Testimony of

Massachusetts Department of Energy Resources

Commissioner Philip Giudice

to the U.S. Senate Committee on

Energy and Natural Resources

on behalf of the Commonwealth of Massachusetts and the

National Association of State Energy Officials

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Chairman Bingaman and members of the Committee, on behalf of Governor Patrick and the Commonwealth of Massachusetts, and the National Association of State Energy Officials (NASEO), thank you for taking on the energy and climate challenges. We look forward to continuing to work with you, as the federal government takes a leading role in the months and years ahead in confronting our energy future.

You have asked me to address use of energy in buildings, which accounts for approximately 39% of total energy consumption in the United States, and more than half of all energy use in several states, such as my own. It is critical that we drastically cut our use of fossil-fuel energy to meet these needs, in order to improve our energy security, protect against the rising prices of energy which are sure to come after our economy recovers, and to address the worldwide threat of climate change. As my testimony will demonstrate, it is also very doable to dramatically reduce our energy waste in buildings. Technologies and building practices exist today which would provide the same or better comfort with a fraction of the energy consumed. We simply need to be much more strongly motivated to fully deploy these better approaches.

Massachusetts strives to be a leader in promoting the use of energy efficiency and renewable energy sources to meet the electricity, heating, and hot water needs of buildings, but there is much more for us to do. Let me briefly list a few of our programs, but then move on to address specific areas that are of most interest in terms of designing federal policies.

First, for over three decades we have continuously provided incentives to businesses and homeowners to install efficiency measures in their own buildings. Legislation passed last year will greatly increase these subsidies, as it mandates that electric and gas utilities invest in all efficiency that is less costly than purchasing more electricity and gas supplies.

Second, we have supported development of clean, renewable energy, both through a renewable portfolio standard for electric utilities and through specific funding for research, development, and installation of renewables. Under Governor Patrick's leadership, we are two years into a program to install 250 megawatts of solar photovoltaics by 2017 – with 7.2 MW awarded in 2008, spurring a 300% increase, to 150, in the number of solar companies in Massachusetts. Last year we broke into the top five states[1] in terms of solar PV market size in the U.S.; and we are now aggressively pushing development of wind power and biomass in the state.

Third, we are focused on energy efficient building codes for residential and commercial construction. Massachusetts passed a raft of energy and environmental legislation in 2008, including a provision that requires us to adopt the most recent version of the International Energy Efficiency Code within one year of its publication, and specific

[1] "Tracking the Sun" report from Lawrence Berkeley National Labs – Feb 2009 http://eetd.lbl.gov/ea/emp/reports/lbnl-1516e.pdf

initiatives to train inspectors and assure full code compliance. We have also developed an advanced or 'stretch' code, for voluntary adoption by towns and cities that wish to go significantly beyond these base code standards, in order to accelerate our transformation of the building construction and renovation sector in our state.

Congress and the President have made a huge effort to increase energy efficiency and promote renewable energy with the recently passed stimulus package. Mr. Chairman, your efforts have been in the forefront of these energy efficiency issues for many years. The package's funding of $3.1 billion for the State Energy Program, $5 billion for Weatherization, $3.2 billion for the Energy Efficiency and Conservation Block Grant and $300 million for Energy Star appliance rebates can all make a huge difference in promoting energy efficiency in buildings. The expansion of the existing homes tax credit to 30% and $1,500 will be strongly promoted by the state energy offices as part of our comprehensive effort to improve energy efficiency in homes. We hope that additional funding of $100 million can be provided in the near future to fund training and technical assistance to improve energy codes, and especially to train contractors, local code officials, architects and others to comply with higher building code standards.

Energy Codes, Past, Present and future

Allow me to focus particularly on energy codes for new construction. This is a critical area, since once constructed a building will be consuming, or wasting, energy for the next 50 to 100 years, and in many cases much longer. It is relatively simple to construct commercial and residential buildings with measures that ensure 20% to 50% less energy waste than current leading codes, and the incremental cost is generally low. The additional cost may even approach zero if the building is planned and designed thoughtfully. However, if this opportunity is missed, then once a building is completed it is far more difficult and expensive to greatly improve the efficiency through retrofits. Thus, ensuring that initial design and construction is done with full attention to high energy performance standards is vital.

Yet we know that developers of buildings, and purchasers, all too often are concerned primarily with minimizing the initial capital costs of a building. Exceptionally few building developers, designers or owners care about lifecycle energy costs of a building. Quickly building the aesthetically pleasing, least expensive initial cost building is seen time and again as the way to make the most money when developing real estate. Stringent energy codes are needed and need to be fully followed to reduce energy waste. In our current economic circumstances, where construction may be difficult to finance and energy costs are low, it is especially tempting to minimize the initial capital costs of construction and to disregard opportunities to save on future energy use. But our economy will recover within the next few years, energy prices will rise again, and buildings constructed today will be with us for a very long time.

Valiant voluntary efforts to increase awareness of the energy choices in buildings has had an affect. More and more tenants are asking for green buildings. Programs such

as LEED and Energy Star are raising awareness. Even today, in a difficult real estate market, there is significant demand in Massachusetts for “green” high-efficiency buildings, in both the commercial and residential sectors. However, market forces alone are not moving us fast enough or far enough to reduce our energy wastage.

Iced – Tea Buildings

There is a litany of what’s wrong in our current practices. For instance, the result of the current status quo is all too often what has been called ‘Iced-Tea buildings.’

While iced-tea is typically served at a temperature only slightly cooler than tap water, it requires both energy extremes of boiled water and frozen water to produce.

This is an apt analogy for how our current buildings are designed to operate. Typically using over-powered heating and cooling equipment, often running simultaneously, in an attempt to achieve a desired temperature that varies within a narrow range of only around 65-75 degrees Fahrenheit throughout the year. Due to building envelopes and labyrinthine ductwork networks that leak air and are poorly insulated, these buildings need to be regularly topped off with heating and cooling to maintain their precarious state of comfort. In addition to massive energy use, many buildings use water with similar abandon, and yet despite all these energy inputs we have widespread mold and air quality concerns, leading to the relatively modern ‘sick building’ phenomenon.

Modern technology provides excellent opportunities to provide occupant comfort while minimizing energy waste. Yet, in general, the owners and managers of buildings fail to utilize this technology well. I’ve been in commercial buildings in winter that are running roof top chillers on a high rise to cool IT equipment, when simple air to air heat exchangers would have done the same thing for a fraction of the energy needed.

In many, perhaps most, cases buildings are never commissioned. Commissioning is the last item on the punch list before occupancy, and even if completed it is seldom a thorough job. Consequently buildings’ heating, cooling, ventilation and other systems are never adjusted in order to perform correctly.

A representative of a major commercial building controls company recently visited my office. I asked how many of their commercial buildings were fully utilizing their building control systems to minimize their energy consumption. He estimated that at best 10% of their systems were ever commissioned and fewer still are re-commissioned at any point subsequent to initial installation of the systems.

Even when buildings operate appropriately on day one, the complexity of modern controls, and the thousands of mechanical moving parts in modern commercial buildings, means that they will not continue to operate optimally without ongoing monitoring, maintenance and commissioning. This is rarely in the budget, but even more importantly these complex systems are not designed for longevity and ease of use. Instead, they resemble proprietary black-boxes with future consulting revenue

potential for the designer, rather than appropriate technology to meet the building operators' long-term needs.

The building that our agency is located in is an unfortunate example. We are in a privately-owned high-rise, several floors of which house state agencies. Not that many years ago the building was renovated, and it has fully automated timing systems and motion sensors for the lighting. Yet until recently, due to malfunctioning controls, and the difficulty of making adjustments, the lights on most floors have been on all night every night. The private offices and conference rooms have motion sensors, but many of these have not been adjusted correctly, so that the lights stay on for more than an hour even when no one is present.

Tenants also commonly lack incentives to control their own electricity, heating, and cooling usage, because they don't pay utility bills based on their specific consumption, as separate from other occupants of the building. This could be corrected by sub-metering of utilities, which modern technology increasingly has made feasible and affordable. In Europe such sub-metering is expected, but in the U.S. it remains the exception rather than the rule.

There is a saying that what is measured can be fixed, but what is not measured will be ignored. This is highly applicable to energy consumption in buildings. When someone purchases a building or takes out a lease, they rarely know what the structure's past energy consumption has been or what it's specific energy-related features are. If purchasers and prospective tenants knew what their future energy bills were likely to be, they would demand efficiency improvements before making financial commitments. For this reason, it is essential that past energy use of buildings be calculated in a standardized way, such as BTU's per square foot, and that these figures be publicly available. Then these numbers need to be converted to an easily understandable universal ranking system, such as an A to F scale. This is being done in several European countries, including the United Kingdom, Germany, and Austria. ASHRAE has just announced that it will develop such a scale, and in Massachusetts our Zero Net Energy Buildings Task Force is recommending that we begin mandating such rankings, first for new construction, and eventually for all buildings in the state.

While we have these systemic problems within the construction sector, at the same time we also have the technical knowledge and design professionals to avoid and solve these problems. It is a relatively easy option to set our sights higher and choose a different path, one that achieves dramatic increases in energy efficiency, while also improving indoor air quality and day lighting. A movement to zero-energy buildings is within our sights, as California and Massachusetts have recognized, with other states giving this goal increasing attention.

One primary barrier to these intertwined and complementary goals is one of capital, or 'first' costs, and investment in design. We no longer build the way we used to a century ago, not just because we have better technology and materials, but also because our real estate industry does not have incentives to afford the time or the capital to invest in new construction the way that humanity has in the past.

Transformational, not incremental, improvements in energy codes

Massachusetts urges a 'step change' in energy codes to reflect the policy imperative of moving our buildings away from exorbitant use of fossil fuel-generated heat, light and power – the Iced–Tea model - towards efficient and integrated design. We believe that a dramatic shift in energy awareness in the design and management of buildings is needed to reduce our long-term energy costs, improve our energy security, and address climate change. Massachusetts and several other states are acting to update codes, but we urge Congress to consider federal action, and a state and federal partnership to ensure an adequate response at the state level.

Historically, energy codes in the U.S. have not been set at the federal level. But this is a time for change, and federal leadership on energy codes is needed. Moreover, a federal and state partnership could reinvigorate the construction industry by raising standards across the board, reaching for and achieving high-performance buildings. Eventually our buildings will have to be net-zero consumers of fossil fuels, so efficient that their consumption can be balanced by on-site production of renewable energy, and we need to be designing for that future now.

Current code development leads to incremental energy improvements

Current code updates from the International Codes Council (ICC), which creates the International Energy Conservation Code, IECC) and ASHRAE are iterative, incremental processes that largely protect the status quo of building construction. ICC and ASHRAE are non-profit membership organizations, essentially private, unelected, undemocratic bodies. These organizations do self-select for the most technically minded code officials, however, decisions are made by whoever happens to show up at meetings, as voting has to be in-person. Votes at IECC are won by whoever organizes the most people around their issue. For example, at last year's Minneapolis annual meeting over 1,000 people voted on requiring sprinkler systems in new residential homes, while only 150 or so voted on adoption of most other provisions. These included a package of measures to improve energy efficiency by 30% that DOE, NASEO and others had worked for two years to develop. The 30% energy efficiency improvement vote was taken at 1:30 am on a Sunday morning, and failed to pass by five votes. What was passed is estimated to improve energy efficiency by 12% to 14%. This is far too timid an improvement. The time is now to be much bolder.

DOE should publish a national building code within six months

We need more advanced building energy efficiency codes and we need specific incentive funding to implement these codes and train local code officers, builders and contractors.

During the last Congressional session advocates pushed legislation which said that if the latest IECC (2009) does not improve efficiency by 30% over the last version, then DOE must write its own code which does raise efficiency by 30%. Such legislation should be proposed again, including possibly with higher efficiency goals. This would substantially improve upon the relatively small efficiency gains that typically flow from the ASHRAE and IECC updates.

DOE has begun development of model energy codes that are 50%, not 30%, better than existing code. These need to be implemented, and could form the basis for a national minimum code in the next two to three years. This level of improvement will require more attention to building design, including continuous air and radiant barriers in the building envelope, higher minimum standards for windows, increased use of insulation, and a rethinking of heating and cooling systems; but existing off-the-shelf technology can meet these goals.

In order to provide for state innovation, federal legislation could specify that a national code from DOE set an aggressive minimum floor which states must adhere to, but each state is free to set even stricter standards for its own code. Since there are large climate differences among the states, along with economic differences, a federal code should preserve the variance in code requirements by climate regions.

We would also recommend that if a federal code is developed, there be a requirement to update it every three years, as the IECC and ASHRAE do now. Technologies are constantly changing, and much progress would be missed by waiting more years for updates. This is a primary reason why Massachusetts passed a law mandating that we always update to the most recent IECC code, because until recently it had taken us eight years between one update and the next one.

In addition to building codes, efficiency standards for appliances, electronics, and other equipment are critical to reducing energy use, particularly because 'plug-loads' are rising rapidly as a fraction of total energy use in buildings. Federal standards for equipment are an integral part of ensuring energy smart codes. The performance and sizing of heating and cooling equipment in particular need renewed federal action, and a commitment to regular future updates. Massachusetts has petitioned DOE to set it's own higher performance standards for heating equipment; but for all states it is essential that the federal bar is raised, and that the new generation of renewable heating equipment options are fully developed and promoted.

Specific Recommendations for Federal Code Requirements

Federal Energy Star standards for new buildings need to be improved in several specific areas:

<u>Heating systems should not require leaky buildings</u> – Heating with any fuel should require sealed combustion units. This technology is already in widespread use today,

and is far safer and more efficient, not least because it doesn't require a hole in the building shell to vent fumes to the outside.

Solar thermal - the Energy Star program already has a proposed Advanced New Home Construction package that would require solar water heating in Southern U.S. climate zones (zones 1-3). We would like to see this implemented and consideration given to solar thermal throughout the U.S.

Higher insulation standards – the same draft Advanced Energy Star package has also proposed 50% improvements in insulation above the latest IECC requirements.

Move away from forced-hot air heating - heating or cooling with forced air in leaky buildings is a recipe for inefficiency. Hot water heating and cold water cooling is not only more efficient and more comfortable, it is also much more compatible with efficient use of solar thermal, geothermal and biomass pellet or woodchip heating systems. Exemplary heating and cooling systems include radiant floor heating in Northern climates, efficient mini-split ductless heat pumps in mixed climates, and radiant water cooled wall and ceiling panels in cold climates. None of these systems require any ducts, so leaky, dusty, mold-inducing air delivery can be a thing of the past. While traditional air-conditioning is likely here to stay for a while, lets make it compete with other more efficient and healthier technologies.

'Stretch Codes' – Massachusetts and Federal

There will always be a market for buildings built 'beyond code' by progressive builders and owners who value leadership in this area. To date the EPA and DOE have filled this residential market with the Energy Star for Homes program, and left the commercial sector more to private and non-profit groups such as the LEED green building programs.

In Massachusetts, as in many states, there is a growing Energy Star for Homes market. Even during the dramatic housing downturn, Energy Star homes are retaining value and showing rapid sales. However, the Energy Star base requirements are only a 15% energy improvement over the 2004 IECC code, and in the higher tier a 35% improvement. These goals equate to a Home Energy Rating System (HERS) score for new homes of 85 and 65 respectively, where zero would be a zero-energy home.

Our newly proposed Massachusetts advanced or 'stretch' code builds on the extensive research and sound building science of the Energy Star Homes program. But based on actual buildings constructed in the past two years we have proposed a minimum standard HERS score of 60, improving to 50 in three years time – roughly 30% to 40% better energy performance than current Massachusetts code (which yields a HERS score of around 92). Thus, our proposed stretch code would be substantially more aggressive than the existing Energy Star Homes program. Last year, 270 homes built in Massachusetts achieved a HERS score of 60, despite there being no financial incentives at that time to go below a score of 70.

Our stretch code is paving the way for future improvements to our statewide base code, based on 3rd party certified performance and heading rapidly towards a zero energy future. A more detailed plan of action for our state will be released in March by the Zero Net Energy Buildings Task Force commissioned by Governor Patrick last year. California has also called for zero net energy buildings in the next decade, in quite different climate zones from New England. Matching or exceeding the current Massachusetts and California targets would be a logical step to take nationwide, and we believe that the program staff at the EPA and DOE have done the work to prepare for this opportunity. They just need leadership from Congress and the executive branch to send the signal to step up the planning and roll out a more forward-looking Energy Star standard for new home construction.

Existing buildings – renovations, additions, and retrofits

New construction matters, but particularly in old states like Massachusetts, it is just the tip of the iceberg. We have massive energy liabilities in our existing building stock, both residential and commercial. As previously mentioned, we have a well developed energy efficiency retrofit program operated by our electric and gas utilities, that is undergoing rapid expansion, but we need to do more.

NASEO is working to promote Home Performance with Energy Star and we are members of the National Home Performance Council. We are attempting to more aggressively promote comprehensive energy efficiency improvements in existing homes.

As a result our stretch code also applies to renovations or additions to existing residential units, requiring any major projects to meet the same 3rd party verified improvements as new construction, but with a maximum HERS rating of 70, or in some cases 85, improving to 60 and 75 respectively in three years time. We are confident that bold action will strengthen, not weaken our real estate sector, and add green jobs and skills to our workforce.

For existing construction that is not undergoing major renovations or additions – which is most of our housing – we also need to dramatically improve efficiency. At present this cannot be done through building code requirements, but can be brought about through providing financial carrots to building owners. Massachusetts has had such incentives for many years, through programs operated by our electric and gas utilities, and we are in the process of greatly expanding those programs due to legislation passed in 2008.

We have long had residential energy auditors, insulation contractors, and plumbers making our aging housing stock more energy efficient. And for decades we have had engineers examining our commercial office buildings, city halls, hospitals, and industrial facilities replacing outdated lighting, motors, refrigeration equipment, and more.

The measures covered by the programs have varied over time, but include steps as simple as caulking and weather-stripping leaky doors and windows, and as complex

and expensive as switching out a 50-year-old boiler for a brand new energy-efficient one. Often, commercial and industrial customers will get a comprehensive energy audit from experienced engineers that will provide a list of more than a dozen energy efficiency measures that will reduce energy expenses, cut pollution, and improve aging capital.

These programs have been highly cost effective, delivering great benefits to the Commonwealth. These include energy bill savings through direct reductions in energy use by homes and businesses that have made efficiency upgrades. But the benefits go farther than that. Energy efficiency reduces demand for electricity from the regional electricity grid, which means that all these measures significantly reduce pollution from power plants and forestalls the need to build new expensive peaking power plants.

Under our 2008 law, the state will make energy efficiency programs compete on price with traditional energy supply. Utility companies will be required to purchase all available energy efficiency improvements that cost less than it does to generate power to meet the same energy need, ultimately saving money on consumers' electricity bills. And it will be done not as an add-on to utility bills, but as an integral part of the way utility companies meet their customers' energy needs.

Multi-family and manufactured housing

Within the existing building stock, multi-family and manufactured buildings stand out for special attention. Such homes represent over a quarter of the housing units in the U.S. and comprise 20% of energy consumed by all housing units, yet receive little attention in the implementation of energy efficiency programs. Saving energy is more difficult in such housing, both because many residents are low-income and because a large majority are renters. The 'split incentive' between tenants and landlords is a major barrier to efficiency investments.

Given the limited program experience to date, now is the time to encourage innovative approaches, to evaluate these approaches, and based on these evaluations to develop broader programs. We suggest a competitive grant program to seek creative solutions to multi-family and manufactured housing efficiency. Administered by DOE, this program would provide grants to state and local government agencies as well as non-profit organizations to create effective, replicable projects. Priority should be given to projects that provide substantial energy savings while targeting recipients with the greatest financial need. Prioritizing highly cost effective programs with significant matching funds will help maximize the return on federal grant funds. **We recommend funding of about $50 million in the first year, rising to about $500 million in year five** for multi-family homes.

In the area of manufactured housing, models in Maine and New Hampshire are instructive. We recommend providing rebates through state energy offices in cooperation with state housing finance agencies. $10,000 rebates to individuals in pre-

1976 manufactured homes in order for them to move to Energy Star homes would be a good start. $2 billion would address 10% of the over two million pre-1976 manufactured housing units.

There are some successful local programs in operation, including in California, Massachusetts, and Vermont, but these are few and far between. Programs could be developed to encourage retirement of old manufactured homes (over 60% of mobile homes are at least 20 years old), to invest in efficiency upgrades for new or existing publicly assisted housing, or to institute multifamily heating system retrofits.

Historically, manufactured homes have been some of the least energy efficient units, provided for the least financially able members of society. Yet such housing is also an efficient method for producing well-constructed and sealed homes, from both an air and water tightness perspective. This makes manufactured homes some of the lowest hanging fruit on a heavily laden tree. Technologies such as structurally insulated panels, coupled with energy recovery ventilation systems and ductless mini-split heat-pumps can and should transform the manufactured homes sector, so that formaldehyde and mold scandals and energy poverty are things of the past.

Current examples of step-changes in building construction

If these recommendations sound bold, let me briefly relate two examples that show how major changes in building design are being made today.

Zero Net Energy Buildings in Massachusetts – In the small town of Townsend, in northern Massachusetts, we learned of a small construction firm building affordable housing with HERS ratings of zero and minus two. These are zero-net energy buildings, using no fossil fuel, and heated and cooled with solar thermal and photovoltaics. Equally remarkable, they are affordable housing units, although the builder has also pre-sold several market-rate houses in the same development. This is but one example of a nascent but growing trend across the U.S. and around the world.

Efficiency and solar heat in Upper Austria - In Upper Austria, a region about the size and population of Connecticut that gets less sunshine than Montreal, Canada,[2] the regional government passed legislation last summer requiring solar thermal space heating to be provided on all new residential buildings. This is also a requirement in Israel and Hawaii, where there is considerably more sunshine.

In Upper Austria they were able to do this because they also have very strong building energy codes that minimize the number of BTU's needed to heat a home. Their new buildings are currently required to be three times as energy efficient as average existing buildings on a square meter basis. Their energy star equivalent program pushes 'Passive Haus' standards that have energy demands less than 10% of existing buildings, and their zero energy homes number in the thousands. They also require all

[2] Data from NASA for Lintz, Upper Austria 1,216 kWh/m^2, and Montreal, Canada 1,319 kWh/m^2

publicly funded buildings to have an energy audit and an energy certificate showing how that building performs on an A-F scale. They now have over 70,000 buildings[3] with publicly available energy certificates, and seven square feet per capita of solar thermal panels.

Their stated goals are to reduce building energy use a further 39% by 2030 and to move to 100% renewable heating, cooling and electricity in buildings, thereby achieving zero-net energy buildings sector-wide and statewide.

In Upper Austria there used to be a significant market share of oil heating, just like the northeastern U.S. states today. In 1999 36% of new homes installed oil heating systems. By 2007 this had dropped to less than 1%, and they tell us that there were only 17 new oil heating systems installed in Upper Austria last year. The oil heating industry has disappeared in a decade, yet this has not led to an expansion of natural gas. Instead, renewable energy heating from solar thermal, biomass wood chips and pellets, and biogas from agricultural waste, have grown from an impressive 32% of new installations in 1999 to a 76% market share in 2007. Upper Austria now exports their pellet boilers and solar thermal heating and cooling technology throughout Europe. In Massachusetts, we will be hosting our second Upper Austrian delegation this April.

Conclusion

We must all look to the future and design and build for it now. That requires educating the public, both private citizens and companies, on the vast potential for improving the efficiency of our buildings. Energy labeling of all homes and commercial space is critical, much as refrigerators and cars are labeled today. We need to know if our buildings are an 'A' or an 'F' and be able to make choices about the 'miles per gallon' equivalent of a building that we are considering a 30 year mortgage or a four year lease on. Massachusetts is committed to doing this, but we, like Upper Austria, are only a small state with big ideas. We encourage a federal - state partnership, to raise national standards while allowing state innovation to transform our energy landscape.

I am encouraged by your engagement in this matter, and as my testimony has indicated, encourage us all to be bold. I suspect that decades from now, no matter how bold we think we are being in this process today, we will look back at this time and wish we had been bolder.

[3] Data from the Energy Agency of Upper Austria: http://www.esv.or.at/esv/index.php?id=33&L=1