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Sustainable Village

Mid-Term Report

IPRO 301

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Team Leader: Siddha Pimputkar

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1 EXECUTIVE SUMMARY

The Illinois Institute of Technology (IIT), through its Energy and Sustainability Institute (ESI), intends to make IIT a Sustainable Village. Accomplishing this goal requires a master plan that guides decision makers on the technologies and strategies that will create a sustainable university. Through philosophies such as decarbonization, resource use maximization, waste stream utilization, and implementation management, the university will not only transform itself, but the communities that surround it. A key to the success of this implementation lies in the partnership of students, faculty, staff, local government, businesses and community leaders. Outreach, education and effective implementation will create an environment at IIT that can be mimicked by any campus, community or organization. IIT will transform from a consumer to a producer, and will help to promote energy producing communities, improved air and water quality, reduced stress on infrastructure, and an increased knowledge base in the creation and maintenance of a Sustainable Village.

The first tangible and recognizable step in the creation of the Sustainable Village at IIT will be the building of the House of the Future. Through the House of the Future, IIT will not only develop a laboratory in which sustainable technologies are tested, improved and proven, but also an example as to how sustainable living can improve the quality of life, reduce the impact on the environment, and remain affordable. The House will receive power from the Hydrogen Fueling Station, serving as a pilot project for implementation of Hydrogen-based power systems throughout the campus as well as the surrounding community. In addition to maximizing the use of solar energy through passive solar design, solar hot water and integrated photovoltaics, the House will make efficient and effective use of rainwater and waste water. When completed, the House of the Future will stand as a testament to the effective application of technology to the improvement of the quality of life, while minimizing the negative, long-term impact on natural resources.

With these visions in mind two teams were created to take the first step towards sustainability. The first team, the Sustainable Village team, has the objective of performing fundamental research in the area of sustainability, creating a roadmap for sustainability and designing a House of the Future as a showcase for IIT's efforts in sustainability. The second team, the Hydrogen Fueling Station team, has the objective of creating a hydrogen fueling station using renewable energy sources as inputs and providing enough hydrogen and energy to power the House of the Future and create a fueling station of hydrogen based vehicles. This report summarizes the accomplishments and obstacles the Sustainable Village team as faced so far.

In order to tackle the objectives of this project the team was split into four different teams: the House team, the Sustainable team, the Knowledge team and the Website team.

The House team has the purpose of defining and designing the House of Future. The team has made great progress in finding sustainable technologies to implement and make the House of the Future not only a consumer but also a producer of energy and other resources. The results of their research can be found as brief summaries in chapter 3 of this report or detailed summaries in chapter 8 of this report.

The Sustainable team has the purpose of performing fundamental research in sustainability, auditing and benchmarking IIT to other sustainable campuses and then creating a roadmap on how to become sustainable. After performing initial research it was found that there are five main areas that need to be addressed in the movement toward sustainability at IIT: fuels, electricity, water/air, people, and recycling. A brief statement of each area is presented in chapter 4 of the report, and a more detailed analysis of the accomplishments is presented in chapter 9.

The Knowledge team has the purpose of collecting valuable information as the two major teams perform their research. The Knowledge team will then work together with the Website team to present all the resources and accomplishments of the team in a professional and intuitive manner to the public. A separate report from the Knowledge team has been created and is available upon request but will be made public once the website design and outline has been finalized and implemented.

Overall the teams are on track according to the project proposal created at the beginning of the semester. Only the Sustainable team has been experiencing problems auditing IIT as gathering the necessary resources has been more time consuming as initially projected.

2 TIMELINE

In order to fulfill the objectives of this project the timeline created at the beginning of the project was followed and so far has only experienced one major setback. Due to the difficulty in contacting faculty members at IIT the auditing of IIT had problems collecting information so far and therefore fell behind schedule. The following table summarizes a few important deadlines. A full summary of the modified timeline in form of a Gantt chart can be found in the appendix.

Event	**Deadline Date**
Sustainable Team:	
• Recycling Program Outline Complete	April 11th
• Auditing of IIT Complete	April 11th
• Roadmap for IIT Complete	April 19th
House Team:	
• House of Future Complete	April 18th
• Research Safety Regulations Complete	April 18th
Administrative Tasks:	
• Website Finished	April 22nd
• Cataloguing Knowledge Complete	April 25th
• Poster Created	April 25th
• Abstract Created	April 25th
• Final Report Finished	April 26th
• Presentation Complete	April 27th
• IPRO Day	April 29th

3 HOUSE TEAM

3.1 MEMBERS

Evans Ogbebor (Team Leader)
Elena Savona
Michael Staats
Anna Ninoya
Philip Golucki

3.2 OBJECTIVES / GOALS

The main objectives for the House team is to design a House of the Future that will be the benchmark of sustainability on the IIT campus, encompass sustainable housing ideas for the surrounding community and be a showcase for the sustainable efforts put forward by IIT.

3.3 ACCOMPLISHMENTS

3.3.1 SITE LOCATION

The site location for the House of the Future was chosen according to the future plans of IIT campus. The site was determined to be in the lot on 30th and state, close to the Stuart building. On the site plan provided in the appendix to this report it is the brown lot next to the Stuart building.

3.3.2 ENERGY USAGE

To achieve this goal of sustainability, the design of the House of the Future is based on the deployment of both active technologies and passive solar design. While active technologies actively produce energy and reduce the building's energy load through mechanical systems, passive solar design solutions reduce the energy load by taking advantage of the building's orientation, natural ventilation, thermal mass, choice of materials and so on.

The main energy goal of the House of the Future is to reduce the overall resources consumption rate of the average American residential buildings, and to show eventually that it is possible to become producers instead of consumers. On reduced-load houses, rather than on highly consumers, in fact, it is reasonable to apply renewable energy technologies to meet the remaining energy needs.

3.3.3 EXTERIOR FAÇADE

The exterior façade of the building will be a modular precast concrete panel system that is easy to remove and recyclable. This system allows panels to be installed temporarily while providing a tight enclosure around the building. They can be removed so that other panels with different properties can be tested in the House of the Future.

3.3.4 INSULATION

The insulation for this for the House of the Future will be cast into the precast concrete panels. Cellulose has been chosen because it is a 75% recycled material that has a lot embodiment of energy and is easy to apply. It provides a 50% higher R-value than conventional fiberglass insulation. Another form of insulation that will be tested in the House of the Future is a phase change material cast into the concrete panels. This phase change material is a type of wax that will store heat over the time of day and release it into the house over the night to reduce the heating load.

3.3.5 OPERABLE WALLS

The House of the Future needs to be flexible to handle all of the testing and changing environments that it will be subject to. This means that the interior walls will need to be movable and removable. These new wall materials can be applied in a controlled lab setting and then brought into the house so that the house will not have to shut down for the installation of new walls.

3.3.6 THERMAL CHIMNEY

The thermal chimney is a passive system that will help cool the building in the summer and heat the building in the winter. This is done by using an all glass double skin façade that is operable to take advantage of the air temperature around the building. On the south façade there will also be photovoltaic cells on the exterior glazing that will provide some sun-shading and power.

3.3.7 FLOORING, WINDOWS AND APPLIANCES

Flooring is an important aspect of the house as it is seen throughout the entire house and is the basis upon which people walk daily. In order to provide a sustainable and durable flooring it has been chosen to use a cork flooring for this house. It is very durable, doesn't require that the cork trees be timbered before they can be used (only the bark is required and can be harvested in periodic intervals) and requires a minimal amount on toxic chemicals to install and fabricate. The main disadvantage that was found was that cork is mainly imported from countries outside of the US and therefore isn't truly sustainable from a transportation aspect.

Windows are a large source of energy loses for a house. During the winter, heat loss from windows can represent 10% of the heating bill, and 30% of the cooling bill during the summer.[1] In order to improve on energy efficiency it was chosen to use triple glazed windows with moderate solar gain and a low E coating.

[1] http://www.efficientwindows.org

Appliances are a major source of energy consumption. In order to minimize the energy requirements for the house it is vital to decrease the amount of energy required to perform the daily tasks. Buying products that have an Energy Star logo for this house is important as they have been shown to consume less energy as other appliances for the same purpose without the Energy Star. A list of possible appliances that the House team is looking into integrating into the House of the Future can be found in the appendix 8.12.

3.3.8 WATER SYSTEMS

As water is a vital component in everyone's life it is important to conserve it and to waste as little as possible. Rather than approaching the house project with today's idea of a very infrastructure intensive, very wasteful and maintenance consuming the team looked into water usage as a whole. For the house the Equaris water system was chosen as this system incorporates the use of storm water and recycles waste water created in the house. By doing so a minimum amount of water is actually flushed into the sewage system and a maximum is reused until the purification requires a more centralized processing plant. The system is capable of purifying a considerable amount of waste water created in the house to potable water, with barely any contaminants with similar quality as water filtered at centralized processing plants. Further by utilizing storm water less processed and purified water needs to be taken from the pipes and therefore also contributes towards being sustainable.

3.3.9 DESIGN OF HOUSE

In our day-to-day lives, we take for granted the *house*. One fails to recognize as a society the systems that are ingrained in our house that make it function like how our human anatomical systems allow us to function as a living being. One produces waste and consume energy without much thought to the point that human and nature are at an imbalance.

This House of the Future embodies the characteristics that will allow for the residents to understand and literally see the "insides" of the house. As this house is a demonstration of what passive design and technological implementation can achieve for a near zero pollutant emissions, the house team has incorporated an exhibition hall for the public to understand the importance of near self-sustaining homes today.

If one would look at the next generation and beyond, there must be responsible moves made toward sustaining a house as a producer than a consumer. Instead of natural gas, fossil fuel and other carbon-based energies that emit noxious gas and byproducts the house team is striving to make energy from near zero emission and basic common sense in architectural practice.

A detailed report on passive and active design as well as specifics for the design of the house can be found in appendix 8.14 through 8.16.

3.4 OBSTACLES

The following bulletin list provides a summary of most of the obstacles faced so far by the house team and how they were tackled:

- **No clear definition of what level of sustainability needed to be achieved**
  Solution: Each team member defines sustainability and tries to achieve that level in their section of work

- **Dynamic vision of the project**
  Solution: The house team accommodated and changed design plans and layouts accordingly.

- **Dynamic site location**
  Solution: IIT facilities finally chose a site conducive to the future plans of the university.

- **Incorporation of all aspects of the house**
  Solution: The house team went over every system, and their requirement, and though there is still continuous change as system requirements continually get refined and or changed due to optimum conditions necessary.

- **The role of the hydrogen station**
  Solution: Both IPRO teams involved in the overall project met and clarified the role of the hydrogen station and what it was going to play in the house's plans.

3.5 FUTURE OBJECTIVES

- To complete the design and layout of the house.
- To create leaflets identifying the dynamics of this house in comparison to the past houses of the future.
- To work on the project presentation for donors and sponsors.
- To create a tangible model for the house.

4 SUSTAINABLE TEAM

4.1 MEMBERS

Andrew Higashi (Team Leader)
Jef Larson
Bezaleel Robinson
Tony Thomas
Joseph Clair

4.2 OBJECTIVES / GOALS

Create a roadmap and master plan on how to make Illinois Institute of Technology's (IIT) Main Campus sustainable. This will be done by auditing and then benchmarking IIT to other similar projects. This roadmap and master plan will be developed with the vision that once implemented IIT will be a leader in sustainability and encourage many others to follow our track.

4.3 ACCOMPLISHMENTS

The team has established a benchmark of other universities that have attempted similar sustainability efforts; it can be found in the appendix 9.1. From the research to develop this benchmark, five central areas of sustainability were identified: Fuels, Electricity, Waste, Air and Water, and People. In each of these five areas, the team has worked to establish a baseline for the present state of sustainability for that area. In each area, strategies and technologies are being explored and researched, however of greater importance, overall guiding principles are being uncovered for application both to the present project and to any future endeavors.

The sustainability master plan will address fuel usage first through decarbonization. After this tenant of sustainability, fuel usage will be optimized through energy efficiency improvement, analyzed through an "energy life cycle", and strategize through the development of synergistic infrastructures that provide fuels from other necessary processes such as wastewater treatment and organic food waste. By addressing fuel using these approaches, IIT will reduce its overall consumption, use waste products to their fullest extent, and when fuel use is unavoidable, use non-carbon-based fuels such as hydrogen.

When people think of sustainability they think of electricity and conserving energy. For every 1 MWh of electricity, 657 pounds of CO_2 is produced, so consuming energy not only wastes resources, but causes a large detriment to the environment. IIT consumes over 5 MWh/student-staff while other sustainable schools consume less than 3 MWh/student-staff. The systematic approach that is needed towards sustainability is to inform students, staff and faculties on conserving energy, to promote buying Energy Star appliances, to use motion sensors for lighting, to promote turning off computer monitors/lights when not in use, to maintain heating/cooling systems, and to eventually implement “green energy” producers which include wind turbines and photovoltaic solar cells. IIT is also coming up on a deadline in 2007 with its power supplier, which will then start charging 8 cents a kWh rather than the current rate at 4 cents a kWh. In order for the university to save money, it needs to take steps to cut electrical use and implement green energy before the current contract ends.

IIT’s current recycling plan follows the city of Chicago’s recycling plan. Blue bags are used to contain paper or other items to be recycled. These bags are placed in the dumpster along with all the other waste to be picked up. The downside to this, is that not all the blue bags are recovered when they reach the waste plant. In an effort to dramatically improve recycling, IIT is looking into recycling companies to handle the waste produced on campus. These companies would initially work on recycling the paper waste, but continue to increase the recycling program by accepting aluminum. Areas that are not covered by a recycling company, but are still of concern include food, use of recycled goods, and transportation of collected recycled items to the pickup point. The recycling of food can be dealt with by creating a compost pile for all thrown away food. The use of recycled goods can be implemented by having a directive to all departments to buy items such as recycled paper. Due to the architecture on campus, dumpster placement is very limited, so volunteers or staff would be required to move the collected recyclables to maximize efficiency of pickup.

The sustainability master plan for air and water addresses issues of cleanliness. We need to have “clean” air to breathe and “clean” water to drink. The air aspect focuses on this through a program “green office.” This program brings plant life into the offices, dorm rooms, and classrooms in order to provide “clean” air, and create a sustainable environment in each of those buildings. Water treatment and savings plans are also a need in the movement towards sustainability. It may be possible though that water treatments through the Chicago Department of Water is cheaper, uses less energy, and is better for the environment.

Sustainability not only refers to the environment and the economy, but is also inherently tied to society. Understanding “people” as a resource within a sustainable society can be broken-down into three main areas: leadership, education, and the well-being of all people. These three components are important for producing the initiative and making decisions (leadership), creating awareness of the need for sustainability and continual improvement (education), and providing an enhanced quality of life while maintaining equality (well-being of all people).

In leadership, the current issues are to change from traditional approaches of hierarchal power, to a more integrated and consensus approach to problem-solving. This can be accomplished through community-based round tables where various groups’ viewpoints are represented. In the university setting, leadership initiative needs to come from the executives for there to be change in policy and a culture of sustainability. For education, the two important factors are research and the curriculum in schools to have a strong focus on sustainability. Finally, for social issues there needs to be a desire to bring about justice and equality amongst people, especially for underrepresented people groups.

For further information, details of plans of implementation can be found in the appendix 9.2 through 9.6.

4.4 OBSTACLES

The major obstacle to completing the master plan has been obtaining accurate information from the university with regard to the consumption of the campus. Presently, this obstacle has not been overcome, and the issue needs to be escalated so that persons with greater influence can clear the path for the team to obtain the information it needs.

4.5 FUTURE OBJECTIVES

Produce a master plan that has two tiers to it: an overriding description of principles of sustainability against which implementation plans can be evaluated, and specific implementation plans for the five central areas of sustainability: Fuels, Electricity, Waste, Air and Water, and People. This will include detailed information on the timeline for implementation, as well as a prioritizing of the work to be done. In addition, resources and partners will be identified for inclusion in the process.

5 WEBSITE TEAM

5.1 MEMBERS

Philip Golucki (Team Leader)
Adam Malacina (Member of IPRO 304)
Bezaleel Robinson

5.2 OBJECTIVES / GOALS

The main objective for the website team is to create a website that will professionally and intuitively present the research performed by the house and sustainable team and further present detailed drawings of the House of the Future next to the road map created by the sustainability team.

5.3 ACCOMPLISHMENTS

So far the team was able to agree upon a basic agenda which needs to be followed to complete the final website on time. Multiple logo designs have been created and a final layout is being completed.

5.4 OBSTACLES

The biggest obstacle for the website team is finding a time to meet. All members of the team have multiple other responsibilities towards this IPRO that are currently more urgent and therefore it is hard to find a time slot that is available for everyone.

5.5 FUTURE OBJECTIVES

The objectives of this team are currently the same objectives as were set forth at the beginning of the semester:

One of the goals of this team is to develop a website that can not only be used for this semester, but that can also be used by future teams and will carry the sustainability efforts put forth by this team. The Sustainable Village project is not a one semester project, and this website was designed with that in mind. The website will look professional, and offer a number of useful features. The website is their mainly to give people information on the Sustainable Village project. To that effect, it will have extensive information on the House of the Future, Hydrogen Fueling Station, and the sustainable IIT project.

The website further needs to be a resource for sustainability on campus and educate those who may want to know about sustainability. It should give people information as to what they can do to improve sustainability in their own lives. In addition, it should have information on group actives at IIT and in the Chicagoland area.

The website will also present renderings of the House of the Future as well as detailed information about it. This will include an extensive overview of the features of the House of the Future that make it sustainable. It is also planned to have rendered walkthrough the house.

The website will also be a platform for the knowledge team to present their research and results and to present contact information for key people at IIT for possible sponsors and people interested in the project.

6 KNOWLEDGE TEAM

6.1 MEMBERS

Siddha Pimputkar (Team Leader)
Jef Larson
Philip Golucki

6.2 OBJECTIVES / GOALS

As this project will be carried on through multiple teams before it is finally completed it is necessary to ensure that no knowledge gets lost on the way. Therefore this team has the main objective to collect information from all the teams as they progress through the semester, catalogue it and make it available to the public and more importantly to the teams that continue to work on the sustainable village project.

6.3 ACCOMPLISHMENTS

So far the knowledge team was able to collect various kinds of resources and information from the house team and the sustainable team. This information has been collected into one word document and has been made available in a first draft. Currently the team is looking into making this information and documents available in a searchable format on the website.

6.4 OBSTACLES

One of the major obstacles faced by this team was that the information provided by the various teams comes in various formats and various levels of depth. In order to provide a consistent and thorough analysis of the information an extensive review of the information provided is required and will be very time intensive.

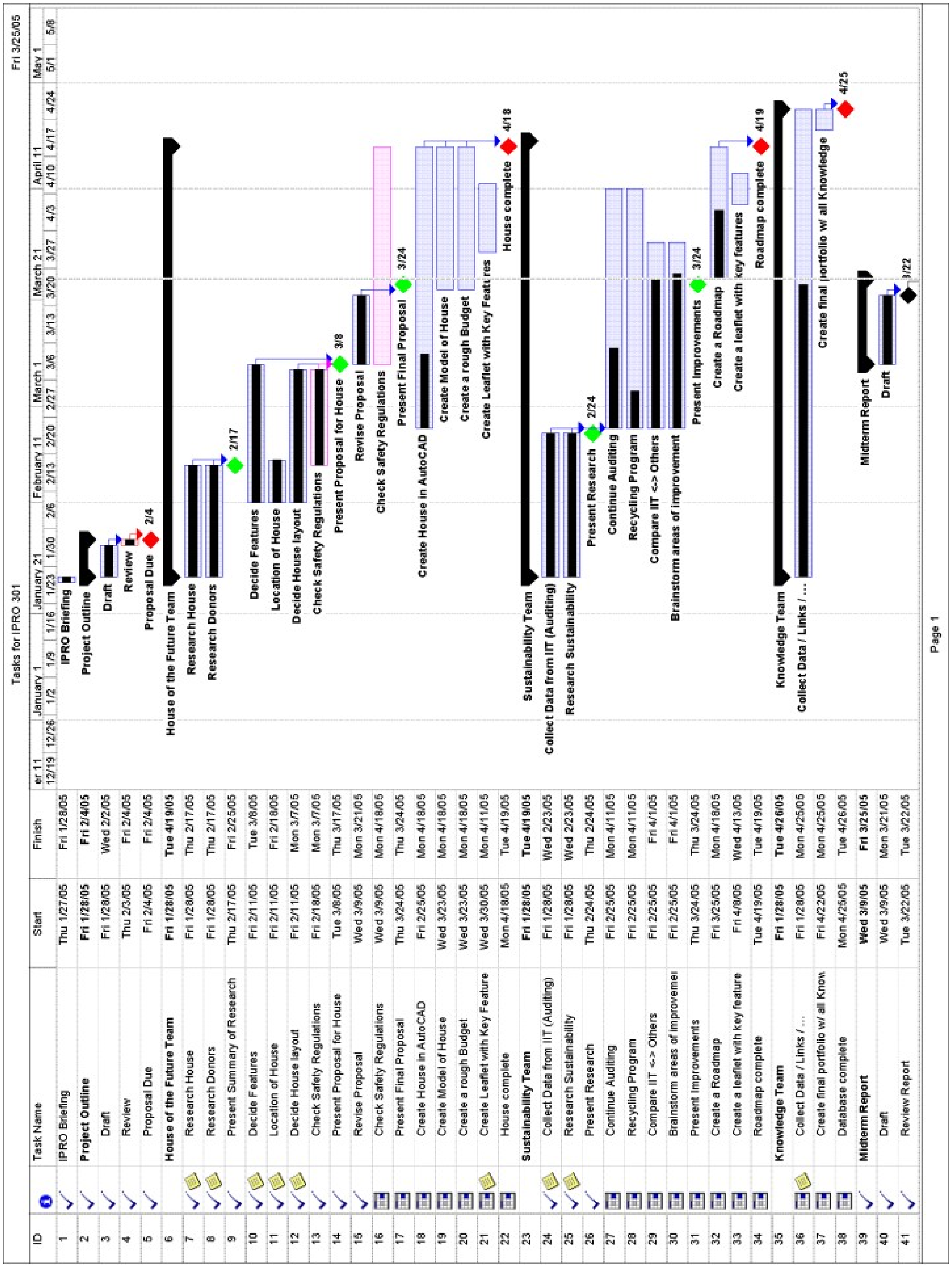
Further as the resources that are made available to the team are not always in standard word for but may take various forms, such as spreadsheets, presentations or only hard copies of reports.

Lastly as some of the information provided to this team comes from external sources and from various departments at IIT it is necessary to label sensitive documents so they do not get publicized by mistake.

6.5 FUTURE OBJECTIVES

The future objectives of this team are still the same as they were set at the beginning of the semester. The team will continue to collect information but from now till the end of this semester the team will be focusing more on how to present the information in an intuitive and informative fashion.

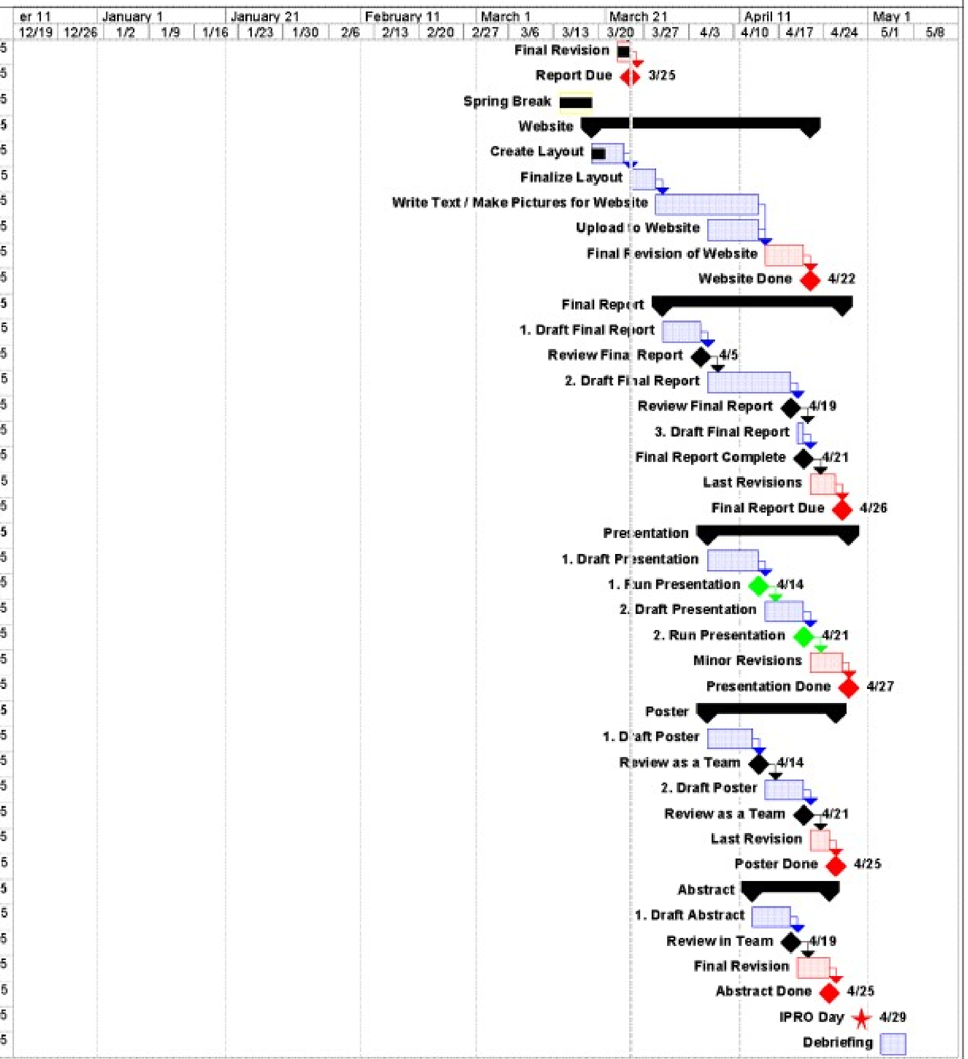
7 APPENDIX – GANTT CHART



ID	Task Name	Start	Finish
1	IPRO Briefing	Thu 1/27/05	Fri 1/28/05
2	**Project Outline**	**Fri 1/28/05**	**Fri 2/4/05**
3	Draft	Fri 1/28/05	Wed 2/2/05
4	Review	Thu 2/3/05	Fri 2/4/05
5	Proposal Due	Fri 2/4/05	Fri 2/4/05
6	**House of the Future Team**	**Fri 1/28/05**	**Tue 4/19/05**
7	Research House	Fri 1/28/05	Thu 2/17/05
8	Research Donors	Fri 1/28/05	Thu 2/17/05
9	Present Summary of Research	Thu 2/17/05	Fri 2/25/05
10	Decide Features	Fri 2/11/05	Tue 3/8/05
11	Location of House	Fri 2/11/05	Fri 2/18/05
12	Decide House layout	Fri 2/11/05	Mon 3/7/05
13	Check Safety Regulations	Fri 2/18/05	Mon 3/7/05
14	Present Proposal for House	Tue 3/8/05	Thu 3/17/05
15	Revise Proposal	Wed 3/9/05	Mon 3/21/05
16	Check Safety Regulations	Wed 3/9/05	Mon 4/18/05
17	Present Final Proposal	Thu 3/24/05	Thu 3/24/05
18	Create House in AutoCAD	Fri 2/25/05	Mon 4/18/05
19	Create Model of House	Wed 3/23/05	Mon 4/18/05
20	Create a rough Budget	Wed 3/23/05	Mon 4/18/05
21	Create Leaflet with Key Feature	Wed 3/30/05	Mon 4/11/05
22	House complete	Mon 4/18/05	Tue 4/19/05
23	**Sustainability Team**	**Fri 1/28/05**	**Tue 4/19/05**
24	Collect Data from IIT (Auditing)	Fri 1/28/05	Wed 2/23/05
25	Research Sustainability	Fri 1/28/05	Wed 2/23/05
26	Present Research	Thu 2/24/05	Thu 2/24/05
27	Continue Auditing	Fri 2/25/05	Mon 4/11/05
28	Recycling Program	Fri 2/25/05	Mon 4/11/05
29	Compare IIT <-> Others	Fri 2/25/05	Fri 4/1/05
30	Brainstorm areas of improveme	Fri 2/25/05	Fri 4/1/05
31	Present Improvements	Thu 3/24/05	Thu 3/24/05
32	Create a Roadmap	Fri 3/25/05	Mon 4/18/05
33	Create a leaflet with key feature	Fri 4/8/05	Wed 4/13/05
34	Roadmap complete	Tue 4/19/05	Tue 4/19/05
35	**Knowledge Team**	**Fri 1/28/05**	**Tue 4/26/05**
36	Collect Data / Links / ...	Fri 1/28/05	Mon 4/25/05
37	Create final portfolio w/ all Know	Fri 4/22/05	Mon 4/25/05
38	Database complete	Mon 4/25/05	Tue 4/26/05
39	**Midterm Report**	**Wed 3/9/05**	**Fri 3/25/05**
40	Draft	Wed 3/9/05	Mon 3/21/05
41	Review Report	Tue 3/22/05	Tue 3/22/05

Tasks for IPRO 301 Fri 3/25/05

ID	Task Name	Start	Finish
42	Final Revision	Wed 3/23/05	Thu 3/24/05
43	Report Due	Fri 3/25/05	Fri 3/25/05
44	Spring Break	Mon 3/14/05	Sat 3/19/05
45	**Website**	**Sat 3/19/05**	**Fri 4/22/05**
46	Create Layout	Sat 3/19/05	Wed 3/23/05
47	Finalize Layout	Fri 3/25/05	Mon 3/28/05
48	Write Text / Make Pictures for W	Tue 3/29/05	Wed 4/13/05
49	Upload to Website	Wed 4/6/05	Wed 4/13/05
50	Final Revision of Website	Fri 4/15/05	Wed 4/20/05
51	Website Done	Fri 4/22/05	Fri 4/22/05
52	**Final Report**	**Wed 3/30/05**	**Tue 4/26/05**
53	1. Draft Final Report	Wed 3/30/05	Mon 4/4/05
54	Review Final Report	Tue 4/5/05	Tue 4/5/05
55	2. Draft Final Report	Wed 4/6/05	Mon 4/18/05
56	Review Final Report	Tue 4/19/05	Tue 4/19/05
57	3. Draft Final Report	Wed 4/20/05	Wed 4/20/05
58	Final Report Complete	Thu 4/21/05	Thu 4/21/05
59	Last Revisions	Fri 4/22/05	Mon 4/25/05
60	Final Report Due	Tue 4/26/05	Tue 4/26/05
61	**Presentation**	**Wed 4/6/05**	**Wed 4/27/05**
62	1. Draft Presentation	Wed 4/6/05	Wed 4/13/05
63	1. Run Presentation	Thu 4/14/05	Thu 4/14/05
64	2. Draft Presentation	Fri 4/15/05	Wed 4/20/05
65	2. Run Presentation	Thu 4/21/05	Thu 4/21/05
66	Minor Revisions	Fri 4/22/05	Tue 4/26/05
67	Presentation Done	Wed 4/27/05	Wed 4/27/05
68	**Poster**	**Wed 4/6/05**	**Mon 4/25/05**
69	1. Draft Poster	Wed 4/6/05	Wed 4/13/05
70	Review as a Team	Thu 4/14/05	Thu 4/14/05
71	2. Draft Poster	Thu 4/14/05	Wed 4/20/05
72	Review as a Team	Thu 4/21/05	Thu 4/21/05
73	Last Revision	Fri 4/22/05	Sun 4/24/05
74	Poster Done	Mon 4/25/05	Mon 4/25/05
75	**Abstract**	**Wed 4/13/05**	**Mon 4/25/05**
76	1. Draft Abstract	Wed 4/13/05	Mon 4/18/05
77	Review in Team	Tue 4/19/05	Tue 4/19/05
78	Final Revision	Wed 4/20/05	Sun 4/24/05
79	Abstract Done	Mon 4/25/05	Mon 4/25/05
80	IPRO Day	Fri 4/29/05	Fri 4/29/05
81	Debriefing	Mon 5/2/05	Fri 5/6/05



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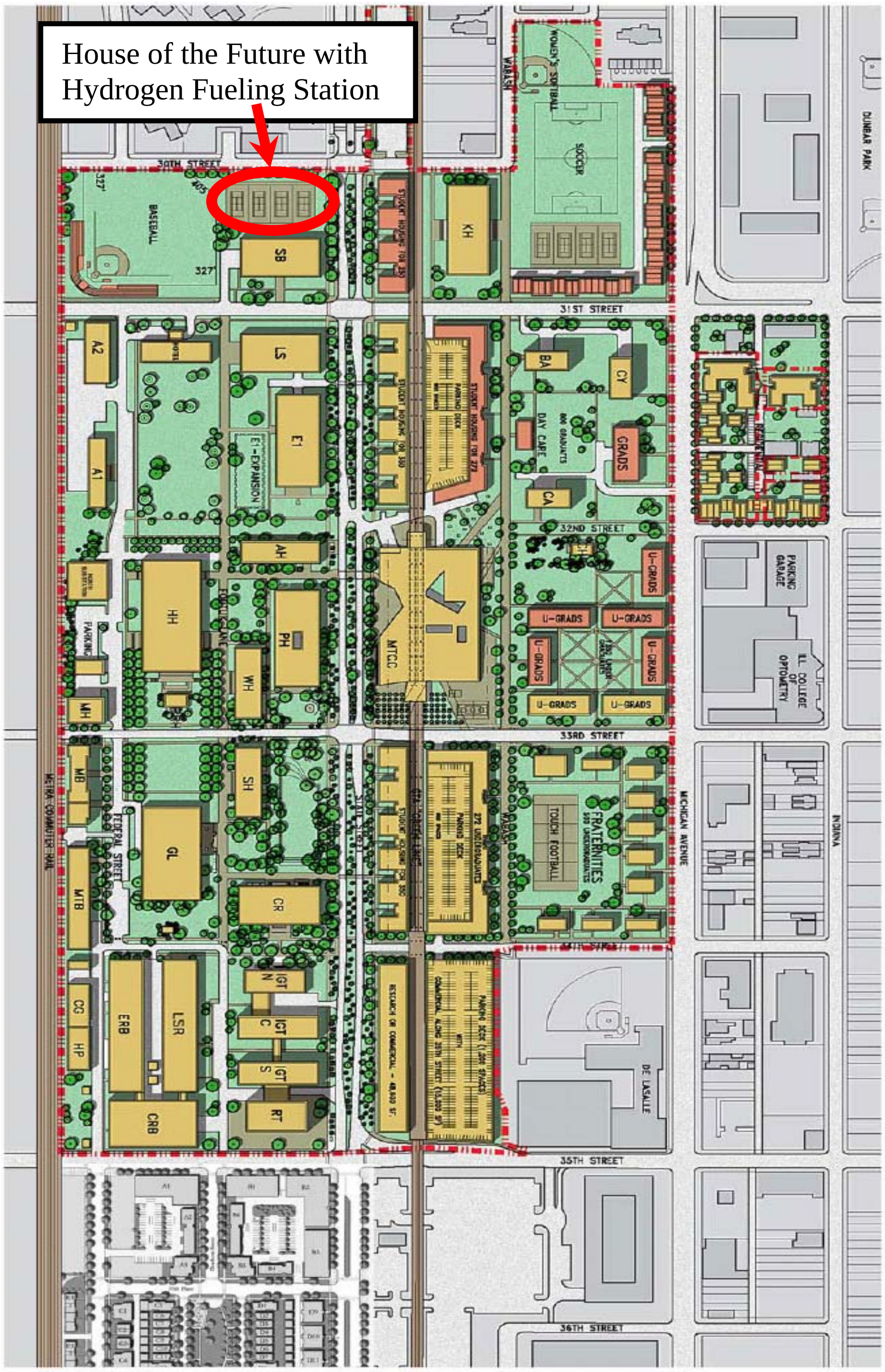
8 APPENDIX – HOUSE TEAM

8.1 HOUSE OF THE FUTURE – SITE LOCATION

IIT's master plan for 2020 is shown in the following picture. The planned site for the House of the Future is located where the big red oval is located.



8.2 PASSIVE SOLAR DESIGN

The house is designed to take advantage of the sun on the long south façade. The southern double skin photovoltaic façade (see Figure 1 below) has the following multiple functions:

1) The semitransparent photovoltaic modules produce electricity
2) Solar chimney: in the winter the air in the house is heated by the sun coming through the facade
3) Natural ventilation: in the summer operable windows provide natural cooling inside the house
4) PV ventilation and fresh air preheating: in the winter, fresh outside air, flowing through the cavity, ventilates the back of the photovoltaic cells, and at the same time it is preheated before entering the house
5) Reduce façade temperature: in the summer, the air flowing through the cavity ventilates the façade and then it is rejected outside

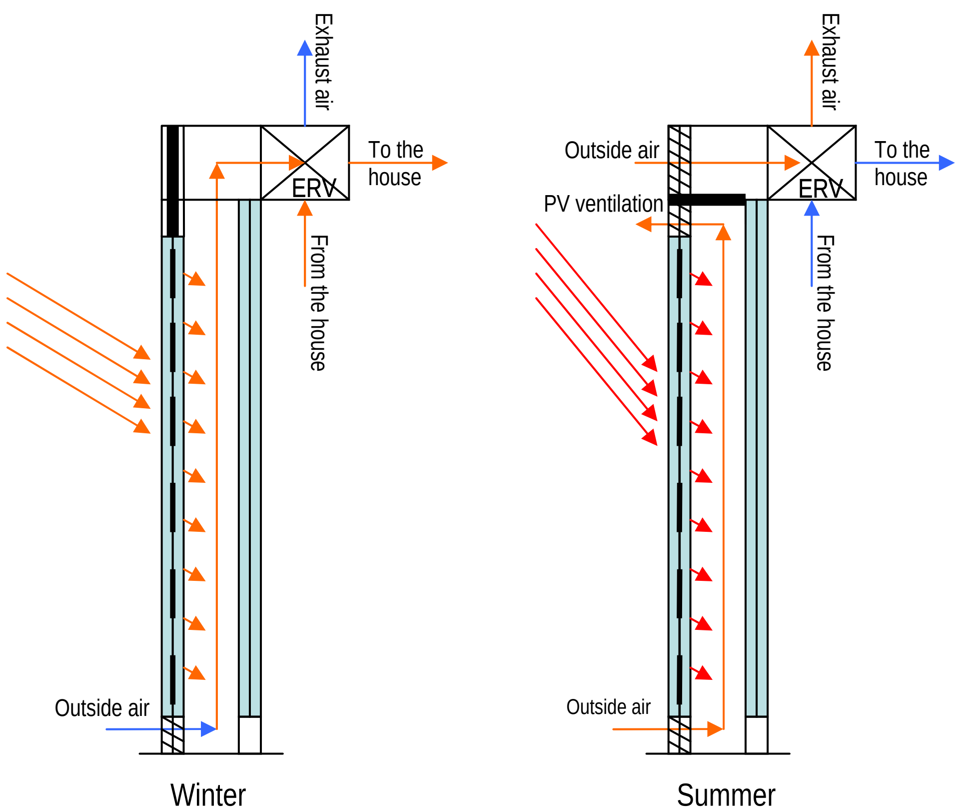


Figure 1: PV back air flow is preheated for the house ventilation system in the winter and ventilates the façade in the summer

8.3 SPACE HEATING/COOLING

When necessary in addition to the passive solar design, the heating/cooling load will be supplied by a geothermal heat pump. Geothermal heat pumps take advantage of the ground temperature (typically constant at 50-55°F), to heat up a fluid that flows in the piping underground in the winter or to transfer the heat underground in the summer.

This technology is not new (the first installation was made in 1919 in Larderello, Italy), but it is the most energy efficient, environmentally clean, and cost-effective space-conditioning systems.[2] Geothermal heat pumps can cut the energy use by 23-44% compared to advanced air-source heat pumps, and by 63-72% compared to electric resistance heating or standard air-conditioning equipment.[3] The cost of geothermal heat pumps is approximately $3,500/ton (the house would need a 3-tons system), and the lifespan is up to 50 years.

The heating/cooling distribution systems are:

- Radiant floor heating: allows energy savings between 15-20% compared to traditional systems because the temperature needed is reduced. Installation costs can be up to 40-50% more than conventional systems.
- Fan coils for cooling: individual units in single rooms. Fan coils provide also dehumidification to achieve the comfort level in the summer.

8.4 MECHANICAL VENTILATION

In addition to natural ventilation in the summer, a mechanical system is provided to supply fresh air inside the building in very hot summer and cold winter days. The energy recovery ventilator (ERV) is able to recover up to 85% of the energy of exhaust air in order to heat or cool fresh outside air. In the winter, the cavity in the double skin façade will provide pre-heated fresh outside air to the ERV while in the summer it will be rejected outside.

8.5 WATER USAGE

The water usage, compared to traditional residential buildings has to be reduced by deploying low flow faucets (.5 to 1 GPM and 1.5 to 2 GPM for kitchen faucets) and showerheads (2.5 GPM or less); dual flush toilets (0.8 gallons per half flush and 1.6 gallons per flush); horizontal axis clothes washer that allow up to 60% water savings compared with the vertical axis washers.[4]

The cold and hot water demand of the specific project has to be defined taking into account the actual destination of the House of the Future.

A storm water recycling system will serve the water for toilet usage.

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[2] Space Conditioning: The Next Frontier: EPA 430-R-93-004, April 1993

[3] “Environmental and Energy Benefits of Geothermal Heat Pumps”, DOE/GO-10098-653, September 1998

[4] http://energyoutlet.com/res/waterheat/waterheater.html

8.6 HOT WATER

The hot water is supplied by solar collectors placed on the roof at a slope between 25° and 40°. The solar collectors investigated are the compound parabolic collectors (CPC2000) by Solargenix, a manufacturing company in Chicago. With this type of collector the water can reach temperature between 105°F and 200°F that is enough for residential use (typically domestic hot water is delivered at 140°F although 120°F is sufficient). One collector by Solargenix (24 ft^2 or 2 m^2) is capable to provide 1 kW_{th} (3,410 BTU/h) of power. The complete system is made of: collectors, storage tank, heat exchanger, piping, valves and temperature controllers. It is very important to size the whole system for the house in an appropriate manner so that the system is not neither oversized nor undersized.

In a typical residential installation in Chicago for 4 people (for a demand of 70 gallons of hot water per day) the system comprises 2 collectors and 80 gallons storage tank and costs between $6,500 and $8,500. The water usage in the typical example is very high.

The cost of the system is $90/$ft^2$ i.e. $2,160 for the whole system including storage and one collector.

As a backup system for the solar thermal collectors, the geothermal heat pump can be used by the use of an optional desuperheater.

8.7 ELECTRICITY

The electricity requirements of the house will be met by the hydrogen fueling station next to the house. In addition, a photovoltaic (PV) array is located on the south façade. The PV modules proposed are based on a technology in development at IIT and commercialized by a spin-off company, Phocus Solar Tech. The photovoltaic array, of an area of about 400 ft^2, and power of 3.5 kW_{el}, will be able to produce up to 3,622 kWh of electricity per year in the specific site conditions taking into account 9% efficiency of the modules.

8.8 EXTERIOR FAÇADE

The exterior façade of the building will be a modular precast concrete panel system that is easy to remove and recyclable. This system allows panels to be installed temporarily while providing a tight enclosure around the building. They can be removed so that other panels with different properties can be tested in the House of the Future.

Since these enclosure panels can be removed they will require much less energy in equipment and people to change out. This is designed on the principle that it will change so it is modular and detailed to be removed with ease.

These precast panels will also have fasteners that are embedded so that other exterior panels can be attached and tested. These new materials can be tested for their water shedding capabilities, UV resistance, and public acceptance, durability, and maintenance requirements. The first proposed panel to be installed is made by Eternit which is a composite material made of sawdust and concrete.[5]

8.9 INSULATION

The insulation for this for the House of the Future will be cast into the precast concrete panels. Cellulose has been chosen because it is a 75% recycled material that has a lot embodiment of energy and is easy to apply. It provides a 50% higher R-value than conventional fiberglass insulation. Since the R-value is raised to approximately 30; 25% less energy is devoted to heating the building. Cellulose will also provide a 36% tighter building envelope which will keep in heat longer and further reduce the amount of energy required for heating.[6] Cellulose is also a much better insulation than fiberglass because it is not as hazardous to human health and will do less damage to the environment when disposed of since it is made mostly of recycled newspapers.

Another form of insulation that will be tested in the House of the Future is a phase change material cast into the concrete panels. This phase change material is a type of wax that will store heat over the time of day and release it into the house over the night to reduce the heating load. To help propagate the proper radiation of the heat into the house the exterior panels that are attached to the precast panels will redirect it inside.

8.10 OPERABLE WALLS

The House of the Future needs to be flexible to handle all of the testing and changing environments that it will be subject to. This means that the interior walls will need to be movable and removable. In the market there are currently track systems that allow walls to be shifted to change the space. We propose using the skeleton of a system offered by Hufcore, Inc. The wall panels will then be inserted into this skeleton so that they can be easily installed for testing. These new wall materials can be applied in a controlled lab setting and then brought into the house so that the house will not have to shut down for the installation of new walls.

By having this flexibility in the floor plan the House of the Future will be more sustainable. This will allow the house to change without much construction costs and very little installation time. It will greatly reduce the amount of energy spent in changing according to the needs of displaying technologies in the house.

8.11 THERMAL CHIMNEY

The thermal chimney is located in the center structural bay of the House of the Future. This chimney is used in the summer to draw cool air from the north of the house through the chimney. This brings cool air in and draws hot air out of the south side of the

[5] www.eternit.co.uk
[6] www.cellulose.org

chimney. To protect from too much heat gain through the south façade, the double skin façade is opened. There are a set of louvers located at the top and bottom that provide air flow so that the heat is not brought into the house. This also provides adequate air flow behind the photovoltaic cells to keep their efficiency at a high rate.

During the winter there is heat gain captured within the double skin façade on the south side. Only the louvers at the bottom are opened to draw air up to an energy recovery ventilator. This preheats the air that will enter the mechanical system and reduce the energy load to heat fresh air that is distributed through out the house. The energy recovery ventilator is also used to capture heat that rises from the entire house at the top of the thermal chimney so that this heat is not wasted (see Figure 2 below).

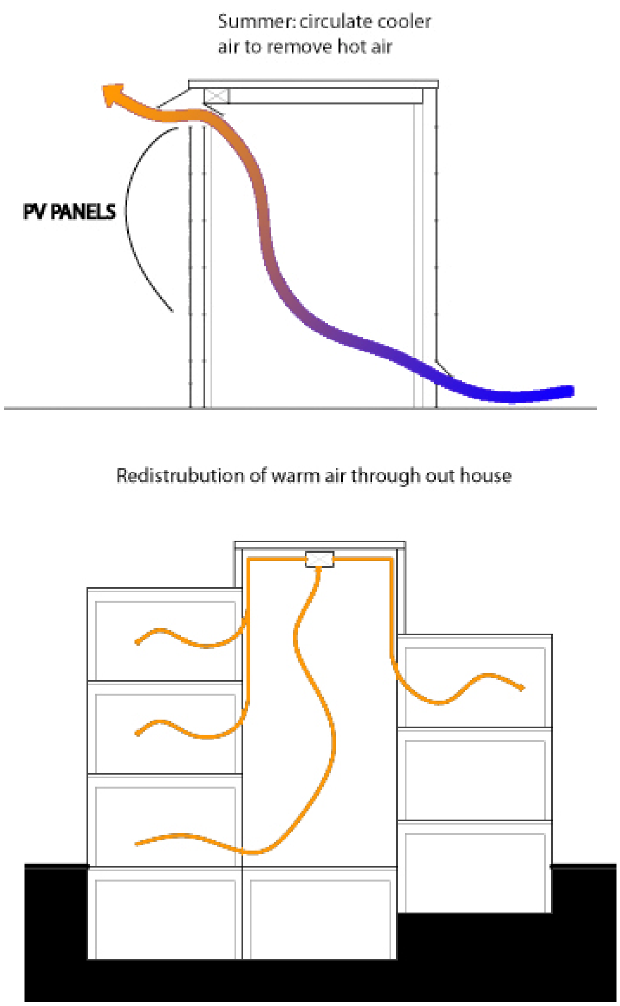


Figure 2: Detailed drawing of wind flow through solar chimney in major seasons (summer and winter, and throughout the house in the winter)

8.12 FLOORING, APPLIANCES, WINDOWS

Flooring is an important factor. It is something that will be seen throughout the entire house. Anyone who walks through the house will notice it. Also, since it covers such an extensive area, flooring offers a large canvas with which to work on. The main focus of this research was cork flooring. The decision came early on to use cork flooring. It was not only recommended by the architects in the group, but it also proves to be a good choice for sustainable design. Other alternatives were researched but no advantages over cork were found for our project.

Cork flooring has many benefits. One of the biggest benefits is probably its environmental impact. Unlike hardwood flooring, the production of cork flooring does not involve cutting down trees. Instead, cork is harvested from the bark of cork trees every nine to fourteen years. This doesn't cause harm to the plant. Indeed, this process means that the trees rarely have to be cut down. In fact, cork trees can live over 500 years. [7] Cork flooring is completely non-toxic. When being manufactured, cork flooring is first coated with a natural resin, and then processed into panels. Cork flooring can be manufactured in two processes, one which involves mixing rubber into the cork. For our project, we have chosen to go with completely natural cork. During installation, cork can be held down by a water based adhesive. This adhesive is also non-toxic, which has a low impact on the environment. Finally, it can be sealed with a natural canuba wax. This means that cork does not release toxic gases under combustion.

The flooring itself provides many lifestyle advantages. It provides great thermal and acoustic insulation. Because 90% of cork tissue is gaseous, cork is also a very resilient. It is less affected by impact and friction than other hard surfaces. Cork can be compressed, and it can return to its original shape. This durability means that cork can outlast hardwood or vinyl. Cork is also highly resilient against rot. Unlike carpets, cork does not absorb dust. Because of this, allergic reactions are minimized.[8] Cork flooring can be installed over radiant flooring. Properly installed cork flooring can be beneficial when installed over radiant flooring[9]. Cork flooring is priced competitively against other flooring. The price per square foot including installation fro ma company in the Chicago-land area called PCI FloorTech was found to be $8 sq/ft.

Of course, cork has a few disadvantages. Water can be damaging to cork, depending on how it is sealed. Also, because cork is soft and resilient, heavy furniture left on it over time can be damaging. Also, because of its high insulation, using too much on a warmboard/radiant panel system can raise the R value to the point where it doesn't help the system anymore.

Bamboo is another sustainable alternative. Bamboo provides benefits to its natural environment. It serves to control erosion in the places where it grows. It can be harvested sustainably after about three years of growth. Harvesting it will not kill the plant, as

[7] http://www.powerhousetv.com/stellent2/groups/public/documents/pub/phtv_yh_co_000428.hcsp
[8] http://www.galleriacollection.com/naturalcork
[9] http://www.warmboard.com/install_cork.html

bamboo is a form of grass, and it can grow quickly.[10] It is an attractive alternative to hardwood flooring. It is also inexpensive to purchase at about $4-8 per square foot. A disadvantage of both cork and bamboo is that they tend to be grown in far away places, and therefore have to be transported long distances. Bamboo is harvested from places like China, while cork is brought in from countries in Europe.

Energy in the home can be lost in many ways. A large amount of energy in the home is lost through inefficient windows. During the winter, heat loss from windows can represent 10% of the heating bill, and 30% of the cooling bill during the summer[11]. Therefore, it is important to have windows with high efficiency. The way the House of the Future is currently designed, the solar chimney has windows that are designed for high heat gain. The rest of the house has to have energy efficient windows. There are many factors to consider when choosing a window. The amount of heat loss through a window is known as the U factor. Windows can come as either single pane, double glazed, or triple glazed. Each additional glazing is another sheet of material, with either air or gas trapped between the panes. Argon gas is commonly used, and is one of the best choices for glazing. Windows are also offered with low emittance coatings, that reduce the U factor by reducing heat loss.

For our environment, the best window for both heating and cooling is a triple glazed window with moderate solar gain, and low E coating.[12] Another option is to use a double glazed window, on a side of the house that sees less sun. Our house uses a combination of the two to maximize efficiency. A triple glazed window was found to be moderately (approx. $20) more expensive than a double glazed window.

It is true that “the best way to live with renewable energy is to need less of it”[13]. Because we can use a good amount of power from a solar source, it’s good to have appliances that have low power requirements. When choosing appliances, it is important to look for the Energy Star logo. Energy Star is a government backed program that looks to reduce energy usage in appliances. Any product bearing the energy star logo must go through a rigorous testing process, and be marked with exactly how much energy it uses. When it actually comes down to choosing which appliances will be used in the house, it will be important to make sure that anything that is chosen is not only energy star compliant, but also that it uses the least energy of anything in its class. To that end, a table has been provided with information on some of the major appliances. Only low energy appliances have been included.[14]

[10] http://www.healthyhomeplans.com/articles/information9.php
[11] http://www.leeric.lsu.edu/energy/windows
[12] http://www.efficientwindows.org
[13] http://www.round-river.com/solarstuff.html
[14] http://www.aceee.org/

Clothes Washers:

Brand	Model	Capacity (cubic feet)	Modified Energy Factor (MEF)	Water Factor	kWh/yr (elec.wtr.htr)
LG Electronics	WM2077C*	3.22	2.03	3.89	195
Bosch	WFMC3200UC	3.03	2.1	5.3	186
Bosch	WFMC6400UC	3.03	2.2	4.5	178
Asko	W660	1.9	1.92	9	176
Equator	EZ 3612 CEE	1.92	1.92	5	143
Equator	EZ 1612 V	1.92	2.04	4.85	135
LG Electronics	WD-324*RHD	1.96	2.1	5.04	115

Top Freezer, Automatic Defrost, less than 18 Cubic Feet

Brand	Model	Volume	Energy Use (kWh/yr)	Annual Energy Cost ($)*
Sun Frost	RF-16	14.3	254	21
Whirlpool	ET5WSE*K*0	14.5	372	31
Roper	RT14HD*P*0*	14.4	373	31
Frigidaire	FRT15HB2D*	14.8	376	31
Frigidaire	FRT15HB3D*	14.8	376	31

Top-Rated Gas Boilers - Hot Water

111,000 - 140,000 Btu/hr heating capacity

Manufacturer	Trade Name	Model Number	Input (Btu/hr)	Electric Energy (kWh/yr)	AFUE
Viessmann	Viessmann Vitodens 200	WB2 8-32	112,000	48	94.1

77,000 - 93,000 Btu/hr heating capacity

Manufacturer	Trade Name	Model Number	Input (Btu/hr)	Electric Energy (kWh/yr)	AFUE
Viessmann	Viessmann Vitodens 200	WB2 6-24	81,000	48	94.2

60,000 - 76,000 Btu/hr heating capacity

Manufacturer	Trade Name	Model Number	Input (Btu/hr)	Electric Energy (kWh/yr)	AFUE
Heat Transfer Products	Munchkin	80M	74,000	76	92
P B Heat	Pinnacle	PI 80	74,000	76	92

8.13 WATER AS A SUSTAINABLE RESOURCE

The earth is one of the most unique planets in this galaxy, not only is it populated by life, but, it is one of the few planets whose surface is dominated by water. In fact, the earth is 70% water[15]. Yet, surprisingly only less than 1% of that mass of water is available to support all the life on this planet. This startling statistic compiled with the rising population growth of human beings has led experts to the following conclusions:

> "A lot of people think water will be the dominant issue Of the 21st century," said Dan Injerd, IL Dept. of Natural Resources.
>
> "In the coming century water issues are going to be as Important as oil, as important as gold issues," said Cameron Davis, Lake Michigan Federation executive Director.
>
> "In the future wars will be fought over water ... not oil," Said Tim Eder, National Wildlife Federation.
>
> "Those of us with plenty of water are going to be Under significant political pressure to share it," said George Kuper, Council of Great Lakes Industries.

The “Have’s” in Mr. Kuper’s quote is the continent of North America. This continent has being blessed with 20% of the less than 1% of the earth’s fresh water. This has led to culture in North America that seems to be barely conscious of water consumption and the problems of water availability.

8.13.1 THREAST TO WATER

The number one threat to water reserves is people, and the continuous population growth. This population growth not only consumes water, but also produces wastes which have to be cleaned up.

8.13.1.1 EARLY SOLUTIONS

The early solutions to this problem were to dump the wastes in rivers, and use other bodies of water to clean it up. This solution was problematic as most of these rivers drained into the lakes which were the fresh water reserves of the people.

Solution:

In Chicago for example, this solution was solved by the army corps of engineers after an outbreak of cholera which killed 90,000, at that time 10% of the city population. The reason for the outbreak was that the Chicago River which drained into Lake Michigan

[15] www.eere.gov

was the source of the sewage cleanup of the city's waste. The army corps of engineer changed the flow of the Chicago River into the Mississippi which then drains to the Gulf of Mexico.

James W. Jardine facility was built in later years to clean up the water being received from Lake Michigan and then it distributes it to the houses**.**

Sewage solution

Built sewers and septic systems to collect waste from the houses which is then cleaned and processed and turned to the Chicago River.

Problems:

Chicago collects two billion gallons of water from Lake Michigan a day, one billion for Jardine and another to keep river and canal systems flowing. Justification for this:

> "The Canadians divert more water INTO Lake
> Superior than we divert OUT OF Lake Michigan. So,
> Right now the Great Lakes have more water coming
> Into it than it did before man started modifying the
> System," said Dan Injerd.

Ethical problems

Cities along the lakes system have reached their population limits, and they are insisting that they also take water form the lake, and they are being told no by the government. Yet Chicago is allowed to do it.

Sewer problems

In 1994, 2.4 million septic tanks malfunctioned in the U.S.[16] In Chicago, we spend 80 million dollars to keep our sewer system up to date. Chicago is one of the few cities that actually have a great record of maintenance of sewer systems.

Water being distributed by Jardine back to the rivers and to the homes has high PH levels of 7.4. Also many impurities are not being cleaned up, like cyanide, minerals, nitrates and so on. (See city of Chicago water quality report in the following two pages).

Also, in order to clean all this water there is an enormous amount of energy being used. Though, numbers were almost impossible to find on who pays it, and how much is expended by the Jardine plant.

[16] www.equaris.com

COMPREHENSIVE CHEMICAL ANALYSIS

CITY OF CHICAGO - DEPARTMENT OF WATER MANAGEMENT - BUREAU OF WATER SUPPLY
WATER QUALITY DIVISION-WATER PURIFICATION LABORATORIES

SAMPLES COLLECTED AUGUST 25, 2003

PARAMETER	IEPA MCL	DETERMINED AS	STORET NUMBER	SOUTH WATER PURIFICATION PLANT RAW LAKE	SOUTH OUTLETS 73rd Street	SOUTH OUTLETS 79th Street	SOUTH ***DISTRIBUTION SOUTH	JARDINE WATER PURIFICATION PLANT RAW LAKE	JARDINE OUTLETS Central	JARDINE OUTLETS North	JARDINE ***DISTRIBUTION Central	JARDINE ***DISTRIBUTION North
TEMPERATURE		°C	00010	23	21	21	24	22	21	20	25	26
TURBIDITY	0.5	N.T.U.	82079	0.80	0.20	0.20	0.35	1.20	0.02	0.15	0.15	0.30
THRESHOLD ODOR, STRAIGHT	*3	T.O.N	00086	1Mm	1Cc	2Cc	2Cc	1E	1Cc	2Cc	1Cc	1Cc
THRESHOLD ODOR, DECHLORINATED	*3	T.O.N.			1Mm	1M	1Mm		1Mm	1Mm	1Ep	1Ep
COLOR	*15	Pt.-Co. Units	00080	2	0	0	0	1	0	0	0	0
pH	*6.5-8.5	STD. Units	00040	8.19	7.52	7.44	7.58	8.29	7.54	7.48	7.46	7.46
FREE CHLORINE RESIDUAL		CL_2, mg/L	50064	0.00	0.79	0.75	0.55	0.00	0.87	0.85	0.54	0.62
SATURATION INDEX, LANGELIER		UNITS +/-		0.35	-0.42	-0.47	-0.27	0.05	-0.43	-0.47	-0.39	-0.42
ALKALINITY, PHENOLPHTHALEIN		CaCO3, mg/L	00415	0	0	0	0	0	0	0	0	0
ALKALINITY, TOTAL		CaCO3, mg/L	00410	115	105	111	106	113	101	108	101	100
BROMIDE		Br, mg/L	71870	0.027	<0.006	<0.006	<0.006	0.026	<0.006	<0.006	<0.006	<0.006
CHLORIDE	*250	Cl, mg/L	00940	11.7	13.4	13.5	13.5	11.2	13.0	13.0	13.4	13.3
FLUORIDE	4	F, mg/L	00951	0.17	0.94	0.92	0.94	0.17	0.95	0.95	0.94	0.96
SULFATE	*250	SO4, mg/L	00945	22.8	28	28	28.0	22.6	26.7	26.8	27.3	26.8
HARDNESS		CaCO3, mg/L	00900	147	143	143	142	141	140	140	140	140
CALCIUM		Ca, mg/L	00916	35.5	33.9	33.5	34.4	33.8	33.2	33.6	33.5	31.4
MAGNESIUM		Mg, mg/L	00927	12.0	11.8	11.7	11.7	12.0	11.8	11.9	12.2	12.4
POTASSIUM		K, mg/L	00937	1.2	1.2	1.3	1.2	1.3	1.2	1.4	1.4	1.5
SODIUM		Na, mg/L	00006	6.2	6.2	6.2	6.2	5.6	6.0	5.9	6.1	6.1
SOLIDS, TOTAL DISSOLVED	*500	TDS, mg/L	00150	164	170	168	163	160	168	169	168	167
SOLIDS, TOTAL		Tot. Sol., mg/L	00500	176	184	183	176	172	177	186	182	183
TOTAL ORGANIC CARBON		NPOC, mg/L	00680	1.93	2.03	2.04	1.84	2.55	1.77	1.80	1.87	2.07
OXYGEN DEMAND, CHEMICAL		O, mg/L	00335	<5	<5	6	5	<5	<5	5	<5	<5
NITROGEN, AMMONIA		N, mg/L	00610	0.02	0.02	0.01	0.00	0.02	0.01	0.00	0.01	0.01
NITROGEN, NITRATE	10	N, mg/L	00620	0.226	0.197	0.196	0.202	0.187	0.190	0.189	0.226	0.190
NITROGEN, NITRITE	1	N, mg/L	00615	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NITROGEN, TOTAL KJELDAHL		N, mg/L	00625	0.173	0.148	0.134	<0.100	0.247	0.211	0.173	0.173	0.182
ORTHOPHOSPHATE		PO4, mg/L	00660	<0.05	0.626	0.544	0.534	<0.05	0.458	0.448	0.525	0.484
PHOSPHATE, TOTAL		PO4, mg/L	00650	<0.05	1.245	1.031	1.035	<0.05	0.889	0.867	1.040	0.960
CYANIDE, TOTAL	0.2	CN, mg/L	00720	0.001	<0.001	0.002	0.001	0.001	0.002	0.001	<0.001	<0.001
FOAMING AGENT	*0.5	MBAS, mg/L	38260	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
PHENOLICS, TOTAL		Phenol, µg/L	32730	6	<1	<1	<1	<1	<1	<1	<1	8
RADIOACTIVITY, GROSS ALPHA	15	pCi/L	01501	<1	<1	<1	<1	<1	<1	<1	<1	<1
RADIOACTIVITY, GROSS BETA	50	pCi/L	03501	1.9	3.3	1.8	1.5	1.4	1.8	1.9	2.4	2.4

* Federal/State Secondary MCL's

** Action Level

***Distribution samples are composited.

COMPREHENSIVE CHEMICAL ANALYSIS
CITY OF CHICAGO - DEPARTMENT OF WATER MANAGEMENT - BUREAU OF WATER SUPPLY
WATER QUALITY DIVISION-WATER PURIFICATION LABORATORIES

SAMPLES COLLECTED AUGUST 25, 2003

PARAMETER	IEPA	DETERMINED	STORET	SOUTH WATER PURIFICATION PLANT				JARDINE WATER PURIFICATION PLANT				
				RAW	OUTLETS		***DISTRIBUTION	RAW	OUTLETS		***DISTRIBUTION	
	MCL	AS	NUMBER	LAKE	73rd Street	79th Street	SOUTH	LAKE	Central	North	Central	North
TEMPERATURE		°C	00010	23	21	21	24	22	21	20	25	26
TURBIDITY	0.5	N.T.U.	82079	0.80	0.20	0.20	0.35	1.20	0.02	0.15	0.15	0.30
THRESHOLD ODOR, STRAIGHT	*3	T.O.N	00086	1Mm	1Cc	2Cc	2Cc	1E	1Cc	2Cc	1Cc	1Cc
THRESHOLD ODOR, DECHLORINATED	*3	T.O.N.			1Mm	1M	1Mm		1Mm	1Mm	1Ep	1Ep
COLOR	*15	Pt.-Co. Units	00080	2	0	0	0	1	0	0	0	0
pH	*6.5-8.5	STD. Units	00040	8.19	7.52	7.44	7.58	8.29	7.54	7.48	7.46	7.46
FREE CHLORINE RESIDUAL		CL_2, mg/L	50064	0.00	0.79	0.75	0.55	0.00	0.87	0.85	0.54	0.62
SATURATION INDEX, LANGELIER		UNITS +/-		0.35	-0.42	-0.47	-0.27	0.05	-0.43	-0.47	-0.39	-0.42
ALKALINITY, PHENOLPHTHALEIN		CaCO3, mg/L	00415	0	0	0	0	0	0	0	0	0
ALKALINITY, TOTAL		CaCO3, mg/L	00410	115	105	111	106	113	101	108	101	100
BROMIDE		Br, mg/L	71870	0.027	<0.006	<0.006	<0.006	0.026	<0.006	<0.006	<0.006	<0.006
CHLORIDE	*250	Cl, mg/L	00940	11.7	13.4	13.5	13.5	11.2	13.0	13.0	13.4	13.3
FLUORIDE	4	F, mg/L	00951	0.17	0.94	0.92	0.94	0.17	0.95	0.95	0.94	0.96
SULFATE	*250	SO4, mg/L	00945	22.8	28	28	28.0	22.6	26.7	26.8	27.3	26.8
HARDNESS		CaCO3, mg/L	00900	147	143	143	142	141	140	140	140	140
CALCIUM		Ca, mg/L	00916	35.5	33.9	33.5	34.4	33.8	33.2	33.6	33.5	31.4
MAGNESIUM		Mg, mg/L	00927	12.0	11.8	11.7	11.7	12.0	11.8	11.9	12.2	12.4
POTASSIUM		K, mg/L	00937	1.2	1.2	1.3	1.2	1.3	1.2	1.4	1.4	1.5
SODIUM		Na, mg/L	00006	6.2	6.2	6.2	6.2	5.6	6.0	5.9	6.1	6.1
SOLIDS, TOTAL DISSOLVED	*500	TDS, mg/L	00150	164	170	168	163	160	168	169	168	167
SOLIDS, TOTAL		Tot. Sol., mg/L	00500	176	184	183	176	172	177	186	182	183
TOTAL ORGANIC CARBON		NPOC, mg/L	00680	1.93	2.03	2.04	1.84	2.55	1.77	1.80	1.87	2.07
OXYGEN DEMAND, CHEMICAL		O, mg/L	00335	<5	<5	6	5	<5	<5	5	<5	<5
NITROGEN, AMMONIA		N, mg/L	00610	0.02	0.02	0.01	0.00	0.02	0.01	0.00	0.01	0.01
NITROGEN, NITRATE	10	N, mg/L	00620	0.226	0.197	0.196	0.202	0.187	0.190	0.189	0.226	0.190
NITROGEN, NITRITE	1	N, mg/L	00615	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NITROGEN, TOTAL KJELDAHL		N, mg/L	00625	0.173	0.148	0.134	<0.100	0.247	0.211	0.173	0.173	0.182
ORTHOPHOSPHATE		PO4, mg/L	00660	<0.05	0.626	0.544	0.534	<0.05	0.458	0.448	0.525	0.484
PHOSPHATE, TOTAL		PO4, mg/L	00650	<0.05	1.245	1.031	1.035	<0.05	0.889	0.867	1.040	0.960
CYANIDE, TOTAL	0.2	CN, mg/L	00720	0.001	<0.001	0.002	0.001	0.001	0.002	0.001	<0.001	<0.001
FOAMING AGENT	*0.5	MBAS, mg/L	38260	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
PHENOLICS, TOTAL		Phenol, µg/L	32730	6	<1	<1	<1	<1	<1	<1	<1	8
RADIOACTIVITY, GROSS ALPHA	15	pCi/L	01501	<1	<1	<1	<1	<1	<1	<1	<1	<1
RADIOACTIVITY, GROSS BETA	50	pCi/L	03501	1.9	3.3	1.8	1.5	1.4	1.8	1.9	2.4	2.4

* Federal/State Secondary MCL's

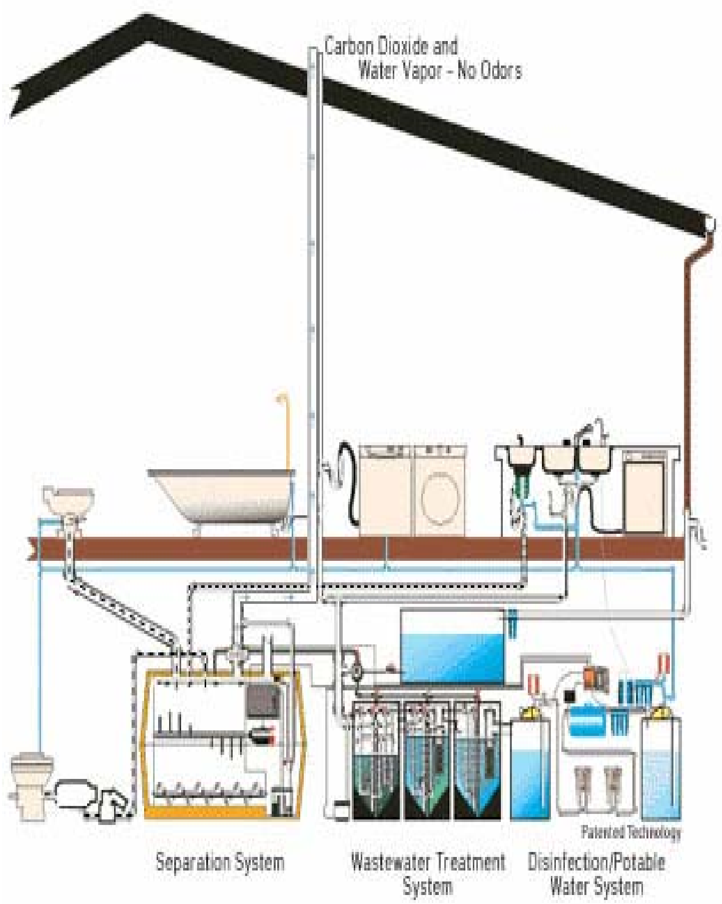
** Action Level

***Distribution samples are composited.

8.13.2 THE HOUSE TEAM'S SOLUTION

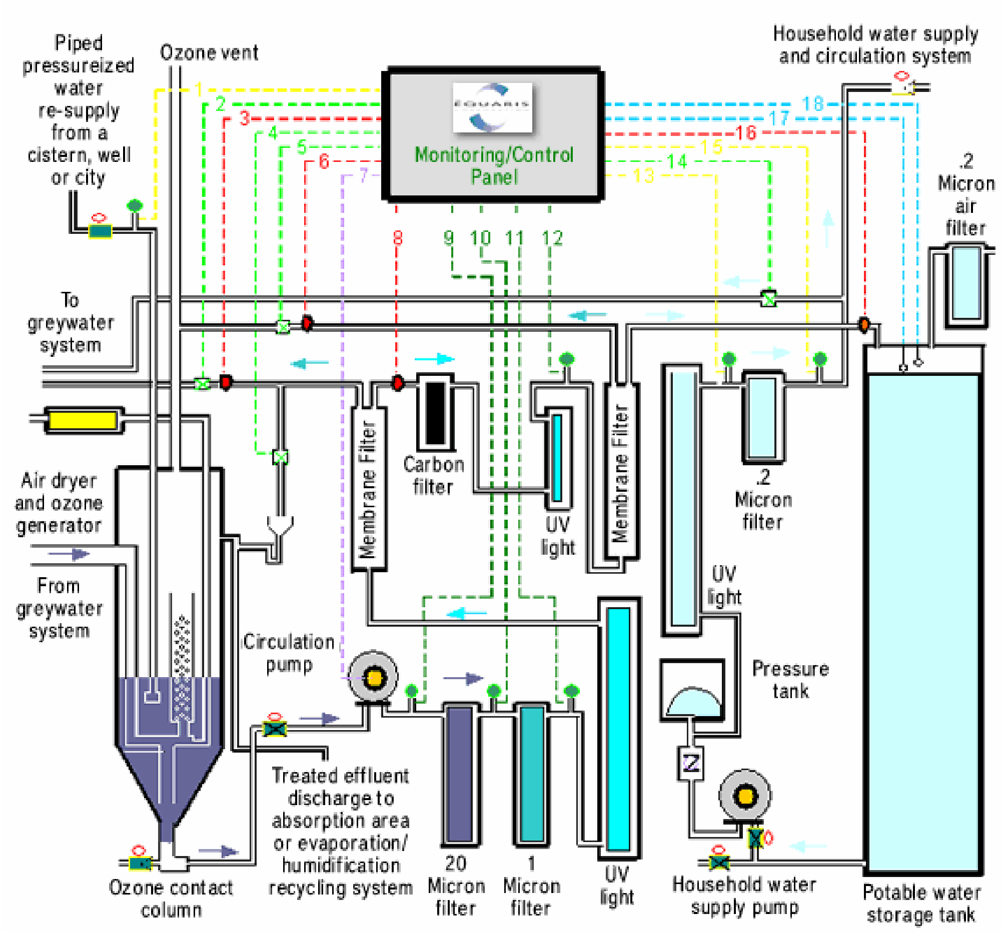
There are a few systems on the market that provide onsite processing and recycling of water and water wastes to potable water. The House team chose the EQUARIS WATER SYSTEM. This system was chosen over other systems because it was the system that fit the idea of using local resources, as the Equaris Corporation is in Minnesota. Thereby limiting the use of carbon fuels in transportation, and also this system unlike some of the systems we considered recycles gray water and water wastes. Most systems only recycled rain water which was the case with rain barrels[17]**,** and French drains[18]. The equaris system also requires very little footprint space, as the entire system can be placed in a basement and or mechanical room, which was integral since there was no need for extra outdoor installation, as in the AcornRainsava system[19].

The following graphic shows the layout of a Equaris system in a house. This particular graphic also includes the sealand opus gravity toilet connection.



[17] www.homedepot.com
[18] www.lynnbecker.com/repeat/AIAhouse/beinggreen
[19] www.v63.net/acornsytems/pages/rainsava.html

The following graphic shows the schematic layout of the filtration system:



8.14 PASSIVE DESIGN

8.14.1 OBJECTIVE

Passive design principles are a unique basis for building space because of its direct and sensitive concept of controlling the thermal and luminous environment within the building. There are two basic reasons why passive design strategy is imperative in sustainability. First, passive approaches have a direct effect on the design of the building envelope. Second, passive systems should be considered as primary source of energy for comfort and efficiency and mechanical and electrical systems should be secondary or a backup.

To intuit the principle nature of passive design a thorough knowledge of the principles of conduction and convection, thermal transmittance, radiation, evaporation, humidity, phase change, sensible heat, latent heat, specific heat, and enthalpy. These concepts result in a comfortable microclimate, or living condition, within the building. In addition, understanding material properties is imperative to gage how the material will act in different seasonal climates and day-to-day changes in temperature and humidity as well as what the material will do when build with other materials. For instance, thermal bridging is a term used to describe a value in heat loss usually associated with glass windows with metal frame that have negative expansion properties where the differential may cause infiltration (cold heat coming in, vice versa), or even cracking windows.

To avoid such construction problems a comprehension of the source of energy is important: the sun. From the sun we are able to gain heat, store heat and cool off during the night. The technique has been used with sun-dried mud bricks in parts of the Middle East and Africa since civilization began, some continuing to this day. Passive design principles are intuitive and based much on common sense; the understanding of the laws of physics and application will allow for progress from sun-dried mud bricks to removable and replaceable walls.

8.14.2 PASSIVE SOLAR HEATING

Passive solar heating is achieved by way of radiation, conduction, and natural convection as opposed to active solar heating with air pumps and fans for forced distribution. With an active system there are apparent ventilation shafts, ducts and piping retrofitted into the building. In contrast, passive system is very intimately interconnected with the placement and replacement of specific building components that may even look bare upon completion. The great benefit of this system is that by sun angle and materials studies we are able to predict and zone the spaces as such for maximum efficiency and comfort. In other words, we are reproducing the “greenhouse effect” with total control without unnecessary emissions.

There are five basic methods of collecting heat according to physical configuration and sun angles.

1. **Direct gain**: Consists of south-facing windows that admit winter sunshine directly unto the building into its interior where the heat is absorbed by the furniture, carpet, or other such masses.
2. **Thermal storage wall**: Commonly associated with a Trombe wall, which is a south facing wall constructed of heavy masonry or a Water wall consisting of water-filled containers as a massive wall to absorb heat. A glass glazing system is constructed outside on the south-facing wall to lower heat loss during the night.
3. **Sunspace**: Analogous to a greenhouse, sunroom, conservatory, or atrium located on the south side of the building. The basic concept is conduction of heat from the sunspace to the adjacent rooms, or convection if the common wall has windows and openings.
4. **Convection air loop**: A solar collector or a thermal mass is placed isolated from the living spaces to store that is distributed as hot air.
5. **Roof pond**: Primarily a system used for passive cooling but has attributes to maintain heat during cooler nights combined with other systems.

To maximize on the five basic components we must consider orientation of the glazing system (window system), the distribution of solar glazing areas (where we place the windows), conservation levels (how airtight and insulated the building and the components are), and nothing has to be perpendicular to the ground. All these points must be put to equal task of accomplishing solar heat gain; however, the latter point is usually ignored due to possible installation difficulties or customization of a window. An increase of performance can be achieved by tilting the solar glazing. Optimum winter heat angle is 50-60 degrees in most all locations in the United States. During the winter we can also take into consideration the reflectance factor of snow onto the glazing increasing solar heat gain. Vertical glazing, as we see today, are easier to construct and install and reduces unwanted heat gains and facilitates the installation for night insulation.

8.14.3 PASSIVE COOLING

If a room heats up because of people, afternoon heat, or electronics, opening the window and letting the heat out is the obvious thing to do. If we break this up into principles and apply it to a building, we have the counterpart of passive solar. Passive cooling has been around longer than passive solar heating, but its use is not widely found. Whereas the sun drives passive solar heating, passive cooling is in essence, nonsolar, making heat sinks to absorb and diminish. Because both systems rely on heat flow by natural means (radiation, conduction, convection, and phase change), they share many similar principles.

The key in understanding passive cooling is to understand the workings of the natural environment. The sun directs heat to the earth, the layer of the atmosphere breaths, but maintains and allows certain rays to heat the earth, whereby the natural heat sinks in the form of water, earth (soil), and sky absorbs and evacuates the unwanted heat. This heat also insulates plant life that cleans the air and produce organic matter for other plant life and animals to live. A basic recycling system that was lost and now made complex in human evolution that will set precedent to the way we live.

Passive cooling components can be categorized by different fields of study on heat sinks rather than actual building components and orientation as in passive solar heating. There are four basic studies on passive cooling:

1. **Ventilative cooling**: The exhausting of warm building air and replacing with outside air; directing across occupant's skin to cool by evaporation and convection. This required air movement is provided by either the wind or "stack effect". Fans can be used.
2. **Radiative cooling**: The transfer of warm heat to a cooler adjacent surrounding surface.
3. **Evaporative cooling**: The exchange of sensible heat in air for the latent heat of water droplets of wetted surfaces (phase changes).
4. **Dehumidification**: The removal of water vapor from room air by dilution with drier air, condensation, or desiccation.
5. **Mass-Effect cooling**: The use of thermal storage to absorb heat during the day and release it during the night for warmth. This is where cool night air is drawn through a building to exhaust heat stored during the day called "Night Flushing".

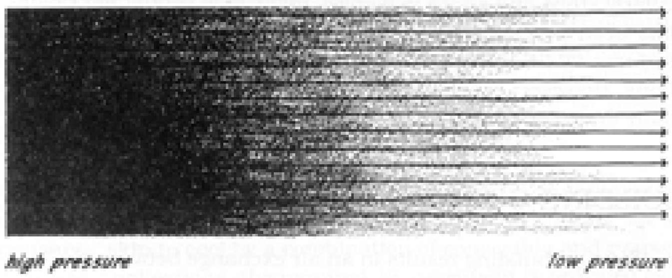
Each field of study will be briefly described, but make note of each diagram that address fundamental principles of physics and why we intuitively open the window when the room is too warm. Emphasis will be placed on Ventilation and Mass-Effect because Chicago climate conditions of high winds, and daily extreme temperature swings make these two studies pertinent.

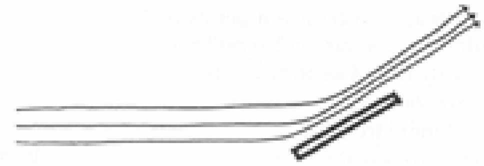
8.14.4 VENTILATION

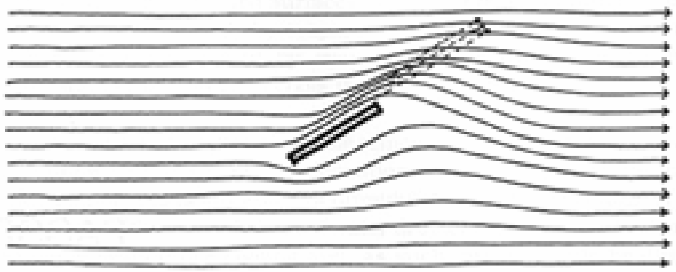
To understand ventilation we must understand airflow. The following principles are governed by physics, materialized by mathematics and the reasons why we feel cold or hot:

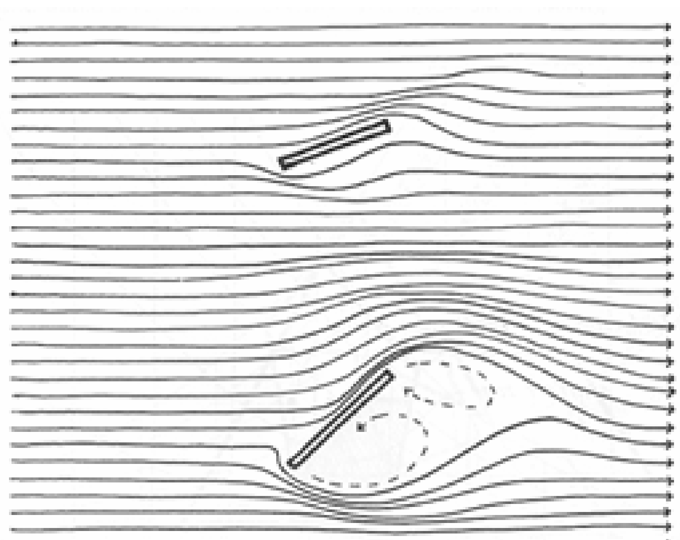
1. Ventilation Principle #1: Air will always flow from region of high pressure to low pressure.
2. Ventilation Principle #2: Air has mass and thus momentum whereby the air will continue to flow in the same direction until altered by and obstruction or adjacent airflow. Newton's First Law applies to this.
3. Ventilation Principle #3: The overall effect of wind at a site is so large that locally deflected airflow will eventually return to the direction and speed of the site wind.
4. Ventilation Principle #4: "Laminar" airflow is smooth with adjacent air moving in similar direction. "Turbulent" airflow results in an abrupt obstruction of laminar.
5. Ventilation Principle #5: The "Bernoulli Effect" causes a decrease in pressure when air is accelerated in order to cover a greater distance than the adjacent airflow. The classic example is an airplane wing.
6. Ventilation Principle #6: The "Venturi Effect" occurs when laminar airflow is constricted in order to pass through an opening causing acceleration in airflow.
7. Ventilation Principle #7: The "stack effect" is when the air in the building warms and become "lighter" than the outside air, and rises to escape out from higher openings.
8. Ventilation Principle #8: Cross-ventilation consists of an outlet and an inlet opening to allow for wind move through a building.

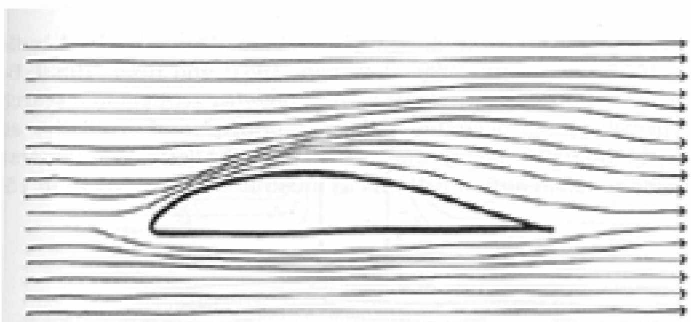
The following diagrams are ordered from left to right in chronological order. Diagrams (Moore, 1993)

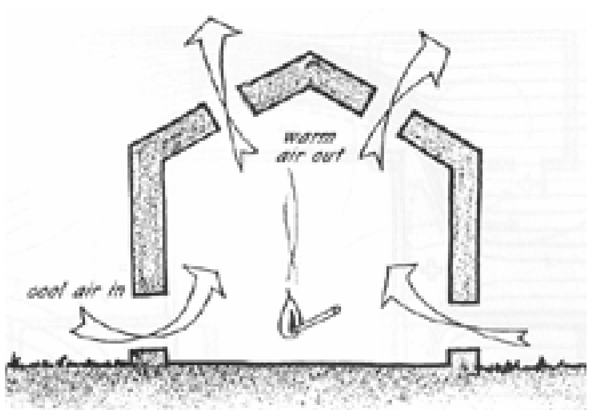

high pressure
low pressure

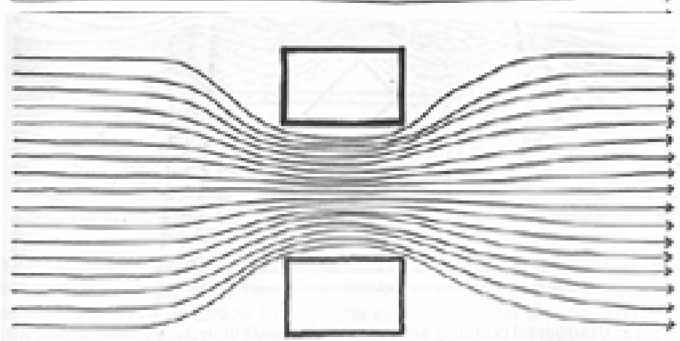


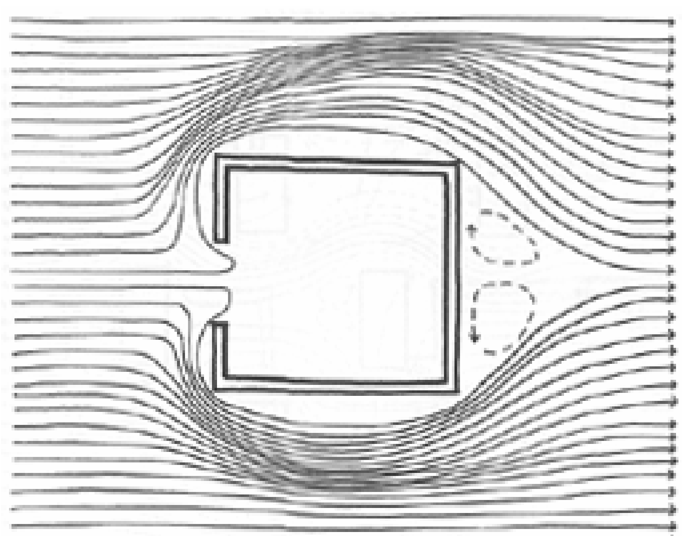







warm
air out
cool air in





Research conducted at the Texas Engineering Experiment Station in the 1950s developed a guideline for ventilation in buildings and devised these diagrams that embody the principles of passive cooling.

8.15 ACTIVE DESIGN

The basic concept of active design is a retrofitting of HVAC (heating, ventilation, and air condition) systems consisting of pipes, ducts, plumbing accessories, and ventilation shafts that are independently designed from the actual spatial experience. HVAC engineers require knowing the occupancy load, heat load, cooling load, openings and materials after the building was designed. In a form of numbers and codes, it is calculated to "fit" the necessary loads of the building. Aesthetically, it is not as attractive, and fire codes especially in the City of Chicago regulate heavily on exposed ducts and piping and the general fire protection of the building.

Most building in Chicago as well as the all across America relies heavily on centralized HVAC systems. The advantages to active systems is that it is on demand, easily replaceable parts, easy and quick installation, and economically feasible especially for large high rises needing mass-produced parts. The disadvantages are that once on demand, in a case of a house with multiple rooms there is no choice but to heat or cool all rooms as opposed to the one room in use. HVAC parts are cheap, disposable, and replaceable, but live shorter than the life span of the building. The source of energy comes from the municipal grid from a centralized energy plant far away from the actual daily lives of the people, losing consciousness of how much energy we use and the emissions that are produced.

Passive design is a method that has succeeded and need not require a backup system. However, many cases of backup active systems occur due to political and code safety measures as well as imperfections by the architect of the passive design techniques.

8.16 HOUSE OF THE FUTURE

8.16.1 SCHEMATICS

The first question is what design issues can solve a fundamental energy problem in a building? There are three major flaws in American homes today. Energy usage comes from *central* heating and cooling, and carbon-based energy appliances. We lose energy through infiltration from the creases of openings, such as windows and doors and where walls, floors, and ceilings meet. In a human anatomical sense, it is as if the body cannot sweat when overheated, or when the body is cold it cannot stay warm unless in constant motion expending extra energy and cannot breath when needing air. By resolving these design issues we should be one more step forward in living in a house with less energy loss and a more comfortable environment.

In typical American homes we have standardized the central heating and cooling system. This does not make sense in an energy standpoint. Why expend extra energy when a space is not being used? The flaw of central air is that it works by networking all the rooms together with one on/off system not allowing for selection of rooms needing heat or ventilation. Compartmentalizing, or zoning, of spaces can be implemented into the architecture. Then through passive design and smart technological monitoring systems to regulate temperature, humidity, air quality, and energy consumption, this will save on unnecessary and irresponsible use of energy.

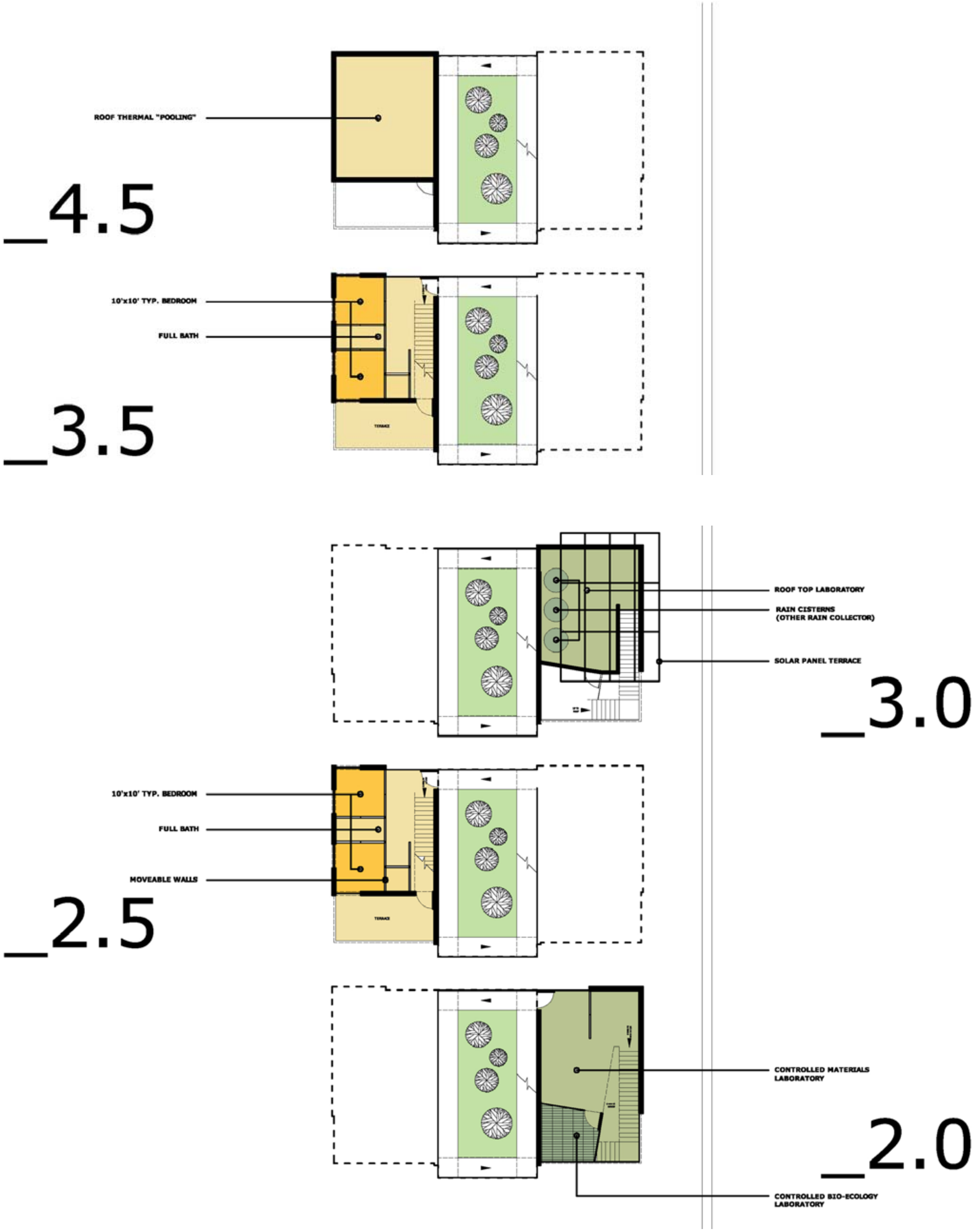
8.16.2 PROPOSAL

The integration of an informative exhibition of sustainability and the methodology of passive design infused with smart technology in conjunction with a demonstration of the next Chicago house should initiate common public interest.

Program:

Public Spaces:			
Exhibition space (ground floor)			250 sf
Exhibition space (basement)			300 sf
Lab + Garden (second floor)			220 sf
Private Space:			
(2) Bed	(4)	10x10=	400 sf/room
Full Bath	(2)	10x5=	100 sf
Kitchen + Common room w/ moveable walls			600 sf
Storage			200 sf
Laundry		10x15	150 sf
Misc:			
Mechanical + Electrical			200 sf
Hydrogen Fueling station (allotted for need basis)			600 sf
Thermal Chimney footprint + Landscaping			600
Total square footage:			**3620 sf**

According to the 2005 International Building Code, the House of the Future qualifies as a mixed-use occupancy for R-2 and A-3. In translation, R-2 indicates that the residents are non-transient (time and date of occupation is not specific), cooking facilities, and no more than 2 dwelling units. A-3 indicates a civic or public gathering place when accessory to an education group with less than 50 occupant load and a given space is less than 750 square feet. In addition, according to Table 503 of the International Code on Allowable Height and Building Area, we cannot exceed more than 3 floors and 15,500 sf/floor for the Exhibition space and for the residential space we can build up to 4 floors where square footage per floor is unlimited. To include the Chicago Building code, handicap ramp accessibility is incorporated by design as the primary circulation within the entire house. For fire safety, there are two means of egress in public areas.


ROOF THERMAL "POOLING"
_4.5
10'x10' TYP. BEDROOM
FULL BATH
_3.5
ROOF TOP LABORATORY
RAIN CISTERNS
(OTHER RAIN COLLECTOR)
SOLAR PANEL TERRACE
_3.0
10'x10' TYP. BEDROOM
FULL BATH
MOVEABLE WALLS
_2.5
CONTROLLED MATERIALS
LABORATORY
_2.0
CONTROLLED BIO-ECOLOGY
LABORATORY


30TH STREET
STATE STREET
KITCHEN + LIVING
TRIPLE PANE WINDOWS HIGH R-VALUE
ENERGY STAR RATED KITCHEN APPLIANCES
_1.5
FLOOR SAMPLE
RECEPTION DESK
THERMAL CHIMNEY
LANDSCAPE FOR NATURAL AIR FILTERATION
SAMPLE PARTITION WALL SYSTEMS
_1.0
SINGLE PANE LOW R-VALUE CURTAIN GLASS SYSTEM
INFORMATION BOOTHS:
THERMAL CHIMNEY
PASSIVE DESIGN
FACILITIES + APPLIANCES
RECYCLE
MORE GALLERY SPACE
MECHANICAL ROOM FOR HYDROGEN FUELING STATION (ACCESSIBLE FROM OUTSIDE ONLY)
AQUARIUS WATER SYSTEM
_B
ACCESSIBLE FROM FUELING STATION DRIVE-WAY

8.16.3 CONCLUSION

The House of the Future need not be an image of the Jetsons or Star Trek or an image of cheap materials to build a house that looks like scrap. "High-tech" scares older generations and instigates unease and discomfort; cheap aesthetics look poor and shanty also creating discomfort. How do we fuse both in a real and progressive design and become more conscious of the world around us, and the environment we live in? The House of the Future is an attempt to take a step forward in this process of regaining energy from nature and to potentially design for a prototype apartment housing for Chicago.

The House of the Future is not unique amongst the world of attempts and successes that have occurred in America and oversees. It is however, unique to the IIT campus. A point needs to be made that anything that is built based upon sustainability principles will not be unique. No more is there such a thing as a design epiphany that strikes everyone's chord in today's bottom-up society. Small ideas count more than ever where the application makes the idea Big.

The House of the Future embodies this characteristic with the vital design and sustaining element of the Thermal Chimney. It is the main circulation space, fulfilling pedestrians and those that are restricted in a chair; it is the ventilation shaft and heat collector where the air is constantly and naturally monitored and cleaned by the foliage planted in the center of the shaft, also for its natural beauty; it can also serve as a separation from the public to private, or it can potentially become two apartment complexes in the future. Well-insulated and installed windows, Energy Star rated appliances, recycled materials for paint, walls, and cork flooring, the Aquarius water system, compost toilets, toilets that flush down less water more suction, moveable and changeable interior walls are all smaller elements in support of sustainability.

When these design elements work cohesively and our human attitude of waste and recycling is made more conscious, then we are able to live in a more friendlier, comfortable environment. There is nothing to lose in the sense of looking forward. Financially, despite its initial setbacks in cost and installation, the capitalism of the American economy will have to comply with popular demand in the future driving costs down. Oil companies are now Energy companies because of the intense research in the realm of hydrogen fuel cell with a $1.6 billion federal funding and nanotechnology amongst the other green resources. With these issues in mind, architects, realtors, developers, and city officials need to come together and begin a new movement towards architecture of *decency*.

9 APPENDIX – SUSTAINABLE TEAM

9.1 UNIVERSITY BENCHMARKING

9.1.1 UNIVERSITY OF COLORADO-BOULDER: ENVIRONMENTAL CENTER

Transportation
- Free bike rental for up to 2 days
- $500 interest free loans for bike purchase
- Bike station and support services during appropriate weather
- Free bus card with university ID
- Links to bus schedules and routes on website
- Promotes hybrids and biodiesel cars including plans for fleet conversion
- Promotes the Boulder Carshare program (similar to IGo here in Chicago)

Food Wastes
- Want to start recovering organic waste for composting

Packaging Wastes
- On site center for collecting and processing recyclables
- Recycling center pushed to be part of master plan

Paper Wastes
- Excellent program that is fed off research, volunteerism and work-study
- Diversion potential analysis should be done
- Looks toward possible garbage collection rates as incentive
- Online tips and help in addition to training
- Special event recycling programs and fundraisers

Metal/Glass/Plastic
- Excellent program that is fed off research, volunteerism and work-study
- Diversion potential analysis should be done
- Looks toward possible garbage collection rates as incentive
- Salvaged materials are marketed
- Recycling = energy avoidance

Building Construction
- Construction waste recycling incorporated into the building program

Money/Capita
- Recyclables are marketed and sold - oversight by Environmental Center

Renewables
- Clean energy information on the website

Communication

- Provides training of staff and students and promotions to encourage participation
- Earth education outreach to PreK-12 kids
- Volunteer opportunities

Other

- Academic credit for research and work on recycling issues
- Green products guide
- Administration signed the Tallories Declaration
- Blueprint for a green campus
- Wide-ranging curricula on environmental issues

Website

- http://www.colorado.edu/cuenvironmentalcenter/
- Excellent site with significant thought and information
- Well constructed and organized
- Full links and get involved section

9.1.2 COLUMBIA UNIVERSITY-NEW YORK CITY: "COLUMBIA CONSERVES"

Food Wastes

- Promotes the NYC composting program
- General tips in the "Living Green" section

Metal/Plastic/Glass

- Color coded receptacles

Communication

- Recycling program implemented and managed
- Tips placed on the website

Others

- Goal is to implement and maintain environmentally friendly practices
- Wants to provide education and information to students, faculty and staff
- Started with the recycling program and has not gone much beyond that
- Does not address the difficulties with sustainability in the urban environment
- Does make good use of NYC as a resource

Website

- http://www.columbia.edu/cu/green/index.html
- Simple, but clean
- Does not have significant amounts of information
- Last updated 2002-2003

9.1.3 EAST CAROLINA UNIVERSITY

Water

- Has a long-term water reduction plan in effect. [Updated July 30, 2004] - 30 page document

People

- Use of recognition programs to get people involved - EcoStar Champion

Website

- http://www.ecu.edu/facility_serv/energy/energypage.html
- Fairly up-to-date

9.1.4 UNIVERSITY OF PENNSYLVANIA

Electricity

- Refit lights with energy efficient lighting, estimated to save 1.5 million in electricity in 5 years. Return occurs after the 3rd year.

Transportation

- redistributing parking spaces visibly to carpoolers
- designing flexible parking permits
- designing a mechanism to encourage car and van pooling
- promoting mass transit

Processed Water

- Penn uses an automated sprinkler system to water the most visible grounds of campus

Other

- Penn composts all yard wastes and shreds woody wastes into mulch

9.1.5 UNIVERSITY OF BRITISH COLUMBIA

Electricity

- Consumes 146 million kWh of electricity—enough to meet the needs of 14,600 homes.
- Energy Use- survey of what affects the consumption of energy and what you can do about it
- Led by an Energy Management Firm (EMF)
- Analyze and Evaluate
- Design and Engineer

Natural Gas

- Procure and Install
- Monitor and Verify

- Train
- See plans at http://www.sustain.ubc.ca/pdfs/plan.PDF

Transportation

- Programs for biking, carpool, telecommute, transit, campus shuttles
- Natural Gas Vehicles
- U-Pass
- Transportation Reports- http://www.trek.ubc.ca/

Portable Water

- Needs 836 million pounds of steam—enough to heat 3,500 townhomes for one year.
- Uses more than 4.2 billion liters of water—that's 450 times more than all the water in the Vancouver Aquarium.

Air Quality

- Emits more than 60 million kilograms of CO2 due to the energy requirements of campus buildings. That's the equivalent of driving from Vancouver to Halifax and back more than 20,000 times!

Paper Waste

- 112 million sheets of paper used in 1999
- Waste Management Department
- Waste Fact Sheet

Food Waste

- Composting Project

Metal/Glass/Plastic

- Litter Reduction
- History and Reports- http://www.recycle.ubc.ca/facts.html

Building Construction

- C.K. Choi Building- http://www.sustain.ubc.ca/pdfs/ckchoi.PDF
- Liu Center- http://www.sustain.ubc.ca/pdfs/liu.PDF

People Resource

- Campus Sustainability Office
- Identifies strategic opportunities for sustainability initiatives.
- Helps establish and maintain sustainability as a high-priority focus throughout UBC.

Money/Capita

- Facilitates consultation with the university community.

- Creates task groups to address specific issues such as social sustainability and waste reduction.
- Fisher Scientific Fund- provides $5,000-15,000 for creative sustainability solutions

Communication
- Training and Education
- TrekStep1- on the job sustainability training for students
- Sustainable Leaders Program

Others
- Sustainability Pledge
- SENSE- Student Electronic Network for Sustainability Education- provides information for courses offered that relate to sustainability

Website
- University of British Colombia- http://www.sustain.ubc.ca/

9.1.6 UNIVERSITY OF STANFORD

Electricity
- This school wasn't as good as I thought when I first surveyed it, so there isn't that much going on…it is mostly student led organization
- first year and a half focused on green building initiative
- future hope to have full-time sustainability coordinator and Green Fund to provide financial resources for future projects

Natural Gas
- The Guidelines for Sustainable Buildings- http://cpm.stanford.edu/process_new/Sustainable_Guidelines.pdf
- Overview
- Process Phases
- Technical Guidelines
- Funding, Decision Tools, and Metrics

Food Waste
- Recycling and composting- separation of food waste
- Increasing purchases of organic produce

Website
- Stanford- http://sustainability.stanford.edu/

9.1.7 BOWDOIN UNIVERSITY

Electricity

- Installing new light fixtures, timers
- Insulation of buildings(walls, roofs, etc)
- Replacing worn steam system components, heating systems
- High efficiency electric motors
- Installing storm windows
- Upgrade boiler, energy management system, and steam distribution system
- Consider steam distribution system that allows individual room control
- Evaluate purchasing a hand-held ultrasonic probe with graph recorder to measure steam use
- Installing more electrical, water, and steam meters to find how much is being used
- Ensure hot water systems are set to temp. between 120 and 130 F

Natural Gas

- Should consider using electric lawn equipment instead of diesel
- Have vanpools for transportation around the campus
- Do not issue parking permits to first year students
- Convert the Central Heating Plant boiler to burn natural gas or No. 2 fuel oil
- Carpooling
- Replace older college pick up trucks with modified golf cart

Water

- Replacing showerheads to low-flow ones
- Replacing dishwashers with water efficient models
- Evaluate low-flow water fixtures, could lead to frequent clogging, low shower head pressure
- Do laundry when there is a full load
- Irrigate in morning hours to reduce water loss to evaporation
- Use soaker hoses for shrub and tree watering
- Exchanging grass clippings and leaves for much with a contractor
- Choose shrubs, trees, and plants that are native, natural, and require the least amount of water
- Discontinue use of Urea for melting ice
- Place paper towel dispensers at individual tables

9.1.8 BALL STATE UNIVERSITY

Electricity

- Turning off computer monitors
- Replace incandescent light bulbs w/ compact fluorescent light bulbs
- Get energy efficient refrigerators
- Use more variable-speed electrical motors
- Advanced temperature controls

- More efficient lighting(timers on light switches and other technical fixes)
- Have better insulation and windows

Natural Gas
- Let college buy light fuel efficient cars
- Carpool
- Limit driving

Transportation
- Use public transportation
- Maintain correct tire pressure in vehicles
- Ride bicycles

Water
- Low-volume shower heads
- flush toilets
- waterless urinals
- Interior faucets should have aerators that combine air with water
- For gardening, drip irrigation
- horizontal-tub washing machines
- Have separate bins for recycling and regular garbage
- Have an agreement with garbage collectors to recycle

9.1.9 AUSTRALIA NATIONAL UNIVERSITY

Electricity
- Switch off campaign (Tips to save energy, encourage energy conserv.)
- Turn off monitors after 15min
- Office tips (http://www.anu.edu.au/facilities/anugreen/office/tips.html)
- heating tips (http://www.anu.edu.au/facilities/anugreen/office/heating.html)

Water
- Monitor total water consumption levels and provide sector-level reports of water consumption-where feasible.
- Develop water conservation awareness campaign for staff and students, integrated into other environmental initiatives
- Continually review water saving technologies and assess their suitability for use throughout the campus
- http://www.anu.edu.au/facilities/anugreen/admin/plan/water.html
- Drain Care (http://www.anu.edu.au/facilities/anugreen/stormwater.html)

Paper waste
- Desk side Recycling Box in offices, students dorm rooms
- Recycling and Reuse program
- scrap paper bins, to completely use papers

- Use environmentally responsible paper where practical
- Bins in offices, public areas, dorms, everywhere
- Office tips (http://www.anu.edu.au/facilities/anugreen/office/tips.html)

Metal/Glass/Plastic

- Campus wide promotion

Communication

- Email Announcement list w/tips and other info for sustainability

Other

- Email Discussion board, place to freely voice opinions
- Campus Volunteer time day (clean up campus do physical labor)
- See detailed Recycling, Transportation, Pollution
- Control and Energy Plans

9.2 RECYCLING PLAN

9.2.1 ALUMINUM/GLASS/PAPER/PLASTIC

- Have marked color coated bins for aluminum, glass, paper, and plastic with signs describing each bin above the bins. Place bins close to the entrance of each building, in the MTCC center court, eating areas, and places used for entertainment.

- In the dorms on every floor have a color coated cluster of aluminum, glass, paper, and plastic, with a large colorful sign above it promoting recycling and designating each bin as aluminum, glass, paper, or plastic.

- Every Fraternity and Sorority should have a cluster of aluminum, glass, paper, and plastic bins, with a representative from each house that is responsible for making sure that each of the bins are being used and emptied.

- Place color coated paper recycling bin in every office bay, computer lab, building lounge, and next to every copy machine and printer, with a big colorful sign above it making its presence known.

- Place color coated and labeled aluminum and plastic bins next to each vending machine with a sign above it designating the use of each bin.

- Paper recycling bins in each room that can be emptied into the larger bin in the hall when it gets full.

9.2.2 MISCELLANEOUS

- Have battery recycle bins in each dorm

- Recycle print toner cartridges

- Recycle old computer parts

9.2.3 PEOPLE ASPECT

- Mandatory online course for staff and faculty that has a set deadline and can be taken whenever they want. An online quiz is necessary at the end of the class in order to make sure that the class was not just skipped.
- Incorporate the recycling efforts into the sustainability education for the faculty, staff and students.
- Start a recycling club up with people who are excited about recycling and can make the campus aware and excited about recycling too.
- Have fliers, handouts, and posters up promoting recycling. In order for people to start recycling they need to be aware of it and feel like everyone else is doing it.
- Have a recycling competition between floor halls, Fraternities, Sororities once a year with a prize. For example, a pizza part for the winners.

9.3 WATER / AIR

9.3.1 GENERAL DESCRIPTION OF FUNCTION SERVED

- Ventilation in the buildings provide breathable air to people
- Water used for:
  - Cooking
  - Drinking
  - Showering
  - Transporting heat (steam)
  - Landscaping

9.3.2 NEED FOR SUSTAINABILITY ANALYSIS

- Proper ventilation in buildings increases productivity and is provides for better health conditions
- Air leaving the building is mainly used air depleted of all usable resources and is more harmful to the environment then the air brought in.
- Water wasted when plants are watered when it is raining.
- Water is wasted because of leaks in faucets, overflowing toilets
- Water leaving Campus is dirty and undrinkable

9.3.3 SUSTAINABLE PHILOSOPHIES RELEVANT TO THE TOPIC

Waterless urinals

- Purchase Price is cheaper than that of flush toilets, all that is needed is drain
- Anticipated Water Savings is 40,000 gallons per urinal
- Save on maintenance

Irrigation and rain sensors

- Saves water during the rainy seasons of Chicago
- Doesn't require manually turning off the sprinkler systems.

Water Filtration Systems

- Cleans and Filters used water and recycles them back into water usage
- More Expensive than buying water from the Chicago Board of water supply

Rainwater collector

- Collects rainwater and incorporates it into the water usage
- Takes up a lot of space

Air Ventilation

- When building new buildings, make it easy for natural ventilation

Green office plan

- Improve air quality in offices and atmosphere of offices by having plants and greenery around inside the building.
- Will provide for better productivity in offices, more oxygen supplied to the people
- Attractive
- Higher maintenance

Becoming a resource producer, not consumer

- Plants would clean the air out and the air that is pushed out of the building will be cleaner and better for the environment
- Water Filtration will help to clean the water out and help save the environment
- IIT can continue to plant trees and plants to beautify the campus, attracting people, while also cleansing out the pollution that is emitted.

Realizing economic payback over the life of the building

- Investing in a system that will efficiently and sufficiently ventilate the buildings will produce benefits through the productivity of workers. Better working conditions less drowsiness
- Less water usage, less money spent

Realizing energy payback over the life of the building

- Less energy used in filtering the water, whether the water is filtered on site or by the board of water supply

9.4 ELECTRICITY

9.4.1 MOTIVATION TO BE ELECTRICALLY SUSTAINABLE

Spending
IIT: $1,565,717 dollars at 4 cents per kWh.
If the same usage continues past 2007, it will be $3,131,434 at 8 cents per kWh

Usage
IIT: 40,000 MWh or 15 kWh/sq. ft or over 5,000 kWh/student-staff[20]
Boudoin: 8-9 kWh/sq. ft.[21]
University of British Columbia: Less than 3,000 kWh/student-staff[22]
Portland State University: Less than 2,000 kWh/student-staff[23]

Decreasing Pollution[24]
ComEd puts out 657 pounds of CO_2 for every 1000 kWh. IIT consumes 39,142,928 kW/h, so IIT is responsible for 25,716,294 pounds of CO_2 emissions per year. When one looks at how the plants absorb this, the equation is 14.7 pounds of CO_2 is absorbed during the annual growth of typical North American trees. So IIT would need 1,749,407 trees to take care of the pollution it creates.

People think that these power plants only affect the plants, but it also affects people. Because some power plants don't keep themselves up to date they are causing health problems. For example the Crawford and Fisk power plants are linked to 41 deaths, 550 emergency room visits, and 2800 asthma attacks every year.

[20] http://facilities.iit.edu/maps1.html
[21] http://www.bowdoin.edu/sustainablebowdoin/index.shtml
[22] http://www.sustain.ubc.ca/index.html
[23] http://www.sustain.pdx.edu/
[24] http://www.elpc.org/polCalc/faq.htm#ourCalcs

9.4.2 HOW DO PEOPLE GET INVOLVED

- Student/Faculty/Staff Participation – what can be done: Get everyone involved!
- Give specific tips to students, faculty, and staff on how to reduce electricity usage and how it will not affect them in a bad way.
- Turn off lights when leaving a room.
- Last person in office has to shut down all appliances.
- Conserve heating/cooling energy
    - Winter - set the heat at 68°F in winter
    - Summer - set air conditioning to 74°F in summer and dress appropriately.
- Turn off computer or at least the monitor when not in use.
- Buy Energy Star appliances.
- Install a compact fluorescent bulbs instead of incandescent bulbs

9.4.3 ALTERNATIVE SOLUTIONS

Wind Turbine

The wind turbine will produce ~18,000 kWh of electricity per year given that the hub height of turbine is at 10m. If it is mounted on a tower that will bring the turbine hub height up to 20m, this would increase the electricity to ~36,000 kWh per year. Please note that the hub height and power output are not linearly related even though it may appear so with the numbers provided. The brand of the wind turbine is TurboDynamix.

Photovoltaics

When dealing with photovoltaics, a thorough study has to be done of the building in which it will be placed on. There are many things that go into the placement of the panels. For instance the sun angle, and how to arrange the panels so that there is still room to walk on the roof.

Example of E1: E1 consumes 2,824,100 kWh of electricity per year (2003-2004 data). E1's flat roof is about 70,000 sqft. If the PV panels from Spire Solar covered the flat roof of E1, there would be an array of 350 kW of power. Take into account that the roof would be completely covered by panels plus some free space to avoid the shadows of one panel onto the other. In Chicago's conditions, the annual yield would be 463,513 kWh i.e. ~16% of the electricity consumed annually by the building. The number of panels for 350 kW is 4,666 if each panel is 75W. Each panel from Spire Solar costs $6 per watt (a 75W panel costs $450) + installation and taxes which will most likely double the cost) for a total of $13-14 per watt. This is the total cost without incentives. Incentives and rebates are able to dramatically cut the cost, especially for IIT that is an educational institute, (maybe 50-60% off).

The state of Illinois gives grants of up to $10,000 for using solar panels. All that is needed are a few requirements to make sure that the panels which are bought are actually quality products which will produce a good amount of energy.[25]

Green Tags[26]

There are companies who help sell green energy in order to help with the cost of producing this green energy. Almost any renewable energy installation that is connected to the grid and is recently installed(less than five years) can receive green tags. Any organization can earn from $1-$100 per mega-watt hour produced by any renewable energy sources. Green Tags accelerate the payback time of the renewable energy system by 10-50%.

9.5 FUELS

9.5.1 GENERAL DESCRIPTION OF FUNCTION SERVED

- Natural Gas feeds steam boilers in central plant.
    - Steam is transmitted through underground pipes to buildings
    - Heat transfer in the individual buildings is through steam-water heat exchangers.
        - Steam provides heating hot water.
        - Steam provides domestic hot water.
        - Steam provides cooling through absorption chillers.
- Natural Gas feeds package, heating equipment in some of the university buildings.
- Natural Gas feeds cooking equipment.
- Gasoline feeds buses used to transport students between the Main and Downtown campuses.
- Gasoline feeds vehicles used by the maintenance staff to maneuver around campus.
- Gasoline feeds trucks, planes and vehicles used to transports goods to the IIT campuses.
- Gasoline feeds cars, trucks and buses used to transport people to and from the IIT campuses.

[25] http://www.chicagosolarpartnership.com/index.htm
[26] www.mainstayenergy.com

9.5.2 NEED FOR SUSTAINABILITY ANALYSIS

- Steam production consumes natural gas which is a fossil fuel
- Fossil fuel burning produces carbon dioxide which contributes to global warming
- Steam production efficiencies require analysis
    - Transmission of steam through underground piping reduces efficiency of the process due to losses in the pipes
    - Steam-to-hot water heat exchangers add another layer of efficiency loss and require maintenance and replacement
    - Steam-driven absorption chillers require the operation of the steam generation plant during the summer
- Steam pipes in the underground unnaturally heat the frost layer during the winter
- Cogeneration facility is dormant due to economic advantages
- Gasoline powered vehicles contribute to greenhouse gas emissions
- Gasoline and oil consumption reduce reserves at a rate that cannot be maintained by production and extraction as the world economy grows
- Natural gas, gasoline and oil costs will present an increasing strain on the operating budget of the university

9.5.3 SUSTAINABLE PHILOSOPHIES RELEVANT TO THE TOPIC

Decarbonization:

- Goal should be no fuel burning to obtain heat for any purpose.
- Landscaping should be increased to provide a natural sink for carbon released through other sources.
- Procurement of materials should have requirement of decarbonization plan and goals.

Maximum efficiency and utilization:

- Any fuel used on campus should have the maximum amount of useful work generated from it.
- Fuels should be directed toward their most applicable use.

Becoming a resource producer, not consumer

- The hydrogen fueling station will transfer the wind and solar energy available on the IIT campus into stored hydrogen for use in providing electricity.

- Through the application of improving technologies, and a continuous plan of energy efficiency improvements, IIT will move from a net consumer of fuels and electrons to a net producer of hydrogen and electrons.
- By working with local companies and communities to bring the strategies and technologies available to turn renewable sources of energy into hydrogen and electricity, IIT will develop local communities that also develop into net producers.

Becoming a waste consumer, not producer

- Realizing that there will always be some form of waste, from food, packaging or paper use, IIT will implement waste recycling programs that seek to maximize the use of the use of the product either directly or indirectly.
- Food waste will be collected and stored to produce methane for processes, such as cooking, that presently work best with gas heat. This food waste will also provide compost for the growth of plants; these plants will provide CO2 sequestration, food and beauty. In doing this, a food waste program will allow IIT to become a net consumer of CO2 and food waste, while improving the atmosphere in the community for social interaction and learning.

Realizing economic payback over the life of the building

- Through the current estimate of fuel consumption at IIT, it is clear that fuel usage represents a significant economic impact on the budget of IIT.
- By moving toward self-sustaining energy production and utilization strategies, IIT will avoid the volatility and burden of fuel costs. This will allow the university to focus resources on the primary mission of education, and to accept more students from lesser economic backgrounds.
- In addition, by developing the technologies, and delivering them to the communities both around IIT and around the country, the university can realize an economic benefit both in reputation and technology delivery.

Realizing energy payback over the life of the building

- Implementation of energy efficiency plans will not only improve the operation cost, but will extend the useful life of campus buildings.
- Extending the useful life of facilities will improve the energy investment portfolio of the campus.
- When buildings and processes are developed, there is an energy investment made that needs to be realized for a system to be sustainable. IIT will develop technologies and institute programs that constantly seek to lessen the “first energy” investment as well as to reduce the “ongoing energy investment” associated with a building such that the buildings become “energy net positive” within their useful lifetime

9.5.4 SUSTAINABLE STRATEGIES TO BE EMPLOYED

1) Eliminate steam plant through the implementation of distributed geothermal heating, solar-concentrated heating, solar hot water and electric hot water heating.
2) Provide all cooling through electricity and passive means.
3) All campus-based vehicular transportation through hydrogen fuel cell vehicles.
4) Campus-sponsored "I-Go"-like, vehicle sharing program that uses hybrid and electric vehicles, then eventually hydrogen fuel cell vehicles.
5) Order goods from companies within a 500-mile radius as long as they are cost competitive. For those goods that are not within the 500-mile radius, evaluate the need for the good and identify possibilities to replace the good with another that can be obtained for the same or less cost within the 500-mile radius.
6) Energy and Sustainability Institute should work with businesses in the Chicago area to develop and follow through on decarbonization plans. Also, for goods that have to be obtained from outside of the 500-mile radius, work to develop companies in the area that can provide the material at or below the cost necessary.
7) As packaged heating equipment is replaced, use electrical heating where geothermal source is not available. When cooking equipment is replaced, provide electric cooking equipment or equipment that makes use of fuel from food waste streams. Electricity will be provided from renewable sources.
8) Implement heat recovery to increase ventilation without increasing the load on the central plant.
9) Develop carbon dioxide sequestration practices that will reduce harmful emissions from processes that have not yet been decommissioned, or cannot be decommissioned because a useful, non-consuming alternative is not available.

9.5.5 GOALS

- Eliminate steam plant by 2045.
- 50% of goods procured within 500 miles by 2010.
- 75% of goods procured within 500 miles by 2020.
- 100% of goods procured within 500 miles by 2030.
- All campus vehicles hydrogen-based by 2015.
- Eliminate natural gas-based cooking by 2030.
- Eliminate fuel-based heating in package equipment by 2025.
- Recycle 75% of equipment replaced.
- Energy and Sustainability Institute develops 10 new companies by 2015 and decarbonizes 100 by 2020.

- Sequestration of 150% of the emissions produced directly and indirectly by the presence of the university by 2030.
- Net consumer of waste by 2020.
- By 2025, all buildings developed on campus will have an "energy payback cycle" of no more than 10 years.
- By 2035, all buildings developed on campus will have an "energy payback cycle" of no more than 5 years.
- By 2030, IIT will be a net producer of energy for consumer, residential and commercial use.

9.5.6 IDEAS FOR FURTHER ANALYSIS

- Use CHP for burning natural gas to produce heat instead of steam boilers
- Wastewater hydroelectric
- Biomass fuels production from food waste for kitchen gas necessity

9.6 PEOPLE

9.6.1 DEFINING "PEOPLE" AS A RESOURCE

Sustainability not only refers to the environment and the economy, but is also inherently tied to society. In the past these three entities were treated separately, but are now being understood to be connected. The economy must now take into consideration that natural resources are valuable capital to be conserved and protected while the society at-large must now adopt changes in lifestyles, attitudes, expectations, behaviors, and values.[27] The figure below illustrates the interconnectedness of the three elements:

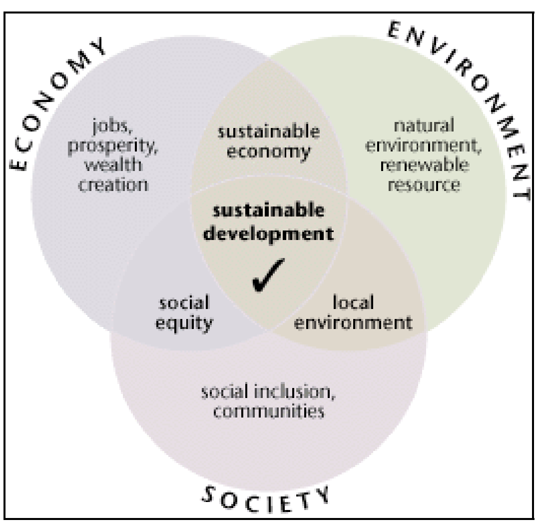


Figure 3: Three elements of sustainability

[27] **Global Tomorrow Coalition:** - http://www.iisd.org/educate/learn/a4.htm

Understanding “people” as a resource within a sustainable society can be broken-down into three main areas: leadership, education, and the well-being of all people. These three components are important for producing the initiative and making decisions (leadership), creating awareness of the need for sustainability and continual improvement (education), and providing an enhanced quality of life while maintaining equality (well-being of all people).

9.6.2 “PEOPLE” AS A RESOURCE: LEADERSHIP

9.6.2.1 REDEFINING LEADERSHIP FOR SUSTAINABILITY

Traditional approaches to leadership are usually based on control and power. As defined in the *Global Tomorrow Coalition Sustainable Development Tool Kit*, “the process is adversarial, the goal is winning, the decision-making structure is hierarchical, the ethic is competition, the ideal is individual and institutional independence, thinking is linear, decisions are by executive prerogative, often patriarchal, and consultation is without obligation”.[28] This approach is what has led to the compartmentalization of economy, environment, and society which created a clash of ideas and priorities. This system in the end lends itself to an attitude of “might is right” and the effects are seen in the depletion of natural resources, economic disparity among people, and racial inequality. In response to this traditional process, a revamped approach is necessary. The process should be exploratory where the goal is resolving problems, decisions should be inclusive and by consensus, ethics should be integrated and not competitive, the ideal would be collective well-being, thinking would be expanded, and consultation would be an integral part of the process.

One of the ways to bring forth a consensus in the community on sustainable development is through a local round table. A round table draws people from the community into a discussion of issues of the economy, environment, and their society. It is best to have an environmental audit performed before the discussion takes place to provide all parties with an understanding of the issues at hand and what policies are in place that do not comply with regulatory standards and also are not sustainable practices. Representation is an important aspect of these round table discussions and a list of important community members that could be represented is given by *Global Tomorrow Coalition Sustainable Development Tool Kit* (variations occur based on geographic location):

- agricultural authorities/farmers/ranchers
- businesses, industries, financial institutions
- conservation and planning authorities
- education officials (school boards, principals or presidents, teachers)
- environmental, wildlife, naturalist organizations
- consumer groups
- ethnic, cultural, faith communities

[28] http://www.iisd.org/educate/learn/gtc6a.htm

- fisheries, aquaculture
- forestry authorities
- government officials (local, county, state, federal)
- health and social services professionals
- labor unions, professional associations
- mining interests
- journalists, radio and television broadcasters
- real estate developers
- native peoples' communities
- recreation and tourism interests
- researchers, scientists, engineers, technical experts
- social interests, service clubs
- utilities
- youth, students, senior citizens

9.6.2.2 LEADERSHIP IN THE UNIVERSITY SETTING

Since the focus of this project is on sustainability at IIT, the leadership structure at the university level should also be understood. A structure which has been in place in many universities is an environmental management system (EMS). An effective EMS should be able to do two main tasks: (a) define the environmental and economic goals, policies and strategies of the organization, and (b) implement them.[29]

The initiative to begin such a program needs to come from the top level of the university and requires the support of all levels of people within the university for success. An EMS model that has been proposed is the Canadian Standards Association's EMS Model: CSA Z750.[30] The CSA model is comprised of four major elements and areas of action/decision-making:

[29] *D. Greening campuses, 1996.* http://www.iisd.org/educate/learn/campems.doc
[30] *D. Greening campuses, 1996.* http://www.iisd.org/educate/learn/campems.doc

Element	Area of Action/Decision-Making
Purpose	Environmental Policy Risk Assessment Environmental Objectives & Targets
Commitment	Environmental Values Alignment & Integration Accountability & Responsibility
Capability	Resources Knowledge, Skills & Training Information Management & Procedures
Learning	Measuring and Monitoring Communication & Reporting Systems Audits & Management Review

Table 1: Canadian Standards Association EMS Model: CSA Z750

The management structure most effective for sustainability at the university level is one where the initiative comes from the top executives, but heavily involves all stakeholders.[31] A sample structure for the university is given below:

A BASIC ENVIRONMENTAL MANAGEMENT STRUCTURE

BOARD OF DIRECTORS

SENIOR
MANAGEMENT
(Vice-President- Environment)

ENVIRONMENT COMMITTEE -INTERNAL
(Membership from cross-section of institution
including students)

MIDDLE
MANAGEMENT
(Environmental
Office or Officer)

STAFF/INSTRUCTORS

STUDENT GROUPS

Figure 4: Environmental Management Structure in University

[31] *D. Greening campuses, 1996.* http://www.iisd.org/educate/learn/campems.doc

9.6.3 "PEOPLE" AS A RESOURCE: EDUCATION

Inherent in the definition of sustainability is for environmental, economic, and social concerns to be not only for the present time, but for future generations. Since the concept is so broad and still exploratory there is not a set of hard guidelines, therefore, it is of the utmost importance that education be at the forefront of sustainability. The future depends much on making better decisions about resources and their uses and for that better information is needed. Thus, research will be a key part of the educational aspect. For example, obtaining an understanding of the full cost accounting of environmental resources used will be important for making decisions about how to use resources more wisely and efficiently. In the university, having sustainability infiltrate the curriculum will be key to creating a culture of sustainability within faculty and students that will go on to be influencers in society through the policies and attitudes of the future.

9.6.3.1 RESEARCH

The concept of sustainable research is complex and far-reaching. It involves different facets which are important ideas for sustainability to continue to advance. At the University of Virginia[32] a summary of research objectives for sustainability are given that provide a framework for understanding how they relate:

- Render visible current human practices damaging to the built and natural environments and to human and ecological health, and articulate the strategies of change that celebrate the concepts and the promise of a sustaining and delightful world.
- Be a living laboratory for the incubation and testing of innovative and sustainable practices and technologies.
- Engage industry to enable ethical and prosperous commerce to be an effective agent of change.
- Create tools to make possible the successful transfer and implementation of sustainable practices and technologies.

The major goals of research then from these objectives then are to uncover what practices are not sustainable and what are, provide a grounds for testing of new sustainable practices, to be an agent of information transfer to industry, and finally create the tools for change that are practical and feasible.

9.6.3.2 CURRICULUM

Sustainability, as with any movement that seeks to be incorporated into the social fabric for any lasting period of time, must make its way into the education system. From pre-collegiate studies to the university, a case for sustainability ought to be made for a lasting impact within the culture. According to Chernushenko in *Greening Campuses*, "the educational system that supports sustainability must have the capacity to teach

[32] http://www.ulsf.org/pub_declaration_resvol22.html

holistic thinking in addition to specialized knowledge. For this to be possible requires several things":

1) Those who develop educational policy and influence curriculum must recognize the need for interdisciplinary and transdisciplinary study and the integration of sustainability thinking into all programs and courses.
2) Instructors must be encouraged to and supported in developing such curricula.
3) Students must be introduced to sustainability concepts as they relate to their course of study and, where possible, to their post-graduation lives.

This integration of sustainability into curricula is directly related to the initiative of the leaders and is thus directly tied to an effective environmental management system.

An example of what a course in sustainability would look like has been developed by Lazlo Pinter of the International Institute of Sustainable Design (IISD). The title of the course is "Sustainable Development: Tools and Methods in Practice". The course objective is given as:

"The main objective of this course is to help apply the principles of sustainable development by understanding the possibilities, constraints and interactions of its decision-making tools and practices. Students will gain familiarity with applying tools and methodologies in a variety of multistakeholder, multi-objective environments. We will use case studies from the public and private sectors as illustration and to enhance your confidence when dealing with sustainability in real-life situations."

The class itself consists of seminars, lectures, assigned readings, and case studies to help students better understand the concepts. Ultimately, the goal in education for sustainability is to have all of the curricula and accordingly all the disciplines incorporate sustainable ideas and practices within their frame of thinking.

9.6.4 "PEOPLE" AS A RESOURCE: WELL-BEING OF ALL PEOPLE

As the understanding of the interplay between the environment, economics, and society grew, a greater need to meet basic human standards of living along with social equality and justice concerns arose as well. The goals of sustainability in the end ought not lose sight of basic human rights and principles, rather they must uphold and protect them. One of the groups that has concerned itself with issues of social policy, which can be summed up as the "well-being of all people", is The World Conservation Union (IUCN). They have come up with ten major categories where sustainability and social policy tie together:[33]

[33] http://www.iucn.org/themes/spg/themes.html

1. **Social Equity in Conservation**[34]
   "Social equity refers to the right of everyone to enjoy a rewarding quality of life, as well as to the expectation for fair and equitable distribution of the benefits and costs among different social groups and individuals for conserving natural systems."

2. **Gender Equity in Conservation**[35]
   "Adopting a gender perspective means focusing on both women and men and their relationships with each other and natural resources."

3. **People and Protected Areas: Tenure and Participation**[36]
   "Sustainable use of natural resources cannot be achieved unless fair access and control to natural resources are available to local people, without discrimination based on gender, class, ethnicity, age or other social variables. There is a need to empower communities and local users, recognizing their rights and responsibilities, ensuring their means to sustainable livelihoods and human development."

4. **Indigenous Peoples and Conservation**[37]
   "These resolutions stress the need to enhance participation of indigenous peoples in all conservation initiatives and policy developments that affect them. Furthermore, they recognize that indigenous peoples possess a unique body of knowledge relevant for the conservation and sustainable use of natural resources."

5. **Cultural Diversity and Traditional Knowledge in Relation to Biodiversity Conservation** [38]
   "Support conservation of the world's cultural diversity and of traditional ecological knowledge of indigenous and traditional peoples."

6. **Poverty Alleviation, Rights, Human Wellbeing and Livelihood Security**[39]
   "IUCN wants to make sure that all its programms are responsive to the need for addressing poverty issues; hence poverty and livelihood security concern the whole organization. Social elements of IUCN's poverty-related work worldwide include community empowerment, participatory approaches to promoting change in governance, rights and cultural identity, and strengthening the role of women in decision making."

7. **Social Aspects of Environmental Security and Vulnerability**[40]
   "There are a wide range of issues related to environmental security and vulnerability. IUCN is concerned with the promotion of peace and human rights, and empowerment of vulnerable communities such as indigenous peoples, as these are fundamental conditions addressing environmental security."

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[34] http://www.iucn.org/themes/spg/themes.html#socialequity#socialequity
[35] http://www.iucn.org/themes/spg/themes.html#gender#gender
[36] http://www.iucn.org/themes/spg/themes.html#parks#parks
[37] http://www.iucn.org/themes/spg/themes.html#indigenous#indigenous
[38] http://www.iucn.org/themes/spg/themes.html#cultural#cultural
[39] http://www.iucn.org/themes/spg/themes.html#poverty#poverty
[40] http://www.iucn.org/themes/spg/themes.html#security#security

8. **Human Rights and the Environment**[41]
   "Full respect for human rights, is connected with the right to a decent quality of life and to other related rights recognized in the International Covenant on Economic, Social, and Cultural Rights."

9. **Social Aspects of Environmental Governance**[42]
   "'Good' environmental governance should be based on the principles of":
   • Transparency - openness in decision making
   • Access to information and justice - accurate and open communication, and effective exercising of environmental justice
   • Public participation - genuine involvement in decision making
   • Coherence - a consistent approach within a complex system
   • Subsidiarity - decisions taken as closely as possible to the citizen
   • Respect for human rights - civil, political, developmental and environmental rights
   • Accountability - for economic, social and environmental performance

10. **Population Dynamics and the Environment**[43]
    "Develop strategies that inter-relate population control, production and consumption policies and sustainable use to conservation of the environment".

The complexities of social policy issues are just as great, if not greater, than the issues of limited resources and the scientific aspects of sustainability. Yet, it will take an interdisciplinary approach and a mutual respect for all parties involved to reach decisions. If in the search for a sustainable future people have lost basic rights and been marginalized, it would be considered a failure by the very definition of sustainability—which is to bring forth social equity.

9.6.5 AUDITING IIT: "PEOPLE" AS A RESOURCE

Auditing the Illinois Institute of Technology will be completed in the coming weeks as it relates to "people as a resource". The "Campus Environmental Audit Response Questionnaire" will be used as an initial guide for the process.[44]

[41] http://www.iucn.org/themes/spg/themes.html#rights#rights
[42] http://www.iucn.org/themes/spg/themes.html#governance#governance
[43] http://www.iucn.org/themes/spg/themes.html#pop#pop
[44] http://www.adm.uwaterloo.ca/infowast/watgreen/projects/audit/response.html