DEBATS

Nobuo TANAKA

I think we have a question from the floor.

Răzvan NICOLESCU

I would like to ask a question. I am from Romania and I work for Deloitte Central Europe. In 2014, I served my country as Minister for Energy. I think we can all agree that in order to deal with climate change, we need to have this energy transition. I hear you all saying that we need R&D, we need to decrease costs. My question to you is how can we manage to actually avoid a duplication of R&D programmes between public sector, private sector, China and the US, between Europe and some other countries? Is it possible to create a kind of platform under the United Nations or under another body and to exchange information? At the end of the day, this is probably one of the biggest threats faced by humanity. We need to cooperate. We need to be more efficient. How can we deal with that?

Nobuo TANAKA

As Ladislas said, it is more or less the market that is prevailing. Solar panels are so cheap now, so definitely anywhere in the world, solar is in the near future. It does not need any kind of public support in the form of tariffs. Japan is suffering from a very high tariff because the cost of generation is getting too high. Maybe a kind of auction in the market would make better sense with the progress of technology. In fact, the market is answering itself, but Ladislas?

Ladislas PASZKIEWICZ

I will add to your answer with one specific comment, which is not public/private, but which is among the private sector. You may know that we have created an organisation called the OGCI, Oil and Gas Climate Initiative, where we are going to dedicate about USD 1 billion, and that is 10 companies that have joined this initiative. Generally, we are competitors, but in this particular case, those companies got together. I can tell you this is Total, BP, Shell, Statoil from Norway, Repsol from Spain, Eni from Italy, Pemex from Mexico, CNPC from China, Reliance from India and Saudi Aramco from Saudi Arabia. You can imagine these 10 companies together deciding that we would not compete with each other, but we would put our research and our money together in order to make investments related to climate change. I think that is a good example. As you mentioned, rather than competing, let us get together because we all have an interest in working together.

Nobuo TANAKA

Thank you. That is a very good point. Yes, André?

André CAILLÉ

I have a final comment on hydro. I realise that there has been opposition to larger hydro plants mainly, but that position came about mainly because of flooding. There are many large hydro projects that are run of the river type. A project in Africa requires only minimal flooding and again, the potential is half of the currently available power in Africa. This is huge and putting that aside will certainly not help what we are trying to do to control climate.

I would like to add to your comments. It is true that it is much easier to capture CO2 from a combined cycle generator, but the same remark can be made for cement plants and amonia plants . Both produce much cleaner effluents than coal. Coal is the worst. If you want to take the low-hanging fruits use large hydro .Then maybe in 50 or 70 years, when we will talk about technologies to change the climate on other planets we could use coal .I think we can still be optimists for future generations.

Nobuo TANAKA

Let me ask the panel one question. We are talking about coal, CCS, hydro and other things. Do you think in power generation at a certain time in the future, we could rely 100% on renewables? Friedbert, I think you say no because of coal, but some people say that promoting renewables as such means that the future can be 100% renewables. Do you think this is feasible, Olivier?

Olivier APPERT

I would say it is already done in some countries. I would say it is done in Norway, for example, and Iceland because of thermal energy and also with hydro. However, it differs from country to country, and I would say that in France, for example, it is completely crazy because the problem of renewables is intermittence. There are solutions to store electricity for a few hours. In fact, Patrick Pouyanné said very clearly that electricity is very difficult to store. It is possible to store it for a few hours, but unfortunately what we need in order to develop 100% renewables is inter-seasonal storage. For the time being,there is no economic solution except hydro storage . Other technologies are considered but for the time being there is no business case for that. However, it is very attractive for politicians, I would say.

Nobuo TANAKA

Yes, that is right. Politically, it is a very correct statement. Friedbert?

Friedbert PFLÜGER

First of all, I hope I have not brought myself into a position that seems in favour of coal. I have just described the resistance. There can be no doubt that we will phase out coal, but it will take much longer than, for instance, the Green Party wants. But the general tendency to get away from coal is also very real in my country.

If I was asked whether we can completely rely on renewable energy sources, I would say: At one stage perhaps, but in the foreseeable future, that is difficult and would be too costly. Let me give you one example. In my country, the heating sector is very important because of the cold winters and, while most people have gas heating systems, some have oil. At peak demand, the German heating system requires 300,000 megawatts. Our power grid is designed for a quarter of that, so at the moment, we cannot say that we will electrify the whole system, supply electricity from the renewable sector, only use heat pumps and get rid of gas and oil completely. There would be an enormous cost for the heat pumps, for the new system, while the infrastructure for gas heating is already fully in place.

At a certain point, we will be in very difficult waters with our population. They will say, 'We want to prevent climate change, but at what price? Are we allocating the money correctly?'. If we continue to pursue our *Energiewende* in Germany, we will have paid EUR 520 billion in subsidies by 2025. I think hardly any other country could afford that. Therefore, we cannot be a model for others anyway, but EUR 520 billion solely for renewables is for us as well a wrong allocation of funds. We would have been better off modernising old gas power plants. Rather than something like electric cars, we would have been perhaps better off looking at low-hanging fruit, such as boosting the use of gas in transportation, especially in the heavy truck sector or in the marine shipping industry.

My belief and my message to you is that we should put more emphasis on gas, at least for the next 30 or 40 years, and reap the low-hanging fruit of climate protection policies – not always talk about this wonderful vision of 100% renewables. Perhaps we will achieve it at the end of this century, but we have to make politics for the foreseeable future. That is our task.

Nobuo TANAKA

Ladislas?

Ladislas PASZKIEWICZ

Just to complement what you say, it is interesting to notice that gas-fired power plants have a reduced start-up time and so it can fit quite well with the intermittency of renewables. The combination of renewable and gas-powered plants actually works quite well. That is one additional comment I wanted to make.

On renewables, we need to think again about the infrastructure model because in the end, when we think about it, we have renewables with a marginal cost of zero, when the whole system of electricity price is based on the marginal cost, and so when you add up the marginal cost of zero, then you question the whole model. The whole system is being questioned. Who is going to pay for the infrastructure? When you have decentralised generation rather than centralised generation, you are going to store on the infrastructure. Who is going to pay for it? It is not just renewable makes electricity, so that is fine. We need to rethink it completely and restructure it, and that is where regulations are extremely important, in my view.

André CAILLÉ

I have spent nearly half of my career trying to explain to politicians the difference between power and energy,I do not think I have succeeded.

Nobuo TANAKA

André, now that battery cost is declining drastically, do you think at some point combining renewables with battery may create some difference?

André CAILLÉ

Yes. Thank you for giving me the opportunity. I would like to talk to you a little bit about a solar plan 60 kilometres north of here. It is in a lab, of course. It is a solar energy park run by Mohammed VI University.

Nobuo TANAKA

Concentrating on solar?

André CAILLÉ

Yes, exactly. They claim they can build 94% available solar system. I only found out last week that this existed. Research will make them better, but we are still missing that 4% and of course every time we flip the switch, especially at night, we expect the light to go on. The 4% exception will not be an acceptable explanation. There needs to be a way to store energy. It is not developed yet, or what has been developed so far is very, very expensive, therefore not affordable and it has to stay in the lab until it is affordable otherwise we are just playing around and these things will be criticised in the future.

To answer your question, I think it will come. It will take time, but reaching the 100% mark should not be something we have in our minds now. I think what was said last night is if we can go from 3% now, or 8% if you include hydro, and increase this to 30% and bring coal down to 3%, that would be great. We should be trying to do just that .Then if we want to do that rapidly, we have to go to the low-hanging fruits. If we do not do that and we stick with the present communication saying that renewables will take over everything, then we will be waiting a long time for this problem to be solved.

Nobuo TANAKA

Masuda-san?

Tatsuo MASUDA

Is it possible to support 100% by renewables in Europe? It will be possible if we can employ disruptive technology. For example, the photovoltaic system, the mechanism is a very old technology. It was developed 60 years ago. It is flourishing now, but it is old-fashioned already. Intermittence could be overcome if we fully use energy from solar. There is a way to consistently produce electricity from solar energy, and some people are working on that, including MIT. That is my first point.

Secondly, the storage of electricity is very expensive of course. Batteries are very expensive still, but there is a technology called wind-powered thermal energy system that uses wind turbines, but to generate heat rather than electricity, and the heat is stored in a molten salt system, which will last 100 years without maintenance. Then that energy is used as a base load. Already intermittent wind power could be used as a base load.

Those technologies are already on the horizon, so we should give more publicity to those and maybe as you pointed out, support those new technologies together with several governments and companies. This is one of the possible ways towards 100% renewables and a big point is whether or not we should include nuclear in this 100%. If nuclear is added, I do not think it is a long, long-term target. It could be reachable. Thank you.

Nobuo TANAKA

We will discuss nuclear a bit later, but do you have a question?

Saïd MOULINE

I am head of the Energy Efficiency Agency in Morocco. We have heard about energy demand and how energy efficiency can play a role to decrease emissions. It is very important to look at the demand. The second point is that in a project 100 kilometres from here, we have a big solar plant with energy storage, heat storage, reaching a price of 11 cents per kilowatt hour. We had a programme for wind. In this country, we reached three cents per kilowatt hour. Developed and financed by private companies, for 850 megawatt, we reached three cents per kilowatt hour today. In the solar plant, we have solar thermal storage that can stop intermittency, but with Solar PV, we reached four cents per kilowatt hour.

That is why I believe in this approach to renewables today, at the price we have reached, in a country like Morocco, which is very energy-dependent, we have coal power plants. It is almost 50% of our production today. That is one thing. Morocco emits 10 times less than Europe, but we have a strong proactive policy for renewables and for energy efficiency because it is a mixture. We are living in a transition. Maybe one day we can reach 100% renewables. I think we can reach that because storage is not only linked to batteries. Even batteries are becoming cheaper and cheaper because of electric cars, but also we are storing in dams. All the wind programmes that we have in Morocco are also linked to dams where we can pump water when it is too windy and we can store electricity by pumping water and using it when we need it.

There are many ways of storage today, so that is why our programme to reach 52% of our capacity from 2030 is a strategy at the highest level of the state. There is a strong proactive commitment. Since 2009, priority has been given to nuclear and energy efficiency. It is cheaper. We believe renewables can play a role and we were amazed by the price that we reached, of three cents and six cents.

My question was also linked to how we can push on efficiency in industry, transport and housing. We are helping farmers to switch from diesel pumps to solar pumps. All the small applications of renewables are becoming much cheaper. It took a farmer in Morocco 10 years to pay it back before. Now it only takes four years for two reasons. The PV price decreased because we stopped subsidising fossil fuel. We talk about carbon tax. How can you have carbon tax when many countries are still subsidising fossil fuel? It is nonsense. To be current, you need to have both. You need to stop subsiding and you need this carbon tax to accelerate the approach. Thank you.

Nobuo TANAKA

Thank you. It is very good input to the discussion. You talked about a target of 52% renewables.

Saïd MOULINE

By 2030.

Nobuo TANAKA

Thank you. Are there any comments?

Louis SCHWEITZER

I have a few additional comments. I am French and for a long time, I headed a car company called Renault-Nissan. I now work in promoting investment in new technologies for the French government. I have a few comments.

First of all, everybody is in favour of a carbon tax and I support a carbon tax too, but it means you have to be able to put it at the borders of Europe because otherwise we will have a competitive problem, which will be difficult to explain and to solve. Up to now, I have not heard from anybody a readiness to impose such a tax on the European borders and I do not know if the WTO would look positively upon it. To me, this is an important issue that should be addressed.

My second comment is that I think the opposition between the ambitious goals in renewables and low-hanging fruit is not something important. I suggest you should pursue both because if you look at renewables, we are still on a learning curve cost-wise and technically. The example just given from Morocco shows that this is happening very fast. If do you not set ambitious targets before you have acceptable costs, then you will never reach acceptable costs. I mean you have to prime the pump at some time. Germany is doing it, maybe in some surprising ways, but still, it helps. I truly believe that even in Europe, we will achieve acceptable competitive costs for electricity from renewable.

Let us take an example on roads. I believe that the electric car does have a future, and this future has started with regulations. China is an example, and a number of cities, but I believe it will be competitive in 10 or 15 years from now. There again, you have priming with regulations and then the economy setting in.

A second example is trucks. I believe electricity is not an acceptable solution for trucks looking forward. Gas instead of diesel fuel is very convincing and I would say almost competitive, so this is a low-hanging fruit. If you look at road traffic and combine low-hanging, immediately attainable and more long-term, more ambitious programmes, you will have success.

Nobuo TANAKA

I agree. I mean trucks can use LNG and other very good options, not compressed natural gas, but also fuel cell maybe. It depends on the station and possibly the infrastructure issues there.

Louis SCHWEITZER

I would need to be convinced, as a former truck manufacturer.

Nobuo TANAKA

Energy is a very likely solution.

Marc-Antoine EYL-MAZZEGA

Thank you very much, Mr Tanaka-san. I am from the Centre for Energy at IFRI in Paris. I am very struck by the global, at least around this side of the table, the kind of agreement that gas has definitely a role to play. I would like to

ask you whether you think this is natural gas or whether you have the impression that it could increase and also be hydrogen, green gas and where and under what conditions and if we need more subsidies there?

Nobuo TANAKA

Yes. That is exactly what I am trying to ask. The golden age of gas is definitely coming and what is the gas supply situation? What could the pricing be? What is green gas, like hydrogen? That is a question for the panel. Is there anybody who wants to answer?

Hermine DURAND

I am from the French Nuclear Safety Authority. Do you really think that replacing coal by gas is going to help us significantly to mitigate global warming and meet the target of two degrees? It is a good starting point, but then two degrees is really a small temperature increase, so is gas really the solution? And you mentioned that CCS has limited capacity, so gas plus CCS is perhaps not the only key?

Nobuo TANAKA

Yes. IEA's wedge analysis tells us that the replacement of coal by gas certainly plays a role, but eventually to achieve two degrees, CCS must be applied to the gas also. A field shift from coal to gas certainly plays a role.

Yukari Niwa YAMASHITA

I want to throw in another question in relation to your question. Our institute has estimated the outlook up to 2040 and this year for the first time, we did it for 2050. We have been doing that for the last 10 years or so to be aware that dependence on fossil fuels is still more than 75% and almost 80%, both in the reference case and then also in the alternative case, like in the IEA's energy outlook. Then we asked this question. We also ran the longer-term integrated model for climate change and realised that it is almost impossible to reach the two-degree target by the end of the century if we assume the 2050 estimation.

How do we reach there where we replace everything with renewables or how do we transit out of coal to gas? Looking at the situation on the market, the gas price is so low and then the investment is not enough and we foresee the supply and demand balance will be met by 2020.

Nobuo TANAKA

Go ahead, Friedbert.

Friedbert PFLÜGER

Firstly, I would like to comment on Mr Schweitzer's statement that we pursue too much low-hanging fruit in contrast to ambitious long-term aims. I happen to completely agree . We need both. We need far-reaching aims, even a vision, and we need the ability to clearly see what we can realistically do in the foreseeable future. What I did criticise at the beginning is that politicians, at least in my country, but my feeling is that it also happens in other places, have a tendency to be weak on the low-hanging fruits only to be even more ambitious with long-term aims because they can never be held responsible for them.

I was calling for a less ideological approach and a more pragmatic approach, which looks at the next five to 10 years. All these predictions about what will happen in 2050 – which is in 23 years – are not purposeful. Let us go back 23 years and see what happened in these 23 years with oil prices, tight oil and shale gas. All our predictions have been completely wrong, so let us not look too far ahead and concentrate more on what we do now. Again, of course, it is also always good to have a vision of the future.

When it comes to gas, it is important to note that I am not only talking about natural gas. I believe that we will increasingly have biogas and synthetic gas, that can be added to make gas greener and more legitimate. Thereby, from a European or German perspective, we can make use of a very mature gas infrastructure and avoid having to replace it with a completely new one. I think that is a very important point that you just made.

Nobuo TANAKA

Thank you. Is Germany in favour of hydrogen? Japan is pushing very hard on the hydrogen economy as such because if we import LNG from the United States, the cost of gas in Japan is at least double, so this gap will never diminish because of transportation and so on. Because of this, just importing hydrogen would make good sense, but the pricing of carbon and so on is definitely necessary.

Friedbert PFLÜGER

I doubt that this plays a big role in our discussions today. What plays an enormous role throughout Europe is LNG. Europe today has 30 LNG terminals. When we had the Russian/Ukrainian gas crisis in 2006 and 2009, we all said, 'Well, now we have to diversify' and meanwhile we have 30 LNG terminals with a capacity of 231 bcm of gas. Europe has pipeline gas from Russia and from Norway, but we increasingly have the alternative of LNG. That makes us much more flexible on the gas market, moving us away from oil index pricing and more towards spot pricing. In addition, I think we have a lot of possibilities to tell the Russians, 'If your price is too high, we will turn to LNG from the US or from Qatar' and vice versa.

Gas production in Europe is declining dramatically, as you may know, but our sources for cheap imported gas are pretty good and, therefore, in combination with biogas and synthetic gas, I think we have a very diversified gas supply.

Nobuo TANAKA

Olivier?

Olivier APPERT

On hydrogen, I am not a believer. I think for decades, there were people advocating for hydrogen and I have never been convinced. I do not see any technological breakthrough in hydrogen production or consumption and I see many economic technology and safety issues regarding hydrogen development. I know that there is a strong lobby from some companies, such as gas producers, but frankly, I do not believe that it will have a significant part in the energy mix for the next few decades.

The question is different for biogas and I would like to highlight the problem of feedstock. I have been deeply involved in biofuels, ethanol and biodiesel, and I am afraid that there will be the same problems for biogas. What is the feedstock available? Clearly, it cannot be in competition with food. Unfortunately, I am afraid that the quantity available is not so important. In Germany, for example, 50% of biogas is made from corn. We have to take that into account. There is a potential, but I am afraid is not very high and also you have to take into account the issue of logistics, which has a cost.

Nobuo TANAKA

André?

André CAILLÉ

I think that the best approach here is, number one, to have a CO2 pricing system. That will produce resources. There could be a taxation period.Its going to be very difficult in the US .Wheatever the system, CO2 emissions have to be priced. Money has to be used mainly to develop renewables. I mean develop the absolutely necessary technologies

to make them a firm supply as soon as possible. In the meantime, I agree with my colleagues here. Natural gas should be used to replace coal .

Nobuo TANAKA

André, because of the very low price of gas now, do we have enough investment for the upstream gas sector to guarantee the big demand increase?

Olivier APPERT

I think there is due to the shale gas revolution. We talk about shale gas essentially about the US, but the world is not limited to the US reserves. There is shale in many, many countries and what happened in the last 10 years is that the technology to produce shale gas has improved greatly, making the price of natural gas in the US very low. Natural gas can be used now in many countries to replace coal-powered generation plants. However, I think we have to make sure that this does not have an impact in postponing renewables in any way because in some countries, shale gas is not available, and we will need renewables anyway.

Nobuo TANAKA

Let me ask the panel a question, which I was asked about two years ago when I participated in Saudi Aramco's board meeting with Daniel Yergin. The current energy minister was there and he asked us as a panellist to the board, 'When will peak demand of oil come?' I was really surprised. It is Saudi Aramco and they are very concerned about Tesla, China's electric vehicle, Japanese Mirai and so on, so it is mainly electric vehicles replacing gasoline engine cars. That was two years ago and they were talking about possibly changing their policy not to export crude oil, but only hydrogen, a clean fuel as such. We discussed technologies, but what do you think? Do you think this peak demand for oil is coming and when?

Ladislas PASZKIEWICZ

Just to follow up on Louis Schweitzer's very interesting question, carbon leakage is still a very important issue because we talked about carbon pricing. If we do not manage to find a way to avoid leakage, as was mentioned, and it is a very thorny and difficult issue to solve, I think the only way to really try to do something pragmatic is to have a low carbon price because it will make leakage more difficult because there are costs associated to carbon leakage.

To complement the answer to the question regarding the real benefit of switching from coal to gas, I just want to remind everyone, of course everyone knows it, but it is worth mentioning, that gas emits half as much as coal and if you were to transit from coal to gas for all power generation, that would represent something like 5 gigatons of CO2, so it is about 10% of what is emitted worldwide today. Saying it would not be enough is not satisfactory. Let us do it. Let us start doing it, even though I agree that all coal will not be substituted.

Maybe I can give my opinion on peak demand. Many discussions are focused on EVs, but I think first, we have to keep in mind that today, the use of oil for light duty vehicles - because heavy trucks are different, electric vehicles do not really adapt very well to heavy trucks because of the weight, because of the distances and so on - the light duty vehicle segment of oil demand is about 25% of demand, so even though there would be a big switch to electric vehicles, what I think by the way is going to take place sometime down the road, that is for sure, but there are two elements that limit the impact. The first one is what I just mentioned, that it is only 25% of demand, and second, that there is another element that is absolutely critical in my view, which is the efficiency of the IC engines, which is going to be actually the main driver for displacing oil demand, rather than technical. As it becomes more and more efficient, the amount of volume that will be displaced will be reduced in the end, and so even though that will be very important, we still see 10% or so of oil demand being displaced by electric vehicles in the future.

Nobuo TANAKA

You think that peak oil demand is not coming so soon?

Ladislas PASZKIEWICZ

No.

Nobuo TANAKA

That is what I hear you saying. Olivier?

Olivier APPERT

I would like to remind you of some facts and figures. The transport sector represents 60% of oil consumption and the bulk of the increase in demand comes from the transport sector. Petroleum products represent 92% of the energy consumption of the transport sector. What about the other 8%? It is 4% natural gas, 3% biofuel and 1% electricity. Electricity consumption is not for personal cars, but mostly rail. We have to keep these facts in mind when we discuss electric vehicles and potential growth. Energy efficiency is a clear target. It is the first dramatic game-changer in the transport sector. We may put cars on the market that consume only two litres per 100 kilometres and hybrid technology will merge. Hybrid technology which incorporate both electric and IC engines is very, very efficient.

Secondly, the alternative to petroleum products is natural gas. This is clearly an alternative, mostly for heavy trucks. Do not forget maritime transport. Biofuel is also very important. Electricity will increase, but I am afraid that in the next 20 years, it will represent only a small part of the displacement of oil in the transport sector.

Nobuo TANAKA

Thank you very much.

Tatsuo MASUDA

I recall a very interesting comment by the late Christophe de Margerie. It was somewhere around 2009 or 2010 at an international oil summit in Paris. He said, 'I feel oil consumption will somehow not exceed 100 million barrels per day'.

Nobuo TANAKA

He was always saying that.

Tatsuo MASUDA

Now it is exceeding 100 million barrels per day, but what he felt at that time still lingers in my mind.

Nobuo TANAKA

That is interesting.

Tatsuo MASUDA

We should not underestimate the gut feeling of the legendary de Margerie today.

Nobuo TANAKA

That is true.

Tatsuo MASUDA

AI have one point to make about transport. 100 million cars would displace only 1.2 million barrels of oil per day. It is marginal, but if 100 million cars exploded due to solid state battery made by Dyson and others, and if the mileage of

EVs increased rapidly, and if more car-sharing was spread not just in OECD member countries, but others, the number of cars would stop increasing. If you take all these elements together, I think oil demand could peak somewhere around 2030. That is my feeling.

Nobuo TANAKA

2030, okay. Do you have any views? I talked to the Chinese guys and CNCP, the research institute guy told me that displacement of gas may happen, so peak demand of oil may even happen in 2025. If it happens in China as such, why not? There is definitely a risk of peak demand coming earlier, so that is the reason why Saudi Aramco is preparing for that and selling part of their shares if they can.

André CAILLÉ

I no longer make any predictions about the price of oil or on peak oil because every time I did, I was wrong.

Nobuo TANAKA

Yes. That is exactly what I had been saying when I was head of the IEA. I never predicted the oil price because I knew I would be wrong. By the way, we still have about 30 minutes to go. Can we talk about the future of nuclear power? Do we agree? Do you think that there is a future for nuclear power, even after the Fukushima accident? Japan's situation is that if we take a public poll, the majority is against restarting current nuclear power plants. The Korean president is saying they are phasing out nuclear power. Germany decided to phase out by 2022. France is moving from 70% to 50% and in the United States, thanks to a very cheap gas price, nuclear power is not competitive. Many current reactors are closing. Some states are concerned about it, such as New York, and are providing certain support measures to maintain nuclear. Without that kind of support, nuclear is not competitive. However, China, India and Russia are building nuclear power plants. That is without question. They need this big power source for their economy.

I think OECD countries will definitely have difficulty building big light water reactor systems in the future. Do we have some alternatives to move ahead? The nuclear programme is not safety only, but spent fuel or high level waste or proliferation risk of weaponisation. North Korea now has a weapon. If the Iran agreement is aborted by Mr Trump, Iran will very quickly go back to nuclear weapons and then that will probably impact on the weaponisation of Saudi Arabia. It is not simply an electric power issue. It is a very serious national security issue. How can we manage nuclear energy in the future? This is my question.

André CAILLÉ

Thank you. I do not think there is any source, including renewables , that does not have opposition anywhere in the world. People do not like wind parks and so on. I would certainly not recommend introducing nuclear in a country where there are none today because there will be huge opposition. In countries where it already exists, where people get to live with it.Japan is an exception, and I think the nuclear industry in this country is pessimistic about the future and this does not help at all. As far as what the international community is trying to do relative to global warming, nuclear is a source that produces less CO2 than any other, so I think nuclear in countries like France should be maintained and maybe developed at this point.

Let us remember that renewables in Germany are backed up by nuclear in France ,or worst by coal.That is the reality because one is firm and the other one is not. What we understand and what we hear about nuclear these days is very negative. Because of security reasons, they will all close down. I do not think it is positive news for the fight against climate change.

Nobuo TANAKA

Lee-san, do you think Korea will continue with nuclear or phase it out?

Lee HYE-MIN

That is a very sensitive matter in Korea nowadays and since I have slightly differing views from the current government policy on nuclear, I just want to say that we need further discussions on the pros and cons of nuclear power plants. You see, the current administration which took office in May, decided to halt the construction of new coal power generators and also halt nuclear power generators under construction, but there has been very intensive discussions among the juries consisting of ordinary people assisted by experts. They decided that we may go ahead with nuclear power plants under construction, but we will not construct any new nuclear power plants in the future. Since there is very strong opposition from the energy experts in Korea, I am not so sure if that policy will be sustained. Thank you.

Nobuo TANAKA

I see. Thank you. Masuda-san?

Tatsuo MASUDA

I suspect the current situation tells us nuclear will not get on well with Western democracy. Nuclear faces problems in every democracy. Japan is not an exception. Mainly companies in the West are losing expertise and even the passion to pursue nuclear options. Toshiba is now on the brink of bankruptcy and Areva is sold and I do not see any enthusiasm coming from those companies because they do not have any investment at home or in the Western part of the world and the rest of the world is now dominated by the Russian Rosatom, together with the government of low interest rate and China is busy at home, but Chinese companies will go abroad.

The Western democratic environment will not accommodate more nuclear power plants, except in France hopefully, and about SMRs, Small Modular Reactors, this is the light at the end of the tunnel, but because of small scale and low efficiency, SMRs will not be commercially viable unless they are ordered in hundreds and this again is not realistic, so my conclusion is that in the West in pure democratic countries, I do not see a big future for nuclear, but for the rest of the world pushed by Russia, followed by China and India, nuclear has a longer future. Thank you.

Olivier APPERT

I agree with you, Tatsuo, but to be provocative, do you think the UK is not a democracy? Anyway, somehow I agree with your comments. The most important country in the world as far as nuclear is concerned is the United States, and their policy on nuclear is totally unclear, and that is a very important problem. President Trump still does not know what to do. As it was clearly explained by Patrick Pouyanné yesterday, the main challenges are related to public acceptance, but also to cost and it is quite new compared to the situation a few decades ago. There has been an increase in cost due to safety measures linked to post-Fukushima, and also the fact that there is no real series effect. The price of PV decreased dramatically because of the series effect and it is not the same in nuclear because there are only a few units which will be built.

I agree with you, Tatsuo, that the Western nuclear industry is not really in good shape, but still there are significant projects in China, Russia and maybe newcomers, such as India, but anyway, due to the situation in India, it will take time and maybe also Saudi Arabia. These countries need to have base load production.

Friedbert PFLÜGER

My country, as you know, decided very quickly after Fukushima to phase out nuclear power. While there are a lot of discussions in Germany about tariffs, energy transition, etc., the consensus remains that it was right to phase out nuclear. This has not been challenged at all and I believe one of the main reasons for that is the fear of terrorism: We do not have tsunamis and earthquakes, but we have ISIS and its enormous willingness to kill as many people as possible. In a climate and in a situation where we have terrorism that we will have to live with for quite some time, we believe that it is not only nuclear power plants, but also the transport and storage of radioactive materials that provide additional vulnerabilities. I think that was one of the main reasons for the phase-out.

When it comes to nuclear in the world, I absolutely agree. We will have nuclear for a long time, not least because nuclear won new legitimacy because of the CO2 discussions. If you take the G7 agreement of Elmau and also G20, the emission reduction goals are only realistic if we count in nuclear. The German green movement never mentions that in Germany. They all say, 'Well, that was a great success for us'. But the Paris Agreement implies that we continue with nuclear. This was never really discussed in Germany, but I think it is part of the truth.

Nobuo TANAKA

Yes. Some other European countries called it "German anxiety".

Friedbert PFLÜGER

I think they were probably more afraid after Fukushima than the Japanese.

Nobuo TANAKA

Yes. Well, the Japanese are very concerned about it, but they are also worrying about a possible accident in China. If something goes wrong, it will have the same impact on us, so Japan can stop nuclear power, but does it help their safety operation in China? In that sense, Japan needs to continue their operation and sharing lessons with China makes more sense. Otherwise we will have much more serious problems. Of course does this convince the public? This is a totally different view, so my argument is with the Small Modular fast reactor technology, this is sustainable nuclear for safety and taking care of high level waste and proliferation. If we can identify these technologies, maybe we can have a chance. By the way, the US and Korea are working on this technology for their new model of the future for nuclear, but we will see. This is very tricky and very, very difficult. We need a good discussion.

We have covered almost all items in energy and climate, but Olivier, you want the floor.

Olivier APPERT

I just want to come back to coal. We discussed coal intensively at the beginning, but I think that we missed one very important point. I would like to remind you of some basic facts and figures on coal. First, the coal price has a leading role in the price of electricity everywhere in the world. Second, 50% of the consumption of coal is in China and so the problem is what about China's coal policy? We think that they are phasing out coal. In fact, for local environmental reasons, they are shutting down many very inefficient power plants and replacing them with brand new coal power plants that are much more efficient and they are building one 500 megawatt coal power plant every week. In fact, more than 50% of China's energy supply comes from coal, which represents 90% of power generation. Clearly, the price of coal is managed in fact by the Chinese government. A high price may jeopardise their economy, but if the price is too low, it jeopardises their mining industry with millions of jobs.

In fact, when we discuss coal, we must discuss China's coal policy. I am afraid that for quite a long time, coal will continue to play a major role in the energy mix. What about India? In fact, India has a plan to increase coal consumption from 500 million tons to 1.5 billion tons of coal because it is produced locally and they have significant

reserves. It is very important to consider the future of coal in those two countries. If we consider the climate change issue, the most important is what is going on in China and India as far as coal is concerned.

Nobuo TANAKA

Indonesia is increasing their coal consumption very substantially. Thank you very much. We have covered quite a lot. We have about 15 minutes. If there are any questions or comments from the floor, they are most welcome. We are exhausted. We will have final comments from the panel.

André CAILLÉ

I overlooked the possibility relative to demand management .. In my country some pretend that we will reduce peak demand by 6% by managing, at a distance, water heaters through digital technologies. This is significant if you compare the cost of that 6% stored in molten salt or pumping reserves. I think demand side management has a new role to play . Because of digital technologies, there is a lot more potential.

Nobuo TANAKA

Thank you very much for a very good point. Masuda-san, do you want the floor?

Tatsuo MASUDA

I would like to close this wonderful debate with an optimistic view. I sometimes have discussions with IEA people, including Tanaka's successor, and I ask them, 'Why not do this, this and this in technology in your forecast or predictions?' The answer is very clear. We are not supposed to include technology that is not yet proven in pilot plans. I have to say there are many, many technologies in the pipeline and very close to test plans. If we shed light on those, the future is brighter and technology can play a bigger role and decarbonisation will take place sooner rather than later. Thank you.

Nobuo TANAKA

Thank you. Ladislas?

Ladislas PASZKIEWICZ

As a corporate, I just want to remind you that even though there are a lot of threats associated with climate change, we see huge potential opportunities, and in particular in energy efficiency, in new businesses linked to CCS, as we mentioned, so I think we should also look at the positive part associated with the transition that provides many, many opportunities for the corporate world.

Nobuo TANAKA

That is your strategy. I remember, Ladislas, that your division is called 'Strategy and Climate'. This is a very interesting name for Patrick Pouyanné's interest in climate in Total, I guess.

Ladislas PASZKIEWICZ

Thank you for mentioning that because it is right that sometimes we ask the guy in charge of strategy, 'Why would you put climate with strategy?' That is a fair question and I think actually it is much deeper than people think. For an oil and gas company, for an energy company, I should say, that invests over 30, 40 years' time, it is very important to embed the impact of climate into the strategy, in the decision-making process of the company. Integrating climate issues into the strategy is something that may appear to be unique, but under Patrick Pouyanné's leadership, we decided to join them together. I am very happy not to be in charge of this function, but it is right that it is quite unique.

Nobuo TANAKA

Yes, this is very interesting. That is exactly the reason why Total has internal carbon pricing and that kind of exercise is probably very important for the other major players in the field to do the same because by doing so, the financial sector will evaluate such companies and the money goes there. Those that are not doing that are eliminated. That is probably a first step, rather than building the carbon tax system or carbon trading system as such. If many companies start doing these kinds of practices, then we are ready to have the institutional arrangement of carbon pricing in the future.

Friedbert PFLÜGER

I do not know if it has to do with the fact that I am German, but I am more pessimistic than others. I see the potential with new technologies, with digitalisation, with CCS and CCUS, low-hanging fruit, everything we discussed. Nevertheless, I believe we are not fast enough. We will not even reach the two-degree goal. My prediction is that we will most probably see, and I deeply deplore it, that the world continues to have increasingly worse weather and more and more natural catastrophes. As individuals, we only begin to live healthily after the first heart attack and it is the same with the world. We can have all the knowledge in the world that it is getting worse, but only climate catastrophes remind us that this is reality and my fear is that we are running behind, so I am a bit pessimistic.

Nobuo TANAKA

If we do not die from the heart attack, it is okay. Olivier?

Olivier APPERT

I have four short comments. In the Kyoto Protocol, at the same level, there were the aspects of mitigation and adaptation. In fact, we do not seriously consider the adaptation issue. There is a small part in the Paris Agreement, but if we are not able to cope with the two degrees scenario, as you say, adaptation will become more and more important. That is my first point.

My second point is that you have to take into account the inertia of the energy system. Patrick Pouyanné reminded us yesterday that capital turnover in buildings is 1% per annum. Replacement takes a long time, such as changing old buildings to brand new buildings. The same applies for power generation. The lifetime of any power plant is 50 years, so the inertia of the energy system is quite important to bear in mind.

My third point is not to focus only on discussing electricity. Electricity represents 20% of the problem. It is 20% of final energy consumption, but in fact it represents 95% of political comments. Lastly, energy efficiency is paramount and we should spend more time discussing energy efficiency.

Nobuo TANAKA

Thank you very much. Energy efficiency is certainly very important. I remember an IEA publication called 'Gadgets and Gigawatts' because energy efficiency certainly reduces power consumption, but the new gadgets in the digitisation of electronics will have more demand, so it is compensating. The total electricity demand is increasing unfortunately, regardless of our great effort in energy efficiency. That was the history, but anyway, thank you very much for your valuable comments.

André CAILLÉ

You must have already concluded from my accent that I am a French Canadian.

Nobuo TANAKA

I noticed.

André CAILLÉ

I learned this afternoon that my ancestors must have been close to the German border because I am a little pessimistic too about a real possibility to limit the increase in temperature by two degrees unless we become much more practical.

Nobuo TANAKA

Thank you very much. Mr Lee?

Lee HYE-MIN

On this issue, I would like to stress the importance of the Paris Agreement, whose objective is to achieve adaptation and mitigation by making all countries participate. How we achieve this objective? It is through technology, finance and capacity building, especially for developing countries. Therefore, the decision of the US administration to withdraw from the Paris Agreement will definitely have a very negative impact on the finance. It is time for all of us to think about how to address this issue in the years to come. Thank you.

Nobuo TANAKA

Thank you very much. I appreciate all the comments and inputs from the panellists, as well as from the floor. We have learned a lot about Trump's impact on this COP agreement and certainly Mr Lee's comment about a certain impact, but at the same time, the private sector's investment in technology development and in renewables will continue, so for that, yes, the impact itself may be less, but of course the coal issue is big and CCS is necessary for that. Carbon pricing is an important way to promote it. An internal carbon pricing mechanism in corporations is probably the first step we have to take. The change is very rapid, so how can we match this speed? This is certainly an issue for the private sector as well as governments.

When I was at the IEA, I always said that the government policy in the energy sector infrastructure must be stable and predictable, otherwise the private sector will never invest in infrastructure for 40 or 50 years. As it very often happens politically, the coal issue is a case, nuclear is one, renewables is the same thing, so by changing the policy if the government changes, that is sending a variable message. How can we make the energy policy more stable and predictable? This is what I was always talking about at the IEA, and having a good dialogue like this helps to reduce the unpredictability. We will continue and I thank you for your contributions. I wish everybody will join me in thanking the panellists for the discussion.