Harvard Electricity Policy Group Virtual Session

Everything is Different: Ukraine, Energy, Climate and Electricity Markets May 5, 2022

Rapporteur's Report

TOPIC: The immediate crisis in Ukraine and attendant turmoil created by all Russian connections in energy markets is compelling a rapid reassessment of the resource mix and impacts on electricity systems. While the case of Europe is the most dramatic, the crisis is not without potentially major implications for North America. Policy making is adjusting in real time. European search for a substitute for Russian gas will inevitably lead to increased pressure for liquification and export of gas produced in the U.S. Might the increased supply of LNG to Europe finally signal the end of abundant low-cost gas in the U.S. and mean higher natural gas prices for the US power sector? LNG exports will be limited, at least in the short run by constraints in liquefaction capacity. How quickly can those constraints be reduced, and who will invest in more liquefaction given the uncertain duration of Russia's exclusion from the market? What alternatives to natural gas are there to meet immediate demand? Will reliance on coal make a surprising comeback? What will happen to ambitious carbon reduction goals? Are hydrogen options readily available? Will nuclear be reexamined? What demand side measures can be rapidly deployed in sufficient and timely quantities? While many of the questions of alternative supply are more pressing for Europeans, whatever measure they undertake will inevitably impact the U.S. The implications of those measures will certainly have short term ramifications but may well have longer ones as well. To what extent will the crisis transform electricity policy and markets? Is everything suddenly different?

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MODERATOR: I've been fortunate in the last couple of weeks and months to be involved in a

number of conversations about the clean energy transition and to be in forums with a number of

Europeans and US colleagues in the energy and electricity industry. And of course, this issue has

come up in the past few months because it's front and center for everyone. A European colleague

made a very memorable remark in one of these forums where they indicated that this war in

Ukraine is really like Europe's 9/11 moment. And the implication of course was that everything was going to be different from this point onwards, and in particular in energy markets as the EU moves first to reduce and then ultimately eliminate its dependency on oil and gas. And we know that it's going to be very hard. So we know that the US has offered to supply Europe with more US produced oil and gas, and particularly in the form of LNG, and European countries have been scrambling to secure alternative suppliers. We hear about this in the news every day.

In another forum, just a month ago, I was interested to hear from an energy analyst that the demand for energy from Asia was essentially inelastic. It had all be locked in through longterm contracts, and really the swing demand on the system for LNG was from Europe. And I also learned that global energy supplies, and in particular the supply chain, can't easily be scaled up in the short term. So this implies to me, at least in the short term, that the available energy supplies will be allocated to those buyers who have made long-term commitments or to those spot buyers that are prepared to pay a little more. And I think this explains the sharp increase in global energy prices during this past winter and what we're seeing in the forwards for this coming winter. I would also appreciate our panelists thoughts on energy demand and supply dynamics, and I'll explain why in a minute.

The other thing that I've learned through these forums, of course, is that most EU countries have very aggressive decarbonization goals. And the current energy crisis would seem to provide fresh impetus to reduce the dependency on fossil fuels. The solution seems obvious on the surface, which is to accelerate the deployment of local renewables rather than relying on imported fossil energy. However, the supply chain for renewables is also becomes really constrained and costly, particularly with respect to the availability and cost of input materials, the specialized equipment needed to support certain industries like offshore wind, and the shortage

of skilled labor across the entire industry. It seems to me that at least in the short to medium term, the war will cause Europeans to extend the message of their own fossil fuel supplies while they look to replace Russian oil and gas, but also seek, in the same timeframe, to try and accelerate the deployment of renewable energy, which is going to exacerbate supply chain shortages for everybody who wants more renewables. Obviously these measures will certainly have short-term ramifications, but may have longer-term ones as well.

So, here's my first question to the panel. To what extent will the crisis and the supply chain frictions in both the fossil and renewable energies affect electricity policy and markets here in the US?

That's a good segue to what keeps me up at night. The New England region, which as you all know, is sandwiched between New York, Canada, and the Atlantic Ocean, is at the end of the pipeline and transmission system and relatively weakly interconnected with our neighbors. We also have a high dependence on imported LNG, and therefore we are tied to the global supply chain dynamics for LNG, and we currently rely on seasonal spot purchases to supply generators. We also rely heavily on oil in the winter that is trucked and barged throughout the region. And we know that inclement weather can affect both the availability and the cost of LNG and oil supplies. We've got a very rapid timeline for decarbonization, and therefore we must rapidly decrease our use of fossil fuels. Our policymakers have made a significant investment in offshore wind and upgrading our transmission infrastructure. And so, therefore, this global supply chain dynamic around renewable energy that I described, will also affect us.

When I stand back from our situation, we have many of the same energy supply challenges and decarbonization challenges as European countries. Which leads me to my second question which is, in the panel's opinion, is New England situation relatively unique? Are we a

sort of odd duck here in the US? Or are there broader lessons to be learned for the US as a whole, particularly as we seek to decarbonize?

I've also observed that, whenever there's a low probability but high impact supply side shock in the system, government steps in to address the problem and restructure the market. This ranges from macro situations like this present war in Ukraine, to more micro situations like the energy crisis that played out in Texas in February of 2021. We know that markets will typically drive producers to achieve maximum economic efficiencies, but I wonder whether it's realistic to expect markets to hedge low probability, high impact events, and moreover, will society tolerate long duration disruptions of electricity supplies or very high prices? I'd say the evidence suggests not. Therefore, we may need to rely on government regulators to hedge these risks through some form of socialized regulatory requirement, which I acknowledge could apply to either the supply or the demand side. So here's my third question. What's the right balance between relying on scarcity pricing to remedy supply side shortages, versus a regulatory backstop of some form?

It also seems to me that the crises in Ukraine and Texas have revealed a vulnerability that needs to be addressed, particularly in regions that are attempting to aggressively decarbonize and reduce the average use of fossil fuels. It seems to me that as we designed wholesale electricity markets, we made a simplifying assumption that is now proving to be incorrect, that a spot market for wholesale electricity would create sufficient demand for fuel such that investors in fuel infrastructure would always make the necessary investments to meet generator demand. But I observe that most of the investment in fuel infrastructure occurred before the advent of wholesale markets, and in the case of gas pipelines, is typically recovered under a long-term contractual arrangement between the pipeline developer and the shipper, which is either a

consumer or producer. However, gas generators in spot wholesale electricity markets do not have a long-term incentive that matches this long-term contractual commitment that is required by pipeline developers, and therefore they can't recover their sum costs related to this primary fuel infrastructure.

There's enough historical evidence that suggests that generators will procure enough fuel to meet their average supply obligation, but I think the evidence also suggests that this procurement behavior does not extend to fully covering low probability extreme events or big shocks to the supply chain. So, if consumers or the policymakers that act on their behalf are not prepared to make long-term commitments to fossil fuel infrastructure, and furthermore signal that they want to reduce the average divide for that fuel supply over time, it seems to me to be unrealistic to expect the market to provide adequate infrastructure to meet these extended high demand events. And I'll remind you that FERC regulated generators do not have a regulatory obligation to hedge these risks, because FERC ruled that generators only have a strict obligation to attempt to procure fuel in real time. And if they can't find it, they don't have the obligation. So, despite our enthusiasm about new technologies like shorter duration technology, giving us the means to balance this day-to-day, we know that those technologies will not suffice to cover extreme weather events or the so-called winter doldrums. This raises the question of how to ensure an adequate long duration balancing energy source, or some form of energy reserve on the system, or accept the risk of controlled outages during periods of energy inadequacy. This leads me to my final question to the panel, which is, do we need such a long duration energy reserve, and if so, who will specify it, and what conditions are required to stimulate investment in the service?

As a final note to the panelists and to the participants in the forum discussion, our objective here is to seek answers to questions that are also compatible with the rest of the wholesale market design and the system that we have in place. I think the first step should be to identify the flaws and rectify as many as possible, and then look to design supplemental policies that are compatible with that system and that fit well, rather than just latching on to things that look appealing but may not fit well. So with that introduction I'll turn it over to the panelists.

FIRST SPEAKER: Great. Thank you for laying that out and providing so much really relevant context and excellent questions. I'd just like to introduce myself to this group, in the sense that I feel like I'm a little bit of a duck out of water in the sense I'm not an electricity expert by any stretch of imagination. My expertise lies more in the geopolitical realm. I've been asked to provide brief comments at the beginning that puts the conflict into a little bit of a current perspective and provide a few thoughts for what this means for energy markets and energy transition.

First, I thought I would just say a couple of minutes on where the conflict is going, and then some of the implications for energy and the energy transition or climate as I see them. And of course, a lot of these are initial thoughts to an ever evolving landscape. So first, where is the conflict going? In my mind, this is a particularly dangerous phase of the conflict. The real prospect for escalation is very much with us. We're seeing what I think can only be termed as a strategic incoherence coming out of the Kremlin, bouncing from objective to objective against the backdrop of real military challenges and incompetency and growing capabilities on the Ukrainian side. Put that all together in the political backdrop that defeat is not really an option for Putin at the same time that we see varying parties in the West define their objectives more

expansively. We've heard from the German foreign minister in the last few days that sanctions will stay in place until all Russians are out of Ukraine, and that would reverse the landscape beyond, or it would roll it back more towards potentially before the annexation of Ukraine. And the United States has publicly expressed that its goal is to weaken Russia. And like none of that should really raise eyebrows, per se, but certainly, those are different goals than helping Ukraine defend its territorial sovereignty or something along those lines.

I would say, just from having had the opportunity to talk to a number of senior administration officials in private, that those stronger objectives or more ambitious objectives vis-à-vis Russia are actually a fair representation of what Washington is intended to do, and that is basically to really destroy all bases of Putin's power right now. And the tools that it has to use are pretty aggressive here. In terms of where this is going we're morphing into a conflict that's really between Russia and the West, and Russia and the United States in particular. And this means that the conflict is going to outlast any fighting in Ukraine, and it's going to have longterm implications for the Russian people, for the Russian economy, and for the global economy.

Here are a couple of thoughts of how I might be wrong about this trajectory because I think it does affect energy markets in a pretty significant way. The major implication here is that these sanctions remain in place for a very long period of time, talking years or really at least the duration of a President Putin's time in power, however long that may be. But there might be some dynamics that evolve that are different than what I'm anticipating. It's certainly conceivable that Zelensky could find himself in a position where he needs to negotiate with Russia, and that he asks the West for one of his tools to be lightening up on the sanctions, and that that might be one way in which we do see sanctions relief on Russia and its energy markets in the short term. Secondly, we' seen unity. I was in Munich a couple of days before the Russian

invasion, and despite the doom and gloom that people were anticipating there certainly was great pride in the sense of unity that this conflict has instilled in the Transatlantic relationship and among European Members. That has maintained itself to everyone's surprise, I would say. But it's not something we can take for granted, as the economic impact of these sanctions continues to bite. The oil embargo is just the latest in what we are going to see in as major economic dislocation in Europe. Potentially a recession in Europe could really strain some of that unity. Then, thirdly, there are plenty of potential crises elsewhere in the world on the landscape, Iran potentially being one that I put at the top. We have the prospect of no Iran deal, which in any other geopolitical setting would be the top geopolitical story, but it's buried behind this. So that could move to the front burner and make the situation in Europe somewhat unsustainable.

Now, let me just say a bit about what I see this meeting for energy overall. There have been a lot of comparisons to the energy landscape or the potential energy crisis in the 1970s, and I think there are some superficial similarities. Certainly, the outcomes in terms of stagflation and potential political instability and all of that could be relevant. But the dynamics are really different because, as we know, Russia is one of the world's largest suppliers of all kinds of fuel: the world's largest exporter of crude and refined oil products, largest exporter of natural gas, one of the world's largest exporters of coal, and one of the world's largest exporters of enriched uranium. We're talking about disruptions that are going through the entire energy system, and the dynamic is very different than people anticipated. We have this momentum of where the West is cutting itself off from Russia, rather than the scenario that all foreign policy experts had anticipated or had been trying to guard against over time, which is that of Russia cutting off resources to Europe and other parts of the world.

In terms of where that is going, I do think we're still going to see a lot of energy disruption. There are two key points here; one is that we're still climbing the sanctions ladder. There are still sanctions that have not come into place that are going to put greater constraints on the flow of energy from Russia to the rest of the world. There are European sanctions that are coming into effect later in May on Rosneft and other energy producers in Russia. Certainly the oil embargo is going to have a lot of disruption in the markets, and that's going to be phased in over the next six months to the end of the year. And most important, I anticipate that the conversation about US secondary sanctions on other countries, potentially India, potentially China, is going to start to move to the center stage. The second thing that makes me think there's a lot of disruption still to come is that Russia now is clearly in the game of using its ability to cut off gas flow to the rest of Europe incrementally, having done so with Poland and Romania. I don't expect the Europeans themselves are going to go particularly far in cutting off gas – and we can get into this. They've already put in place an ambitious program to wean themselves off of natural gas exports, with the goal of two thirds off of natural gas exports by the end of this year.

So, how could I be wrong about a worsening energy situation? One a recession. Certainly, this is all of the talk in Europe, or at least what I hear from my European friends and colleagues. Secondly, on the oil component, the extent of the disruption really depends on two key things. The first is to what extent do China and India and other countries actually absorb the oil that Europe is no longer going to buy. I think there's a lot of economists who think this is going to be pretty seamless. My sense is, this is going to be bumpier than people anticipate because China has lots of good reasons for why it doesn't want to become more reliant on Russian energy. It has a policy not to import more than 15 or 20% of its energy source from any one country, and it's already at about 10% for Russian gas. It doesn't have any infrastructure to increase that in the short term. On Russian imports, it's already probably coming somewhat close to where it's comfortable being. Secondly, there's a whole issue of, to what extent is the US going to be able to mend its relationship with Gulf suppliers of oil. I have some thoughts and insights on that, if we want to go down that road.

In wrapping up, I would say the implications for the energy transition are threefold. One is obviously energy security being brought to the forefront. And to me this is done in ways --and the moderator suggested this -- that in Europe energy security had kind of been excised from the conversation, and now it is back center stage. And I think it's done so in the context of appreciating that the kinds of disruptions that Europe is seeing right now are the kinds of things that create the largest geopolitical risks to the transition itself. These kinds of disruptions, these kinds of energy prices, are the things that completely sap popular opinion to do difficult things related to the energy transition. So, there's now this focus on meeting immediate energy needs and warranting the focus away from the net zero 2050 goal a few decades away to looking at that transition of what's going to happen, and the reality that the longer the transition is drawn out, the more vulnerable that Europe is going to be. That's one implication that the energy security focus is going to be lasting.

The second implication, again, relates to what the moderator said about government interventions. I think we are going to see a lot more government interventions in energy markets, both in the United States and in Europe, as governments need to play more of a role if they're going to be able to help societies meet energy security in the short term without building infrastructure that is going to impede the energy transition over the coming decades. I've been talking to people about an idea of transition assets and how the government might actually defray the cost of building an asset that won't be used for as long as it would be in a normal commercial

environment, and that the government might come in to decide that is worth paying extra for society to have energy security in the short term without having those pieces of infrastructure necessarily be used for their entire commercial life.

Lastly, I would say, I guess net-net, while I'm pretty optimistic about Europe being able to actually do this dual dance of transitioning while meeting energy security now, I'm overall a little bit more pessimistic for two reasons, and they really relate to the developing world. The first one is just the relationship between deglobalization and energy transition. I'd be interested in other people's views that the energy transition is probably a deglobalizing movement on its own. But given that this crisis has been probably deglobalizing, this is going to make the energy transition a little bit more difficult in terms of the flow of ideas and people and talent and technology. The second reason, again relating to the developing world, has to do with the revival of coal, and there are all kinds of interesting things going on in this department that I'm sure someone else on this call knows in even greater detail. But I'll just point out some of the interesting implications, if you look at what's happening in China. China has announced that it's going to increase its own coal production this year by 7% for energy security objectives, which means that China is importing less coal, which means that it's importing less natural gas, and that means that no other countries can import coal and not have to import, or not have to compete for limited LNG supplies that are being pulled to Europe. We're seeing kind of a real rejiggering of that energy landscape in a way that I think, on the whole, creates a larger space for coal and creates even more difficulty for developing countries to square the triangle, whatever it is, but of addressing energy access, decarbonizing their economies, and doing so in the context of rising fuel prices and, in many cases, the impending food shortage that's related to the conflict as well.

I look forward to learning more about some of these markets and dynamics that there are so many people on this call who are very expert in. Thank you.

SECOND SPEAKER: Thank you, great to see everyone and great to hear you guys and have a chance to participate in this. I'll kick off with the same disclaimer as the first speaker, that a lot of the detailed aspects of the moderator's questions are not my area of expertise. I did grow up in the electric utility and gas utility business and lived through deregulation, but that's not why I'm here today. So, I'll hopefully contribute a little bit along the lines of kind of picking up where the previous speaker left off about the on-the-ground realities of the of gas business, regarding LNG in particular. What we're seeing, what the challenges and opportunities are as the world is reshaped, to what extent obviously has yet to be determined, and I'll provide some thoughts on where we're going from here for our business as it relates to LNG and perhaps contribute a little bit on gas and power structure. As some of you may know, my company is today the largest US LNG exporter -- about 12% of the global market from a standing start, starting operationally in February of 2016; construction began in August '12. These dates should give you a sense for the long cycle business that is the LNG business.

On the import side, things can pop up relatively quickly. Egypt so far has the record. When its crisis was playing out about little less than a decade ago it brought online a floating imports terminal in nine months from start to finish. That's what Europe is trying to do today. That is relatively simple. It is really a question of availability of floating regas units. There are roughly 30 of them in the world today, relatively easy to build more inside of about two years in the yards in South Korea and China. Liquefaction takes longer and is much more expensive, an order of magnitude more expensive. When we were a failed import business, we charged about 30 cents in MBTU for our import capacity. Now we charge \$2.50 to \$3 as a cost-of-service type economic construct for our export projects. Iit's an order of magnitude more expensive, two to three times longer to build. The market structure, however, and to go back to a little bit of what the moderator was saying, the market structure is a little bit different in that 95% of our company's volume today is sold under long-term and short-term contracts, about 85% long-term, the rest a relatively short term.

But that doesn't determine where those molecules go. The LNG market of 15 plus years ago, which was dominated by Australia, Southeast Asia supplying various markets but majority Asia, was really a point-to-point business. In building on the evolution of the LNG market, our customers today can take their cargoes wherever they want, with the exception of a handful of countries, North Korea, for example. So we today are overwhelmingly sold to third parties, and those third parties decide where those volumes will go, and that's exactly what you've seen as a response in Europe starting late last year through this this crisis that's unfolding. That has been a blessing and a curse: a blessing from a physical standpoint of reallocating that volume, and a curse that Europe's market design has not only saddled it with massive energy insecurity but also astronomical bills. If you analyze kind of the run rate of what Europe is paying for MMBTU or per megawatt hour, however you want to measure it, we're surpassing 20% of Europe's GDP as annualized energy costs, which is clearly not sustainable and unlike the vast majority of markets, which are relatively immune to these price spikes. Our friends in Taiwan or mainland China or South Korea are paying a fraction of what these prices are. Not only are corporations and buyers paying a fraction of that, but the consumers are paying a fraction of that because they are benefiting from the pooled, diversified supply portfolio of the of the load serving entities.

Europe decided, in what I've always thought was an insane market design, to rely on the market, on the spot price, and literally every consumer in Europe is paying that marginal market clearing price. We sell our product at about a third of the prevailing market price to our customers. Europe pays that market price, and two thirds of that value are captured by our customers, who in many cases are the same entities, under the umbrella of the load serving utility in Europe, but that supply goes into a different company and has no structural linkage to the supply obligation of the regulated utilities. Market structure has been a huge failure in Europe and this is something that we've been talking to Brussels and the Member States about for five plus years now. It looked really good for a while. You know, two years ago when the world was. paying \$2 for MMBTU everywhere, the market design was not saddled with these above market long-term contracts.

To the moderator's question of how does the world play out, our world has never been balanced. Right? It's either consumer surplus or producer surplus. So now it's a very challenging time for balancing and reconciling those accounts. In terms of this crisis and what will unquestionably change at least over the medium term, the LNG world had reconciled itself to there being really three primary sources of future supply. And those three were Qatar, the US Gulf Coast, and Arctic Russia. Everything else was onesies and twosies. That's who captured the commercial off-take. That's who build facilities. That's who was going to have a very robust growth trajectory over the coming decades. And now both commercially, from the counterparty and contractual support standpoint, and certainly already we're seeing the operational and execution challenges of how to build a liquefaction project that relies on construction services and liquefaction equipment and other providers that have either been sanctioned or have selfsanctioned. You're already seeing that play out today. Even projects that were underway are

delayed likely by years, and the question will be post conflict, whether it is a diplomatic solution with Putin at the helm, or a regime or post-regime change (the first speaker can address this); does Russia and its resource base and its available infrastructure come back to continue to supply the world, or does it become one of the failed petro states, and we're faced with the world needing to needing to beat those shortages.

The other lesson that we learned, and maybe this is the most apropos to the moderator's 9/11 point, that security is redundancy and diversity. Redundancy is expensive, not incredibly expensive, but it obviously results in investment in underutilized infrastructure. But we have mechanisms to deal with that. We're constantly adjusting regulatory constructs to address that. There are many solutions, and as it relates to the Russia conflict in particular, two best case studies in recent history. Lithuania invested in import infrastructure for LNG, brought online one of these floating regasification units called Independence in Klaipeda about seven years ago. Over the ensuing years it has been at various times called a white elephant, and there were lots of complaints about why we're already paying for this when we have perfectly good pipeline infrastructure and gas supply contracts with gas farms that are cheaper than what you're paying for market priced LNG. But you know, it requires taking, of course, a broader and longer-term view of that type of investment. The other success story, as we look through today's lens on that front, has been Poland. It brought online a terrestrial terminal on the Baltic officially named after the Polish President who died in a plane crash that Poland largely attributes to Russian intervention. That project came online in 2017, and Poland began planning for this cessation of Russian pipeline flows which occurred on April 27 in 2014. So again, to give you a sense for how long it takes to put these pieces in place in Poland's case, our counterparty, the primary gas utility PGNIG, has a contract with gas farms that expires at the end of this year and has always

been planning on not renewing that. So it was both a political and an economic decision in that case, and it did build this redundant infrastructure. It signed up for pipeline gas on the new Baltic pipe. It has been supportive of additional infrastructure in Europe, primarily the Lithuania to Poland gas pipeline, continues to expand its import capability and investing in its grid to have that kind of reliability and ability to source gas, not just from pipelines, but also from LNG from Ecuador, Qatar, and multiple projects in the US, including ours.

So, the solutions are relatively readily available. They're relatively inexpensive. One of the things that we could never understand is why more investment wasn't made in terminals. As I said earlier, they are relatively inexpensive and, Europe has invested in this infrastructure. I think the Lithuania to Poland pipeline is about 70% financed by Brussels. A new LNG import terminal in Croatian on the island of Krk between Brussels and the government of Croatia was about 75% financed by the government. The same goes for the Greece-Bulgaria interconnector that's about to come online. Lots of investment has been made, just insufficient to give the continent more ability to diversify away from its 35-40% supplier. It would have been clever of Brussels to think about not having any single supplier be more than 15 or 20%, but that's easy to say in hindsight.

I think over the next couple of years, from my vantage point, Europe makes a good dent in in replacing Russian pipeline flows. I don't think it is able to meet its objectives. The problem is that the investments that weren't made two, three, five years ago are at the root of that. You just simply cannot replace these kinds of volumes. And to one of the moderator's points, there are a number of markets in Asia that are committed to gas and elastic pricing for a whole host of reasons. What we say about Europe is, in two years it's gone from the market of last resort to the market of greatest need. And so now it'll fight tooth and nail for every one of these cargoes, and even if it gets the cargoes, it'll be insufficient because we are physically reaching maximum

import capacity. So we'll be in that state for the next two or three years. This year incremental LNG, if all goes according to plan, will displace about 40% of Russian pipeline flows, but literally, physically, no more can be done, both from an infrastructure standpoint, which will be solved in the next one to three years, and also from an incremental supply standpoint, which will not really become more readily available until very late this decade.

To comment on the first speaker's observation about transition assets, I think that's a good construct. I think, with relatively little Brussels and policy support, a lot of these pieces can be put in place. You have all heard about Germany's rush to build additional regas terminals. No one on the ground in Germany knows how it will be done, literally. The guys we talk to every day have no idea. They're going here. They're going there. They're sitting down at the table. It's a brand new world. Something will likely get done, but there won't be commercial assets to begin with. Right? So it requires new structures, new sponsors, new systems. How will capacity on those terminals will be apportioned, etc.? There are lots of questions to be to be answered on that front.

In terms of the rest of the world, again deferring to others for the geopolitical implications of this, I don't see a world where China and India genuinely wean themselves off Russian energy. We don't even have Japan weaning itself off Russian energy. Right? As Shell and BP and others have moved aggressively to exit projects, the Japanese have been resolute in saying that they are staying in those projects and will continue to buy the off-take. Energy security for a long time will trump the geopolitical priorities that may have leant the other way.

For a final comment, from a commercial standpoint, this European gas crisis was a certainty years ago. It did not require this tragedy to play out. It was well underway, and this would have happened, in my humble opinion, regardless of what Russia did. It just simply could

not properly balance its system with its plans to retire the massive amount of solid fuel baseload power. And it was going to be much more reliant on gas, and imported gas at that. Regional and domestic production is in irreversible decline there. This crisis, if you will, from an energy price standpoint, was dialed in for this decade over the previous decade.

Europe can continue to progress on decarbonization. But in terms of the economics of its energy supply it's going to continue to be challenged because, again, as I look at our book of business and our forward book of business, it is dominated by Asian players. They have different regulatory compacts. They have different incentives, and they are much more comfortable signing up for the type of contractual commitments that we as LNG developers and operators ultimately want. Europe will continue to be hampered by that and its ability to bring the right solutions to the table. I'll stop there, and leave the opining on what the Northeast can do for Q&A. Thank you.

MODERATOR: Thank you very much. With that we will move to our next speaker, who lives in the Northeast, and might have a few thoughts on this.

THIRD SPEAKER: The moderator provided an excellent and nuanced framing for our conversation, and I learned a lot from my fellow panelists. Our organization works in Europe, and we focus on the US states and their policy setting and actions and how they might be affected by the war. And so there's a lot to deal with. People come into government leadership for service or politics, but these times are testing the metal of political leaders -- the trade war, pandemic, shooting war, the tension between globalism and nationalism. For the people who are successful in resolving these things, success is not always rewarded.

Europe is committed to climate action in its EU Constitution and in repeated legislation, most recently its Fit for 55 package designed to reduce greenhouse gas by 55% in 2030. Faced with energy disruptions from the war, Europe is mobilizing to accelerate reductions in gas use. The last speaker is far more expert in this than I am, but my observation is that there are opportunities to significantly reduce Russian gas right away, as he said, and that there are, I think, plans to eliminate Russian gas completely. We have a plan that we put out with a few other NGOs to do that by 2025. A significant part of that is a doable escalation of deployment of distributed energy resources and renewables on top of the path that's set aside in Fit for 55. This graphic shows the chunks of change that lead to decoupling of Europe from Russian gas, which include a significant deployment of heat pumps for heating, a significant deployment of renewables, and a significant increase, as the last speaker said, in the utilization of existing import capacity in Europe.

Now Longfellow, who walked the same Cambridge streets many years ago as Bill Hogan and Ashley walk today, offers a metaphor for the present American relationship with gas. There are two-sides to this issue. On the one hand, gas for power generation is a backbone for the economy, certainly in New England, and generators use gas with high efficiency systems, and they provide grid flexibility to accommodate all kinds of things, including variable wind and solar output. When markets are calm, gas is cheap, and pipelines move it effectively from extraction to power plant. The gas industry is an embedded cog that makes the economy go.

On the other hand, sometimes markets are not calm, and in the last 20 years we've had several episodes of shocks to the gas system, and gas prices increased by multiples threatening those close to the economic margins. And, don't get me started talking about Texas. Markets are

increasingly global, and it may become harder for a place at the end of the pipeline like New England to avoid the new effects from gas moving on ships around the world.

Now, somehow, to address climate imperatives, as reported by the UN IPCC, the world must decarbonize power by 2050, and this will present challenges and dilemmas, and that's what we have governments for, to lead and to set a path, to take tough decisions. Making those decisions tougher is the strength of the gas industry to make its case in states across the US.

I want to change gears for a moment and talk about very rare, sometimes called black swan events. Some of these have natural causes. Some are caused by human actions. Climate change driven events, of course, may be a mix of those. It seems like these very rare and hard to predict events are happening more frequently. For me, this is why resilience should be high on the agenda for any state government, bringing together many related agencies to identify with as much imagination as the leaders can muster, not just what can go wrong, but what can cause the most disruption to the social fabric. I hope, no one wants to be seen as the ostrich, purposefully avoiding looking at the landscape.

An approach to addressing these bad scenarios is through gaming. We already see this with war games, and the NRC put states with nuclear power through annual drills that can seem apocalyptic to the participants, in order to prepare decision makers in the event of the unthinkable. Perhaps the federal government can help states with resilience scenario planning. I've dropped this suggestion into the US DOE. Then states can make informed decisions on buying insurance to protect its people and its most precious attributes from the unthinkable. I agree, I think, with where the moderator is going, that markets will not do this.

The US lacks an overarching commitment to climate action. As the presidency volleys back and forth, administrative actions ebb and flow. Those states that are committed to climate

action seem steadfast, backed by businesses responding to shareholders, customers, and employees. The climate business is growing. Evident to states committed to climate action and decarbonization is that new investment in mass market gas systems is faced with a new probability of a service life much shorter than its useful life. There is a concern, a fear of regret. Here comes a big dilemma, only made more evident by the war. My message to states is to accelerate actions that diminish dependence on gas and take comfort that Europeans are putting actions in place consistent with climate goals, investing in buildings and data that allow people to do more with what they have.

I'm going to wrap up with a few thoughts. First, I want to resonate with the moderator's notion that government needs to take more ownership of protecting society from very bad outcomes. Here are a few cases listed here, where markets will not protect us from bad outcomes, and government needs to take action, or at least authorize action. Do we think that it's likely that government will take these actions? People who know me know I'm persistently optimistic, though my optimism is often tested. One trigger that may have the most weight is the occasional price spike that accompanies gas volatility. The public tends to demand action when prices spike threaten. My team has come up with a paper that goes directly to the moderator's desire to dampen price spikes.

So, I do have some messages for states. First, climate change is a slow moving yet urgent concern that merits a high priority, and I think we tend to have trouble rationalizing the slow part of that with the urgent part of that. I worry that as greenhouse gas concentrations grow, humans will see it move faster, and perhaps we already are seeing that. Economies strongly dependent on fossil fuels need to plan to undo this dependence. Now I'm not here today to advocate for manufactured fuels or district energy or the several other ways that gas companies are

contemplating remaking their businesses. I am here to say that states should look at all these with clear eyes about cost and scale and alternative competitive uses and to ask more questions about the useful lives of imminent investments in the gas system. Noting arguments that gas can be replaced with manufactured gas or hydrogen from renewable sources, I urge your consideration to an idea that recently cleared both houses of the Vermont legislature, a clean heat standard.

The moderator alluded to long duration storage in his remarks. I think this is an important topic, whether it is from developing technology, perhaps flowing from the US DOE earth shot that was recently announced, or from creative uses of short duration storage by system operators, this category of resources generally associated with storage hydroelectric power will become more important as gas use diminishes. States should encourage developments in long duration storage if for no other reason than as part of their resilience preparations.

Now many people in this session may have already invested in heat pumps, in their homes, in their businesses, hopefully, supported by energy efficiency programs. That would be great. It is possible that as many with means make this switch, the mass market gas system becomes increasingly dominated by low income people. That would not be great, as such a system may become more expensive to users than they can afford. States can preempt this by affirmatively targeting low and moderate-income housing with heating electrification or other solution.

Many of my presentations seem to come to the end talking about leadership, and I'm doing it again. Leaders face facts and resist relying on wishful thinking. Leaders appreciate the power and knowledge that they have, and their limits. Collaborating is likely to lead to more effective regional approaches and reveal common interests that may lead to advocacy with the federal government, with RTOs, businesses, and other states. Leaders are not afraid of tough

questions and want to reveal all their options. There is a healthy level of engagement between US and European government officials, and I think this needs to strengthen now and extend around the world.

When I look at states, I see capital. I see people, businesses, buildings. I see resources in all these and reasons to invest in all of them. Grid modernization and the use of data could be prioritized for better results to enable people to do more with what they have, and grid modernization could be better justified by all of the regulated companies involved. States need to protect the most vulnerable. As I have said, I suggest prioritizing their welfare in the energy transition. Because we will be living with change, let's celebrate when change goes well and challenge the media to report on success.

MODERATOR: Thank you very much. I think you did an excellent job representing the views of the states. I thought that you set out to do that deliberately but, I think your commentary would resonate with many state officials here in New England.

FOURTH SPEAKER: I'm going to make every effort here to build off the commentary that has already been presented here. The moderator's asked me to really dig into a lot more of the federal policy lens, like a compliment to Rich, with a little bit more heavy weighting on electricity markets, but we'll also touch on some other federal policy components of this. Here we are today talking about effectively just applied risk management policy in energy supply chains and climate, which is near and dear to my organization's heart. We do a mixture of both federal and state work and, as mentioned, most of my comments today will be focused on federal, but there'll be a little bit regional emphasis on Texas and New England, given some of

the natural gas situations that they've had on the resilience side of the equation that feeds into today's conversation.

Our previous speakers have set a pretty good stage of what the political lens looks like these days. One thing that I'd really add to this is that if we had this conversation five years ago, same geopolitical circumstances, we'd actually be having a different set of diagnoses and remedies in place on some degree of the policy side of the equation. A lot of this has to do with actually how private markets view and internalize risk and uncertainty. I think in the last few years under the so-called stakeholder capitalism era that we've actually seen a pretty major shift in how a lot of firm behavior is functioning, and I think that has a lot of profound policy implications, especially on the climate front. But it is interesting to also see how geopolitical risk directly factors into a lot of firm behavior, but also as firms are more concerned about reputational considerations than they were in years past. Certainly, anything that has ties that affect a reputational harm, as reputation does seem to have an effect now on everything from default risk to cost of capital to actual revenue and cost streams in a variety of book asset management perspectives.

One thing that is a common theme that cuts across a variety of things is that we're seeing a lot of political challenges and push back to price spikes. I am a firm believer that we want wholesale natural gas and electricity markets to reflect marginal costs. I think it's extremely important. The big contention right now, actually, is that the political response is just so negative, especially when you have sustained wholesale spikes. But, I will note that it's actually not the wholesale price itself that drives adverse political consequences. It tends to be a function of how that trickles through to end-use customers. Right? What you heard in Texas last year was actually about the subset of 1% who are exposed to the wholesale price. You didn't hear about

the 99 plus percent who actually benefited. Because the retailers were absorbing the risk. Right? And similarly, you hear the same thing, I think, in New England. Right? With the nature of stakeholders more concerned about how things ultimately hit voters' wallets, and they don't typically directly interface with the wholesale markets.

So, it is important to make sure we get the wholesale architecture right, and that flows down through the retail architecture as well, too. In the nature of where we're at going forward, I think there's a lot of misfires in our dialogue today that kind of pit climate and energy security objectives against themselves. One way I think we overcome that is to say healthy markets are actually highly compatible with both climate objectives and energy security objectives. We should be talking about transferring risk actually more to the private sector, addressing inherent moral hazard problems, better definition of property rights, remedying information asymmetries, lowering artificial barriers to entry and exit, transactions costs, and of course everyone's favorite externality pricing -- some of the cross fires that unfortunately hadn't been really manifested in the nature of what I call natural gas policy schizophrenia here on the home front.

The last speaker laid out some of the pros and cons, and I think when we have a public dialogue that has oftentimes pivoted more towards picking fuel winners, rather than letting healthy markets sort through what the natural substitution effects should be, as well as what I think is really interesting, the huge potential for natural gas markets to actually cannibalize themselves with cleaner new entry displacing dirtier segments within the ranks and having that whole value chain in the natural gas system. Here at home we see a lot of environmental competition within the natural gas industry now over the last few years.

Then you enter this into the LNG conversation, which is another area where our domestic climate lens has been so focused on emissions reductions at home, irrespective of the

international emissions profile. One of the things that's really blown a lot of people away was when a report came out here that looked at US LNG exports to Europe actually having 40% life cycle, a lower life cycle of emissions, than Russian gas. That's good evidence of how actually liberalizing marketplaces, making them more fungible, transparent, etc., actually unites a lot of our climate and energy security objectives. The nature of our politics may be pessimistic, but I actually think the underlying economic fundamentals are more conducive to talking about leveraging competitive forces.

Here's the best menu I could provide of the compatibility between policy reforms that both advance more climate stabilization agenda and energy security, both at home and abroad. I'm not in the interest of time going to go through all of these one by one. And these slides will be available later so I'm just going to pick out a few to highlight. First off, I'm just going to start by noting that the expansion of market institutions, especially marginal cost spot pricing, is really important. We need to actually be moving more towards integrated marketplaces globally. At home, we need to be talking about expanding organized wholesale markets, but also making sure that the participants in those markets have the motive to actually respond to price signals which we don't see, depending on the retail structure of those generators. In that sense, I think that's a huge undertaking, and the political pushback that comes from doing that is actually because we see more deficiencies in risk management.

It's important to make sure we expand market institutions and at the same time have good risk management policies in place. This is everything from the credit and collateral and hedging requirement conversations we might see in ERCOT now or in ISO New England, or even in versions of how we see different conversations between whether capacity markets have a role or less role going forward and what the role is of spot markets with retail hedging mechanisms. An

area where we definitely do not want to go is to revert back to price controls. I actually think suppressing price signals is incredibly antagonistic to both climate and energy security objectives. When you have higher prices, that is your natural signal to how to allocate scarce resources. That's why economists actually sit there and go, these markets need to be signaling this because this is the important signal on how to have shifts in demand, how to have substitution effects on the supply side of the equation. So, it's very important that we have all those components in there and that we're not using emergency actions to address things that are long-term economic structural risks, that we make sure that we have market compatible policies in place. Some of the environmental transparency and product heterogeneity pieces that actually speak a little bit more towards helping marketplaces internalize the preferences of various stakeholders for climate considerations, which I think is going to be the driving force of the clean transition, probably from here on out, irrespective of what you see with any federal policy shifts.

For all this talk on risk management, I want to definitely introduce the concept of uncertainty management as well. The distinction there being, a risk of something with a known probability. When you don't have moral hazard problems and address some of the information deficiency issues between actors, markets do a really good job, frankly, of internalizing and addressing those risks quite well, whether that's financial hedging practices, physical hedging practices, etc. Where we start, I think, having some major concerns is when you get into the inability to assign a probability to these tail risks, especially the ones that have very high consequences. A good distinction might be how we've seen the restructured markets do a good job anticipating more routine cold weather spells or heat waves, whether in ERCOT or New England. We've seen a track record of it being very profitable for those markets structures to be in place to do that. Where we've seen them struggle is to talk about like the extremely low

probability events that no one was actually accounting for, or to the extent that there was, they were heavily under accounted for given the magnitude of outcome. That could be everything from, say, let's take New England, a cyber-attack on Algonquin or Iroquois pipelines and how that would affect that system. That would be something that would probably fall under that uncertainty management lens.

Also, just because a marketplace may not fully internalize an effect doesn't mean that an intervention is automatically going to improve social welfare. So that's where I think we need to focus on the high consequence events. Once you start moving further down that spectrum towards low consequence events, the magnitude of the market failure starts to diminish, and the risk that government failure outweighs market failure grows. If you look at the track record of the last 50 years of US energy policy, you've seen a lot of interventions typically that try to pick more winners and losers or adjust a lot of incentives in certain ways that haven't been very efficient or have had cost outweigh benefits. So, let's focus on the big items here.

How should we to think about the treatment of uncertainty in the electric industry? A lot of it is just going back to even revisiting concepts we were introducing a few years ago on resilience economics. Number one, don't do anything stupid. Don't panic. There are certain shortterm conditions that do require emergency responses, but the solutions set to the structural elements and the years ahead requires a really robust conceptual understanding through an economic lens that ultimately takes the perspective of end users, because that's ultimately who we care about. Since our tendency for federal institutions to focus on wholesale markets, irrespective of the impact on the end user, is a real problem, we have to make sure that we're taking that end user perspective when we do that consequence analysis. Rhen we start looking at how you apply an economic framework. This gets tricky for uncertainty because if you don't

have a probability, then you can't develop expected values, which means you can't do your conventional cost benefit analysis tools. You have to start using tools a little bit more like breakeven analysis for a lot of this work.

Lastly, as you evolve the framework that has a set of technical criteria based on economic indicators, you tailor the framework and specific solution sets to the degree of regional heterogeneity. If we look at even the nature of what we saw in Texas or fNew England, the nature of the natural gas issue is very different. One's midstream, one's upstream, one has a lot more to do with things that are within the control of the electric industry, and one is a little bit more questionable on that front. This gets into the role of what institutions are appropriate and those types of responses.

In terms of some just ideas for hands-on applications, the moderator really wanted me to dig into the 1-in-10 standard, so I'll just say broadly with reliability metrics and standards reform on this application. We heard a lot of our previous speakers talk about the duration effects. I think that's huge. Right now, reliability policy in this country, the way we do standards process, it's frequency based. So how can we determine the consequences of events if we're sitting there saying, hey, you know, a 20-minute curtailment is the same as a multi-day curtailment. Right? When we're assessing these things, that doesn't make any sense. You have to look at the magnitude of the consequences, and that's going to be the probability times the duration. Ideally, we should be doing that based on the social welfare effects. Right now, we just use engineering heuristics. There's no indication for how the value of lost load varies by consumer class or by specific end use, or how it varies by the duration of an outage. There's order of magnitude differences in social welfare effects there. That's got to be accounted for as we think reliability policy going forward. And one of the ways that can manifest itself is, right now we forcibly treat

all service as the same, when even though the underlying economic preferences and willingness to pay are orders of magnitude variants by those characteristics. We really need to think about rethinking reliability policy and those lenses.

Quickly, here's a couple other applications. FERC's got a new transmission NOPR out there, with a lot of interest in these fat tail events. One of our concerns in the comments was, who's going to define that event and on what basis? And I would argue that we should be thinking about metrics like those that I just recommended here. I do think there's going to be a lot. We know the capacity markets are here to stay, at least for a number of years, so let's talk about what their proper role is going forward. When we get into uncertainty analysis, we do start raising some questions about whether certain scenario-based capacity accreditation makes sense. And that could even get into some of the zonal definitions, too, when you talk about what constraints on the system under what scenarios. And then lastly, there's a lot of pending compliance filings and other developments on DER policy at the wholesale level. That's huge going forward because, ultimately, the value of service continuity at the wholesale level, again taking that end user perspective, is a huge function, ultimately, of the ability of end users to physically hedge reliability risk. And whether that's power walls, or it's CHP or a whole suite of other technologies, F-150s coming forward, we're seeing a whole bunch of new technologies come out at the local level or a customer-specific level that can really provide a huge hedge and some community forms of resilience. That can really affect the extent that it's economical to armor the central system. And that's going to be a linkage between what the last speaker and I talked about at that state-federal nexus.

AFTER A 10-minute break, the group resumed for open discussion. To maintain anonymity, participants asking questions are not identified and speakers who answer each question are just listed as respondents in order.

MODERATOR: I was struck by the speaker's observation that he's selling a lot of these after the forward to intermediaries that are then supplying buyers in Europe, and that those intermediaries get to capture the spread between what he's selling the product for versus what it can be sold for in Europe. And that made me wonder about, in the short run, the importance of pricing in terms of steering the commodity to where it's needed most. I think there's this tendency of policymakers in particular who want to avoid price shocks. Yet if you jump in, and you somehow suppress pricing in the market, you can actually get the adverse effect with regard to the reliability outcome. I was curious about the speaker's view on that and see whether anybody else on the panel wanted to weigh in on that dynamic.

RESPONDENT 1: So yeah, absolutely. As I said, the vast majority of the economics are captured by these intermediaries. Transparent prices in Europe, I think most of you probably see the Dutch TTF price signal, and many of you probably also see the UK price signal of the national balancing point, NBP. There are about half a dozen other relatively liquid pricing points in Europe that you don't see as readily, Iberian Peninsula being a great example, completely unconstrained in terms of import capacity, either pipes from North Africa, or Via LNG built a lot of terminals, massively constrained going from the Iberian Peninsula to France. You can move less than a BCF a day. It's irrelevant what that price signal sends as far as it relates to Central and sort of Northern Europe. In Northern Europe, UK, Netherlands, Norway, are very well

connected via pipeline infrastructure. Where we are today and, as a price signal, UK is trading about \$12 to 13 in MMBTU below Northern Europe because it's interconnectors are full, and the Norway and the Netherlands are running full. You're at these market dislocations where now the Dutch TTF price can go to the moon, and the only balancing effect it will have is destroying demand. It will not incent a single ounce of additional supply. The early conversations we had with the administration and everyone else, when in December-January the panics started to go off about what can be done, my message was, there's nothing you can do that a nickel of additional profitability hasn't already done. Like the armada of LNG shifted. In fact, if you look at how much US LNG went to Europe in January, it was 50% greater than US exports, because all that stuff that was on the way to Asia got the message, hey, we can make an extra nickel if we turn around and headed back into the Atlantic basis. And there was one famous story of a cargo that actually went through the Panama Canal, and less than a day later, turned around and went right back through the Panama Canal to deliver into Europe. So that's what needs to be addressed. That's why the Baltics are coming into our offices every week talking about additional regas infrastructure. That's why everyone is in Berlin and all over Baltic Europe, as well as the southern periphery. Last I counted, there were seven important projects proposed for Italy alone. So a lot will be attempted. My best guess is over the net two to four years, somewhere between four and seven projects will, incremental important projects will come online and will help, but the plan to displace Russian piped gas, you know, through the middle of this decade, I just don't see it being feasible.

RESPONDENT 2: Sure I'll come in with, I think it's a point that supports the overall direction of the conversation about price signals and how effective they're being right now. On the other

side, looking at the supply issues, but looking at the demand issues, you know, we see across the board in Europe, you know, nearly every European country coming in with some kinds of big subsidies, you know, billions of dollars of euros, to try to shield consumers from the cost of the high prices. So that, to me, doesn't strike me as a politically sustainable approach to this particular crisis. But it is obviously politically expedient, you know, particularly in the context of French elections and other things. So, you know, there's that component that's not maybe working as well, or as quickly as it should be. And IEA did interesting study on the back of Europe's Repower Europe strategy, which was the strategy that the EU has put out to try to bring down natural gas consumption from Russia over the course of this year. And a big component of the IEA's plan that says about maybe 60% of the imports could be replaced in this calendar year, a big part of that is reducing demand. And if we're shielding consumers from the price impact, then I think that's going to be a harder thing to achieve. So just in support of that comment about the importance of price signals.

RESPONDENT 3: Well, it seems to me that we have a tiger by the tail he here with trying to deal with the gas supply challenges that are uncontrollable. So I guess I'm going to say again that trying to reduce demand, and do it fast, I know that there have been a lot of conversations between European leaders and people who make heat pumps to try to figure out how to get more of them faster into Europe. So at least with respect to heating, there is an effort, a strong effort to disrupt that. Back to you.

HEPG PARTICIPANT: My question for the panelists goes to kind of the distinction between short term issues and medium to long term issues. I've spent a lot of time in Europe. I was on a conference call this morning with a group of European market design experts about what to do about this. And the short-term options are all painful. It's like having a curable disease. The longterm prospects are good, but it's not going to be pretty in the meantime.

My question goes to the medium to long term, and it's kind of related to this issue of price signals. Some folks in Europe are talking about an import tariff on Russian gas. Which is not a short-term solution because, at the moment, Gazprom has pricing power in Europe. That's part of the problem. They own the largest gas storage facility in Germany, so on and so forth. So in the short term tax on Russian gas imports would largely or entirely be passed through to consumers. But to the extent that over the medium term pursuing some of Anatol's suggestions about new import terminals, we can start to lessen Russian market power so that more of the money that is being taxed on Russian import gas would actually reduce netbacks to Gazprom and to Putin. But the key for me, though, is that what this crisis, I think one of the messages this crisis is sending it is that Germany and others have vastly underestimated the true long-term cost of reliance on Russian gas. There's a geopolitical risk component that has not historically been priced into Russian gas. And you know, the worst medium to long term outcome from this would be to revert to once again underestimating the externality cost of reliance on Russian gas, unless and until there's a dramatic change in the governance structure in Russia. What do people think about the idea of, in the same way that we talk about internalizing the externality of carbon emissions, using some sort of an import tariff or tax to internalize the geopolitical risks involved in reliance on Russian gas imports in Europe.

RESPONDENT 1: I say I think it's a very interesting concept. I cannot tell you, I had a to talk to our trade guy, talked about some, anything in kind of the WTO world view of this, and how I

think there would be, it'd be a big precedent. There would be a lot of questions about how you define geopolitical risk? How do you quantify it? How do you make sure it gets used for something that is going to be tied to the right purposes, right, in any type of application? because once you open up and set of precedent on this, then you can apply it elsewhere. But one thing that, like over your temporal dynamics there, is noting that in the short term, it would be by large pass through, but the price signal will be really helpful in the long term for dynamic effects. Right? Those dynamic effects are going to be determined by forward price expectations. So one thing is, if you were to use this type of tool, if you had a firm commitment by the governments, where you knew is going to be phased in on a multi-year time horizon, and markets were very confident in that, then you could have that actually built into the market expectations, and it would drive substitution, and it would minimize the consequences as a past through effect. But that's just one design element.

RESPONDENT 2: To me, this is a component of a multi-step solution. To me, the first step is using Brussels and the Member States in a coordinated way to develop some redundant infrastructure. If there is kind of a consistent policy comment that I keep articulating on this front it is, I don't think, there's so many things that need to be solved, don't worry about the private sector's stranded assets. Let the private sector worry about that. We write shit off all the time. Right? We make mistakes, all the time, write off billions of dollars all the time. A statistic that I trot out all the time, from January 1st of 2015, right after the OPEC Thanksgiving of 2014 through January of this year, over 600 ENP and oilfield service companies filed for bankruptcy. We all know dozens upon dozens of power generators that have filed for bankruptcy. There are three that I know of that we call Chapter 33s. They've done chapter 11 reorgs three times. Is the

world in that much pain because of that? Not really. Let the private sector worry about that. If that is seen as a policy solution to not have infrastructure as a way to accelerate transition, I put to you that that's a very dull instrument to affect that change. So redundant infrastructure, number one.

But number two, I think all of these decisions of how Europe will manage through this crisis over the medium or longer term will have a very difficult time being accepted if there's not the fundamental change of rate mechanism design. If every citizen in Germany lives and dies by the marginal pricing, it's going to be very difficult to affect change and have a more stable system, and I think that that's a hole of Brussels dug for itself that it should reverse itself on sooner rather than later. And then, once you get those two pieces in place, then you can then you can very effectively, having the flexibility in the system to avail yourself of different suppliers, kind of like Lithuania did, kind of like Poland did, kind of like Iberia has done. Then you have a lot more flexibility to implement those tariffs. Look at the fight we had with China. Like we have direct agreements to sell to CNPC and others. There were tariffs on US LNG. Did it really bother China? Did it really bother us? No. So I think there are many, many legs to the stool. The first one, I am absolutely certain of, on redundancy. The second on changing rate design is just my recommendation. And then you have the right tools to affect those changes.

RESPONDENT 3: So just a couple of thoughts. First just coming at it from a political question about, you know, will Germany and the rest of Europe revert back? Will it be tempted to revert back? You know, I think this is a lot of political question, and I would come in and say, as many of you are probably aware, I mean the shifts in German thinking and German policy have been so fundamental on the national security front and on security policy front, I mean they have, it's been stunning. And I do feel that the sense is, these are not going to be reversed. And I think it's quite different from the earlier gas crises of 2009, 2006 with Ukraine, where there was the question, will Europe pay more for a more secure source of gas that doesn't run through Ukraine? And they toyed with that idea and decided against it. But this is, I think, a fundamentally different kind of crisis. So I don't anticipate that there will be like a gross reversion back for those reasons.

And just to comment on a proposal that I've heard people make about a price cap, basically saying that Europe will only pay so much for Russian energy. You know, there are people better positioned to comment on that, but my feeling is, and I'd welcome other views, my feeling is, it's different on the oil and the gas side. Russia doesn't have infrastructure to send 155 BCM of natural gas to other parts of the world in the short term. So its potential that basically, that Russia would continue to sell that gas. But we're now in a landscape where Putin is doing things that really don't make economic sense. So, and is willing to cut off natural gas. And natural gas only supplies one out of every four dollars of earnings that Russia gets from its energy. But I think there's some questions there. On the oil side, you know, I think there are willing buyers who will probably pay more than the price cap would involve. I don't know. It just doesn't seem to me the most efficient way to deprive Russia of resources or to get the outcome that we're trying to get. It seems like there must be more direct or effective tools to do that.

NEXT HEPG PARTICIPANT: Yes, I thought about that, especially the comments about market prices in Europe and how sustained they can be, and so forth. One comment and a question, panel. By the way, very, very timely and great to have this discussion. I'm very

grateful that this was organized. It's just so much on our minds. It's just really helpful to have it and very good panelist presentations.

My comment is, in terms of West Europe switching, it's not just a matter of what they do, call it upstream, in terms of getting or moving toward renewable energy, which I agree, they will enter into it in a large, sustained effort. But the downstream, which requires actually shifting how home heating is provided, and also electrification of cars. It's not just enough to go from natural gas to electricity. It has to get actually to how consumers consume those products and into the final goods they really want, which are mobility and heating. So it seems to me the whole journey for them is that much more complicated and involved than then only a matter of having more renewable energy.

My question goes more to a sort of a geopolitical one, which is, let's assume this really is the case, that this is very much the 9/11 for Europe, and this is going to define how they think of things for the next 25 years, and basically leads to really virtually an expelling of Russia from involvement in Western European affairs and economy. The natural gas and oil that they have isn't just going to sit there in Russia, and I just seems to me there's going to naturally be a greater connection to be made in the future between China and Russia, and I take your good point that China, in principle, wants to limit itself to how much oil and natural gas, it might take from Russia. But on the other hand, you know, build a few more large gas pipelines from China to Russia as a satellite of its world economic status. And what we end up with in 25 years is almost a furthering of the blocks in power between a China hegemony with her at least very much more great power with Russia, junior partner, vis-à-vis Europe and the United States. And just wondering if you had any comments about that

RESPONDENT 1: A really interesting question. And let me answer it at two levels. I think on the high level, the is this going to be one of the lasting geopolitical implications of this crisis, and I think the answer is yes. The Russia-China dynamic is fascinating and troubling. It's very different. I mean China has taken a different approach towards this crisis than it has essentially taken in past decades, which has been largely to say that it is, you know, it is against any kind of meddling in the sovereignty of other countries, so this is a departure from China, and it's a reflection of the close relationship between Xi Jinping and between Putin. And I think it's an indication of that relationship which has been strengthening over the last five or six years or so. I mean, the two leaders have met I think 32 times. So, there's definitely something going on there. But just to add another layer of kind of intricacy to what you're describing, Barney. I think it's useful to look at the numbers and the magnitude to get a sense of how long it would take for Russia to just move its gas exports to China. I use the number that Russia last year exported 155 BCM of gas from Russia to Europe. That's only by pipeline. There's another about 18 BCM by liquefied natural gas. And last year, China doubled its gas exports to China to somewhat short of 10 BCM. So we're talking 155 verses 10. On February 4th, when the two leaders met and made that lasting commitment right before the invasion, they talked about a second gas pipeline, which I think is about 10 more BCM. And that will take some years to make. And if you really look, you can even go on Gazprom's website, you look at the infrastructure, the fields that are feeding Europe are not connected in any way to the infrastructure out to the east. So you know, it's not impossible. It's certainly been an ambition, but if we really look at what Putin has done over the last 15 years, he has a doubled down on infrastructure connecting Russia to Europe. You know, look at Nord Stream II. That was all about, building redundancy. The objective of Russia over

the last 15 years has been to take Ukraine out of the train in terms of getting its gas to Europe. And so that's been the objective. And now the Russians have to embark on an entirely new objective. So again, we're talking about not impossible, but certainly not in the short term kind of a medium term project. And feasibly, as I said, you know, China just doesn't want to be totally reliant on Russian gas. So I think there's a limit. I think right now, China supplies about 10% of China's gas. Maybe they'll go to 15. Maybe they'll go to 20. But they don't have any supplier over 20% of any source. So the idea that they would take 155 BCM of, again, just completely inconsistent with Chinese conceptions of energy security. So I think there's a lot, there's less there than meets the eye for those reasons, but I think the overall relationship is an important one to watch. The last thing I'll say, I'm sorry to go on so long, the last thing I'll say is, there has historically been attention in the China-Russia relationship. And it has to do with Russia feeling like it's not on equal footing with China, that China feels like it's the, has the upper hand in their relationship. Russia doesn't like the feeling that it's an energy appendage to a much more dynamic China, which it essentially is. And everything we're seeing in the global economy and on the energy landscape is going to reinforce that dynamic. Which is not to say that's going to scupper the whole relationship, but it's not going to be without bumps in the road.

HEPG PARTICIPANT: Thank you. That data was very telling. So China's total consumption about 100 million, I'm sorry 100 BCM? Is that what I infer from your comments?

RESPONDENT 2: No it's about 400. But what they import is 100.

RESPONDENT 1: Imports.

HEPG PARTICIPANT: Imports about 100 million. OK, a hundred BCM?

RESPONDENT 1: I don't know. I can confirm that number, but I think it's, so right now, last year Russia got about 10 BCM via pipeline from Russia, and I think about 6.8 BCM. I don't have the numbers in front of me. But Bia LNG, and I think that's roughly 10%, so that would I guess make about 160 BCM of imports. Does that sound right?

RESPONDENT 2: Yeah it's about right. It's a little bit higher these days. Last year, China became the largest LNG market and was right around 100 BCM in '21. But ballpark, those numbers, and I completely agree, for whatever it's worth, with everything the first speaker said. I also think that if you look at our business, at the US LNG business, no one has signed up for more volume and term over the last year, year and a half than China. Household names like CNPC and Sinook and Sinopec, and less household names like Sinocam and ENN and 4N Guanjuo and others. So it's going to play all sides, because as the first speaker said, you know, it will pay for that diversity of supply, and it will do that in a relatively coordinated way.

I will just mention again, that there is the alternative scenario. Iran is not a big player on the global gas scene, not because it doesn't have a massive gas resource, and Venezuela is a pimple on the derriere of the oil business, not because it ran out of reserve. So we'll see how failed a state Russia ultimately is. RESPONDENT 3: My only observation to add is that China is deploying heat pumps at a really fast rate in their construction. I think for heating, gas is not available, and they're trying to leap over gas for that. I think gas for power generation is what we were just talking about.

NEXT HEPG PARTICIPANT: OK. Two things. One, I thought the question was about the willingness or failure to price political risk in Europe with respect to the ports was interesting, but I think it's also, I don't want to say naive, but not realistic given our own experiences. And I think sure, when the first respondent commented about it, but look at our own short- term impacts in terms of gasoline prices. You know the president's talking about removing the federal gasoline tax, which is exactly backwards. California is talking about removing the state tax, and there's a proposal that would actually give me a refund for my car which exceeds what I pay in a year for gasoline because I didn't drive very much. I mean they're doing everything exactly backwards, and there's a political process. And there was zero strategic or political willingness in the short run to do anything about that. One run, it seems to disappear. Bill may remember, Alexander Flax from a long time ago. In the Arab Israeli War in 73, I have a little assignment where I estimated the increased cost to consumers, tried to put a value on the strategic implications of what we were doing in the Middle East and oil purchases, and suggested a gradual, I think at the time it was a nickel a year increase in federal taxes, which, as you may know, I think are of 17 ¹/₂ cents right now. That would have been like 2.50 by now. The proposal in any event was allowed to leave the building. I wrote it in December, and I remember coming back with a little note from Alex saying, this this isn't what we do.

And I have a question for the second speaker, totally unrelated. You talked about liquification and gasification sides and things, and have a good feel for the timing, and

everything you said made sense. But where is the shipping world? I mean, you know, where's the carrier capability in that equation? Is it a five-year lag? Is it a one-year lag? Who controls that? I've always thought that was more binding in the logistics, particularly because of some of the US safety and export considerations, but just so you, I assume this is all built in Asia and Korea, probably. But where does that stand in the equation on the team being supplied for LNG.

RESPONDENT 1: No, you're absolutely right. It is Asia driven. The three main South Korean yards are about, still about 90% of that business. The majority of the rest is two yards in China, and then somehow Japan manages to squeeze out a carrier or two every couple of years, so it still has a little bit of that business. We of course are useless, and the estimates are a Jones Act LNG carrier that could deliver to Everett and would cost about five times what the South Koreans charge for it. It can produce about 45, 46 vessels per year, that complex. Rule of thumb is every million tons uses two of those, so you can add 20 to 25 million tons of liquefaction and have that relatively easily be met by the shipbuilding industry. If you were to order one today, it would be delivered in about 22, 23 months, a little bit of cost inflation on the back of higher steel prices, but other than that not an issue. A little over 600 vessels in the world today. It's very loose today because this marginal new entrant that is US LNG, that really was also designed to move a lot of its volume to Asia, is of course now, as we've been discussing, moving the vast majority, 75% of the production from our facilities went to Europe year to date, and that is half of the ton mileage. Right? The shipping market is quite loose. We don't see that being a constraint anytime soon. it will be a little tighter in the winters as Asia is still more likely to be that marginal buyer, but really not an issue you know for the foreseeable future.

HEPG PARTICIPANT: So that's really not for liquification. OK, Thank you.

MODERATOR: Just to expand that question for a minute, it's something that we've been digging into a little bit up here in New England, which I didn't appreciate, which apparently is a blend issue as well. You can't just take any old LNG and dump it into any pipe, either. So it's the BTU content that you have to consider. Is that a big constraint, or is it easily resolved?

RESPONDENT 1: You're right, it is a constraint. Certain markets, Japan, for example, likes a rich LNG stream. Its gas grid is set up for that Southeast Asian liquids rich product. Other markets are more flexible. Yeah, if you're a decent sized market it's not a big issue. There are lots of ways to deal with it. We, when we were planning to be a big importer, you know, in the early aughts, one of the challenges we had bringing in rich LNG into the Gulf Coast was addressed by building nitrogen injection units, right, just throw in some more inerts, and your BTUs per volume are fine. Our friends in Taiwan, for example, keep an eye on that and blend cargoes from a relatively rich market and a relatively lean market. So not a big deal. Oh, the first speaker wins again. So is something that that the grids need to keep an eye on, but really not much of a tax on the efficiency of the system.

RESPONDENT 2: Thanks. I had wanted to weigh in earlier on the participant's point about the wisdom of relying on Russian gas for so long. As a former diplomat or person in government, I can tell you, having had a long series of discussions with Europeans about the wisdom of relying on Russian gas, there just wasn't that perception of risk. You had Europeans saying to you -- not all, the Poles, others, the Baltics maybe seeing things differently -- look, Russia was a reliable

supply of gas throughout the entire Cold War. The reality is that Russia up until last week had continued to supply all of that energy. I completely agree with the HEPG participant. This is short-term politics. I mean look at the fact that that our president is going to OPEC, something that he and no one working in his Administration thought that he would be doing, to try to bring prices down.

And the last point I'd make, which I think is a really interesting point, maybe it takes us too far off track, but maybe not, has to do with, you know, is the world replicating these kinds of dependencies, not on Russia, but on China for inputs of critical minerals. I just spent a day yesterday with people on this topic, and really don't see any short-term prospects for moving supply chains away, at least for the processing, from China over the short and even medium term, maybe, and that will have huge implications for the pace and scope of the energy transition in other parts of the world.

BILL HOGAN: I want to come back to this idea about what the first speaker coined about the Transition Act assets: that you make big investments in things that are capital intensive, as I understand it, and then, are going to have short lives because we don't want to mess with the long-term green agenda transition. How is this going to operate? It seems to me that that's just inherently intertemporally inconsistent. So, the problem is going to arise after the fact when you've built it, and it's sunk, and it's just sitting there, and then we could use it really cheaply compared to all the other alternatives and all the things that we're having to deal with that you won't be able to stop people from actually using it. What you want are not capital-intensive projects that are expensive now that are going to be addressing the immediate problems, if you can think of them, but not to make these long-term investments. I just don't think it's credible. I

also don't think it's efficient, if you give any credibility at all to the fourth speaker and other fellow travelers like me about the prices and externalities and so on. If you had a natural gas facility that you would build there, and a lot of the cost was sunk, and then you applied it a carbon tax to it, would you use the natural gas in that facility? And the answer is probably yes, you would, so that would be the efficient thing to do going forward. I don't see how creating new stranded assets is a policy which is actually going to work in any way or has any credibility.

RESPONDENT 1: I can address that along a couple of dimensions. One is the way our industry works, and I'll just give you the specific example of our company. We will not commit capital to a project unless we get our money back inside of 10 years on a fully contracted basis. The way we deal with that is we syndicate it out. Say we're going to build this \$40 billion worth of kit, lineup a couple dozen big money balance sheeted friends that will pitch in and absorb that risk, and the depreciable life of the thing might be 35, 40,50 years, but the economic life and economic return of capital is inside of a decade. So, we'll see. We are optimistic. We think they'll stick around for the depreciable life and then some. But you know, if we're wrong, again, it's not existential. We're a great case study in all of this stuff because we screwed it up initially. Right? We built \$2 billion worth of kits to import this stuff, and it turned out in 2007-08 that we don't need to import any of this stuff anymore, and we turned around and built export facilities. Germany, Italy, Spain and others built a lot of combined cycle gas power plants that literally never ran. They were commissioned and mothballed right away. Some of them were dismantled, moved to other parts of the world.

I just go back to the fact that we will make mistakes. Some of them will be existential in terms of the corporate entity, but most of them will be absorbed by bondholders and equity

holders, and I'm of the view that there are so many things that policymakers need to fix and address this issue. Even though the TCFD framework requires us to look at this stuff, and we do regardless, that's just not a societal need today, in my humble opinion. I will also say that a lot of policy solutions help us sleep at night, whether that is the SPR, one way or another, we can argue about how useful it is. Reliability must run payments for generators that keep stuff around for decades longer than a merchant facility would have been kept around for. There are a lot of things that that are policy driven and on the surface are inefficient, and to me are meant to address that very rare black swan event. The last speaker made a great point on duration, but magnitude is also important, and society, in my view, should pay for some of that redundancy.

RESPONDENT 2: I think you have said a lot of what I would like to say, but it does strike me Germany has identified that it is going to be what they judge to be in the interest of society to have more energy security in the short term that's not reliant on Russia. But if I were a company, would I really be interested in buying these, or building these regasification terminals in Germany, when, at the same time everyone in Europe is saying we're committed to net zero, and we're moving our goals forward? I think there really is a conundrum there. And what's the justification for the government coming in? There's a lot of different mechanisms that could be used to entice the private sector to make these investments. But to me it would seem to make sense that, basically, the government is paying for the intangible energy security elements. So that's the societal good that the private sector is not going to pay for, that the government thinks is necessary in the situation. Tat's the notion behind the idea, but I think I'm one of many people struggling to figure out exactly what it looks like.

RESPONDENT 3: I want to point to some issues when you talk about remedies to immediate crises like pending, ongoing crises or short near aftermath, like we saw in Texas. My first question is, if the prices reflect underlying market fundamentals and the underlying market participants are competitive in nature, what in the short term is needed to provide that additional inducement for any type of transition investment? Is there is some additional premium that's not being reflected? I'd leave it to the other folks that have a little bit more European expertise. The one thing we saw in Texas was, Well, crap, we don't like scarcity pricing. It's that high and that long, so what we're going to do is, we're going to put some price caps in place. Oh crap, then we have missing money. S,o you know what we need? We need another mechanism here. What are we going to do? And then we start exploring further down the totem pole and then all of a sudden now we're going down the cash for clunkers route.

One of the concerns I have in a lot of markets going forward is, if we don't have some of these risks and uncertainties built into the underlying market design, then whenever something does happen, you're going to have massive calls for intervention. But you also are going to have the situation where actually you're just going to have a lot of skittish grid operators, and we've already seen a tendency to start getting that creative with the RMR conversation and the CAISO first resource adequacy RME ability. We have to get our institutions in order here, or reliability concerns, with or without merit, are going to start to play into this and really see a lot of calls for intervention. We've got to first be very proactive in getting these risks and uncertainties confidently built into the market architecture, but then also to build plan. I'm trying to wonder in the interim here, if you keep the prices, if you don't artificially suppress prices, is there any socially beneficial reason for additional intervention for some out of market transition asset in

the interim? And how do we make sure we have controls to know that these out-of-market resources don't persist through maintenance efforts later on?

MODERATOR: That resonated with me. One of the reasons I've been talking about what I've been talking about is to try and reduce our anxiety level.

NEXT HEPG PARTICIPANT: This is a little bit of follow up to Bill's question, and also following up on the second speaker's last point that you'd only invest in these things if you get your money out in 10 years. This is now a short-term change that presumably wasn't anticipated in Europe, and it's in the context of this commitment to decarbonize. The question is, how long does it take? Do you see either you or others in the industry now jumping in with the expectation that this is going to be the change that last long enough for these investments that takes several years to come online to actually make sense? And a related sort of second question. I think in Germany, from what I read, the investment in the regasification is generally justified by the government by saying we're going to make these things future proof by allowing them to regasify not just natural gas, but something much fancier down the road that's consistent with a net zero strategy, whether that's hydrogen or ammonia or something like that. So I'd also like to get your sense and others' sense about how realistic that is to have that supply chain from liquefaction to the ships to regasification be future proof and therefore minimize the risk that these assets will become stranded.

RESPONDENT 1: The cryogenic infrastructures for hydrogen and LNG are totally different. The tanks would be totally different. I guess you could put the arms for hydrogen on the same

berth once you remove the LNG ones. But yeah, it's, as the first speaker said, there'll be lots of different solutions. In Germany, for example, the projects that have been on the board for decades, in some cases decades. The original commercial sponsors are involved, not even on paper at this point; they're involved organizationally. These are going to be projects that the government will pay for, and that's one model. Another model, even though we think that and hear this from a lot of our counter parties, if you look at who has signed up globally to underwrite this liquefaction infrastructure, you will see it is still overwhelmingly Asia. Europe, even with the crises that being the better part of a year old, obviously accentuated by this geopolitical crisis that has been layered on top of that. The corporate entities that put US LNG on the map are still corporately fully committed to phasing out gas in their portfolios. This means that they can't sign up for much more than 10 or 15 years, and Asia is perfectly happy signing up for 20, 25 years. Which one of those are companies going to choose?

One of the possible other solutions, though, is as the large public European champions who are very committed to net zero goals themselves and have their PR and IR campaigns to heed to, the private solutions will come up. I would say half a dozen plus private projects are underway. Their business model will be very different. They'll stay out of the public eye. They won't have the kind of scrutiny the public companies do, and will make a lot of money for two, three, five years, and afterwards we'll hand the keys over to creditors or whoever else and really don't care about the kind of longevity and stability that that a public company does. I think there'll be a broad range of solutions.

RESPONDENT 2: You mentioned that in terms of investing in liquification facilities over a long term, it's only the Asians that are signing up for that. Those liquification facilities could be

useful for Europe now, but then they'll be useful for Asia later. Doesn't the financing side actually become more problematic when we're talking about regasification? Because it's those regasification infrastructures in Europe that aren't going to be the ones that don't have a long life, and you can be sending liquefied natural gas, but you can shift to whatever market you need later. But in Europe it's just about regasifying for that market, for that time period. Is there a distinction there?

RESPONDENT 1: Yeah, I think you're absolutely right, there's a fundamental demand growth story in Asia. There's a fundamental demand contraction story in Europe. There'll be conservation. There'll be heat pumps. There'll be electrification which you know, will have some tangential demand for gas generation over some period of time, but overall, the European 55 BCF a day 550 BCMA market we expect will continue to shrink. It's just going to need more imported gas for a while because North Sea and Groningen and onshore sources will continue to decline, so I completely agree. We hear these policy suggestions that, well, why don't we do these deals where Europe takes the first 10 years and Asia takes the next 10 years. And I think to myself who would ever negotiate that? How could that ever possibly practically occur? What will occur, to your point, is Asia, as its load grows, dispatching them as much supply as possible, hoping that down the road they'll be underutilized, under committed liquefaction, and it'll have much less expensive, marginal cost driven as opposed to long run marginal cost driven, supply. I completely agree with you. I think I look at something like the petrochemical industry. Exxon, others built these \$6 billion ethylene crackers, knowing that they're going to make their money 18 months out of the next decade. They just have the balance sheet and the wherewithal to build

that and sit around and wait, you know, 8 ¹/₂ years for the 1 ¹/₂ years of pay. Regas in Europe is going to be the same.

NEXT HEPG PARTICIPANT: A couple of very quick reactions, and then my question. One is, I want to double and triple endorse the speaker's comments about the stranded asset issue. The idea that infrastructure needs to have guaranteed revenues for something approaching the economic life of the asset is the product of the fervent imagination of regulated utility executives. As somebody who has built dozens of independent power plants in different parts of the world, I can tell you that if you look at the pro forma, something like 80% of the return on capital is expected to be received in the first six to seven years. And so that's where you want to be highly confident. Frankly, as long as you're reasonably confident that conditions after that are going to be based on market supply and demand, there's a lot of risks you'd be willing to take. I think that's something that a lot of people who aren't involved in privately investing in these sorts of infrastructure assets don't fully appreciate.

As far as the price, the gas price cap in Europe, I mean I hear that as well. I am in some conversations with Kirsten Meyerhof, who many of you know, is a proponent of that idea. But I don't think it's going anywhere, certainly not in Brussels, among the Members State policymakers that I'm in discussions with. There's more interest in the Russian import gas tax idea than on a gas price cap.

I touched on my question briefly when I intervened earlier. There's a more mundane kind of quotidian market oversight issue in play in Europe that we haven't really talked about, which is not so much replacing Russian gas imports, but dealing with the fact that Gazprom at the moment is a dominant supplier and has pricing power. In fact it's now quite evident that the

significant run up in gas prices in Europe that occurred long before the invasion was very clearly orchestrated by Gazprom. Only about 80%, 70 to 80% of the gas that Gazprom supplies to Europe is under long-term contracts; the rest is spot market sales and short-term sales. While Gazprom was reliably, until last week, fulfilling their contractual obligations, they had literally withdrawn from the spot market and were very deliberately not filling the gas storage facilities that they own, which again they have market power in gas storage as well. Is there a much less onerous or ambitious objective that any market overseer or market regulator would have which is to begin to whittle away at Gazprom's pricing power, and therefore Gazprom's ability to hold Europe hostage?

RESPONDENT 1: I would want to say that that this is one of these unacceptable risks, once you realize the control that a supplier could have on a whole society from having that kind of power. Now, what do you do about it, that's a big dilemma. But I think, when I was in government, every year coming into the winter I would look at the storage curve from EIA to see if we were on track or below normal. And if we were below normal, I sent out all kinds of alerts to people. But I could only respond way after an opportunity to deal with what might happen to us. I think we see this over and over again, and at some point, somebody's going to get fed up and say that government has to take an interest in the storage practices of an undifferentiated market to make sure that we're safe.

RESPONDENT 2: And to your point, Europe is making moves in that direction. Requirements that storage be at least 90% full going into the winter is contemplating these use-it-or-lose- it provisions because I'm completely in the participants' camp that this was, the market dynamics

were completely orchestrated by Gazprom. It is the residual monopolist supplying over 150 BCM into a 550 BCM market. There's nothing you can do, as we've discussed at length to replace that in a couple of years, even. To me, it was doing the profit maximizing by doing that. Europe allowed it to be in that position and did not allow the counter parties, to the participant's previous point, to enter into additional long-term contracts. Gazprom, invasion again, and war aside, for years said, look if you guys want more, sign up for more. We'll sell you more. The idea that Gazprom would put 10% more volume or 5% more volume into the spot market, thereby negatively impacting its own profitability was always a very strange argument to me. How you untie that knot other than by creating enough demand destruction or reallocation and supply flexibility to displace that 150 BCM I don't know; that's a very tricky one.

MODERATOR: This is something I worry about from New England's perspective. On a much smaller scale we are, I think, vulnerable to the exercise of market power by essentially foreign LNG suppliers. We have two import terminals inside of New England, just north of Boston, one in Boston, one a little north of Boston. The biggest LNG supplier is in Canada. Because of the Jones Act, we can't take any US energy, and so we're completely dependent on foreign LNG suppliers. Furthermore, the reason I asked the question earlier on about blends, I also discovered recently that we can only take energy from a subset of all the possible energy supplies in the world because of the blenders. It seems to me that an energy from a subset of all the possible LNG suppliers in the world because of the blend issue. And so it seems to me that an LNG supplier actually has massive market power, particularly when the gas pipelines get constraint. Or am I wrong about that?

RESPONDENT 1: It's pretty perfectly competitive. I don't know the exact number, but I think about two thirds. The only place that that I know that Boston can't receive is Petronas. It's too rich in GHP. But you're going to pay the market price for that marginal cargo or two, but you're going to have 17 different providers falling all over themselves to supply it.

MODERATOR: But would I be correct in assuming that if prices are high enough in the sense that New England gas prices in the winter are going to have to be competitive with European prices in order to attract the cargos?

RESPONDENT 1: That is absolutely true. I'm just saying that you'll get the cargo. You'll pay the market price for it. But you're not going to suffer. The last participant and I were going back and forth on this on the chat; you're not going to suffer the same consequences that Europe is suffering in that it'll be ultimately the way that cog that is passed through the system. I don't know, pick a number, \$30 an MMBTU cargo or \$40 number an MMBTU cargo, would be volumetrically probably more expensive than Algonquin's supply in the winter. Yet, it's just going to be diluted in a very large pool of supply that has been procured as a smoothing function over the previous years.

MODERATOR: What I'm also observing here in New England is a conversation swirling around the state regulatory community about managing prices for the winter and doing things to, for example, subsidize oil to try and protect consumers. But it seems to me that could work counter to attracting LNG cargoes. There's lots of incentive in the marketplace from high prices to bring in domestic oil. But if the real swing supply in the wintertime is LNG imports, the thing that's going to bring the LNG imports in are the high prices. Or am I missing something?

RESPONDENT 1: I completely agree with you on attracting LNG. I'm not sure what the transmission mechanism is from heating oil market manipulation, though. Right? They are no longer substitute goods to a very large extent. I actually lost track of how many dual fuel power plants are and things like that, but precious few these days. Right?

MODERATOR: There's a third of our combined cycle feed have dual fueling. And we've got a number of large units, mostly on the coast, that burn residual oil. The idea that's out there is, fill up the oil tanks, creating incentive for the oil providers, and therefore, you can manage price for consumers and hedge reliability risks. And what we've seen, of course this past winter is we burned a lot of oi. It was the second highest oil burn in the history of our market since they started: 80 million gallons. The prior winter that was higher than that was the winter of 2017-18 when we had a polar vortex coming in for two weeks, and we had a 100 million gallon burn in a couple of weeks. I think that's the conundrum. I look at that and say, we're totally tied to the spot market, and the generators are going to hedge their forward standard off of commitments to a certain point, and we know that the generators will contract for some amount of LNG cargo. But what worries me is that if 95% of the market is hedge but 5% of the market is not, then you could have a really bad outcome when it gets really cold. So, what does the region do with that? And it seems to me the long-term solution for the region is to get off imported LNG. And I think you said it's insane what Europe did, which was ultimately tie itself to Russian gas. In some ways,

we've also made a decision over a period of years, I think inadvertently, and we've become tied to global LNG imports, and we're not going to get off that easily.

RESPONDENT 1: Right. But you're going to have high gas prices in the winter, usually with or without LNG imports. The region is just gas infrastructure constrained. So until you find a way to manage that, either by demand response, which is quite robust in the Northeast, or fuel displacement, you're always going to be in a constrained market.

MODERATOR: I agree. My question really is whether or not one should interfere with pricing going into the winter, and whether that is helpful or harmful to reliability?

RESPONDENT 1: I don't have the answer to that, but I think from a physical LNG standpoint, Everett will always be able to source a cargo. You're just going to have to pay for the foreseeable future enough to get it away from Northwest Europe.

RESPONDENT 2: And I'll just say, I think it's good to help people who have trouble paying for their energy, and otherwise to not mess with pricing.

RESPONDENT 3: I've got a laundry list of things to respond to now. I think it'd be interesting to do a comparative analysis of market power detection and mitigation tools, in the natural gas market in particular, both at home and in Europe. But also something that that's come up here domestically is looking at the difference between intrastate pipes. It really took on a lot of interest in ERCOT last year, but there was interest in it prior to that too. And I have to admit I'm not familiar with the structure that they have in Europe on this front, but it would seem like there's a lot of inquiry underway right now on that, which is a lot less sophisticated than how we've approached it in electricity. But there's a component of structural horizontal market power. And you have that more from a market monitoring and mitigation lens, but you could also have it, to your point on identifying the purposes of uncertainty management, too, if you want to do a scenario analysis component. The second speaker mentioned in opening remarks a 15 to 20% of Russian import sort threshold effect, if I recall. But whatever that threshold may be, you could view this through the lens of market power, both in terms of instruments for energy security purposes in one application, and then instruments to address economic and physical withholding, which is more on the duration of how we viewed natural gas price spikes domestically. But that might be an interesting discussion or item for further discussion. But if anyone has any insight on that front at the moment, here, I think people would really find that interesting.

MODERATOR: Bill?

BILL HOGAN: I want to come back to, it's related to this, this question about the longer duration events. The fourth speaker talked before about the frequency standards which is mostly the rate at which they occur, and the one-day and 10-year argument. Thinking about that, it never specifies how long it's going to last. If it lasts a short period of time well, you know, that's one thing, and if it lasts two weeks, that's another. This duration question I think is extremely important. My own view of this is that so far, I understand that the political problem is enormous. I'm not going to try to downplay this, but my view is that I haven't been able to really think of policies that are dramatically different, when you think about the duration problem,

because essentially the long interruption is a series of short interruptions. Then you ask the question, well, we have interruption now. What do we do now? And then the next period, and so on. And longer duration events are low probability, and they're awful when they occur. They're just terrible. But I don't think they actually, at least from an analytical point of view, change much about ow you would structure the system and go forward. I'm a scarcity pricing guy, as you know, and so I think that's the answer. It's not the only thing, but it's certainly part of that answer. And what I'm worried about in a lot of these conversations is not going through that analysis, but making the assertion that we heard it a couple times today: So, well, this is just unacceptable. We can't accept this. And so we have to do X or Y or Z, some policy which, when you think about it for a little while, doesn't solve the problem. It doesn't, and the truth of the matter is, it is acceptable. That's our policy, is that when we get into a tail event, and it's a low probability event, we're going to have curtailments, and the conditions are going to be awful, and it's going to be terrible. And we have to be realistic about that. We've had this conversation in the past year about don't make promises you can't keep because you're adopting policies which are really disconnected from the promises that you're making, and you're avoiding the hard issues here. So, the duration question is extremely important. I think that has a lot to do with how you evaluate the economics and so on. But I don't think it's the case that we can design policies which will get us out of the box that when tail events happen, we have to resort to things which are really unpleasant. And we ought to be honest about that upfront.

RESPONDENT 1: One thing that came up with your last point, Bill, there about what can't get us out of the box, that some things are just unpleasant. Going back again to some of the conversations we started a few years ago with folks on grid resilience, there's also a degree of inherent exposure that we can't just armor or build more redundancy in the system and just fix across the board. And so that's where a lot of the conversations came up on survivability. And this maybe gets a little bit more towards the downstream mitigation components of, hey, if anything goes wrong on the central system, do we have more ability to make sure that the downstream effects are contained to at least fewer outages or probably more importantly shorter duration and loss widespread across a big footprint. But that was a big conversation point that's come up. And the third speaker might have a few ideas on this one because that's come up a little bit more in the retail market conversation point, too.

RESPONDENT 2: Well, I remember after Hurricane Sandy, some of the communities affected by the surge -- I know that this happened in Hoboken, New Jersey -- they started talking about public safety micro grids. What were they trying to do? Recognizing that there might be a long duration outage, they wanted to protect people. You can't protect everybody's house, but you can give somebody a place to go. You can make sure that public response is all functioning, that communications are good. So this is a scenario that they probably hadn't thought before. So that probably qualifies as a black swan event. But it's the kind of gaming out what they really wanted to do and investing, basically buying insurance, for the prospect that this might happen again, not in order to provide everyone with power or to deal with anything relating to costs of doing that, but to deal with the public safety crisis that might occur, so that there would be a better answer than they had when Sandy hit. I think that's an example of a different response that's out of the realm of markets, but is very much in the realm of what government is supposed to do to protect people.

RESPONDENT 3: Just a different kind of response to Bill. It's not a criticism of this conversation. In fact, this conversation has been excellent in the sense it has been devoid of some of the emotion that I've experienced a lot of in other similar topics of conversations over the last few months. But you know, when we think about why is this unacceptable, our conversations almost seem to be like, oh, this is unacceptable because it's, you know, the market isn't balancing, or the prices are high, and this is creating vulnerabilities in the population that may be Government should take responsibility for. But there's that huge other component of this conversation, which is the reason why so many Europeans and people around the world are finding this unacceptable, is also because this is funding an atrocious war in the heart of Europe. So you know, the fact that Russia is going to be making close to \$350 billion from its energy sales this year, which is one third more than it made last year, is considered, you know, I mean again, I take your point, Bill, that like we always say in government, like this is unacceptable, but then you know it turns out it's less unacceptable than the other options. Right? But you know, I do think we've got two elements of unacceptability that maybe make this a different case than some others we might refer to. But we'll see.

RESPONDENT 1: Yeah, that almost seems like you're kind of making a point that like, hey, we're trying to impose all these sanctions on one hand, and then we're feeding the beast on the other. Right?

RESPONDENT 2: Exactly.

RESPONDENT 3: That is what so many Europeans I talked to, right, they know who is funding this war in Ukraine. Europe is passing, I don't know the exact number is, something like \$800 billion a day to Russia for its energy sales. That just doesn't feel right in the context of what's happening.

NEXT HEPG PARTICIPANT: Boing back to New England, I really appreciate the last point just made. I think what's going to be fascinating for this region, if we now have to or start foreseeing that there are going to be some very high prices for LNG, and that ripples right into the New England market, and it's going to be sustained for year after year after year, if we're looking ahead. That's one of the plausible outcomes here. But, as some have heard me say at other meetings of this group, we have tremendous frictions in terms of inelasticities of supply to handle that. In other words, it's just, we're now coming to a judgment that the timeframe when the offshore wind is going to get developed is being pushed out, and obviously that could make a material difference in the need for gas in the wintertime. That's when wind is strongest and can be most reliable. But we may not be seeing many of those assets online until the very end of this decade. And in the meantime, we're certainly not going to see any more natural gas pipelines. We're having discussions about how much more dual fueling might be potentially possible, but that depends upon states having a willingness to see dual fueling permitted. And you know, it's just hard to see what is going to happen that's going to break the price spike, it's not going be a spike. It's going to be a continued high plateau. And hence I think you know, indeed, probably running more oil and potentially even our one coal unit will be running more in the winter time. Just offhand, I don't know of anything that's in near term that's going to really dampen this, and it's a severe price shock. This past winter, which was not particularly cold, we saw \$3 to 4 billion more in our energy market. That's hundreds of dollars per family. And that's likely to be sustained, at least it's a likely prospect. So, this is going to be a very different situation. I think we have to be aware of the public response to that. If they feel that there is really high energy prices sustained without any market response for a long time, this is not going to be an easy era.

RESPONDENT 1: I don't envy you in ISO New England for the situation that you're in, in that regard. This is something where like the regional context matters. In Texas it's totally different. If you get the price just right, you can pretty much build whatever you want in that two and a half to three-year horizon and get some new entry in there to be responsive to that. New England is just the total opposite. In New England, it appears to be very difficult to even build things that are just going to import clean energy, anything that has some carbon intensity component to it. And you know, markets don't signal new entry for things that governments won't allow to get built. And so New England's got a bit more of a government failure question than market failure on some of this stuff, and that kind of changes the messaging approach regionally to try and engage with stakeholders.

RESPONDENT 2: Well, I will notice that some of the proposals that get made are not well thought out.

NEXT HEPG PARTICIPANT: We've been having a version of this discussion in our boardroom for seven or eight years now, and one of the things that makes this particularly challenging is it, as someone said earlier, well, you know, you're only going to have a small piece of your supply at \$30. The problem is, if that's where the market settles, everything costs \$30 per MMBTU. So the impact on prices is disproportionate to the amount of expensive gas itself. All the cheap gas that gets burned, and oil and coal and nuclear, gets the same price in our market. Whenever we end up having to rely on internationally competitive LNG, we're going to be paying essentially the same price as Europe. And that is a difficult thought for anyone who is concerned with the economic competitiveness of New England. It's actually quite simple but incredibly frustrating.

BILL HOGAN: We definitely have a custom. We always end on time because we promised everybody, especially our speakers, and we always save time at the end for the brilliance of the moderator to tell us what we just heard. Or we can continue. I know the government failure question in New England, I mean, a couple of people have already mentioned this. The rate design problem for the retail customer, that's a that's an important topic, and we could get into that, but we don't have time today. So I think brilliance from the moderator is what's an order here.

MODERATOR: I don't really have anything brilliant to say; I could share some of my concerns. And I must say I haven't heard a clear answer from the conversation today. So we'll be doing a repeat of this in a few weeks when our board meets with us, and we'll be rehashing a lot of these discussions. It's an interesting situation for us, because we're very dependent on imported LNG. We're very dependent on oil, actually, in the wintertime to keep the lights on. As the last participant pointed out, the hope that we would see new injections of large-scale renewable energy is fading, and it's looking like more like the end of this decade. In the meantime, the wholesale markets are under enormous pressure in terms of them being able to sustain the

resources that produce the bulk of the energy today. And so it's not clear to me how long the system sustains itself. You know, we've watched what happened in California, and you know, what happened was a sort of a slow slide into market failure, where ultimately the Californian ISO is keeping things together, along with the California Commission, by authorizing side contracts for resources to maintain reliability. And so I worry about that scenario occurring in New England, and I don't think it takes a lot to sort of push us across that line. And part of it is regulatory uncertainty buzz at the federal level, as well as the state level, and we know we've got to do some things on our end to bolster pricing and price efficiency in the energy and services markets. But I always come back to, my thought is that I think you can rely on the markets to take care of the average demand conditions, the average hot summer and the average cold winter. It's the excursions beyond that that worry me. And so I think the societal reaction when you end up, particularly in the winter, having to shed load, it might be the right economic efficient answer in a way, but I don't think society is going to tolerate that. And I've seen this actually in New England in terms of the lack of tolerance for long duration outages just at the distribution level.

I worry about where are we heading? We're systematically putting all our eggs into one basket, which is the grid. I mean that's the whole purpose of using the grid as the means to decarbonize the economy. Right? And then I think about, well OK, most of the energy is going to come from the renewables, which it has to. When the renewables can't produce the swing supply, the instantaneous supply is going to be much bigger. There's going to be a much bigger need than there is today. So what's going to supply that? And I don't see, you know, we're investing in transmission to enable renewables. We're making an assumption, which I see in some ways is similar to the assumption Europe made, which was we can just rely on cheap gas. It will always be there whenever we need it. But we already know today that that's not the case

because of the constraints that we have on the pipeline system. What happens ten years from now, 15 years from now, when we hit that winter event when the renewables can't produce, and there's nothing behind it to be able to balance the system? So that problem, I don't believe we've solved anywhere in market design, and I don't see us trying to solve it from a policy perspective either. I think it's a huge gap.

BILL HOGAN: I certainly agree with you, and I think it is a huge gap. I think where we would probably diverge as to what's the solution to that problem and how to deal with it. But that's a topic for another time. And certainly thank you, and I want to thank the speakers for a terrific presentation. I learned a lot here, and not all of it good news. But I definitely thought the discussion was excellent. So thank you, and to all the participants.