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Policy Options to Scale-up Solar Heating and Cooling

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Toby Couture

Good morning, everyone, and welcome to the International solar Alliance expert training course. This is Session 45 in n this training series focusing on policy options to scale up solar heating and cooling technologies. I'm Toby Couture from E3 Analytics and I'll be giving this training session. This training series is supported by the International Solar Alliance and the Clean Energy Solutions Center and this training is part of Module 8, focusing specifically on the issue of solar heating and cooling. Quick overview of the presentation, we'll look at the basic learning objective, the core of the presentation, followed by some concluding remarks, there's also a number of references for further reading for those of you interested in diving a bit more deeply into this topic, followed by the knowledge check at the end with a few multiple-choice questions.

So let's dive in. The focus of the presentation is to understand solar heating and cooling policy, understand how policies can be used to scale up the use of solar heating and cooling, understand which policies have proved most effective in scaling up the market and understand the role of policy and driving overall technological change and cost reduction in the second one. So it's important to understand from the outset that heating and cooling demand matters. It is a massive part of our energy mix, and, in many jurisdictions, it represents the majority of actual building energy use. You can see here that water heating, space heating and space cooling accounted for over 70 per cent of the energy used, and in the EU, the share of energy used in heating and cooling is estimated at over 50 per cent.

So again a very substantial part of the market is in heating and cooling. We often focus in renewable energy policy on electricity policy and the focus on

electricity policy is partly a legacy that goes back to the 1970s and '80s, from the beginning of renewable energy policy in the formal sense, where the focus was on trying to get new technologies like wind power and solar power as well as bioenergy technologies to produce power scaled up and mature. Now that those technologies are increasingly mature and increasingly cost competitive was a growing interest in scaling up the development in the heating and cooling sectors, recognizing, in a way, that the global community, researchers, policymakers, analysts have broadly ignored the heating and cooling sector. Now it's important to underscore the sector hasn't been ignored entirely. There have been some areas and jurisdictions around-the-world that have made this a priority.

There've also been some jurisdictions that have really invested quite a lot in terms of R&D, in terms of subsidies and policy supports for the heating and cooling sector, particularly district heating but, again, the focus overwhelmingly in terms of renewable energy policy has been on renewable electricity policy and one of the focuses, one of the goals with this training is to try to open up a little bit more the world of renewable heating and cooling policy and provide a comparable kind of overview of some of the main tools, some of the main policy tools and instruments available in this sector. Most of the markets that have a substantial share of solar heating and cooling in their energy mix, particularly in the household energy mix, like Barbados, Cyprus, Israel and Spain, have relied, directory or indirectly, on mandates to install solar thermal technologies in new or existing structure. Mandates have been among the most widely-used tools and continue to be adopted even today in 2019 in new jurisdictions around-the-world so although solar thermal technologies are increasingly cost-competitive, are increasingly economic and increasingly attractive, a number of jurisdictions perhaps partly because they're becoming so economically competitive are starting to say, "Well, why don't we just mandate? We just make them obligatory in new construction or even, in some cases, as we'll see in California, mandating them in certain cities in California in all retrofitted buildings, the use of mandates is one way to really galvanize the market and create demand for the technologies, give suppliers and installers a rapidly-growing market that they can serve and further improve, further reduce costs and further improve installation quality as well as product quality. So mandates can really help drive the market towards maturity by requiring it in buildings, which, again, creates that leads to a more mature installer-and-service service market.

We see this also in China, which is and remains the world's largest solar thermal market in terms of installed capacity with a very significant usage across-the-board in the residential and commercial sector for solar thermal technologies. The labor force is there in markets where the labor force isn't there and where those skills aren't there it's very difficult to galvanize the market so there's a bit of a chicken-and-egg problem. One of the things that policymakers can do is, again, catalyze the market by focusing on awareness-raising by introducing policies like mandates and obligations as well as by providing targeted incentives and supports as we'll see in the coming presentation. So often these mandates have not been stand-alone. They have been supported by a policy ecosystem with a range of different instruments

and a range of different tools, including direct financial incentives, like rebates and grants as well as things like low-interest loans so that households can borrow to finance the systems.

Now for households that have as in most parts of the world that don't have disposable, sufficient disposable income to buy systems in cash, access to finance really matters and we'll get into that a little bit more in the slides ahead. The importance of solar heating and cooling technologies is likely to grow significantly in the years ahead. There is a push underway to scale up renewable energy sources across the electricity, heating, cooling and transport sectors and the heating and cooling sector is really ripe for significant scale-up. As we said in addition to the focus on the electricity sector in terms of renewable energy policy there has also been a bias predominantly towards the heating sector when focusing on heating and cooling so, in other words, heating has benefitted from much more attention in terms of solar heating than solar cooling has. And we touched upon this in another training session, Session 44, looking specifically at solar heating and cooling technologies with some case studies where we look more closely at solar cooling so if you're interested in that, I encourage you to have a look at that presentation as well.

A key factor here is that air conditioning demand is growing at a rapid pace, in the cooling sector, driven by economic growth and rising living standards. Air conditioning is often considered an aspirational purchase. It's one of the first things that households in developing countries in emerging markets purchase when they have sufficient resources. Air conditioning units individually are quite cheap with a few hundred dollars. It's within the range of affordability for a growing number of urban residents in developing countries and, again, that's one of the reasons why sales are booming. In India for example as we saw previously and was also underscored in Training Session 44, AC sales have grown from approximately 2 million units in 2006 to approximately 30 million in 2018 just demonstrating just how rapid the growth in need or rather the growth in demand for cooling is.

Air conditioning represents approximately 40 per cent of power demand in cities like Mumbai, in India so, again, a major piece of the puzzle and this underscores again why the greater focus on solar heating and cooling technologies is so timely and so important. Of the 2.8 billion people worldwide that are living in the hottest parts of the world, only 8 per cent currently have air condition systems. This underscores the tremendous opportunity and yet as this development occurs in emerging-market cities around-the-world be it in Latin America, MENA Region, Asia and even in the Pacific Islands Region and Oceania, policy lags behind. Policy on solar cooking is almost non-existent. Policy on solar thermal in general is growing but remains again far from where it could be in light of the tremendous market need and in light of the tremendous demand for affordable heating and cooling solutions. As renewable energy sources like solar power, solar thermal can more cost-effectively provide and meet this tremendous market need. We're going to see much more demand and a need for, again, fully

supply chain fold skills of installers, manufacturers across-the-board to really get the sector scaling up to better harness its potential.

In rapidly-industrializing countries like India, this shows why the focus on this is so important today and so important on this even if we limit the focus strictly to new construction estimates suggest that fully 75 per cent of buildings that will exist in India in 2030 have not yet been built. So you can really see that if we don't get this right, if we don't get this right through building codes, if we don't get this right through mandates and through other obligations to include solar or through simply support policies, there's a tremendous opportunity missed and a lot of inefficiency gets baked into suboptimal building design infrastructure. We have the technologies. We have the knowledge. We have the case studies showing the cost effectiveness of solar heating and cooling technologies, it's time to put that into practice in more markets around-the-world and this is really where the question of policy is front-and-center.

This again puts policy in the way in the spotlight, in particular smart policy to try to influence the trajectory of future energy demand and, indeed, of emission because in the heating and cooling sector the two are intimately linked. So let's have a closer look at some of the main policy tools in the tool kit for solar heating and cooling. Why is policy still necessary to support the sector? If solar and heating technologies are mature, if they are cost-competitive, won't the market simply adopt them on its own, won't demand if were cost-competitive why aren't we seeing homes and businesses around-the-world including in markets like India and China and Indonesia and Brazil adopting solar heating and cooling technologies on their own? The short is that despite increasingly attractive economics, there are a number of barriers that continue to hold the sector back.

Let's unpack that a little bit in a slightly longer answer. Solar thermal technologies often have a high, upfront cost. Compared to an air conditioning unit for example in the cooling sector that can be purchased for $100.00 or a couple hundred dollars in most markets around-the-world solar cooling technologies are multiples of that so the upfront cost is significantly higher, which puts it out-of-reach for a significant number of households in terms of affordability. Now if you look at the challenges in affordability there is essentially what can be considered a type of affordability curve that as the price of the unit decreases it becomes affordable for a greater number of the population, a greater percentage of the population. As the cost of the technology increases down the curve there's this ever-shrinking share of the population that can afford this using their disposable income so this affordability curve gives you a sense of and which would differ by country and by market that many households simply do not have several hundred dollars to spend on the high upfront cost of a solar-thermal system.

Even if they do they would often rather spend it elsewhere on other goods, be it mobile phones, better television set or household appliances like better oven range or dishwasher, clothes washer and so on. So solar thermal and solar heating and cooling technologies are not necessarily top-of-mind for

many people around-the-world not only in emerging markets but also even in North America, in Europe, in countries like Japan it is not frequently a top-of-mind purchase because energy costs are considered just a part of life (you get a utility bill, you pay your costs as they are) and with an air conditioning unit you're also in control and you can modulate it. If you don't have enough money this month to afford a costly electricity bill you can save on your usage and simply not turn your air conditioning unit on or at least turn it on less or less frequently. With solar or thermal technologies once the system is installed the upfront is there and you ultimately need to pay it be that through a loan or through the sum cost of the initial CapEx. So it's a different kind of purchase and a different kind of system.

The widespread lack of awareness continues to hold the sector back in that many people don't really know how cost competitive solar thermal technologies are, in particular solar cooling technologies. This lack of awareness again impacts consumer behavior because when people are looking at building new homes, building new apartment buildings, again, it's not frequently on the radar and so there's a significant amount of progress to be made on the question of awareness alone. Also surveys from different countries around-the-world on consumer behavior underscore that there are still persistent concerns over performance and reliability of solar thermal systems. If you look at just at solar hot water systems, which are probably the most widespread application of solar thermal technologies, in particular flat plate collectors. In some countries the performance standards are fairly low or there are none, which means that the products are manufactured locally by relatively small companies and may not meet sufficiently high reliability and performance standards to build trust in the market so a major barrier in many countries remains the question of trust. Do customers trust the technology that it's not going to break down, that it's going to last for 10 if not more years and that they won't run into issues in terms of reliability or intermittency of access to, for example, hot water?

So that's a big issue. A further challenge is one that we underscored previously is that there's often a lack of qualified manufacturers as well as qualified installers. The installation matters and getting quality product in the market also matters and this is not the case in every jurisdiction around-the-world, particularly sub-Saharan Africa and in parts of the MENA region and parts of Asia, still very heterogeneous product markets, which leads to varying quality across-the-board. A further challenge here is that even if there are high-quality products available on the market they're often significantly more expensive so if you're looking at a solar thermal system that might cost, say, $1000.00 versus one that's going to cost, say, $3000.00, the $3000.00 system is going to have, likely, much better performance, much better longevity, overall, lead to happier customers but the price point matters. Customers are often hesitant to buy the-top-end product and will rather what economists called satisfice by buying a product that's more in the middle or the lower-middle of the product range.

In developing countries it's even entry-level products that are more often widely sold. Similar dynamic is seen in cooking sector where the cheapest

stoves are often the ones that sell the best just because those are the ones that people can afford not because they're the ones that people can afford not because they're the ones that people that will lead to the greatest consumer satisfaction or greatest energy efficiency so a host of issues there. Further challenge why policy is necessary is because there's a lack of reliable quality standards. In many markets standards don't exist or are just being put in place, which, again, leads to or connects to a host of the other trust and performance-related issues that we just discussed. Solar heating and cooling systems typically require suitable roof space, which can be a major barrier for many, particularly living in multi-unit residential buildings, solar heating and cooling systems can be blocked by nearby construction, especially in rapidly-developing urban megacities in developing countries, nearby construction pops up from one month to the next with large hotels, high rises emerging where there were only single-story or double-story housing and buildings before, often in formal construction. So if you are a household for example living in the outskirts or in the peri-urban areas of Dhaka and Senegal or outside of Nairobi or Lagos in Nigeria that's a significant risk, the idea of investing in a solar thermal system that could be blocked by neighboring construction is a significant deterrent to investment. Some of this has been addressed, again, underscoring you might be wondering, well, what can policy do about that?

In certain jurisdictions like in Portugal as well as in certain parts of Spain, laws and local bylaws are being adapted and implemented that include a so-called right to the sun where essentially the sunlight is protected and nobody can build you know in such a way that will shade unduly the neighboring buildings so by securing a right to the sun, in law, you change the overall building landscape and restrict fundamentally building height. Now that may work in cities in Portugal or in cities in Spain where the construction sector is more mature and where housing and growth is not as rapid. Some would question the applicability of these kinds of right to the sun laws in emerging market cities. So again there's "context matters" but it does show that even policy can address even certain intangible risks like these. And as we saw also in the previous slide skills are often lacking, installation quality remains a big issue as does product quality and, by and large, the construction industry has not yet mainstreamed the installation of solar heating and cooling in their practices so it's not a core part of American … it is in a few select markets.

We mentioned Israel, Barbados and some markets like Cyprus in The Mediterranean and certain Greek islands and certain parts of Greece and Italy. It is fairly mainstream because there's demand for it and people clearly see the cost savings but this is far from the case universally. Historically solar heating and cooling technologies and scale up has been supported by a range of different policy tools. I would discuss mandates. We also discussed low-interest loans. Some cities are starting to use even things like bulk-buying programs to support the adoption of solar heating and cooling technologies, essentially putting out a call for all citizens who are interested in participating in a bulk buying program that they can get it at a reduced price from a reliable, certified installer and that's something that local governments can take into hand by putting the awareness out there, putting the option out there

for households who are interested in getting a volume discount to be part of a bulk-buying program so we're seeing some innovative attempts and approaches to try to scale up the market further using policy tools like that and we'll look at a couple examples in the slides ahead.

Interestingly solar thermal technologies are also starting to be purchased on a third-party power purchase agreement basis, effectively purchasing on a dollars-per-unit basis from locally-sited solar thermal projects. So for commercial applications and institutional applications like universities, colleges, schools, hospitals, hotels even the possibility of buying heat, essentially, on a dollar-per-unit basis is increasingly cost-effective, is increasingly cost-competitive with the heat cost of a unit of natural gas or a unit of heating oil or even a unit of electricity if the heating is provided with electricity. So with that rising-cost competitiveness it becomes possible for institutional buildings, companies and so forth to actually buy renewable heat from solar systems on a per-unit basis just like they would buy solar electricity on a per-kilowatt hour basis so there's new business models are opening up new potential there. Innovations in these kinds of business models, like third-party leasing where the systems are not owned but rather leased and third party PPAs have the potential to significantly reshape the market, we are seeing some experimentation around this was ESCOs and similar companies doing third-party solar thermal and the likelihood is that this will very much continue to grow as awareness spreads and as the technology because more widely known and the business model because more widely recognized, however, in some cases, in many cases, such business models require changes in enabling regulations and sometimes even changes in the law. So just because a business model is working on jurisdiction it doesn't mean that it can automatically be scaled up in the next and that, again, underscores the need, even in cases like this, for policy.

Policy doesn't necessarily need to mean subsidies and rebates. It also means things like supporting enabling regulations and changes in law to unlock market growth. Another really important change, before we dive in to the individual solar heating and cooling policies that has made a lot of this, a lot of the sector more mature and easier to scale up is the emergence of the improved metering technologies, metering technologies that can meter the usage of heat in individual applications, be it in individual households, even individual appliances. Using hot water, for example, metering technologies are making it possible to coordinate that across a wide range of different appliances from one solar thermal system and those metering innovations are what enabling, for example, multi-unit residential buildings to co-finance community-scale or building-scale solar thermal systems and to jointly benefit from the renewable heat provided so, again, lots of innovation, lots of business models to emerge to unlock the sector, unlock some of the potential. So with that let's dive into the Policy Toolkit. First on the list is Mandates and Obligations.

Mandates are effectively an obligation to install solar heating cooling on particular building types. In some cases they focus only on commercial or only on institutional, like, public buildings. In other cases they're based

on the square meterage so if a building, all the buildings beyond a certain number of square meters can be required to install solar heating and cooling applications. These kinds of mandates are also referred to as "Solar thermal Ordinances" often introduced, again, by city governments. Mandates like this are typically technology-specific (in contrast to building codes, which are technology-neutral).

So in other words a building code will say, "Buildings…new construction needs to meet this particular energy performance standard" or "this particular energy efficiency standard" or "this particular energy usage per-square meter per-year standard." There's detailed performance standards down to that level of specificity for new construction. These are particularly wide-spread now and being implemented across Europe. Those kinds of building codes are often technology-neutral. In other words they set the standard and building owners and developers are left to their own devices in terms of choosing which technologies should be used to best comply with the standard. So those are kind of … there's less direct ways of encouraging the solar thermal sector than this policy tool Mandates and Obligations or solar thermal ordinances, which really are stipulating and mandating the usage of that technology in a particular building type. There are lots of examples of these kinds of ordinances around-the-world.

One of the first European cities to approve a mandate for solar thermal systems was the Solar Building Ordinance in 1999, which came into force, in Barcelona, in 2000. The mandate requires that all new and renovated buildings use solar energy to supply a minimum of 60 per cent of the buildings running hot water needs. Now while hot water represented on average only 13 per cent of households' energy consumption across the EU in 2009, in Spain the share has been estimated at 27 per cent and even 28 per cent in Barcelona, itself, so a much higher share of the overall household energy consumption, represented by hot water.in certain cities. Now in that context requiring this can make a lot of economic sense and it can also help alleviate stress on the grid from producing either the gas grid from _____ _____ _____ grid _____ the heating is provided with electricity. The second main tool is the use of Grants and Rebates. Grants and rebates are effectively direct cash incentives offered for the purchase of renewable heating and cooling technologies, like solar thermal systems.

The grants are typically offered upfront and are often capacity-based $/kW installment. Rebates are also often structured this way and are available upon demonstration of the proof of purchase so once you buy the system you get the money back. These kinds of rebates and grants can also be structured as per centage of project costs rather than a lump-sum amounts so $3000.00 or, say, $800.00 per-system or up to a certain threshold size per-kilowatt or they can be structured as a per centage project costs like, for example, it will cover up to 30 per cent of eligible project costs up to a maximum of $500.00 or something like that so combining various caps and eligibility restrictions on the grants and rebates. Many markets around-the-world have used these kinds of tools and many continue to today. A couple of examples: The Concerto project launched in the EU offers grants that are capped as a percentage of

total project costs to support solar heating and cooling investments. The city of Itabashi in Japan offers grants similarly for solar thermal systems that cover up to 5 per cent so it's fairly small amount of the initial costs up to a maximum of $425.00 USD.

So fairly small grants but, again, this is designed to signal to the market that there are public funds available and can help tip the market. A third tool is "fiscal incentives." Now "fiscal incentives" automatically means instruments that use the tax code so either tax rebates or tax exemptions, exemptions, for example, on VAT, in some cases, even reductions on import duties as well as the use of things like investment tax credits or accepted depreciation kinds of incentives. Those are all various forms of fiscal incentives, can be used and targeted to the solar heating and cooling system and you can see here a few examples. The US is quite common, quite common and uses the tax code, Australia as well as France. At a city level in Washington, DC they introduced a personal property tax exemption for investments in various renewable energy technologies, including solar thermal and solar PV systems so, again, city-level incentive supplementing the existence of other incentives at the federal level.

The US federal government also offers tax incentives for solar investments in solar thermal so various fiscal or tax-related tools. A forth is using "Fees and Levies." So essentially you can support a technology to make it cheaper by offering grants and rebates and fiscal incentives or you can make other things more expensive to thereby shift the competitive landscape in favor of heating and cooling technologies that use solar or that use renewable energy sources. Some restrictions are trying to level the playing field in precisely that way by adding taxes or fees or fossil or emitting sources of heating and cooling so, for example, energy taxes or carbon taxes specifically fossil fuel-based heating fuels such as natural gas or home heating oil are being used in some sectors to scale up the sector in the greater use of solar technologies. Such fees can provide an important signal to the market while narrowing the cost gap or even making solar even cheaper than what it is against current technologies without adding on tax changes.

It's important to underscore that in many jurisdictions fossil fuels for home heating benefit from various kinds of tax exemptions, too. So home heating fuel is commonly exempted from value added tax or from sales taxes in many jurisdictions, which means that the level playing field is not, the playing field itself is not that level to begin with and repealing or tweaking or adjusting, revamping fossil fuel subsidies for a range of different fuels can also be an important policy measure to help, again, level the playing field for renewable technologies like solar. In countries such as The Netherlands and Denmark, several energy and environmental taxes are imposed on fossil fuel use, including on home heating fuels, which, again, tilts the playing field towards renewable sources. In Vermont, the US state, representatives voted recently to increase the taxes on home heating fuels specifically in order to encourage the greater adoption of renewable options such as solar thermal systems. You can see then in these cases how fees and levies can be used to shift market behavior and consumer behavior.

The fifth: Financial incentives. Now what's the difference between fiscal and financial? "Fiscal" deals with the tax code; "Financial Incentives" is a broader category. You could argue that financial incentives include many of the things we talked about previously (grants and rebates and those kinds of things). What we mean here by "financial incentives" is things that facilitate the financing specifically, like the revolving loan funds, soft loans, on-bill financing as well as performance-based incentives that facilitate access to financing or help improve the bankability of solar heating and cooling technologies, for example, many jurisdictions around-the-world offer low-interest loans for solar thermal systems, both residential and commercial systems. A number of utilities are starting to offer on-bill financing to basically allow you to pay off your system through a surcharge on your utility bill every month and some jurisdictions, like the UK, are even using performance-based incentives in the form of, for example, the UK's renewable heating incentive where they actually pay for heat that's produced and it's metered just like a feeding tariff.

It's essentially a feeding tariff for heating sources. So you can see here that these are all financial types of incentives that improve the bankability of these technologies. Such incentives can play an important goal in driving adoption and make it easier, of course, to get banks involved. Banks will often hesitate to finance or to issue loans for solar heating and cooling technologies because either the performance is not well-known and the technology is not trusted, the due diligence requirements are too high. Banks would need to become familiar with each particular aspect of the technology and what can go wrong.

The overall willingness of banks to lend to small-scale projects like most solar thermal projects is simply not there. Many banks simply do not touch these kinds of investments. There are larger-scale solar thermal projects that are starting to emerge that are financeable by banks because they cross those various thresholds. They're big enough to be worth spending the due diligence, time and resources on but for most household systems these are too small. So what governments have done is they started to respond to that by establishing revolving loan funds and low-interest loans and including institutions or agencies that are responsible for issuing those loans to households and businesses.

For example the Municipality of Shelburne in Nova Scotia has adopted a PACE financing program that's property-access clean-energy financing that enables local governments, local homeowners rather to invest in solar thermal installations up to $8000.00 CAD per-home and to repay the loans to the municipality via an increase on their annual property tax assessment so this is a quite clever mechanism using essentially a financing program, like the PACE program, $8000.00 CAN is about $5000.00 US or $6000.00 US, which means that up that amount, which is enough to finance just about any home household system, the program is there and it enables the customer to essentially borrow through the municipality. Similarly KfW Bank offers low-interest loans for solar thermal systems as well as on a range of other innovative thermal technologies. So low-interest loans remain an important toolkit. Germany has over 2 million solar thermal systems across rooftops,

across-the-country so you can see for a country of 80, say 83, 84 million, probably half as many households, probably between 40 million households, that's still fairly small penetration but by global standards certainly not negligible in terms of the impact and, again, a significant share of these systems have been supported by KfW's low-interest loan program. "Building Codes" are similar to mandates, which we saw in the first point, "Mandates and Obligations" except that they're technology-neutral as we saw.

The building codes set out a minimum technical standard that needs to be met by new or existing construction. Such standards can drive the adoption of solar heating and cooling technologies, particularly now as the later are often the most cost-effective way of complying with these new building codes. In that regard the new European building code standards that are being promulgated are likely to encourage a significant amount of growth in the solar heating and cooling market because these standards require, effectively require the use of some level of renewable energy on-site and solar thermal is a fairly, in that regard it's fairly low-hanging fruit. Some examples: Spain, France and Brazil. So let's look at Spain a bit more closely. They adopted new building codes at a national level that cover that include a minimum contribution of renewable energy to cover demand for hot water.

The policy was introduced at a national level, adoption and enforcement is occurring at the city-level, leading to a number of local zoning, planning and regulatory measures at the city level to comply with these codes. So again you see here the policy's not just about introducing one tool and leaving the market to the rest, policies work best in concert and, like any good symphony, you need more than one instrument and the instruments need to be operating in unison or in some degree of harmony with one another to lead to the best, the best outcome. New building codes stipulate the standard which building owners and builders can use to meet the technologies. Solar thermal is increasingly one of the most cost-effective ways of complying with these kinds of building code standards and that's therefore one way to drive the market forward. "Public Procurement and Direct Investment": Procurement policy can play a big role, essentially governments leading by example. This is one way of catalyzing the market, of catalyzing investment in solar heating and cooling technologies while creating more awareness and more visibility for solar heating and cooling technologies.

There are hundreds of examples across Australia of local governments using solar thermal systems to … and financing them, directly, out of municipal budgets to provide hot water for athletic facilities and pools for example, swimming pools, and given that such a significant portion of the community goes to the pools, people see the technology, they see that the system is being powered this way or is being heated this way and it generates a conversation, a conversation that can, in the months or years to follow, lead to households making the same decision so the visibility of the technologies bringing them out into the market can be another important way to scale up the industry. A couple of examples: There's a large-scale district thermal network investment recently made in Graz, in Austria, to develop a centralized, large-scale solar thermal system that feeds solar energy directly into the district

heating system throughout the year. When it's completed later in 2019 the system will be the largest in the world, a total of 15MWth and almost 1 million m³ of water storage, a very significant public investment renewable energy, in solar heating. The village of Zlín in the Czech Republic, similarly, set out to invest in a large solar thermal plant to provide households, local industrial plants as well as the municipal swimming pool with hot water in its district heating system. The eighth option and policy tool in our toolkit is "soft cost reduction strategies."

Soft costs are defined as non-hardware costs. In other words they represent the additional costs associated with permitting, customer acquisition, inspections, paperwork and all of the rest required to get a solar system installed. Reduced such soft costs can significantly reduce the upfront costs for the technology for end users while also helping save customers' valuable time so a growing number of cities are starting to take soft costs seriously. Permitting processes can almost always be significantly simplified with standardized forms, simple application procedures … soft cost and _____ _____ costs in renewable energy technologies like solar and particularly residential solar and this is why the focus on soft cost is yet another way to make solar thermal technologies more affordable to end users and simplifying the process for end users to help scale up the market. It's like the behavioral economist Dan Kahneman says, "If you want people to do it, make it easy," and the easier you make it from a permitting perspective, from a paperwork perspective to invest in solar thermal the more people will do it so this is a major area where much more is being done but, again, much more needs to be done. So this is a major area where much more is being done but, again, much more needs to be done.

Soft cost reduction strategies have been adopted across a wide range of jurisdictions in the US where the whole concept of soft cost has been really popularized and discussed, including in Sebastopol, California. The city introduced a range of measures to streamline permitting, inspection and other requirements via a soft cost reduction strategy and interestingly it included a series of mandates for solar including in both existing retrofitted buildings so buildings that are undergoing significant retrofits as well as new construction. Furthermore soft cost reduction is one of the major goals of the U.S. SunShot Initiative, which, again, mainly focused on solar PV soft cost reduction but many of the same lessons are being used to scale up solar thermal applications and again help reduce soft costs in this sector. The ninth tool we touched on earlier is "bulk-buying programs" or "bulk-buying strategies." This is when the government or some organization agrees or offers to purchase particular technologies in bulk to allow customers to benefit from volume discounts. So they put forward a campaign.

They say, "If you register by August 31st you will get solar thermal system from this certified trusted installer at the following price." Because of the volume, the economies of scale, the installer can offer lower pricing and it also simplifies that for the installer because they don't need to do the customer acquisition for every individual customer. You essentially aggregate all of that demand in the market, set a deadline, say, by August 31st, register

for your solar system and that then creates a basket of projects that the installer can then execute upon and install in the weeks and months ahead. Bulk buying strategies have been shown to be tremendously successful and are tremendously popular in places where they've been used. They can also be done effectively at zero cost to the government so it doesn't even need to be government-led.

A number of bulk buying programs across the US and Australia are done by NGOs and other non-governmental organizations. So these strategies are simple, can be implemented anywhere, they play a significant role in raising awareness and because they're often connected with a competitive process to select the installer or installers that will install the systems, they can lead to and typically do ensure higher-quality installations. So this is, again, a very simple but readily scalable policy approach to encourage quote from the market. It's been used for many renewable heating and cooling technologies throughout many parts of Australia, for example in Darebin as well as in Stonnington. I probably pronounced the first one wrong there, have used both buying for solar, water and heating technologies while other cities such as Sutherland Shire are offering bulk buying for hot water heat pumps as well as well as in Healesville for solar hot water systems and solar-powered heat pumps so a wide range of programs being led by local councils, local governments to encourage the greater adoption of solar heating technologies.

The 10th and next-to-last is the use of "bans and phase-outs." Bans and phase-outs refer to restrictions on other non-solar or non-renewable heating and cooling technologies. They can help drive demand for solar heating and cooling by shutting out other technologies from the market for environmental, human health or other reasons. Safety, in some cases with natural gas, for example, some local districts have shut out, have faded, have decided to phase out natural gas from their heating mix partly in order to meet emissions reductions targets so, again, a range of motivations. Once a ban is in place it helps catalyze awareness among citizens and businesses and can lead to a wide range of investments in a number of different building types and in the process because there's a ban, new markets are created and you can get more competition among companies and that's always a benefit to consumers.

A few examples: Sweden, Denmark and Krakow (in Poland). Starting on September 1st, 2019, Krakow is prohibiting the burning of coal and firewood in boilers, stoves and fireplaces across the city, making it the first city in Poland to do so. Polling in the city has revealed that 96 per cent of residents support the ban. In response houses are going to have to heat either using solar thermal technologies or using more efficient qualifying technologies like heat pumps and other options. Similarly certain cities in China have banned the use of coal for residential heating in certain applications. Such bans drive the adoption of alternatives, including solar thermal. We've covered 10 key instruments in the policy toolkit but in addition to all of this there are a number of important enabling measures or what are sometimes called "flanking" policies that can further support the growth of the sector.

This includes technical standards and certifications processes, streamlined inspections, streamlined permitting as well as enabling regulations, as we saw in the case of third-party ownership and PPAs for thermal energy from solar thermal systems. The laws need to enable those kinds of things to happen otherwise they simply won't. Flanking policies are a core part of what has been called the "Policy Bedrock." Policy Bedrock applies across the different range of renewable energy technology costs from the early commercialization phase all the way up to the policy, so-called policy framework phase so regardless of the costs of technologies in relation to fossil fuels, in relation to alternatives, these kinds of flanking policies, like streamlined permitting, streamlined inspections make sense and are an important part of enabling/unlocking/scaling up the market. So a few concluding remarks as we wrap up. As we've seen the policy toolkit for solar heating and cooling technologies is broad.

Strategies have been shown to work best when different policy support measures are used in combination with flanking measures, in other words, with streamlined procedures, streamlined permits. Another key insight from all of this is that policy stability and predictability are also important agreements. Sudden changes in programs or in incentives can have negative impacts on market growth as well as on company development so stability matters. Also continuity matters so if there is an incentive or rebate program in place, having some degree of continuity or transparency around the trajectory of the rebates if they are going to decline over time give a schedule of decreases over time to ensure that there is some continuity and some predictability in the market. Start-and-stop policy change is never good for market growth.

Another interesting lesson learned from a lot of these solar thermal policies and programs is that policy makers should avoid creating an incentive to delay a purchase. For example if a new policy is introduced with, say, a rebate or a grant attached, starting in January of 2020 then the market essentially will die for the next number of months until January 2020 has arrived and people can start benefitting from the scheme so although the intention is good to establish a program it has the perverse effect of actually killing the market, which can really negatively impact local businesses because they essentially … business dries up as everybody wits for the scheme to kick off and the subsidies to be available. So a host of issues there with the development of policy and regulatory schemes that should not be ignored. The track record of start-and-stop development is not a particularly encouraging one. Another key aspect here is clear eligibility requirements so if you have a policy, particularly with grants of financial supports or loans attached the requirements for the technologies and the materials need to be clearly articulated including potentially via lists of eligible products or of certified installers such as via an installer registry.

So we've seen a number of certified installer registries in markets throughout the Middle East, like in Dubai as well as in Malaysia under the solar policies there and similar approaches are being used in a range of other jurisdictions. Make it clear what qualifies and it needs to be precisely stipulated in the

program rules. Another key point is that awareness matters. Efforts to increase awareness are a key part of scaling the market. Application procedures should be simple and streamlined. This comes back to our flanking policies and financial incentives are most effective when they're carefully calibrated and linked to system size.

An additional point is that access to financing is critical. As we discussed in many markets if not most markets banks are not lending to the residential solar heating and cooling market. They are paid mostly out of cash sales so they're paid essentially with savings. The need to get financing at the table particularly in lower/middle-income countries as well, even as in high-income countries, low-interest loans and similar mechanisms can be an important way to reduce that upfront cost gap and make it possible for people to participate. Similarly with PACE financing programs so if people can borrow by the municipality and pay off their system via their municipal property taxes that's another way to unlock, again, financing for the technology.

Fundamentally solar heating and cooling has an important role to play in energy security. By reducing reliance on energy imports jurisdictions including everything down to cities and towns can become more energy-secure. It can help reduce electric loads at times of peak demand as well as in the evenings when residential hot water use is high so the use of on-site distributed solar heating and cooling technologies can really help reduce strain on the grid and provide a number of benefits to the system. It creates obviously in addition resilience against rising energy prices so if you are able to meet a growing share, a substantial share of your energy thermal needs with on-site renewables then you are protected against the volatility in energy prices and additionally for a lot of local governments one of the biggest drivers is creating jobs and driving economic diversification. A large portion of the value chain in solar thermal technologies cannot be, by definition, de-localized. In other words these jobs are local, the installer markets are local, the service markets and maintenance markets are local and for many local decision makers this becomes an important factor in deciding when deciding what the city or local government can do to scale up the market further.

In light of the importance of solar heating and cooling technologies and, again, the tremendous untapped potential of solar or thermal technologies, the need for stable, long-term policy frameworks to scale up the market is increasingly clear and although we've seen there is a growing amount of policy attention and policy focus being developed and devoted to the sector, more needs to be done because these policies are still far from mainstream and overwhelmingly in renewable energy policy circles, the focus is still on renewable electricity policy rather than on policy in the heating and cooling sector and that need, the balance needs to shift with more attention being given to solar heating and cooling technologies. It's my hope that this presentation has helped in some way, in some small way shift that balance by shedding more on some of the policies and tools that can be used to accelerate growth in the sector. So with that I'd like to thank you very much for your attention and invite you to look at some of the further readings, a number of different reports and publications focusing on policy, on initiatives across

Europe and around-the-world that have been published including some major reports by IRENA and the International Energy Agency. I'm Toby Couture from E3 Analytics. I'd like to thank the International Solar Alliance for their support for this training series as well as the Clean Energy Solutions Center.

Now I invite you take a few moments to answer some multiple-choice questions. Thank you very much for your attention. I'm wishing you all a great day.