# Construction Yesterday Today & Tomorrow

Marshall Plan Scholarship Program

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April 27, 2011

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1. Introduction

The history of high energy efficient housing starts in the 1970. Motivated by high energy costs and rising oil prices United States Americans and Canadians started researching ways to decrease their reliance on these expensive commodities. By 1976 terms such as “super-insulation” were being used in universities across America. The most famous called the “Saskatchewan House” was built in 1978 and continued to influence building methods for the next decade. Unfortunately when the oil prices regressed so did the research for more sustainable houses.

By the mid 80s the development of energy saving houses started progressing again. Starting in Germany the term “Passive house” was used when talking about these super insulated almost self sufficient houses. Now Austria is the leader in world development of these homes, making Austria one of the “greenest” places to live.

Building Codes can be dated back all the way to Babylonian times in the “Code of Hammurabi” 1700 B.C. On these tablets it is written:

*"229. If a builder builds a house for someone, and does not construct it properly, and the house which he built falls in and kills its owner, then that builder shall be put to death.230. If it kills the son of the owner, the son of that builder shall be put to death. 231. If it kills a slave of the owner, then he shall pay, slave for slave, to the owner of the house."*

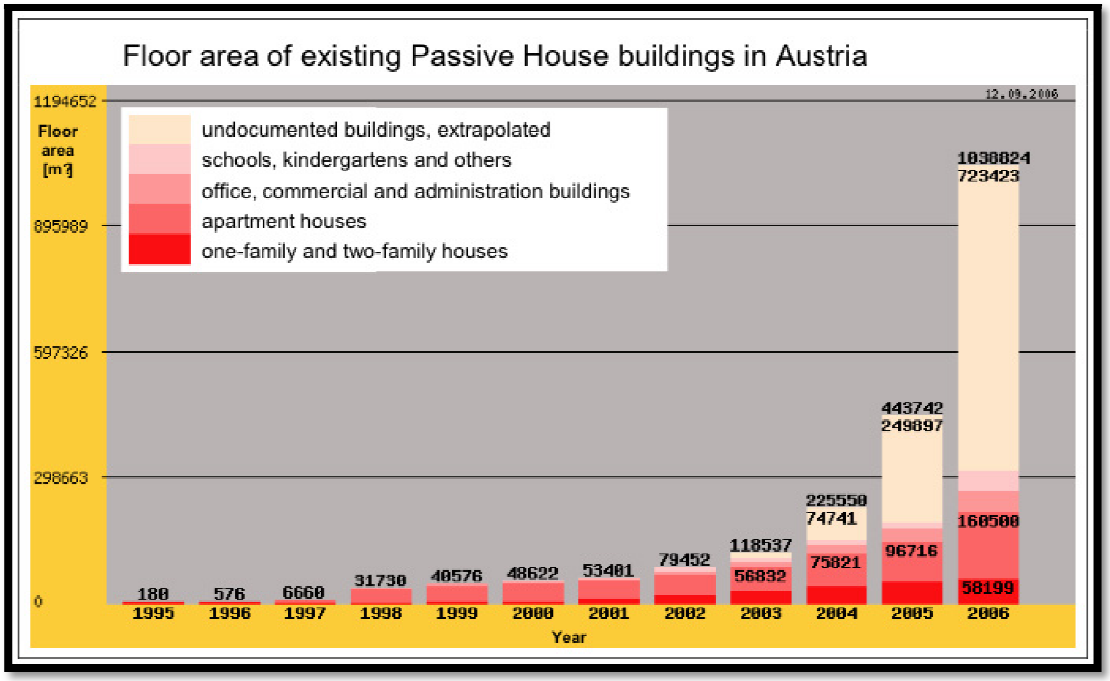
Laws since then have become less extreme, but I would not dare say more relaxed. Back in the 1700 it was simple, if you are at fault for a death then you are to pay the consequences. Now there are codes for everything you can imagine. Standards keep both the employees and the customers safe. These regulations differ from country to country, so I am taking a further look into what rules are the same, which are different, and why.

## 2. New Technology

### 2.1 Passive Houses

Passive Houses, defined as a house or building that requires no heating or cooling system, but rather maintains a comfortable temperature without any energy. Austria is the leading country of highest number of passive houses per resident worldwide, and this is no coincidence. The Austrian government has been actively

encouraging passive building. About 1.3 percent of the gross domestic product is used for housing subsidies. A law states that all new housing subsidies in Austria must meet the passive housing requirements set by the European Committee of Standardization (CEN). In the state of Styria it is even required to have solar heating in subsidized housing estates. There are many requirements pushing the Austrian people to become more energy efficient.  There are mandatory thermal insulation requirements; an energy performance certificate is mandatory for all new and old buildings which shows the flow of energy and characteristics of building service equipment such as heating and cooling.



The government even gives incentives to build passive buildings. For private homeowners a seven thousand Euro subsidized loan is given to those who choose to build passive homes. “Building for Tomorrow” is a research organization funded by the Austrian government for nineteen million Euros.

There are three main factors to a passive house; a super-insulated envelope, solar inputs, and air tightness. Passive housing in Austria on average requires only ten percent of the heating energy than that of a typical Austrian house. To be considered a passive house it must pass heating load tests. In Austria the heating load has to be less than $10w/m^2$ ($3.17\ btu/hr.ft^2$). The air change rate cannot exceed .6 times the house volume per hour at a pressure of 50 Pa (.00725 psi). But how do you build a passive building? The materials don’t matter; it could be light frame timber, massive timber, concrete, or brick, as long as it is tight and has good insulation. Even old buildings can be modified to be passive. It requires good exterior insulation, triple glazing and ventilation with heat recovery. While it is harder to reach the requirements of a true passive house with an older building it is not impossible. Some pros about passive housing are the energy cost reductions, but also the air quality. In this type of building there is a filter the air passes

through before it circulates throughout the house removing dust, pollen and allergens. Also, if comparing to the Air conditioning units used in the United States which recirculate the same air instead of exchanging new air from outside, the passive style of cooling is healthier.

The Austrian Passive House Group (APG) is a group of five of the top companies from Western Austria. These companies are working with energy efficient construction and passive housing. Together these five companies have gained global recognition. Their homes have been featured at the Olympics and set an example for the rest of the world as one of the most efficient building types. According to http://www.oesterreichhaus.at , The official APG website "On 7th January 2010 APG's Austria House was officially presented with a klima:aktiv certificate, making the start of the New Year perfect for the Olympic Austria House. klima:aktiv is an initiative of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management for active climate protection and is also part of the Austrian climate strategy encouraging environmental protection, reducing CO2 emissions through several programs, and campaigning for greater utilization of renewable energy sources"

## 2.2 Straw Houses

The Straw House, more commonly known as the S-House is a type of house built ironically enough, out of straw. Every part of the S-House is biodegradable except for the minimal concrete foundations. First step is preparing the land. Excavation soil makes up almost one half total waste and more than three times any other structural waste in S-House construction. The foundation holes are dug and lined with foil to aid in the removal process in the future. Later when the foundation beams are poured there will be Rebar inserted as a handle for easier removal. A layer of gravel is spread atop the ground to protect the raised floor since there will be no basement, just an unfinished crawl space. A material suitable for passive houses is used to create a floor and short vertical barrier. Many materials can be used, but in this case wooden sheets with interlocking edges are used. Before the bails of straw are installed on top of this floor they are checked for moisture content. The process is done carefully to

ensure there are no open gaps without straw, any space will compromise the effectiveness of the straw insulation. The same floor material is placed directly on the straw. These panels will interlock with the short vertical walls creating a sealed insulation pocket. The sealing is done with glues and adhesives, no nails or screws. The same wooden panels will be erected and sealed at the edge of the floor as the exterior walls, and again the same panels will be sealed at the top as the ceiling. Same as the floor a small vertical wall is erected around the perimeter and the area is filled with straw. This time there is not a top layer, but instead a roof built several inches above the hay to create extra ventilation and insulation. Until this is sealed off the house will be covered because of the threat of moisture getting to the straw. The outer walls at this point will just be the thin wood paneling giving almost no insulation value. Along the outside of the entire house straw bales are secured with wooden dowels and hemp rope. When the entire building walls are wrapped in straw bales the walls can be sprayed with clay plaster. This can be found

from the dirt gained from the excavation if soil type is sufficient. The clay will stick to the bales because of their rough texture, but will need to be smoothed after spraying. The windows and doors, in this case wood framed, will be installed using wooden dowels, no metal screws.

New “Treeplast” screws made from lignin content of wood fibers are formed in molding machines which do not very much from plastic molding machines except the end product is biodegradable, and all natural. These screws are used to mount boards comparable to two by fours which the siding will attach to. Dowels and glue again are used to attach the siding. In this case pretreated siding which has irregular widths to cut back on production waste is used. Once the exterior is completed a final treatment is applied to protect the wood, especially where the dowels were inserted.

During this kind of construction process the ecological footprint is only 2364 (m2a/m2 wall) where as a conventional wall

construction is 24915 (m2a/m2 wall) more than 10 times greater. More testing in homes such as this one is being done in test boxes with other materials such as cork, integrated hemp, and flax. These boxes have heat flux plates which record the humidity and temperature of the materials.

## 2.3 Solar Energy

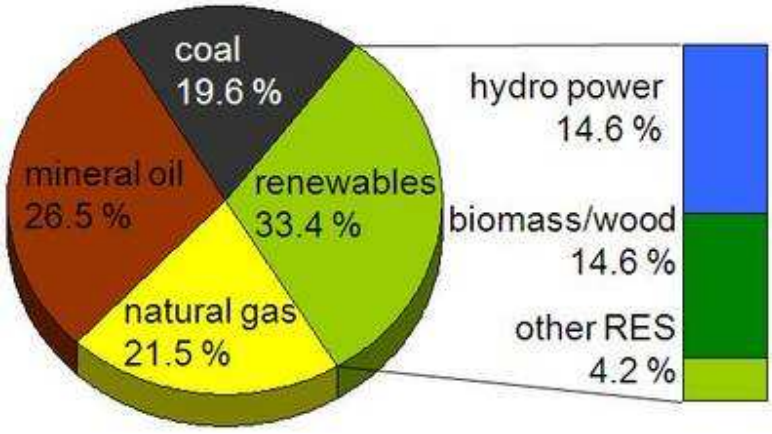
Solar energy is an important and thriving part of Austria. Northern Austria to be more specific has over one million $m^2$ of installed solar collectors. These solar energy collectors can be found on homes and businesses in Upper Austria. Alone this region generates an annual heat output of 335 mio. kWh. This is a one hundred thousand ton reduction of $CO_2$ per year. Austria is the number one region in the world for installed solar collectors. Upper Austria alone produced over ten percent of all Europe's solar panels. When compared to the solar panel sales of Australia, Austria produces more than fifty percent more.

## 2.4 Renewable Energy

Austria is the technological leader in production of boilers for biomass energy sources. Biomass is wood, wood chips, pellets, and

any wood product used to create heat or energy. Biomass contributes fourteen percent of Northern Austria's energy. The Upper region of Austria has made a commitment by 2030 all electricity and space heating will come from renewables. Biomass can be used in automatic wood pellet heating systems, automatic wood chip heating systems, direct heating installations, and biomass [power] plants.

Wood pellets are compact sawdust cylinders are popularly used in low energy homes, also in large scale power plants. The pellet central heating systems will be a direct substitute to gas and oil boilers. The pellets are cleaner for the environment; the pellet stove is self cleaning, and automatic just like any other boiler.



## 2.5 Development

When comparing Austria to America it is a huge difference in attitude and opinion about certain topics. The cost of a passive house is approximately eight percent more than a regular house, but in return there is a ninety percent energy cost savings. In the eyes of an Austrian they see themselves living in this house for a long time, taking in the benefits of this energy cost reduction for possibly a life time, where as an American would most likely think they will be moving in two or three years, so the extra cost up front won't pay off for them down the line. On top of which energy costs in Austria are higher than in the United States, so the payoff would come faster for the Austrian homeowner.

Looking further into the pros and cons of the passive building style it is clear the benefits outweigh the cost tremendously especially for Americans. By using the passive building standards the average American household could cut their costs up to ninety seven percent. Not only would the houses be better insulated and tighter, but the fact that Americans don't use renewable energy that commonly presents an opportunity to save money and the environment. There are solar cells, solar thermal energy, wind energy, bio fuel, earth heat exchange and more ways to use energy

that is easily collectable all around. Austria uses one thirtieth the amount of energy of America per household for heating, cooling and hot water.

The difference between Austrian thinking and American thinking is the education that each receives. In architectural schools for example. In Austria architecture is combined with the civil engineering aspect of construction focusing on buildings and their functions and how they will be built, and last throughout time. In America architecture is taught as an art separately from civil engineering which is taught as a heavy construction program focusing on streets, bridges, dams, and things of that nature. Austria has a program called the Urban Wood program. This program is currently available at three schools, TU Wien, Politecnico di Torino, and Technische Universitat Dresden. This program is for college students interested in construction and educates them on wood building to prepare them to manage a wood construction project. This program is important because wood in becoming less used in construction and as a renewable resource it should be used more rather than less.

In Austria recycling materials a concern. There are bins for plastic, glass, paper, and rubbish for daily home use, but the

recycling doesn't stop there. On a construction project every material is used as much as possible and the remainder of the product is either recycled or used on another project. Other more wasteful countries should learn from Austria and develop a better system or recycling to reduce waste on job sites.

## 3. Building Codes

### 3.1 Structural

In Austria there are building codes, the most important are memorized while attending University. The code books are extremely expensive thus not every commonly seen, but there are also Compact Disk form of these codes that can be viewed on the computer. One problem Austria has with these codes is how difficult it is to find them. In America there is a standard code book issued every couple years. They are also expensive but most construction firms have them, and follow the codes exactly. In Austria there are not as many structural codes and requirments as America, but there are still quite a few.

## 3.2 Environmental

There are also environmental codes that have to be followed. The same situation of expensive and uncommon code books applies here. In Austria though, the environmental codes are much more than than in America. In Austria there is little to no waste on a construction site.

## 3.3 Inspections

Comparing the construction process of Austria and America is like comparing an apple to an orange. They are both fruit but two completely different things. In America there is an inspection on each major step in a building. There will be an inspection of the foundation, the walls, the electrical, the plumbing, the ventilation system, and then finally the finished product. In Austria the building may never get inspected if it's not big enough. As for larger buildings in Austria there may be an inspection but only when the building is completed. There can be surprise inspections if there is a concerned call about either improper structural properties or environmental violations.

## 4. Safety Standards

### 4.1 United States

In the United States the safety standards are serious business. The main safety requirements are wearing hard hats, ear protection if necessary, eye protection, safety restraints if at risk of falling, boots, pants, and sometimes gloves. When more than normal construction hazards exist the safety precautions also increase. Each person that enters the job site must be in compliance with all safety requirements or they will run the risk of fines. There is a government agency called OSHA (Occupational Safety and Health Administration) that goes to job sites at random and unannounced to find personnel in violation of the rules and issue fines. The fines can be devastating to a company if caught multiple times in violation. Such fines can even damage a construction firm's reputation and chances to get future work since entire job sites have been shut down for repeated violations.

### 4.2 Austria

In Austria the safety requirements are not requirements at all, they are suggestions. They suggest proper footwear and a hard hat but no one will come to check and make sure the workers are

wearing them. I myself watched some construction workers taking down scaffolding at 40 feet up without a safety harness. Within the next couple years Austria will be enforcing more safety rules like a majority of the countries in the European Union already do.

5. Conclusion

After looking at Austria's new technologies such as Passive housing, Straw houses, Solar Energy, and Renewable Energy we can see that Austria is ahead of the rest of the world as far as being environmentally friendly. The government's active participation in funding these types of buildings is impressive and seems to be paying off.

In the future I look forward to seeing what new developments are being made in Austria. And by 2033 northern Austria should be completely reliant upon renewable energy for their heating and hot water.

Structural, Environmental, and Safety Laws in Austria aren't up to standard with most of the more developed countries around the world, but in a short time to come there will be advances and changes made to the current system.

6. Resources

http://www.s-house.at/cgi-bin/news.pl

http://www.ostina.org

http://www.scribd.com

http://www.esv.or.at

http://www.oesterreichhaus.at/en/agp-a-partner

http://urbanwood.tuwien.ac.at/news/