



Energy Conservation using Window Glazing in India

Siddharth Lohia¹, Swati Dixit²

B-Tech Student, Dept. of Electrical Engg., GNIOT, Greater Noida, Uttar Pradesh , India¹

Assistant Professor , Dept. of Electrical Engg., GNIOT, Greater Noida, Uttar Pradesh , India²

ABSTRACT : This paper presents window glazing techniques to optimize the energy savings of a building or house in India. We assume that the construction of building or house is as per the norms of civil engineering and related authorities. In order to achieve this goal, house owner and flat owner must take suitable actions to reduce their energy consumption without compromising from their standard of living. The energy conservation methods involved in this research were installing the Solar Panel at roof, replacing normal Single glazed windows with Double glazed windows ones, then with Triple glazed windows ones. Replacing their appliances like CFL bulb with LED Bulb, C class energy saving appliances with A class energy saving appliances or 5 star rating appliances. When we were doing this research, we observe that replacement of normal Single glazed windows with Double glazed windows with LED bulbs and 5 star rating appliances has more energy efficient than normal Single glazed windows. We also replace Double glazed windows with Triple glazed windows ones and we observed that it has more energy efficient. By this research we observed that Double glazed windows is perfect for Indian weather conditions, especially in North India where there are scorching summers and moderate winters. When budget increase we installed Solar Panel at the roof. The study indicates that replacing household appliances should be considered only when a budget greater than Rs. 15 lakhs (approx). Return on Investment period as per study is about 2 years (approx), even at the high budget. A budget decision of Rs.7 Lakhs (approx). was found to be the best decision for short term investments, whereas a budget decision of Rs.25 Lakhs (approx). was found to be best decision for long term investments.

KEYWORD : single glazed window, double glazed window, triple glazed window, solar panel, C class appliances, A class appliances, LED bulb, thermal efficiency.

I. INTRODUCTION

As per the present situation of India energy sector it is very important that we use energy where we require and optimization is very important. By this we can support to healthy life and strong economy for today and future as well. As we know that buildings in India has very great effect as the consumption of building is very high and it is approximately 39% - 40% in all the form of energy as comparison with the USA.

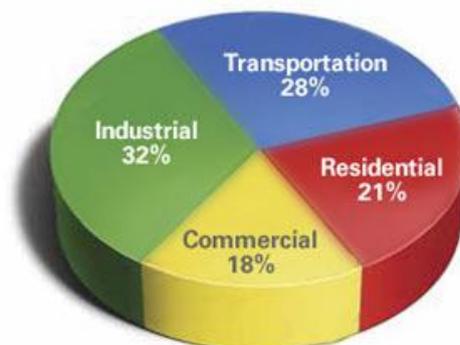


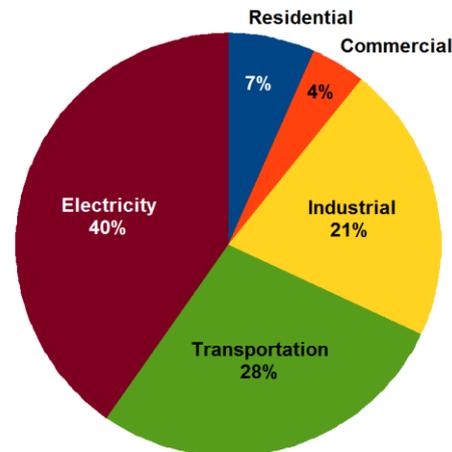
Figure 1:- Energy Consumption by Sector in India

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

US Energy Consumption by Sector



Data Source: US Energy Information Agency

Figure 2:- Energy Consumption by Sector in USA

As we know in 1973, when the global crisis on energy came, after that there came some good and effective method of saving of energy. In that method one was important to design a building in such a way that save the energy and losses can be minimized. By that time many countries has changed its law and rules that how can we use energy in efficient way in commercial as well as in household as well because residential consumption is also very large in amount. In order to achieve energy consumption by commercial and residential building in India. Government of India has undertaken a two pronged approach to cater to the energy demand of its citizens while ensuring minimum growth in CO₂ emissions, so that the global emissions do not lead to an irreversible damage to the earth system. On one hand, in the generation side, the Government is promoting greater use of renewable in the energy mix mainly through solar and wind and at the same time shifting towards supercritical technologies for coal and nuclear based power plants. On the other side, efforts are being made to efficiently use the energy in the demand side through various innovative policy measures under the overall ambit of Energy Conservation Act 2001.

Energy Conservation Act 2001 RULES AND REGULATION

The Energy Conservation Act (EC Act) was enacted in 2001 with the goal of reducing energy intensity of Indian economy. Bureau of Energy Efficiency (BEE) was set up as the statutory body on 1st March 2002 at the central level to facilitate the implementation of the EC Act. The Act provides regulatory mandate for: standards & labelling of equipment and appliances; energy conservation building codes for commercial buildings; and energy consumption norms for energy intensive industries. The EC Act was amended in 2010 and the main amendments of the Act are given below :

- ❖ The Central Government may issue the energy savings certificate to the designated consumer whose energy consumption is less than the prescribed norms and standards in accordance with the procedure as may be prescribed
- ❖ Commercial buildings which are having a connected load of 100 kW or contract demand of 120 kVA and above come under the purview of ECBC under EC Act.

Ministry of Power, through Bureau of Energy Efficiency (BEE), has initiated a number of energy efficiency initiatives in the areas of household lighting, commercial buildings, standards and labelling of appliances. In order to achieve this goal, house owner and flat owner must take suitable actions to reduce their energy consumption without compromising from their standard of living. The energy conservation methods involved in this research were installing the Solar

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

Panel at roof , replacing normal Single glazed windows with Double glazed windows ones , then with Triple glazed windows ones . Replacing their appliances like CFL bulb with LED Bulb , C class energy saving appliances with A class energy saving appliances or 5 star rating appliances and mathematical technique i.e. linear programming for optimization

In this project we have considered many aspects like climate and thermal condition and location of building. For this we have taken suggestion from many property dealers and also discussed the various features that help in improving the efficiency of energy and cost minimization. This method was also discussed on the view of visitors in that place where we are going to implement that method. Diakaki proposed that for the improvement of energy savings we can do many changes and improvements. Like we can change or improve the quality of window, doors and heating systems of the window.

II.WINDOW GLAZING

You've probably heard the words 'window glazing' from your contractor or architect. If you are thinking that it is some complicated process of treating glass, well think again. Window glazing is nothing but the window glass that is fitted in the window frame. In other words, it's the glass pane part of your window. Most often, a single window glass is placed within the frame. This is done by a specialist called a glazier and can also be organized by your contractor.

In this era of green buildings and the requirement for more energy efficiency, double glazed windows and triple glazed windows are also making their presence felt.

III.DOUBLE GLAZED WINDOWS

Double-glazed windows have two panes of glass fitted into a window frame. An inert gas like argon is filled between the two panes to increase insulation. Double glazed glass is perfect for Indian weather conditions, especially in North India where there are scorching summers and moderate winters. The double window panes not only provide relief from extreme temperatures outside, but also insulate your space from the noise outside. They are also very hard to break through and therefore provide you with ample security against intruders.



Figure 3:- Double glazed window (structure)

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

❖ How do double glazed windows works ?

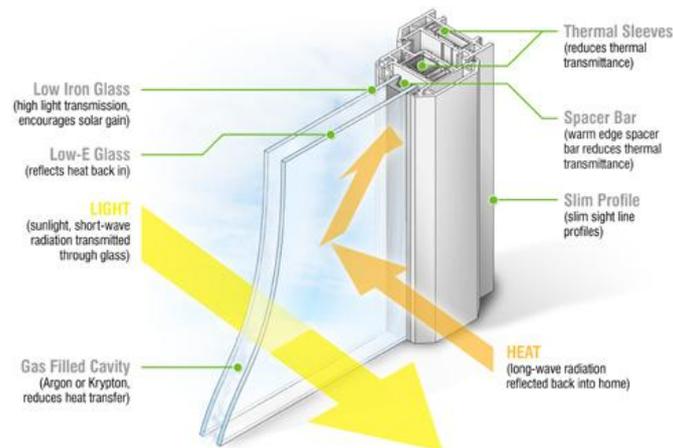


Figure 4:- Double glazed window (working)

A single pane of glass provides very poor insulation because glass is a good conductor of heat. So much of the heat in your room literally goes out the window. Install double glazing and you have a layer of air or argon gas trapped between two panes of glass. Because air or argon gas is a poor conductor of heat, much less heat is lost through the window. If the inside of one sheet has Low E coating, even less heat is lost because the coating reflects heat back into the room.

Your home's with double glazed window operates just like fibreglass batts and woollen clothing. It traps a layer of air or argon gas between two panes. Air or argon gas is a very poor conductor of heat, so the trapped layer sets up a blanket of protection between cold air on one side and warm on the other. Glass itself is a very good conductor. So in a home without double glazed window, heat is going straight out of the window. As shown in the figure 4. Argon gas is a inter gas.

❖ BENIFITS

- Save money by reducing your heating bills with the thermal reflection properties
- Reduce outside noise.
- Complete protection in extreme weather
- Internally glazed for added security against intruders.
- Cooler in summers and warmer in winters.
- Improves your lifestyle.
- And many more..

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

❖ THERMAL EFFICIENCY

Thermally efficient Double Glazing

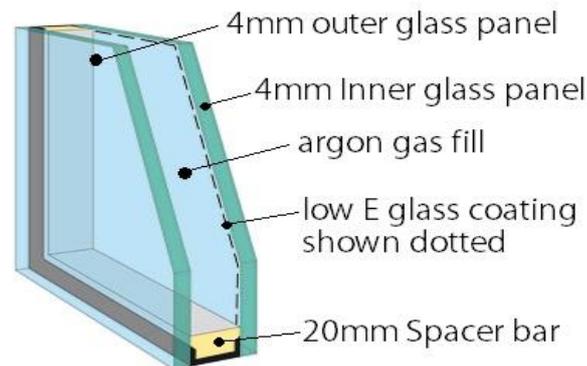


Figure 5:- Thermally efficient double glazed window

The typical space between panes ranges from 6mm to 20mm. A minimum space of 12mm is recommended for optimum thermal performance.

Double glazing window energy efficiency can be further increased by substituting dehydrated air with an inert gas, such as argon, xenon or krypton within the unit. Argon, which has 34% lower thermal conductivity than air, is the most commonly used. Although argon-filled units cost around 5% more than air-filled units, they can improve a double glazing window's energy rating by over 30%.

Glass designed for improving thermal insulation is known as Low E, or low-emissivity glass. Low E glass has a transparent metallic oxide coating which acts almost like a one-way thermal gateway. The coating works by selectively reflecting long wave radiation, characteristic of internal heating sources. Solar heat gain, which is short-wave energy, can pass through into the room but indoor heating cannot escape to the outside as it is long-wave energy. The coating effectively reflects the room's radiated heat back in, whilst allowing heat and light from the sun to enter through. The Low E glass can now provide up to three times more insulation than standard double glazing window.

❖ Merits of double glazed window

- ✓ Cost of double glazed window is less than triple glazed window of same dimension.
- ✓ Double glazed window can reduce the heat loss up to 50%
- ✓ It has less weight than triple glazed window
- ✓ The cost of frame is less.
- ✓ It is best suited for normal winter and summer.

❖ Demerits of Double glazed window

- ✗ Less energy efficient than triple glazed window
- ✗ Less durable than triple glazed window
- ✗ It has higher U value than triple glazed window

IV. TRIPLE GLAZED WINDOWS

Triple-glazed windows, as the name suggests, have three panes of glass fitted into a frame. The three sheets of glass have two air gaps filled with argon.

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

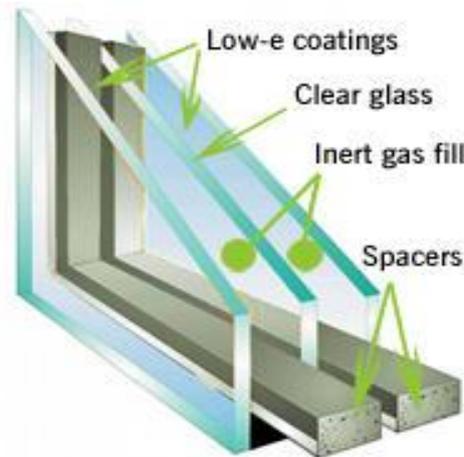


Figure 6:- Triple glazed window (structure)

These windows offer 28% - 30% (approx) more insulation than double-glazed windows. It also decreases thermal transfer by 75% - 80% making it the most energy-efficient option around. It also mitigates noise. Therefore triple-glazed windows perform all the functions of double-glazed windows, but with more effectiveness. They are just marginally more expensive.

❖ How do triple glazed windows work?

Windows have many uses such as allowing light into a building, enabling us to see outside from the home and, at the same time, keeping the inclement weather out. All this can be achieved by a window with a single pane of glass, triple glazed units provide the more insulation against the loss of heat, wind, rain and reduce noise levels from outside the home.

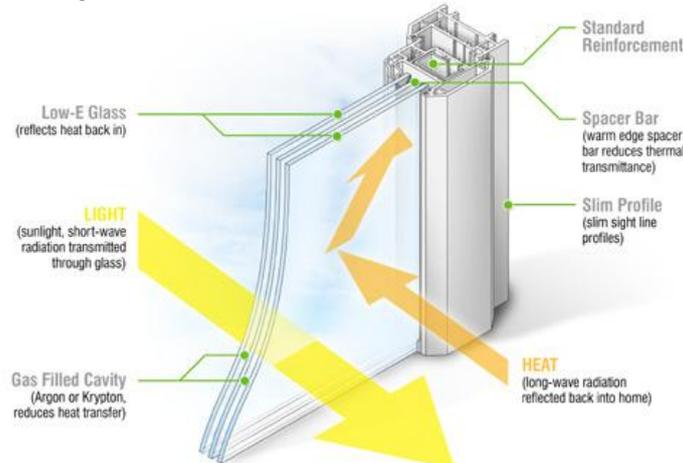


Figure 7:- Triple glazed window (working)

The three panes of glass may be treated with a low-emissivity (low E glass) metallic coating that reflects some of the heat back into the home to increase their energy efficiency and are incorporated within a rigid sealed unit with an air gap between each sheet of glass so, instead of having one air gap in the case of a double-glazed window, there would be two air gaps in a triple-glazed window. The air gap may be filled with an inert gas such as xenon, krypton or argon to reduce the heat loss even further. The sealed unit is normally constructed of wood or uPVC (Unplasticized polyvinyl chloride).



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

❖ BENIFITS

- They are well suited to climates where there is extreme heat, humidity and cold.
- They are more suited for congested area since it is highly effective for sound proofing.
- It provide more security against intruder.
- Improves lifestyle.
- and many more...

❖ THERMAL EFFICIENCY

There are some big differences between the various types of windows on the market today. A good window is suppose to reduce the heat during the summer and enhance the heat during the winter. This is one of the reasons why its so important to select windows carefully. To invest money on new triple glazed windows will defiantly result in a higher effective yield than the most lucrative interest rate on the market today. As if that was not enough it will also contribute to a healthier environment since every saved kilowatt hour reduces the carbon dioxide emission by one kilo. The second law of thermodynamics states: "heat does not flow spontaneously from a cold material to a hot material, but it allows heat to flow from a hot material to a cold material". In other words heat loss occur when heat flows towards colder materials through the windows of the house. The heat loss in house mainly occurs when the heat in a room finds its way out through the frame of the windows. The Structure of Triple Glazed windows provide greater insulation by filling the gaps between the layers of glass with gas such as argon etc. this creates less thermal conductivity. Such a gas between the layers of low emissivity (low E glass) coating. A low emissivity coating on glass drastic changes its characteristics. It allow short wave length sunlight to enter a room and heat it and at the same time does not allow long wave length to pass through the windows, thus the window minimizes the existing heat loss more efficiently than double glazed windows.

The table show the U- value factor of double glazed window and triple glazed window :

Appox. U-value W/(m ² k)	Normal glass	Window with one low E glass		Window with two Low E glass	
		Air	Gas	Air	Gas
Double Glazed	2,5	0.98, 7.92	1, 5.89	0.98, 7.92	1, 5.89
Triple Glazed	2,0	1, 4.96	1,3.91	1,2	0.94,0

Windows that have low U-values has a higher temperature on the inner layers of glass compared to windows with high U-values. This means that the risk for down draught decreases and the comfort on the inside increases. In a room with a high humidity the risk of getting condensation will decrease significantly with triple glazing. Most triple glazing manufacturers produce windows with a U-Value of 1.3 W/(m²K) as standard.

The decrease in energy usage is of course depending on how much the U-Value improves. The temperature plays a big role in the energy consumption game. This means that depending on the area the results may differ. For instance up north India in the colder climates the efficiency of switching to triple glazing will be more apparent than in warmer climates down south India.

Merits of Triple glazed window

- ✓ It is more energy efficient than other windows
- ✓ Lower U Values than double glazed window
- ✓ It performance is increase when use in combination with Low E glass coating with inert gas filled between the panes
- ✓ Best suited for extremely winter and summer condition
- ✓ It is safer than double glazed window.



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

Demerits of Triple glazed window

- ✗ It is more expensive than double glazed window.
- ✗ Initial installation cost is too high than double glazed window.
- ✗ Maintenance cost is also high
- ✗ It has high cost of frame because of heavy weight.

V.COMPARISON OF TRIPLE GLAZED AND DOUBLE GLAZED WINDOW ON THE BASES OF SUNLIGHT AND HEAT PASS THROUGH THE PANES OF THE WINDOW

Window	Sunlight (%)	Heat (%)
Double Glazing		
I. Plain glass	82	76
II. one layer of Low E glass Coating	78	71
III. Insulating cover and one layer of Low E glass coating	78	63
Triple Glazing		
I. Plain glass	78	72
II. one layer of Low E glass Coating	73	62
III. Two layer of Low E glass coating	65	60
IV. Insulating cover and two layer of Low E glass coating	65	50

" pl. note that gas or other various types of coating is not taking into consideration."

VI.SELECTION OF MATERIAL FOR WINDOW FRAME

Chartersitics	Wood	Alumini um	Steel	uPVC
Cost	Costly	Costly	Cheap	Cheap
Safety	Good	Fair	Good	Excellent
Insulation	Fair	Fair	Poor	Excellent
Corrosion	Good	Fair	Poor	Excellent
Durability	Good	Fair	Poor	Excellent
Thermal conductivity	Nil	High	High	Nil
Surface Finishing	Good	Good	Poor	Excellent

VII.RESULT AND CONCLUSION

From the above research it is concluded that double glazed window with uPVC frame is best suited for Indian building and houses. However it has certain disadvantages as compare to triple glazed window .



International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

But according to Indian climate condition it is best and economical choice. In India ITC Green centre , gurgaon , Wipro Technologies centre , gurgaon, Olympia technological park , Chennai and many more use these kind of high performance windows and give supportive hand to the energy consumption and environmental protection.

VIII.SUGGESTION FOR DESIGNER OF COMMERCIAL BUILDINGS AND HOUSES IN INDIA

In an energy consumption pattern of a building there are many other factor beside designing, installation and operation of HVACs which affect the consumption of energy . These component have indirect impact on energy consumption of the buildings HVACs system. Hence some useful suggestion has been given to the designer and constructor of the commercial building .

1. Insulation in exterior walls and exposed roof :-

In order to achieve energy consumption and green building concept, it is suggested to use lower U value insulation in exterior walls and exposed roof throughout the building.

Now Consider that building having 60mm thick XPS over deck insulation in roof and 26mm thick XPS insulation or 250mm thick AAC\CLC blocks or 300mm air gap in exterior walls to reduce the heat transfer from the walls

Recommended U value

- For exterior walls :- 0.694 W/m²k
- For exposed roof :- 0.364 W/m²k

2. Double Glazed windows with uPVC frame

In order to achieve the green building concept . we suggest the use of lower U value glass (Low E glass)

The U value of doubled glazed window is 3.182W/m²k

Consider the use of VTL (Visibility light transmittance) glass.

Use more doubled glazed windows in the direction of south and west side in order to receive maximum solar heat in winters.

3. Use A class appliance in place of C class appliance like refrigerators , air conditioning system or HVACs system with 5 star rating or with inverter technology, dishwasher with 5 star rating, use LED bulb for lighting and many more energy saving technique.
4. Turn on your thermostat down by 1⁰C, can help to reduce your electricity bill by 10% (approx).
5. Turn off the appliance when not needed.
6. Roof of the building is use for installation solar panel. And electricity generate from the solar panel is use for lighting purpose in day as well as night.
7. Use solar water heater for warm or hot water requirement.

IX.FUTURE SCOPE OF RESEARCH

Research is never ending, a finding today is a stepping stone for tomorrow. Like this particular research , though has achieved its purposed objectives, but can still be carried out for further investigation . Internal load of lighting system have not been considered due to time constraints.

The research has further scope to study the internal load of lighting system and by improving the design of internal lighting system, energy efficiency may be further improved. Buildings and houses component such as lighting system ,equipment have indirect impact of HVACs load , this could also be investigated in further. There may be also further scope of more energy saving by applying triple glazed windows in place of double glazed window , appropriate fan selection, lower interior and exterior design if found suitable may also lead to energy conservation in commercial building and houses in India. The research has further scope to analysis with some suitable simulation software.

REFERENCES

- [1] L. Perez-Lombard, J. Ortiz, C. Pout, A review on buildings energy consumption information, *Energy and Buildings* 40 (2008) 394–398. [2] B. Hunn, Fundamental of building energy dynamics, in: Massachusetts, Institute of Technology, London, England, 1996.
- [3] N. Hamza, D. Greenwood, Energy conservation regulations: impacts on design and procurement of low energy buildings, *Building and Environment* 44 (2009)929–936.
- [4] W.L. Lee, F.W.H. Yik, Regulatory and voluntary approaches for enhancing building energy efficiency, *Progress in Energy and Combustion Science* 30 (2004)477–499.



ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

- [5] M. Balat, Security of energy supply in Turkey: challenges and solutions, *Energy Conversion Management* 51 (2010) 1998–2011.
- [6] J.A. Wright, H.A. Loosemore, R. Farmani, Optimization of building thermal design and control by multi-criterion genetic algorithm, *Energy and Buildings* 34 (2002) 959–972.
- [7] Jacobsson S, Johnson A. The diffusion of renewable energy technology an analytical framework and key issues for research. *Energy Policy* 2000;28:625e40.
- [8] Yalcin Yasar, Sibel Macka Kalfa, The effects of window alternatives on energy efficiency and building economy in high-rise residential buildings in moderate to humid climates, *Energy Conversion and Management* 64 (2012) 170–181.
- [9] Xu Han, Jingjing Pei, Junjie Liu, Luyi Xu, Multi-objective building energy consumption prediction and optimization for eco-community planning, *Energy and Buildings* 66 (2013) 22–32.
- [10] S. Jaber, S. Ajib, Optimum, technical and energy efficiency design of residential building in Mediterranean region, *Energy and Buildings* 43 (2011) 1829–1834.
- [11] M. Frondel, S. Lohmann, The European Commission's light bulb decree: another costly regulation? *Energy Policy* 39 (2011) 3177–3181.
- [12] A.G. Murray, B.F. Mills, Read the label! Energy Star appliance label awareness uptake among U.S. consumers, *Energy Economics* 12 (2011) 12 doi:10.1016/j.eneco.2014.04.013.
- [13] R.G. Newell, A.B. Jaffe, R.N. Stavins, The induced innovation hypothesis and energy-saving technological change, *Quarterly Journal of Economics* 114 (1999) 941–975.
- [14] M.L. Persson, A. Roos, M. Wall, Influence of window size on the energy balance of low energy houses, *Energy and Buildings* 38 (2006) 181–188.
- [15] How to measure and estimate your roof, Retrieved on May 16, 2013 from <http://www.newenglandmetalroof.com/roofing-estimator-guide.html>.