

Enabling Technologies: Key Role in Increasing Renewable Energy Uptake?

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Webinar Panelists

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Katie Contos

Hello, everyone. I'm Katie Contos with the Clean Energy Solutions Center, and welcome to today's webinar, which is hosted by the Solutions Center in partnership with Renewable Energy Policy Network for the 21st Century. Today's webinar is focused on enabling technologies' key role in increasing renewable energy uptake. Before we begin, I'll quickly go over some webinar features. For audio, you have two options. You may either listen over your computer or over the telephone. If you choose to listen through your computer, please select the mic and speakers option in the audio pane.

Doing so will eliminate the possibility of feedback and echo. If you choose to dial in by phone, please select the telephone option and a box on the right hand side will display the telephone number and the audio PIN you should use to dial in. If anyone is having any technical difficulties with the webinar, you may contact the go to webinar's help desk at 888-259-3826 for assistance. If you'd like to ask a question, we ask that you use the questions pane where you may type in your question.

If you're having difficulty viewing the materials through the webinar portal, you will find PDF copies of the presentations at cleanenergysolutions.org/training, and you may follow along as our speakers present. Also, the audio and recording and presentations will be posted to the Solutions Center training page within a few days of broadcast, and will be added to the [Solutions Center YouTube channel](#), where you'll find other informative webinars as well as video interviews with thought leaders on clean energy policy topics. Finally, 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 resource library as one of many best practice resources reviewed and selected by technical experts.

Today's webinar agenda is centered around the presentations from our guest panelist Rana Adib and Ilya Chernyakhovskiy who have joined us to discuss REN 21's recently renewable 2017 global status report, and also discuss current developments in various energy technologies, infrastructure, market, and institutional frameworks that can advance and facilitate expanded deployment of renewable energy. Before we jump into the presentations, I will provide a quick overview of the Clean Energy Solutions Center, and then following the panelist presentations, we'll have a question and answer session where the panelists will address questions submitted by the audience. At the end of the webinar, you'll automatically be prompted to fill out a brief survey as well. So thank you in advance for taking a moment to respond.

The Solutions Center was launched in 2011 under the Clean Energy Ministerial. The Clean Energy Ministerial is a high-level global forum to promote policies and programs that advance clean energy technology, to share lessons learned, and best practices, and to encourage the transition to a global clean energy economy. Twenty-four countries in the European Commission are members covering 90 percent of the clean energy investment and 75 percent of global greenhouse gas emissions. This webinar is provided by the Clean Energy Solutions Center, which focuses on helping government policy makers design and adopt policies and programs that support the deployment of clean energy technologies.

This is accomplished with the support and crafting and implementing policies related to energy access, no cost expert policy assistance, and peer-to-peer learning and training tools such as this webinar. The Clean Energy Solutions Center is co-sponsored by the governments of Australia, Sweden, and the United States with in kind support from the government of Mexico. The Solutions Center provides several clean energy policies and services including a team of over 60 experts that can provide remote and in-person technical assistance to government and government supported institutions, no cost virtual webinar trainings on a variety of clean energy topics, partnership building with deployment agencies and regional and global organizations to deliver support, and an online library containing over 5,000 energy policy related publications, tools, videos, and other resources.

Our primary audience is made up of energy policy makers and analysts from governments and technical organizations in all countries, but we also strive to engage with private sectors, NGOs, and civil society. The Solutions Center is an international initiative that works with more than 35 international partners across a suite of different programs. Several of the partners are listed above and include research organizations like IRENA and the IEA, and programs like SE4ALL, and regional focused entities such as ECOWAS Center for Renewable Energy and Energy Efficiency.

A marquee feature of the Solutions Centers provides is a no-cost expert policy assistance known as ask an expert. The ask an expert service matches policy makers with more than 50 global experts selected as authoritative leaders on specific clean energy finance and policy topics. For example, in the area of renewable energy policy, we're very pleased to have Camilla Ramos, managing director and founder of SELA, serving as one of our experts. If you have need for policy assistance in renewable energy policy or any other clean energy sector, we encourage you to use this valuable resource. Again, this assistance is provided free of charge.

If you have a question for our experts, please submit it through our simple online format, cleanenergysolutions.org/expert. We also invite you to spread the word about this service to those in your networks and organizations. Now I'd like to provide a brief introduction for today's panelists. First up is Rana Adib who is the research coordinator at REN21. One of her key responsibilities is the annual production of REN21's highly referenced renewable global status report. Following Rana, we will hear from Ilya Chernyakhovskiy, who is the energy analyst at NREL. Ilya is the co-author of GreeningTheGrid.org Toolkit and he serves as the lead for NREL's scaling renewable energy in Central Asia project under US Agency for international deployment power the future initiative.

And with those brief introductions, I'd like to welcome Rana to the webinar.

Rana Adib

Hello, everybody. I'm checking. I hope that you're able to see my slides.

Katie Contos

Yes, we are. If you just want to put it in—yeah, perfect.

Rana Adib

Now it works, sorry for that. Okay, I'm very happy to participate in this webinar. Thank you very much to the Clean Energy Solutions Center to host another webinar on the global status report. So very quickly to start for you guys who might not know what REN21 is. So REN21, they're a renewable energy policy network for the 21st century, and we're a global multi-stakeholder network, which is dedicated actually to the rapid uptake of renewable energy worldwide.

We always speak about the coalition of the willing here, and have different type of stakeholders participating. So international organizations, national government, industry associations, NGOs, and science and academia. I will do a quick presentation of basically a summary presentation of the REN21 renewables 2017 global status report. That's our annual flagship publication, which we're producing since 2015, and which is being produced in a collaborative effort of a network of 150 experts worldwide participating in this. This report features a global overview on the renewable energy market. So globally market, and then three trends for the different renewable energy technologies. We have a chapter on distributed renewable energy for energy access. Investment flows, the policy landscape, and energy efficiency, and for this year, we had for the first time actually a new chapter on enabling technologies and energy systems integration.

Because we clearly see that there is a big trend here, and that there are technologies that are not directly renewable energy technologies, but which are really key for deploying renewable energy to a large extent. Also, we have a feature with a changing topic. This year, it was on deconstructing the base load myth, and oh yeah, we'll speak about this. Who was also involved in the authorship more in detail. So very quickly, what's—the year 2016 in renewable energy, what we've seen that there was for the investors acquiring the possibility for acquiring more renewable energy capacity for less money.

What does this mean? Basically, costs went down again, and this is something which was very interesting. A hundred seventy-six countries had renewable energy targets, so that's also increasing, and what we see in terms of the policies, auctions, and particularly in the power sector obviously were held in 34 countries in 2016, which is more than double of the year before. So that's really a policy trend, which is significant. The newly installed renewable energy—renewable power capacity set new records in 2016 with 161 gigawatts added.

And this was increasing actually the global total by almost nine percent compared to 2015. The star performer was Solar PV, which accounted for 47 percent of the total additions, followed by wind and hydropower. Interestingly also for the fifth consecutive year, investment in new renewable energy power capacity was double the investment in fossil fuel generating capacities. So here, we really see a continuous trend, which is also explained by the fact that renewable energy power is definitely the least cost option in many countries.

When we are looking into CO₂ emissions, renewable energy contributed again along with energy efficiency significantly to decoupling actually the CO₂ emissions from economic growth. Next to obviously the reduction of the use of coal. So we can say that 2016 was another extraordinary year for renewables, and total global capacity was up nine percent compared to 2015, and to reach 2016 gigawatts at year's end. So obviously, there are some renewable energy champions. China is leading the United States on second place. United Kingdom, Japan, and Germany when we are looking into the investment in renewable energy, power, and fuel.

Not including large hydro. The picture is quite different when we're really relating this investment to per unit GDP, where we see leading countries like Bolivia, Senegal, Jordan, and Honduras, and Iceland. And that's something which is important to say because we also see lots of dynamics in new countries coming up that have not historically had like let's say like 10 to 15 years of renewable energy support policies. So in the world in 2015, renewable energy provided 19.3 percent of global final energy consumption, which is the renewable energy part split into modern renewables, 10.2 percent, and traditional bio-mass 9.1 percent.

Modern renewables is going up, and traditional biomass is slightly going down. In the power sector by year's end in 2016, an estimated 30 percent of world's power generating capacity was provided by renewable power. And reaching actually 24.5 percent of the electricity demand. In the heating and

cooling sector, what we see is that the power sector is really the area or the sector which is using renewable energy more where the outtake is more significant. The heating and cooling sector in this sector, modern renewable energy supplied nine percent of total global heat a month, and the vast majority was provided by bio-mass, solar thermal, and geothermal. Here we've seen that 2016 was a difficult year for the sector, which was mainly linked to low fossil fuel prices, and also relative lack of policy support.

I'll come back to that later. The transferred sector even stands behind the heating and cooling sector, with four percent of the world's road transfer fuels covered by liquid bio-fuels, which accounts for the majority of transferred energy used. There is an uptake of bio-gas used, but what we see is that there are still technological barriers to really use renewable energy in the sector. Very clearly, there is a trend for electrification of the transferred sector, and that's a new market. And it's also interesting because there are some synergies which can be developed between the transfer and the power sector.

So what is driving renewable energy is definitely policies and regulator framework. Still, so 176 countries have targets, as I mentioned before. Here, we clearly see in blue, you have more the power policies. Heating and cooling in orange and transport more in yellow-ish, so power is taking the lead here. And what you also see when you're looking on the right side in 2016, you really have this turquoise color is the auctions, which have been going up quite significantly.

Sorry, that's not a—that is a—yeah. The transfers, we had 68 countries which had transferred obligations, and heating and cooling, there are 21 countries with heating—mainly heating obligations. Knowing that the heating and cooling sector is significantly also supported by fiscal incentives. How did this translate into investment? So in 2016, there was an investment of 241.6 billion USD, which is a significant reduction compared to 2015 of 23 percent. How does—how can we explain that there are two main reasons for this. One is very clearly the one that costs are continuously reduced, so that's one aspect. The other aspect is however also slowdown in some key markets. And in particular, China and Japan. Now when we are looking to China specifically, what we see here is China was facing technological restrictions to integrate higher shares of variable renewable energy, and they are now investing significantly into strengthening the transmission distribution lines or infrastructure to be able to integrate higher shares of renewables.

So it's not a disengagement of the country of the renewable part, but just a shift of investment for the moment. So what we see here is just that there is regional developments, which differ significantly, and here is the comparison actually between on the left side, the investment in fossil fuel and nuclear power, and on the right side, the investment into modern renewables. So we clearly see that there is basically a 63.5 percent of the investment was committed to constructing new renewable power plants. So I will focus just because of the topic, I'll focus mainly on some power technologies just because it seems more relevant, but please be informed that in the global status report, we're also covering all of the thermal renewables.

And we have a chapter on distributed renewable energy access, which is also interesting when we're talking about enabling technologies. So [inaudible] obviously has a key role to play in these applications, too. So Solar PV, as I mentioned, was the lead, and in 2016, there were added capacities of 303 gigawatt, and just to translate it into another number, this corresponds to 31,000 PV panels installed every hour worldwide. And this number also indicates the knowledge of jobs which are being created, local values which are being created.

To also see the geographic spread by end 2016, every continent had over one gigawatt installed capacities. At least 24 countries had over one gigawatt installed capacities, and at least 115 countries had more than ten megawatt installed capacities. So that's really a significant method. Solar PV is all over. When we are looking into the leading countries, China is up to 126 percent over 2015, and it's still the market leader. Looking at the wind power sector, 55 gigawatt of wind power capacity have been added throughout 2016, and this represents an increase globally of 12 percent. Over 90 countries, and again, that's to show the geographical spread, over 90 countries have commercial wind power activity.

With 29 countries having more than one gigawatt installed. Here again, China is leading, but we see that compared to other countries, the uptake in 2016 of added capacity was a significant decline compared to 2015. What is very interesting is when you were listening to solar PV and wind, obviously there is always a question of variability of renewables. So the fact that sometimes production there is sometimes not there depending on weather conditions. Earlier, we'll speak about this later, but we—what is important, and this is really contributing to debunking this myth of the intake of variable renewable energy into the grid. At least 24 countries met more than five percent of their annual electricity demand just with wind power, only wind power.

In the year, we have a share of 10.4 percent. Two states in Germany reach 86 and 60 percent. [Inaudible], there is 5.5 percent, in Iowa, 36.5. When you're looking at the graph, you see like Denmark, Ireland, Portugal, Uruguay, Cypress being close to 20 percent, up to 40 percent. So it means it is possible. Now when we're looking to bio-mass energies—okay, why is this possible? One area is definitely including in flexibility options, storage is a topic, which we'll hear about more. But it's also important to think about the other renewable energies, which are dispatchable renewable energy, and which is presented two of these. So biomass energy, biomass accounted for 14.1 percent of total final energy consumption.

We see that a traditional biomass in heating buildings, also cooking, is representing a big part, but when we're looking in heating industry, transferred in electricity, it's really modern biomass, which is more present here. When we are specifically looking to buy power capacity, they increased by six percent in 2016, reaching 112 gigawatt, and the generation also increased by six percent. Another technology which has a key role to play also in the overall system is hydropower. Total global hydropower capacity

increased to 1,096 gigawatt, plus 25 gigawatt in 2016. Again, more than one third of new capacity has been added in China.

So this feature, we have included in this year's report on deconstructing the base load. I think it's—I will not go into detail here, but what is very important to see at that traditional base load generators such as coal and nuclear are really beginning to lose their economic advantage, and may just no longer be the first to dispatch energy. So renewable energy has increasing role to play in the grid, and there are a number of countries as I mentioned before that already integrate large shares of variable renewable energy. So technically, it's possible. We need to create, however, the right market conditions, too.

So if you want more details, stay online because Ilya will speak about it, but also have a look at our report. So what did this mean on renewable energy in the world? The overall share of renewable energy has increased only modestly, so this is something to say. There is lots of things ongoing, but it's not quick enough, and this is really a big, big message which needs to be out there. If we want to really contribute to the renewable energy or sustainable energy transition, then we need to increase our efforts. Why did modern renewable energy not significantly go up?

So they went up, but they did not catch up on the growth of energy demand, which was of plus two percent from over the last ten years from 2004 to 2014. And there was a decrease of traditional biomass, but at a slower pace. So at a minus—sorry, I don't have the number here, sorry for that. And there was an increase in fossil fuel and nuclear, which is of two—sorry. Excuse me, I need to look at—of 1.8 percent, so slow compared to modern renewables of 4.7, but altogether, it's just not—the growth is not allowing to catch up, actually, on these developments. So mainly the energy demand growth and fossil fuel growth.

And this is really a big pity because it's not only climate change an engine—or powering actually renewable energy deployment. It's also cost conditions, but renewable energies really allow for having opportunity to create jobs, and this is something which is in particularly in developing countries also very, very important. So here, we had an increase of 1.1 percent over 2015. Now what is necessary to really reach the advantages renewable energy can bring? One thing is clear is we need to speed it up, and speeding it up also means like fossil fuel needs to stay in the ground.

I mean it seems obvious to some people, but we see that it's not obvious to all decision makers, and if we want to reach basically the Paris agreement goals, but also energy access goals, there is really a need to reduce—not to invest into infrastructure, which is locking us in into traditional and more conventional technologies and not giving the space to renewable technologies. That's one aspect. But another aspect is when we're looking into fossil fuel subsidies for every euro or dollar spent on renewable energy subsidies. They are [inaudible] for dollars or euros spent on fossil fuel and nuclear subsidies, and this is really something which needs to stop if we want this development to start. The other part is if better integrated tutorial

planning, which will allow for establishing also some flexibility, smarter more flexible systems to integrate variable renewable energy, and to clearly have a system—some systems approach here.

Not only looking into renewables. We also need to address energy efficiency and demand [inaudible] management, and using enabling technologies more. So if you want to have more information on REN21, please visit our website here, and I'm obviously available for any questions. Thank you.

Katie Contos

Wonderful, thank you so much. Now we'd like to welcome Ilya Chernyakhovskiy to do his presentation.

I. Chernyakhovskiy

Thank you. Thank you, Katie, and thank you, Rana, for that excellent presentation of the global status report. So my name is Ilya Chernyakhovskiy. I'm with the US National Renewable Energy Laboratory. And I'll—this presentation will be focusing on some specific comments on enabling technology that can facilitate the integration of variable renewables. So to start, we'll start with some background on how power systems work and the role of supply and demand in balancing. So balancing is a really important concept for grid operations. The power system keeps the balance of supply and demand at all times.

And so on the supply side, we have components like conventional generators, renewable energy generators, storage as well. On the demand side, we have buildings and industry, electric vehicles that are creating electricity demand, and also storage. And both of these supply and demand side components are variable through time. So the objective of the power system is to keep these in balance, both at the second minute hourly level, and also in the long term in terms of power system planning of supply resources. So another important concept for this idea of balancing is the flexibility of the power system.

So in this chart here, we're depicting the electricity in a power system over a week. So in the yellow, we see the load profile or electricity demand over the entire week, and we see how it varies. So there's a peak during the evening hours, and it falls off at night. In the green, we're depicting the renewable energy that's being injected into the grid throughout the week. And then in the orange is the difference between the yellow and the green. So the orange is what we call the residual load or net load. And the key takeaway here is in the pattern of the orange.

So if we look at how the orange varies compared to the yellow, the ramps are steeper, the peaks are shorter, and we have to turn down lower in order to meet that residual load. So this net load or residual load is that demand that needs to be balanced by traditional resources, which may require more flexibility in the power system. Especially as we increase the penetration of renewable energy on the system. This next slide shows what we call the flexibility supply curve. Each box on this curve represents one mechanism or intervention that can be used to increase the flexibility of a power system. So for example, we see storage on the far right, and the different types of storage that we can categorize based on their capital costs.

We also see institutional options for increasing flexibility, so if we go on the far left, we see renewable energy forecasting as a fairly low cost, low hanging fruit option for increasing flexibility. Now as I mentioned, there are basically two categories of flexibility options. There are the physical ones, so these are physical systems that we can use to integrate renewables, and then there are the institutional frameworks that can increase the flexibility of a power system. And what we typically find is that the lower capital cost options are those that require institutional changes.

So these, for example, are changes to the dispatching and scheduling of a power system, increasing the balancing foot print, so increasing the foot print of electricity markets, geographically. So those are institutional triggers that can be low hanging fruit options for increasing power system flexibility. And as we move to higher levels of renewable energy penetration, as we saw on the previous slide, in order to meet that more variable net load, we may need to use technical/physical options such as storage in order to increase flexibility.

So now, I'll focus a little bit on storage and how storage has been developing as an enabling technology. So energy storage essentially captures energy during periods when demand is low or prices are low for electricity, and then it releases the stored energy when demand or prices are high. And in the most—for the most part around the world, we see pumped storage as the primary type of storage technology. So pump storage is when we take water, we pump it up to a higher elevation when electricity prices are low. And then we release the water, run it through a turbine and generate electricity when prices are high. Other types of storage include thermal storage, electrochemical storage and electromechanical storage.

And the total amount of non-pumped hydro storage that we see installed in 2016 is 6.4 gigawatts. And what I like to bring your attention to is this increasing role of battery electric storage, and we're seeing a very significant trend in increasing adoption of battery electric storage around the world. So grid connected battery storage grew by 50 percent in 2016. For stationary battery storage, the United States was the leading country, followed by the Republic of Korea, Japan, Germany, Italy, and Chile. There are two primary driving factors that are contributing to this uptake. So the decreasing costs of battery technology, and second is the need for fast frequency response on the grid. Batteries have an excellent capability to provide fast frequency response, which is a method for balancing supply and demand at very short time scales.

So electric grids in the US, in Europe, and in other parts of the world where they're seeing a large uptake in renewable energy technology are using battery storage as a mechanism for flexibility in order to meet that more variable net load. Now another aspect of energy storage in the future could potentially be the uptake of battery electric vehicles. So electric vehicles can serve as a method of storage for both households and the electric grid. In the future, we can see grid operators evaluating the ability to use EVs as a distributed energy storage system.

However, this is still in the future. We're seeing this rapid uptake in electric vehicles, and as they grow in penetration, we could see this as being an important factor in the renewable energy and energy system mix. So the global deployment of EVs has grown rapidly in recent years. In 2016, they reached sales of 775,000 units, and this represents in total one percent of global passenger car sales in 2016. China and the United States are the market leaders in unit sales. Norway is well ahead of other countries in terms of market penetration. Now to date, we don't see a lot of examples of a linkage between renewable energy and electric vehicles, but we do see this as an opportunity in the future for physical increase in power system flexibility.

So that's all I have for my presentation. I'm happy to take your questions.

Katie Contos

Thank you to each of our panelists for those outstanding presentations. As we shift to the Q&A, I'd like to remind our attendees to please submit questions using the question pane at any time. We also keep several links up on the screen for quick reference, the point where you can find information about upcoming previously held webinars, and how to take advantage of ask an expert program. We have some great questions, so for the first questions, I'd like to ask Rana, what are resources that are there for those who are interested in learning more about regulatory power policies?

Rana Adib

Regulatory power policies. So there is a—I mean we have the REN21 policy database. That's one source. We're happy to share. Also we're currently putting this information online on the renewables interactive map. This is I think a good source to see what is existing. Another part is very clearly the policy database on renewable energy from IEA and IRENA, which is a joint database where you can also find additional information, and then when it really comes to designing policy—I mean specifically policies for countries, I think it's—yeah, probably IRENA and World Resource Institute are quite good sources to go to. IEA, too, but probably less focused on renewable energy. So that's a good starting.

When it comes specifically to renewable energy policies, renewable for developing countries, more in the off grid market, there will be players like UIPDF, GAZ that have good information here.

Katie Contos

Wonderful, thank you. For both of you, what are the trends in 2016 for off grid distributed renewables, or what were the trends?

Rana Adib

So, very clearly, from what we see is off grid renewable—so there are three areas we're covering in the DSR. There is one part which is on the standalone systems. Here you'll have things from the solar lantern up to solar home system, but also pico hydro. The other part is mini grids, and then when we're really looking into energy in general, there is also the whole clean cooking part where one part is more efficient cooking, but another part which is also fuel switching. So solar cookers, bio gas digest [inaudible] are big trends. The big trend definitely is—and this is a trend which is ongoing since now two or three years I'd say.

Reduced systems costs. So when we're not only looking into the renewable—so PV panels. The costs have drastically reduced over the last three or four years, but when we're looking into the overall system cost, they have reduced, and in parallel, the efficiency has increased, which means that today, with a smaller system, you can provide same levels of energy service [inaudible] with larger systems. And this also means that the systems are more affordable. The other part—so that's a technological part in this standalone systems factor.

The other part is very clearly that today, with a pay as you go business model, there is new business models and payment schemes, which continue to make these technologies affordable to a larger share of users. And today, pay as you go companies are in particular evolving in East Africa. That's the most dynamic market. That's also a market where the large share of investment into [inaudible] companies have been included or have been reached. What we see, however, is that now Asia is also starting to look into pay as you go models. So for instance, Bangladesh, which is the leading country when it comes to installed capacities of solar home systems, I think was—if I'm not mistaken with over four million systems installed. Sorry, I don't have the number in mind. But they have provided basically solar home systems building a micro-credit scheme and are now slowly also starting to introduce pay as you go models.

When we're looking to the mini-grid market, this is a market where interestingly when we're looking globally at mini grids, historically, this was something which was more common really for [inaudible]. This is at least where it started. Today, the US is the leading market for mini grids. This is really driven very much by energy security and making the energy system more resilient to climate change. What we see here is clearly countries are looking into developing more IPPs. This is also something which is quite active in western and eastern Africa. Digitalization plays, again, a big role here. However, I'd say there is less experience so far on the regulator framework. So there is also more activities or—yeah, more innovation taking place or a need for innovation.

Clearly, what other entry points in developing countries, too, is very often like a business model with an anchor client where you basically have an industrial site like mine or a commerce or a hotel which has energy needs. So where the mini grid can provide basically on the one part commercial electricity, and then on the other part, also provide electricity to villages. That's—yeah, that's one aspect.

Katie Contos

Wonderful, thank you so much. For Ilya, what do you see as the most promising trends in energy storage going forward, and are there any new emergency—emerging technologies that you could think of could eventually have widespread deployment?

I. Chernyakhovskiy

Yeah, thanks for that question. I think that the most promising trend we're seeing is the rapid decline in costs. And what we're seeing primarily is that this is due to increasing economies of scale. So as the market for size of technology has increased and the market for electric vehicles has increased

dramatically over the past several years, the price for lithium ion batteries has decreased primarily due to the increasing amount of manufacturing and improvements in manufacturing of lithium ion batteries. So this trend of decreasing battery costs and emerging technological solutions for manufacturing is really driving interest now in storage solutions for managing renewable energy variability.

Katie Contos Thank you, Ilya.

I. Chernyakhovskiy Was there a second part to that question?

Katie Contos I think you covered it all. The second part was are there any new emerging technologies that you think could eventually have widespread deployment?

I. Chernyakhovskiy So again, so I see this in two different categories. So we see battery storage solutions for residential homeowners, and then also battery solutions at the utility scale, and also at the individual solar plant scale. So for example, in India, there was a solar tender that included energy storage component, so that I see as a very interesting trend and possibly a solution for managing variability of individual solar plants, which can help the investment and cash flow of individual investors.

Katie Contos Okay, very good, thank you. Rana, I believe this question was directed towards you, but Ilya, feel free to answer as well. As you stated in your presentations, we saw a decrease in employment and investment in renewable energy in 2016. Could you name a few key things that would need to be done or change in order to increase both investment and deployment?

Rana Adib Yes, sure. I think that just to—I have mentioned it, but it's important to keep in mind that one of the reasons why investment went down was that cost for renewable energy went down. So this is obviously—it translates into stable insulation in terms of in solar capacities, but reduced costs, so it reduces investments. This is actually a part we don't want to lose because it just means that renewable become more and more affordable in more countries, and this is definitely a trend which we need to maintain. What is really necessary for the investment is clearly creating leverage playing field. I think that's the way you say it, sorry, I forgot it. Which means like reducing subsidies for alternatives, which are when we're just looking at the cost basis, more costly, but which are being subsidized. So that's reducing fossil fuels. The other part is when we're looking into markets which are going—so creating stable and long-term visibility for investors in the countries. We still have countries which have policies supporting renewable, then partly retrospectively or retroactively even they are being reviewed.

And this is creating a lot of insecurity for investors and the industry. And this is something which is really key for attracting investment for creating long-term industry for moving the energy transition forward. And also for creating jobs and local value. What we also see—and that's on the policy part, but what we see is we have other type of players coming in more and more. Like the city is coming in, corporations coming in, consumers coming in as actors here. Having to find targets of 100 percent renewable energy for instance,

internal targets which incorporate social responsibility policies in the companies, and these are basically developments which are very positive and can also contribute significantly to attracting investment.

So when we're speaking about creating the good policy regulated framework, it's not only at the national level, but it can also be at the sub-national level, at the city level in companies. I hope that answers the question.

Katie Contos

Thank you. I think it did, wonderful. Ilya, what are some of the policies that countries use to incentivize storage capacity?

I. Chernyakhovskiy

Yeah, thanks for that question. So far, what we've seen is that mandates are the most common form of support. So for example, in the US, states—certain states require utilities to procure a certain amount of storage capacity. In other places, we've seen storage included in tenders, so I mentioned the India example in a reverse auction mechanism for solar capacity. There was a storage component included in that, so that's another way to incentivize storage. In Europe, certain countries like Germany and Italy are offering different types of residential level incentives. So like low interest loans, grants, tax rebates.

Those are the types of incentives we've seen in the early stages of rooftop solar adoption that have worked really well, and they're being implemented now for residential storage applications as well.

Katie Contos

Okay, thank you, Ilya. We have a quick follow up question. What are the current lowest cost options for energy storage?

I. Chernyakhovskiy

So right now, we're seeing lithium ion batteries as the lowest cost energy storage solution for residential applications. Yeah, I hope that answers the question.

Katie Contos

I believe it does. Thank you so much. Going back to Rana, do you know if we saw any significant increases in electrification or energy access in 2016?

Rana Adib

That's a tricky question because let's say one element of the answer is having good data. And on electrification or access to electricity, unfortunately globally, there still is not very good data. The other aspect is here that we have more information on the number of systems installed or sold. So we've got glass and IEC market reports, they have an assessment of something like they are covering according to the assessment. Fifty percent of the market. However, in particular in developing countries, we have a population growth rate which is huge, so even if there is more and more in solar capacities, the uptake on electrification is unfortunately not quicker than the growth rate.

I mean that's—so IEA is publishing electrification rates for every country. They are I think doing an update on two to three years in the country surveys. The World Bank, which is doing the global trekking framework under SE4ALL is also starting the—they started with some pilot countries who do some surveys. The idea is to roll out this approach globally and have this on a continuous basis, and it will take probably another I would assess—that's just

a personal assessment, but another couple of years until we'll have a real up to date picture. So in theory, yes, but population growth rate is basically a slowing down the development you could see in the electrification chair.

Katie Contos

All right, wonderful, thank you, and thank you to both –

Rana Adib

Sorry, Katie, I just thought that one interesting information, however, in this context when we're looking into off-grid renewables is for example, the case of Tanzania. That's only one case, but where you can really see that this is also a sector which is contributing more and more to electrification is that, for instance, the pay as you go company Off Grid Electric has in 2016 connected more households to off-grid systems and electrified these households than the Tanzanian utility. This is also something which is acknowledged.

So off-grid solutions are today acknowledged as clear energy access or electrification solution, which is also quicker than very often quicker than extending the grid. So we might also have very good surprises during the next couple of years that this sector is really uptaking so quickly that in a couple years, we might have significant changes in terms of energy access.

Katie Contos

Wonderful, thank you. For both of you, what are your thoughts on the hydrogen economy? How soon can we expect it, and in which countries first?

Rana Adib

To be honest, I'm not very well placed to tell you where or how soon we can expect it. They were always back and forth on hydrogen. Obviously, it has lots of advantages when we're also thinking about sectors, which are quite difficult to de-carbonize when we're looking at renewable energy based solutions like when we're thinking on transfer. So basically, shipping, aviation, also in the heating cooling part. Hydrogen might play a role. The countries which are probably pushing forward the most are the countries which have already a good natural gas infrastructure because hydrogen has a major account, let's say. It needs a specific distribution infrastructure. So here, I think these are definitely the countries which are looking more into this, also because operators of this infrastructure are also looking at possibilities to enter renewable energy based activities.

Katie Contos

Okay, thank you very much. We also have a question—is there—what do you think is the biggest problem facing the east African countries if there are any, and who are increasingly using the pay as you go model?

Rana Adib

Sorry, Katie, could you say this again? Because you cut out.

Katie Contos

Oh, I'm sorry about that. What are the problems you feel are the biggest problems facing east African countries, and who are using the pay as you go model?

Rana Adib

So, what are the biggest challenges? I mean the biggest challenges—this is a region which is very active. The biggest challenges east Africa are facing for the moment is that in some of the key countries when we're looking into off grid and pay as you go is the political framework, the regulated framework. So countries like—yeah, Kenya for instance have reviewed their de-taxation,

and this is a major challenge the pay as you go companies are facing. So that's one aspect. And obviously this is also something which is—I mean even though very honestly the pay as you go company really manage to attract interesting investment and there is also continuous trend of attracting more investment, obviously when you have such risks at the political level or the, yeah, regulator level, this might be challenging for attracting investment.

So that's when we're looking at the overall framework. Who are the users? The users are not only households in rural areas, but many households in urban and suburban areas where partly even adjacent where the grid is there. So but yes, I mean I think there is a coverage rate of 70 percent of the population in sub-Saharan African have a mobile phone, so pay as you go companies are potentially targeting all these people, and yeah. The other part, certainly when we're also looking into pay as you go, when we're looking to larger systems, we clearly also see not only households, but also commercial activities, small businesses, and the other part is very clearly here we're probably not a pay as you go scheme, but more the off grid part is institutional users.

So schools, prisons, health centers.

Katie Contos

Okay, wonderful, thank you. And thank you both for the informative question and answer session. I'd like to provide either of you with some opportunities for some closing remarks to today's webinar. Rana, would you like to begin?

Rana Adib

Okay, sure. Yes, so maybe I think the main message is we're really on a good track, and at REN21, we're very excited to be able to report again that renewable energy are uptaking, and there are very interesting opportunities when we're looking at the cost of renewables, but also on increased sector coupling, the calibration or bringing together renewables and the efficiency sector coupling also. However, we really need to keep in mind we need to move faster if we really want to address or reach climate goals. And this is just something—we don't have the time and that's really called for everybody to contribute to create and advocate for more stable and more fair policy and regulator frameworks, knowing that there are really, really good reasons apart of climate to really invest in renewables and deploy this more.

So we hope that next year, we'll be able to report again on good advancements, and also quicker ones. The other part is clearly what we see is that we need to see renewable energy as a systems part. So having more systems approaches as needed, seeing this—so I take again, the example of China, which is a country investing now into transmission and distribution lines for allowing to integrate renewable energy more. So on the energy planning side, and in general, more generally, also when we're thinking about the linking to the transfer sector, in the infrastructure planning side, it is really important to take in the most recent costs in the planning, in the modeling to have the good assumptions to not come up with solutions which are not up to date anymore.

Katie Contos

Wonderful, thank you so much. Ilya, would you like to say any additional remarks today?

I. Chernyakhovskiy Yeah, so thanks, Katie. So I think the main takeaway that I'd want to share from today's webinar is there are many different options for integrating renewable energy at high penetrations, and it can be done cost effectively, and certain enabling technologies are definitely part of the mix. So for example, storage and possibly electric vehicles in the future, but there are certain institutional low hanging fruit that can be used now in order to prepare the system for a large penetration of renewable energy that will keep the system reliable and cost effective, and most importantly, low carbon and low price for consumers.

Katie Contos Wonderful, thank you. On behalf of the Clean Energy Solutions Center, I'd like to extend a thank you to all of our expert panelists and to our attendees for attending in today's webinar. We very much appreciate your time and hope in return there are some valuable insights that you can take back to your ministries, departments, or organizations. We also invite you to inform your colleagues and those in your networks about Solutions Center resources and services, including no cost policy support through our ask an expert service. I invite you to check the Solutions Center website if you'd like to view the slide and listen to a recording of today's presentation as well as previously held webinars.

Additionally, you'll find information on upcoming webinars and other training events. We're also now posting webinar recordings to the [Clean Energy Solutions Center YouTube channel](#). Please allow about a week for the audio recordings to be posted. Finally, I'd like to kindly ask you to take a moment to complete the short survey that will appear when we conclude the webinar. Please enjoy the rest of your day, and we hope to see you at future Clean Energy Solutions Center events. This concludes our webinar