoon distinguished council members. When you hear people talk about nuclear fusion, it's important to understand that the required fuel sources for commercial nuclear fusion do not exist. Only deuterium is available abundantly and in nearly unlimited quantities.

Tritium is a different story. It does not exist in nature as a natural resource. With the exception of tritium produced by and for military agencies, the only tritium available for scientific or industrial use is produced from a small, specialized fleet of aging heavy-water nuclear fission reactors. By 2060, all of these reactors are scheduled to be decommissioned.

As an alternative, fusion scientists have hoped that enriched lithium-6 could be used to breed tritium inside fusion reactors. It is certainly possible for this physics reaction to occur, but there's two problems.

First, fusion reactors will need tons of lithium-6. Aside from the military production of lithium-6 for nuclear weapons, there is no source for commercial lithium-6 at the level of tons.

The second problem, as identified in a 2020 paper published in the leading peer-reviewed fusion journal, is that there is no known method to breed tritium faster than it will be consumed and lost in fusion reactors. I'll be sending scientific citations to you via the PCAST organizers. I thank you for your attention and for your service to President Biden.

LANDER: Thank you! For that extremely information-rich comment and for sending us reading materials. That's exactly the function of the public comment session, is to allow knowledgeable people to contribute to PCAST meetings and you have done so, so thank you very much.

From: Urvishkumar Mehta [redacted]
To: MBX OSTP PCAST MBX.OSTP.PCAST@ostp.eop.gov
Sent: Mon 3/14/22 8:02 PM
Subject: USA-India - International Relations: 2021-2022 Development, Disaster Response, Events with Judicial, Legislative, Executive & Administration

ATTN:
National Science and Technology Council
Office of Science and Technology Policy
Attn: FOIA Officer
1650 Pennsylvania Ave, NW
Washington, D.C., 20504
Phone: (202) 456-4444
Fax: (202) 395-1224

Subject: USA-India - International Relations: 2021-2022 Development, Disaster Response, Events with Judicial, Legislative, Executive & Administration

International:

- **United States Of America - Special Envoy John Kerry Visit - 2021**
- **United States of America - Secretary of State - Anthony J Blinken Visit 2021**
- **USA-India Trade Policy Development - Ambassador Tai's Participation US-Indo Trade Policy Forum**
- **USAID Launches a New Initiative to Accelerate the Clean Energy Transition and Improve Energy Access in South Asia**
- **U.S.-India 2+2 Intercessional Dialogue**
- **Secretary of the Treasury Janet L. Yellen's Call With Finance Minister of India Nirmala Sitharaman**
- **Deputy Secretary Sherman's Meeting with Indian Minister of External Affairs Dr. S. Jaishankar and Indian Foreign Secretary Harsh Shringla**
- **NSA Jake Sullivan's Call with NSA Ajit Doval of India**
- **NSA Jake Sullivan's Meeting with Minister of External Affairs Subrahmanyam Jaishankar**
- **Secretary of Defense Austin Joint Remarks with Indian Defense Minister Rajnath Singh**
- **India Chair of the UNSC.**

Prime Minister Narendra Modi Visit to White House 2021

Russia President Vladmir Putin Visit 2021

USA and India Participation in G7, G20 and COP 26 Summit

Green Multilateralism: Partnerships, Finance, and Innovation: 2021 India-Germany-EU Dialogue

India and the United Arab Emirates (UAE) will sign the first .bilateral free trade agreement (FTA) between the two countries and the comprehensive economic partnership agreement (CEPA)with the UAE will have clauses to protect domestic industries.

QUAD I: USA, India, Australia, Japan

QUAD II: USA, India, Israel, United Arab Emirates

ASEAN Summit for South Asian Countries - Aug 2021

United States and India - Democracy Summit - Dec 2021

ASEAN Summit for South Asian Countries - Jan 2022

QUAD and INDO-PACIFIC Summit - Feb 2022

International Law and Space Treaties:

Artemis Accord and Space Treaty with NASA

Digital Copyrights and Burnes WIPO Treaties

Nuclear Warefare and Cyber Space Treaties - Arms control model that reflects the reality of multipolar world.

Tax Treaties with Most Favoured Nation (MFN) clauses in tax treaties.

UN Environment Programme (UNEP) and India signed a Host Country Agreement on the sidelines of the UN Climate Change Conference (COP26) in Glasgow.

Domestic:

Development and Laws:

Implementation Required with Uniform Civil Code with International Religious Freedom and
Ministry of National Religious and Linguistic Minorities with International Humanitarian Law and Cultural Development

Budget 2022 - Cryptocurrency and NFT - 5G Spectrum Development and Auction

State of Gujarat - CAPEX for Technology Development with Quantum Computing, Blockchain and BioTechnology

Citizenship Amendments ACTS and working within State- State Jurisdiction

The apex court of India suspended the implementation of three contentious Farm Laws keeping in view the farmers' protest.

The Gujarat Assembly amended the Freedom of Religion Act, 2003, thereby bringing in stringent provisions against forcible conversion through marriage or allurement. It is the third state after Uttar Pradesh and Madhya Pradesh to pass such a bill.

Tata Group acquired 100% stakes in Air India from the Indian Government through its subsidiary Talace Private Ltd, as part of Disinvestment of Public Sector Units in India.

Vision to develop at the multilateral level, bringing politics back into regulation will help safeguard data and democracies. An excellent example of political regulation is the European GDPR data architecture, platform, system and space.

Disaster Response and Operations:

COVID-19 Global Vaccination Drive - Phase-I and Phase-II Vaccination Drives through Public-Private Partnership and Collaboration with USAID.

Afghanistan Repatriation and UNHCR for Refugees

State of Gujarat Tauktae Cyclone and West Bengal Cyclone Yaas Disaster Response.

Cyclone Jawad wreaked havoc across three Indian states-- Andhra Pradesh, West Bengal and Odisha. The cyclone began on 2 December and ended on 6 December 2021.

The United States Donates 500,000 Doses of the COVID-19 Vaccine to Bhutan

U.S. Department of Agriculture and Maharashtra Department of Agriculture Unveil Memorandum of Understanding on Agricultural Cooperation.

Defense:

Passing of Chief of Defence Staff, General Bipin Rawat

Secretary Antony J. Blinken on the Passing of Former Secretary of State Colin L. Powell

U.S. and Indian Army Kick-Off Exercise Yudh Abhyas in Alaska

CNO Adm. Mike Gilday Visits Western Naval Command Headquarters; Delivers Keynote Address to Indian Navy
Australia, India, Japan, and U.S. Kick-off Phase II: MALABAR 2021

Australia, India, Japan, and U.S. Kick-Off Phase I: Exercise MALABAR 2021

U.S. INDOPACOM Commander Adm. John C. Aquilino Visits India

A Protocol on amending the agreement between India and Russia on cooperation in the field of Kalashnikov Series Small Arms Manufacturing.
The agreement on the program for Military-Technical Cooperation from 2021-2031 was also signed.
The agreement signed was a protocol of the 20th India Russia Inter-Governmental Commission on Military and Military-Technical Cooperation (IRIGC-M&MTC).

Embassy and Consul General of India:

Consul General Melinda Pavek at the Bengal Chamber's Environment and Energy Conclave in Kolkata

U.S. Consul General's Coimbatore visit highlights business ties, education and institutional partnerships

U.S. Mission in India Approves Record Number of Student Visas in 2021

U.S. Consulate General Chennai Celebrates Sister Cities Chennai and San Antonio

India and United States Renew Agreement on Development Cooperation

U.S. Special Operations Command, Gen. Richard D. Clarke

Consul General David J. Ranz UN World Water Day March 22, 2021

Science, Innovation, Technology and Space:

WhatsApp announced a change in its privacy policies and data sharing norms. The announcement of data sharing with its parent company Facebook led to massive outrage and a shift to other similar applications such as Signal and Telegram.

A cyberattack on Air India was reported and the personal details of about 4.5 million customers globally were compromised, including passports, credit card details, birth dates, names and ticket information.

Pegasus (spyware) database was accessed by Forbidden Stories and Amnesty International. The data revealed that more than 300 Indians were under surveillance through Pegasus.

Commercial arm New Space India Limited (NSIL) and GSLV F10 mission failed due to cryogenic stage anomaly. A national-level failure analysis committee was constituted and it has identified the rootcause.

The government notified the Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules 2021 under the Section 79 of the Information Technology Act.

India has banned 54 apps it says are of Chinese origin, including Sea Ltd.'s marquee game Free Fire, citing security concerns, people with knowledge of the matter said, the latest instance of tensions between the two neighbors locked in a protracted border dispute.

Passing of Recognized People in India:

Passing Indian (Bharat Ratna) Singer Lata Mangeshkar - Feb 2022

Achievement:

India achieved the milestone of administering one billion Covid-19 vaccine doses as part of the national immunisation drive started in January.

Past Attacks on Indian Democracy:

Mumbai Attacks and 26/11 and Hotel Taj Attack, Pathankot Attacks, Delhi & Parliament Attacks, Jammu and Kashmir Attacks, Ladakh Attacks.

Endnotes

[1] Intergovernmental Panel on Climate Change, *Sixth Assessment Report*, Switzerland, IPCC, 2021.

[2] European Commission, "Trade > Policy > Countries and Regions > India", European Commission.

Your attention to this matter is appreciated.

Yours,
Auto Legislative Policy Director (Don M - Intergovernmental and Congressional Affairs)
Office of Urvishkumar Mehta
Commissioner, Federal Government, USA
Phone: [redacted]
Pronounce: (He | Him | His)
Email: [redacted]

From: Urvishkumar Mehta [redacted]
To: MBX OSTP PCAST MBX.OSTP.PCAST@ostp.eop.gov
Sent: Mon 3/14/22 8:03 PM
Subject: USA-India - International Relations: 2021-2022 Report of Development, Disaster Response, Science Innovation Technology & Space and Events with Judicial, Legislative, Executive & Administration

ATTN:
National Science and Technology Council
Office of Science and Technology Policy
Attn: FOIA Officer
1650 Pennsylvania Ave, NW
Washington, D.C., 20504
Phone: (202) 456-4444
Fax: (202) 395-1224

Subject: USA-India - International Relations: 2021-2022 Report of Development, Disaster Response, Science Innovation Technology & Space and Events with Judicial, Legislative, Executive & Administration

High Commissioner, Urvishkumar Mehta Visit to 2021-2022 Report to State Department - Office of Foreign Mission and Department of Defense

International Commission on Religious Freedom and United States International Trade Commission and Congressional Delegation

Office of Science and Technology and Policy - Presidents and Vice President Administration

Federal Emergency Management Agency - Advisory Board and Delegation

American Red Cross - State of Gujarat and UT of New Delhi Meeting

Indian Institute of Technology Alumni and Technology Deliberation Meeting - New Delhi, Mumbai

ASAEN 2022, Democracy Summit 2022, QUAD Summit 2021-2022, US-INDIA Defense Exercises and 89th Airforce Celebration and Navy's Swarnim Vijay Varsh to celebrate the 50th Anniversary of India's victory in the 1971 war.

USA-India International Relations - 2 Democracy, Legislative, Judicial and Assembly System and Function

State of Rajasthan Meeting with Chief Minister and Governor - July-2021
Nathdwara Temple and Trust - State of Rajasthan, India -

Union Territory of New Delhi, India Visit: - Nov 2021
President Ramnath Kovind Meeting and Congressional Delegation
Prime Minister Narendra Modi Meeting and Congressional Delegation
Ministry of External Affairs Delegation - Meeting with Secretariat Harshvardhan Srikhanla and Mr Jaishankar Subramaniam
Parliament of India - PRIDE Program Visit part of International Foreign Official Program

Temple Visit and Meeting: ISKCON, New Delhi, President Prabhupada Swami

State of Himachal Pradesh: Buddhist Temple and Dalai Lama and Meet with Chief Minister - State of Himachal Pradesh - Nov 11, 2022

State of Punjab: Golden Temple and Shri Harmadi Sahib Visit and Meeting with Chief Minister - State of Himachal Pradesh - Nov 12, 2022

State of Goa: Lady of Gloria Church, Benaulim Visit and Meeting with Chief Minister and Governor - State of Goa - Nov 17, 2022

State of Gujarat:
Yogi Divine Society, Swaminarayan Temple President Meeting: Aug-2021
BAPS Swaminarayan Sanstha, Baroda Visit, President Mahant Swami Maharaj: Sep 2021
President Saint Bhagwat and Anoopam Mission, Anand Meet and Governor of Uttarpradesh Meeting - Oct 2021

State of Gujarat:
Vibrant Gujarat Summit - Jan 10, 2022
State of Union - State of Gujarat - Legislative Assembly Visit and Secretariat, Madam Speaker, Governor Meet - March 4, 2022
Defense Expo and Gandhi Ashram Visit - March 11-14, 2022

Upcoming Visit Schedule:
ISRO - Space Application Center Visit - March 2022

State of Uttarpradesh:
Kashi Vishwanath Temple and Governor Delegation and Meeting
Mallikarjun Temple Visit and State of Hyderabad Chief Minister and Governor Meeting

Department of State and Office of Foreign Mission:
Consul General Mumbai Visit - Sep - Oct 2021
Embassy of New Delhi Visit - Nov 2022

Congressional Commendation Recipient and Report to Government of India - Executive, Legislative and Assembly and Congressional Delegation to United States - Federal Government - Department of State - Office of Foreign Mission and Department of Defense.

Endnotes

[1] Intergovernmental Panel on Climate Change, *Sixth Assessment Report*, Switzerland, IPCC, 2021.

[2] European Commission, "Trade > Policy > Countries and Regions > India", European Commission.

Your attention to this matter is appreciated.

Yours,
Auto Legislative Policy Director (Don M - Intergovernmental and Congressional Affairs)
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