Dr. Timothy Unruh: Hello. I'm Timothy Unruh, Program Manager for the Department of Energy's Federal Energy Management Program. Welcome to First Thursday Seminars. Now in its second year, this series provides you, the Federal energy and environmental professional, with current information on critical topics that you have identified and requested. We encourage you to continue to provide us with this important feedback through the evaluation at the end of this program.

This year, First Thursday Seminars will offer training on alternative financing investments through public-private partnerships and public benefit funds, the generation and deployment of renewable energy, alternative fuel vehicles and fleet infrastructure development, procurement of energy-efficient products and the design, operation and maintenance of sustainable high performance buildings. These practices demonstrate Federal leadership in sustainability, lessen dependence on foreign oil, reduce greenhouse gas emissions, and save taxpayer dollars. They are critical to meeting the important mandates of Executive Order 13514. We hope these programs help you reach your energy, water, and greenhouse gas reduction targets.

While we present several of the most important topics, no single one is a standalone solution. Only through an integrated, whole systems approach, can we meet our executive order mandates. Visit the FEMP website at any time to view an archive of previous First Thursday Seminars and to find additional resources, technical assistance, and guidance to help your agency meet its mission critical goals. Enjoy the seminar and thanks for joining us.

Kathy Hyland: Hello, welcome to the Federal Energy Management Program's First Thursday Seminars. I'm Kathy Hyland and I will be your moderator today. This is the fourth course in this series and will focus on renewable energy. If you have not already printed a copy of the learner guide and handouts, you may want to do so now. You can do so by accessing the website on your screen, www.femp.energy.gov/firstthursday. You can also print them out after the seminar. These materials and a video archive of this presentation will be available 24/7.

Now let me cover the objectives for our training today. It is our hope that after completing this training you will be able to discuss various types of renewable technologies, their benefits, uses and limitations; discuss processes for considering renewable energy technologies for your site; discuss steps in the project delivery process from screening to procurement to commissioning; consider financing alternatives; and discuss options for purchasing renewable energy.

Our format today is simple. There will be a presentation followed by a question and answer session. And we really encourage your questions. From time to time on your screen you will see an email address, a fax number and a phone number so you can phone in your questions or use another method to send your questions in. If you'd like to speak to the instructor live, you can phone in your questions and someone will speak with you directly. So we really encourage you to do that.

Our instructor today is Dr. Andy Walker. And he comes fresh from a snowboarding accident, complete with broken arm. Andy is a principal engineer at the National Renewable Energy Laboratory. He conducts engineering and economic analyses of energy efficiency and renewable energy projects for FEMP and for non governmental clients. And he specializes in assisting various organizations to plan renewable energy projects at multiple sites.

We also have with us, live from Washington, D.C., at the Department of Energy, Anne Crawley. I will introduce Anne further in this broadcast. So without further ado, let me turn the presentation over to Dr. Andy Walker.

Dr. Andy Walker: Thank you, Kathy. It's my pleasure to be here in Tennessee. What they say about Southern hospitality is true. And if you ever make it down here I'd recommend the fried green tomatoes. They're delicious.

Let's start off with a definition of renewable energy. We use the word renewable to distinguish these technologies from fossil fuels, which are finite and will eventually run out. But the Energy Policy Act of 2005 gives us a more specific definition as electric energy generated from solar, wind, biomass, landfill gas, ocean, geothermal, municipal solid waste or increases to the output of existing hydroelectric facilities. We'll discuss each one of these technologies in a little bit of detail.

The goal that everybody's working towards now in the Federal sector is the goal that was set by the Energy Policy Act of 2005. Required the Federal government to increase its use of renewable energy for electricity to 5 percent by 2012 and then 7 ½ percent by 2013.

Another provision of the act is to provide a bonus or extra credit if the renewable electricity is produced on Federal land and serving a Federal facility or produced on Native American lands and serving a Federal facility. So if you generate 1 kilowatt hour of renewable electricity on site, you get to count 2 kilowatt hours of renewable energy credit towards the 7 ½ percent goal.

So the Energy Policy Act is a statute or a public law. That's the will of the American people expressed through their elected representatives. But then we also have Executive Orders, which as Federal employees are more like our boss telling us what to do. And Executive Order 13423 adds the requirement that half of that renewable energy counting towards the 7 ½ percent goal has to be new projects put in place after January 1, 1999. The statute didn't say anything about technologies that produce heat, but the Executive Order allows those to count towards the requirement that half of it be new.

Executive Order 13514, it's kind of a very comprehensive executive order, which has as its metric the greenhouse gas emissions. And so it establishes the greenhouse gas accounting and sustainability plans for Federal agencies. Even though the Executive Order 13514 doesn't say very much about renewables specifically in terms of prescriptive requirements, we see renewables as a key strategy towards controlling greenhouse gas emissions. So that's a very important executive order as well.

And then subsequently the Energy Independence and Security Act of 2007 does have some rather prescriptive requirements for renewable energy and Federal facilities. One is that it requires that 30 percent of the hot water in any new Federal building be produced by solar water heating. A lot of times when we do the analysis we figure out that the optimum economics occur at about two-thirds or three-quarters of the load being met by solar. So the 30 percent might be considered some kind of a minimum.

The Energy Independence and Security Act has a scale which ratchets down the amount of fossil fuel use that a new Federal building can use. Starting with a 55 percent reduction in 2010. Then going to 65 in 2015 I think. And 80 percent by 2010. And then 100 percent by 2030. In other words, by the year 2030 any new Federal building would have to use 0 percent fossil fuels.

Now we can take all the energy efficiency measures that we can, try to get the load as low as possible, but as the saying goes, you can't save yourself rich. Eventually these buildings are going to have to use energy and that energy would have to be provided by renewable energy according to the law.

The regulation for Federal lifecycle cost effectiveness, 10CFR436, used to have a 25 year limit for electrical and mechanical measures in terms of the analysis period. This law increased that to 40 years, so it gives you an additional 15 years of energy cost savings to amortize the investment. That'll make more renewables look cost effective and serves as an incentive for renewable energy at your facility.

And then finally, this act made some changes to clarify some things about energy savings performance contracting. A couple of highlights there. The law made it easier to combine appropriated funds with alternative financing funds. And it also clarifies that you can sell excess electricity from a renewable energy project on your site that was implemented under an energy savings performances contract.

FEMP has issued some guidance for the Energy Policy Act and Executive Order 13423 that clarifies some of the questions. For onsite projects agencies must retain or replace the renewable energy certificates to show that they've used the renewable energy on site in order to count it towards the goal. We're going to come back to this topic of renewable energy certificates towards the end of the hour, so I'll save that discussion for then.

But simply hosting a renewable energy project on site does not necessarily count towards the goal if your utility is using that to count towards their renewable energy portfolio standards. If your utility already includes renewable energy in the mix of power that they deliver to your site that does not count towards your goal. So the renewable energy that counts towards your goal would have to be in addition to any that's being supplied by the utility as part of their regular mix.

The rules for the greenhouse gas accounting are stricter in a sense than the EPAct 2005 requirements. And one highlight there is that when you're doing the greenhouse gas accounting you can only count the non base load carbon savings from your utility. And so there's a different accounting procedure that is used for the greenhouse gas accounting rather than the percent renewables accounting.

This pie chart shows how the U.S. uses energy now. About 30 percent of it is petroleum. That would be in the transportation sector, vehicles. Twenty-five percent natural gas is used mainly in buildings but also electric power. The 21 percent coal is used almost exclusively for electric power generation, as is the 9 percent nuclear. And this brings us to the 8 percent of our energy that we get from renewable. Thirty-five percent of that is from hydropower. That would be in the electrical sector. Twenty-four percent wood refers mainly to waste wood that's used in processing, mostly in the paper industry. So they're using the waste wood directly there on site. The 20 percent of the renewable energy that comes in the form of biofuels displaces petroleum in the transportation sector. The 9 percent wind is used to generate electric power. We have biomass waste, geothermal, and solar is currently a tiny little 1 percent. But we think there's a lot of potential to increase that percentage of solar energy in the mix.

This figure from the Energy Information Administration shows how energy use has changed over the previous years and how it's projected to change into the future. I'd like to point out a couple of highlights on this slide. First of all, if we consider natural gas at the top, we see that natural gas use has increased rather significantly over the last five years. And that's due to two technologies in the natural gas industry. One is directional drilling and the other is hydraulic fracturing. These two technologies allow them to extract a lot more natural gas out of the rock than they were previously. And the effect of that has been to increase the supply of natural gas and to reduce the price of natural gas.

But the other number that – the other line that you see increasing on this chart is the black line towards the bottom that's labeled non hydro renewables. And that's what we're talking about this afternoon. And we can see how that's increased a lot since 2005. And the EIA expects this category of non hydro renewables to increase more than any other energy resource in the future. So if we look out through 2035, there's more of an increase in the renewables in any of the other technologies.

So now we can turn our attention to each one of these technologies a little bit. Let's start out with solar energy. What are the solar technologies that are available? Well, we have photovoltaics and concentrating solar power which produce electricity. And then solar water heating and solar ventilation air preheating that produce heat. And we'll discuss each one of these.

Photovoltaics are semiconductor devices that convert the sunlight directly into electricity. And that's kind of remarkable that it can do so without any moving parts, without consuming any materials in the process. And I'd also like to mention that these photovoltaics have very long lifetimes. They come with warranties of 20 or 25 years. And the first one that was built by AT&T Bell Labs in 1954 was still producing power when it was tested 50 years later in 2004.

The photovoltaics produce direct current or DC electricity. And that has to be converted to alternating current or AC electricity with power conditioning equipment to make it compatible with your building. I like this figure because it shows the size and type of the various components that you'd have in a complete photovoltaic system. The PV modules are connected in series until the voltage reaches a voltage not to exceed 600 volts. And then we have to start another series string in parallel with that. So this figure shows two series strings of modules. Each one of those has two conductors coming out of it. Those small conductors are combined into larger ones in a combiner box. Then they go into the building to a DC disconnect on one side of the inverter. The inverter converts the DC into alternating current. So on the other side there's an AC disconnect and then the power from the AC disconnect could feed your building panel either with or without a transformer if that might be required.

As an example of this I'd like to consider the Veterans Administration Building in Loma Linda, California. We had the privilege of helping the Veterans Administration evaluate the feasibility and implement this project. The rooftop system is rated for 309 kilowatts of direct current. And that's over fifteen hundred of those PV modules. So one of the characteristics of photovoltaics is that it's modular. You start out with these small modules and they can be combined into bigger systems and bigger systems and bigger systems, all the way up to the megawatt scale.

On this flat roof the rack system does not penetrate the roof, which is a lot of concern to building owners. They don't want to penetrate the roof because they don't want to introduce the possibility of water leaking into the building. So the industry has evolved to try to minimize roof penetrations and to control the forces on the photovoltaics by controlling the aerodynamics. The photovoltaics might only weigh between 2 and 4 pounds per square foot, but the wind load might be more like 40 pounds per square foot. So it's not a matter of holding the photovoltaics up. It's a matter of holding them down. And then in some areas like California, the seismic requirements can govern the design requirements.

The DC power goes into a 330 kilowatt inverter. And that's fed into a motor control center right up near the roof of the building. A lot of hospitals do have big power serving equipment on the roof of the building, so it was easy to tie in at that point.

NREL did the feasibility study for this project. And we estimated that the system would delivery 475 megawatt hours or 475,000 kilowatt hours over the course of a year and a $60,000.00 a year savings. The VA procured this system off the GSA schedule. It's one nice thing that the GSA has provided is that you can buy a complete photovoltaic system, including design, furnish, install, commission, the whole project can be purchased off the GSA schedule. So thanks to the GSA for making that available.

A lot of photovoltaic systems incorporate this online monitoring. And this is a screen capture from that system at Loma Linda. Up at the top you can see what the system is doing now and what the environmental conditions are. The sunlight, temperature, wind speed. And then below that you can choose whether you want to display the output over the course of the day, over the course of a week, a month or a year. And I've selected year here so we can see 12 months of delivery and the annual total at 497. Remember, we predicted the delivery would be 475 and it turned out to be 497.

And then down at the bottom there's some information that helps interpret this to the employees that are working in the building and also the public that's visiting the building. What does that mean in terms of carbon savings? And then some other ways of interpreting that include how many homes does that power? What's the equivalent of automobiles on the road? The equivalent of trees planted is another common way to interpret this kind of information to the public.

This figure shows the photovoltaic resource across the United States. This would be the sunlight that would be available to power a renewable energy system. And we can see that some places in the desert Southwest, southern California, it's above 6 ½ kilowatt hours per square meter per day. Throughout most of the rest of the West it's above 5 kilowatt hours per square member per day.

and if you look in some places like western Washington state west of the Cascade Mountains, that's the cloudiest place in the country with about 3 kilowatt hours per square meter per day.

We can use that information, along with some assumed costs of photovoltaic systems and assumed economic parameters, to calculate what the price of electricity would have to be in order to result in a cost effective project? In other words, what's the value of the photovoltaic generated electricity.

This figure is shown without any incentives from utilities or state governments. So it's based purely on the solar resource. And we can see in the desert of southern California the photovoltaic energy could be delivered at a price of 13 to 15 cents per kilowatt hour. Through a lot of the rest of the Southwest, 15 to 17. Most of the country is 20 to 30 cents. And up in those cloudy places in Washington state it's in excess of 30 cents per kilowatt hour.

So you're probably recognizing that that's a lot more than people pay for conventional utility power. But it is competitive if you operate a remote generator powered by propane or diesel fuel that's not connected to the utility. Those kind of systems can have costs, the highest I've seen is for a propane generate at a park entrance station. They were paying $1.68 per kilowatt hour for the power from that generator. So photovoltaics can certainly compete with those kind of standalone systems. And up until 2004 those kind of off grid systems that were not connected to the utility represented the bulk of the market. Due to utility and state incentives since 2004, the bulk of the market has been with the grid connected systems, which do displace utility electricity.

This map is the same map except now we've got the effect of incentives considered. So states like California and several others have incentives such that the price of the photovoltaic power is less than 5 cents a kilowatt hour. That's going to look cost effective to anybody doing a project. So by taking advantage of these incentives they do cost effective projects.

And so if you see the whole state colored out that's a state incentive. And then in some places like Colorado and Texas you can see where individual utility territories have rolled out their incentives.

What about solar thermal applications? Systems that can deliver heat are categorized according to their temperature. Low temperature systems, which are used primarily for swimming pool heating, represent about 90 percent of the solar water heating market. They can be very low cost and yet high efficiency because they're not operating at a high temperature. And then medium temperature would be used for domestic hot water. Things like cafeterias, laundries, billeting. Any facility that uses hot water. And especially seven days a week. Like hospitals and prisons use hot water seven days a week, so they're perfect applications for solar water heating.

And then high temperature refers to generating a high temperature heat for an industrial process. Frito-Lay, for example, uses solar energy to fry Sun Chips at their facility in Modesto, California. But it could also be used for absorption cooling or principally electric generation is what we were referring to here where the high temperature heat is used to generate electricity.

This is a schematic diagram of a solar water heating system. There's lots of schematic designs available. I like this one because it has redundant freeze protection and it also protects against overheating. We first used this schematic on a school in Phoenix that we knew was going to be closed in the summertime. And it worked so well there that I've been recommending it for a lot of projects ever since.

Basically the way it works is the loop with the solar collector in it circulates a propylene glycol solution. That's transferred to the potable water by means of a heat exchanger. So we need two pumps to circulate both the propylene glycol solution and the potable water. Those pumps can be turned off either because the solar collector's too cold or because the solar preheat tank is too hot. And when it's in that condition the fluid from the collector drains back into that drain back tank and it protects it from both freezing in the wintertime and overheating in the summertime.

This map shows the cost of energy delivered from the solar water heating system with the effect of incentives included. So the first thing you notice is that not as many states have incentives for solar water heating as they do for photovoltaics. Couple noteworthy ones there are Oregon and Arizona. And there’s also some utilities in Texas and so forth that offer incentives for solar water heating as well.

But to draw some conclusions from this, in the southwestern US the solar water heating can deliver energy at about 7 to 9 cents per kilowatt hour. In the rest of the West it’s 9 to 11 cents. Up in the Midwest it’s 11 to 13 cents. And in the cloudiest places in the country it’s 13 to 15 cents per kilowatt hour.

So for most of the country in that 7 to 9 to 11 cent per kilowatt hour range, solar water heating is cost effective when compared to electricity. Even without an incentive. And it can be cost effective when compared to other more expensive fuels like propane or oil. But it’s generally not cost effective when compared to natural gas given the price of natural gas today without some kind of incentive or without some kind of a goal that you’re trying to meet.

Here’s an example of solar water heating at a Social Security Administration building in Philadelphia. There’s 180 evacuated glass tubes in a rack that absorbs the solar radiation and impart that to the water that’s circulating through the recirculation loop of the building. The 27 square meter system costs $37,000.00 and delivers about 36 million BTUs per year. The bar chart shows how the output really does vary throughout the year. It’s quite low in the wintertime due to heat loss off the collector and a reduced solar resource. But in the summertime it’s producing over 4,000 mega joules, which are almost equal to a million Btu per month.

Concentrating solar power uses curved mirrors to focus the solar radiation onto a pipe that runs down the focal line of the mirror. This can achieve the high temperatures that are required for either the industrial processes or the electric generation.

An example of this is a 17,000 square foot system at a Federal correctional institution in Phoenix. There’s a 23,000 gallon storage tank in that steel shed to the right of the photograph. And then from there the hot water is delivered to all the buildings in the prison through about 2 miles of underground distribution piping.

The system delivered over a million kilowatt hours in 1999. Which was about 87 percent of the prison’s hot water requirement. The system was installed under an energy savings performance contract. So of the $77,000.00 that the prison saved in 1999, 70,000 of that was paid to the energy service company and $7,000.00 was retained as savings by the site. So they were able to achieve that savings without any capital investment, without any performance risk through the mechanism of energy savings performance contracting.

This map shows the concentrating solar resource, which is a little bit different than the resource that we were looking at for photovoltaics because it uses only the parallel beams of sunlight that are coming directly from the sun that can be focused by a mirror.

Solar ventilation preheating uses a perforated metal plate to absorb the solar radiation. And then it draws ventilation air in through the small holes, through the small perforation holes. And so it’s a very simple technology. It’s just perforated metal siding. This figure shows how it would be combined with a fan and ductwork to deliver preheated air into a space.

A system like this would be used in a industrial facility. If I had a commercial building, it would feed the preheated air into the first stage of an air handling unit. In either case, either on the face of the wall or at the air handling unit there would be a bypass damper. So if the thermostat in the room is not calling for heat that bypass damper would open and allow the fresh air to come in without being preheated.

These are some photographs of this kind of siding installed at a building in Canada and also a helicopter hanger on Fort Carson, Colorado. It's used exclusively for preheating outdoor ventilation air. And that's really the only thing that it's good for. It is also used for crop drying in California and Latin America.

So if we figure out the cost of delivered energy from this technology, we see that for most of the country, certainly along the Canadian border and through the Rocky Mountains, that those are the best places for this technology and can deliver heat at less than 50 cents per therm. I think natural gas right now, at least in Colorado I think is like 49 cents a therm. So this is the one solar technology that I can share with you that does compete with low price natural gas.

And notice that the sunbelt – that the desert southwest is not the best application for this technology. The best application is actually up along the Canadian border. And that's because they can use the heat more days of the year. The only place where this technology might not make sense would be like southern California, southern Texas, Florida. And the reason for that is even though they've got plenty of sun, they can't use the heat.

This is an example of this technology installed on a chemical storage building at an EPA laboratory in Golden, Colorado. The 300 square foot system preheats about 2,000 CFM of ventilation air. We measured the efficiency of this system at 58 percent. And so not only is this a cheap and simple technology, it's also highly efficient. And the 58 percent is more efficient than the other technologies. For example, photovoltaics might max out at about 20 percent efficiency. Solar water heating might be between 25 and 40 percent efficient. So despite its simplicity this is a more efficient technology. Saves about 60 million Btu per year and $450.00 worth of natural gas. So the calculated payback period was 13 years for this project.

How about wind technology? Small wind turbines are different than large wind turbines. Small wind turbines are designed and constructed mainly for reliability. So they have very few moving parts. They might only have one moving part where the turbine rotors attach directly to a generator.

Large wind turbines on the other hand are designed for bulk power production. They do have a lot of moving parts and complicated systems, complicated lubrication and gearing systems and control systems. And complicated systems to position the turbines into the wind.

The wind generation in the US has been increasing exponentially. And we'll see this exponential growth when we talk about a lot of the clean energy technologies. And here in 2011 it increased to over 40,000 megawatts of wind generation in the US. So even though the renewables currently provide a small fraction of our nation's energy requirements, the exponential shape of this curve is exciting. It means that there's a lot of growth in this area.

This map shows the wind resource across the country. And one thing that you can notice is that almost every state has at least some wind. California was initially the leader in wind power development in the US. It doesn't look like they have a great wind resource, but the wind was developed along mountain passes where the wind is focused as it goes through a mountain pass. So in California we have wind developments at Tehachapi Pass, Altamont Pass, San Gorgonio Pass. And so no matter what state you're in you might have those unique locations where there's good wind resource. But the wind basket of the US if you will is North Dakota, South Dakota, Nebraska, Kansas, Oklahoma and the northern part of Texas. And here they have a nice combination of a strong wind resource and flat land where it's easy to construct wind farms. So we're seeing very, very large wind developments going into those areas.

And if you look to the west, the wind resource kind of suddenly stops there. That's because the Rocky Mountains represent a barrier to wind blowing from the west. But there's a 75 mile wide gap in the Continental Divided called the Southern Wyoming Wind Corridor in Wyoming there. That's where the wind pours through. And that's a great place to put wind turbines. That happens to be where Warren Air Force Base is located in Cheyenne, Wyoming. They installed two 600 kilowatt wind turbines at a cost of 2 ½ million dollars. Enough power to generate 522 houses on the base and avoid 5,000 tons a year in greenhouse gas emissions. Over its 20 year lifetime the project is expected to save 3 million dollars in energy cost. And based on the success of this project they're planning additional turbines at that location.

How about biomass? Biomass comes to us in a lot of different forms. We have wood waste, agricultural residue, animal waste, municipal solid waste. And so what resources are available at your site and what technologies you could use to convert those to useful energy kind of depend on your unique situation. Some of the conversation options include direct combustions or burning the biomass fuel, gasifying it into a gaseous fuel, which could be used in a gas turbine. If we cool that gasified biomass very suddenly we can create a liquid fuel, which could be stored on site for a couple of days and used in a liquid fuel boiler. And then there's biological processes such as bacteria that use anaerobic digestions to break down biomass into methane and yeast that break down sugars into ethanol, which can be sued as a fuel.

This map shows the biomass resources county by county. And it adds up all the biomass resources into one metric of thousands of tons per year. So it includes all your crop residues, forest thinnings, mill waste and everything else. Even though those biomass might be of different types, they're all added together here. And what you notice is that the northwestern United States and the southeastern United States, remember they didn't have much solar resource. The northwest didn't have much solar resource and the southeast didn't have much wind power, but they're both blessed with renewables. So if you look at all the renewable energy resources, chances are good that there's some renewable energy resource in your area that you can use.

As an example of the biomass let's consider this renewable fuels heating plant at the National Renewable Energy Lab in Golden. The building there shows a bay door on the left-hand side. That's where trucks pull up and unload the woodchips into a storage bin. The 3.3 million dollar cost of the plant was financed under an energy savings performance contract. It uses waste wood from the forests. There's a pine beetle epidemic in Colorado right now, so the Forest Service removes the wood from the forest. And now this is a useful purpose for that waste wood. It provides about 75 percent of our heating requirements of three of our largest buildings on campus. Projected to save $400,000.00 a year. The woodchips cost $29.00 a ton, which converts to $2.42 per million Btu or 24 cents a therm. So that's about half the price of natural gas right now. And that fuel savings is what creates a stream of revenue to pay off the plant.

What about geothermal technologies? We can use the heat out of the ground directly to heat buildings. We can use it for electric generation. Or we can use ground source heat pumps which use utility power to run a heat pump to extract heat from the ground to heat your building in the wintertime or to reject heat to the ground to cool your building in the summertime.

The black dots on this map show where those surface resources are. So up around Boise, Colorado, and also Del Norte, Colorado, they use that hot water to heat municipal buildings and swimming pools and things like that. And we could do that at Federal facilities as well. I was involved in a feasibility study at a Forest Service nursery in Boise which was considering to use water from a hot spring to heat their greenhouse.

And then the colors indicate what's the most favorable locations for drilling down into the very hot resource that can be used to generate electric power on a large scale. And you can see that this is concentrated mostly in the western United States from northern California through Nevada, Idaho and into Wyoming. And that's responsible for the geysers and hot springs in Yellowstone National Park and in Wyoming.

But of these technologies for geothermal, the one that's most likely to find application at your site is ground source heat pumps or geothermal heat pumps. And this is a photograph of an installation at Marine Corps Air Station in Beaufort, South Carolina. Here you see them installing the ground loops. These pipes of cross linked polyethylene would be buried into the ground, either in vertical bore holes or horizontal trenches. And that would provide the heat exchanger by which the heat's either accepted or rejected from the ground. This installation replaced twenty-five hundred tons of existing air conditioning system, and it can also be used for heating water. And that serves over twelve hundred housing units on the base.

Hydroelectric potential, if you happen to have a dam on your site you could increase the power output of that either by replacing electric generating equipment that had been resolved over the years. Or increasing the efficiency or capacity of what's there on the dam. If you were to build a new dam that would not count towards the renewable energy goal.

We're involved with the design of a museum at Mesa Verde National Park. The water supply to that museum drops about 2,000 feet elevation. And so they're going to replace the pressure reducing valve with a hydroelectric turbine to generate power there. So there are opportunities at Federal facilities for hydroelectric power.

A lot of Federal facilities are located on the coast or maybe even on a small little postage stamp of an island out in the Pacific. And so their resources are principally ocean energy resources. The ocean energy technologies in my opinion are relatively immature compared to the other technologies that we've discussed. In this photograph you can see two very different designs for turbines that could be submerged into a ocean current or a tidal current. And you can see that they're very different.

And this reminds me of the early days of wind power where people had all kinds of contraptions to convert wind power into electricity. And that kind of evolved into the horizontal axis three blade design that you see on almost all wind farms these days. And I think the same thing is going to occur with the ocean energy technologies. Some of these technologies will win out as being more cost effective or more efficient than the others and we'll start to see some more standard designs.

Ocean thermal energy conversion uses the difference between the hot water at the surface of the ocean and the cold water at deep depths to power a heat engine to generate electricity.

If we're designing a new building we should certainly consider passive solar heating. And that would be the case for buildings that do not have a lot of internal heat gain. If your building is already heated by busy people and computers and lights inside such that your air conditioning systems is running all year round, then you cannot benefit from passive solar heat. But for most other types of buildings we can use passive solar heat to heat our buildings in the wintertime, as long as we take measures to make sure that it doesn't overheat in the summertime.

The ways of incorporating passive solar heat into a building are limited only by the architect's imagination. But they do have some things in common. They all have south facing apertures because the sun is low in the southern sky in the wintertime. They all have overhangs to block the summer sun, which is higher in the sky. They have additional mass to store the heat overnight. And they have controls, such as shades or windows, so ensure comfort.

I think that daylighting is probably the principal opportunity for solar energy in commercial buildings. Lighting accounts for about 25 percent of the total electric use in the Federal sector. And a large portion of this, probably at least 50 percent, could be saved by effective use of daylighting. It's easy to get enough daylight into a building. If you were to carry a light meter out in the sun it would read 9,000 foot candles where we only need 30 or 50 foot candles on the desk. It's easy to get enough daylight into a building. The challenge is how to distribute that daylight evenly in the space and how to avoid problems like glare and veiling reflections on computer screens and things like that.

Kathy Hyland: Okay. Giving Andy a break, let's hear from Anne Crawley. Let me introduce Anne. Anne Crawley manages FEMP's renewable energy technologies program. Her team's role is to accelerate Federal facilities use of renewable energy. And they do that by providing guidance, information and technical assistance to renewable projects.

[Music]

Anne Crawley: Hello, I'm Anne Crawley, team lead for the renewable energy technology program at the Department of Energy's Federal Energy Management Program. America is on the threshold of a revolution in domestic energy production that uses renewable energy as an important part of a clean energy economy. Renewable energy is made in the USA. It strengths our domestic economy. And it protects the environment.

Every week new and existing technologies are making it possible to upgrade and retrofit agency buildings and sites and take advantage of agency land with reliable and affordable renewable energy solutions. To help you start finding the best solutions, FEMP provides maps to locate solar, biomass, geothermal and wind energy resources around the country. Once you have mapped out best options for your facility, FEMP offers prescreening tools to help you assess the most productive and economic system to power your site.

To help choose, size, design and operate your system, FEMP offers webinar and on demand training sessions. These programs can introduce you to a variety of FEMP services and help you plan, implement and finance renewable energy projects. From the data that you need to collect to get started on a project to procurement all the way through project close up.

You can also learn more about how other Federal facilities have successfully integrated renewables into their daily operations. Case studies gathered from around the country showcase a diverse array of technologies at a variety of military and civilian facilities. Application briefs also provide valuable information about initial investment, payback periods, operating costs and resulting energy savings.

I encourage you to get involved and keep up to date on renewable energy news and events by joining the Renewable Energy Working Group. This forum brings together government, industry and NGO representatives to share best practices, guidance, financing opportunities and new technology advances. Visit the FEMP website to learn more.

The Department of Energy's national laboratories, and in particular, the National Renewable Energy Laboratory, offer a wealth of expertise to accelerate your progress, meeting legislative and Executive Order mandates and goals. Contact any member of our FEMP team to help you get started.

While the answers to clean energy and energy independence are complicated, renewable energy technologies are proving to be one solution worth investing in. Thank you for joining us. I look forward to answering your questions later in the seminar.

Kathy Hyland: Thanks, Anne. As I said earlier, Andy and Anne will be available to answer questions at the end of this seminar. Now back to Andy.

Dr. Andy Walker: So we've talked about technologies. Now let's talk about how to implement these projects at your site. This figure shows how you might take a structured approach to move through a project starting with facility screening, feasibility study. A feasibility study establishes the technical and economic feasibility of a project. But how do you know where to do your feasibility studies? Are you going to do a feasibility study on every technology for every site? Well, it makes sense to take a structured approach of planning where those best opportunities are so that you're not wasting your time and money. And that's called screening.

If a project is feasible you could issue a request for proposals, select a contractor, design the project, build it, acceptance testing and commissioning. And the performance period is very important because these projects are capital intensive. And in order to realize the return on that investment they have to make sure that the system continues to operate properly for a very long time period, often 25 years.

And then what do you do at the end of the performance period with regards to the disposition of the equipment?

Screening helps you determine which technologies to consider. And the steps are to first of all establish your baseline data. How much electricity do you use and how much does it cost? How much natural gas do you use and how much does that cost? Do you use hot water? Do you use ventilation air? How you use energy. And site data such as do you have available land or available roof space. Where's the transmission capacity? This kind of data could be collected up front.

We determine local renewable energy resources from the maps that we've been referring to during this program, but there's other sources of information that you should investigate. For example, universities and airports often collect climate data, so you might be able to get some site specific data from them as well.

Explore your incentives that are available from state governments, from local utilities, other organizations. Air quality management districts have offered incentives in some examples. And so these incentives can really make all the difference as to whether a project is feasible for you or not. And then consider the characteristics of the different technologies that we've discussed.

So the resource maps that can help you with the screening are posted at the first URL here. And then the financial analysis that FEMP has done with that information is also posted at the second URL. Some of those maps express things in terms of a savings to investment ratio. If the lifecycle savings exceed the lifecycle investment of a project, then the SIR is greater than one and the project is deemed to be cost effective. If that ratio is less than one, then it's deemed to be not cost effective.

Couple of other tools that are coming soon. FEMP Is currently working on a levelized cost of energy calculator where you can go to a website and enter your specific information and calculate a levelized cost of energy for each one of these technologies that you could compare. That should be online within the next couple of months. And also an energy performance and cost matrix where the efficiency and cost of each one of these technologies can be compared side by side.

It's difficult to keep that information up to date because things change so rapidly. For example, the cost of photovoltaics has dropped rather dramatically in recent years. So FEMP is providing a useful service by making that information available to people and keeping it updated.

In My Backyard is a website. The URL is listed here. When you go there it'll look like an aerial photograph. You can zoom in our site. You can draw a rectangle on your roof. And the program will calculate how many square feet are in that rectangle, how much photovoltaics you could put in there. What the annual energy production would be. And it also has similar capabilities for wind energy.

I like the RETscreen program produced by an agency of the Canadian government, because it has all of these technologies, all the ones we've discussed – photovoltaics, wind, solar ventilation, preheating, solar water heating, geothermal heat pumps. This Excel spreadsheet program, RETscreen, has algorithms in there to calculate the energy savings of each one of those.

Federal Renewable Energy Screening Assistant is a product that FEMP had on their website. It's been taken down for redevelopment. I met with the people that are working on that last week, and they're making good progress to get that back up online. And then Homer is another program which is kind of unique in that it allows you to account for the interactions between things like photovoltaics and wind power. If you already had a photovoltaic system and you come along and add a wind turbine, how is that power going to be used?

And then in addition to these tools that FEMP makes available, FEMP also helps agencies by providing the service directly. And Shawn Herrera at FEMP headquarters administrators the technical assistance process, which is to help agencies move from each step in that project process. In other words, after you finish your screening, help you do a feasibility study. After you finish your feasibility study we can help you do a request for proposals and so forth to move down each one of the steps of that project process.

And then another service that we've been providing we call Renewable Energy Optimization. It's a screening. And this example of 31 DOE sites should be just considered kind of a conceptual example. These numerical results haven't been vetted with the sites yet. So let's not refer to any of the particular results. But the objective here is to go through for each site and identify all the measures, all the renewable energy measures which might be cost effective.

So, for example, where you see a blue bar at a site like Pantex that might be a wind project. Green are biomass projects. Orange are solar projects and so forth.

If we added up all 31 DOE sites, this method identified 269 million dollars worth of measures that would save 217 million kilowatt hours per year. Save 26 million dollars in utility operating costs. So a ten year payback and 11.3 percent rate of return. These are the kinds of results that we generate with the REO method to help agencies plan their renewable projects across a portfolio of real property located all across the country.

FEMP worked with the DOE Solar Energy Technologies Program to issue this guide on how to procure solar energy systems. It helps you establish what your goals are and to assemble a project team of your technical engineering, energy management , procurement folks, legal folks, contracting folks, to get a project done. And then the steps that you'd have to go through to execute those projects. And those steps depend on the financing and contracting mechanism that you've chosen. So this guide has a chapter on energy savings performance contracting. Another one on utility energy service contracts. Another one on an enhanced use lease. And another one on agency appropriations. So if you're undertaking a solar energy project, I'd definitely encourage you to download that from that URL.

So all of these financing mechanisms are available. These have been the topic of the previous two First Thursday Seminars, so I refer you to go back and view those online to learn more about these alternative financing mechanisms.

The operational phase is very important as we mentioned because this system has to operate 25 years in order to realize the savings. Energy savings performance contracts are a good way to make sure that that operation will happen, because the contractor only gets paid if the system delivers energy.

There's other mechanisms, such as service contracts and additional warranties which are available. Whether the cost of those is justified depends on a close look at them.

And then there's the possibility of the facility doing maintenance themselves. There's some problem with this because all of these renewable energy systems are backed up by conventional systems. For example, solar water heater would always be backed up by an electric or gas water heater. So a lot of times people don't even know if their solar system has failed cause they still have hot water at the tap. Or even if they know it's failed it might not be the highest priority for the maintenance staff to fix it. Other issues include maintenance staff that don't have an inventory of spare parts or don't have the expertise that would be required to maintain a system like this.

Measurement and verification is required by statute for projects that are implemented under an energy savings performance contract. But it's a good idea to do it even for a project which you've implemented with agency appropriations because the measurement and verification gives you the feedback that you know your system is operating properly. And it gives you the diagnostics that you need to fix the system if it's not operating properly.

FEMP has guidelines with regards to measurement and verification. And also the International Performance Measurement and Verification protocol describes specific measures for each one of the renewable energy technologies.

The bottom line of all this is that it's easier to measure the performance of a renewable energy system than it is an energy efficiency measure because the system is actually delivering energy, which you can measure with a meter. Whereas an energy efficiency measure you'd be trying to measure the savings, which is the part which is not there.

This figure shows a survey of 185 solar water heating systems. Seventy percent of them were operating fine, but 65 percent of them were not. And it's interesting how 90 percent of those failed systems could be repaired for less than $500.00. And a lot of them could be repaired for even less than $100.00.

An example of this would be a temperature sensor that has simply fallen off the surface that it was trying to measure. That could be remedied with a 50 cent stainless steel hose clamp if somebody was paying attention to the system. So rehabilitating older systems can be much more cost effective than building a new one.

There's some special considerations in new construction. First of all, in new construction we want to take all the energy efficiency measures and sustainability measures that we can and then what energy requirement is left over we want to try to meet with onsite renewables. This can vastly reduce the energy bills of a facility all the way down to zero. The building that I work in is net zero. There's a building here at Oak Ridge that is net zero. And so those demonstrate that it is certainly possible.

The steps of a new construction process start with a financial prospectus. This would be the business case for building a new building. Is it worth it to build a new building? And renewables can affect this discussion in a couple of ways. First of all, the renewables can add to the price of a building. Maybe instead of $250.00 a square foot, maybe now with including the renewables your cost is going to be $270.00 a square foot. But it also improves the benefits of the building.

For example, the lower operating costs are important in the financial prospectus. And also it's useful to feature the green features of a building, such as the renewable energy, in marketing the building and probably getting higher rent rates, for example.

As we incorporate the renewables into the building it's going to affect the architectural program. Roof space, for example, instead of locating all our mechanical equipment on the roof, maybe we could locate it inside the building or on the ground somewhere and leave the roof space for solar energy system. Or at least maybe we can push the mechanical equipment around to create a space for the solar systems up on the roof.

It's important to coordinate among all the disciplines on the design team. The electrical, mechanical, structural. They all have to be orchestrated by the architect to achieve a favorable result.

With regards to integrating in with the existing systems, electric power from a renewable energy system can be fed directly into a building panel if the panel's big enough. If it's not big enough, you might have to upgrade that panel. And if you're trying to put more renewable energy than that on, you might have to go upstream of your building panels all the way back to the utility service entrance to the facility where the transformer is and inject the renewable energy there.

With regards to thermal energy, the solar usually preheats for a conventional water heater. And then if the solar is delivering water that's too hot to send to the taps, a tempering valve is also required to mix with cold water before it's sent to the tap. So these are a couple of measures that are considered when integrating thermal energy into an existing system or into a conventional system.

One of the characteristics of renewable energy is that they're intermittent. For example, the solar is only going to deliver energy for four to six hours per day. So for the other 18 hours of the day you have to use utility power. And this is true no matter how much solar you add to a building. As you add solar you're adding kilowatts, but you're not adding hours that the kilowatts are available.

So as we try to get a higher and higher percentage of our requirements for renewables we get into a situation where we have to sell power back to the utility during the day and buy that back at night and do that kind of virtual accounting to achieve a higher percentage of our energy from renewables.

So how the utility treats that additional power depends on their regulatory policy. The most favorable policy is called a net metering policy where they give you the full retail value of the energy for what you put back on their system. If they don't have a net metering policy, then they're required by Public Utility Regulatory Policy Act to pay you what's called their avoided cost, which might only be their fuel costs and it might only add up to 2 cents or 4 cents per kilowatt hour. And then in the worst case scenario if they're not regulated, like a rural electric cooperative or a municipal utility, they might not be required to take your extra power at all. So it's important to investigate what the utility's regulatory policies are and how they're going to treat the excess power that you put back on their system.

Now let's say you're not able to do a renewable energy project on your site. You have the ability to purchase renewable energy, either through a regulated utility green pricing program. You can purchase renewable energy certificates. If you're in a deregulated market where you can shop around for your power, you can pick one that's based on renewables. Or you can purchase power from a renewable energy project on your site through a power purchase agreement.

Renewable energy certificates are basically the credit for doing a renewable energy project that is separate from the kilowatt hours of the energy itself. So they represent a means of purchasing the credit that you need towards your statutory goals without actually doing a project. Some other reason to buy RECs might include if you want to support the renewable energy economy and development of renewable energy projects in rural areas.

Some advantages of buying RECs are that they improve the market efficiency of renewable energy by allowing the renewable energy projects to be built on a large scale where the resource is the best and the transmission capability is best and the price is the lowest. And then a Federal agency anywhere across the country could purchase the renewable energy credits from that supplier in order to meet their goals.

Here's some resources for buying renewable energy certificates if that's the way you choose to meet your goals. Western Area Power Administration conducts a procurement of RECs once per year for Federal agencies. Those are usually announced on the FEMP website. And the next one is coming up very soon here, May 16. So if you have a requirement to buy RECs, visit the FEMP website and get in touch with either Mark Radecki at Western Area Power Administration or Chandra Shah at our laboratory to help coordinate that.

Defense Logistics Agency does several procurements per year. General Services Administration also has this authority to purchase electricity and they can help Federal agencies with renewable energy purchases.

Federal Energy Management Program is listed here. FEMP doesn't have the authority to purchase electricity for Federal agencies, but we do have the training and guidance and other resources that you can use for that.

If you do an onsite project you could sell the RECs. And that's often and important source of revenue to do a project. But if you sold the RECs, then you would not be able to count that towards your statutory goal. So one thing that's recommended is what we call a REC swap or selling your more valuable RECs for solar and then purchasing less expensive RECs from landfill gas projects or hydropower projects around the country to make up for that. And if you do that, then you can keep your extra bonus for doing an onsite project on a Federal facility and serving a Federal load.

Power purchase agreements are where a site would provide land to a third party developer who would come in and build a project. And then the Federal facility could purchase power back from that developer. The best way to purchase that power back is as an in-kind transaction in exchange for the land lease. And then you might have to pay for power beyond that.

In a deregulated state where you can shop around for your wholesale power provider, then you can purchase energy that has a high renewable energy content.

I'd encourage you to visit the FEMP website for renewable energy. Everything that we've discussed here, including the statutory requirements, descriptions of each one of the technologies, steps on how to go through a project process, all these maps, various analytic tools, online trainings and cast studies are all posted here on this FEMP website. It's really a wealth of information that I'd encourage you to tap into. And the URL is listed at the bottom of the slide here.

FEMP convenes a group called the Renewable Energy Working Group, which provides a forum for Federal agencies to get together and to work on common problems. They can discuss projects that they have planned, share lessons learned from projects, discuss the pros and cons of various funding resources and also work together to help issue the guidance that agencies can use to meet these loads.

So how to get started. You know the questions to start with are, what are the objectives of my project? What are the resources that are available in my area? What are the needs that I'm trying to meet? Of all these, what applications are best for my facility given my resources and the way that I use energy? What's the size of the project that optimizes my economics? Should I do a small distributed project or a large utility scale project? How much funding do I need? What are the sources of funding that I can assemble to help make the project happen?

And then finally I'd like to conclude with this list of contacts. We've heard from Anne and myself. But Boyan Kovacic is also a good person to talk to when undertaking a renewable energy project at headquarters. And Chandra Shah is our expert on utility issues and renewable energy certificates and power purchase agreements.

Kathy Hyland: Okay. Thank you, Andy. In this part of the seminar we're going to take your questions. So please phone them in. The information will be on your screen. I have a couple of questions ready already. So let me start with the questions that have come in already. Andy, this one I'm directing to you. It says, we have a small remote facility in the west. What is the best way to justify the potential for incorporating a combination of small scale wind and PV to eliminate our diesel generators?

Dr. Andy Walker: So a small diesel generator in a remote location is actually a really good application for either PV or wind or some combination of PV and wind. The reason for that is it's expensive to deliver diesel fuel to a remote location. And you run the risk of spilling the diesel fuel as you're delivering it. And so the National Park Service, for example, they have a goal of getting diesel generators out of all the parks. Not so much for the energy cost but for the environmental impact of handling diesel fuel in these remote locations.

And then the generator could be retained on site. It could be switched over to propane, which doesn't have quite as many environmental impacts. But then the presence of the photovoltaics and the wind power could allow that generator to be turned off most of the time. And so we get the best of both worlds. We get the low operating cost of the renewable energy systems with no fuel consumption. And we get the reliability of the onsite generator should the intermittent renewable energy resources not be available.

Kathy Hyland: Okay. Anne, let me send this question to you. What trends are developing regarding the use of public lands for renewable energy generation such as solar collectors and geothermal energy? And a second follow up to that is what incentives are there related to that?

Anne Crowley: There's a lot of activity on the Bureau of Public Management BLM land. They're doing – on solar they've done a big environmental impact assessment across all of the land, making it much easier to do the permitting. And in fact, they've approved things on a fast track. If you've watched the news, they've also done that for wind. Geothermal is a little more complicated. There are particular sites. And where those resources are, they're looking at it. Whether it's on DOD land or BLM land. Those are not quite as developed. Specific ones people are working on, but it's not as comprehensive as they've looked at the solar and the wind.

Kathy Hyland: Thanks, Anne. Okay. I have another question, Andy. What are the main differences between partnering with a utility for renewable energy generation versus an ESCO or other type of financing company?

Dr. Andy Walker: So the question is what are the differences between an energy savings performance contract and a utility energy service contract. They're authorized by different legislation and have different rules associated with them. With an energy savings performance contract the term can go up to 25 years. Whereas utility contracts are only typically authorized up to ten years. There's a couple of authorities. The Western Area Power Administration, for example, I think can sign 20 year contracts due to their special authority to purchase power. And then the Department of Defense has a special authority called 10 USC 2922A, which allows them to sign contracts for up to 30 years, although there's some discussion about which technologies are included in that and which ones aren't because that UESC refers back to USC 2917, which is specific to geothermal power.

But some of the more practical differences are the energy service companies are getting their financing from the big money houses at rates which are typically lower than the utility financing. They're borrowing from the big financiers like Goldman Sachs. They get interest rates, I think last I checked were on the order of 7 ¼ percent or something. They might be lower than that now.

Utility energy service contracts on the other hand, they have a cost of money associated with them that's related to the rate of return that the utility has been able to negotiate with their regulators. And it could be significantly higher than that. I've seen as high as 12 percent. But other than that, in terms of getting a project done on your site, they're both available and both could yield successful results I think.

Kathy Hyland: Anne, anything to add to that?

Anne Crowley: I don't think so. I think it's, you know look into both of them. The utility sometimes works better on smaller projects whereas the ESPCs you need a certain, you know big enough project to make it worth their while. Whereas if your utility's interested they may be willing to make their Federal customer very happy.

Kathy Hyland: Thanks, Anne. My next question is from the Chicago EPA. In his geographic area what would the price of solar be in an average household?

Dr. Andy Walker: An average household, I think the average power consumption of a household is like 1.6 kilowatts. Let me round up to 2 kilowatts just to keep the numbers round. So if you were to try to kind of roughly match that with a 2 kilowatt PV system on your house, you'd be looking at an investment of about $15,000.00 for that I think. Large projects are cheaper on a per kilowatt basis. But for an individual household, I think if you went into the expectation of about 7,000 to 8,000 dollars per kilowatt, I think then you'd have enough money to do your project. Hopefully bids would come in less than that, but it would be something on that order.

Kathy Hyland: Thanks, Andy. All right, next question. Are solar ventilation applications good only for large facilities like airplane hangers or storage facilities? Could they also be used in an office building or like multifamily housing?

Dr. Andy Walker: Is that for me or Anne?

Kathy Hyland: Let’s start with you.

Dr. Andy Walker: Solar ventilation preheating systems can be done on a small scale or a large scale. In fact, the example that we considered in the slide was at 300 square feet was actually a pretty tiny system. Most solar vent preheat systems are in the thousands of square feet. So they can be done on a small scale. But what’s more important than that is can you use the heat. I don’t think it’s a good application for residential applications because you don’t ventilate the house during the day. If you had a ventilation fan that was running all day, then yes, solar ventilation preheat could reduce your heating requirements for that. But to add a ventilation fan to a house that doesn’t have one just so that you can use the solar ventilation preheat technology wouldn’t make sense.

So what you’re really looking for is, whether it’s large or small, you’re looking for a building that has ventilation air requirement during the daytime.

Kathy Hyland: Anne, anything to add to that?

Anne Crowley: I don’t think so. I think he covered it.

Kathy Hyland: Okay. Anne, let me direct this next one to you. What are the main environmental issues to be considered when locating a large wind turbine or wind farm?

Anne Crowley: For the –even before you get to environmental you want to have an area that you can put a large wind farm on. and what we’ve learned from looking at our facilities here at DOE for those big utility scale projects, they want, the people who are building and financing those want those really big. If you’re doing it just for your facility, it can be smaller. But the economics may not be quite as good.

For the environmental issues associated with wind, one of the issues are interaction with birds and interaction with bats. They’ve learned a lot about the interaction with birds. Andy mentioned that a lot of those wind sites are in passes where the wind comes through the pass. And that’s a place that birds like to go too. But they’ve learned a lot that if they put turbines back, not very far, but just back from the edge of the hill or whatever, it makes a big difference in terms of the impact with the birds.

Bats are something that they’re learning more about now. And they don’t – they’re not always good for bats. And so if there are a lot of bats in your area you might want to carefully consider. You are required to an environmental impact statement if it’s a big enough project and environmental assessment if it’s a small project that likely wouldn’t have impacts. But I think they’ve learned a lot recently and are still learning more about the bat impact.

Kathy Hyland: Thank you, Anne. Andy, one for you. What is your outlook for the use of vertically oriented building integrated PV? Are these technologies suitable for Federal facilities?

Dr. Andy Walker: Yeah, we see projects where the photovoltaic is mounted vertically on the exterior wall of a building. And it does work. The output would be reduced. If I had a photovoltaic panel tilted at the optimal orientation, which is facing south towards the equator and tilted up at an angle that’s equal to the local latitude. So if I was here at 37 degrees latitude I’d want to tilt the solar panel up 37 degrees from the horizontal and south facing. That’s the optimal. And if we do that a photovoltaic panel might be expected to deliver its rated capacity for about 1,500 hours per year. If it’s mounted vertically on the wall, then that number goes down to about 850. So more than half, but the output’s significantly reduced because the sun is going to be hitting the vertical surface at an oblique angle. So there's going to be a cosine effect there which reduces the solar energy that's incident on the panel.

It's an attractive place to put photovoltaics because photovoltaics are made out of glass. And they can be integrated into a building in the same way that glass windows are. So we do see a lot of applications, but people should understand that the output is going to be reduced.

Kathy Hyland: Thanks, Andy. Anne, this one's for you. What is the opportunity for producing biomass energy crops on Federal lands?

Anne Crowley: Let me take just one second before I answer that and just a comment to add to Andy's. that although the output may be reduced from vertical PV, the fact that you might be replacing glass with something that's got the PV integrated into it means that sometimes your costs can be – well, particularly in a new building, you might be able to offset the cost of the glass. And so the costs might be a little lower than for a standalone PV application.

In terms of biomass crops on Federal land, there's a lot of Federal land that's in trees. And those would be – and people are using those for woodchips and sometimes they use them for woodchips to fuel plants. It depends on who controls the land and what their mission is for that land. The Forest Service has many and Bureau of Land Management has many. Like all of our Federal requirements, we have lots of requirements. And they interact. So in some places it may be available to be used for fuel or resources.

In terms of planting, you know crops that would then get harvested, I'm not aware that there's a lot of Federal land that would be appropriate for that. I think the farmers own most of that.

Kathy Hyland: Thanks, Anne.

Kathy Hyland: Andy, back to you. What is the most common problem with integrating renewable technology with conventional power?

Dr. Andy Walker: I would think that most of the problems occur with that issue that we discussed that as you try to get a higher and higher percentage of your energy requirements from renewables, you will get into a situation where you have to sell renewable power back to the utility. And so the utility's policy towards that has been probably the biggest problem with that. Even utilities that started out with a favorable policy. And I'm going to talk about the utilities in Hawaii just by way of example. They started out with a favorable policy towards renewables, that net metering policy. Where if put a kilowatt hour back on their system they could give you the full retail value of that kilowatt hour. But there was a limit on how much power system wide that they would make that policy available for. And they've hit that limit. And so the cost of energy is so expensive in Hawaii because they use oil primarily to generate electricity that it's cost effective for people to do photovoltaics even without an incentive. But guess what? On top of that they have the incentive. The Federal and state tax credits. So everybody in Hawaii's doing photovoltaics.

And what the utility has done is for all the customers on a particular utility circuit, they'll limit the photovoltaic power on that circuit to 10 percent. Used to be 10 percent. I think now they're increasing that to 15 percent of the peak of that circuit. So if your neighbor does a big PV system that might preclude you from being able to do a PV system.

And so really I think probably at this point in those places in Hawaii, there's also some places in California that are experiencing this same issue. You know once you get to a point where you're providing more than say 20 percent of your energy from renewables, then you can't really expect the utility just to be able to absorb that and to make the power transaction without some complications on their side as well.

I think the ultimate solution to this is going to be storage. Electricity is very hard to store. And so we don't see very much storage on the system at all. So research into how to store electric power should probably really be a priority. Because if we're going to get to very, very high penetrations of renewable energy in our system, which we're ultimately going to have to as the fossil fuels run out, then we will have to invent some cost effective and efficient way of storing electric energy.

Kathy Hyland: Thank you, Andy. Anne, last question for you. Geothermal heat pumps seem like an obvious choice for energy savings. Why aren't we using it more?

Anne Crowley: They are a great choice and generally cost effective where they work. There are limitations. If you've got a lot of rock underneath you it's not as cost effective to drill down and do that heat exchange. But I think it's largely just people aren't used to it. They are, you know highly capital intensive, but then a much lower operation cost. It's been very effective at several big military bases in the South. So it's becoming more and more common. We've used it very effectively in energy savings performance contracts for Federal agencies, because they're a great application for that.

But it just hasn't – you know it's like anything else, it sort of builds the recognition of it and knowing that it's available. So I expect it to continue to grow, especially as energy costs increase.

Kathy Hyland: Thank you, Anne. Thank you, Andy. That's all for today. I want to point out that this is a series of seminars. And next month on Thursday, June 2, there'll be a session on electric vehicles and their supporting infrastructure. Here is a quick look at the upcoming seminars.

[Music]

Once again, thank you for joining us today. We hope you will register for additional seminars by accessing the website on your screen, www.femp.energy.gov/firstthursday. Finally, please take a moment to complete a brief evaluation that will help us determine what future training topics you would like FEMP to offer. And to help us with ways to improve the First Thursday Seminars. You can also complete a quiz to reinforce your learning and print a certificate for your records. You can access this quick evaluation and quiz in one of three ways. Go to the website, www.femp.energy.gov/firstthursday, and find the quiz and evaluation there. If you registered for this course, you'll get an email follow up with a link. And if you're watching this today by live webcast, you can click on the paperclip icon and it will take you to the evaluation and quiz.

We would like to thank the Department of Energy's Federal Energy Management Program, our instructor Andy Walker and Anne Crawley of FEMP, for making this seminar possible. And thank you for joining us. We'll see you the first Thursday of June for our next seminar on renewable energy.

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