Launch of IEA's New Transition to Sustainable Buildings Strategies and Opportunities to 2050 Publication

—Transcript of a webinar offered by the Clean Energy Solutions Center on 27 June 2013—
For more information, see the clean energy policy trainings offered by the Solutions Center.

Didier Houssin International Energy Agency

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Sean Esterly [Hi, I'm Sean Esterly] with the National Renewable Energy Laboratory and welcome to today's webinar hosted by the Clean Energy Solution Center. We are very fortunate today to have Didier Houssin and Mark LaFrance with us and they will be discussing the findings from IEA's new publication transitioned to sustainable building, strategies and opportunities to 2050. We have not looked at the role of technologies and policies to transform the way energy is used in the building sector.

One important note of mention before we begin our presentations 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 reviewed and selected by technical experts.

Now, before we begin, I'd like to quickly go over some of the webinar features. For audio, you have two options, you may either look into your computer or over your telephone. If you choose to listen to your computer, please select the mic in speakers option in the audio pane. By doing so, we will eliminate the possibility of feedback and any echo and if you select the telephone option, a box on the right side will display the telephone number and audio pin you should use to dial in.

Panelists, we ask that you please mute your audio device while you are not presenting, and if you have any technical difficulties with the webinar, you may contact the go-to webinar's help desk and that's at 888-259-3826.

Now, if you'd like to ask a question which we encourage, we ask that you use the questions pane where you may type in your question. If you are having difficulties viewing the materials through the webinar portal, you can find links to the PDF copies of the presentation. Those can be found at cleanenergysolutions.org/training and you may follow along as your speakers present. So, that link is up there now.

Also, an audio recording of the presentations will be posted to the Solutions Center training page within a few weeks.

Now, we have an exciting agenda prepared for you today and that is focused on the launch of IEA's new publication, transition to sustainable building, strategies and opportunities to 2050. Didier Houssin and Mark

LaFrance will cover the report which presents detailed scenarios and strategies to 2050 and demonstrate how to reach deep energy and emissions reductions through a combination of best available technologies and intelligent public policy.

Now, before speakers begin their presentations, I will provide a short, informative overview of the clean energy Solutions Center initiative. Following the presentations, we'll have a question and answer session and wrap up with discussion and closing remarks.

Now, this slide provides a bit of background in terms of how the Solutions Center came to be. The Solutions Center is an initiative of the clean energy ministerial and is supported through a partnership with UN Energy. It was launched in April of 2011 and it's primarily led by Australia, the United States and other CEM partners.

Outcome to 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 we're attending today.

Now, the Solutions Center has four primary goals and those serve as a clearinghouse of clean energy policy resources. It also serves to share policy best practices, data and analysis tools specific to clean energy policies and programs. The Solutions Center delivers dynamic services that enables expert assistance, learning and peer-to-peer sharing of experiences.

And then lastly, the center fosters dialog on emerging policy issues and innovation around the globe. Now, our primary audience is energy policymakers and analysts from governments and technical organizations in all countries, but we also strive to engage with the private sector, NGOs and civil society.

Now, our marquee feature that the Solutions Center provides is the expert policy assistance. That's known as the “ask an expert.” It's a valuable service offered through the Solutions Center. We have established a broad team of over 30 experts from around the globe who are available to provide remote policy advice and analysis to all countries and at no cost.

In the area of energy access, we are pleased to have Cesar Trevino, leader of the Mexico Green Building Council. Terry Walters of [inaudible] [0:05:02] Consulting and representative from the Global Buildings Performance Networks, serving as our experts on sustainable building. If you have a need for policy assistance on sustainable buildings on any other clean energy sector, we encourage you to use this useful service.

Again, this assistance is provided free of charge and to request assistance, you may submit your request by registering through our ask an expert feature at cleanenergysolutions.org/expert. We also invite you to spread

the word about this service to those in your networks and organizations. We encourage you to explore and take advantage of the Solutions Center resources and services including the expert policy assistance, subscribe to our newsletters and participate in webinars.

Now, I'd like to provide brief introductions of our distinguished panelists. First up is Didier Houssin, director of sustainable energy policy and technology at the International Energy Agency. And following Didier, we will her from Mark LaFrance. Mark is working in the energy demand technology unit of the International Energy Agency's sustainable policy and technology directorate on analysis related to building. Didier, welcome.

Didier Houssin Okay, thank you very much for this introduction and good morning and good afternoon everyone. Thank you very much for joining this webinar and before speaking about this new book we are releasing today, just two words about the IEA for those of you who don't know about the IEA. The IEA was created in 1974 basically about energy security issues but since its formation, it has devoted to look at various aspects of energy policy.

The directorates of the sustainable energy policy and technology, I'm in charge of what looks more particularly a long-term issue, energy efficiency, climate change policy and also energy technology. Our flagship publication, Energy Technology Perspective looks into clean energy technology in the long-term frame by 2050.

Just a few words about the ETP publication because it's kind of the background, we spoke about a launching today on building. ETP 2012 identifies the low-carbon energy technologies that can help achieve a 50% reduction from today will embodying all of the expected increases. The most important option in both the shorter and longer term is improving energy efficiency. Improved energy efficiency in the end-use sectors accounts for 38% of the total emissions reduction in 2050.

So, today's publication is actually focusing on the how to achieve energy efficiency in the building sector. And all end-use sectors actually building is the largest with natural gas and electricity having large shares. Renewables also accounts for 30% of the mix in buildings and consumption. So, it's a major share but most of this is unsustainable biomass in developing countries.

Buildings also uses a wide array of technologies. They are used in the building envelope and its components in space, heating and cooling systems, in water heating, in lighting, appliances and in office and service equipment. Policies thriving to reduce energy and CO2 emissions, must address the growing energy needs of the sector, taking into consideration all its energy consuming components.

While there are already cost-effective technologies that should be pursued immediately, others can become cost-effective with modest government

support and incentives. So, this new IEA publication provides the path forward for the building sector to be less energy and carbon intensive while investing in high performance buildings and a high efficient product.

Under business as usual scenario, building energy consumption is expected to increase 50% by 2050, which is driven by economic growth and an estimated 2.5 billion more people. 40 extra joules of savings are possible, which is 25% less than in the 60th scenario which is equal to the combined consumption of India and Russia. Stringent energy building codes are needed for all new buildings but it is especially important in developing economies since they have high consumption rates.

Deep innovation is important for existing buildings as 50% existing building was still in service in 2050. In OECD countries, the rate is even higher as closer to 75% and this is why we need to pursue integrated policies to address this market segments which would lead to self-sufficient business models moving forward.

The majority of solutions already exists although R&D can improve performance and lower costs to develop more viable cost-effective solutions. The major efforts will be to facilitate the deployment of advanced technologies and emerging markets. To this end and unprecedented efforts and coordination is needed among viable sets of stakeholders. Here, you see the majority of technologies and policies are needed in every region.

However, the IEA believes it is important to prioritize the top 2 items for those technologies and policies for each region. That's what we have summarized on this slide. So, I'm not going to go into the details, but just give you a couple of examples. When we look at technology for example, the IEA is recommending advanced and deluxe cold climate for China, Russia and United States as the top priority.

The European Union is the second priority because it has been pursuing programs that it has already. Similarly, greater effort is needed in the European Union on income which is the highest priority for Europe, whereas it is the second priority for China, Russia and the U.S.

When we look now at policy, the IEA is recommending mandatory policies for most regions. Appliance and equipment standards are critical to reduce electricity and passive fuel consumption in regions like ASEAN, Brazil, China, Mexico or South Africa. While these standards are important in India, we suggest that the highest priority for India, the mandatory building codes due to the high rates of new construction expected.

For well-established slower growing economies such as the European Union, Russia and the United States, the IEA believes the highest policy

priority should be on deep renovation of the existing buildings from the top.

This graph that we will show in a minute shows the energy savings broken down by OECD and non-OECD regions to move to the scenario. OECD energy growth can be curtailed but non-OECD continues to increase due to the larger population and economy growth, however, the growth is significantly reduced in the 2DS scenario. All fuels contribute with the move to less carbon intensive fuels and a greater share for renewable energy. Unsustainable and unhealthy biomass is reduced significantly and replaced with modern forms of energy.

However, from a systems perspective, biomass can be used more efficiently in centralized operation for a variety of purposes. Electricity in non-OECD increase systematically which leads to higher saturation rates of appliances, electronics and lighting as well as the desire for greater comforts of air conditioning.

Total carbon emission reductions is 9 gigatons with a third of this amount coming from end use serving efficiency improvement to a stringent efficiency standard, promotion of heat pumps in lieu of electric resistant heating, to increased solar, thermal and greater electricity co-generation with waste heat and renewable and existing demands can be reduced by 2000 terra watt hours in 2050. This is approximately equal to half the current electricity consumption in the U.S. or the entire electricity consumption of South America, Africa and the Middle East combined.

Energy efficiency in the building sector will reduce the burden to move towards cleaner sources of electricity. However, two third of the emission reduction are from the organization of the electricity sector that was fully explored in our ETP 2012 publication.

Of course, this implies a high level of investment and these are micro-investment projections that you can see on this slide which are yet difficult to respond. They relate to a variety of measures with some having shorter payback periods and others require much more time to recover the investment. Later success in R&D to bring down the cost of deep renovation for example, would result in better rate of return to achieve the 2DS scenario.

After this general presentation of the key points of the book, I'd like to hand over to my colleague, Mark now for more details.

Marc LaFrance Thank you, Didier. Welcome everybody. So, I'm glad to be presenting the book today. The first slide that we have here is the residential sector and in the world, the residential sector has the largest energy consumption and if you look at the savings, we really need to tap into every end use. But there are three distinct areas here. One is we have a very large heating load for space heating and water heating and to get that savings, it includes the

investment and building envelope as well, and then another major part is the biomass.

As Didier explained, we have large amounts of unsustainable biomass and we really need to curtail that to move towards the more modern fuels which will increase the emissions but those fuels can be better utilized and centralized applications to reduce their consumption.

The last thing here of course is the appliances and lighting which really goes back to appliance standards. We're going to show this in a lot more detail. Now, this slide refers to the service inspector or many people call as non-residential or commercial buildings sector and you could see this very large wedge that relates to other equipment.

The way we're going to go after this is really through much more aggressive mandatory policies to curtail the application of more electronic equipment as well as top fuel equipment. And again, going back to the heating loads, it's still significant and we really need all the major elements to be curtailed in the commercial sector.

Now, the publication has an extensive section on regional analysis and Didier showed a nice macro chart on the high priorities but we go into detail in every one of the regions as to what - how much is the current consumption, what are the forecasts and what are the recommended measures to mitigate that future consumption to a more sustainable future. So, for those of you that may be interested in your particular region, this book provides both details for your region along with the macro technologies and policies that are needed.

So, another major part of the book is that we have a chapter dedicated to building envelope. We have one chapter dedicated to heating and cooling and then a chapter dedicated to lighting appliances and cooking. So, here we can go to the top level items that are required for building envelope. This chapter obviously goes in a lot more detail but one thing that we think is needed is we need more R&D for windows to develop cost-effective highly sitting windows for cold climates.

We also need a variety of retrofit solutions that are much more cost-effective because windows could be very cost-prohibitive when you try to retrofit them. We also recommend optimal level build installation which varies significantly based on climate and on energy prices, but the vast majority of buildings today have inferior amounts of insulation and we need much more focus on achieving optimal level.

We also want to do better air ceiling, reducing the infiltration because in our heating and cooling loads, a major part of that is conditioning the outside air that is leaking into our buildings. It also leads to much better indoor air quality. We also recommend attic operate which could be nice, easy, cost-effective measures for the building envelope and lastly, we really need to focus on harmonizing building material ratings and

standards, especially in growing, developing countries, where we're trying to develop the market infrastructure for these advanced building products.

Here's just an example of the kind of level of analysis we do in the book. Here, it shows a variety of window, standard configurations that exists in the marketplace and we're recommending for the entire world to move towards at least a double-pane, lowly glass window performance. And then for cold climate, we want to see people moving towards at least the level of the same performance equal to a triple glazing and then for the long term, especially for very cold climates and for very cold climates and for zero energy buildings, we need to move for the vacuum glazing or a quadruple pane window.

So, for our heating and cooling recommendation, we recommend more work on heat pumps from an R&D standpoint, but of course as well as the deployment standpoint. Many moderate climates and countries can right away move from light resistant heaters to heat pumps, very cost-effective, can be done immediately but we have some climates that are very cold where heat pumps aren't viable unless it's a ground source heat pump which do tend to be a little bit more expensive.

So, we want to see more work on R&D and we want to move people from gas condensing boilers which are 95% efficient to a gas pump, should be coal efficient performance, 1.2 or equal to 120% efficiency.

So, we're calling for standards that would bend the sale of electric resistant heating as your primary source for space heating as well as water heating. We believe that heat pump water heaters can be very viable. Japan for example has a half million units sold annually and they're very market viable. Europe and North America have made a lot of progress on voluntary programs and market introduction.

We also talked a lot about the need for solar thermal and greater renewable energy that can curtail the use of water heating and space heating, and then there's certainly some applications for solar cooling which are more of a technical and economic challenge but with other types of progress on heat pumps, they could be viable as well.

And there's significant amounts of currently district heating that's taking place in the world that is not necessarily that efficient and for example, the Scandinavian countries have an excellent job of very efficient systems, but we have many developing and emerging economies that really need to upgrade these systems to much better sources or low carbon sources of fuel as well as much better inflated networks leading to more energy efficient buildings for the demand.

Here is the chart, just to give you another example of the analysis in the book of heat pump. For those of you that may not be aware of the performance of a heat pump, a COP is almost equal to 100%. So, pure electrical resistance is only 100%, so here we're talking about

performances of 300%, 400%, 500% and 600% efficiency. So, you can just imagine moving technology and applications from 100% to 600%. Now, that's a six fold improvement.

In the book, we estimate an average of a factor of three because of climate conditions and market conditions, but certainly, this is an area that we can do much better on and one of the arguments against this is people say, "Well, I have a very clean source of electricity in my country. I have lots of hydro, or I have a very high nuclear share." If we can move to heat pumps, we can free up that extra electricity capacity that can then be used for other sources such as electric vehicles so, we have a much more sustainable entire economy for that network.

Okay, so the last technical chapter is on cooking, lighting and appliances. In this case, when most people look at developed countries, they don't think about how much energy is being wasted in the inefficient use of biomass. When you start looking at the detailed analysis of this book, it is a major factor in developing countries.

So, we would like to see this be used in a much more efficient manner. This photo here is an example of a simple cook stove. But for people that are just using a regular oven campfire, this has significant efficiency improvement and quality of life improvement, less unhealthy conditions for children and women predominantly. But we also can do that biomass in centralized systems. We can use it for co-generation. We can use it for bio fuels, lots of other uses for that.

And several countries have been banning incandescent light bulbs, but in many cases, they may only be going to a marginally better bulb such as a halogen bulb. But we want to see people move towards the levels of performance of commonplace light bulbs or improvement on the order of factors of times four, significant improvement that are available, very cost-effective and very well-received in certain countries as long as the quality control on the product.

And then the last thing in this area is really moving towards the next generation of lighting performance which is solid state lighting and there's a lot of R&D going on that, as well as one of the most efficient light sources is one that doesn't have to be turned on. So, if you have an advanced façade system that now allows for natural daylight, so you'll optimize your interface with the outdoors to get natural daylight, less artificial light, less cooling load and the entire system is optimized for performance and this is being done in many parts of the world and in high performance buildings, but we need to get that to become a more standard practice. And of course, energy management is the major part of all of that.

So, this particular slide just shows you where we are for lighting performance and these curves that go up for the solid state light, just show the potentials would be tremendous on how far we can go with solid state

lighting. The bottom of the chart shows where the incandescent light bulb and then above that you can see halogen. Of course, it does save energy. It is a good step forward but it's certainly not enough where we can go to [inaudible] [0:26:44] light bulbs where you see the yellow bar above, can be significantly better and that's where we need to get for minimum performance rather than just a voluntary performance.

Okay, so when we look at all of these components, first of all, we need to do integration within a building by itself but we also want to integrate all of the sectors so that the transportation sector is integrated with our buildings. We charge electric vehicles in a building that may have PB on its roof and how do we reduce the electricity peak demand issues on the grid and how do we tap in to the weight from industrial sectors to use that in our city for heating and cooling. How do we get free cooling from aquifers and lakes and rivers and the ocean?

So, lots of integration that needs to take place so that we can optimize and reduce our supply and our demand system for the future, especially when we get to 2050, this has to be very well established and in place and that's the vision.

So, the last chapter of the book deals with policy and it deals with component as well as systems integration, and we believe that we need both. So, certainly to promote a zero energy building or a very high performance commercial building, you need to have a systems level policy. So, these may be performance certificates or zero energy building objectives. At the same time, we believe it's imperative to have component policies to bring down the cost of the best available technology to make the product more viably available, make sure we have multiple suppliers of products.

How do we transform the best available technology in a highly developed country and how do we move those into developing emerging markets. You know, just because it rolls out in one country, there are many market barriers in other countries. And so, we believe that a key element here is to - you know, how do we break through the barriers with all of the lessons learned and we really call for more action to do this.

But in this chapter, we explained in detail all of the successes and activities that have taken place that makes them that should be pursued.

Okay, so the IEA also has done significant amounts of work in buildings already as well as future parts that will be forthcoming. One is we're going to be working on a building envelope roadmap that will be coming out in the fall and we also have a policy pathway on building energy code. So, with today's publication along with these two major publications, we're going to have all the key ingredients as to how to transform the construction of buildings in the entire world, whether you're in a highly developed OECD country or whether you're in a developing country.

And the basic methodology of construction leads to all the heating and cooling loads and it's a major part of buildings and this really will help move us forward as to where we need to go. So, we also made our flagship at the ETP series and in 2014, we are going to include buildings but mostly looking at electricity supply sectors. So, with improvements of the supply sector along with the end users, that's how we get a more sustainable future.

At the bottom of the page header, four covers of other products that are applicable to buildings. So, in the past we've had our heating and cooling roadmap. We got our solar-thermal roadmap. We also had our pathway on building energy performance certificate as well as our flagship ETP 2012. So, all of these are great resources for people to find additional information about what's available.

Okay, this is the last slide that we'll leave up for a little while. I know it's kind of busy but it really has your positive information. I mean, how do you purchase the book today? And so, if you go to this webpage, you will see the full executive summary and table of contents that are available for free download and we do offer significant discounts and packages for anybody that contributed to the book and we do thank all those contributors, there are many of them. I believe we had close to 30 countries represented and over 80 reviewers on this book from all the six continents.

Anyway - and then of course there's an email contact just for the feedback for the book as well as another EGP webpage for buildings. And there's my personal copied information. I am doing the working on the building sector. So, my job is 100% buildings at the IEA. So, anyway we're going to turn it back to the clean energy Solutions Center but I just want to leave this up for a few moments for you to see this. So, thank you.

Sean Esterly Didier and Mark, thank you for the outstanding presentations. We do have a couple questions and I do want to remind the audience, if you have any questions that you'd like to ask, please use the question panel on the right. And the question is the spending estimates average 300 billion a year. Is this total public and private investment? And if so, what is the public spending estimate as a fraction of the total?

Marc LaFrance I'm sorry Shaun, we had a little bit of - could you just repeat the last part of the question again? We were just doing some transition with the electronics.

Sean Esterly Yeah. I'll just repeat the whole question, the spending estimates average 300 billion a year. Is this total public and private investment? If so, what is the public spending estimate as fraction of the total?

Marc LaFrance Okay, yes it is both and it represents, for the most part the marginal investment above and beyond a normal business case which would be if you're going to replace a certain product, it's only the premium above that

product. But at this point, we don't have the breakdown between the two. I mean, for the most part, the investment for energy efficiency would be seen as being the private sector, except for the public buildings and then the policies for promotion would be the public sector additional benefit, but that's generally a very small fraction of the total investment because it's just in the transition when you go from emerging markets to fully viable technology.

But it's a very good question but like we said in our slide that this is a macro estimate and it's very difficult to refine and more work is needed for investment.

Sean Esterly — Very good. The next question is the summary slide on recommendation for top and secondary priorities by region and technology is interesting. Would you please speak more for that analysis used to come up for this recommendation?

Marc LaFrance — Sure. Okay, so what we've done is when we look at a particular region, we are looking at where is the largest amount of energy consumption that's taking place that need to be curtailed, along with what we see as the existing policies in place. So, for example, anybody that looks at China, you would say, okay, well, we didn't put the building code as the highest priority because China has done lots of work on building codes. They're already taking it very, very aggressively. It's certainly like a very critical area but they've already started working on it. So, we didn't put it as the highest priority.

So, it's a balance between the technology status, the energy consumption forecast and what they're doing already. And so, we've done that analysis and we've come up with the priorities. Now, like we said, every one of these technical and policy criteria could be checked off for every country. There's work to be done in all of these areas. And we realize that it needs to take place. But we try to identify what we believe from all of our extensive analysis doing this entire project what are the top two most critical items for each region. That's not to say the other items should be ignored, just try to put a little more focus on what the top elements are.

Sean Esterly — All right and next question is how do you integrate other organization's work in building sectors like UNEP or SBCI?

Marc LaFrance — Well, the primary way is we do collaborate with lots of organizations. A perfect example is the global billing performance network and all of their organizations. But we read literature but of course the biggest involvement is we reach out the people for peer review. So, like I said before, this publication in the draft form went out to almost 250 to 300 people for review. We received almost 90 comments and input and so that's the primary mechanism. Now, obviously the IEA works on many other publications and projects and we have joint projects with lots of organizations that go beyond this publication.

So, I would say that it's mostly collaboration and in some cases we do have joint publications that take place as well. This happens to be an IEA publication, so we do work extensively with a variety of organizations.

Sean Esterly — All right, and the next question is who will take the agenda of green, smart, energy efficient buildings at the international level?

Marc LaFrance — Well, I know that this came in as a text question and if the person who presented that question was online, we could probably ask him a little bit more. So, when we talk about international leadership for green and sustainable building, this is obviously taking place by many organizations. For the Major Economic Forum for example, the Clean Energy Ministerial, you know, all kinds of international corporations. You know, one of the things that the IEA has done a phenomenal job - I've only been here for less than a year - is that the IEA network actually is a mechanism for multiple countries to come together on joint research and there's been so many success stories from the IEA network for collaboration.

But of course, one of the things that we're trying to do with the IEA is how do we tap in to all this extra piece that we have and all of these key findings and how to we elevate those to policymakers. We need to go beyond the analysis into the action mode. And so, that's obviously done at the individual country level and the IEA's goal is to inform them and that which we're talking today, we're highlighting in case publication examples where - let me give you an example. The UK has already mandated condensing gas furnaces but yet it's a moderate climate.

Now, why don't we have that in climates that are very cold? And of course, you got to look at the energy prices. So, we're trying to highlight what are the key elements. But global implementation on green buildings is a very challenging area. So, hopefully I answered the question but it would have needed maybe a little more clarification the way it was presented. Thank you, Shaun.

Sean Esterly — Yeah, no problem. And with regard to that DEDS, to what degree are energy inputs considered a factor since quadruple pane means production of four panes of glass and hardware, versus a vacuum IG requiring only two panes in later patching?

Marc LaFrance — Shaun, that's an interesting question. So, embodied energy is critical and we specifically didn't get involved in detailed life cycle assessment in this particular publication, but we realized that's something that's concerned by everybody. To some extent, those types of things in a pure competitive marketplace, if somebody's manufacturing a high energy product, that would be reflected in its purchase price.

So, we're recommending a level of performance which is particularly U value and obviously, if somebody could come up with a market viable vacuum blazing, that should be preferred. It also would be a nice way to combine that with a dynamic window but we don't specifically get

involved with the details of the embodied energy. I mean, it's a critical issue for the environment, but it's something that is not factored into our energy analysis and our energy savings.

It's funny because I was also at a recent event where they were discussing the environmental impact of having more embodied high levels of installation for passive house versus PV. But of course, we need both. We need to optimize what's the most cost-effective solution for that particular application in that climate. And so, I think it bought it in, you will definitely be a factor but it's not something that we specifically look at.

Sean Esterly — All right and next question is, what particular end use should we focus on to increase efficiency for slum populations in developing countries, since they are moving up the income ladder fast and tapping the urban damage?

Marc LaFrance — Okay, thanks Shaun. Also, in the room I also have John Dulac and Natalie Trudeau who worked extensively on this book. And so, we probably should have introduced them as well if there are any questions that come up. So, in developing countries, obviously, population and GDP are major factors in energy consumption and Didier explained that we're looking at a population growth by 2050 of approximately 2.5 billion.

So, while we're talking about saving energy, we're talking about preparing the growth of energy as well. And so, we know for example that in developing hot climates, currently, people are using very small amounts of cooling energy. But as they get wealth and as they desire greater levels of comfort, that cooling energy is going to increase dramatically. And so, instead of just putting in large air conditioning, wouldn't it be nice if we could put in cool roofs, reflective glass, reflective walls and ways to reduce the need for air conditioning so that maybe they never even need the air conditioning or they don't desire it or at least if they do install it, it's only a fraction of the capacity of what it would be otherwise.

So, the issue of GDP and population growth in developing countries is a major part of the analysis and it's a major factor in energy consumption by 2050.

Nathalie Trudeau — And I think the other thing we're taking into consideration is that a large part of the population currently in the world as the income is increasing, as the revenues are increasing in countries, they will have the possibility to move into cities or to move into proper accommodation, putting an increase in the energy consumption.

This is taken into account in 2D analysis. And that's why in some countries, even though you have increase in energy consumption, we are assuming that there will be energy efficiency. But there is growth of course because the population, the living standards are increasing.

Sean Esterly — And the next question from the audience is, does the report include assumptions on fossil fuel costs behind the scenarios? Was there any

consideration of alternative scenarios based on increased natural gas supply and lower prices?

John Dulac — The buildings model used for the production of this book is part of our energy technology perspective theory. So, the energy supply and demand and the underlying cost for those are assumed in the model. Now, there's been a clearance in the revolution. Much of the others I've been thinking about was about the shale gas in the United States and what this might have in terms of implication on cost.

But as gas is not the major energy source in the building sector presently, we obviously have not accounted for this in the scenarios presented in the book. However, we realistically would think that expansions of renewable, gas technology, et cetera, would all eventually have a market effect of keeping prices stable, not necessarily seeing major decline, although you may see periodic declines in prices, rises in prices based on demand.

Sean Esterly — Very good. And can you explain the recommendation of DEB for U.S. and Europe but not for other countries?

Marc LaFrance — Like we said before, we're looking at the top 2 highest priority for certain regions and before we could really start pursuing a zero energy building priority, you need to have a pretty well-established basic energy-efficiency program in place.

So, for example, currently in the world, North America and Northern Europe have an excellent building envelope, they put a lot of investment in high performance building envelopes, surely greater than the rest of the world and to the next logical step for them is to go to zero energy building performance. Now, it's still going to take some time to be fully market viable if you don't have large energy carriers. But if you step back in the world, I mean obviously, Europe with higher energy carriers, that zero energy buildings will become market viable in Europe first than anywhere else in the world because of the current energy pricing scheme.

But certainly, North America can work on it and the next logical step once you've already established a basic building code and you have a good program in place to move building codes forward which Europe and North America already have.

Sean Esterly — And the next question is, the research did not include anything from sub-Saharan Africa, is there any ongoing research regarding energy efficiency in buildings in sub-Saharan Africa?

Marc LaFrance — Well, we definitely include South Africa and in our buildings model, we include all regions of the world but we don't get into the detail of some of the smaller countries and obviously it's a large region for population. But for energy consumption, currently, it's obviously not huge in the world.

So, we definitely account for the entire world in our buildings model and that included in our macro finding but we only were able to get down into South Africa. I mean, this is a very extensive study and that's one of the complexities we have that this model includes the entire world. And so, this publication today is partly unprecedented because how many people have an analysis of the entire world for energy consumption forecasting. All of the major technologies need to be worked on and all of the policies that need to be pursued to implement those technologies.

So, all of this combined, but I would say that what are the key issues for mostly developing Africa is there's lots of amount of biomass as well as we're going to see large growth for electronics and appliances. People are going to modern forms of energy. So, there's obviously going to be growth there but I think the recommendations from other regions are applicable to the African region as well.

Nathalie Trudeau — And currently right now, there's a lot of policies and a lot of development going on into Africa. There's a lot of national programs that are promoting the implementation of solar water heaters to get rid of the unsustainable biomass. There are energy programs that are put in place. There are studies that are done for how to include building, how to include the use of the biomass. So, a lot of activities and there is a lot of organizations that are collaborating.

IEA is also collaborating with a lot of South Africa currently to develop roadmaps for deployment of solar, not only for electricity but in the residential application. UNEP is also doing a lot of work with these companies. So, there are lots of activities going on in Africa right now.

Sean Esterly — And the next question mentions a lot of the organizations that you just talked about, UNEP, IEA, UNCSD, they're wondering, are there any other organizations that are working at the international level?

Marc LaFrance — So, one of the key ones is iPeak and they are obviously very concerned with implementation and the IEA is working with iPeak closely to use a lot of the tools that we've developed so they can use those for deployment and for implementation education. So, of course we work with other organizations such as World Bank and that sort of thing.

Sean Esterly — And next question is, many of your recommendations are around mandatory standards and government policy. Are the barriers primarily requiring government action or they're a role for the private and finance sectors?

Marc LaFrance — Thank you, Shaun. Of course we certainly are recommending mandatory policies because if we look historically, they have been the most effective in the building sector. But we also talked about how all of these policies work together. It's very unlikely to be successful with implementing a mandatory policy if you haven't had activity on R&D or for voluntary programs, so, just basic educational programs.

Now, unfortunately in the building sector, it's very rare that technology just goes on its own. Usually, they need to get some kind of motivation to be informed about the opportunity but certainly, there are many examples of where the market force should take over. And so, if you have a very cost-effective light bulb, let's say if you have a CFL light bulb that's maybe U.S. $3.00 or 3.00 Euros, whatever, that's much more cost-effective when they first came on the market at $10.00 and $12.00.

So, obviously bringing the cost down, educating the public when they see their energy bills being very high and then, "Okay, what could I do to change this?" And so, this publication explains some of the market mechanisms where when would somebody seek a way to save energy, whether it's on a voluntary basic study by looking at their bill or whether it's a policy that says, "Okay, we're going to give out free energy audit," and to educate the public that way, or it could be an energy performance certificate when they go to lease or purchase a building, they get notified of how high their energy is compared to the other buildings.

So, all of these, there are certainly many, many policies that are not based on mandatory. But we just want to locate some of the key elements that we think are essential to drive forward the savings to achieve a much more sustainable future, but certainly that path includes many voluntary and market-based programs along the way, it's not just mandatory.

Sean Esterly And next question is what is the proposed strategy to effectively implement incentive programs to drive adoption of the measures you proposed?

Marc LaFrance Shaun, you said what are the market mechanisms?

Sean Esterly Yeah, proposed strategy to effectively implement incentive programs to drive adoption of the measures you proposed?

Marc LaFrance So, obviously, this is a follow-up question from the previous one but there certainly could be a government intervention for incentives. But there's certainly many private sector elements. So, let's say for example you have an electric utility company and they're looking at what's the cost of adding new capacity. And so, the classical, the demand side management policy is that even if they get permission from their regulatory commission but purely based on market forces, it's more cost-effective for them to incentivize people to reduce their demand than it is to build a new power generation.

So, by basically spending money to incentivize the introduction of new technology, then that could be recovered through reduction in the capacity of the new electric generation. Now, one of the things that we also talked about is we're also concerned about that incentive that go on too long. It's important to use incentives at the critical point in the technology maturation curve so that when some of these new are being introduced, you need an incentive. But once it establishes its marketplace and it's cost-

effective, widely available, okay, the market force need to take over and you no longer need incentives.

And actually by spending money on some of those cases, you're actually wasting critical public policy money, or in this case, utility incentive money that could be used for other, more viable options. So, we do talk about, like for example, we're recommending incentives for insulation but not for typical insulation which is very viable. We're saying insulation for deep retrofits.

So, for people that are taking the building envelope, looking at all elements of a systems approach for the building envelope and then only installing half of the HVAC system instead of the full capacity of the system. So, that's an example of an incentive that we would only recommend at a certain type in the marketplace because today, this retrofit is not widely available, whereas a basic insulation, attic insulation is widely available. So, the book definitely explains the differences of when these incentives should be used and when they shouldn't be used.

Sean Esterly And the next question does expand on that a little bit more, it's from someone that's a junior energy advisor and a project focusing on renewable energy and energy efficiency and rural electrification and they're looking at energy efficiency in building and there's very little or no awareness in this area and no capacity. How can they move quickly in addressing that issue? And are there available training that can help build capacity on energy efficiency and building?

Marc LaFrance Obviously, the best ways to read this book. If somebody is saying, "Okay, I'm in a rural developing market and I'm trying to combine what are the key energy efficiency elements with renewable energy," in this case it would most likely be solar, thermal for water heating would be great, and how do you combine that together and doing all that in a rural application. I mean, obviously dissemination of the information is critical.

We're publishing the book. We're also going to be working with lots of organizations as to how can we disseminate the book. We have many options that we can sell the book at reduced prices in collaboration with non-profit universities. This project was quite expensive to complete. It's been going on for a number of years but in this past year, it was reinvigorated and it's extensive about the material.

Like I said, I don't think that another product of building technology that exists that goes to this level of comprehensiveness for how wide it addresses issues, but also the technical details of what are the key elements you need to look at. So, I hope that helps.

Sean Esterly Very good. And solar water heaters are not available in Nigeria. What is required to introduce them fast? Could you talk a little bit about that?

Marc LaFrance Okay, well, I mean obviously, looking at one particular developing country, I don't know the specifics but I would say - well, first of all, we do have a roadmap just on solar thermals but one of the most successful stories is China. China has implemented very cost-effective solar thermal systems that have smaller capacity so they might not meet the needs of a highly developed country, but for Nigeria, it's probably perfect.

And so, there are certainly ways to do it. Now, one of the things that we talked about is for example, how do you take an established technology and introduce it to a new market? And that's the perfect classical point. So, you can't just tell to me, "This is what you need." It's the combination of saying, how do you educate them on what's needed? How do you get the parts availability? How do you get companies interested in introducing that technology to that marketplace?

And so, all of those factors need to be worked on, this book doesn't provide all those answers but it certainly provides us a major part of how do you move forward on that. But if China could figure this out in let's say a colder climate then certainly, the technology would make sense in a warmer climate. So, that will mostly help.

Sean Esterly And next question from the audience is, has a potential of energy renovation, example, the insulation, of current energy-leaking buildings constructed during the '60s or '70s in Europe been identified and presented publication?

Marc LaFrance So, I guess I believe they're referring to air leakage, I believe by the way that's worded. So, obviously, in the publication we have a section on air ceiling and what's required. One of the key elements of air ceiling is that it's validated that you ensure that you have proper testing.

Now, we do address the issue of saying that deep infiltration reduction can be costly. We do present cost data on that but certainly reducing the air infiltration by 25% for example is very cost-effective. Going to 50% air infiltration reduction may increase the cost by a factor of four. So, we do identify the need for additional research to optimize air ceiling in existing buildings. It's much more of a challenge in existing buildings than it is in new construction.

Sean Esterly And the next question is, outside the OECD, building standards may need to use adaptive comfort standards to be truly low-energy, yet our SRA type standards assume conditioning 100% of every cubic inch of the building every hour of the year. To what extend does the IEA research consider this issue, because if we insist on conditioning old buildings the way OECD countries do, a low-energy building stock may not be viable or may be prohibitively expensive?

Marc LaFrance Okay, that's a good question. We certainly are not expecting the energy intensity for all developing countries to reach that of highly developed countries. But I would say that the issue of adaptive perspective is going to

be addressed quite extensively in our building code pathway. Right now, currently the French building code has basically addressed that type of issue. We look at the whole sustainable environment, the orientation of the building and then how is the building going to be used, what's the comfort factor going to be.

So, that's a very good point. We don't model to the level of detail where we stop doing complete building simulation modeling like you will do on an individual high-performance building. That's beyond the scope of the building modeling right now.

Sean Esterly — Very good. And what is the level of investment you think is required for new and current building stock retrofits and from where will this finance come?

Marc LaFrance — So, one thing that we don't get into extensive details on the finance part. It's just basically a summary of where we started from EGP 2012 but well, we obviously call for more action on the business models associated with deep renovation. So, if you can envision - today roughly in developed countries, about 1% of the building stoppage is retrofitted per year, and we want that to become a deep renovation, very cost effective. If you're going to do the measures anyway, then, to do the marginal increase for high performance products, those are vastly cost-effective especially when you look at the package of short-term and longer term payback period.

Then, the next set of buildings would be one where you're trying to motivate people to renovate a building that wasn't planned to be renovated but it's certainly in need of renovation. And those, there should be a viable market path for those as well. But what we're calling for is more researches. This is in that area that we call for more research on to address, how do we do the deep renovation on buildings that may be needed before the end of its useful life and it could be cost-prohibited.

So, there's more work that's needed there and this is a very difficult topic and it's something that we like to work more on but right now it's not currently being planned due to other priorities, but there's lots of organizations that are doing simple work. They are calling for deep renovation and hopefully, we can collaborate with them and see their findings on this important topic.

Nathalie Trudeau — In many countries, for the building sector, what we're asking recently is the emergence of some escrow that are supporting financially the development, the implementation of technologies that are currently cost-effective. So, this may be something that might be interesting in some countries where it can work. What our book is providing a little bit of information about the current financing cost and the investments required of the household, the cost savings we can achieve through building but in our ETP 2012 publication, we have a full chapter that discusses the financial options that is available for energy savings in different sectors of the economy.

Sean Esterly And we have a good follow-up question on the financial part, could you please comment on the common perception that there is a lack of funds for energy projects and that's the reason why these projects don't take off. So, given that many funding options are available and clients still don't implement these energy projects. Do you know why that might be occurring?

Marc LaFrance Obviously, that's the challenge. So, when people talk about the lack of investment, most of the time when we look at the building sector, it's really decided on a building-by-building case. And so, we look into something as simple as new construction and residential housing, you know, people may decide to finance non-energy efficient be benefitted over something else, or we're looking at the commercial building sector where large investment firms are interested in flipping buildings every three full years.

So, they're looking at two of the three-year payback period to flip a building and they're not looking for the longer term. But you know, there are some examples of owner-occupied buildings, a lot of Fortune 500 types of companies that have decided to take a sustainable approach and investing in long-term high performance building solution. So, it's certainly out there but to motivate the investment community to focus in on the deep retrofits or major improvements is a challenge without any type of public policy motivation or benefit that goes beyond their immediate interest.

So, it is a very interesting topic and it probably goes beyond the core elements. The IEA has something to work on financing with some of our other publication and so I would suggest to the person that asked that question to send me an email and I will forward you our publication on finance for more reference. Thank you.

Sean Esterly Very good. And to the person that asked that question, I will message you through email in just a second. I know you touched on this, Mark in your presentation a little bit but could you talk a little bit more about the major differences between hot and cold climate building technology and the associated cost implications?

Marc LaFrance Okay, thanks Shaun. So, in the book, we do talk about the climatic concerns when we look at various technology solutions and policies that are recommended and the first, most obvious point is that depending on how much heating or cooling load you have, it's a direct factor in how cost-effective something is. So, if you can imagine the same solution, it has a fixed price, but you're only using the product half as much, then obviously the cost-effectiveness is diminished.

And so we explain this in detail and give a pretty extensive chart to show lots of examples of how climatic conditions are a concern. One of the biggest challenges is the mixed climate that had both the heating and the cooling load but let's say it has a little bit of both and not a severe

situation, those could be the most challenging because you need to pretty much invest in a cold climate solution as well as a hot climate solution.

And so, we do explain this in the book quite well but it's quite difficult to go into any more detail in today's call.

Sean Esterly — And the next question is, how important is it to brand programs so you can help with market transformation? Could we develop an international brand that is similar to Energy Star so EE is recognized globally and consistently?

Mike — Well, Shaun, there's been many brands for energy efficiency beyond Energy Star that does predominantly components and equipment, of course it does buildings as well. But we also have a lot of the sustainable green building programs that we have in this book. But at this point in time, we're not saying we need to supplant any of those programs. We probably need to expand what we're doing and I think replacing what we have to something new is not necessarily the answer. The answer is how do you get all these pieces together, how do you integrate them? How do you come up with an integrated policy package that takes everything into account? It's probably much more important than just one particular brand recognition.

But one of the key things we mentioned in this publication is that so many people have tried to take solutions from developed countries and just move those over into a developing country and any solution has to be adapted to the local culture, regional considerations and so it's very important that these solutions are applicable to the market that's doing it. So actually, I probably would think that might not be the way to go but it's certainly welcome for debate. Thanks.

Sean Esterly — And the next question is, how are your policy recommendations built into [inaudible] [1:12:23] Green Star building rating systems, GRIs, all of those?

Marc LaFrance — Okay, when you say how they built into it, so again, that would be a good way to have a little discussion with the person that raised the question. But we certainly mentioned many of those programs that you just described and so for example, one of the concerns that we raised is that some of these green sustainable programs such as the Green Buildings Program or the Green Program, sometimes, because of the way that they provide the accredits which goes way beyond energy efficiency, which include the embodied energy, for example, the previous question or some of the environmental factors which are very important.

But it's not unheard of that somebody would have a silver lead building consuming less energy than a lead platinum building. So, we are obviously calling for much more stringent efforts on energy efficiency which includes the labeling programs as well as leading to mandatory programs.

People are also recommending flexible building codes which gives the builder the flexibility to pick and choose the items that they want to achieve performance.

But we're also saying that there needs to be a minimum quality of performance for every component to ensure that we don't have a really deficient area. So, we would say that all of these programs that have been very effective in educating the public and getting their attention, just needs to be strengthened for energy efficiency. So, for example - how hard would it be to say, okay, if you're going to have one of these labeling schemes, you cannot have electric resistant peters for water or for space heating in the building.

And then someone will say, "Well, we have such a small load of heat anyway. We don't need a heat pump." Well, the truth is, you could have a small capacity heat pump that's very cost-effective and you certainly could do better. Anyway, that's kind of a long answer and I don't want to get too long here but that just gives you a quick flavor for what we need to address.

Sean Esterly All right, that was the last of our questions. So, Didier and Mark, thank you for the outstanding presentations and discussion. And before we take our quick survey, I would just like to provide the two of you a quick opportunity to provide any additional or closing remarks that you'd like to make.

Marc LaFrance Well, I just want to say first of all that this is an extensive team effort and John Dulac and Nathalie Trudeau and I, we work extensively on this book with the excellent leadership of Cecilia Tam who's our unit head. And this type of thing would not be possible without the significant team effort as well as major contributions from many reviewers. We got lots of improved data and content from people.

This is the type of project that you never can get enough. In other words, there are still additional areas that need more research but it's quite an extensive set of work that will significantly move the knowledge base forward to building. This is a type of publication that even if you're the world's best expert in a particular element of building, you can learn from this book.

If you're a beginner, it's so much extensive it's going to be helpful to you. I have been working in the building sector for 20 years and I've never seen something that spans so many different areas and myself to doing this project and working with excellent team members. I've been able to learn a significant amount as well.

So, hopefully, people will have a chance to get the book and learn from it and then together, we can try to move towards this sustainable future. And so, I also want to thank the solution center for hosting today's webinar and we look forward to continue to work with you on a variety of other

projects that the IEA is working on and I want to thank all of the participants for spending the time and please, if you don't do anything else today and you think this was knowledgeable, send a link to the book to some of your friends in your networks and give them some information about how they can get to access the material. So, thank you so much.

Sean Esterly Okay, thank you again, Didier and Mark. And now, we just like to ask our audience to take a quick minute to answer a survey on the webinar you viewed today. We have four short questions for you to answer. Your feedback is very important so that it allows us to know what we're doing well and where we can improve.

The first question is the webinar content provided me with useful information and insight. And the next question, the webinar's presenters were effective. And next question, please, overall, the webinar met my expectations. And last question, how did you learn about this webinar?

Very good. Now thank you very much for answering our answering our survey, and on behalf of the Clean Energy Solutions Center, I'd like to extend a hearty thank you to all of our expert panelists, Didier and Mark and to our attendees for participating in today's webinar. We had a terrific audience, a lot of good questions. We very much appreciate your time.

I invite our attendees to check the Solutions Center website over the next few weeks if you would like to view the slide and you can also listen to a recording of today's presentation as well as any previously held webinars.

Additionally, you will find information on the upcoming webinars and other training events and we also invite you to inform your colleagues and those in your networks about solution center resources and services, including the no cost policy support. I hope everyone has a great rest of your day and we hope to see you again at future Clean Energy Solutions Center events. This concludes our webinar.

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