Energy Technology Perspectives 2014: Harnessing Electricity's Potential

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Webinar Panelists

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This Transcript

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Sean

Everyone, I'm Sean Esterly of the National Renewable Energy Laboratory and welcome to today's webinar which is hosted by the Clean Energy Solutions Center and the International Energy Agency. And today's webinar will discuss the IEA's 2014 edition of the energy technology perspectives. And one important note of mention before we begin our presentation is that the Clean Energy Solutions Center does not endorse or recommend specific products or services. Information provided in this webinar is featured in the Solutions Center's resource library as one of many best practices resources refute intellected by technical experts. And before we begin I'll quickly go over some of the webinar features, so you have two options for audio. You may listen through your computer or over your telephone. And if you choose to listen through your computer just select the mic and speakers option in the audio pane to eliminate any feedback and echo and if you choose to dial in by phone, just select the telephone option and then a box on the right side will display the telephone number and audio pin that you should use to dial in. And panelists we ask that you please mute your audio device while you are not presenting and if anyone is having technical difficulties, you can get assistance at the number at the bottom of that slide which is 888-259-3826. And we encourage anyone to ask questions throughout the webinar. To do so simply submit your question through the question pane and those will be presented to the panelists following the presentations. If you're having difficulty viewing the materials through the webinar portal we will

be posting PDF copies of the presentations to cleanenergysolutions.org/training and you can follow along. And, we'll also be posting a video and audio recording of this webinar to that site within about a week of the webinar.

And so today's webinar agenda is centered around the presentations from our guest panelists, Didier Houssin and David Elsinger. And these expert panelists have been kind enough to join us to discuss key findings from the IEA's 2014 edition of Energy Technology Perspectives which is examines what must be done to provide sustainable options for generation, distribution and energy consumption. Now before our speakers begin their presentations I'll provide a short informative overview of the Clean Energy Solutions Center initiative and then following the presentations we'll have a question and answer session where the panelists will address questions submitted by the audience and then some closing remarks and a very brief survey. Now this slide provides a bit of background in terms of how the Solutions Center came to be and the Solutions Center is an initiative of the Clean Energy Ministerial and is supported through a partnership of UN Energies. It was launched in April 2011 and is primarily led by Australia, the United States and other CEM partners. Some outcomes of this unique partnership includes support of developing countries through enhancement of resources on policies relating to energy access, no cost expert policy assistance and peer to peer learning and training tools such as the webinar you're attending today. And there's four primary goals for the Solutions Center, first goal is to serve as a clearing house of clean energy policy resources, second is to serve to share policy best practices, data analysis tools specific to clean energy policies and programs, and third is to deliver dynamic services that enable expert assistance, learning and peer to peer sharing of experiences and then lastly the Center fosters dialogue on emerging policy issues and innovation around the globe.

Now our primary audience is energy policy makers and analysts from governments and technical organizations in all countries but we also strive to engage with the private sector, NGOs and civil society. This slide gives an overview of one of the marquis features that the Solutions Center which is the Ask an Expert. And ask an expert is has established a broad team of over thirty experts from around the globe who are available to provide remote policy advise and analysis to all countries at no cost. So for example, in the area of sustainable energy action planning, we're very pleased to have Mr. William Becker, a senior associate with Natural Capitalism Solutions, serving as our expert. So if you have a need for policy assistance in sustainable energy action planning or any other clean energy sector, we do encourage you to use this service. Again it's provided to you free of charge. So to request assistance simply submit your request by registering through our Ask an Expert feature at cleanenergysolutions.org/expert. And we also invite you to spread the word about this service to those in your networks and organizations. And

so in summary we encourage you to explore and take advantage of the Solutions Center resources and services including the ask an expert assistance, the data base of clean energy policy resources, subscribe to our newsletter and then participate in webinars like this one.

So now I'd like to provide brief introductions for our distinguished panelists today. And our first speaker that we'll be hearing from is Didier Houssin, the director of Sustainable Energy Policy and Technology at the International Energy Agency. And our second speaker is David Elsinger, who is a senior energy technology analyst at the, at IEA, where he is leading the IEA flagship Energy Technology Perspectives publication and work on electricity system technologies such as smart grids including system modeling, policy and technology analysis. And so with those introductions, please join me in welcoming Mr. Didier Houssin to the webinar.

Didier Good morning and good afternoon everyone, thanks for this introduction and thanks to all of you for joining this webinar. It's a pleasure today to share with you some of the key results of the Energy Technology Perspective 2014, ETP [inaudible 0.06.06] 2014 that was launched this afternoon in Seoul by the executive director of the IEA here in the Clean Energy Ministerial meeting. ETP is one of our flagship applications in the IEA and its analysis offers a comprehensive long-term view of energy system trends and technologies that are essential to meet goals for affordable, secure, and low carbon energy. This long-term view is regularly challenged by developments that have lasting and transformative impacts such as the Shay gas boom in North America, cost reductions in several renewable technologies and the [inaudible 0.06.45] nuclear power progress. These various examples clearly show that technology market developments and external events influenced the evolution of our energy systems.

But they draw attention to a troubling fact, in face of rapidly growing demand and increasing urgent threat of climate change, we're continuing to respond to the energy system as it evolves rather than actively managing its transformation in a holistic way. To achieve an energy system that is sustainable, not just in terms of reducing carbon emissions, but also and providing secure and affordable access for all, pretty strong [inaudible 0.07.27] leadership.

A radical change of course is long overdue and ETP shows how technology can help us meet our goals and the time is now. As you can see on this slide, where energy demand has grown the carbon intensity of energy production has stayed the same resulting in increasing high emissions. Understandably different priorities have meant that while carbon intensity has fallen in some countries, in many growth areas a focus on economic performance has meant rapidly expanding coal use. Indeed while emerging economies have stepped up their visions and become leaders in deploying local carbon energy technologies, the

ongoing allure of coal underlines the need to improve coal plan efficiency and scale up carbon capture storage and use. And ETP shows that change in direction we must make at looking at three main policy scenarios, the Six Degree Scenarios or Six-DS is largely an extension of con-trends what happens if we have business as usual. The Four Degree Scenario or Four-DS takes into account recent pledges made by governments to limit emissions and step-up efforts to improve energy efficiency. And finally there is the Two Degree Scenario or Two-DS which is the main focus the ETP 2014. This scenario describes an energy system which is consistent with limiting the increase in global temperatures to two degrees Celsius. This Two-DS, two degree scenarios confirms that over population and economic growth can be decoupled from energy demand, even for oil. Although analyzed through the lens of climate, it has also profound benefits for energy security and for the economy; the convergence of these topics is becoming increasingly clear. Energy efficiency remains the largest contributor to global emission reduction particularly in transport industry and buildings and we'll discuss that in a moment. But energy efficiency alone will not enable us to meet these targets; it needs to be combined with other technologies to meet our targets. And how we approach those would be key, yet quality efforts needed but its transition are impressive they are cost effective.

Investing in clean energy will pay off as you can see on this slide. And indeed that investment to get to clean energy system is immense, forty-four [inaudible 0.10.06] trillion U.S. dollars of additional cost, but this represents only a small portion of global GDP and it is offset by over a hundred and fifty trillion in fuel savings. Even with a ten percent discount grade it pays off in the long run. But in addition to higher cost, the major challenge in making progress today is financing. Increased upfront cost of many low carbon technologies make financing more difficult. So what is the result of these challenges? And as you can see from this chart that summarizes the way we estimate clean energy progress, we're not on track. This [inaudible 0.10.46] as you can become slightly more pessimistic than last year, as you can see here. To continue to delay those needed investments and we do this, we know that the longer we wait to transform our energy system, the more expensive it will get. There's one exception and the exception is renewable [inaudible 0.11.05] and they are on track. But this is not enough to meet long term sustainable energy goals. A broad range of technologies are needed across all production, generation and unused sectors, especially in the electricity sector. Now the crucial role of electricity in global energy systems is something [inaudible 0.11.25] that we need to get right.

We believe it is going to play a defining role in the first half of this century as the energy career that increasingly powers economy growths and developments. And that it will enable the transition to clean energy system. This is why we've decided this year to focus our analysis at ETP 2014 on how to harness electricity potential, that's the second part of the

ETP 2014. And even though we have options to get it right, the challenge is immense but the electricity sector is rich with solutions, renewables, nuclear power, CCS to name a few. But we need strategic and coordinated investment to meet our goals and to leverage cleaning up electricity generation to clean up all and do sectors by switching to electricity. I would like now to turn to David Elzinga who has been the project manager for this publication and he will expand further on the reports, David.

David

Thank you Didier. So to build on the previous context, I want to provide a bit more information. Electricity's demand is growing across all sectors that we analyze, between 80 and 130 percent by 2050. And this is just, this is not just a climate issue, regardless of which scenario we follow, electricity is becoming more important. In the Two-DS energy efficiency moderates some of this growth in electricity demand but this does not make the roll of electricity any less important. In fact, across all scenarios the growth of electricity as a share of overall energy demand grows from 17% in 2011 to 25% or even slightly more by 2050. But there's one key difference here, in the Two-DS, by 2050 electricity overtakes oil products as largest energy carrier in the energy system. The growth of electricity use is not necessarily a positive development, let me reinforce the message previously, we must actively manage this transition to support global growth for economic secure and low carbon energy. In fact, if we looked today at electricity generation it consumes near 40% of global primary energy and produces 40% of global emissions. If we continue as we are these trends will not change and will only increase in scale. But if we look at the Two Degree Scenario, the growth in overall energy demand is moderate, moderated and the increased use of electricity means that the power sector now consumes over 50% of primary energy. But this is not the same as it is today, in fact much of that comes from renewable or low carbon sources. But we'll talk about that more later. But when you look to the emissions profile you see that it only contributes 5% of global emissions so therefore the electricity system is largely decarbonized. Now let's take a look at how we generate that electricity.

When we look at the shares today we see that fossil fuels produce nearly 70% of electricity whereas renewable only produce 20% of all electricity. When we look into the Two-DS scenario in 2050 we see a reversal where renewables produce 65% of all electricity and fossil fuels have shifted down to 20%. This is a huge change. And under this reversal we see the greatest growth coming from veritable renewable generations such as wind and solar and then just wind and solar themselves account for 30% of all electricity generation by 2050. The result of this is that the system variability, so the variability in the electricity system will increase and new operating paradigms will be required to operate the electricity system with this increased flexibility with the same levels of reliability as we have today.

So now I want to just shift a little bit before I go on on some of those topics. Up to this point we have been talking about the global trends on electricity system development but when it actually is evolved, transformed, it is done so on a regional basis. So let's take a look at this slide a little bit. What we see is when we look at OECD member countries or developed countries, and compare that to developing countries or emerging economies, we see a much different, a much different direction. In OECD countries what we see is that growth between now and 2050 is very, very small. It averages around 16% across the countries. But when we look at the non-OECD regions, we see much higher growth averaging over 145%. So the challenge in OECD regions with low growth is that they will need to maintain a high level of reliability, typical of electricity supply with low growth of revenues and an aging infrastructure. You can contrast that with the challenge in non-OECD regions which will be to manage large investments needed to meet the growth in demand for electricity. But with these large investments, in infrastructure, they have the opportunity to use best in class technology as they build out their electricity systems.

And one of the interesting things we looked at in a little bit more detail this year was in, in the situation in India, in what we see in India is that even in the Two-DS scenario where electricity demand is moderated over time, we see growth to be in the order of 300%. And they face two major challenges; one is adequately powering the projected economic growth that they expect in India and also bringing electricity to the three hundred million citizens who currently lack access. While nearly 75% of the electricity in India comes from coal, it does need to be commended for its ambitious plans to better exploit its abundant potential from generation from low carbon sources. But one last thing on India is that they do need to address complex administrative processes and the investment risks, bringing those down is vital to decrease the high cost of financing. So earlier I talked about the increase deployment of variable renewables and the increased amount of variability in the electricity system. This is going to need increased flexible flexibility resources. In what see is that there are four large scale types of flexibility but I'm going to focus on two today. That is dispatchable thermal generation and storage. When we look over the medium term we see that natural gas thermal generation in the Two-DS shows a strong interplay between variable renewables and the flexibility of natural gas generation to provide both base load as well as balancing generation to support renewable, renewable deployments. Gas power generation supports two elements of a cleaner energy system, increasing the integration of renewables but also has a capability to displace coal fire generation. In regions with ambitious deployment for renewable electricity, part load efficiency, ramp rate, turn down ratios and start up times are going to be more relevant for gas fire plants than full load efficiency.

Now moving to storage, I know that this is a very much hyped topic, we see many different articles on storage in the news. And especially we hear of breakthroughs in battery technologies and I think it's tempting to think that storage is going to be the one solution that's going to solve all the problems of flexibility and the integration of renewables. But we took a close look at it this year and what we see is several conclusions. For one, is that we see that storage technologies come in all shapes and sizes from gigawatts scale pumped hydro to batteries in your mobile phone, not to mention thermal storage technologies. The technology is not the same for all applications and for the moment apart from pumped hydro in the electricity system, the contribution of power storage is minimal due to higher cost and insufficient performance. Indeed affordable large scale and distributed storage can be a major contributor to grid optimization and flexibility to integrate wind and solar. But we think, and we do think that wind could be a very important technology in the global electricity system over the long term as research and development are provided some very compelling results, but our analysis did not quite support the optimism over power storage for now. We believe that while there are a number of near term opportunities for storage, in many applications the costs need to come down by several factors in order to be competitive.

Previously I mentioned the role of natural gas for power generation for base load electricity production; let me start by saying that natural gas should only be seen as a bridge to cleaner technologies unless CCS is deployed. By 2025 gas demand continues to rise but after '25 in the Two Degree Scenario, emissions from gas fired plants are higher than the average carbon intensity of the global electricity mix and therefore natural gas loses status as a low carbon fuel. Recognizing that base load gas fired plants will require CCS to meet the Two-DS targets, we undertook a comparison of the costs and benefits of applying CCS to both coal and gas fired generation. And we came up with some interesting results. When we look at the cost per ton of CO2, it is higher for gas than coal, but that's not the actual goal here. The goal is to provide low cost clean electricity so when we compare the cost of low emissions electricity gas is more attractive than coal fired generation. So this finding reflects the importance of developing and using the right policy to meet the right goals. Comparing generation technology based on the cost of low carbon electricity shows where CCS or gas can be more effective and more effectively support the transition to a low carbon energy system.

So far I've largely talked about the supply side of the electricity system, but let me move to the demand side. De-carbonization of electricity has spillover effects in all energy sectors, mainly in the building and industry sectors but also in transportation. The impact of power system de-carbonization is most prevalent in the building sector which already uses 50% of global electricity generation. By increasing the shares of electricity demand while de-carbonizing the electricity system positive spillover effects occur and energy sectors are automatically de-carbonized.

Let me look at a little bit more detail at the different sectors. Electrification of transport delivers substantial benefits, for example, although electricity makes up only 11% of total energy demand by 2050 in the Two-DS, it accounts for approximately 50% of transport efficiency gains. So that shows that by using electricity in vehicles you are gaining, you are improving the efficiency of those vehicles and degreasing fossil fuel, fossil fuel consumption but also then that allows you to move to fully electric vehicles. But that is not to say that electrification of transport can offer emission reductions in all situations. If you have a highly emitting electricity system, electrifying transport may lead to higher emissions and not less. In ETP 2014 we have developed a tool called the Low Carbon Electric Transport Maximization Index or LETMIX, using this tool we're able to offer analysis and advice as to what situations can offer the maximum benefit to electrifying transport based on individual country's situations.

Looking at the building sector, we see that key pumps for cooling, heating or cooling of space and water, not only reduce emissions but also allow electricity to displace the use of natural gas. The, we did a variant of the Two-DS called the Two-DS Electrify Buildings, looking at both the European Union and China and considered the deployment of heat pumps beyond Two-DS levels for both space and water heating applications. In addition to reducing overall energy use and emissions the EU gas shares fall from 34% in 2011 to a 2050 level of 32% in the Two-DS and then even lower at 25% in the Two-DS Electrify Buildings scenario. Looking at China, in 2011 the share of natural gas in buildings was around 6%, in the Two-DS large expected economic growth and urbanization drive up China's building energy consumption by 25% in 2050 and increase demand for space heating and water heating drive the share of natural gas for those purposes to almost 20%. But again we see that in the Electrify Buildings scenario, this helps to decrease that growth in natural gas demand in China. As part of a special feature this year, ETP 2014 explores a hidden energy implication of more and more devices going online. As internet access and usage spreads at a rapid rate, data volumes increase exponentially and consumer demand for smart network enabled devices surge, so does the energy consumption for these devices. The electricity demand of network enabled devices is expected to almost double between 2013 and '25. And as these devices spend most of their time in standby mode, up to 80% of their electricity consumption can be needed just to maintain the connection for the network. If we can reduce that amount, these savings can add up. In fact global electricity demand of network enabled edge devices and network equipment could be slashed by 65% by just implementing best available technologies resulting in a savings of almost 740 terawatt hours per year. That corresponds to about 4% of current global final electricity production. That's a lot of energy that could be saved.

Now one of the last topics that we cover in detail is financing of low carbon generation. And this, as we said right at the very beginning, this is very important during the transition to a low carbon electricity system. Current low carbon generation is not only more expensive than conventional generation such as combined cycle gas turbines, but it is also more capital intensive. The increased upfront capital cost can increase the various risks perceived by investors, such as construction risk, electricity price risk or all carbon policy risk among others. And these risks threaten to limit investment needed to power, to the power sector for low carbon generation and policy makers need to find way to limit these risks, but to do so in a way that is transparent and is done in a way that meets large scale policy goals. So how do you clear the obstacles on the road towards a clean energy future? We're reiterating some of the messages from ETP 2012 on ways to transform our energy system but this is especially important for electricity systems. One key conclusion is that sustainable electricity system is a smarter; more unified and integrated electricity system.

When we look at today's system it's centralized in one direction, but tomorrow's system will be decentralized and multidirectional. Complex and diverse individual technologies will need to work as one; technologies they must be deployed together rather than isolation and policy should address the electricity system as a whole rather than individual technologies. And success of doing this will hinge on systems thinking. That's because it's more efficient by identifying synergies across sectors and applications, it enables the use of new technologies and new market models and it focuses on the efficiency of the service provided rather than just the energy delivered. So today we've given you just a taste of the analysis we have done in 2014. I just want to share with you the number of topics that we cover this year. One is that we look at solar energy, not only “photoable” tags but also concentrating solar power or solar thermal electricity. There's significant cost reductions that have been happening in this and we look at how far we can push this by 2050. We also look at the evolving role of natural gas, being able to provide flexible generation or base load production and you've touched on some of those points today. As electrification is easier and cheaper for some transport modes than for others, we've taken a look into what modes can provide a good opportunity in the near term and what are some long term benefits for these. Can e-mobility actually replace oil? Complementing the development of the IEA storage road map this year, again we've looked at the role of electricity storage and do we really need it in the energy system and what role can it play?

I touched upon financing earlier, we dig into what are the future power generation project risk profiles and how will they be compared with historic approaches and conventional technologies, and we want to evaluate and provide some answers as to the need for novel investment vehicles, market structures and policies. And lastly we've looked at India

as a very interesting case study with its high growth and need to electrify millions in its population. What are they doing and what can they be doing to do this in a low carbon manor? In conclusion I want to point out one thing, first is that there's a significant amount of visualization, data visualization and downloadable data when you purchase the ETP 2014. So I want to leave you with three messages in addition to that. First, we must manage the energy transition rather than respond to economic and climate events. Secondly, that electricity will play a central role in that process and in economic growth and so putting technical and organizational pieces of that puzzle together will be key.

And finally, that in order to do all of this, we require strong leadership from both policy makers and industry, and this means embracing a shared vision that looks to the longer term with regard to both investment and policy and mobilizing the necessary financing now rather than paying a much higher price down the road. So with that I say thank you very much.

Sean Great, and thank you to both the panelists for the excellent presentations and at this point I'd just like to remind the audience that if you have any questions you can submit those to the question pane in the go to webinar window. And with that I'll move on to the first question that we did receive from the audience and they ask if you've could, elaborate more on the fuel switching in context of the second slide, and I believe this was during Didier's presentation. Oh, it does say by Mr. David.

David Fuel switching, well one of those, one of the key aspects of decreasing carbon intensity is moving away from the more dirty fuels. So this can be largely around moving from coal to natural gas so you're still using fossil fuels but you're using a cleaner based fossil fuel. Natural gas has about half the emissions intensity compared to coal fire generation. So that's one of the major ones that we see. But what it also touches on at times is fuel switching within transport as well. That's another thing where you're moving from, from fossil fuels to electricity. That can be another form of switching that can offer those savings.

Didier If I may, I compliment the question on the web slide showing the difference between the Six-DS and the Two-DS, so where will the reductions from Six-DS to Two-DS come from? We have the first one is [inaudible 0.33.39] electricity efficiency at 38% so energy efficiency if you level is the key tool to reach the Two-DS target, then we have renewables at 30% which is higher than in previous ETP, why because we take into account progress and as we said, when we track progress we see that renewables are have even overshot the objectives so they are [inaudible 0.34.03] and increasing role in our model in the Two-DS scenario. And conversely CCS at 14% and nuclear at 7% continue to bring a significant contribution to the Two-DS scenario but at lower level than two years ago in our previous modeling exercise.

Sean Great, thank you both. The next question that just came in is what is the future role of nuclear power in the Two-DS scenario?

Didier Well, I would start and maybe will compliment, as we just said, the nuclear continue to play a significant role but at a lower level than two years ago because we take into consideration of cost decision made by a number of countries to phase out nuclear, slow down their investing in nuclear but at the same time we see that nuclear investment continue to move forward in a number of countries, in particular in emerging countries because on one side we have 80% of the nuclear fleet in OECD countries but 80% of the new build and 72 reactors are under construction and most of them in emerging countries. So we take that into consideration in our, in our model but we do think that nuclear has a significant role to play in moving the direction of the Two-DS.

David Exactly, and I just want to add to that, one of the things I didn't mention that we did this year is we actually did a Two-DS high renewables variant and in this variant what we constrained is the development of both nuclear technology and CCS deployment. And what we found in that case is that renewables make up a much larger share of the global generation system by 2050 but what happens is that we see a higher cost, so the higher cost of the high renewable scenario is about 4.5 trillion dollars higher but there's an additional 2.5 trillion in savings, so the overall additional costs of the high renewables variant is about 2 trillion dollars relative to the Two-DS scenario.

Didier Thank you.

Sean Great, thanks again. And moving on to the next question, where does India stand today in terms of the ratio of fossil fuel to renewables generation, and where do you predict it will be in 2050?

Didier Well India is largely depending on fossil fuel and mainly on coal for its energy supply and even if India has adopted low carbon energy for its power sector, this is simply very much depends on coal. From that perspective, also another point that we flag in the chapter on India is that India needs, as well of the first objective is to bring electricity supply to 300 million Indians that are lacking access to electricity. And so the India generation is projected to increase by a factor of 2.5 in the Two-DS and a factor of 3 in the Four-DS. The question of energy access is very key. So what India needs to do considering the high dependence on coal is to move to clean coal technologies because today around 60% of subcritical units built in the world are built in India so there is still even lots of new builds, majority of new builds in coal fire plants that are subcritical so that to not use the existing clean coal technology that would be already much more efficient and provide less air quality problems. And the second thing is to, that India needs to expand nuclear capacity to achieve a low carbon growth scenario as well as developing further renewables because India has a significant potential in terms of renewables including hydro power to

diversify its energy supply, in particular [inaudible 0.38.44] electricity mix.

David You know, I'll just add to that. One of the parts of our analysis to, for India is actually we carried out our detailed analysis only out to 2030 for India. When we did our global analysis of course we carried all countries out to 2050 but what we find is that with the explosive growth that we see in India, it looking out to 2050 just became highly uncertain because they're going through such growth and just transition where they move away from coal if they do follow a Two Degree Scenario path. So just wanted to add that that we have done the work out to 2030 but we don't actually go out to 2050 in the detailed scenarios of India.

Didier Thank you.

Sean Thank you Didier and David. And the next question asks how do you make governments see the energy system as a whole? And they did some contexts, big generation projects are considered more attractive politically in several areas than promoting energy efficiency or demand management policy, such as in the UK. How do you reverse the trend as the report says governments must?

Didier That's a very good question, thank you. It's always true that governments and policies makers are more interesting on the supply side and also some analysts are more interested in the supply side than on the demand side. And at the same time we really emphasize in the report that energy efficiency is the first tool to move to a Two Degree Scenario. And what we see is that higher energy prices have led some efficiency gains so there is a strong rational for energy efficiency investment but we're not on track if you look at the different energy sectors. And this confirms that governments must intervene and markets to correct market failures and the examples are of this need include policies such as Eco fuel standards or building codes that have been farmed to be an accessory to improve efficiency and very effective when they're effectively put in place and we also point out in our work at the IEA that on the multiple benefits of energy efficiency, associated benefits that can be very significant in terms of the economy health and environment. So these are really issues for governments, so there is a need for more government intervention to incentivize investment in energy efficiency but we do think that the high, projected high energy prices and provide a very strong rational tool to encourage governments to do more in terms of energy efficiency policy. And we see that energy efficiency policy is more discussed among governments and policy makers, in particular in emerging countries that are struggling also with the cost of high imports for fossil fuels.

David And I'll just add to that as well. The demand side in energy efficiency is just one of those large, large levers on systems thinking that is not fully being exploited. But we're also, two additional points, one is that the theory in the understanding of systems based thinking is starting to come

to fruition a little bit, there's much more thought of this and I think that's also due to the convergence of increased information and communications technology. So we have more tools to use through smart grids, is I think the best example and the convergence of the transports system with the electricity system. That's an example of two, where today those two energy systems are largely separate as we start to see more electric vehicles we have a cross over and that's going to push more systems thinking in saying how can we leverage those electric vehicles to support the electricity system and then conversely how can we operate those electric vehicles so that they don't cause problems in the electricity system. So I think as these questions come more and more that these crossovers between systems that are right now separate, governments and policy makers are going to have to face this but we're trying to say, get ahead of the curve, start looking at it now, start doing this long term strategic planning now so that you can be more active in this transition rather than reactive.

Didier Thank you.

Sean All right, thank you both. And the next question that I've received from the audience asks, do you think that in variable renewable energy based power systems, the energy only market has to be complimented by capacity based market schemes in order to guarantee security of the supply in the long run?

Didier Well, capacity market is an issue which is very much discussed in electricity reforms in particularly in Europe in countries where the share of renewables is going, is becoming larger and larger which brings up an issue in terms of profitability for the backup generation capacity from fossil fuels and we are, we've seen recently lots of gas fire electricity plants being shut down in Europe because of the lack of profitability if they're run on a limited fan base. But the, so the capacity market is certainly one of the options to ensure, to enable a wide share of intermittent renewable power generation but it's not the only one. There is, as we've shown in the slides, there is a variety of options to improve the flexibility of power system and make it possible to accommodate higher sharing renewables and including, of course, back up, dispatchable generation but also demands that response and a lot of upside can come from smart grids, in particular, the demand side reactions but also energy storage for certain application and also improve interconnections and wider electricity markets like having more in terms market in Europe. So capacity markets is one of the options, not the only one, but it needs to be looked at now very carefully in terms of ensuring that the security of power supply but at which level it should be put in place is another issue because there is a risk of having different markets in different European countries [inaudible 0.46.03] capacity markets that just developed at national level. Thank you.

Sean All right, thank you Didier. And what is your opinion on countries that have hydro as their base load and cannot switch to natural gas, especially considering that hydro is climate vulnerable?

Didier Well, hydro is a vulnerability in case of droughts but they have also tremendous advantages as for renewables they have low CO2 emission impact, they are very cost effective. I think the countries that are, that have a rich hydro endowment like Canada, like Brazil, like Norway have a very interesting ascent and I think that the vulnerability can be addressed through a thoughtfully approach in terms of renewables. I think we can see Brazil developing other renewable sources like biomass, solar, and wind. And the other way to address the vulnerability of hydro is having a wider market as it is the case in Nordic countries where you have an electricity market in the north that covers the Scandinavian countries and for which you have a variety of electricity mix which would help address a drought case in hydro production, you know for instance. Thank you.

Sean Thank you Didier. And what is the definition of a renewable energy that was applied in the research?

David We include large scale renewable or large scale hydro as a renewable energy. And solar, wind, biomass, geothermal, ocean, so it's a very wide definition and I guess the key one is it includes large scale hydro.

Sean Great, thank you David. And next question is asked, with respect to the allure of coal, as you mentioned and the need to scale-up clean coal solutions and invest in clean coal storage or carbon capture storage, sorry, this is largely understood as in respect to new coal. How do you deal with existing coal?

Didier That's one of the very difficult questions because in the Two-DS where you need to phase out progressively subcritical coal so the older coal plants and depending on the such scenarios the level of the phasing out subcritical coal is different but in our Two-DS scenario basically you would totally decarbonize the power generation system through renewables first, through nuclear and fossil fuels that needs to be accompanied by CCS to be totally decarbonized and we have a specific chapter actually on natural gas where it shows that natural gas power generation is increasing until 2025 but then afterwards it starts to decrease because even in terms of CO2 emissions, gas fire plants have CO2 emission level which is higher than the average power generation in the Two-DS scenarios which means that a need to be accompanied for base load generation by CCS and we specifically looked at the comparison between coal fire plants with CCS and gas fire plants with CCS and show that CCS for gas is actually a probably more effective option if you look at the carbon emission for electricity generated.

David And I'll just add a small point too is that, yes, dealing with old plants or subcritical plants, and putting CCS on them is very difficult and

sometimes it's highly non-cost effective but in the Two-DS as part of that, we do account for the decommissioning of about a hundred and or 850 gigawatts of thermal generation before it's technical life. So what that really demonstrates is that as we make those investment decisions for infrastructure that's going to be around for a long time, sometimes we have to make the hard decisions of actually decommissioning them before their technical life is over.

Didier Thank you.

Sean Thank you. And one of the attendees asks states that geothermal has not been included in a scenario yet, can you give the reasons for excluding that?

Didier Now I don't think geothermal is excluded, I think geothermal is included but actually when we track progress we say renewable on track can be on the targets but we are specifically looking at wind and solar that are the cost is growing and renewable sources even start from a lower basis and actually be intermittent renewable sources that raises the most difficult issues in terms of integration to the grid. But other, other renewable sources like geothermal, biomass or off-shore wind for instance, are also, are also sources that play a role but insufficient, actually progress has been very slow for off-shore wind, or geothermal or ocean energy and our Two-DS scenario, they contribute to 4% of electricity generation compared to practically zero today. So they play a role, not enormous but they start to play a role in particular after 2025. Thank you.

Sean Thank you Didier. And let me see, I just had another question come in. What do you think that nuclear power deployment is not contract in contrast to renewable energy; could you just elaborate a little bit on what you mean by that?

Didier The what we call on track, we have a chapter which is called Tracking Clean Energy Progress, it's actually an update of a report that we've published every year over the last years for the Clean Energy Ministerial and which basically looks at what has been happening over the last 12 months in 2013 in terms of progress in clean energy. We looked at all the technology options and just one was in red in the slide I just showed for renewables and because we track progress against an intermediary milestone of the Two-DS scenario 2025 so basically it's a decomposition of the Two-DS where we look at where we would need to be in 2025 and are we getting closer to that target now or not. And in nuclear, clearly we've not been on track for obvious reasons, several countries have decided to phase out nuclear and in 2013 even if a number of nuclear plants are under construction in terms of new starts it have not been a year for the launch of many projects in terms nuclear plants. So it's basically a factual assessment of what has been happening in 2013 and it leads us to revise a bit the contribution of nuclear in the Two-DS scenario by 2050

when we update our model of what we do every two years and not every year.

David And I'll just add to that, a small comment is that when we look at our trajectory that we're on today, we actually see a very high uncertainty when we say we're on track, we think we're going to be between 5 and 23% off target by 2025. And that's a very wide range but that's because we don't exactly know, are some of these plans for new plants actually going to go through or aren't they? Are countries going to make more decisions to phase out nuclear or not? So therefore we see a large uncertainty. Thank you.

Sean All right, thank you. And in terms of more strategic systems, thinking for cost effective transformation of the energy system, can you reflect a bit on the need for a more active demand side and why you're analysis looked only at dispatchable generation and storage as the key options for more flexible resources?

David Well actually when we look at, this year, we did quite a detailed analysis on the storage side. Now storage is neither supply nor load, it's both and so one of the first things that we learned about this type of analysis is that it's highly complex and you can say the exact same thing about the demand side. So the reason we haven't done it yet is because we focused on storage this year and we're going to be moving in that direction over the next couple of years. We see that the demand side right now is largely focused on providing peak demand reduction and I think that's a very important issue and I would say it's important for virtually every single electricity system and probably not only virtually, important for every electricity system in the world. But what we want to see is the use of demand side for also increasing system flexibility and what that means is, instead of only decreasing demand, sometimes in situations of excess power generation from either wind or solar actually increasing demand for a period of time to absorb that and then turning that off at a later time so you have no increased use of electricity, you've only shifted it. So all that to say is that we see this as a very important issue, we're starting to analyze more and more on this, this side of the equation and we see it essential, important and highly interesting.

Sean All right, and if you could summarize the ETP 2014 in three key points, what do you think those would be?

Didier Yes, if I had to summarize it in three points which is this report, I would say that we have, the first message is that electricity is going to play a defining role in the first half of the century as the energy career that increasingly powers economic growth as I've said before. And so the importance of getting right the electricity system and decarbonize it is certainly one of the first message. The second is that we must embrace a share vision that looks to the long term in terms of investment and policy and mobilize the necessary financing. And the third message which is

also linked to the, to the tracking report is that we're not making the progress that is necessary to ensure a low carbon energy system and a change of course is actually needed. And I would say maybe I would add another one actually which is important in having a system thinking, a global thinking about the energy system rather than looking at just a specific options or specific technologies side by side, one by one but really to take a system approach on the future of our energy system. Thank you.

Sean Great and I did receive another question that has multiple parts to it so let me read it through and I can repeat it you need me to. What kind of analysis is carried out on the power sector in India? Did it include modeling of the entire sector, and if so is it a state-wide or national study? And then what were the key results from this study described as the last chapter of ETP 2014?

David All right, so this was sorry in reference to India?

Didier India.

David So the, the system we did look at the system with a certain amount of aggregation but also in terms of the country as a whole but we did look at some of the issues as to around where the electricity generation is happening and where are the demands centered. So from that perspective, I'd say it's a bit of a hybrid, the analysis overall on ETP is quite, quite high level, we described the world across 28 regions so, but India is treated as a separate country because it's such a large consumer and it has such greater growth. In terms of the, the general, I guess, conclusions on this, I could go on forever and I think we've largely covered it on a general basis but we see huge growth in electricity demand, especially under the Six Degree Scenario and if they don't move towards de-carbonization their going to need more and more coal for this generation and although there's a large amount of coal available within India there are still some struggles. They actually are importing a large amount of coal today despite having indigenous resources so therefore from an energy security point of view, it makes sense for them to diversify any ways, we still see them using a fair amount of coal out to 2030, that's quite logical and using, hopefully moving to more indigenous coal, but they need to get away from the subcritical plants if they're going to have any hopes of having a more low carbon system. So those are just a couple of conclusions, but I'll leave it at that for now and encourage you, of course, to check out the book for the full picture.

Didier Thank you.

Sean Great and I'd just like to thank Didier and David again for that great discussion that is the last question that I had from the audience. So at this point, David, Didier, if you have any last comments or closing remarks that you'd like to make, I'll give you a chance here.

Didier I'd like to thank everyone at the Clean Energy Solutions Center for organizing with us this webinar, thanks a lot. And to all participants for their very good questions and we invite everyone to buy the book or read it. I would like to point out that you can download the tracking clean energy progress report which is one chapter, the update from our website and that you can, and you can have access now to the ETP and PDF [inaudible 1.02.24] or in hard copy which is now available from our website. And thanks again to all of you. David?

David Just too also say that the data from the analysis, when you purchase the book, it's fully downloadable and from, fully downloadable from the web and this allows you to really use our analysis to do your own examination, your own figures. But in addition to that you can also download all our figures that are in the book use them for power points and that does include the Excel data that makes those figures. So we're really making an effort to not only produce a high quality publication, but also give you a lot of data that you can use for your respective work. Thank you.

Sean Great, thank you again. And now I would just like to ask our audience to take a minute to answer our quick survey, we have just three short questions for you and your feedback is just, lets us know what we're doing well and where we can improve for future webinars. So Heather, if you could go ahead and display that first question for the audience, and the question is the webinar content provided new useful information and insight? And you can respond right in the go to webinar window. And the next question Heather. The webinar's presenters were effective? Great and the final question is, overall the webinar met my expectations? Great, thank you for answering our survey and on behalf of the Clean Energy Solutions Center I would like to extend another thank you to our expert panelists and to each of our attendees for participating in today's webinar, very much appreciate the time and the questions that you submitted for the discussion. And I invite everyone to check the Solutions Center website over the next few weeks if you would like to view the slide and listen to a recording of today's presentations as well as any previously held webinars and additionally you will find information on upcoming webinars and other training events. We also invite you to inform your colleagues and those in your networks about Solutions Center's resources and services including the ask an expert policy support. Hope everyone has a great rest of your day and we hope to see you again at future Clean Energy Solutions Center events. And this concludes our webinar.