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As we gather here today, we begin several days of discussion about the role of nuclear energy in this still very new century. In contrast to past discussions about this subject, the outlook for the future of nuclear power must be made in technical, policy, and economic environments that are extraordinarily unclear.

The world came together in Paris at the end of 2015 to set itself on a path toward a low-carbon future, but two years later, the path remains uncertain. Many countries have made broad political decisions to reduce carbon emissions, but few have made substantive steps toward realizing this vision. Despite ambitious words, some have made steps in the opposite direction, presenting an easy political message rather than a substantive strategy to implement a true low carbon economy.

This is not new. Energy has always been a political matter. The history of the region in which we convene today has been shaped, in part, by energy politics since before the turn of the previous century.

In OECD economies, a powerful and resilient system of electricity generation and distribution has been constructed that has successfully fostered industrial expansion and an enhanced quality of life and health. This system serves as the framework on which future plans may be crafted and it gives us the ability to experiment, to test new approaches, and even to make mistakes.

But this framework is, today, under vastly increased pressure. It is being asked to do what it is ill-equipped to do and it is suffering from a lack of investment in needed infrastructure. The electricity markets themselves are in a state in which zero or negative pricing is commonplace and the companies that built the successful systems upon which everyday life depends face financial unviability.

Baseload plants, which today supply nearly all of our electricity, are being shut down. In some places, even hydroelectric plants, which are second only to nuclear power as the source of zero-carbon energy in OECD countries, are operating at a

loss. In many markets, the only electric supply that can be built is that which is subsidised by governments. Some consider this to be an energy transition. Others worry that we are witnessing the erosion of an infrastructure that powered economic development for many decades and, perhaps, an opening of a door to economic decline.

Whichever side of this debate is correct, the reality today is that many electricity markets are dysfunctional, emissions are not falling rapidly enough to meet global targets, and uncertainty about the future of energy is higher than it has ever been.

Whatever picture emerges for the future energy portfolio for the world, it will need to adapt to what may be a vast new wave of electrification, with electricity poised to displace petroleum in many transportation applications.

The future energy portfolio must also reflect the aspirations of the 1.2 billion people in the world today who are currently without access to electricity and the 2.7 billion people who lack clean cooking facilities. It will also need to respond to 6.5 million premature deaths that today occur each year due to air pollution.

These challenges are likely to grow—not shrink—as the global population grows from 7.5 billion today to about 10 billion by 2050.

So what will the energy framework look like in the future? There are many projections and scenarios. Many plans and intentions. But the reality is no one knows.

There is no reason to believe that the analysts and prognosticators of today have any better foresight than those of the last ten, twenty, or thirty years. And their records are dismal.

I am often asked about the future of nuclear energy in the world. On one hand, the answer is quite clear. New nuclear plants are, today, being built all around the world. Roughly 60 nuclear reactors are under construction around the world as we speak—including four units 300 kilometers west of this hall. Dozens more are in the planning stages. If these projects and plans proceed, all of those reactors are likely to be in operation in 2050, as well as will many plants already producing electricity today.

It is true, however, that the regional distribution of nuclear power plants may become very uneven. To some degree, that simply reflects the particular preferences of individual countries, with their individual circumstances taken into account.

But the fact that nuclear plants are being built in some parts of the world and shut down in others, also reflects market dysfunction and policies that heavily subsidize renewables and suppress nuclear energy. And it reflects the failure of many traditional suppliers to deliver on their promises to build a new generation of plants on schedule and within set budgets.

Nevertheless, whatever the reasons, each country should be free to take its own energy path.

For some countries, the emphasis today is on renewable energy. This is a reasonable and rational path, particularly as the cost of wind and solar energy drop. We should use these resources and in some circumstances—such as in developing countries that lack extensive infrastructure—renewables should be the energy resource of choice.

The question that must be answered, particularly by OECD countries with their vast, well-functioning electric supply frameworks, is to what degree variable renewable energy resources can practically be applied. Many authoritative studies and projections exist and the conclusions vary; some, such as a 2015 analysis assembled by France's EDF, indicate that 40% variable renewables is an optimum target. Others, such as the International Energy Agency, think 75% could be achievable.

The outcome will rely on advancements in transmission and distribution, energy storage, and other technologies. But it is clear that the higher the proportion of variable sources, the greater the grid stability challenge. For a country with 75% variable renewables, a capacity equivalent to about 25% of demand must be able to be ramped up and down within an hour to maintain a stable supply.

To the degree that natural gas thermal plants remain, as they are today, as the backup supply to enable increased use of variable resources, the objective stated by many countries to reduce carbon emissions by 80 percent or more by 2050 will be elusive.

Professor James Hansen was the scientist who first raised broad awareness of climate change when he testified before the U.S. Congress in 1988. Originally highly regarded as an expert studying the atmosphere of Venus, he became aware of parallels between that hot planet and trends on the Earth. Dr. Hansen concluded that carbon in our atmosphere was impacting weather and warming the planet. He remains one of the leading voices in the world advocating aggressive action to reduce carbon emissions.

Dr. Hansen has said, starkly, that "renewables plus natural gas equals planetary doom."

I imagine there are many people who will listen intently to Dr. Hansen when he speaks of the threat of climate change, but fall suddenly deaf when he highlights the folly of an electricity system that is fronted by wind turbines but backed by constantly spinning gas turbines and quietly restarted coal plants.

This is particularly true where nuclear is substituted by a mix of renewables and natural gas—experience demonstrates consistently that carbon emissions rise.

The need to plan for and implement an advanced energy system that will support our future needs, desires, and realities is too important to continue listening selectively. We must have our ears and our eyes open and our efforts set to give future generations the greatest benefit previous generations bestowed to us: choices.

With so much uncertainty about the future, the world will need as many tools as possible at its disposal. Nuclear energy is one of the options in the global toolbox to address climate change, air pollution and energy security.

Whether renewables ultimately comprise 40 percent of our future electric supply or 75 percent, something else will need to provide the other 25 to 60 percent. And that something else must be fully dispatchable, available when renewables are not. Available when the winters are long and cold. Available when the summers are unbearably hot and the wind is still.

Far from being a conflicting choice with renewables, nuclear generation could be an enabler for large scale renewable deployment. The complementarity between the two technologies may mitigate risks related to renewable intermittence, contributing to a decarbonised and more secure electricity system.

If we are truly to reach this advanced energy system of the future, three things will be needed.

First, we must address the dysfunction in our electricity markets. Requirements for utilities to use subsidized renewables, which have zero marginal cost but enjoy guaranteed remuneration, have dramatically depressed wholesale prices and drained electric utilities of the resources that will be needed to build the systems of the future in many OECD many countries of the resources that will be needed to build the systems of the future.

In today's power markets, no technology, not a single one, renewables included, is able to finance itself on the basis of market prices. This is simply not sustainable—unless governments plan to essentially nationalize their electric systems and use taxpayer resources indefinitely to support these policies irrespective of cost.

The NEA's analysis demonstrates that a better path would be to redesign the markets to incentivize the use of low-carbon energy technologies and to allocate system costs—such as transmission access—fairly to those technologies which create them. We should also create pricing systems that reflect the realities of high-fixed cost low-carbon technologies—which concerns both nuclear and renewables. In order to ensure sufficient investment, we must create long-term financing mechanisms that ensure stable returns over the lifetime of the wind farm, nuclear plant, or other installation. Finally, we should remunerate dispatchable capacity for the service that it provides to the system by being ready to satisfy demand at any time.

Second, we need to reinvigorate research and innovation on a broad front. We benefit today from the broad and forward-looking research programs of the past. By not continuing to plant seeds that can grow over the long-term, we risk starving the generations that will follow us.

For nuclear energy to play a larger role in our future energy system, we should explore innovations to make nuclear plants more flexible and cost-efficient while achieving high levels of nuclear safety. We should explore Generation IV technologies and advanced, proliferation-resistant fuel cycles. We should undertake a major new global initiative to develop the materials of the 22nd Century today.

Because we truly do not know what energy resources and technologies will be needed or available over the coming decades, we owe it to the future to maintain a broad front of research, development, and innovation. Given the long-term nature of energy research and infrastructure development, the choices we make today will weigh heavily on the ability of the next generation to respond to the challenges of 2050.

Finally, we need to bring our polices in line with our desires. In 2015, the OECD, the Nuclear Energy Agency, the International Energy Agency, and the International Transport Forum reported to an OECD Ministerial Council Meeting regarding how to better align policies across different areas for a successful economic transition of all countries to sustainable low-carbon economies. This report found that across a broad range of policies covering everything from agriculture to energy, despite the positive words from most governments about reducing carbon emissions, their policies were moving in the wrong direction.

If we are serious about reducing carbon emissions, we must make that our priority, not the promotion of the technologies that provide nice photo opportunities but lead to higher emissions.

We at the NEA work with our member countries and others around the world to provide the analysis needed to chart our next steps. Programs and initiatives such as Nuclear Innovation 2050, which can bring regulators into the discussion about future innovations, and the forward-looking Generation IV International Forum bring countries together to explore the technologies of the future. We will do these things and more.

But in the end, the governments of the world must rise to real challenges of the future and follow the example of our forbearers who looked beyond the easy answers of today and addressed the hard tasks of tomorrow. The forbearers who built the great electric systems that brought light to the darkness in the 20th Century. The forbearers who harnessed the atom and took humankind's first steps into space. And the forbearers who built a great global city in the Arabian desert.

Thank you.