CITY COUNCIL
CITY OF NEW YORK

------------------------ X

TRANSCRIPT OF THE MINUTES

Of the

COMMITTEE ON ENVIRONMENTAL PROTECTION

------------------------ X

September 22, 2015
Start: 10:08 a.m.
Recess: 12:33 p.m.

HELD AT: Committee Room – City Hall

B E F O R E:
COSTA CONSTANTINIDES
Chairperson

COUNCIL MEMBERS:
DONOVAN J. RICHARDS
ERIC A. ULRICH
RORY I. LANCMAN
STEPHEN T. LEVIN

A P P E A R A N C E S (CONTINUED)

Anthony Fiori
Director of Energy Regulatory Affairs
Mayor’s Office of Sustainability

Alex Posner
Professional Geologist
New York City Department of Design & Construction

Frederick Stumm
Doctor
United States Geological Survey

Bob Wyman
Geothermal Activist

Olsen
Graduate
UCLA

Ling Tsou
Co-Founder
United for Action

Katherine Scopic
People’s Climate Movement

[gavel]

CHAIRPERSON CONSTANTINIDES: Alright. Good morning and welcome. I am Council Member Costa Constantinides, Chair of the Committee on Environmental Protection. Today the committee will hear Intro 609 of 2015, a local law to amend the administrative code of the City of New York in relation to the use of geothermal energy in New York City. Since ancient times naturally occurring hot water has been used for baths, for therapeutic uses and other purposes. These uses are limited to locations where certain geothermal resources are or near the surface. Whatever heat from within the earth can be harvested in various ways to create usable, clean, renewable energy. The earth’s core retains heat from the time of earth’s formation. Additional heat is generated by the breakdown of radioactive substances within the earth. And 46 percent of geothermal entity, energy, come from the radiated heat from the sun stored in the shallow layers of the earth. This heat moves via convective, convection and conduction outward from the core to the… from… towards the earth’s surface. The result is virtually a unlimited amount of heat that keeps the subsurface at a steady warm temperature. On December 14th, 2014 Mayor de Blasio signed legislation enacting local law 66 of 2014 which required New York City to reduce its green… citywide greenhouse gas emissions by 80 percent relative to 2005 levels by the calendar year 2050. Buildings through the use of heating fuel, natural gas, electricity, steam, and biofuel are responsible for over 70 percent of citywide emissions. Given this and the fact that the vast majority of existing buildings are expected to remain beyond… well beyond 2050 the city's stock of one million buildings represents the greatest potential source of citywide greenhouse gas emissions reductions and is necessary for the city to reduce emissions from the building sector in order to comply with local law 66. Renewable energy can be utilized to reduce emissions from buildings by increasing reliance on renewable energy technologies on site, within buildings, to supplant the current role fossil fuels play in heating, cooling, hot water, and cooking. Reducing the city's reliance on fossil fuel based energy sources in favor of renewable energy sources particularly in buildings it's critical to achieving the city's goal to reduce the greenhouse gas emissions, 80 percent by 2050. Ground source heating and cooling uses technology to enhance the heating and cooling potential of underground heat. This use is much broader in scope than use of geothermal resources for electricity generation near the surface as relatively shallow wells can reach depths with sufficient to meet these energy needs. The essence of ground source heating and cooling is that it uses ground loop technology to exchange heat between the even temperature of the earth and the inside of a building in order to heat the building in winter and cool the building in the summer. In the case of New York City, the subsurface areas maintain steady temperatures in the low 50s degrees Fahrenheit. In a ground loop system, a fluid such as water is pumped between the building and below ground level environment. In the winter the heat picked up ground fluid… underground by the fluid is used to heat the building. And in the summer the fluid removes the heat from the building and deposits it underground. Ground source heating and cooling can be affected almost anywhere in the

United States using a geothermal heat pump, a highly efficient renewable energy technology. Many residential buildings and commercial organizations in New England operate with ground source heating and cooling systems including Trinity Church and the Massachusetts Audubon Natural Center in Boston, Massachusetts. And the City Annex Hall in Cambridge, Massachusetts. New York City also has buildings either using or planning to use geothermal energy including the Weeksville Heritage Center, The Brooklyn Children's Museum, and St. Patrick's Cathedral. Traditional… traditional technology… traditional systems rely on heating or cooling air and then transporting it around the building, a much less efficient approach. In addition, where hot and or chilled water can be used instead of disposed underground further efficiencies can be achieved. Next each heat pump works independently to heat or cool the zone or room it serves making these systems both efficient and better at servicing buildings that have multiple zones. Last ventilation can be achieved in using additional heat pumps. There is no need for heat recovery systems. All these advantages help make these systems easy and cheap to maintain and contribute to their long life expectancy. One final and critical advantage is that these systems are better for the environment than other similarly purchased systems. All the advantages above; less equipment, efficient movement of energy, and the like directly lead to a lower pollution footprint. In addition, the small amount of electricity needed to operate the system is located at a power plant and not on site where a scrubber and other technology will help reduce pollution. All these traits add up to make geothermal heating and cooling the best technology in terms of greenhouse gas emissions. That is why I believe Intro 609 is so crucial in getting our city as far… getting our city to the 80 by 50 paradigm. Under this… under this bill the city will help develop standards for the installation and maintenance of geothermal systems including standards related to assessing subsurface conditions. It will also help develop qualifications for person… persons who install geothermal systems. As people looking to invest in a potentially expensive new system should have peace of mind that their installers are qualified to do the job. Finally, it will also establish a program encouraging the installation of solar energy systems coupled with geothermal heat pump systems in buildings citywide giving homeowners and property owners another path to fully… full carbon neutrality. New York City is yet to fully embrace its geothermal energy generation potential. However, most New York City buildings could utilize geothermal energy for heating, cooling, and hot water production. Today's hearing is a step towards a more sustainable future using energy that does not create greenhouse gas emissions and does not damage the environment in the process of retrieving energy. Now let's hear from the administration. So we have Anthony Fiori, the office… Mayor's Office of Sustainability, Alex Poner, Alex Posner from the New York City DDC, and Cathy Passion okay, Mayor's Office of Sustainability. Want to make sure I said it right. With a name Constantinides you want to make… pronounce people's names right. Samara if you can swear in the witnesses.

COMMITTEE CLERK SAMARA: Can you please raise your right hands. Do you swear affirm to tell the truth, the whole truth, and nothing but the truth today?

ANTHONY FIORI: Yes. Good morning Chairman Constantinides and members of the Committee on Environmental Protection. I'm Anthony Fiori Director of Energy Regulatory Affairs for the Mayor's Office of Sustainability. And I'm joined by my colleagues Cathy Passion, Senior Policy Advisor in the Mayor's Office of Sustainability, and Alex Posner, a professional geologist and Project Director with the Department of Design and Construction. Thank you for inviting us to testify regarding the Introduction 609 or Intro 609 which would further the city's understanding of where opportunities for geothermal systems lie in New York City and foster their application where it makes sense both technically and economically. Intro 609 is an expansion of Local Law 32 for the year 2013 which sought to explore the feasibility of developing geothermal energy resources in the city. On February 28th, 2015 the Mayor's Office of Sustainability in coordination with the Department of Design and Construction published online a report entitled geothermal systems in their application in New York City February 2015 hereafter referred to as the GSA study. This in conjunction with the geothermal heat pump manual 2012 developed by the Department of design and construction meet many of the reporting requirements in Intro 609. These reports also provide valuable lessons that can inform Intro 609 and focus the city's efforts on the greatest opportunities for geothermal systems in New York City. At this point I'd like to turn it over to Alex who will provide a brief overview of geothermal systems, their benefits, and what conditions are necessary for their success. I will then speak to some ideas on how to strengthen the bill. Push the…

ALEX POSNER: Okay. Good morning everyone. I am Alex Posner and I've been working for the Department of Design and Construction since 1999. For the past 15 years I and others at DDC have been designing and installing geothermal systems for DDC public building projects throughout the five boroughs. Geothermal systems have been used extensively for heating and cooling buildings throughout the world for over 70 years. These systems if designed properly can reduce or eliminate a building's dependency on fossil fuels, eliminate rooftop mechanical equipment and reduce energy cost. Because of DDC's proactive position in advancing the concept of high performance or greener sustainable buildings since the 1990s geothermal systems have been one of many options for improving a building's energy efficiency and overall design. Just to be clear these systems as many may believe do not generate electricity but instead utilize low temperature energy generally between 50 and 60 degrees Fahrenheit and found at depths between 300 and 2,000 feet below the earth's surface to precondition indoor air temperatures. This constant stable temperature available year around is the beauty of these systems compared to solar which does not operate when the sun doesn't shine geothermal's always available 24 hours a day. By construction bore holes or wells to depths mentioned above we create a pathway to retrieve the earth's stored energy from the surrounding bedrock or groundwater. The energy is transferred either by pumping natural ground water or circulating a groundwater antifreeze solution in and out of grounded boreholes or wells thereby transferring this energy to the building. A heat pump which incorporates a compressor similar to those found in your home air conditioner or refrigerator is used to bring temperatures into the range designed for human comfort. The advantage here is that the heat pumps are reversible to accommodate changing needs throughout the four seasons providing both heating and cooling in one unit. Again this is all accomplish… accomplished by utilizing the year around steady temperatures of the earth. The three basic types of geothermal systems utilized by DDC and others within the city are open loop systems, closed loop, and standing column. An open loop system essentially uses groundwater from an aquifer such as those found in great quantities in Brooklyn and Queens. Energy transfer is directly from the constant water temperature in the aquifer to the heat pumps. The second system known as a closed loop system utilizes drilled bore holes down to approximately 500 feet. Energy transfer here occurs by pumping an antifreeze solution in and out of each bore hole via polyethylene tubing and into the building’s heat pumps which then precondition indoor air resulting in the need for less fossil fuel based energy to bring indoor air to the desired comfort level. The third type of system we use is called the standing column which is a freestanding open bore hole down to 2,000 feet that brings in small amounts of available ground water up through the center of the bore hole and into the heat pumps. The heat pumps reject the water and send it back down into the same bore hole. As the water flows down the inner walls of the bore hole it reject the higher or lower temperatures back to the earth for later use similar to a rechargeable battery. For projects that do not have enough horizontal space for standalone geothermal systems hybrid systems may be available. Hybrid systems… sorry hybrid designs that combine geothermal systems with traditional systems can still reduce energy usage and increase the overall efficiency of a building. The geology of the city is very complex compared to other parts of the country where the subsurface geology may be more homogenous in nature which is why understanding the subsurface is key to any project success. The system then may work in one part of the city, may not be appropriate or cost effective for another. For example, open loop systems use ground water for heat exchange by extracting and returning ground water through supply and diffusion wells installed in permeable aquifers such as standing gravel deposits. While these are generally the least expensive systems to install water quality is a critical factor as dissolved metals, bacteria, and high… can severely impact design maintenance and overall life expectancy. Open loop systems are most appropriately used in areas of Queens and Brooklyn where highly productive aquifers are very common. By contrast the standing column well is a variation of the open loop system that combines the supply and the diffusion well into one unit. This results in the slower transfer of heat requiring much greater depth to bore holes, down to about 500… 15 hundred feet to achieve sufficient surface area for heat transfer. These systems are applicable where bedrock is close to the surface which mitigates drilling costs as is the case in sections of Manhattan and the Bronx. Finally, a closed loop system is sealed and completely separated from the surrounding environment. Heat exchange occurs through a conduction between a closed antifreeze loop and the ground. System costs are similar to standing column system. They also require the least amount in maintenance but are also the least efficient and so require the greatest amount of land area. Because of the above described complexities it is imperative that not only qualified engineers but geologists who are well versed in subsurface conditions of the city facilitate the design and construction of geothermal systems. Since beginning the geothermal program at DDC around the year 2000 the agency has installed approximately six systems with a few more currently in construction and several new ones in design. The number of installations reflect the majority of DDC's work which involves building renovations and a difficulty of installing geothermal systems in existing buildings. To educate and assist DDC project managers and their consultants DDC published a first edition of geothermal heat pump manual in the year 2002, the only one of its kind at the time. Subsequently because of changes in the industry and technological advances in materials the book was updated in 2012. Since that time the manual has become the how to guide for doing geothermal in the city. I will now turn it back to Anthony to discuss recommended modifications to the bill for consideration.

ANTHONY FIORI: Thanks Alex. The Office of Sustainability appreciates the attention the city council is paying to geothermal energy systems. We believe that these systems hold the potential to help us reach the goal of cutting citywide greenhouse gas emissions 80 percent from 2005 levels by 2050. As Alex described geothermal systems have the potential to provide many benefits for any building in energy management project. Given DDC's breadth of experience with these systems and what we learned in our research as described in the February 2015 GSA written study we'd like to provide some suggestions to strengthen the bill so that it results in the implementation of geothermal systems in a judicious and cost effective manner. Our suggestions fall into three main categories; amending the reporting requirements to make the information as useful as possible, determining ways to ensure that standards are set for quality geothermal systems. And designing an efficient and easier way to assess geothermal feasibility on a site specific basis. Intro 609 asked the city to play a leadership role in scaling up the application of geothermal systems within city buildings and on private properties. It looks to do this in a number of ways. The bill calls for a report on the range of issues relating to geothermal systems in the city. These issues have in large part been addressed by the Mayor’s Office of Sustainability and Department of Design Construction’s February 2015 GSA study. Where the bill requires additional or new information such information would be very difficult to obtain and in some instances impossible and in our opinion would not be necessary to advance geothermal systems. For example, the bill requires making publically available the locations of buildings currently using geothermal systems and for each such building the type of geothermal system used. While this is possible for city buildings it would be impossible for private buildings because permits not required for closed loop geothermal systems with wells less than 500 feet in depth. Therefore, there is… there are no readily available records of private buildings that have installed these types of geothermal systems. We would like to see this gap filled by requiring notification of such instillations. In addition, the bill requires making publically available the potential benefits of replacing all fossil fuel heat systems with geothermal systems including the expective [phonetic] health benefits like premature mortality, morbidity, emergency room admissions, and lost work days. First it should be noted that the complete replacement of fossil fuels by geothermal systems is in fact not possible. Geologically there is not enough thermal capacity to supply geothermal energy to a city as dense as New York City. Second it would be tremendously resource intensive to demonstrate something that we already know to be true. There's no arguing that avoiding the use of fossil fuels through the increased efficiency would result in health benefits. In fact, the Department of Health and Mental Hygiene recently published a paper looking at the public health benefits of reducing fine particulate matter through the clean heat program which helped building owners comply with clean fuel regulations promulgated by the Department of Environmental Protection. While the Department of Health and Mental Hygiene's work can potentially be leveraged to assess the impact of geothermal systems on public health indicators this would require significant additional resources to conclude what is already demonstrably true. Beyond the reporting requirements the bill would also call for a rule making set standards for the installation and maintenance for geothermal systems and registration as well as other requirements for designers and installers. To the extent such standards can be developed on a broad basis they can be found in the Department of Design and Construction's Manual which provides general guidance related to the criteria for selecting a specific geothermal system, construction of those systems, and operation and maintenance. Anything more than this would require a detailed site specific engineering study. The bill also directs rule making related to requirements for persons who design and install geothermal systems. The administration agrees that required qualifications should be made clear. We look forward to further discussions with industry stakeholders and the council to determine the most appropriate method to determine such standards. Other important considerations include how these standards would be enforced, what the workload and cost involved with enforcement and registration might be. Would these justify a registration fee? What penalties might come from violations of these standards? And would any of these standards require amendments to the plumbing or construction codes? Finally, the bill calls for a determination of the number of city owned buildings in each community district for which instillation of geothermal systems would be cost effective. The city manages roughly 4,000 buildings. To determine the cost effectiveness of a geothermal system for each city building would be very costly and time consuming because of site specific engineering analysis would need to be completed. Rather than performing a full assessment of each city building we… we recommend that the council authorize the development of a geothermal system screening tool to address new construction or a retrofit to an existing building’s heating and cooling system. Then where and when applicable a detailed engineering and benefit analysis. This would allow the city to cost effectively assess where geothermal systems make sense and then provide a definitive mechanism for valuing the climate benefits associated with geothermal systems as compared to more traditional solutions. By using the screening tool we'll be able to zero in on those projects that present viable opportunities for successful geothermal implementation without undergoing a costly engineering study for buildings where a geothermal system does not make sense. As Alex mentioned successful implementation of geothermal systems depends on site specific conditions. The Department of Design and Construction has completed phase one of mapping work that describes the underlying hydrogeology of New York City and its application for citing geothermal systems. In phase two this map will be layered with thermal conductivity, building energy use, and lot area to further define where conditions are suitable for geothermal systems. This tool will also consider neighboring lots coupled with the space requirements for a given building. It is our belief that this approach would make the process of determining feasibility of geothermal and city buildings much quicker and less costly as well as providing the public with a tool to help determine feasibility. Where a given public project meets the key criteria included in the screening tool than a detailed engineering and benefits analysis should be required to compare geothermal systems with one coupled with… system and other options as determined by the building owner or developer. This benefits analysis should include the federal environmental protection agencies’ social cost of carbon to factor in the cost effectiveness calculation greenhouse gas emissions associated with each of the alternative systems. The EPA and other federal agencies use the social cost of carbon to estimate the climate impacts of rule making the social cost of carbon is an estimate of the economic damages associated with an increase in carbon dioxide emissions conventionally one metric ton in a given year. This dollar figure also represents the value of damages avoided for a one-ton emission reduction in CO_2 emissions. The social cost of carbon is meant to be a comprehensive estimate of climate change impacts and includes changes in net agricultural product… productivity, human health, property damages from increased flood risk, and changes in energy system costs such as reduced cost for heating and increased cost for air conditioning. However, given current modeling and data limitations it does not include all important damages. The international panel on climate change's fifth assessment report observe that the social cost of carbon estimates omit various impacts that would likely increase damages from carbon dioxide emissions therefore we recommend using the highest of the social cost of carbon numbers reported by EPA, the 95th percentile social cost of carbon estimate at a three percent discount rate which is currently valued at 117 dollars per metric ton as the minimum dollar value to factor into the benefits analysis.

Alternatively, site and project specific data can be developed. The higher of the two values should be used in the benefits analysis. In addition, if in the future other monetary benefit programs come into existence, for example payments for peak load reduction, they should also be factored into the benefits analysis. Once these elements have been factored into the analysis the option with the lowest net present value should be selected. The proposed legislation is aligned with the sustainability goals outlined in One NYC. And the Office of Sustainability agrees with its intent. We hope these suggestions help to strengthen the bill and foster the implementation of this low carbon energy solution in New York City. The administration looks forward to working with the council to further refine the proposed legislation in a way that allows the city to meet the energy efficiency, resiliency, affordability, and sustainability goals laid out in One NYC in a cost effective manner. Thank you.

CHAIRPERSON CONSTANTINIDES: Thank you. Want to recognize my colleague from Queens Donovan Richards. Thank you Donovan for being here. Thank you for your testimony and let me… I have a few questions. So first I definitely appreciate those suggestions. I think that there is a solid ground for us to work together and collaborate to get where we want to go. And I appreciate your efforts today that you sort of put through these suggestions. So thank you. So do you have an estimate for how many buildings in the city could potentially use geothermal? Ballpark.

ALEX POSNER: We only know that the Department of Design and Construction has designed and installed six systems.

ANTHONY FIORI: Six systems installed and several in design and construction.

CHAIRPERSON CONSTANTINIDES: And… you know which areas of the city do you think would be best utilized.

ANTHONY FIORI: Well again it depends on what… what borough we're talking about; Brooklyn, Queens… Open loop systems are probably the most efficient. They're the cheapest. But they also can be the most problematic also because of groundwater quality issues. Not necessary everywhere but you do have to test it. You can do closed loop systems in Brooklyn and Queens also. Again you know they're a little bit more expensive you know then the open loop systems. And with closed loop, again which do require a lot of land space, and unfortunately we don't… you know this is New York City and you know land space is at a premium. In Manhattan in the

Bronx we mostly do standing column because bedrock is very close to the surface. You can also do closed loop there you know which go down to about 500 feet. But again you need a lot of horizontal space. Staten Island probably mostly standing column because bedrock is close to the surface and closed loop. So again Brooklyn Queens is most amendable to open loop systems but they can be problematic.

CHAIRPERSON CONSTANTINIDES: I hear you.

ANTHONY FIORI: But we have done two… two systems over there and they are operational.

CHAIRPERSON CONSTANTINIDES: Great.

ALEX POSNER: I would… I would just add that think the… the good news is there’s different types of geothermal systems that allow themselves to be used under different geological conditions. Some of the difficulty in… in the city has been trying to retrofit buildings with these systems. They… they appear to be more amendable to new construction. With retrofits there… there is the mystery of the underground infrastructure that always presents some… some difficulties. Underground spaces is taken up by quite a bit of…

of our infrastructure and then drilling and instillation with… with the associate piping that's required you know really deserves considerable property area in order to get drill rigs in and the vertical clearance that drill rigs need to… to do these instillations you know require… require some open property area in order to get installations done.

CHAIRPERSON CONSTANTINIDES: Alright so let's walk this quickly… I want to recognize first my colleague from Queens Rory Lancman is here. Thank you Rory for being here. Want to just quickly walk through what currently is there. If you wanted to… what state and city permits would someone need to obtain if they wanted to install a geothermal system?

ANTHONY FIORI: Well again a lot of that information with the permitting is in you know DDC's 2012 you know heat pump manual. But just roughly for open loop systems you… you're required a drilling permit from the State Department of Environmental Conservation. And with that comes a permit to operate the system. Again the state's main concern is water quality issues because you are extracting the water, bringing it up to the surface, and then putting it back into the same aquifer. So even though they're really a closed systems they consider it a open because you're bringing it up to the environment. So they're concerned about the amount of pumping and the… and the quality. And I believe if you pump a million gallons per day or more you're required to have a public hearing. We've never had that before but…

CHAIRPERSON CONSTANTINIDES: Mm-hmm.

ANTHONY FIORI: …that's one of the requirements. It's generally not a you know a major problem getting those permits. So that's a open loop systems. With closed loop systems there's… as far as I know there's no permitting once so ever as long as they're less than 500 feet. Again they can go greater than 500 feet but nobody's ever done it. Discourse considerations. But if you do go greater than 500 feet you have to get it… what's called a… a state mining permit. Again that's through DEC. That's anytime you go below 500 feet. Same thing with standing column wells which generally go down to anywhere between 13 hundred and 2,000 feet you’re required the same permit. It’s not a big deal. It’s just another piece of paperwork.

CHAIRPERSON CONSTANTINIDES: Is there anything that we do here in the city that’s additional permitting or it’s just only for the DEC that…

ANTHONY FIORI: It’s… there are some other… For example, open loop systems, again those are the ones you find in… in Brooklyn and Queens, because you are extracting water and injecting it back into the same aquifer it’s under the EPA regulations. It’s called the UIC program, the underground injection control. Basically they delegate their authority to the state. But there is some paperwork involved. They just want to know you know what we’re doing, you know the amount that we’re pumping. And they delegate their authority to the state. So the permitting comes from the state. But initial we do have to notify EPA.

ALEX POSNER: I would… I would add that the Department of Environmental Protection is working on changes to the building code to require permitting for… for drilling for geothermal and… and other drilling purposes between 50… greater than 50 feet in depth in order to protect the water and sewer system.

CHAIRPERSON CONSTANTINIDES: Okay. Now do you think there'll be fees associated with those permits or…

ANTHONY FIORI: I'm… I'm sorry I didn't hear you.

CHAIRPERSON CONSTANTINIDES: Do you think there'll be fees that'll be associated with those permits or…

ANTHONY FIORI: I do not know that there'll be any fees associated with that.

CHAIRPERSON CONSTANTINIDES: Okay. Because it sounds like to me… there's any… one potential hurdle to geothermal is the upfront cost associated with the installing them. What can the city do to reduce the upfront costs or sort of help educate people on what programs they can get that can help offset that over time.

ALEX POSNER: For… for public buildings the Department of Citywide Administrative Services administers capital grant program called ACE. So there are some funding through that program that may be applied to public installations of… of geothermal where the city pays the energy bills. At this present time, I don't know of any grant programs either state or federal that are available for private. The New York state energy research and development authority at one time had a program opportunity notice for geothermal systems. I'm not aware that that is open for funding at this time.

CHAIRPERSON CONSTANTINIDES: Alright. I'm going to turn this very quickly over to my colleague Donovan Richards and then I'll… I'll come back for a few more questions.

COUNCIL MEMBER RICHARDS: So good morning. First I want to thank the administration and thank our chairman for moving geothermal into the city's conversation. So I just wanted to go through in particular costs. So I think in your testimony you were speaking it would take a lot of resources and money to obviously look in particular at… at buildings… city owned buildings across the city. What sort of resources would the city have to allocate to ensure that we checked our own catalogue of buildings? What do you anticipate there?

ALEX POSNER: Yeah so what… what we're proposing is… is that we develop a screening tool that can be applied to each of our… our own buildings and as well be accessible to the private sector to… to use to assess the feasibility. That combined with DDC's manual provides broad based guidance on the… the type of geothermal system and the feasibility of installing geothermal systems. Beyond that we'd have to do a detailed engineering study to understand all the site specific conditions that would… would make or break a geothermal system. Since there… there're very site specific conditions that's not possible to do on a… on a broad basis. So in engineering… a detailed engineering study with a cost benefit analysis for the 4,000 plus public buildings would be extremely expensive. It would require not only internal but also consulting resources.

COUNCIL MEMBER RICHARDS: And how much do you anticipate this would cost?

ALEX POSNER: I have not calculated those dollar figures.

COUNCIL MEMBER RICHARDS: So how do we know it would be too expensive.

ALEX POSNER: Well I can… I can tell you from typical engineering studies that depending on the size of the building an engineering study could be upwards of a million dollars.

COUNCIL MEMBER RICHARDS: For one building?

ALEX POSNER: For one building depending on the size of that building.

COUNCIL MEMBER RICHARDS: So why don't we… So is there a possibility of… of… let's not… We have 4,000 buildings, we know that. Is there particular areas that we can look in? Can we limit the scope of the particular buildings that we would look at and… you know and obviously you know we want geothermal to work and we know we have 4,000 buildings but are there particular areas or particular buildings in parts of the city that you can just focus on outside of just focusing on the big number 4,000? So are you open… what I'm saying is are you open to a pilot and possibly looking at buildings you know that you would think would fit the scope in particular areas for geothermal usage?

ALEX POSNER: So I think what we think makes the most sense is to… to structure this in an iterative fashion so that we can develop this screening tool that can be applied to all of our buildings when… [cross-talk]

COUNCIL MEMBER RICHARDS: So all new… new construction you're saying?

ALEX POSNER: Both new construction and…

COUNCIL MEMBER RICHARDS: Okay.

ALEX POSNER: …and buildings that are going to retrofit their heating and cooling systems.

COUNCIL MEMBER RICHARDS: Okay.

ALEX POSNER: We would apply that screening tool at the time of… of that retrofit or the planning of the new building being that the project passes that screening tool we would then recommend that it be required to do a detailed engineering benefits analysis for that building or new project that also incorporates the social cost of carbon so that we can then begin quantifying the environmental benefits associated with the geothermal system and put it on somewhat of a level playing field with other types of traditional systems.

COUNCIL MEMBER RICHARDS: Yeah I think that makes sense. Just last question. So NYSERDA obviously has money. And have you looked to work with NYSERDA in particular to tap into their resources? Are you doing anything in particular around geothermal? Are you familiar in Nassau or Suffolk County possibly or… or with your relationship with NYSERDA and do you see a partner in NYSERDA in moving this forward as well?

ALEX POSNER: Yeah. So in… as I mentioned in the past NYSERDA had… had program opportunity notices for funding for geothermal systems. NYSERDA currently is going through a reformulation of how they operate. And they're getting out of the business of providing grants for projects… specific projects and rather providing funny… money to understand the market barriers to different energy efficiency and renewable solutions. That's coupled with the state's clean energy fund which is being developed at this time and the reforming energy vision which is the state's own program to change how energy is generated, distributed, and… and charged for. We do believe there's opportunities to work with NYSERDA for funding for programs that look at what the market barriers such as the high upfront cost that… that you’ve mentioned earlier before and… and look at opportunities to reduce those… those barriers.

COUNCIL MEMBER RICHARDS: Alright. Thank you so much. And congratulations Chairman on a great job and look forward to obviously seeing the final draft of this bill when we pass it. Congratulations.

CHAIRPERSON CONSTANTINIDES: Thank you. Thank you Councilman Richards. I appreciate it… other questions. Thank you. And the screening tool that you’ve talked about is it something that can also be utilized by the private sector correct? Did you perceive that they can use this as a… a way that for understanding how to utilize geothermal on communities?

ALEX POSNER: Yes. We do foresee that as being an opportunity for the private sector to use.

CHAIRPERSON CONSTANTINIDES: Okay. I mean we… I think we agree on the overall goals. I mean we… getting to 80 by 50 is a shared priority. One that is going to… we have to incorporate buildings… geothermal… you foresee geothermal being a… a part of that?

ALEX POSNER: Yeah we… we believe geothermal's an important tool in… in the toolbox to get us to our 80 by 50 goals. And… and we think that there's a great path forward to… to promoting the installation of… of geothermal systems.

CHAIRPERSON CONSTANTINIDES: Yeah. Councilman Lancman you have any questions? Alright now well I definitely look forward to working with you to implement some of these suggestions and… and getting this bill moved as quickly as possible so we can help our city move that forward.

ALEX POSNER: Thank you chairman. Thank you.

CHAIRPERSON CONSTANTINIDES: Okay great. So I have Doctor Fredrick Stum from the US Geological Survey, Bob Wyman representing himself, okay, and then… Olsen… all experts in the geothermal field. If you'd please take your seats and our Committee Attorney Samara Swanson will swear you in.

COMMITTEE CLERK SWANSON: Can you please raise your right hands. Do you swear affirm to tell the truth, the whole truth, and nothing but the truth today?

FREDERICK STUMM: I do.

COMMITTEE CLERK SWANSON: Thank you.

CHAIRPERSON CONSTANTINIDES: Alright so USGS… So Doctor Stum if you'd… you begin please?

FREDERICK STUMM: Sure. My name is Fredrick Stum. I'm a research hydrologist with the United States Geological Survey from the New York Water Science Center in Corum… Decorum Office on Long Island. I wish to thank the Committee on Environmental Protection for inviting the USGS to present some of our work relating to geothermal energy. I've been applying advance borehole and surface geophysical methods to environmental and engineering problems throughout New York City for almost 20 years. I published over 20 scientific publications relating to groundwater, hydrogeology and geophysical methods. The USGS in cooperation with the New York City Department of Environmental Protection has been collecting and analyzing New York City's hydrogeologic framework data sets using over 50 test boreholes that were drilled for the third city water tunnel. That began in 1998. Since

2014 the USGS has been working in cooperation with the New York City Department of Design and Construction. We've been collecting, tabulating, and mapping the bedrock elevation and thickness of sediments in the five boroughs to produce the first comprehensive map at high resolution for application for geothermal using a geographic information system and other… other type of technologies. Today I'm going to provide the committee with a brief overview of some of the research and how that research can be applying to specifically to geothermal and other groundwater applications. Just to give a very quick background… the geology in Manhattan, specifically the bedrock, is quite complicated. It represents a billion years of history so basically we have high grade metamorphic rock that was produced under high pressure and temperatures. It consists of a sequence of niche and schists with isolated areas of marble. In Staten Island the western most part is underlain by sandstones and shales. These rocks were formed during the assembly and breakup of continents. So due that… to that process a number of faults and factures in the bedrock actually create pathways for groundwater. The bedrock is fractures and faulted in several areas such as the 125th street fault which I'll show you as we… as we move on and across cuts Manhattan. During the cretaceous period sediments were deposited along the coastal plain. They included sands and clays which are underlying still to this day Queens, Brooklyn, and Staten Island. During the ice age Palestine time we had glaciers that had advanced. They covered much of New York City and the eroded and carved valleys into the bedrock creating some of the complicated layers that we're talking about. It also cut through some of the cretaceous deposits and they deposited their own sands, gravels, and clay deposits. So we have quite a complicated history which is now our job to unravel and try to apply that for… for geothermal. The USGS in cooperation with the New York City Department of Design and Construction compiled 80 years of test boring data that goes back to the WPA times and the… in the 1930s. We had a number of programs where test borings were drilled almost on every city block in New York City. And the depth of bedrock and some of the geology was collected, carefully categorized and… and put down on paper and stored. A lot of this data also was augmented over the years and decades by the New York City subsurface exploration group which was a legend when I was studying geology as an undergraduate as far as the data set that was available. And all of this… this has been compiled with other agencies like the Army Corp of engineers. We've worked with the transit authority. We've reached out to most agencies. The USGS assisted the New York City DEP and the water tunnel project. And over 50 borehole data set was also included. We also did seismic reflection in the East River and collected bathymetry data and… and the Army Corp also has collected a lot. So all of this was put together. It indicates a total of 14,000 data points. So it's… it's again pretty ambitious but using technology which is now available to us we can much more rapidly integrate that into a GIS which can be served up to the public specifically to the city and also to other agencies and contour that data and produce the… the… the bedrock maps you see there. It's a preliminary version we are in the process of getting it approved. And then it'll be put online and available between our agency and also at the DDC as well… at the website. The depth of bedrock is kind of a critical piece of information as… as Alex Posner outlined earlier as far as determining feasibility for geothermal. Overall the elevation shown in this map of the bedrock surface is quite variable in New York City. It ranges from over 300 feet above sea level. Specifically, that would be in Staten Island and… and northern parts of Manhattan. And it extends over 1,000 feet below sea level when we're dealing with in the Coney Island area and you know parts of Brooklyn and Queens. So you've got quite a range. This is just a close up. We made specific maps for each borough. And the idea is that high enough resolution you can zoom in… this is not a zoom… as zoomed in as you can get but the idea is to try to get almost to within a block by block basis. Again the elevation is contoured and color coded. In Manhattan we have over 200 feet above sea level areas in the northern most part and 300 feet below sea level on the coastline. Two valleys kind of are… are indicated. It's hard to see here but again around the 125th Street area there's a… a little yellow kind of a line you can pick out. You don’t have to be a scientist to kind of see some of the color changes at least. And that’s what we wanted to do to expand that information gap between scientists, engineers, and then the general public. And in the southern part of Manhattan you can see that lighter yellow area. That’s that glaciated valley that was eroded out in… in the bedrock. What we did next we took that great data set. We were really… really happy with some of that result and… and the resolution was high enough that what we did digitally was to create a depth of bedrock. We felt that that would be even easier comprehensive information type of thing. For the depth of bedrock or what we would call like a sediment thickness map, so it depends on how you want to look at it and how you want to utilize it. It’s really the first of its kind ever made for the five boroughs at this type of resolution. We use the elevation of the bedrock shown before and digitally subtracted again using the GIS technology of a high resolution map of the land surface which is now available which we didn’t have before. So we also included the surround bathometry in the east… East River, the Hudson River, and New York Harbor. So the resulting depth of bedrock map or sediment thickness again is a very useful tool to re-determine the amount of sediment overlying the bedrock anywhere in New York City. This will laid obviously in specific selections of locations.

[background, off-mic comments]

FREDERICK STUMM: Right. Exactly. So what we wanted to do… not every… [cross-talk]

[background, off-mic comments]

FREDERICK STUMM: Higher.

[background, off-mic comments]

FREDERICK STUMM: Right. It’s closer to the surface…

[background, off mic comments]

FREDERICK STUMM: Right it’s… it’s really… it… it’s color coded for how thick… how thick or how deep it would be to get to bedrock. We can look… so that’s… we wanted to… to try to make that… Because it was… there’s different ways… people think in different ways and they want to apply things in different… in… for different applications. So the data was available. We decided to go with that and it ended up being a really good exercise because it’s a better way of viewing some of the information then just having a contour line. And let’s see my next… there it is. And that’s Manhattan again. You can see in the upper part… in the northern part of Manhattan that… again that yellow kind of line that kind of diagonally cuts across Manhattan that is the 125th Street fault. And another area to the south is that deeper glaciated valley. And basically the… the materials… the… the questions that we’re trying to ask now is now that we’ve got a map of the materials what are they made up of. So some of the questions that we’re looking to answer next in our phase two would be applied… What… what is the hydraulic or groundwater properties of the sediment and the bedrock itself. Such properties would be the sediment type, the sand, silt, or clay, to determine where the aquifers are and how interconnected they may be. It’s also important to know how… how well they transmit groundwater, their transmissivity is another feature. And where salt water would be located because that would have an impact… you may have a… a shallow depth of water and maybe plenty of… of sand aquifer. But if there's saltwater it's not something you want to find out about later on in the process. And again using it as a screening tool. If we take a look at 8-8 prime I just want to show you what it… this is a 1953 USGS publication that was sort of the standard technology making some cross sections and contours but just represents southern Manhattan and… and the contact of bedrock and how variable it really is in cross section. A number of new wells have been drilled by the USGS and… and as… with some of our other partners this is a… a cross section of the southern part of Kings and Queens County. These were borings that were drilled to bedrock. So we'll take a look at the… at the sediment. And basically bore hole geophysical logs were… were lowered in these bore holes and information on the geology and the water quality were… were collected. Again this is the first time we've ever had a cross section of this extent. To the left is… would be Kings County, Brooklyn. And to the right would be in… in Nassau County. And the main thing to take away from this is… there's a number of different colored lines to a scientist or an engineer that might… it might mean something but those are gamma logs. The earth naturally gives off gamma radiation in… it's concentrated in the clay units and it's minimal in the sand. So it's a great tool for mapping the aquifers. And basically we also lower another tool… those red lines are actually conductivity logs. So salt water is much more conductive than fresh water and we're able to map the salt water intrusion due to pumping from the last century in Kings and Queens County we have intrusion in the Magothy aquifer which is one of those deposits. We have clay deposit below that, the Reardon clay. And then the loid below that. And basically it's another tool when you integrate that to… to map… to map some of the extent of… of the… of these wedges of intrusion. The other thing to keep in mind with geothermal is you may be an area that's currently… it might be near an interface to know that. That's why we want to map it. Because if you are withdrawing water you could create… you could pull in potentially salt water. So while the well system was installed at one point it was fresh water these wedges can migrate landward if we… if we over pump certain aquifers. This is… this is some research that we're… we're currently publishing. This is the… from what we understand is one of the first water table elevation maps of the glacial deposits overlying bedrock in southern Manhattan. These were a number of wells that were drilled by the New York City DEP during the water tunnel project. And we were able to determine the… the flow of ground water. And in general you can see it's sort of… in this part of… of Manhattan it's south of 30th Street. And basically there's recharge in the center and… and it extends to the south and to the coast line. The next figure is… is basically when we did aquifer pump tests on these wells we were able to determine chloric concentration. And chloric concentration is really the… the primary ion that's involved in sea water so it's a great quick indicator for salt water. And what we have is from the previous century there was a number of… of pumping that was enough significant pumping in southern Manhattan utilizing the aquifer that was there. And it intruded… it caused the salt water intrusion to take place. So we have almost pure sea water in some of the parts of the aquifer in Southern Manhattan. So we have to keep aware of that. And… and basically what we're looking to do is to compile the same kind of data set in the other boroughs. The last figure is we call transmissivity of the glacial aquifer. And really what that means to… to the general public is how well does it transmit water. And it’s just basically a number that represents that. So the higher values would be sediment that would not transmit water very efficiently. And the higher numbers would be very very efficient and… and able to produce large amounts of ground water. So again that’s another piece of… of information that… that we’re looking to map in some of the boroughs. Just to cover borehole geophysical logging that’s a whole nother [phonetic] course you could take on that. But in general all that it really involves is drilling a bore hole and sending a probe that can measure specific perimeter down that bore hole and we can collect that information. So once you compile different probes you can get a lot of information in one location on what to expect in the ground water. This is an optical televiewer scan of a bore hole in Manhattan. This is what a fracture would look like. So earlier it was unwrapped. We were able to… it’s basically a video that scans using a magnetometer the borehole wall. And that's actually what a fracture looks like that transmits water in Manhattan. It's about 360 feet below the surface. And we were able to rotate it in case you don't have core in the city… obviously for engineering applications was interested in that for the DEP work. But it's just a representation of what can be done depending on a location to maximize the development of groundwater. And that's what was utilized to… to build up some of this data set we're talking about. The resolution with this tool is about one millimeter in the vertical. And just to cover quickly. In the center of this figure is… use sonar or acoustic as well and then you can unwrap that. In the middle is north and to the side is south and the… the… the red indicates a… a long two-way travel time which is a fracture. And the blue represents contact with solid bedrock. So once you start talking about fractured rock you have to kind of do more… more background information because each fracture is an aquifer of its own. And to the right is an optical televiewer scan of the same exact section. So that takes a high resolution video and obviously you can get a lot more data out of it. So what does that get us? As far as a city tunnel number three project we were able to delineate the layering of the bedrock, what the geologists call the foliation but it’s the layers of the bedrock especially for the tunnel boring machine. We were able to determine the 3D fracture patterns in the bedrock itself because there are patterns based on the stress that the rock went under. And we can also quantify the total bedrock or individual fracture transmissivity. How… how transmissive is the bedrock in parts of Manhattan. That was important when you’re building a tunnel 600 feet below the surface but it’s equally important if you’re going to be planning a major geothermal project on a city project that building that you were talking about. And again these… these… these data sets, I’m just going to show you a few quick results of it. That was not that quick. This is just one bore hole I’m going to show you. This was the tunnel alignment that we had done some of the work. But in general believe it or not there’s information in that. It looks like a lot of squiggly lines that’s maybe to the general public but there’s a lot of information on this figure.

The main thing to take away here… if you look at the dots that are plotted… we're actually able to map the depth of each fracture, how big the fracture is and what angle it's… it's tilting toward north, east, or south. And the yellow indicates fractures that are tiny micro-small fractures. The green dots are medium fractures, and the blue are large fractures. So the two arrows are indicating the zones where the large and medium fractures were producing ground water in this particular well. This is a 600-foot-deep bore hole. Okay going back to geothermal we need to know the groundwater properties of the bedrock. These are probes that actually measure the temperature. That's a major parameter for determining the efficiency of a system and… and… and what the ground water may be doing in an area. And basically those two red arrows are indicating the zones that were producing ground water in this location. So I'm going to go into it a little bit longer but if you notice the… the temperature curve in the middle of the… of this plot it's flat. There is no… everyone thinks of a geothermal gradient whereas you go deeper the temperature increases. But because of groundwater it actually can reverse or… or cause a flat lining effect. But if you notice as we get near the bottom of the borehole at about 500 feet the temperature starts to increase with depth. And that’s where the geothermal effect that we see in New York City really starts to take… take over. I’m not going to go into this too much but really what this… what you’re looking at is a result of five years’ worth of… of work and analysis for the DEP. These are all transmissive fractures in Manhattan. And… and because we were able to determine which fractures transmissive that bullseye is really almost subhorizontal fractures. So you actually have fractures in Manhattan that produce water. They’re subhorizontal. And then there’s a cross cutting one… if you look to the right… I guess the lower right corner there’s another small bullseye. Those represent northwest dipping fractures at a higher angle. And that in a nutshell is the groundwater flow system from Manhattan. So what can you do with some of that information with the bedrock itself. This is a potential metric surface of ground water. You can think of it as a water table map for the bedrock.

We have recharged in the central park area. And then discharge again to the south and then out to the coastline. If we look at chloric concentrations… sorry… if you look at chloric concentrations in the bedrock you can see Southern Manhattan is pretty much intruded by saltwater. And the fresher water would be more on the center part of… of the island. We'd also did aquifer testing on the bedrock. And what you're looking at is the actual… the ability of the… of the bedrock in Manhattan to transmit ground water. In general, most of the bedrock was moderately transmissive. But if you notice there's a couple of those contour lines… they are much higher values as far as transmissivity. And that was associated with faults and fractures… associated with those faults. So it's a very site specific type of thing as far as how ground water's transmitted. And I'm just going to show you quick example. This is one of the deepest geothermal wells that we were involved in at the theological seminary. And just the main takeaway from this is its 15 hundred feet to the bottom of the borehole. If you look at the temperature curve it's the… it's the… I guess it's the third… it’s the third or fourth log here. It’s kind of in red and… and blue. It’s to the left of the blue line. That’s the temperature curve. And if you look in the upper part above where we have overburden versus the bedrock if you notice the temperature actually increases and then it decreases. We found that phenomenon in most of our bore holes in Manhattan. And that really represents the decades of heating our basements and subways. And we’ve actually charged the bedrock with all of that heat energy. So we’re talking about geothermal. We’ve actually created that over the decades and decades of… of us just living in Manhattan. And then well if you notice as you go further down in the depth the temperature actually decreases. And that’s due to again the ground water effect I was talking about. There is flow between the fractures. And then once we go below about five six hundred feet you start to see the temperature increase with depth. And that’s the normal geothermal grading that we’ve been talking about. One last thing if you notice it’s another major issue with these deep bore holes. They’re very difficult to keep vertical. And property rights issues is another problem where we don't want your geothermal well to maybe end up in your neighbor's… under your neighbor's property. And that's almost what happened in this instance. If you look with these tools since they have magnetometers and tilt meters we can actually calculate where the bore hole is. And that's one of the major issues the DEP had with this site. It was very close to the water tunnel and they wanted to make sure they knew where and document where this bore hole was going. So we did some of this work. And if you look at those lines the… the red squiggly line is actually the… the… the compass direction. That indicates the bore hole was going to the northeast. And the… the blue line… on the right most blue line is actually the… the tilt or the angle and it… and it… at… near the bottom of the bore hole was as much as six degrees away from vertical. When you put that into a program and look at it from plan view… like basically you're standing in the middle of the bullseye is where you start drilling. To the upper right is where the bore hole ended up. And… and that is called deviation. In this particular instance most of our bore holes from our research indicates the… the layering of the bedrock will predict the direction that your bore hole will go into. There’s always those up dip. So if you’re… if you’re bedrock is layered and tilting toward the south when you drill into it your bore hole will go up to the north. So it’s kind of a… Anyway so this bore hole ending up 35 feet away from the starting point in the northeast direction. So again the DEP’s very interested in documenting… and I know that’s another issue that some of these deep borings need to… we need to know where they are. Not only where they’ve been drilled but also the direction that they may go in for the underground infrastructure that New York City either has today or maybe in the future. And one last thing I’m going to show just we… we help… we… we worked cooperatively with Cornell University at a geothermal test site at Roosevelt Island. And the main take away from this figure is that we… we found a large fracture over 300 feet below the surface that was dipping to the southwest. And it actually undercut… it was underlying the entire well field and it was a high transmissive system. And in case someone’s interested and looking at what exactly does a fracture look like in 2D we actually used radar and were able to produce a cat scan of the bedrock. So what you're looking at is really a picture, a cross section of the bedrock that's never been seen before in New York City unless you did an excavation. You can see the fractures are subhorizontal. Those little light blue lines indicate a slightly slower speeds for the radar. And the redish line that you see is the dipping large fracture between the bore holes. These bore holes were 70 feet apart. So just to summarize… The… New York City's overburden is comprised the unconsolidated rock of sand, silt, clay deposits. It ranges from less than… to zero… to over a thousand feet in thickness. You have salt water intrusion which can cause corrosion issues with certain systems. It's been documented and… and is… is being mapped currently for Kings, Queens, and in Manhattan. The USGS has used advanced geophysical tools to delineate the overburden in fracture rock flow system. Manhattan's bedrock has its own groundwater flow system and it's dominated again like I said the subhorizontal and northwest fractures. The transmissivity is highly variable in the bedrock. We have two orders of magnitude with that transmissivity. And that's something to keep in mind depending on the design of the system. And again the USGS and the New York City DEC are working cooperatively together and we are planning to delineate and map the geothermal properties for the rest of New York City and… and the bedrock in overburden. So really to… in order to promote the use of geothermal energy in an area with complex geology and highly variable thickness of bedrock overburden detailed hydrogeologic information is really required. Through our cooperative program with the New York City DDC the USGS has begun that process of producing that data and the maps require for proper application of geothermal in New York City. And I would like to thank the committee for allowing me this opportunity to present some of this research and I welcome any questions you have. Thank you.

CHAIRPERSON CONSTANTINIDES: Thank you. I want to make sure I recognize from Queens my colleague Council Member Ulrich. Thank you for being here. Hi. Mr. Wyman.

BOB WYMAN: Hi, my name is Bob Wyman. I live in the city. I’d like to thank the… the… the committee, the chair, the members, and also the sponsors of this bill for… for action… for looking at this issue again of… of geothermal heating and cooling and… and heat pumps in general in… in the city. It’s this… it’s the willingness of I think our political leaders and our… and our… and our government to look at this issue which is one of the reasons why living in New York City is… is… is such a… such a great… great thing to do. If you look at the rest of the country when they think about energy issues or environmental issues etcetera, it seems that everybody is totally focused on issues of electrical production and perhaps on transportation issues. But the reality is that we know here in New York City… as we do in New York State in General that thermal energy… the thermal energy requirements of… of heating and cooling our buildings are some of the largest… represents of the largest demand for energy in our state. We know for instance in the state if you… if you’re concerned with carbon emissions only 18 to 23 percent of all of our carbon emissions come from electrical production. On the other hand, according to NYSERDA and to the PSC about 30 percent of our carbon emissions are the result of burning fossil fuels for heat in this… in this state. Transportation certainly is larger than… that produces more emissions. It’s about 40 percent for the state. But still what that tells us is that in… in our state and certainly in our city electrical production as a… as an environmental as an energy issue turns out to be a third level issue while transportation and heating and cooling of our buildings are the primary causes of… of… of energy demand in our city and our state. Of course the thermal demand in the city is much larger proportionally than the thermal demand for the state. Okay. I think a lot of people don’t recognize that and I think that means that… but… but I think hopefully this committee does and I hope it means that the committee will recognize that we probably need different policies here in New York State then… then other places. The fact that other places are not so worried about the issues of heating and cooling should not compel us to simply follow the trend. We need to worry about the issues that impact us. I'd also like to set some context if I could in… in saying why I think it is so important that we move forward on this bill and pass it and get the work done. And that is that if we look forward into the future… I mean we've been told today by the administration that it's impossible to convert the city from fossil fuels to… to… to ground source heat pumps. But I think actually if we look forward we have to ask the question in 2050 what will be the dominant form for heating and cooling in this city? Maybe not in 2050 2060 2070 go as far out as you like. What will be the dominant form of heating and cooling in this city. And I think the answer is it will not be fossil fuels. It doesn't matter if you're excited about climate change, pollution, or whatever today we do know some things that are very important to know. And that is that the price of fossil fuels will inevitably increase over time. The volatility of that… of those prices will increase. And we know very clearly that our society's willingness to tolerate the… the externalities… the negative effects of burning fossil fuels is increasing every… is… is decreasing every day. We are becoming less and less willing to tolerate the burning of fossil fuels. There will come a time in New York City when we like for instance Denmark, the entire country, has banned the use of fossil fuels for heating in buildings. In the entire country. That day will come here in New York. Okay. And we will see it in New York. We will see that heat pumps whether they be air source, water source, or ground source… we will see that heat pumps will be the dominant form of heating and cooling in the city. You don't have to be a visionary to know this. We know this because physics tell us the most efficient way to transfer heat from one place to another is in fact with a heat pump. Any kid that goes through high school physics learns that. The carbocyclic etcetera. The very tech… the very method that we use to… to evaluate even the… the engines and turbines that might be used for… for bringing fossil fuels these are essentially heat pumps. So what we think… what we need to do I think in this city and… and I think it's the responsibility of our government is to look for, to recognize, that it isn't just that the heat pump systems are… you know have some advantages today.

They may be better or… or… or worse than some other system but we have to recognize that we have a multi-decade process that we will go through hopefully with the leadership of our… of our… of our governmental system to do this. But we will go through a multi-general… multi-decade process here of converting from fossil fuels to heat pumps. Now some people will come back and say why are you so confident its heat pumps and it’s a very simple answer. First as I said before they are the most efficient way of heating and cooling so one would expect that eventually the best system will win. But the other thing frankly is that there are no known alternatives. If you ask anyone how can we heat and cool our buildings or I say how can we heat them. You can burn stuff… we’re eventually going to stop doing that. You can use electric resistance heating. The reality is that it’s horribly inefficient, terribly inefficient to simply you know have used base board and things and pair them via electricity. We have enough problem producing electricity now to… to… to power the systems we’ve got. The only other alternative is in fact some form of heat pump. It may be an air source heat pump, a water source, or a ground source but it’s going to be a heat pump system. And I think it’s time that we recognize that the future of our city is in fact with heat pumps. It may be that there parts of the city like Manhattan where ground source heat pumps are particularly difficult to install because of the bedrock, because of the need for standing column wells etcetera. But we do know that there are areas of the city like the… like Brooklyn and Queens where heat pumps… where ground source heat pumps are much… much easier to… to… to install because of the ground conditions. We also know for instance that the conditions in those cities and in those parts of the city like in Brooklyn and Queens almost demand that we do this. Right now Brooklyn… Queens… we have the Brooklyn Queen Demand Management Project where ConEd is talking about paying $3.65 per watt of avoided electrical consumption during peak periods during the summer. $3.65 per watt, okay. On the other hand, if we then look at what would be the… the… the potential. What happens when you put a… a ground source heat pump into a home in Brooklyn or Queens. In Brooklyn and Queens if you look at single family homes it’s sort of like you know if we look at what we found on Long Island which is just a little bit over the boarder we discover that using ground source heat pumps in Brooklyn Queens would probably reduce the peak demand by somewhere between 1.5 and… and two kilowatts. It… at… at peak conditions. In theory ConEd ought to be willing to be pay them somewhere on the order of about $7,000 dollars okay to install a… a ground source heat pump in Brooklyn or Queens. Because if you can reduce peak load by 1.5 to 2 kilowatts in those areas you’ve accomplished what they need in terms of reduction of… of peak load commissions. It’s time that we began to look at our city. Okay see these… see these requirements. Understand that heat pumps are going to be an important part of our future and… and start considering not just the question of can we encourage a few more installations go from six city buildings that use heat pumps but rather of the 4,000… How do we get to a thousand? How do we get to 2,000, 3,000, or more? And I think what we need to do is something very similar to what the city has already done with… with renewable electricity even though they recently said this was renewable energy. But what the city recently did with renewable electricity is that we put it on an RFI. They didn't rely simply on the expertise of people in the city but they asked the industry how would you go about providing New York City with renewable electricity on a broad scale. It's time that we ask industry and… and… and others to come forward and tell us we have a city here with 4,000 government buildings. We have a million buildings in general. How do we take this city and get it off of fossil fuels and get it onto the cheaper, cleaner, technology that is afforded to us by heat pumps? I would strongly suggest that the bill include a call for an RFI to essentially go out and… and… and be very aggressively and say this is not for a one building pilot. This is not for yet another school, yet another tiny cluster of buildings. But essentially how are we going to manage the process of going from almost 100 percent fossil fuel, heating, today to say 80 percent non-fossil fuel heating in 2050. How do we get there? This is a problem that we will have to address. We can do it better if we have leadership from the government and we have an ordered process between now and the several decades from now when we know that we will not be using fossil fuels. We know we will be using heat pumps. The only question is what is the path from here to there. Thank you.

CHAIRPERSON CONSTANTINIDES: Thank you. Mr. Olsen.

OLSEN: Say again… [cross-talk]

[cross-talk]

CHAIRPERSON CONSTANTINIDES: It's okay. If you want to grab some water… Please go ahead.

OLSEN: I passed out some handouts. And it's the same thing that the… that should show up there on the screen. So do I have a time limit? Like everybody wants to have lunch pretty soon or what's… what's the status for that.

CHAIRPERSON CONSTANTINIDES: Feel free to go ahead.

OLSEN: Okay. No specific time limit. Alright. Well thank you for inviting me to testify. I… I hope you'll find it useful. I'm a… an engineering graduate from UCLA. I live in New Jersey but I do get to New York City quite often. I have a daughter living here so I'd like to see things go well for the… for the city. And I pretty much second the ideas you heard from Bob Weiman just a minute ago. So anyway this first slide shows the fundamental way in which you might be able to get heat pumps to work better than they do if you have only a constant temperature available to you from underground. Basically the horizontal scale is called lift but that's really the… just the difference in temperature between the input and the output side of a water to water heat pump. So what… what you can see there is if you have a differential temperature that's as high as 50 degrees centigrade the… the middle two curves which you can assume represent a ground source heat pump system… actually it's the… the second curve from the top you'll get a… a coefficient of performance which is essentially efficiency of maybe three. I would say that's a little optimistic. I would say more like two. But as you can make that… when you make that so called lift temperature, differential temperature smaller you can gain a factor of two or even three higher efficiency which means that your electricity use for the same amount of heating or cooling in the building would be one half or one third of what it would otherwise be. So moving along here's a… an example of what people call a hybrid heat pump system. It's a little bit beyond the standardized approach. And this comes from a document published in 2011. And it represents a system hypothesized for an office building in the North of France. In this case the authors of the article were assuming only heating was needed but the idea here is that instead of using only the ground for your heat pump they are proposing to use solar thermal collection above ground. And that would be what… what they call unglazed collectors. These are the same thing that people commonly use for heating swimming pools. They're very inexpensive pieces of… sheets of plastic with embedded tubing. And it turns out that that approach give you a very significant advantage if you have enough area to do it which you might not have in Manhattan but you might have in the outer… outer boroughs. So the next slide show is specifically how much better you can do if you have that improvement to the heat pump system put in. What this graph shows is on the left hand side you have the result with a standard ground source heat pump. For their hypothetical office building the cost to go the whole system would be 900,000 euros. As you start adding in the unglazed solar collectors you reduce the total cost of the system. And that's shown by the red… the red line at the top. And if you had as much as 750 to a 1,000 square meters of these solar thermal collectors you can reduce the capital cost by about 20 percent which is fairly significant. Now as I mentioned you do need some area to do this. But it might be possible in some… in… in office buildings in the outer boroughs of… of New York City. So these two groups… I went too far, got to go back. The… if anybody wants to… to see the details of what those two slide were these were the two reports both from 2011 that show the simulation results over a 20-year time period. Here's another example of almost the same concept. Again it's… would be called a hybrid heat pump system. And let's just look at the left hand half of this slide. It shows a cooling tower and again a… there's a three port valve to allow water to flow either in series through the ground heat exchanger and the cooling tower. Or you can exclude the cooling tower and only use the ground condition water. Now we know that these systems do provide a significant benefit. However, I believe that it’s possible to have even a greater benefit if you entertain the idea of having a difference… a different series connection or parallel connections or reverse flow for the water in either of those sections of the system. So that shows up on the next slide. In this case instead of having one three port valve there are six valves and we have now something called a solar/air heat exchanger. So basically we’re… we’re saying that the sun can provide some heat or even the… the… the outdoor air in some cases. This opens the door to having both… the equivalent of an air source heat pump and a ground source heat pump all in one. But it does require extra valves and temperature sensors and… computer. So these are ten different modes of operation that can be accomplished with that previous design. And in some cases you will use the… the sun solar thermal collection to condition the ground temperature if you don’t need any heating or cooling for the building at a given time. I should also mention the unglazed solar thermal collectors will collect heat from the sun. They will also serve to collect cold in the winter with antifreeze. You can basically condition the ground to be colder than it would otherwise be. So the idea here is that if you can make… make the ground either hotter than it would normally be for use in the winter you garnered advantage because of having a higher coefficient of performance. Vice Versa. If you can make the ground cooler, you can gain a higher efficiency in the summer for a similar reason. Now what we have considered so far is only one region underground. And we're… we're trying to think about ways to make that region not only a stable temperature but maybe a… a higher than average temperature or lower than average temperature when you… you need it. We can think about now having two separate regions underground instead of only one and we can condition each of those underground regions to be either hotter than average, hotter than the deep earth temperature, or colder. So we can have one of each. One underground region which will be hotter than the deep earth temperature all year long. The other underground region will be colder than the… the underground temperature all year long. And these valves allow the… the optimizing of the flow. The… the series path can… can direct the… the water to always be optimum. So this is a… kind of a side view of that previous concept. We have the same four blocks here. We have the solar/air heat exchanger. We have two regions underground which we're attempting to show as kind of a spiral configuration rather than anything else. But of course those underground regions could be bore holes as we've heard about already. They could be standing column wells as we've also heard about already. So we have the… the four blocks that were shown previously that is a heat pump… solar air heat exchanger and two regions underground. There's a systems controller, basically a computer, we… we're assuming here that all of the valves and pumps can be put into that flow control block above ground. There's also an electrical generator. Because if you have access to both hot and cold water you can generate electricity. So this would be what some people call a trigeneration system. But notice there are no fossil fuels involved in this. This could be a self-contained system. This is somewhat futuristic but I believe it will be possible and I think we will see it. Now the spiral underground heat exchanger basically is a less expensive way to do a heat exchange underground as compared to the other relatively standard approaches that is less expensive than bore holes. You're not digging any… any depth into the ground at all. At this case it shows two parallel paths going around the spiral. And the idea is you want to keep the most extreme temperature always at the center of your storage region. You don't want to have an extreme temperature near the edge, near the perimeter because that would dissipate the heat more quickly than would need to be done. Although this shows a circular path you could do almost the same thing with a rectangular path. So this would be something that could be fitted underneath a building for new construction. So you could have the height and width of this… this spiral path adapted to the dimensions of a specific building. Now an obvious question comes along… how big does this have to be to store on a seasonal basis… that is if you want to store for six months, store summertime eight going into the winter or vice versa. And this graph shows some simulation results in doing that. This assumes that we have some average numbers for ground thermal conductivity and a perimeter called diffusivity. And so with these assumptions and with the assumption that we're going to heat this ground up for perhaps 60 days. And we're going to then allow it to cool down for 150 days which brings a… brings to a… a seasonal effect that is five or six months of cooling what percentage of the heat remains in that underground region. And that's what this graph is attending to show. The dotted line is essentially correct. It's been verified with other simulation of its… So you'll see that with a radius of five meters you're going to lose most of the heat over this five month or 150-day time period. So that's too small to be very effective. On the other hand, if you get up to a size of 15 meters radius you're able to store roughly 80 percent of the heat or cold for this 150 day time period. So that gives you a rough idea about how big it has to be to make it work as you would expect… as you would expect to have. I found four examples that are something like what we were just discussing. And I… I have them arranged in… in sequence of size. This is the smallest size. And if you want to see more detail on this it shows up with the website at the bottom right. But these are for individual homes or buildings. And this is not seasonal storage. This would be storage for a much shorter time period. But there may be a heat pump involved in this. But in… in some cases they may not have it. We… we're showing here solar thermal collectors on the roofs of these buildings. And these… if you look at that website these solar thermal collectors are what… are… are called evacuated tube types which will work in all seasons of the year as long as the sun is out. Here's another example which is on a larger scale now, something more appropriate for New York. To keep it simple let's just consider the far left example with the far right example. These are systems being done currently in the state of Main by a man named Jeffrey Harrison. And the far left example is a standard bore hole approach which would be part of a ground source heat pump system typically. And what this is… is if you want to have a 54-ton effective heating or cooling system you're going to need 18 bore holes that are 500 feet deep… deep. That's fairly expensive to do but it's… it's not far from reality for around here. Now if you don't want… if you want to have a more economical way to provide the same 54 tons you can do it with a horizontal array of plastic pipe shown on the far right. This is high density polyethylene type plastic material. And what the assumption is here is that for the same 54 tons you're going to need dimensions of 300 feet by 115 feet. So what are the… what's the cost of doing this either way? Here are the cost numbers. The… and these are cost per ton on the far right. You'll notice that the standard bore hole approach at the top is $3,400 per ton. On the other hand, there are two examples of the horizontal pipe array cost. One of them is 11 hundred dollars per ton. The other one is 16 hundred dollars per ton. I hope that's right. Let me just double check that. Yeah that's the right number. As I say these are being put in today so we know that this is a reality. So it's a less expensive way to get a… an equivalent effectiveness from a ground source heat pump. That's the bottom line from this. But you do need some more significant area to put… above ground to put that system in. So moving along here this is what's being done in London, England. I'm assuming that we want to be aware of what's… what's been done in other countries to bring the best ideas in for yous here in New York. So the website is clearly shown there. And you can see more completely what they do from that website. Now what they're doing is they're putting in an array of pipes below an asphalt surface on the left. And although they show some kids playing there my assumption would be it would be more likely to be a parking lot. An asphalt parking lot. The asphalt will get very hot in the summer, it'll get very cold in the winter. So that serves as an ungrey [phonetic] solar thermal collector essentially. So what they're doing there… and they have multiple projects that have done this already is they're putting that heat from the left hand asphalt pipe array under the building into another pipe array shown by the red dots. So they're warming up the dirt under the building all summer long. Now you notice in this case they do use a heat pump to boost the temperature up when they need it. So basically this is again a way to get a more efficient use of… of the heat pump system as compared to bore holes where they're only looking at the deep earth temperature. The temperature they'll get here is much higher than the deep earth temperature. And you'll notice they say they're going to double to the coefficient of performance by doing it this way. So it's not only less expensive than bore holes but you get double the COP. It's kind of a win-win situation you might say. So I think we can learn from this and maybe replicate some of this for what happens in… in this area. This shows heating only but there are also doing the reverse. They're collecting cold in the winter… storing that underground. This would be stored in a separate area underground, not the same area. So now you end up with two regions underground; one hot, one cold. So you get a higher coefficient of performance both summer and winter. This shows a picture of the early phase of installation again in England. As far as I know this is only being done in… in England. So I… I believe it's something right for picking up and replicating elsewhere including around here. You notice they do not have a connection at the center at this array of pipe. And so I believe it could be improved even beyond what is shown in this picture. Here is the largest example that I would like to draw attention to. In this case they are going back to the use of bore holes. But they're using the dirt as the heat storage medium. And this is seasonal thermal storage being done in Canada near Calgary. And the name of the project is Drake Landing Solar Community. And the website is very simple. It's D L S C dot C A. So basically in this cake they're using a fairly large array of… of flat plate solar thermal collectors on the garage roofs of a housing complex where there are 52 freestanding homes. These are two story homes that are roughly 16 hundred to 2,000 square feet I believe. So all summer long they're putting heat into those 144 bore holes. And they're about 120 feet deep. So the temperature they're able to get in the dirt is… is up to 70 to 80 degrees centigrade. And that's enough heat to… to heat all of those homes in the… in the winter of the middle of Alberta, Canada. And it's been operating for about eight years and it works quite well. Here's a cross section view of those 144 bore holes. It doesn't show all 144 here. Basically it's a cross section view showing both the… the depth and the width of the bore hole array. And also I put in a hemisphere there to replicate what you might do if you had just a horizontal spiral array up at the top. Now this system does have eight inches of insulation at the top. So they… they avoid losing heat into the atmosphere. That is… that is a requirement for all of these types of systems basically. So there… there are three elements of cost if you want to put in these kind of arrays. There's the plastic pipe. There's the insulation. And there's the excavation. Three costs. But again it tends to be less for the equivalent… of… of doing bore holes or standing column wells. Now the disadvantage of what was done at… at the drake landing community in Canada is it was too expensive. So no one has replicated it at this point because of these high cost numbers. You'll notice that the… the bore hole field all by itself was $620,000. And so that comes about to about $62 per square foot. If you compare that cost per square foot with what we had previously back here the cost per square foot for these examples is about $2.40 per square foot. So it's tremendously different if you do not spend the money for those 144 bore holes. But you're still able to use a heat pump with it if you want to and get a good result. So… so far we've talked about three different types of solar thermal collectors; unglazed type, what are called evacuated tube type, and flat plate type. So this shows the result. This would be perhaps more interesting to an engineer rather than to other people. But what it shows is that the un… the evacuated tube types will work at a… with a very high outdoor temperature. The unglazed types will… will not. I think in the interest of time I'm going to speed this up. This is a graph that shows the cost of putting in four different types of seasonal thermal energy storage systems underground. You'll notice that one type that we've talked quite a bit already about are… is the bore hole. That's shown in… in green there. There's also aquifer storage which is very predominant in the Netherlands. But it may not be appropriate for around here. There is the concept called pit storage which is very widespread in the country of Denmark and works quite well. And then there is the use of just very large tanks, these would be insulated tanks to store a large enough amount of water to… to provide heating all year long. Now the spiral array with an insulator on the top would need to be about 90 to 100 feet in diameter to… to… to represent 400 cubic meters which would… which would be similar to the very smallest of those tanks at the top. However, the cost we estimate is going to be instead of 450 to 500 euros per cubic meter it's going to be about 50… 50 to 60. So we think we have a much less expensive way to do seasonal thermal storage. Here's something else that is being developed only in Europe as far as I know. And I'm trying to… to follow it but it's… the website is shown at the bottom right. It's called fluid glass. And the website is fluid glass dot E U. And they are starting to publish some fairly interesting engineering reports on this concept. And I think it would be appropriate for New York City. The idea is that these are special type of windows. They have four… four panes of glass. And this is taken directly from that website… pardon me. The four panes of glass are shown here in gray. So that leaves three hollow spaces that can be made use of. What they're proposing to do is have water flowing in one or more of those hollow spaces. So the example they show here is with water flowing in the outer most hollow space and in the innermost hollow space. So they can collect either hot or cold with the water that flows in the outermost hollow space. And they can help condition the room with the water that flows in the innermost hollow space. Now I believe that there is a… yet a… some… some other interesting ways that this system can be used. And let me just mention two that I think would be somewhat better than what this shows. If you reverse the colors between blue and yellow, there you can have water flowing in the center most hollow space only. So you would have then a triple pane window, very highly insulating, but you also have essentially a flat plate glazed solar thermal collector. So the water that flows in that central space can get very hot and if you have a place to store it most likely underground you could bring… bring that heat back and use it in the winter. So that to me represents an interesting opportunity. The other interesting opportunity is if you have water flowing only in the outer most hollow space and leave the other two spaces filled with air or gas or even a vacuum. Some people are… are doing vacuum for the… for these types of windows. You again have a… a… a triple glazed… I mean a… a… a… a triple glazed window which… which is highly insulating but you can collect cold with the outermost hollow space with water flowing there. So what I believe we can look forward to not in the next year or two but in the next five to 20 years would be some steps going towards a more fossil fuel free New York City. And I've listed here five different tasks to think about doing. Task number one; develop large scale seasonal thermal storage which is kind of an offshoot of ground stores heat pump technology. It basically is an enhancement of the standard ground source heat pump ideas. Get a higher efficiency and a lower cost. Number two, I guess I can call the bullet points; build more and larger solar electric and wind farms perhaps offshore. They're certainly doing it in Europe, Germany, England, Denmark. They're doing all of this more and more. Number three, which might look a little bit unusual; pumped hydroelectricity. I believe that can be done along the Hudson River and the Delaware River because you have fairly high hills up… upstream on both of those rivers. And again they're doing this in Europe right now. Along the Rime River they're… they do have pumped hydro there. And the idea is to make sure you can store the energy from the solar electric generation and the wind farm generation to give you a steady electricity source even though the sun may not be shining or the wind may not be blowing. The fourth bullet point down there is the use of the multi-pane windows to collect both hot and cold. And then the last bullet point I'm suggesting the use of ice storage tanks with heat pumps or chillers for diurnal thermal storage. So I'm optimistic that these kind of approaches can lead to essentially a fossil free New York City within the next several decades. So thank you again for inviting me and I hope it's been useful.

CHAIRPERSON CONSTANTINIDES: Thank you… thank you all. I have a few questions. What do you believe… regulatory impediments to widespread geothermal energy use in New York City?

BOB WYMAN: Well one of the significant impediments that we've had in the past has been that NYSERDA and PSC have essentially had a policy opposed to the technology, that explicitly prohibited or discouraged people from installing it. As you… I think you may have heard of the phrase fuel switching. A lot of our state funds have traditionally been collected through the system's benefit search either from gas consumers or electric consumers. It's been the position of NYSERDA and the PSE in the past that they would then encourage you to improve efficiency of an electrical system or a gas system using those monies. But if for instance you wanted to switch from a very dirty inefficient oil furnace to for instance a highly efficient clean geothermal heat pump you would get no benefit from the state and you would… you would not be allowed to use that for… for any renewable credits or whatever. And this is because it was fuel switching. It was… it was considered even though you were an electrical customer and you were becoming more efficient in your electricity it was considered a bad thing. Our hope is that in the REV [sp?] process as they move more towards a policy of fuel neutrality that the government… that the state government policy will in fact be able to respond to what is most efficient and what is most clean as opposed to whether or not it's switching between fuels and things. We also have a difficulty in that a lot of our policies are very silo-ed. For instance, once again NYSERDA and PSE policies, even federal policies, will often reward anything which say will reduce electrical consumption over the period of a year okay. On the assumption that reducing electrical consumption results in efficiency increases. But the reality is that something like a ground source heat pump system will typical redu… yes it will reduce your electrical consumption during the summer. But because it's… it's substituting a small amount of electricity for the fossil fuels that you would have burned during the winter for heating it increases your consumption during the winter. If you're in a heating dominant climate like we are here in New York the result is that your aggregate electrical consumption for the year will often increase even though what's happened here is… is really great for the utilities and the rate barriers. You've reduced your consumption during the summer when you're cooling okay. And that's the most expensive electricity. You've increased your consumption during the winter which is and… and… and you do that at a time when you're not… when you're essentially increasing utilization of the grid and thus you're increasing the profitability of the utility during the winter. Yet because it's an overall aggregate increase government policy and regulations will discourage this or prevent it in many cases. The… the shame here of course is that well say take… I mentioned before Brooklyn and Queens. If in fact, we were to convert say 20,000 homes or living units in Brooklyn Queens to ground source heat pumps we'd see… we'd see the 40 megawatt reduction in peak load that they're trying to get for the 150 million dollars they're spending. The interesting thing is that instead of having to charge the citizens of… of Brooklyn and Queens increased rates in order to pay the 150 million dollars because a ground source heat pump system would be increasing consumption during the winter when it is essentially free for the power company to provide that power okay. It's entirely possible that if you were to convert to ground source heat pumps in Brooklyn and Queens that you would see a reduction in rates rather than having to tack on additional fees to cover the 150 million dollars because essentially the power company would make up for the money during the winter that it was spending to reduce the power consumption during the winter… during the summer. We have a lot of these very odd sort of conflicts that are written into our regulations and written into our laws which are based on… on say you know old thinking or people not thinking systemically. Many cases where for instance this business of… of… of equating the reduction in electrical consumption with efficiency somehow is an… an environmental quality is… is written into the law okay. The… this was… this was actually reflected on by our public service commission and their response to the clean power plant regulations where they pointed out in those regulations there… in their response to the EPA on those regulations. And they explicitly said that it is entirely possible that in New York State it would be much more cost effective for us to encourage the… to… to address the thermal energy power… thermal energy issues than to address the electrical energy issues. It would be much more cost effective for us in New York state to do things like increase the consumption of electricity while decreasing dramatically the amount of fossil fuels. So the… this just gives you some sense. We also have other things in New York City. We've got the problem with sidewalks. You know one of the things that's in the bill for instance is the statement that the… the city should identify space available or space suitable for the installation of this… of… of this technology. As you know in most… most areas in New York City a building covers the entire ground it sits on except for the sidewalk and maybe the… the alley in the back. It turns out for a lot of smaller buildings or even some very large ones with… with standing column wells the sidewalks provide enough space to in fact heat and cool the entire building. They're all you need. For instance, the seminary building that was mentioned… that's basically drilling in the sidewalk. It's drilling in the perimeter of that… that building. The difficulty is… is getting permission do drill a small hole, not a long pipe but just a small vertical hole in the sidewalk can… can be very difficult and it requires that you pay annual fees for essentially renting your piece of the sidewalk. The question I have on a regulation like this is that I can see how that makes sense for a pipe or if you're going to… you're going to put… extend your building somehow and take advantage of it. But the city should want everybody who can to install a cleaner cheaper heating system. The city should be doing everything it can to encourage people to be… to be using available space such as the sidewalks to… to install vertical… vertical bores. There… there's very few better ways to use those sidewalks than to… than to reduce the… the fossil fuel consumption of those buildings. All the way through our regulatory… our regular… regulations you'll find these sort of odd things. It's not because people I think have been opposed to the idea of the geothermal but rather that most of those regulations were written by people who were not thinking about this technology, who were not anticipating it, and who certainly didn't understand the consequences of what they were doing. For instance, the… the guys who write you know demand… management demand reduction regulations trying to encourage people to reduce the consumption of electricity they're… they're absolutely doing you know what they think is… is the right thing. They just don't realize that when you take things to reductions in electrical consumption you're discouraging not only ground source heat pumps you're also discouraging things like electrical vehicles okay. And we need both of those moving forward. So my apologies for a long answer but there are many issues on the regulatory side.

CHAIRPERSON CONSTANTINIDES: I definitely hear you. I think we need… definitely need to work closer with NYSERDA as my colleague brought up to ensure that they're…

BOB WYMAN: Oh I should probably… probably say now sorry to interrupt but NYSERDA has just created a… a new office to which they've appointed the… to… Director of… of Renewable Thermal Technologies. Donovan Gordon has just been appointed to that position. So we're hoping… And this is one of many signs that NYSERDA is getting it now where they didn't in the past. But we're hoping that the… the Office of Renewable Thermal Technologies Programs, sorry, and the funding that they've been given means that they'll… and… and what's going on in the REV and the clean energy process. We're hoping that that will be a… a… a real see change in the way NYSERDA approaches these problems in the future. Sorry.

CHAIRPERSON CONSTANTINIDES: …mean so… just to kind of go back. We talked a little bit with the administration about this but there are areas of the city that are better for geothermal you would say that throughout the five boroughs we could do geothermal.

FREDERICK STUMM: Well like Alex had mentioned from the DDC obviously you know Brooklyn and Queens is… is already… you know you have the material. Depending on the location and the type of system. Obviously the salt water issue. But that can be you know mitigated depending on the type of system that's put in. And that's… you know again using… depending on the location I know… like was mentioned on some of these larger scale projects like the seminary they did utilize the sidewalk space to… to put the standing column type of design in. So the… the approach would be to use you know some of these maps as a screening tool. But yeah. I mean it's… each of the boroughs have its own… has its own unique sort of geology and hydrology. Somewhat also Staten Island has similar aquifers as… as Kings and Queens in certain locations. Other parts of it has more of a bedrock type of outcrop. So…

CHAIRPERSON CONSTANTINIDES: So having that screening tool that the administration talked about before would definitely be a… a solid addition to the bill?

FREDERICK STUMM: Right.

BOB WYMAN: The… the… the… in principle a screening tool would be a wonderful idea. In practice we should understand that it could have very significant issues. And that is that the screening tool will undoubtedly imbed within it assumptions about the technology, assumptions about what… what are the characteristics of… of the systems that can be used in these areas. And the re… the reality is I think from everything I've seen from the administration so far in their various manuals and such the… they are not completely up to date on the technologies that are applicable in an urban space like ours. This isn't surprising because frankly the problem… or shall we call it urban geothermal has not been well explored in this country even though overseas in… in… in places like you know the Scandinavian countries and European countries they've done a lot that… a lot more than we have. For instance, you know just in… in Queens well let's say… say… see in that part of the country… see the far… city… Like in the Rockaways given the type of soil they have, given that the water level is so close to the… to the surface there are even opportunities to use some techniques that haven't even been discussed here today which is… which is a vertical technique but using augurs which are essentially big post hole diggers. Where what you do is you don't drill 100 feet down, you don't drill 500 feet down, what you only… what you do is you go down 20 to 25 feet but with a 24-inch-wide pipe. And then you put what are called DX pipes within this. Essentially you make a pipe full of water in the ground and it turns out in that kind of soil this is a… a particularly cheap and effective way which is suited for the Rockaways but would be a total waste of time in Manhattan okay, or even the Bronx or something. But it's a… it's a… it's a marvelous technique which is appropriate for the Rockaways and they've got some experience out on Long Island in doing this. And I think what… this is why when I spoke before I asked that an RFI be considered because I think what we really need to do is to give industry the opportunity to come in and… and… and tell us… not only industry but also you know people at the universities and the rest you know tell us the different techniques that they would use if in fact there was an opportunity here to do… to do a lot of… of geothermal, to essentially give them the scale. There are all sorts of things. Like we know for instance there are hammer drilling techniques where you can go into… into a basement okay. So if you don't have a sidewalk, if you don't have any space given this different kinds of soil you can actually going a basement and you can drill vertical bores from inside a basement using various techniques. That… they do a lot of that up in Canada for instance. They'll go in the parking lot under a building and they'll put in bore holes under the… under the… under the… under the parking lot without disturbing the building above it. These are technologies and techniques that have not been used here in the city because in the city there is essentially no geothermal business. You know what we know is we got maybe a hundred or so geothermal installations today. Six of them in city buildings. There is no industry here and the result is that the city has not been exposed to… to the kinds of innovations that could be used in the city if… if only we were to encourage people to come here and tell us about them.

CHAIRPERSON CONSTANTINIDES: No man I hear you man. I mean I represent a district in Queens that we have many multi-family homes. And… and how we can best utilize geothermal in… in… in these types of neighborhoods or something I'm… I'm… [cross-talk]

BOB WYMAN: Right and… and you guys… you're all pay… you… those people are all paying too much. It… it… it's… the… the fossil fuel people have really convinced people I think in many cases that the fossil fuels are cheaper. And… and sort of everybody gets scared of the upfront costs on the geothermal systems and the heat pump systems. The reality is if we do lifetime cost of… of… of energy we find out in almost every case, especially in places like… like Queens where you got the ground that you do that the geothermal systems will be cheaper. The problem with them isn’t that they’re cheaper. The thing is that today they’re unaffordable okay because of those upfront costs is the question you asked before. However, we know that in the solar industry they had exactly the same problem. They know that you put up a solar panel. It costs you some money to put it there but once you… once you’ve done it you’ve essentially got free power for the rest of your life or at least the next 20 or 30 years. The problem with solar panels was they’re too expensive to install, the upfront costs. So they solved the problem. And the way they solved it was through third party ownership, by having people come in and say yeah we want you know 20 30 year investments. It’ll give us a five, six, eight percent return over the 20 or 30 years. If we had… if we could encourage the same sort of thing say for those buildings out in Queens where you are essentially tell people we’re going to do the same thing for geo… for your heating system that we’ll do for your electricity system okay for no money down from you okay we will put in a heating system and then you’ll pay us essentially a monthly fee for the next 20 30 years unless you want to buy the thing out okay just like a solar panel today. And that's how 90 percent of solar panels get… get… get installed today. What… what you'll have is you'll have cheaper cleaner heating. Okay you'll have almost dead certainty of what your heating and cooling costs will be from year to year as opposed to that… today when you're betting on what the price of oil or gas is going to be okay? The thing we need to do to make this possible is to essentially go to the financial community, go to the people who would do this okay and… and tell them we want it to happen and we as a city are going to encourage it to happen and… and… and we're going to plan the process. Because we know as I said before we're going to do this okay. Over the next I don't know 10 20 30 40 50 years we are going to get those dirty expensive fossil fuel systems out of not only the Queen… out… not… out of not only Queens but also the rest of the city okay. Let's start this process. People believe that we were following this process, that we actually were moving forward you would have third party ownership programs appear for… for heating systems just as we have them for solar. And they would be just as… I won't say… actually just as… as applicable. You'll find that they'll be even more effective than they are for solar. The difference is that almost every building in the city… almost every building in the city can use geothermal whereas only a small number of them can really benefit from… from… from the solar technologies. I'm not in any way against solar. I'm just from a… from a scale point of view that many more buildings can… can benefit and much more energy can be reduced and… and generated on site with… with the heat pumps then… then with the alternatives.

CHAIRPERSON CONSTANTINIDES: So you're saying that you believe that geothermal could be widespread?

BOB WYMAN: Yeah I… [cross-talk]

CHAIRPERSON CONSTANTINIDES: What percentage do you think of the million buildings do you think… [cross-talk]

BOB WYMAN: Well if we believe the guys at Columbia they did a… they did a… Professor Modey [sp?] and his people did a study on this a while back. And they said that their estimate was it's something on the order of… of 800,000 of the city's buildings, that's about 80 percent, could benefit from… from this technology. They said primarily it's basically Manhattan's the problem. As he pointed out to you on the slides there… there are a couple spots in Manhattan where you can do it but otherwise you're doing… you're… you're… you're doing standing column wells and very expensive things. And it's… it's hard. If you look at the… the rest of the city where… where the buildings are a… a very large portion of the city. I think… I think actually the Columbia numbers when I looked at their maps which they haven't formally let out. They… they didn't account for things like the water tunnels and a few other issues so maybe it's not 800,000, maybe it's 600,000. But that is a very large number of buildings. And… and that's essentially buildings that we could convert today given the technologies that we know about today. Once we have an industry in place. Once we have people actually you know digging into the problem of urban geothermal I think what we'll do is we'll develop the technology so that we can actually get to the 800,000 level.

CHAIRPERSON CONSTANTINIDES: Thank you so much for your testimony gentleman. I appreciate your time and efforts. Thank you so much. Alright we have one last panel. We have Ling Tsou from United for Action. And we have Katherine Scopic [sp?] from the People's Climate Movement New York. Hi good afternoon. Samara will swear you in.

COMMITTEE CLERK SWANSON: Please raise your right hand. Do you swear affirm to tell the truth, the whole truth, and nothing but the truth today?

CHAIRPERSON CONSTANTINIDES: Who'd like to go first?

[background, off-mic comments]

LING TSOU: My name is Ling Tsou. I'm a Co-founder of United for Action which is a grassroots or volunteer activist group based in New York City. And we advocate for no fossil fuels. No clear… no nuclear energy. And we want to promote conservation, energy efficiency, and renewable energy. I just wanted to say thank you to Chair Constantinides and your staff for this initiative, for holding this hearing you know for geothermal and promoting renewable energy. And we all know that climate change is the most critical issue today. Because if we don't solve this issue today it may be too late. You know there will come a point when the damage is irreversible. And we have to act now. And I really believe that if we do what… you know we… we throw in all the resources and all the talents we have. We should be able to go 100 percent renewable in 2030. I think going just 80 percent reducing the greenhouse gas in 2050 is too… too late… too far away. And I think geothermal is just one tool in all the renewable energy. And we can combine that with solar, with wind, hydroelectric, small ones, not the huge dam. And… and you know power storage. We should be able to get there. And if Germany can get more than 50 percent of their energy from renewable sources now we can certainly do better than that because they don't have the… you know they don't have sun… they don't have the kind of weather we have here. So thank you very very much. And with your help you know we'll get there.

CHAIRPERSON CONSTANTINIDES: Thank you. Thank you. Alright Ms. …

KATHERINE SCOPIC: Greetings. And thank you to members of the New York City Council and to the Environmental Protection Committee Costa Constantinides for introducing this local law to enable the installation of geothermal renewable energy in New York City particularly as our buildings account for about 75 percent of our emissions. I applaud you for the timeline of beginning reporting by July 1st of 2016 as the issue is so urgent. And after just hearing Bob about how many buildings by the 60… 600,000 buildings it's… it's extremely important and I doubly applaud you. As I've taken several courses at General Theological Seminary located at 170… 175 9th Avenue and 20 Street Chelsea I am aware that in August 2006 having received approval from Community Board 4 on July 26 they began work on their long plan for geothermal heating cooling system. At that time, they created the single largest geothermal well field in New York City area consisting of 22 standing column wells installed beneath the sidewalks surrounding the campus. They had to drill down into the bedrock to a depth of 1,500 feet and the empire state building to the top of its lightening rod is 1,453 feet. So they had to drill down further than the Empire State Building is high. As they were interested in preserving the integrity of their buildings the hot water system fit perfectly with the hotter… hot water systems the buildings already had. There was little construction needed for the buildings. They expected to recoup their costs within nine years so that year 10 would be clear with low maintenance for this geothermal system has been estimated to reduce general theological seminaries, carbon dioxide emissions by more than 1,400 tons a year. That's pretty significant. I thank the council and Samara Swanson for the outstanding side sourced and… site sourced and stored renewable energy conference held February 27th of this year at the CUNY advanced science research center Steinman Hall that presented several types of closed and open vertical and horizontal loop geothermal systems. It was a most educational conference especially on this renewable energy source and served as good preparation. I have two questions and this morning's panel in part answer them but I'm going to read it anyway. This bill calls for reporting of the number of city owned buildings in each district for which instillation of a geothermal system would be cost effective. This implies the need for more trained professionals able to make these assessments. Will there be funding from the city for training the people needed for these jobs? Second question… In the case of general theological seminary, it took quite a while to get community support for the project as drilling was required. In fact, in speaking with them they said it took a lot longer than they thought it was going to take to get the community on board. Will there be coordination with the related city agencies to ease any potential difficulties and help the… the geothermal installation processes go smoothly? Again I applaud and thank you for taking this step to move us closer to reducing our… reducing our greenhouse gas emissions. And I hope it's not in… inappropriate for me to put in this plug here. I hope that if there's anything you can do to help the city obtain power purchase agreements for offshore wind that could also help us reduce greenhouse gasses in a big way. I hope you will. Thank you for this opportunity for comment.

CHAIRPERSON CONSTANTINIDES: Thank you. I think we're looking at all renewable energy sources. So there will be many more hearings to come. We'll be discussing many other potential technologies as we move along so…

KATHERINE SCOPIC: Wonderful. I am so impressed by this and I look forward to doing anything I can as both a citizen and a member of several different environmental groups to support you in your work.

CHAIRPERSON CONSTANTINIDES: I definitely appreciate that. I definitely appreciate your time both here today. And you know as we move forward to reducing the city's greenhouse gas by 80 percent by 2050 we need to… we need every sector to play a role. And buildings most certainly have to be a main focus for us.

LING TSOU: Well if we… [cross-talk] all work hard we'll get there sooner than 2050.

CHAIRPERSON CONSTANTINIDES: Absolutely.

LING TSOU: That's our goal.

CHAIRPERSON CONSTANTINIDES: Absolutely. Absolutely. I want to thank you both for being here today and thank you for your very thoughtful testimony. I appreciate it.

KATHERINE SCOPIC: You're welcome.

LANG: Thank you. Thank you very very much.

KATHERINE SCOPIC: Thank you.

CHAIRPERSON CONSTANTINIDES: Thank you. I want to make sure that I thank… oh you're… you… I want to make sure I thank the committee staff for their hard work today. Our legislative attorney Samara Swanson and our Policy Analyst Bill Murray for your efforts to put this hearing together and all of your continued work on behalf of the people of the city of New York and our environment. So thank you Samara and thank you Bill for your great work. I want to thank my own staff Nick Wazowski, Shara Sharone [sp?], Nick Rolfson [sp?], Nickie Pacinos [sp?] for all their work to help with this hearing today. Together. I want to make sure that I… I recognize again the Mayor's Office of Sustainability and DDC for their good testimony today. I… I see it and I want to make sure I… I thank all of the scientists and advocates that were here today that spoke. I think we have… Okay so we also… for the record we also have testimony that was handed but not… not… not given today from John Riner [sp?] from PW Grocer [sp?], the plumbing institute, and I believe I also was handed testimony from AIA. Yes? Yes. Okay. So I was also handed testimony from AIA that will be going on the record. I think that we do have a path here to make it easier to implement geothermal in the city of New York to expand its use. And I'm looking forward to working with the administration to getting this done, and getting this done in a timely fashion. So thank you so much. And with that I'll… I'll gavel this hearing of the Environmental Protection Committee closed.

[gavel]

C E R T I F I C A T E

World Wide Dictation certifies that the foregoing transcript is a true and accurate record of the proceedings. We further certify that there is no relation to any of the parties to this action by blood or marriage, and that there is interest in the outcome of this matter.

Date September 28, 2015