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It's Time to Expand Nuclear Power

Guests:
For the Motion: Kirsty Gogan, Daniel Poneman
Against the Motion: Arjun Makhijani, Gregory Jaczko
Moderator: John Donvan

AUDIENCE RESULTS	
Before the debate:	**After the debate:**
49% FOR	**47% FOR**
21% AGAINST	**42% AGAINST**
30% UNDECIDED	**11% UNDECIDED**

Start Time: (00:00:00)

John Donvan:
We have a key note conversation because the topic relates to science. Would you please welcome to the stage Bill Nye, the science guy?

[applause]

Bill Nye:
John, so good to see you!

John Donvan:
Great to see you.

[applause]

So, that was the appropriate level of applause, I think.

Bill Nye:
Wow!

John Donvan:
There was a really interesting story that relates to you and Intelligence Squared that I want to start with.

Bill Nye:
Ah, yes. Yes.

John Donvan:
And you were -- you have been, in the past, a member of our audience. You've been out there. And there was one particular debate that you attended, and an interesting thing happened. Pick it up from there.

Bill Nye:
So, I was at a debate about genetically-modified organisms, GMOs. And --

John Donvan:
The resolution was: Genetically modified food --

Bill Nye:
Is good or bad. Or was necessary.

John Donvan:
No. It was -- it was stated as an imperative: "Genetically-modified food." It was a sentence.

Bill Nye:
Ah, yes.

John Donvan:
Okay.

Bill Nye:
So, I have been skeptical -- had been skeptical of it because we have so much extra food in the world that goes to waste.

00:01:06

And when I was -- when I had come of age and was doing science education on the TV, there was -- it would -- to sequence the genome of a corn plant would take a month or so. And so, I felt that you could have knock -- so-called knock-on effects. You could do something to the ecosystem of a farm that you didn't mean to do. And this would then make it -- GMOs just not necessary, and let's not do it, and let's not -- you know, Prometheus; let's not mess with the unknown. But I watched the debate. And the key figure for me was Rob Fraley, who was the head of Monsanto. Monsanto -- aghh!!

[laughter]

And he was very compelling. And so, he button-holed me after the debate. And he invited me to St. Louis, to Monsanto -- aghh! -- in St. Louis. And I went there. And I looked around, and I did more research, and I said, "Genetically-modified foods -- or genetically-modified organisms are really okay." They can sequence -- they, those people -- can sequence genes now in about five minutes.

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It's really amazing. So, in the 20 years since I did the "Science Guy" show, I believe that that's unjustified. I believe that technology advanced to the point where they really can get a very good sense of what will happen to ecosystems. And they do just extensive tests. And Monsanto -- Monsanto! -- is now there. And did you ever see Young Frankenstein?

John Donvan:
Yes.

Bill Nye:
You know, Frau Bruko -- uggh! You know? So, I decided that they're really not the great evil. And we have -- when I was a kid, I came to New York City. The World's Fair was here. And there were -- the United Nations had a total board. There were 3 billion people in the world. As of today, there are about 7.6 billion people.

00:03:09

There are going to be 9; there are going to be 100 -- probably 10 billion people. And they're all going to have to eat something. And I think genetically-modified crops are going to be a big part of the future. That's what I've concluded.

John Donvan:
So, since we're --

Bill Nye:
But it started here.

John Donvan:
And that's what –

[applause]

-- I will not interrupt an applause line for Intelligence Squared. I almost did. But I -- it would be interesting to hear your experience on the process of changing your mind in the face of a scientific argument being put before you. Tonight we're hearing -- we're going to be hearing scientific arguments. A lot of us are laypeople in regard to science. Can you share two things? One -- I'll ask it in sequence; so I'll say the same question -- repeat the same question later. But the first one is, in any way, was it difficult for you to let go of a conviction? Like what's that emotional process like?

Bill Nye:
Well -- and I tell every -- you don't do immediately. It's not the so-called lightbulb. You sit and think about it. And I -- you know, I had the resources to go two places. I went to St. Louis and walked around Monsanto. Then I went to Minneapolis, to the Monarch Venture.

00:04:16

So, one of the concerns about glyphosate, which you know as Round-Up, is that it kills milkweed, which farmers think of as a weed -- but a monarch butterfly -- I don't know exactly what they think, but I believe they think of it as food. And so, one of the concerns was -- or a huge concern was you're killing the monarch butterflies because the glyphosate is killing the milkweed. So, they had this meeting of what I would describe the corporate pigs -- Monsanto, aghh! -- Frau Burko -- and --

John Donvan:
It's getting smaller and smaller.

Bill Nye:
-- and the hippies, the monarch butterfly loving hippies. And they reached this -- I thought -- kind of cool agreement. There are now refugees of milkweed on what people call the flyways of monarch butterflies. It's really -- it's kind of cool.

00:05:07

John Donvan:
But if you come to a point --

Bill Nye:
But it took weeks.

John Donvan:
Well --

Bill Nye:
It took months --

John Donvan:
And if you come to a point sort of intellectually, emotionally, and psychologically, where you're saying, "I was wrong. That means I was an idiot."

Bill Nye:
No, I -- there's other reasons that I think I'm an idiot.

John Donvan:
Okay.

Bill Nye:
Yeah, yeah.

John Donvan:
How -- but how --

Bill Nye:
There's a lot of evidence -- I think people who know me.

John Donvan:
The process of letting go of an idea.

Bill Nye:
Oh, it's -- you don't do it in a weekend. It takes quite a while. But it was Intelligence Squared that changed my mind. So, thank you.

John Donvan:
And so, my other question -- the second part of that question –

[applause]

The other part of the question is, so, for a lay audience who won't have the chance to go visit headquarters, et cetera -- again, we have an hour, hour-and-fifteen-minutes tonight -- how do we listen to these arguments? How do we judge the quality of the arguments that are being made when science comes into it? What do we -- what should we be listening for?

Bill Nye:
Well, it's --

John Donvan:
In general.

Bill Nye:
I mean, to me, science is a discipline, and it's a habit of mind that is really -- takes -- takes years of messing with it to overcome.

00:06:09

You know, we have this expression, "confirmation bias," where you have a belief. You see something that confirms it, and you embrace that. You see something that would -- if there's a verb "disconfirm" it, or "deny" it, and you push that away -- so, it -- in science, we do our best to be objective. Now humans are doing it, so there's going to be humans involved.

But the idea is to evaluate evidence -- the modern word we use is critical, to think critically about evidence. It's a habit of mind that takes a long time. I'm a mechanical engineer. And you know,

when you -- if the car doesn't stop with the -- when the brakes are applied, then there's something wrong with the brakes, people. We've got to address this. You can't ignore it. And so, tonight, I'm -- I am doing my best to be agnostic. I want to hear what these people have to say about nuclear power, I'll tell you.

John Donvan:
What are you going to be listening for?

Bill Nye:
There's a couple things that everybody wonders about -- is what are we going to do -- I'll save that one. But first of all, is it safe? Writ large, is nuclear power safe? And then, what are we going to do with nuclear waste?

00:07:15

Is there a good place to put nuclear waste? Everybody wants to know that. Do you want it in your neighborhood or the other guy's neighborhood? And then, there are extraordinary claims about how much it costs on both sides. Some people say it's very expensive. Some people say it's very cheap. And I'd like to hear -- I'm very interested in hearing what the two sides have to say about this.

John Donvan:
Could we take a little step back? You mentioned you were a mechanical engineer.

Bill Nye:
Yeah. I'm a human, but also -- yeah.

John Donvan:
[laughs]. So, you're an engineer who is mechanical or you're an engineer of --

Bill Nye:
See, it's a great question. Yeah. I'll have to think about it.

[laughter]

John Donvan:
Let's -- what -- I have a card that says you're a scientist, engineer, comedian, author, inventor, education advocate, CEO of the Planetary Society, host of the Science Rules podcast. You starred in a Netflix show: "Bill Nye Saves the World." But perhaps, Bill is best known for his children's science show, "Bill Nye, the Science Guy."

Bill Nye:
Yes. [cheers]

[applause]

Whoo! Thank you! Yes!

00:08:09

[applause]

So, speaking of science and habit of mind, that show was designed for people 10 years old, because -- no, I'm not joking -- because we had very compelling research that 10 years old is about as old as you can be to get the so-called lifelong passion for science. And I think it's about as old as you can be to get a lifelong passion for anything.

John Donvan:
[affirmative]

Bill Nye:
If you know somebody who's a journalist -- he or she liked telling stories before they were 7, you know? Like you, you're a journalist -- you probably liked stories --

John Donvan:
I loved your show when I was a kid.

Bill Nye:
You're joking me.

[laughter]

You're joking me.

John Donvan:
[laughs] Um --

Bill Nye:
What are you, six months older than I am, or something?

John Donvan:
Yeah, six months.

[laughter]

Bill Nye:
So, you're a kid. So, that habit of mind -- the reason we did that, 10 years old, was to -- dare I say it -- change the world.

[laughter]

Because I came of age as an engineer when we were creating the Ford Pinto. If you don't know

this, this was a vehicle where the -- if you got rear-ended, it would quite commonly catch on fire. And there was some notorious things where people got killed by this thing exploding.

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And what made it go bad was there were documents at the Ford Motor Company, where the legal department had reckoned how much it would cost to pay the lawsuits instead of move the tailpipe away from the gas tank.

John Donvan:
Yeah.

Bill Nye:
And I was embarrassed, as a mechanical engineer. Really? That's what you're doing. The Chevy Vega -- you had to take the engine mounts loose and tip it to change the spark plug. So -- and we abandoned teaching the metric system, and we took solar panels off the White House. All these things were happening. And I thought, "Man, the U.S., my beloved home country, is going to heck in a hand-basket." And I wanted to influence the future. And I'm not joking you -- and that's why I think the Science Guy show got this applause. I think.

John Donvan:
So, you went from being a scientist, practicing scientist to being onstage, to being in front of the --

Bill Nye:
Well, mechanical engineer using science to make things and solve problems. Yeah.

John Donvan:
Difficult transition or --

Bill Nye:
Well, it's okay.

[laughter]

I started, as some of you may know, by winning -- in Seattle only -- the Steve Martin lookalike contest.

00:10:25

[laughter]

And because I was pressured by a group of friends who said, "You're just like this guy, man." And I just was -- really respected what he was doing as a comedian, where you have to just -- the audience has to choose when to laugh. You can't force it.

John Donvan:
So, you like to teach, and you've agreed --

[laughter]

-- you've agreed, though you will qualify yourself as not an expert in this, but you've studied up for it to give us a little bit of lesson that we can use in this debate about how nuclear power is generated, just basically how it works.

Bill Nye:
Yeah, so -- sure. So, I bet most people here know that we have discovered electrons, protons, and neutrons.

00:11:08

And so, there are certain elements that are created and essentially exploding stars that contain energy, primordial energy in them, that's still there today. And you've heard of them: Uranium. You might have heard of Neptunium, which is -- only would exist for a brief time. Anyway, uranium decays. Some of the neutrons go flying out of it. And if you can get the neutrons to run into each other, it generates heat. And we love heat. We take the heat, and we boil water or some coolant, and run a turbine, which turns into an electric generator or a magnet, a coil of wire moving through a magnetic field, and we get electricity. So, it's heat. And so, this is called fission. And it's a process different from what happens inside a star. That's fusion. But it's big atoms falling apart. And the energy of big atoms falling apart, we harness.

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But the same flying apart atom will damage your DNA. And so, this is why -- that's radiation poisoning or -- you don't want to -- you don't want that. And that's why people are afraid of it.

John Donvan:
When people talk about nuclear waste, what is the waste?

Bill Nye:
So, right now, we use a certain fraction of the uranium and then bury the -- or put the rest of it someplace. And there's big concern if bad guys, or bad gals, got hold of the right amount of uranium -- nuclear material. There's another fabulous adjective: fissile, fissile material, that which could be fissioned. Then, you could make a bomb. And even easier would be to make a bomb that doesn't really explode the way you might have think -- you might think of at Hiroshima and Nagasaki with the mushroom cloud. It's just radioactive. And you blow it all over the place.

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And then, you'll have this mythic thing called radioactive fallout. And fallout is just dust that's now radioactive. It now has these neutrons flying off it, or gamma rays flying off -- a high-

energy electromagnetic radiation, like light, flying off of it that damages you, and can make you sick, and everybody's afraid of it. And so, if the wrong guys got hold of this stuff, it would be -- it, potentially, could be really dangerous. And so, our nuclear material that we use to fission in reactors is kind of diluted in a solid -- in a solid kind of way. And we bury the leftovers. Or, that's the goal is to bury the leftovers.

John Donvan:
And how long does that stuff stay hot?

Bill Nye:
Well, that's some -- there's some debate. And you used the word, "hot." That's an industry term. That's hot uranium there.

John Donvan:
Yeah.

[laughter]

Bill Nye:
That's hot stainless steel. No, it is. And 10,000 years. So, if you're scoring along with us, some of it is only 1,000 years. The Roman Empire -- I mean, you know, in astronomy, we just we just round to the nearest power of 10.

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That's 10 Roman empires. Like, wow, you know, that's potentially quite dangerous. And what does it say about you as a society that you're willing to -- how hardy are you that you're going to bury something that's that dangerous? However, the stuff exists in nature. You know, the dream of nuclear energy, when I was growing up, is you dig up the material, you mine it, you purify it or concentrate it, fission it, get the energy out, and then bury it again. Sounds cool. What's not to love? But it's been fraught with all sorts of problems.

John Donvan:
You have something of a two degrees of separation from the discovery of plutonium.

Bill Nye:
Well, I met the guy. Is that what you mean? Yeah.

John Donvan:
Yeah.

[laughter]

Bill Nye:
So, I think --

John Donvan:
You met Bob Plutonium, right?

Bill Nye:
Yeah.

[laughter]

So, at the California Science Teachers Association, Glenn Seaborg, who unlike many of us here, had a Nobel --

Bill Nye:
-- Prize. Anybody? Sure.

[laughter]

And he got it for nuclear physics. He discovered, or created, or invented plutonium.

00:15:19

And this is in Hanford, Washington, Washington State. I don't know if you've ever been. You may have been to Seattle. Western Washington is the evergreens and everything. But eastern Washington is, like, this separate prairie desert-ish kind of place, semi-arid place. And so, that's where they were -- that's where they were messing around with these, potentially, very dangerous material. So, we had lunch. There were eight of us around the table. And he said, "Bill --" he was in his 80s. I'm doing my best "Glenn Seaborg" here. "Bill, they wanted me to call it plutinum [sic]. But, come on, plutonium sounds a lot cooler."

[laughter]

"Yes, Dr. Sea -- yes, it sounds way cooler [laughs]." And then he went on. He said, "The wanted -- they wanted -- they wanted the atomic symbol to be PT plutonium." But he said he insisted that it be PU.

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The atomic symbol -- "if you look at the periodic table, atomic symbol is PU," he said, "because this stuff stinks."

[laughter]

And he understood just how crazy dangerous it is. You know, if you have powdered plutonium and you breathe it, you're gone. I mean, you're not going to live. And so, plutonium, it turns out, its -- uranium is 92 protons. Plutonium's 94, and it has more energy, and is more extraordinary -- more extraordinary -- is extraordinary [laughs]. And you can make the mythic plutonium weapon, which is a super-powerful nuclear weapon. And the dream of -- I imagine people --

what I'd like to hear is one of the ideas is to take uranium and breed it -- that's a verb -- into plutonium, and then use the plutonium to make heat, and energy, and electricity. But plutonium is nominally dangerous. And at the -- but at the Planetary Society, one of the things we've strongly advocated for.

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You know, the -- there's the word isotope, which is -- so, the atomic number is how many protons. The isotope has extra -- is -- includes the number of neutrons. Protons and neutrons weigh almost exactly the same or have the same mass. So, Plutonium-239 is what you use to make weapons [booming sound]. Plutonium-238 is what we use in spacecraft because it stays hot for decades, stays orange-hot for decades. And so, with the right thermocouples or, sort of, equivalent of solar panels encasing the plutonium, you get electricity for decades. And the two Voyager spacecraft, which have gone beyond the solar system, or as far as anything's ever gone, rely on plutonium. They're both still working. They were launched in 1977. They're still working. The Curiosity Rover on Mars has Plutonium-238.

00:18:11

It's still working. So, that aside, that stuff's cool. But we're here to talk about nuclear power, right which is a different use of the stuff.

John Donvan:
So, a term we are likely to hear tonight. What is a sievert?

Bill Nye:
Oh, a sievert. Sievert: it's 100 RAM, which is --

John Donvan:
Yeah.

[laughter]

I think we all knew that.

Bill Nye:
So, since the 1940s, people have messed around with trying to decide what the biological effects of ionizing radiation this stuff will do to you. And they came up with this thing: roentgen in equivalent man. It wasn't W, it was M. And this is how much damage it would do to you. So, a sievert, now -- what we all want, you know -- I quote, of course, Ernest Rutherford: "All science is either physics or stamp-collecting," meaning all science is either physics or just keeping track of, you know, other things.

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So, chemistry is really physics and biology is really chemistry. So, biology's really physics. So,

it's all -- yeah. So, sievert is based on the fundamental units of meters, seconds, and kilograms. And so, it's based on if you have a volume of air and you ionized what would be an amp, a cool ohms, you know, an amp of electricity, then -- and you would put that on a person, how much damage does it do? That's what a sievert is based on. And let me just put it this way. Every year we get two or three millisieverts, a thousandth of a sievert. If you were to get five sieverts, 5,000 millisieverts, you'd almost certainly die. Half the people in the world would die within 60 days. And this is -- you know, at Chernobyl was the famous thing or infamous thing where people got a lot of sieverts and they died. And radiation poisoning is this crazy, complicated thing. Breaks down your DNA, your fast-producing cells -- like, in your intestine; that's why people start vomiting.

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And if it gets in your lungs, the fast-producing cells, it's just really weird stuff. So, you don't want to -- don't breathe plutonium, you know?

[laughter]

John Donvan:
I always love to leave things on a positive note.

Bill Nye:
But here's the thing --

John Donvan:
And so --

Bill Nye:
It's very well understood. I mean, I will give them that, that it's very well-understood. And I'm sure this is going to come up. You know, we've had three just really weird nuclear events. Three Mile Island, which is in Harrisonburg, Pennsylvania; it's right at the end of the runway. And they had a leak. And the evacuation plan sent people in same -- opposite directions across the same bridge. That was -- nothing exactly went wrong, but it's undesirable. And then, Chernobyl was just a mess. I mean, dangerous, horrible mess, killing people -- estimated, you know, 4,000 people or something. And then, now, Fukushima. And so, these are three -- hang on. So, these are three accidents that -- okay. There's industrial accidents all the time.

00:21:20

John Donvan:
Where -- since we're getting into the debate material here --

Bill Nye:
Yeah. Well, here's what I want to hear from these guys and gal -- is those -- the public -- the problem is the public is aware of these things. And how are we going to address that? Sorry to go on a big digression there.

John Donvan:
I want to say this, to end it on a positive note. It has been a pleasure, and an honor, and --

Bill Nye:
Oh, wow --

John Donvan:
-- a lesson. Thank you very much.

Bill Nye:
Thank you.

John Donvan:
Bill Nye.

Bill Nye:
Let's change the world.

John Donvan:
Thank you.

[applause]

Bill Nye:
Cool. Thank you so much, John. Thanks for the extra bit --

John Donvan:
That's okay.

Bill Nye:
Cool. Let's listen. Let's hear what they have to say.

[applause]

Critical thinking!

[applause]

John Donvan:
The place names will scare you: Three Mile Island, Fukushima, Chernobyl, places where catastrophic accidents at nuclear power plants made the case -- at least critics of nuclear power argued -- that nuclear is just too dangerous for any society to consider building into its future. And so, for many years, for many people, the sun had seemed to be setting on nuclear as a way to keep the lights on.

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But you know what other quality nuclear power has? It is virtually carbon-free. Its impact on global warming is virtually negligible -- which raises the question, if we are looking for ways to mitigate climate change, should nuclear be getting a new look? Would the risk of nuclear be worth it? Would the risk of nuclear be worth it, or is it riskier not to go more nuclear? Well, we think, in all of these questions, we have the makings of a debate. So, let's have it. Yes or no to this statement: "It's Time to Expand Nuclear Energy." I'm John Donvan, and I stand between two teams of two, experts in this topic, who will argue for and against the resolution. As always, our debate will go in three rounds, and then our live audience here at the Florence Gould Theater in New York City will vote to choose the winner.

00:23:10

And if all goes well, civil discourse will also win. Again, our resolution is: It's Time to Expand Nuclear Power. Let's meet our debaters. Please, first welcome -- on the team arguing for the resolution -- ladies and gentlemen, Kirsty Gogan.

[applause]

John Donvan:
Kirsty, this is just to say hello to you. Kirsty, you are the co-founder and executive director of Energy for Humanity. That's an NGO that is focused on de-carbonization and on energy access. You flew in from London to join us. It's so great to have you here. Thanks --

Kirsty Gogan:
And thanks so much for having me. I'm really delighted to be here.

John Donvan:
It's our pleasure. Kirsty Gogan, everybody.

[applause]

And let's meet your partner. Ladies and gentlemen, please welcome Dan Poneman.

[applause]

Daniel Poneman:
Thank you.

John Donvan:
Dan, you have some government service related to this issue. You were former Deputy Secretary of Energy in the Obama Administration.

00:24:02

You're now president and CEO of a global energy company that is supplying enriched uranium for commercial nuclear power plants. It is called Centrus Energy. Thank you for joining us tonight.

Daniel Poneman:
Thank you. Glad to be here.

[applause]

John Donvan:
Great to have you here. And of course, we have two debaters arguing against the resolution. Please first welcome Gregory Jaczko.

[applause]

Greg, also a person with the government service in this issue. You are a former chairman of the U.S. Nuclear Regulatory Commission, after which you wrote a book, the title of which was, "Confessions of a Rogue Nuclear Regulator." And you are now the founder of an energy company called Wind Future LLC. Greg, it's great to have you on Intelligence Squared U.S.

Gregory Jaczko:
Thank you. Pleasure to be here.

[applause]

John Donvan:
And let's meet your partner. Ladies and gentlemen, please welcome Arjun Makhijani.

[applause]

Arjun, long-time expert in this field. You're the president of the Institute for Energy and Environmental Research, and you're author of a book called "Carbon-Free and Nuclear Free, a Roadmap for U.S. Energy Policy."

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You have spent decades studying nuclear disarmament and energy efficiency. It's great to have somebody like you here. Thanks so much for joining us. Ladies and gentlemen our four debaters –

[applause]

-- arguing on the resolution It's Time to Expand Nuclear Power. Let's move on to our debate. Let's start with Round One. Round One will be opening statements by each debater in turn. Up speaking first, for the resolution, Dan, you can make your way to the lectern. It's Time to Expand Nuclear Power. Please welcome, everyone, Dan Poneman, former Deputy Secretary of

Energy.

[applause]

Daniel Poneman:
Thank you, John. Thank you. I'm going to start by asking a question. How many people here believe that climate change is a global, environmental crisis that requires our best efforts to address?

[applause]

Wow. I would say that's a vast majority. I agree with you. Evidence supports your concern. We've just experienced the 10 hottest years in history of the planet. We are looking at a future of mid-century, in which we could see 99 percent of our coral reefs gone -- that support 500 million people. Arctic sea ice in the summer, gone. Hundreds of millions of people displaced.

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And what are we doing about it? We have a Paris Climate Agreement that pledges to get to 2 degrees centigrade global warming, over pre-industrial levels -- or better yet, 1.5 degrees. But in fact, we're way off track. If you took all of the pledges that the countries that signed up for the Paris Climate Agreement undertook to support that agreement, and assume they did everything they promised to do to reduce greenhouse gas emissions, you'd go below right past 2 degrees centigrade. You don't get close to 1.5 degrees centigrade. And of course, are governments ever on track with their pledges? Of course not. So, here we are, five years later, and two-thirds of the major emitters are already off-track.

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So, how are we going to get back on track? First, consider the scope of the problem and the urgency. By 2050, electricity consumption will increase by 100 percent. That's necessary to sustain the growth of the world and the prosperity of the people who live there. In that same period of time, scientists tell us we've got to cut carbon emissions from electricity production by 100 percent. Electricity is the easy one to solve before you get to transportation, and building heat, and agriculture. Now, I love renewables. And I was proud, as Deputy Secretary of Energy, to chair a credit review board that put $30 billion of loan guarantees to work and started the first utility-scale grid solar photovoltaic industry in this country, that supported the largest wind farm in this country, that put the Tesla on the road, supported biorefineries, and geothermal, and storage. All great stuff. But guess what? If you did all that, it still doesn't get you to decarbonizing the electricity sector by 2050. Now, don't ask me. If you go to the International Energy Agency or the Intergovernmental Panel on Climate Change, they will all tell you the only way to close that gap is by a significant expansion of nuclear power. Now, we've already heard some from Bill Nye -- thank you -- and we'll hear more about waste and radiation, et cetera. I'm going to focus just one moment on one of the problems that's a deep concern of many: the spread of nuclear weapons.

00:29:08

And I'm here to tell you that nuclear weapons do not — have not historically spread through commercial nuclear power. To the contrary, I can tell you of a case when the Soviet Union broke up. I was privileged to be part of a team that negotiated the purchase of 500 metric tons of highly-enriched uranium from the Soviet Union, the former Soviet arsenal, 20,000 weapons' worth. And we blended it down to commercial reactor fuel, supplied one-half of U.S. commercial nuclear requirements for 20 years. And since commercial nuclear is 20 percent of U.S. electricity for 20 years, one in 10 light bulbs in America was lit up by a former nuclear weapon pointing at you. So, don't accept easy bromides. Fear of nuclear power has killed many more people than nuclear power has killed. Consider Germany. After Fukushima, they closed eight reactors. Since that time, 1,100 people per year have lost their lives because of coal-fired pollution.

00:30:16

The question presented, then, is are we going to put everything we've got into this fight to prevent disaster to our planet? Or, are we going to leave the most prodigious source of carbon free energy in history on the table and hope for the best? That's why I say it is time to expand nuclear power.

[applause]

John Donvan:
Thank you, Dan Poneman. Our next debater will be speaking against that very resolution: It's Time to Expand Nuclear Power. Please welcome Arjun Makhijani, president of the Institute for Energy and Environmental Research. Ladies and gentlemen, Arjun Makhijani.

[applause]

Arjun Makhijani:
Thank you. Well, thank you for all your work on solar energy, and storage, and so on.
You are very successful and that'll be part of my story. We do need to eliminate carbon dioxide. No disagreement. We don't have a shortage of low CO2 sources of energy. But we have a shortage of two things in solving the climate crisis.

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We have a shortage of time and we have a shortage of money. Nuclear energy is really bad for both. In 2005, there was a big announcement with fanfare, around then, of a nuclear renaissance. More than 30 reactor applications were made to the Nuclear Regulatory Commission. And, as in the previous generation of nuclear, most of them were canceled. Only four started construction. Two of those four were canceled after billions of dollars of expenditures. The other two, being built in Georgia, are years and years behind schedule and billions and billions of dollars of cost overruns.

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We can't afford that kind of delay. We can't afford power plants that take 10 and 15 years to build. This -- we have seen this scene before. In the first round of nuclear, almost as many reactors, about 100, were canceled as were built. The financial scene was so bad that Forbes, not known as an anti-nuclear group, Forbes said -- and this is a quote -- "that nuclear power" quote, "is the largest managerial disaster in business history. It is a disaster on a monumental scale." February 1985.

Arjun Makhijani:
That was the first round. What should we do now?

Fortunately, as a result of a lot of good work in this country, Department of Energy, Germany, and other places, today, utility scale, solar, and wind are cheaper than nuclear: $40 a megawatt hour for solar and wind; $155 a megawatt hour.

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Did I make this up by somebody who doesn't like nuclear power? No. These numbers are published every year as estimates for new power plant by Lazard, Wall Street, also not known as an anti-nuclear group. So, I'm giving you bowtie credentials. You saw the guy with the bowtie.

[laughter]

So, I'm giving you bowtie numbers. In reality, nuclear power tends to get more expensive as they get in. And solar and wind, the history is they've gotten much, much cheaper. So, of course, solar and wind are variable. So, there's a delta between $40 and $155. You do need storage. You do need a smart grid. You need investments and so on. So, instead of saying, "Oh, you need everything," I actually did years of work to figure out what would it take, what would it cost, and how do you compare it to business as usual. And I did it with actual data for the state in which I live in: Maryland.

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I used demand data: your heating, your cooling, your dishwasher, your fridge -- hour-by-hour modeling. I have it on my computer in my hotel room down the street. I also got hour-by-hour data for wind. I got hour-by-hour data for solar. I added the smart grid. I added the storage battery, five hours of storage. It's cheaper than business as usual, 10 to 20 percent cheaper. And since I finished my calculations, solar and wind are cheaper now than they were back then. They've -- so, twice it's gone bad with nuclear. We have the answers. So, now we're told small modular reactors are going to come along because the large reactors take too long and are too expensive, and small modular reactors were going to do mass manufacturing, and because they'll be a supply chain at mass manufacturing, they'll be cheaper.

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Well, when you go from large to small, you lose something that's well-known called economies of scale. When you go to mass-manufacturing, you also gain something. It's called the possibility of recalls. How are you going to recall a radioactive reactor that's now in the center of your electricity system? No answers. I seem to be the only one that's actually raised this question. I haven't gotten an answer yet. And these reactors are vulnerable to problems. Now you've got a costly reactor. It's not going to be cheaper than what existing reactors are. In fact, a recent report that the state of Maryland said that small moderated reactors will likely be more expensive.

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John Donvan:
Arjun, I'm sorry. I have to break in because your time is up.

Arjun Makhijani:
I will finish. This is a mirage.

John Donvan:
Thank you very much.

[laughter]

[applause]

John Donvan:
And a reminder of where we are, we are halfway through the opening round of this Intelligence Squared U.S. debate. I'm John Donvan. We have four debaters, two teams of two, arguing it out over this resolution: It is Time to Expand Nuclear Power. You have heard from the first two debaters and now on to the third. Welcoming to the lectern our third debater, please give a round of applause for Kirsty Gogan, co-founder and executive director of Energy for Humanity.

[applause]

Kirsty Gogan:
Thank you. My younger self would be shocked that I'm here on the stage today arguing in favor of this motion to expand nuclear energy. I've dedicated my life to working on environmental and social justice.

00:37:02

After college, I was a grassroots environmental activist, planting trees, boycotting flying, organizing protests against GMOs, and cars, and nuclear weapons, and globalization. And I don't usually do debates. I'm more of a coalition-builder, more interested in common ground

than arguing. And yet here I am because, frankly, so much is at stake. Changing my mind about nuclear energy felt like betraying my tribe. It was hard to admit that I was wrong, hard to be judged, even excluded by my friends for challenging the environmental anti-nuclear touchstone. But climate change made me reevaluate nuclear energy. And it was a shock to find that I'd been wrong about the risks that I thought were real, about our chances of making a real dent in climate change without it. But despite 30 years of successfully building political support for action on climate change, we have not made a dent in the upward trajectory of emissions.

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In fact, incredibly, half of the emissions that are currently in the atmosphere today we've committed in the past 30 years. Since Al Gore published his first book on climate change and now according to the IPCC, we have another 30 years, just 30 more years to fully decarbonize the whole of the global economy, not just the power sector, industry, heat transport. Now 2050 may seem like a distant future, but in 2050 my daughter will be the age that I am now. And meanwhile, today, humans live safer, longer, more productive, healthier, more secure lives than at any other time. And that prosperity, that modern life depends on massive amounts of electricity. Reliable energy, and yet half the people in the world still lack access to enough energy. Many depend on dangerous smoky fuels for cooking and for lighting in their homes.

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And this lack of access to modern energy causes millions of deaths every year, disproportionately affecting women and children. In households without access to electricity, women can spend up to 35 hours a week just collecting fuel. So, this isn't just an environmental issue. It's an ethical issue. It's a public health issue. It's a feminist issue. So not only do we have to replace the entire global fossil fuel infrastructure within those 30 years, but probably double or even triple it to meet rising global energy demand and bring modern energy services to all people. So, in light of this, many organizations, including the Union of Concerned Scientists, the IPCC, the International Energy Agency, have started to change their stance on nuclear energy. And I looked again at the evidence and I found that the facts didn't justify my opposition. And yeah, even taking into account, you know, those famous accidents. Nuclear energy is the safest form of electricity generation.

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In fact, coal kills way more people in a single day of normal operations than 60 years of global energy has, even including those three big accidents. In fact, for decades, nuclear energy has been the single largest source of clean electricity generation in the United States and in Europe and is recognized by the world's most credible authorities as being a critical part of our response to the climate emergency. So, this isn't about nuclear versus renewables. The simple truth is actually that tackling climate change will be more expensive, more difficult and more likely to fail if we exclude nuclear energy. Now, climate -- okay, it's a complicated problem. But you know what? Mostly it's an energy problem. And broadly speaking, you can boil it down to a simple two step strategy. So, first of all, expand clean electricity generation and then electrify the hell out of everything. Some modern industrialized economies, they've already achieved the first

step. You know what success looks like from a climate perspective? It looks like France and it looks like Sweden today.

00:41:15

Sweden holds the record for the fastest and most complete clean electricity transition, completely phasing out fossil fuels. And you know how they did that? They did that by whilst growing their economy with some of the lowest energy bills in Europe. How did they do it with the only proven real world way that we know how. They did it with a combination of nuclear and renewables. But there's something else. As a humanitarian and an environmentalist, the real appeal of nuclear energy is its incredible energy density, thousands of times more energy dense than coal, which means it can power whole civilizations with a tiny ecological footprint. And what about the waste? I used to worry about the waste, but it turns out that waste streams from nuclear energy are trivial compared to fossil combustion. Waste has not, will not and does not cause harm to people in the environment.

00:42:07

John Donvan:
Kirsty, I'm sorry, I have to jump in. Your time is up as well. Thanks, everybody. Kirsty Gogan.

[applause]

And please welcome to this lectern, our final debater on the resolution, It's time to Expand Nuclear Power. Here is Gregory Jaczko, former chairman of the U.S. Nuclear Regulatory Commission.

[applause]

Gregory Jaczko:
It's always nice to go last because you get to hear his arguments, and I'd have to say I haven't heard much in the way of arguments. What we've heard a lot is what I like to call is the unicorn nuclear industry. There's a lot of statements that were made by Kirsty, by Dan about this impassioned need to deal with climate change, and I agree 100 percent. And in fact, what I actually worry about is with a lot of people talking about nuclear in that way. And talk as if nuclear is the thing that's going to solve this problem north and in fact, it's actually not.

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You didn't hear a lot of facts about the nuclear industry, about what it really takes to build nuclear power in the way that they're talking about. So, let's talk about those facts. First of all, right now today and it's not just electricity that matters, it's energy, right? There's more to energy. There's more -- what we use for energy didn't just electricity. And today four percent of energy in the world is produced by nuclear power. If we look at electricity, it's about ten, eleven, twelve percent. Renewables are bigger than that. In both cases, both for energy and electricity. Today. So, renewables already have a head start. Moreover, when you look at the biggest issues they

talked about, 2050, 2050 is a very important date from the climate perspective. But more importantly is 2030. Most of the modeling shows that by 2030 we have to make significant reductions in our carbon footprint in the world. If you take a typical nuclear power plant today and remember that four percent or that 10 or 11 percent to get to a substantial amount of nuclear power tomorrow, we need to start building thousands of nuclear power plants in the world because it takes anywhere from 10 to 15 years to build a nuclear power plant when you start from scratch -- and that's on that's on the conservative beneficial end.

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It could be anywhere from 15 to 20 years to do that. Okay, so we're talking about tomorrow starting to build over a thousand two, three, four, five thousand nuclear power plants, and that's not just in countries like the U.S. or France that have existing nuclear power programs. It's places all over the world. Well, to do that, they can't just start from scratch or they can't just start and magically bring on a wand and build a nuclear power plant. They need engineers. They need welders. They need people with experience dealing with this technology. And that takes another five, 10 years to build up that infrastructure in that capacity to build license and operate nuclear power plants. And I know - I was the regulator of the Nuclear Regulatory Commission, the head regulator in the United States. That infrastructure does not come easy. We had over 4,000 people or close to 4,000 people in my agency, and I would visit other countries that were desperate to have nuclear power programs.

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And that was what they came to us and said, can you help us build our infrastructure? So, we could all agree today that this is a great thing. Nuclear power is wonderful. But the practical reality is we cannot build the amount of nuclear power plants we need in order to make a real dent in climate change in the next 10 to 15 years. But I worried about this for a long, long time because I have two small children, I have a four year-old daughter and about to be 7 year-old son, and I worried about the future. And I've always been conflicted, having dealt with the Fukushima nuclear accident at the NRC. And I thought, my gosh, you know, I'm concerned about this technology, but I'm more concerned about climate change. And so, I began to realize and look and learn and recognize that in fact, the cheapest and fastest growing sources of clean energy in the world are renewables, hydro and renewables.

00:46:07

What we call kind of when we say renewables, we think of wind and solar and geothermal and these kinds of things. Those are the fastest growing sources of energy. And Dan talked about Germany today. Germany generates 40 percent of its electricity from renewables, including hydro. The problems with people dying have nothing to do with renewables. They have to do with coal. It's coal that's killing people in Germany. And that coal use has actually gone down over the last 10 years, largely replaced by natural gas and renewables, which have gone in the last 10 to 15 years from about a few percent to 40 percent of the generation of electricity in Germany. And nuclear has gone down. In the United States, nuclear power has been at about 20 percent of our electricity generation for decades. If this is such a great technology, why hasn't it

been doing all these wonderful beneficial things, why hasn't it been eliminating cold deaths for the last 30, 40, 50 years? Because it's been impractical to build. We started out in this country with plans to build over 200 nuclear power plants.

00:47:11

That got whittled down to one hundred or so. When I was chairman of the Nuclear Regulatory Commission, there were 104 operating reactors. Today, we have fewer than that. So, it's going in the wrong direction and the prices are going up. Renewables are going in the right direction and their prices are going down. So, we don't have to make this choice between the difficult challenges of nuclear power versus climate change. We have better alternatives that exist today that we can deploy in the timeframe that we need to actually make a real dent in climate change in the next 10 years, not in the next 30 or 40 years. So remember, when you hear about the nuclear industry, think about the unicorn. That's the industry that they're talking about. It's a unicorn industry. It's a wonderful, beautiful, mythical creature. And it doesn't exist in the real world.

[applause]

00:48:01

John Donvan:
Thank you, Greg Jaczko. And that concludes Round One of this Intelligence Squared U.S. debate, where our resolution is: It's Time to Expand Nuclear Power. Now we move on to Round Two. And Round Two is where the debaters address one another directly. They also take questions from me, and a little bit later on, from you, members of our live audience here in New York City. Our resolution is: It's Time to Expand Nuclear Power. We've heard a range of arguments between the two sides. We've also heard some common ground. Let's stake out what that is first of all. Both sides agree that climate change is real and urgent; that time is running out. They agree that the world's need for electricity consumption is going up, perhaps by as much as 100 percent in a short period of time. They agree that renewables have a place, and that renewables -- and increasing renewable energy is a worthy goal. They agree that coal is very, very damaging to human health. Where they disagree is on the question of whether nuclear is too dangerous to be the solution to climate change as part of the mix, or whether it is too expensive, or too impractical.

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The team arguing for the resolution are arguing that that is not the case at all. They say that, with the clock ticking, the only way to get the situation dealt with quickly -- quickly enough -- would be through nuclear power. They say that nuclear is actually the only option.

00:49:23

And they say it has to be a critical part of the whole solution. They cite examples of nations like Sweden and France, which they say have already figured this out. They also make the argument

that fear of nuclear power is actually more dangerous than nuclear power itself -- that the issue -- we were just getting to that in Kirsty's opening, that the issue of waste is somewhat exaggerated, and the harm is somewhat exaggerated. I'd like to get into -- more into that, into the conversation itself. The team arguing against the resolution -- Arjun Makhijani and Gregory Jaczko -- they also argue that time is running out, but they say that in the issue of dealing with climate change, whether in the next 10 years, that time -- with time and money short, renewables actually beat out nuclear. They say that nuclear power plants have proven -- again and again -- to be too expensive and to take too long to get up and running.

They say that, in fact, renewables are getting cheaper and spreading. And they basically make the argument that the choice between the danger of nuclear power and a carbon-free world is a false choice; that we have other options. So, there is a lot there for us to dig into. I want to go to the side arguing for the resolution, and take a piece of the argument I heard from your opponents. I'll start with either of you who would like to go forward first. Your opponents have made the argument, countering your argument that nuclear is the only solution, by saying, "Look at the record of the last 20 years. Nuclear power plants just can't get off the ground. We're decreasing the number of nuclear power plants. They take too long." They -- I'm not sure if they're arguing for practical construction reasons, design reasons, bureaucratic reasons -- but that it's in a world where they say we're going to need thousands of nuclear power plants, in a short period of time, to beat a solution -- that it's just incredibly impractical. Who would like to take that?

00:51:09

Kirsty Gogan:
Yes. Nuclear energy has proven over and over as being absolutely the fastest way to add clean electricity generation, per capita. And you know, the perception right now in Europe and in the United States, around the idea that nuclear is too expensive and too slow to make a meaningful contribution towards solving climate change is informed by, honestly, what's a really small sample of first-of-a-kind, first-of-a-generation projects. And they're not representative of the vast majority of nuclear plants that are being built in the world today.

John Donvan:
You're referring to plants that were built 30, 40 years ago?

Kirsty Gogan:
No. I mean, I'm talking about they -- the projects that are being -- still being built today in Europe, and in the United States, in the U.K. -- and here in the United States -- that give the impression that nuclear is expensive and slow. But actually, those projects are first-of-a-generation plants that have to be licensed with an inexperienced regulator. You have to qualify the supply chain. You have to train the labor force. You have to establish your siting process. And then, you know, you have to build it for the first time.

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We would expect to see at least a 30 percent reduction from the first-of-a-kind to second-of-a-kind, and then further cost reductions with subsequent plants. And the way that we form that

impression is through experience of programs being -- very successfully delivering projects in a very time-efficient way that are cost-competitive, not only with fossil fuels, but also with renewables.

John Donvan:
So, to boil it down, you're saying the more we build -- if we were to start building them, the more we build, the faster we would get at it -- it would get better. Okay.

Kirsty Gogan:
The first one you build is difficult and expensive. And after that, it gets much easier.

John Donvan:
Let me take that logic to your opponents.

Gregory Jaczko:
Well, I mean, again, we can go to facts. I mean, I was the chairman of the Nuclear Regulatory Commission when we licensed the plants in the United States, which are, to a certain extent, first-of-a-kind.

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The industry was well-aware that they had to meet cost and schedule -- timelines. And they assured me of that repeatedly, because they knew that Wall Street would not fund additional projects because there had been a history of cost -- and throughout the entire U.S. nuclear industry -- and really, in many places in the world. That -- one of those projects is now over five years behind schedule, and over $15 billion over budget. And that was not a new project. I mean, it was a new project, but this was not with an untrained regulator. This was not with an untrained workforce. The industry had been doing plant upgrades and other major modifications to plants in order to train that workforce to be prepared to do it. They simply mismanaged the project, which is typical of how the nuclear --

John Donvan:
But is it inevitable? I mean, your opponents are saying that's not inevitable, and that, with experience, that process could get more streamlined.

Gregory Jaczko:
Well, I mean, they've been saying that for 30 years. I mean, that's nothing new in the nuclear industry. So, you know, we can continue to make those statements. And again, perhaps some 15 years, we'll find out that it's not true.

00:54:07

John Donvan:
Dan?

Daniel Poneman:

You know, Mark Twain once said a cat who sits on a hot stove lid will not sit on a hot stove lid again, but he also will not sit on a cold stove lid. So, let's not learn the wrong lessons from history. When we got going, as a country, we built 104 nuclear units. Those units produce electricity at 3 cents per kilowatt hour. That's cheap. That's cheap. And when you add into the cost of solar and wind -- which I love -- transmission, and the backup power, you're going to need -- it's very competitive. So, I think it's critical to realize, when you do get this kind of momentum, what you can do in a scarce decade. One example will suffice. Kirsty just came back from Sweden. In their biggest year of building nuclear power, they added 600 kilowatt hours per person per year. Germany, in its most ambitious decade of wind and solar expansion, added 120 kilowatt hours per person per year.

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France, 450 kilowatt hours per person per year. These are facts. California, 70 kilowatt hours. And that's what you have to measure. It's just the installed capacity. So, when Greg talks about the installed capacity for wind and solar being -- expanding, that's great. But since the wind does not blow the sun does not shine, you have to divide that by how often it's available.

John Donvan:
Let me bring in Arjun.

Arjun Makhijani:
Yeah. So, this idea that we're building completely new power plants, first-of-a-kind is a little -- stretches the truth. These power plants -- the AB-1000 [spelled phonetically] that is being built -- were supposed to be streamlined, learn lessons from Three Mile Island -- safer, faster. The regulator said we streamlined the regulatory process. "We'll give you a license for the site and the operating license" -- all at the same time, so it will be faster, cheaper, and better. As it turned out, it hasn't been faster. It hasn't been cheaper. It hasn't been better. The fundamental design of the nuclear power plants that are being built here, in France, and in Finland -- and so on -- has not changed. They're all lightwater reactors. They all boil water -- either directly or through steam generators -- and they all run on a steam turbine.

00:56:18

They all have the same kind of controls with control rods. So, there is nothing fundamental different -- fundamentally different about this technology. It is the same technology that was actually supposed to be better. Now, I'm not a fan of Wall Street, but I do think that they do look to the dollars and cents, and what's going to fatten their pockets. And there was a reason that they didn't finance it. They got burned the first time around. Think why Forbes would take on a really big business like nuclear, supported by the government, with free insurance -- essentially free insurance on your back and my back, if there's an accident; a major accident -- and say, "This was the largest managerial disaster in business history."

John Donvan:
Let me --

Arjun Makhijani:
And they didn't fund the second round.

John Donvan:
Let's bring in Kirsty.

Kirsty Gogan:
Yeah. So, I sometimes make a joke that the next time I convert my loft, it's going to be, like, really efficiently done. [laughs]. Unfortunately, I won't have that opportunity, but we do have that opportunity, to learn from the experience of building the first-of-a-kind. And you know, the first-of-a-kind costs, of licensing, and training, and qualifying the supply chain -- they don't have to be spent again. So, my question, really, is, you know, why wouldn't we apply the same effort and resources to driving down cost and driving up rates of deployment for all low carbon technologies? Why would we just apply that learning to drive down the costs --

John Donvan:
Why -- let's take that question --

Kirsty Gogan:
-- in solar? Because actually, all that -- the really important thing that matters -- sorry, just to finish the point is the overall performance of the system. Actually, what we really care about is that our energy system is clean; and reliable; and affordable; and flexible; and, ultimately, cheap. And what we know, what the evidence is very clear on is that the best way to deliver the performance of that system, and the low-cost system, and the clean system is through a combination of nuclear and renewables.

00:58:14

And so, why wouldn't we apply the same efforts to driving down the cost, as we have done successfully for wind and solar?

Gregory Jaczko:
Well --

[applause]

Gregory Jaczko:
-- again -- I think, again -- and we're trying to create an impression that the nuclear industry is just a brand-new industry that's just doing all these things. It's been around for 60 years. We, in fact, have been doing all of those things. They just haven't worked. So, you have to --

Kirsty Gogan:
We've been operating the plants for 60 years. And, in some ways, that's a great asset that they lost so long. But, on the other hand, we end up using capability of building new projects, which is the thing that I'm talking about which we haven't done for more than two decades in this country.

Gregory Jaczko:
Right. You said, "Why wouldn't we put those efforts to driving down costs?" The industry did put significant resources and effort into driving down costs. In the United States, for instance, the industry created trade schools that were specifically designed to train the workers to build the plants in Georgia, to build the plants in South Carolina.

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And the plants are still wildly over budget and over cost. So, the industry has been spending money on those things. It's just not worked.

Kirsty Gogan:
Well, it has in the past. It very successfully driven down costs.

John Donvan:
Let me bring Dan in.

Daniel Poneman:
I think it's important to recognize that after Three Mile Island, we had a 30-hiatus, a 30-year hiatus in which our talent pool dissipated, and which our supply each pool atrophied. And, therefore, it's not actually accurate to say we've been doing this continuously ever since. Korea is building reactors. Russia is building reactors. Korea's finishing four reactors right now in the United Arab Emirates. China is building reactors. They're all doing it cheaper and faster. I refuse to believe that American ingenuity, and supply chain, and talent pool is not up to the task. We just have to apply ourselves.

01:00:07

[applause]

John Donvan:
Dan and Arjun, I had expected to hear you make more -- you're making the economic, and time, and practicality argument. You haven't talked about the danger argument at all. I'm curious why you haven't said that nuclear is dangerous. Is it because you actually don't think it's -- you don't think that that's actually the case?

Gregory Jaczko:
I -- you know, I don't think it matters. Because, you know, if you have $100 to go do carbon-free electricity, you can build far more with renewables than you can with nuclear. And you can do it faster. So, it doesn't matter that you have all these external issues about safety.

John Donvan:
That's going back to your saying the choice is not necessary.

Gregory Jaczko:

The choice is not necessary, exactly right. You -- you know, we don't have -- you know, in many ways, this isn't really a debate anymore. I'll tell you a story. I wrote a book. And as part of my --

John Donvan:
Don't tell me that here.

[laughter]

Gregory Jaczko:
Well, I'll just say I wanted to give a talk to a group of finance people in the in the energy industry. And they said, "You wrote a book.

01:01:04

You're promoting your book. We'd love to have become speak, but we don't really have anything for you to talk about because our people know that nuclear is a dead industry." So, you know, now the industry is promoting this idea of climate change as a way to try and revive the industry. But in the marketplace, it's not a debate at all. The debate's over. And renewables have won.

John Donvan:
Let me bring that to Dan.

Daniel Poneman:
I, respectfully, disagree. Renewables are great and you can introduce them to the grid, 10, 20, maybe even up to 30 percent. And the grid can absorb it. But after that, you have to compensate. And you have to have backup power, which is usually fossil-fueled. So, you're not getting the carbon-free benefit. And the -- in addition, if you're not going to fuel it with carbon-fueled resources, you're going to need batteries. Just one more point here.

John Donvan:
No, go for it.

Daniel Poneman:
Varun Sivaram, in "Taming the Sun," a brilliant analyst of the solar industry, says that for batteries to support wind and solar providing 100 percent, as our opponents would have you believe, would require 8 to 16 weeks of battery storage in the United States.

01:02:10

We have 43 minutes of it now. And we don't have the transmission lines, which people aren't too keen to build in their back line -- backyards, either. And so, I think we have to put into perspective that you do need, as Kirsty said, a system. And renewables can be a great part of it, but they need to be supported by flexible, dispatchable power, and that's what nuclear provides.

John Donvan:
So that -- that was a question I wanted to get to. So, there are times when the wind doesn't blow. There are times when the sun's not out and there's not going to be juice from the system. You need something else. If it's not nuclear, it seems very likely you're going to fire up a gas plant and you're back to carbon emissions again. So, they're arguing, "Let nuclear be that thing that steps into the gap." What about that?

Arjun Makhijani:
Well, I hope that Mr. Poneman was listening because that's exactly what I laid out. We're not talking about weeks of storage. This is a straw man that is frequently put up. If you have solar, you need weeks and weeks of storage and lots of batteries.

01:03:05
Agreed. If you just have solar and batteries, it's not going to work. That's why when I laid it out for you, I said -- well, I did the hour-by-hour calculation. Let me give you the numbers. For 68 percent of the hours, the load is directly and fully met by solar and wind, by renewables, a little bit of hydro. If you have five hours of annual average load of battery storage -- now, this is directly from hour-by-hour modeling -- just five hours, you get to 96 percent. The other 4 percent of the hours is -- there's a lot of hours in the year. You don't want to be elected -- you don't -- but you cannot meet it just by adding batteries. So, that's why you have a smart grid. Today, we have a dumb grid.

[laughter]

The amount of -- the amount of intelligence in the switches communicating between your house and the electricity system can all be fit, fitted onto a $10 flash drive.

01:04:06

That's how dumb the grid is. You have to have two-way communications. If you have a smart grid, demand response, do you care when the heating element in your frost-free refrigerator in the freezer comes on?

John Donvan:
Okay, that's --

Arjun Makhijani:
But that can be part of a --

Kirsty Gogan:
That's a smart grid.

John Donvan:
Let me take -- let me -- are you persuaded?

Kirsty Gogan:

[laughs]. It's kind of not about whether I am persuaded. It's really about, you know what, all if they're kind of best and most credible analysis is telling us. So, if you look at the International Energy Agency or, you know, any number of other organizations, including the EIA here in the U.S., we see a really frightening amount of fossil fuel still on the system, even with very aggressive build-outs, even with very ambitious and very successful build-outs of renewable energy, up to midcentury. Up to the 2050 point, we see around 60 percent of fossil fuels still on the system. We're working right now with the National Renewable Energy Lab, as part of the Clean Energy Ministerial, which is the annual gathering of ministers that look at how on earth they're going to deliver against the Paris agreements.

01:05:12

We're working with Enril [spelled phonetically] with their scenarios for very ambitious renewable build-outs. And we see a lot of gas still on the system. And what we've been doing with them is modeling what happens when you add nuclear in. So, this isn't about renewables or nuclear. This is about renewables and -- that's actually going to deliver the clean --

John Donvan:
But your opponents are arguing that there is a way to do renewables without nuclear and still be carbon-free by being -- by using technology, and artificial intelligence, and the smart grids.

Kirsty Gogan:
It depends on where you are. And, you know, you can concoct scenarios that are technically feasible. However, they're what we would consider high-risk. And there's a real question here about whether that's a risk --

John Donvan:
What do you mean by "high-risk?"

Kirsty Gogan:
-- that we're prepared to take. A risk associated with narrowing your options very severely. Enril have indicated to us that to achieve the sort of 100 percent renewables' build-out in the United States, you'd need to be building three 1,000 mile transmission lines per year, every year, for 30 years.

01:06:14

Now, just to give you an idea of what that means, we haven't been able to build one of those in 15 years of trying. Now, that is a very high-risk strategy, as far as I'm concerned. And I don't know how you guys feel about it, but it's too high a risk. It's not a risk I'm prepared to take. And it's certainly not a risk that my daughter has to take.

John Donvan:
Well, it seems you're both making the same argument against your opponents: that without sufficient effort, and intelligence, and planning, the other guy's solution can't work. So, they're --

Gregory Jaczko:
Let me just say -- let me just say, again, you know, we can look at modeling. Modeling isn't what matters. What matters is what's happening in the marketplace today. There is nothing stopping nuclear from doing all the things that Dan and Kirsty are saying, right? There's no -- this is not a new technology that has laws against it that say, "You cannot build nuclear power plants." In fact, it's a very established technology that has proven, over decades, to be too costly and too --too long to deploy.

01:07:11

There's nothing that -- you know, the renewables are the new technology.

Daniel Poneman:
But why is it working in Sweden and why is it working in France and why are the South Koreans building?

Gregory Jaczko:
It works, but it's been consistent in that -- because renewables are working in those places, too. Sixty-five percent of Sweden's electricity comes from renewables.

John Donvan:
But you're saying the market is -- okay. Go on. Go on. Sorry

Gregory Jaczko:
It's not large. It's not dominated by nuclear. And it's a small country. France is currently at 80 percent nuclear and their intention is to go down over time. So, you know, we're -- as I said, what we need, if we want to do nuclear, is, today, to start building thousands of nuclear power plants in the world today or tomorrow. We can --

Kirsty Gogan:
Let's do that.

[laughter]

[applause]

John Donvan:
And, Dan, I want to give you the last word on this. And then I want to go to audience questions.

Daniel Poneman:
-- just say, "Let's do it." Then -- but the industry can't.

Gregory Jaczko:
Okay. First of all --

Daniel Poneman:

And that's the problem.

Daniel Poneman:
The rule of holes is when you find yourself at the bottom of a deep hole, stop digging.

01:08:03

Okay, so it's not just about building thousands that with all due respect, it's a red herring. First, we got to stop shutting down perfectly well operating plants, point one. Point two, its mythological to say that it's all a free market and it's just not making it. If there were a burden on carbon. If nuclear were compensated for its unique attributes of always on response. Think Hurricane Harvey. People are alive today who would be dead without the nuclear power plants that kept running. I got plenty of calls at Department of Energy from Minnesota and Wisconsin congressman during the polar vortex, when the coal plants and the gas plants shut down and nuclear kept running. So, if the market actually appreciated the virtues of nuclear, the fight would be far --

John Donvan:
That was 2014. I think we have short memories, but it got really, really cold.

Daniel Poneman:
January 2014. Last point, Greg, probably focuses on facts. In 2011, California got 53 percent of its power from clean sources and then it pushed solar and wind a lot over the last seven years. And after seven years effort in 2018, they were still stuck at 53 percent because instead of pushing out carbon, it pushed out -- it didn't push out, but it was replacing hydro and nuclear.

01:09:20

We have to get to zero. You don't get to zero by staying even or growing our carbon emissions.

John Donvan:
I'd like to do audience questions. Gentleman in the suit, could you stand up so they can find you? Thanks.

Audience Member:
Hi. My name is Tom. My question I haven't heard anything about health care, and one of the things with nuclear is there is an aspect of health care. If you look at [unintelligible] if you Google search images of that, you'll see patients who go from cancer to no cancer. There are isotopes that are derived from nuclear power through fission products that are used in nuclear medicine. These are necessary for the field. How do you derive these without expansion of nuclear power?

01:10:16

John Donvan:
Okay, so my question, if I can refocus it. Is nuclear power actually good for its appropriate

practice of certain kinds of medicine? In other words, if we shut down nuclear power plants, we wouldn't be able to do that kind of. Is that what you're saying? Is that the question. No, no, I get it.

Kirsty Gogan:
Yes, I agree. We should expand nuclear energy.

John Donvan:
Well, that's a surprise.

[laughter]

Arjun Makhijani:
I thought that question would be directed at us.

John Donvan:
It's going come back to you.

Kirsty Gogan:
Because we need, actually to urgently build more nuclear reactors to produce nuclear material for nuclear medicine. Things like prognosis and cancer treatments. That's absolutely right.

John Donvan:
All of our questions will go to both sides.

Arjun Makhijani:
Nuclear isotopes for medicine are not produced in nuclear power reactors. They're mostly produced in nuclear research reactors, which are very small and you don't need it, need very many.

01:11:13

The value of isotopes, which I use in medicine and none of us would argue that they shouldn't be is very, very great. It's not like 4 cents a kilowatt hour, which is energy. You have to produce energy cheaply for the economy to run. Nuclear isotopes can be very expensive because health care is expensive. Okay make it cheaper. Research reactors. Nobody's arguing that we shouldn't be making nuclear isotopes. You need a couple of research reactors. You can make them and accelerators. There are ways to make isotopes without making power and I think we don't make --

John Donvan:
I think we've dealt with that. Sir, if you can tell us your name.

Chris Anderson:
Hi there, my name's Chris.

John Donvan:
Chris, as in Chris Anderson, who founded TedTalks.

Chris Anderson:
Well, kind of.

John Donvan:
Well, welcome to --

[applause]

John Donvan:
Welcome.

Chris Anderson:
Really interesting debate.

01:12:07

I mean, I'm surprised at the level of agreement that it's not been a debate about safety primarily. It's really a debate about economics. Two different visions. And it would help me to have each of you address this from the point of view of what the world needs to do by 2050. You've both got a vision for the grid that the world needs, the energy solution, not the a lot of the conversation has been about the U.S. Model this for the world -- on the one hand, a grid using nuclear power and renewables in the right mix that you like. If to build out basically what I've heard you says at least 2X, what fossil fuels are currently delivering. What is the cost that the world is going to have to invest over the next 30 years? And on the other side -- oh, and by the way, on the other side, if we just go the renewables route, you have to include, obviously, the cost of all these batteries and so forth. How much difference are we talking about? Or do you each have an approximate number there? Because I think we want to know what the overall math is.

01:13:17

John Donvan:
Thank you. Let 's let Dan take it on one side and one of you from the other side.

Daniel Poneman:
It's a great question. Life is full compared to what's and I think what you have to look at -- I can't give you an integer of a sum certain of it's going to cost X, okay? But what I can tell you is that the M.I.T. researchers who have analyzed this will tell you that if you try to get all the way there with only renewables, it will cost you 60 percent more. And that's conservative. And if something's more expensive, you buy less of it. And if you buy less of it, it's going to be slower. And then we're going to blow past 2050. So, all those massive investments occurs to time out in long distance transmission lines, which they just closed down a seven year effort to build one from Oklahoma to the southeast. All of that backup power that you're going to have to build to backup the 90 days in Texas when you don't have any wind that's going to be enormously

expensive.

01:14:10

And if you want to do it all with solar and wind, you're going to have to so massively overbuild on that side. You're going to be paying people, as is now happening in California, sending electricity to Arizona. When you have got too much power on the grid, you can't use it. And so it's much more expensive. The cheap way to get the job done is by nuclear supplementing renewables.

John Donvan:
Other side?

Arjun Makhijani:
I mean. Oh, well. So, I actually did the calculation. For you, it took four years. When you compared the capital investment in renewables, compared to business as usual. The capital investment is comparable. So, you don't come out ahead, one way or another, going this way or that way. Where you come out ahead is when you have solar and wind. The operating maintenance costs are very low. And you have no fuel costs. You have zero fuel costs. So, why is it cheaper? Because after you take into account -- and you can't do it with batteries, and solar, and wind alone; you do have to have a smart-grid -- so, we have to change out our -- do we need thousands of miles of new transmission lines?

01:15:20

No. In fact, if you want -- as you know, in New York City, just down the street here, across the bridge, they did not build a new power plant after Hurricane Sandy. They decided to do solar and storage because a local distributing system would not have been down for a whole week after Hurricane Sandy. If you want resilience, we have to change the model of the sector, even if climate -- you know, even if CO2 were not a problem. Just the intense storms and the severity of what we're experiencing -- and that we cannot suffer electricity disruption for a week -- that would lead you to solar, and wind, and storage, and flexible and smart grids, and electrified transmission.

01:16:08

John Donvan:
Okay. I'm going to jump in. Kirsty, can you give 30 seconds on this?

Kirsty Gogan:
Let me just try and answer the question, right? So, we've got 30 years to make it, or 30 years to break it. That's the situation. So, we just published an article recently called "All of our climate solutions need to be Impossible Burgers." And the idea behind that is that -- when I was starting my pro-nuclear environmental NGO, someone was giving me advice. And he said, "You know what? You think nuclear is controversial? Try meat." Because actually, the number one thing that an individual can do to reduce their own -- their personal carbon footprint is to eat less

meat. And no politician wants to tell anybody to eat less meat, let me tell you. And then, the Impossible Burger came along. And now, it's saturated the market. It's available in every Burger King. And it's just -- it's cost-equivalent. It's tasty. It's still junk food. Everybody loves it. And we've kind of cut through the problem. So, we need all of our climate solutions to be like that.

01:17:00

And the reason that I advocate for nuclear energy is not just because it's just about the power sector; because actually, what we haven't talked about today is that this is the whole economy -- that's heat, and industry, and transport, and shipping, and aviation. And frankly, we cannot base our climate mitigation strategies on behavior change or using less energy. What we need is cheap substitutes. And nuclear technology is uniquely suited to produce those clean, synthetic drop-in fuels that we can use in airplanes, and we can use on ships, because it's got a tiny environmental footprint; it's scalable; and it produces high-temperature heat. And guess what? We can use that high-temperature heat, so long as it's cheap enough, to make hydrogen, and to make other carbon-based fuels so that we can switch out diesel; we can switch out gas --

Gregory Jaczko:
Okay. Yeah. Let me just say --

John Donvan:
Wait, wait, I -- well --

Kirsty Gogan:
And we could do it fast.

Gregory Jaczko:
Let me just say -- let me just say --

John Donvan:
I had said 30 seconds, and [unintelligible] minutes.

Kirsty Gogan:
I'm sorry. I'm really --

John Donvan:
Can you do 15?

Gregory Jaczko:
Yeah. The big --

Kirsty Gogan:
It's my job --

Gregory Jaczko:

It's very short. The big element in what Kirsty just said is if it's cheap enough. It's not. So, you can generate high-temperature --

Kirsty Gogan:
Let's make it cheap.

Gregory Jaczko:
-- fluids with solar. You can do the same kinds of things. But just to get to Kris's point very briefly --

John Donvan:
Let's go up to the -- you finished, so I just want to get the next one teed up.

Gregory Jaczko:
We also have to think about this deployment. We're not just talking about deploying in Germany, in the United States. We're talking about rural India. What is a good solution in rural India? Well, a good solution in rural India is solar.

01:18:24

They've done a tremendous amount of solar right now. So -- and these are solutions that are happening today. Meanwhile, India struggles with building on its renewable -- or its nuclear program. So, the practical solutions that actually work in much of the world are not large power plants; it's distributed power that can be rapidly deployed without a lot of technical capability, and without a lot of infrastructure.

John Donvan:
Okay. Let's go to the next question --

Gregory Jaczko:
And that's the better solution for most of the world.

John Donvan:
-- in the back, up there. Up at the top row, there's a gentleman standing up. Please make this a great question, because it might be our last one.

Audience Member:
Well, I do want to talk about Fukushima. And in addition to the technical aspects of the meltdown, subsequent reporting uncovered just an industry that had become laden with cronyism, and decay, and entropy, and rot. But that's also true of a lot of other human endeavors.

John Donvan:
So, what's your question?

Audience Member:

So, is there something about the nuclear industry? Is the nuclear industry just worse in those aspects than the renewable industry? Because it's a human endeavor. And should we just not put our faith in these human systems, that -- as we call this nuclear industry has proven fallible.

John Donvan:
All right. Let me take that question to either Dan or -- I think that's, like, a big, big softball to you guys. So -- [laughter] -- so, I'm going to let this side respond to it. And I'll maybe get in one more question.

Daniel Poneman:
Well, I'll --

John Donvan:
And it's been somewhat hinted at, that it's a very problematic business -- is what your opponents have been saying. And you're -- the questioner is putting an even moral spin on it.

Daniel Poneman:
Human nature is a constant. I will tell you, having worked in and around this business for 45 years, I have found people of extraordinary integrity. I know of no other industry that internalizes all of its costs. You know, the other industries have lots of waste. We account for the waste. We contain the waste.

01:20:04

I'm not going to sit here and tell you that there's infallibility in any industry. I think human nature is human nature. What I can tell you is we have to keep our eye on the ball. And the fact of the matter is, that was a tragic earthquake and tsunami -- killed 18,000 people. But that wasn't from the nuclear. They just recorded their first nuclear fatality in 2018. Nobody died in Three Mile Island. Fifty-seven people died out of Chernobyl, and maybe, as Bill Nye said, maybe up to 4,000. We are trying to save the planet. Now, I'm all for going against corruption whenever and wherever you can find it. Is there arrogance? Yes. Is there sclerotic thinking? Yes. Go after it. But please, don't sacrifice the planet in the process, because we need carbon-free energy.

Arjun Makhijani:
There's some mythology in what you've just said.

[applause]

There's quite a bit of mythology in what you've just said. We account for the waste and contain the waste? You tell that to the Navajo people of this country. You –

[applause]

-- where the uranium was mined. There are more than 200 million tons of uranium mine waste -- a large part of them in Navajo country.

01:21:20

And still not remediated; they still don't have clean water. And they still live in radon-contaminated houses, many of them. There are two –

[applause]

-- there are more than 200 million tons of mill tailings, which have thorium-230, which is a byproduct -- waste byproduct of uranium, which goes into the fuel. There's 20 tons of waste at the reactor. But behind every ton of waste, there is hundreds or even thousands of tons of uranium mining and milling waste, both of which are radioactive. And we import most of the fuel. So, we're --

John Donvan:
Arjun -- Arjun's -- Arjun --

Arjun Makhijani:
-- damaging other countries as well.

John Donvan:
So, what is the bottom line on that horror that you describe, in relation to the question before us? Are you saying that that is endemic; it's unavoidable; it's going to be repeated -- that that's just the way the business is always going to be? Or --

Arjun Makhijani:
Oh, uranium mining is unavoidable in the uranium business. If you -- if you want nuclear fuel you have to do uranium mining.

John Donvan:
I want to take it to this side now.

Arjun Makhijani:
Or you have to separate plutonium.

John Donvan:
Well -- or Kirsty. Either one.

Daniel Poneman:
Quickly, very quickly --

Kirsty Gogan:
Well --

Daniel Poneman:
Can I just --

Kirsty Gogan:
Please.

Daniel Poneman:
If you took all of the waste generated from the beginning of the U.S. commercial nuclear industry, it would fill one football field 10 yards deep. That's it. From coal, it would reach up to the space station. You take all the nuclear waste that would satisfy your energy requirements for your lifetime, it would fit in a soda can. So, we have to put this in the context of the scale. We know how to contain it. We've seen geologic formations that have done it.

01:23:02

The Finns have figured out how to do it. The Swedes ended up with two communities competing for the opportunity to host a repository. This is a solvable problem.

Arjun Makhijani:
I guess the facts don't offer to --

Gregory Jaczko:
Well, the -- well, I'd just say, the original question had to do -- I think -- with accidents, and with the nuclear industry. And I think one of the -- again, one of the things you have to keep in mind is that if we do dramatically increase the amount of nuclear power plants we have in the world, we will increase the frequency of accidents. So, accident frequency -- because they are a largely unavoidable scenario. So, we will get to a point in which, if we're dramatically increasing the reactors, we're talking about accidents maybe happening every year, every two years, every five years. Now, all of those accidents may not require significant health effects. But they are going to affect the industries. They're going to affect the energy generation. And all we have to do is look to what happened in Japan after the accident in Japan. Japan shut down its entire nuclear fleet, because they had to do safety checks on those reactors. And what happened is, they turned to fossil fuels, and their emissions went up. So, their solution was dramatic increases in energy efficiency, and a build-out of solar power in about five years, where they dramatically increase that.

01:24:13

So, now they have replaced that nuclear generation with efficiency, conservation, and solar. And in fact, their emissions are now back down to lower than they were before their nuclear program had its catastrophic accident. And to put it in perspective, the cost of that accident is pegged at several hundred billion dollars. Several hundred billion dollars.

John Donvan:
All right. Let me let the other side have a -- I might not be able to get your question depending on how long Kirsty takes.

[laughter]

Kirsty Gogan:
Okay. So, two sentences. So, Fukushima showed that nuclear going wrong is better than coal going right. And the World Health Organization reports -- which I've read in detail around the Chernobyl and the Fukushima accidents -- have told us that, by far, greatest public health impact caused by both of those accidents was fear of radiation, not radiation itself. And that is all to do with how we responded.

John Donvan:
Do you have a question that you can put in one sentence now?

01:25:12

Audience Member:
Yes. You mentioned that what we need to do is make -- make it cheap, right? That's the problem. So, my question is it possible to make it cheap, in a very few amount of sentences, how? And if it's not possible, why?

John Donvan:
Okay. That was great.

[laugher]

Male Speaker:
Okay. Can I --

[applause]

Kirsty Gogan:
Well done.

[applause]

John Donvan:
Dan?

Daniel Poneman:
There's a whole new generation coming along. And they are going to build reactors that are standardized in design. One of the reasons why these reactors have gone so far over cost and over schedule is because they're stick-built, they don't finish designing the reactor before they start building it. There's common sense things that can and should be done. I was responsible for project management. We have -- we can have contracts that align the interests of the contractor with the interest of the ratepayer, which we have not had. We can have smaller factory-built modules that -- as is happening in the L&G industry -- will be then shipped to the site, standardized sites, so you're not doing a different bespoke design every single time.

01:26:15

We just got to do things smarter, better, and cheaper. And I, again, refuse to believe that we don't have the ingenuity to do it.

John Donvan:
Other side.

Gregory Jaczko:
I mean, the industry told me that 10 years ago. They told me that 15 years ago. They told me that 20 years ago. So, it's a common talking point that the next generation of reactors is going to be better. The reactor, and specifically in the United States, were promised to be better. They failed dramatically. So, you know, again, it's a unicorn.

Arjun Makhijani:
Let me answer.

Kirsty Gogan:
Well --

John Donvan:
I'm sorry, Arjun. I've got to wrap it up.

[laughter]

John Donvan:
I'm sorry --

Arjun Makhijani:
Why can't they --

John Donvan:
I'm sorry. That concludes round two of this Intelligence Squared U.S. debate where our resolution is It's Time to Expand Nuclear Power. Let's begin round three. Round three are closing statements by each debater, in turn. They will be two minutes each. They will stand, again, at the lectern for this. And making his closing statement for the resolution, please welcome, again, Dan Ponemon, former Deputy Secretary of Energy.

01:27:13

[applause]

Daniel Poneman:
Thank you. Thank you, John, and thank you to our esteemed opponents. A lively debate. On November 14, 1938, President Roosevelt convened a meeting at the White House. And he was briefed on the impending threat from Nazi Germany. Now, remember, FDR grew up as a boy loving the sea, loving sailing, building model ships. He'd become Assistant Secretary of the

Navy under President Wilson. He had communicated with Alfred Thayer, man on the superiority of naval power and what could be done strategically for our country with naval power alone. And, yet, that day, facing an existential threat of a rather different character, he authorized a massive expansion, something they said could not be done of American airpower. In 1939, we produced 3,000 airplanes. By 1945, we had produced 300,000 airplanes and won World War II.

01:28:25

Now, conceivably, FDR could have said, "You know what? I don't think so. I think Admiral Mann was right. We can do this with sea power alone." And maybe we could have won World War II without that air power. What do you think? Maybe, maybe not. But he decided to go for it. And the question he had to ask is, did he want to risk the answer to an existential threat on the hope and the prayer that his preferred strategic outcome would be achieved with naval power alone. He did not. I think we're in an existential moment today. And the question is, are we going to leave the most prodigious source of carbon-free energy known to humanity outside of the realm of what we're going to try. It may work. It may not work. I think we have no choice but to throw everything we can at the climate problem, including nuclear. And that's why I ask you for your vote, that now is the time to expand nuclear power.

[applause]

John Donvan:
Thank you, Dan Poneman. That is the resolution. And here to make his closing statement against the resolution, here is Arjun Makhijani, president of the Institute for Energy and Environmental Research.

Arjun Makhijani:
I'm going to answer your question. The reason you can't --

[laughter]

-- make nuclear cheap is because in an electric power plant, the nuclear reactors only the boiler. Eighty, 90 percent of the costs are downstream. And the nuclear boiler is much more expensive than the coal boiler by design. Okay. Now, let me tell you a story. How did nuclear power start as an idea that might be cheap and economical? It started with the Atoms for Peace speech. It is a fig leaf on the horror of the thermonuclear bomb. President Eisenhower didn't want to make a gloom-and-doom speech. And he said, "Give me something good to say." And they gave him Atoms for Peace. After that, there was a propaganda campaign and they called -- Commissioner Murray called it propaganda, at that time. That resulted in the greatest business managerial disaster in the history that I've told you about. That was round one. Fool me once. Then we had the nuclear renaissance. It's all streamlined. We had standardized design, AP 1000. We'll build them large like cookie cutters, standardized, streamlined licensing procedures. Last time, we had all this, you know, inspections and re-inspections. Now, we'll do it right. Fool me twice.

01:31:01

Now, we've got this mass-manufacturing standard, small modular reactors. Let me tell you, the small modular reactors that's being certified, it has the steam generator inside the reactor, which will be very much more radioactive than the steam generators we have today, which is the most frequently replaced expensive component of pressurized water reactor. In fact, they've been replaced in all of them. Fool me thrice. Now, if you want to be in the "fool me thrice" school, expensive, and doesn't work too well, and takes too long, sitting at the edge of the climate precipice, please vote for them. Otherwise --

[laughter]

[applause]

John Donvan:
Thank you, Arjun Makhijani.

[applause]

John Donvan:
The resolution is It's Time to Expand Nuclear Power. Here, making her closing statement against the resolution, Kirsty Gogan, co-founder and executive director of Energy for Humanity.

[applause]

Kirsty Gogan:
Thank you. So, the vast majority of nuclear plants that are being built today, they're being built on time, and they're being built on budget, and they're very cost competitive with fossil fuels and with renewable energy.

01:32:17

And when we did this study looking at new-build projects around the world for the British government, we looked back at the United States' experience. And, you know, what was really surprising and interesting to find, was that you guys have done it before, as well. And you've actually achieved an average cost, which is equivalent to the best cost to being achieved in the rest of the world today. And you know how you did that? You did it through a programmatic approach: by building up skills, and experience, and capability within the supply chain, within the labor force, within the regulator, within the project leadership team, to deliver good projects. So, you've done it before. Now, the anti-nuclear movement was created at a time when climate change just wasn't really understood as an existential threat. And if it wasn't for climate change, yes, we should just burn gas. But now is the time to re-evaluate what we think of as the risks of nuclear energy, in light of the real and present danger is presented to us by climate change, by air pollution that threaten the lives of millions of people, materially, every single year.

01:33:18

And we just cannot base our climate mitigation strategies on poor people remaining poor. Because it's not realistic, it's not ethical. And you know what? It's not our decision. Condemning women to spend 35 hours a week collecting firewood to cook food, which will then kill her and her children through respiratory illness isn't an energy strategy. It's a humanitarian disaster. But you know what? This creates an untenable gap, a gap between what the science tells us is needed and the reality of what's happening in the world. Because, yes, we're successfully driving down the costs of renewable energy. And yes, we're building wind and solar. But carbon emissions are not coming down. Now, the deadlock is breaking. The union of concerned scientists have changed their minds. And if you think that there's a chance that what I'm saying is true, then you will support the amendment, the motion to expand nuclear energy. Thank you very much.

[applause]

John Donvan:
Thank you, Kirsty Gogan. And our final speaker will be speaking against the resolution, please welcome to the lecture and Gregory Jaczko, former chairman of the U.S. Nuclear Regulatory Commission.

01:34:19

[applause]

Gregory Jaczko:
I'm convinced. I think they've presented a wonderful argument. It's just not true. So, you know, we can talk about these very impassioned pleas about women not burning things. That's not what we're talking about here. We can solve that problem with that woman with a solar solution today. I don't need a debate. I don't need an NGO to make that argument. That's what's happening in the real world. The solutions that we need to deal with the climate crisis are in front of us. They're cheap. They're available, but they're not nuclear. It doesn't matter what we decide today, what anyone decides today about whether we should we should give nuclear a new a new opportunity, a new look. It cannot compete in the marketplace. It cannot provide the kind of power we need in the future. And it has all these ancillary issues about safety, which we haven't really touched on, but which are there.

01:35:21

So, these are wonderful, impassioned statements that, like I said, always make me think, my gosh, am I thinking the wrong thing? And then I go out and I see what's happening in the real world. And we certainly aren't building enough of what we need to build, but we're certainly right now today building far more renewables than we are building nuclear. And we're not building anywhere close to what we need with nuclear. And we can't build anywhere close to what we need with nuclear. So, we can say that we're going to give nuclear a chance and that it's time for nuclear and it doesn't matter. Our hope rests with the things that can work today, not

with the things that we promised are going to get better tomorrow, because they've been promising for 15 years that they're going to get better tomorrow and they haven't. And yet, while we're talking about this, renewables have quietly become so cheap that they can work everywhere and they can be deployed in rapid numbers.

01:36:14

And in fact, I'll just close on this. We hear a lot about the wind not blowing in the sun, not shining. The sun comes up every day. It only doesn't shine during an eclipse.

And how many solar eclipses do you remember in your life? Solar works on a cloudy day. It's still sunny. So, if you think that we can solve the world's problem with nuclear, then God help us because we're not going to get there. So, vote for our solution.

[applause]

John Donvan:
Thank you, Gregory Jaczko. And that includes closing statements in our Intelligence Squared U.S. debate. And now it's time to learn which side you feel has argued the best. We want to have you again, go to your phones to place your second and final vote. Okay, while you're doing that, first thing, I want to say that this was a very passionate debate and it was somewhat technical as well. But I felt that all four of you helped us understand the technical side of it, that you were very, very accessible and that that was really, really useful to all of us.

01:37:15

And also, it's clear that you feel very passionately about this. All four of you. But as I said at the beginning, our goal is to get people to think. But to respect the fact that there are valid opinions, there are valid arguments on the other side, whether you agree with them or not. They're reasonable, they're respectable. And you all showed that respect to each other. So, you met our goal and our targets. I want to thank you for the way that you all argued here today.

[applause]

While we're waiting for the votes, sometimes we have a little bit of time and I see a certain dynamic among the debaters. I'd like to just probe into it a little bit. And what I saw was there was so much common ground that you both have that you both have to end mission inside of zero carbons and a solution to it. Some of you have undergone -- you especially Kirsty, talked about undergoing a conversion, switching sides. I'm just curious as you listen to the arguments tonight. Is there something that you heard from the other side that that's not part of your argument, but that you think your side really should listen to and take seriously? That they that they actually do have a point?

01:38:18

And I'll start with you, Greg. By the way, no is an okay answer. This doesn't have to be a Kumbaya moment.

Gregory Jaczko:
No. I mean, it is, you know, the point is that we shouldn't take anything off the table. I mean, that's true. We absolutely shouldn't. I mean, you know, I think at the end of the day, nuclear is not going to deliver, but we shouldn't take it off the table. You know, I think that in that regard -- the resolution wasn't taken off the table or expand it.

John Donvan:
Kirsty, what do you think?

Kirsty Gogan:
You know, I kind of started this evening saying that I really hoped that actually my goal was for us all to achieve some consensus. And I feel like that's happened. Which is kind of was my wild ambition. So, thank you. All right.

John Donvan:
Arjun?

Arjun Makhijani:
I actually changed my mind 14 years ago when my mentor, David Freeman, who is the father of energy policy in this country, wonderful man in his nineties. He said we should get rid of coal and oil and go to solar. This was 14 years ago when solar was ten dollars a watt.

01:39:31

And I said, you're going to send every industry into bankruptcy or to China. We can't afford that. And he said, I won't use the expletive, but he said don't be a naysayer. You haven't studied the energy issue for quite some time. I worked for him in the 70s. So, do it. And I did. And I surprised myself by concluding that it was possible to have a carbon free and nuclear free economy in the United States that would still be economical at that time, it appeared to be extremely difficult with very ambitious RND. But ten years later, it appeared to be a slam dunk.

01:40:18

John Donvan:
Where's the part where --

Arjun Makhijani:
I didn't change my mind as a result of this debate. I changed my mind previously as the result of another debate.

Daniel Poneman:
It's a tough one. I would say to a first order. I will identify the space in which I think what you asked for, John, could happen. That is to say, I think all of us were surprised at the level of

consensus on the objective, okay? I don't think anybody here disputes that that first 10, 20, even 30 percent can be cheaply and wonderfully achieved through renewables. The open question -- and it is an analytical question -- is, when it comes to these challenges, such as the transmission, such as the intermittency, such as the backup power and what it is -- can -- could we -- you know, if we went off in a room somewhere, and have -- you know -- proper analytics behind us, come to closer convergence on what that thing looks like?

01:41:23

John Donvan:
Yeah.

Daniel Poneman:
And that would be the one place -- I wouldn't say we've achieved it now, but that would be the open question, in my mind, that I think would be worth exploring.

John Donvan:
But it couldn't be a smoke-filled room, because that would be CO2. So, none of that.

[laughter]

Daniel Poneman:
We've got too much of that.

John Donvan:
I have the final results. You have voted twice on the resolution -- It's Time To Expand Nuclear Power -- once, you before you heard the arguments; and again, after you heard the arguments. We're going to give victory to the team whose numbers have changed the most between the first and the second votes. Here are the results. On the first vote, 49 percent of you agreed with the resolution, that it's time to expand nuclear power. 21 percent disagreed. 30 percent were undecided. On the second vote, on the second vote, 47 percent agreed with the for side. They lost 2 percentage points. The team arguing against the motion -- their first vote was 21 percent. Their second vote was 42 percent.

01:42:13

They picked up 21 percentage points. The team arguing against the resolution -- It's Time to Expand Nuclear Power -- named our winners. Our congratulations to them.

[applause]

Thank you from me, John Donvan, and Intelligence Squared U.S. We'll see you next time.

01:42:27

[end of transcript]

This is a rough transcript. Please excuse any errors.