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The Power of Helium-3

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The following presentation was made by Basement Science Team member Benjamin Deniston at the Aug. 8 LaRouche PAC webcast.

I want to take a few minutes to get into the issue of helium-3 fusion that Lyndon LaRouche has put on the table, and the Chinese have put on the table, and that we're emphatically backing and supporting as the most important thing to be done right now. So, in general, fusion power, nuclear reactions in general, fusion and fission, are millions of times more energy dense than any form of chemical fuel, chemical energy, and you get new qualities of energy that allow you to do more types of work than you could possibly do with a lower quality source.

But that being the case, it's still the fact that not all fusion fuels are created equal. And so, to make sure people are very clear on the importance of helium-3 specifically, we should juxtapose that to the current types of fuel being pursued under, say, a first generation, or what I would call a 20th-Century mode, of fusion power.

Now, the current reactions are mostly dependent upon isotopes of hydrogen, and the issue you get with the current fuels being pursued, which are accessible on the Earth, is that most of the energy released comes in the form of what's called a neutron, and the challenge involved here, is that the neutron generated cannot be controlled by a magnetic field, cannot be influenced by electrical fields, and therefore, cannot be contained and controlled by the plasma. And so, what you're left with, with first-generation, or what I'll describe as 20th-Century types of fusion reactions, is you create products that you can't contain within your fusion plasma itself, and your ability to get useful power out of them requires using the heat generated from these products to then boil water, generate steam, and spin a turbine.

If you're familiar with that process, it's because that's how we generate power with coal; that's how we generate power with natural gas; that's how we generate power with nuclear fission power. Now, this is a very inefficient process. In general, you get maybe up to 40% of the actual energy created by your fuel reaction that can be converted into electricity, and the rest is completely lost.

So we pull up this first graphic. This is an illustration of the electricity generation in the United States in 2011. So, when we say that the current steam/turbine cycle is only 37-40% efficient, we should look at what that actually means. This is the entire electricity generation, power generation, in the United States. You can see the sources of the power, coming from the left, coal, natural gas, nuclear, what they call "renewable"—although they're kind of lying there, because most of that "renewable" is hydropower, and the second-largest "renewable" is wood. So if you want to look at what they throw around as geothermal and solar and all these other wild ideas, it becomes an incredibly small fraction of anything actually used, because it's so inefficient.

But all of these sources of energy, the majority of all the energy generated by these fuels is lost, it goes nowhere. It's not used at all. The conversion loss is the giant section splitting off, up on the top. That's all energy we're generating from our fuel sources, which we have no use of, whatsoever.

So for the total U.S. energy production, it's about 37% efficient; 63% of that energy is completely lost to the conversion process, which is limited by the basic process of heating water, creating steam, using the steam to turn a turbine. You can do a little bit better with certain gas cycles, other than steam cycles, but you're still limited by this fundamental process.

The first generation of fusion fuels is bounded by this same process: If you have a product like deuterium-tritium fuel, which is the fusion fuel that's the first-generation fuel that's being pursued by most fusion programs today, most of your energy is generated in particles you cannot control in the fusion plasma, and you have to stick with basically a 20th-Century mode of power production to get your power from this much higher quality reaction. So that's the current, say, first generation or 20th-Century method.

Second-Generation Fusion Fuels

Now, there have been long investigations by fusion scientists of what you might call second-generation fuels, or advanced fusion fuels. Now, these are fuels that have somewhat potentially higher temperature requirements to get the ignition, but when you get the ignition, the vast majority of all the energy released can still be contained within the fusion plasma itself. You don't have to stick to this neutron cycle, you don't have to go to this steam cycle to generate electricity. You can act on the fusion plasma itself, to do what's called direct conversion: to use the qualities of the fusion plasma to then generate electricity directly, or generate it from various modes of radiation that the plasma will emit.

But the point is, this type of process immediately doubles your efficiency in converting your fusion reaction to electricity, to power, but it puts you in the domain where you're looking at the beginning of a real, advanced fusion economy. We're actually beginning to generate power, not in the mode of the 20th-Century steam cycle, but working with the physical properties of the fusion plasma itself, to begin to generate these powers directly.

And the most advanced, the best available fuel for that, the fuel that gives you the most energy per reaction at the lowest temperature requirement, to get the ignition, is helium-3. So it's not a new surprise to many serious fusion scientists and others, that helium-3 is the ideal fuel for an advanced fusion economy, for a 21st-Century fusion economy, not a 20th-Century fusion economy.

So, to support the world and support the development of the Solar System, we're going to need this helium-3 source. And the other advantage I'll get into, in just a few moments, is that it opens up completely new potentials in space transportation as well, for the same reason that the reactions of the products you get are completely controlled by magnetic fields, and allow you to use the fusion reaction directly, to completely transform our access to space.

So these are two expressions of the power of helium-3: why it gives you a higher energy-flux density for your economic process, and why it's the best fuel available for mankind, immediately, today.

10,000 Years into the Future

Now, as has been said, where do we have to go to get this? We have very little helium-3 on Earth. But the Sun has been producing this stuff for billions of years, cranking away, spitting this stuff out, and there is a huge amount of it embedded in the lunar surface, in the lunar regolith, in the lunar soil. And the method of extracting this, is not necessarily all that difficult. So, with an ability to get to the Moon, set up serious mining and development operations, we have at hand access to a vast potential of a completely new capability for mankind, a new capability for mankind that will transform the Earth, and transform the Solar System.

Now, studies have indicated there are upwards of 5 million tons of helium-3 on the Moon, and that has been said to be enough to power the entire planet Earth for 10,000 years. Now if you think back, a lot has changed in 10,000 years. So if you're talking about securing power for 10,000 years into the future, we've got a lot of room to work with under that perspective.

But to put this in concrete terms that will help people conceptualize this—how much is 5 million tons? What does that mean?

So we did an example to illustrate one pedagogical expression of what the energy density of the power of helium-3 is, as viewers of the LaRouche PAC website know, we've been very upfront and concerned about the global water crisis. And there was recently a report on the rapid loss of water in the Colorado River Basin, that, according to studies by new NASA satellites, the rate of water loss has been significantly more than had been realized. And over the past nine years, mostly from groundwater depletion, pumping water out of the ground, the Colorado River Basin, as a whole, has lost about 7 cubic km/year, which is equal to about half the flow of the Colorado River itself! So for the Colorado River to be supplied, that would require increasing its own flow by 50%. But that's the rate at which we've been depleting the water availability in the Colorado River Basin.

So, say we want to look at the water crisis from the standpoint of the Moon and helium-3 fusion. Say we wanted to match this rate of water loss, which is a devastating threat to the Colorado Basin in the entire

West, with desalination. Say we wanted to do that with desalination using helium-3 fuel: How much helium-3 would it take per year, to match the rate of loss that's occurring in the Colorado River Basin? Well, if you crunch the numbers, it's one-third of 1 ton of helium-3 per year. That's enough to fit in the back of a pickup truck, and that's enough to power desalination to match the water loss of this entire river basin.

Again, to compare this with other sources, if you wanted to do this with coal, you could power desalination with coal. You could generate electricity and do desalination. But to match the same levels, it would take 6.7 million tons. So, one-third of 1 ton, to 6.7 million tons. Now, again, what does that mean, 6.7 million tons, when you picture 6.7 million tons? If you wanted to put that into railcars, you're talking about 67,000 railcars. If you go to the second graphic, that's the equivalent of the length of the I-5, stretching from San Diego to the California-Oregon border.

I imagine most people have been stopped at a railroad track, waiting for the train to go by: You better hope it's not this train, because you're going to be in trouble if you're waiting for this many—for 67,000 railcars, stretching the entire length of California along the I-5 Freeway. This is contrasted to the helium-3 fitting in the bed of one pickup truck. That's amazing; that's some power! And if you think about it, you're talking about, with mankind, it only requires one-third of 1 ton/year, for mankind to match the requirements of an entire river basin in the United States.

So that's the kind of power we're talking about; and with this level of energy-flux density, mankind can not just solve the problems in one river basin in the West, but we can control the global water cycle. We can solve our water needs, we can solve our fuel needs, we can produce synthetic fuels. We can address these concerns. We can open up entire new resource bases with the higher productive capabilities of high-temperature plasmas in thermonuclear fusion, and we can greatly expand what LaRouche has defined as the science of the powers of labor, the physical powers of labor; that, what you see historically, with the development of mankind, is that the ability of the individual to produce work, is not defined by the muscle power applied, or even the energy applied, but the *energy-flux density* and the high-technology applied to the individual worker is what creates growth, creates value, creates an expansion of the economy, and that's the type of perspective we have with this helium-3 proposal.

The Helium-3 Age of Mankind

Now, I wanted to just take one other example, to look at the other aspect which LaRouche has put on the table regarding the helium-3 age for mankind: And that's the application to space, and space propulsion.

I thought it was useful that, just over the last couple of days, there was a remarkable event, which was the European Space Agency rendezvous, the first spacecraft to rendezvous with a comet. We've flown by comets before. We've done a fly-by, taken some pictures and passed on—that's been interesting. But this will be the first time, right now, this *is* the first time we've actually put a manmade spacecraft in orbit around a comet. And in a few months, we're going to descend a lander down onto the comet, and investigate the comet, which will also be a first.

So this is exciting stuff, a very impressive mission, very good. But let's be serious and look at what it took to do this. I want to pull up the third graphic here, just to illustrate, following this case study, to look at the relation of fusion and helium-3 propulsion to mankind's development of the Solar System. Here you see the orbits of the Earth, Mars, and the comet, 67P. So, now, we generally think about travel as going from Point A to Point B: The Earth is Point A; the comet is Point B. But, in the realities of travel in the Solar System, especially using chemical propulsion, it's not quite that simple.

We can go to the last graphic. You see added on here—it's somewhat messy and complicated—you've got to take some time to unwind the whole thing: This is the actual trajectory that the spacecraft took to reach this comet. And instead of going from Point A to Point B, it went from Point A, Earth, around the Sun, back to Point A, Earth, used the gravity of the Earth to get a little bit of a boost, went all the way around, and two years later, went to Point C, Mars, to get another gravity boost, and then went around for another two years, back to Point A, Earth, to get another gravity boost, send it on a path where, five years after that, it arrived at Point B. So you go A, to A, to C, to A to get to B, in space travel under a chemical propulsion mode.

That took 10 years to do this, to reach this comet. Again, this is an impressive mission, this is very exciting, it's good it was done. But, we can not survive in the Solar System if it takes us 10 years to get to another body. Now, if this were fusion propulsion, and if we used the energy density of fusion, and specifically, helium-3 fusion, again, because of the fact that all the reaction products produced by the fusion reaction can be controlled by a magnetic field, and can be pushed out the back to give you thrust, your propulsion, which you can't do if you have a lot of neutrons in the reaction—you're left with a much less efficient method—with that level of advanced helium-3 fusion propulsion, it would probably take on the order of couple weeks to get to that comet. So, 10 years, maybe down to a week, or a bit slower, a month or so.

So this is just a couple of illustrations, case studies, but the general principle is that this is the basis for mankind's access to the entire Solar System.

The Defense of Earth

Now this covers, obviously, the defense of Earth: Asteroids are going to hit Earth again, comets are going to hit again. If mankind is going to survive, we need the capabilities to get to these bodies quickly, to find them, to know where they are; but it's subsumed by a broader perspective, which is mankind's mission to develop the entire Solar System, mankind's mission to use the Moon as the powerhouse, the power store, the base of operations, to empower mankind, uniquely, mankind wielding this capability: It's mankind wielding helium-3 that can do this, to then bring mankind to the next level of controlling and developing the Solar System as a whole.

And so that's, I think, the perspective we need to have, for what's been put on the table with what China is doing. And what our response needs to be is to get behind this, as the only sane approach. As LaRouche has said: What the planet Earth now depends upon, is the adoption of the helium-3 driver program as *the* basis for policy, as *the* basis for any sane national economy at this point. LaRouche said, yes, we recognize it's going to take some time; it's not going to happen tomorrow, but so what? You decide to do it, you make that decision, you set that as the benchmark, the metric, the goal, and that shapes everything you do from there. That means what you do today and tomorrow is now changed, even if you're doing the same thing; it's now changed by the fact that it's contributing to creating that.

So the most important thing now, is to adopt that as the mission, which then defines everything we do from now, until then, and gives mankind the capabilities needed to handle the Solar System, and beyond.