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Leadership in Sustainable Agribusiness, Innovation, and Solar Thermal Renewable Energy: Opportunities for Sustainable Agribusiness

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ABSTRACT and Case Discussion Guidelines

John Hollick, P.Eng, is the President of Conserval Engineering, a private company in Toronto with subsidiaries in Buffalo NY and Paris France. John is a Professional Engineer, an inventor, and a business person. His technology, SolarWall (SW) is one of the top 2% solar technology firms world-wide, as assessed by the US Government. It captures and makes conveniently available a very high proportion of solar radiation, over 90%, dwarfing the efficiency of photo voltaic panels (PV). The original technology is extremely sustainable requiring almost no maintenance, offering long term production with a life expectancy of several decades. Over the years, John has obtained several patents for his inventions, the last one awarded in December 2014. These patents reflect the continuous development of new technologies, new solutions built around the SW. Today SW offers solutions combining PV and thermal energy capture, or systems that may work to provide heating in the cold season and cooling in the warm season. All of the technologies are very cost effective.

The case concerns possible agribusiness applications of one or more of the technology solutions developed by Conserval Engineering: the case users have been retained by John – thanks to their knowledge of agribusiness in their own country – to suggest possible applications of these technologies to local agribusiness industry. Mr Hollick has agreed to share a recent proposal (2010) to apply one of these technologies to solve the energy requirements of *Food in Italy*, while providing a significant carbon footprint reduction. He thinks that the analysis of this proposal and the material presented in the appendices will provide an opportunity to reflect on the potential of his technology and on the complex nature of the decision making process, and on some distortions resulting from public subsidies to some but not all sustainable technologies. That notwithstanding, the reflection on the first part of the case should reflect on the multiple gains that can be achieved with the adoption of these technologies in the specific local context.

So, the case users armed with their reflections, their knowledge of agribusiness in their own country, and the short and essential description of the different technologies offered by Conserval Engineering, are asked to provide an illustration of what they consider the most promising applications to their own country's agribusiness industry. Yes, the case does not provide actual costs of the different technologies, other than for the proposal to *Food in Italy.* At the same time the case users can certainly provide a qualitative perspective, based on the fact that these are the most advanced and cost effective technologies in the solar thermal industry.

Part 1 of the case will primarily be structured around the discussion of these practical application to the local agribusiness.[*] Part 2 will focus on business sdevelopment. In using the case in teaching, parts 1 and part 2 could be linked to two different days.

Keywords. Agribusiness, Solar Energy, Innovation, Sustainability, Carbon Footprint Reduction

[*] The Competition at the Agribusiness School of the University of Buenos Aires saw this case discussed by several teams from different Latin American nations. This provided for very interesting original suggestions.

Part 1 of the case

1 The original invention

SolarWall technology (SW) is the brainchild, the invention, of a brilliant Canadian engineer, John Hollick, of Toronto, Canada. John dedicated his career to developing sustainable solar energy-based solutions to the energy needs of modern buildings. The sustainability argument is quite compelling: government programs emphasize the reduction of the carbon footprint and greenhouse gas (GHG) emissions; this is very important of course, but a much smarter idea is not to produce those emissions and still have abundant energy for our everyday life.

John's objective has always been clear, simply put: to invent and apply solutions that are sound and simple, very cost effective, with optimal engineering and limited moving parts or complex electronic to make them low maintenance and sustainable, in difficult environments. Most importantly, these solutions are very cost effective and environmentally sound, as they are designed to capture and harness the energy of the sun and use it to replace heating fuel, diesel, natural gas or electricity to satisfy the heating needs of a building.

SolarWall is the core technology John invented. It is simply impressive, managing to capture more than 90% of solar radiation, and converting it to usable heath. This often goes a long way to making the building self – sufficient for its heating requirements. Consider this: when adopted during the initial construction phase (as opposed to a building retrofit) this technology actually reduces construction costs compared with conventional building techniques and provides essentially free energy. Brilliant, simply brilliant.

John's interest in this case is well described in his email and presented in Appendix A.1. The SW technology is briefly described in Appendix A.2. SW is very simple and requires minimal maintenance. The US Government has assessed it to be of world class quality, ranking it in the top 2% of solar technologies. The recent induction in the American Society of Mechanical Engineers Exhibition, Appendix A.3, confirms its worth.

The SW technology is very flexible. The US Air Force, for example, has adopted it for many bases in cold weather locations, to serve their mandated objective to reduce its carbon footprint. A number of large industrial and commercial building have adopted it for the same purpose, and the flexibility of the technology is clearly demonstrated by the fact that it can be found on the most different buildings, for example: on US Air Force bases in Alaska, on most new chicken barns in Ontario (Canada), on university buildings, on industrial plants, in some cases still working well after 30 years of productive life. John has been quite successful in inventing new products that take advantage of the technology and address specific needs of clients, joining SW and new tools, such as solar panels, or modifying SW to optimize it for new innovative applications.

Recent innovation

John is a very creative inventor. Appendix B.1 to B.5 present a brief description of some of the major applications based on SW or on new inventions derived from it:

- B.1 presents the second generation SolarWall solution;
- B.2 presents SW and LEED, outlining possible points that could be earned from SW in a building seeking LEED certification;
- B.3 presents SolarDucts to install a SW based solution on roof tops;
- B.4 presents SolarWall PV/T, combining photo voltaic panel to produce electricity with the traditional SW technology, which provides the additional benefit to reduces the temperature of the PV panel therefore increasing its efficiency;
- B.5 presents Process Drying, of more direct potential interest for agribusiness.

Appendix C.1 presents NightSolar, Solar Cooling System, the most recent invention by John, awarded a US patent in December 2014 (see appendix C.2), a significant innovation combining in a roof top installation both summertime cooling and wintertime heating.

Appendix D presents an application of SolarWall PV/T addressing the specific needs of *Food in Italy*. It is presented later in this document to illustrate the objective complexity of the decision process to adopt a SW-based solution, but will also lead to the appreciation of some compelling reasons to do so. Of course, the go/no go decision, whatever it will be, will be driven by client-specific factors. That notwithstanding, reflecting on this actual business proposal will facilitate the understanding of the many issues to be considered when considering the SW technology.

Over the years, SolarWall has grown from the original head office in Toronto, to opening a subsidiary in Buffalo New York in the US, and in Paris France. The company is growing internationally, with a sound engineering-based business model: to develop practical and cost effective solutions to producing cost-effective sustainable energy, with a very low carbon footprint.

SolarWall is always looking for innovative applications. In agribusiness it feels that possible applications may include fruit and crop drying, including coffee and tea, tanneries, specialized livestock barns, processing plants and large office buildings … the sky is literally the limit.[*]

2 Expanding the original SW inventions

Food in Italy

SolarWall is ideal for heating in a cold climate, as it can capture more than 90% of all forms of solar radiation converting it into heat which is often sufficient to make the building largely self–sufficient in terms of its heating requirements. How about the more sophisticated needs of a Renzo Piano designed building requiring heat, cooling and a lot of electricity? Well the answer is in the proposal for *Food in Italy*: integrating SolarWall PV/T technology with solar panels and placing it all on the roof of the structure, making this almost invisible form the adjacent piazza, and of course respecting all mechanical services already on the roof. This responds to a specific objective: to address heating needs during the cold season and electricity requirements throughout the year, and illustrates the fact that the flexibility of this technology allows it to be installed on designer buildings, not just industrial "boxes".

New solutions for intermediate climate

Appendix C.1, as noted above, presents a new application of the Solar Wall technology, designed to respond to energy saving opportunities in an intermediate climate where cooling needs are important in certain periods of the year, and heating is required only in the winter. In essence, this is a dual purpose solution to the needs of cooling and heating in different seasons. According to John (see email in Appendix A.1) this may represent a potential solution to some Agribusiness applications.

3 John's objective

What John needs is an assessment of the market potential for agribusiness applications, and has hired your group, currently working in a leading university program, as consultants to should develop innovative ideas and potential applications. After all, as John says, one never knows where the next sustainable application may be. Armed with your reflection of *Food in Italy*, your knowledge of agribusiness in your country, and the short and essential description of the different technologies offered by Conserval Engineering, you are expected to provide an illustration of what you consider the most promising applications to agribusiness in your own country. Yes, we do not have actual costs of the technologies, other than for the proposal to *Food in Italy.* At the same time you can certainly provide a qualitative perspective, based on the fact that these are the most advanced and cost effective technologies in the solar thermal industry.

Please review the experience of *Food in Italy*, described in the remaining part of this case. Reflect on the questions in this document, and reflect on potential applications to agribusiness you can visualize based on your own experience in your own country. For the first part of the case discussion you will need to discuss your reflections on Food in Italy dilemma and, based on these reflections, and considered the significant flexibility of SW, for example the innovation presented in Appendix B.1 to B.5 and C.1, you will be called to present your assessment of the potential application of SolarWall technology in agribusiness in general and in your country in particular. You are asked to first reflect on the dilemma of *Food in Italy*, then extrapolate your reflection and SW's flexibility to assess its potential for agribusiness, using the six questions at the end.

[*] SolarWall is active in carefully screening potential markets, not just agribusiness. For example, a lot of work is currently being done in China exploring opportunities for partnerships with local reliable business, in real estate and construction.

4 The Food in Italy proposal

On a foggy November afternoon, Carlo Rossi, president of Food in Italy (FI), a fully owned subsidiary of a large food multinational group, was on his way to an executive meeting called by the newly appointed CEO of the multinational group. The meeting was the first called by the new executive, who wanted to become better acquainted with FI activities, its recent and projected future profitability, and its plans for the future, with a special emphasis on innovation. [†]

Rossi was focused and motivated: this meeting was going to be an excellent opportunity to gain approval for a proposal he had recently reviewed regarding the installation of a leading solar technology at FI's headquarters. He was sold on the merits and broad potential of this world-class technology which, he reasoned, had multiple applications for FI and, much more relevant, the multinational group. It only had to be tested once, and it would then fly throughout the group. In a sense, then, the smaller investment by FI was in reality a pilot for a potentially much larger adoption by the entire group. Rossi wanted to receive approval to invest in this Canadian solar technology which would significantly reduce net energy consumption at the corporate head office, significantly increasing the building's energy self- sufficiency, reduce its CO_2 Equivalent (CO_2e) emissions and become a show case opportunity to further enhance FI's image as sector leader in terms of product quality, business and environmental innovations, and commitment to overall triple bottom line sustainability.

As president of Food in Italy for the last 8 years, Rossi had nursed the growth of the company along three main product lines. First and foremost was the export of top quality Italian typical foods. FI was selling its "Italian Excellence" products only through carefully selected retail stores; its portfolio included important cheeses like Parmigiano Reggiano "Masterpieces of Tradition"; Prosciutto di Parma DOP aged 18 months; several regional Extra Virgin Italian Olive Oil "Every region in Italy has its own flavor"; Balsamic Vinegars "The precious gift of time"; Artisanal Compotes "a creative approach to traditional ingredients"; and Italian Appetizers and First Courses "Authentic Italian flavors". These products were carefully sourced by FI, produced under precise contractual obligations focused on quality and tradition, and exported throughout the world. The main market was the US, followed by Northern Europe, and Japan. China was starting to emerge. Second, was a small specialized food media operation, publishing high quality recipe books specializing in regional Italian foods. Most of the publications were aimed at English-speaking clients, primarily living North America. The third group of products included culinary training courses and culinary tourism in Italy. This was the most profitable segment of the company, attracting people to the head office of the company housed in a Renzo Piano designed building with superior facilities including 4 large teaching kitchens and an architecturally stunning auditorium with a removable complete show kitchen and advanced multimedia support. Business was brisk, and consisted of an ever growing flow of high net worth tourists from the US and increasingly from China and other Far East countries. Clients ranged from well-off professionals to eccentric high–net-worth individuals who expected to move around Italy by private helicopter. Rossi was delighted to accommodate even the most expensive tastes and needs. Not surprisingly, this was the most profitable product line for FI.

Rossi had always pushed FI to be the top quality player in all that they did. Particular care had been devoted to promoting the image of FI as champion of Italian food tradition, intended as the sharing of a multi-sensorial cultural experience of the highest quality level, a sustainable tradition based on the simplest and purest of ingredients and excellence of Italian typical food tradition. Indeed, he had grown the company into its industry-recognized leadership position. FI was recognized as the innovator in this segment of food business, but could not ignore the reality of an increasingly crowded market, with several challengers broadly arising from the same traditions and commitment to excellence that constituted FI's own foundations.

Rossi was reasonably satisfied by FI's recent sales milestones: in 2011 revenues were expected to exceed 30 million Euros, with food exports reaching 24 million Euros; revenue from the publishing operations reaching 1.5 million Euros; and the advanced kitchen training and organized regional food tours revenue expected to surpass 6.5 million Euros. As noted, FI was a fully owned subsidiary of a family-owned large multinational food processor, a world leader in their own product market. Consolidated sales for the entire group were in excess of 6 billion Euros in fiscal 2011. Rossi was very well connected and had earned the full trust of key members of the family, and as such, the early years of FI were quite positive. The company was growing, much like in an incubator which nourished and protected it. This provided much needed longer term breadth of planning and leadership decision making.

[†] Please refer to Appendix D for a complete offer and Appendix E for a Board presentation.

The executive meeting started on time and the atmosphere was quite friendly. The senior spokesperson for the controlling family told Rossi that the family felt Food in Italy had reached the age of majority and that it was time FI learned to walk with its own legs. True, FI was a key star in the multinational stable of fully owned subsidiaries, fulfilling a strategic function of promoting traditional Italian foods internationally, but it was also time that FI started to contribute more in terms of its own profitability. The controlling shareholders were committed to FI and told him that the company would be able to rely on basic services (management of accounts payable and accounts receivable, as well as warehousing and transportation in Italy) that would be provided at cost by the mother company. The multinational would remain as lender to FI and satisfy its financial needs, provided it qualified under the standard commercial requirements the family expected of all subsidiaries. These standards were defined by precise ratios and other quantifiable, objective indicators that Rossi knew well. In fact he had been a key person in the executive committee that had defined them. The standards were valid for all companies, world-wide, and more than a few executives had been held accountable for failing to meet them; some had been terminated once the family had concluded that a leadership replacement was necessary to rectify the situation. The meeting progressed well. There was general agreement on all issues discussed.

Rossi, prudently optimistic, felt good about the opportunity to present his proposal in what he felt was a truly remarkable innovation. In preparation for this part of the executive meeting, Rossi had already shared with his colleagues the original proposal received by the Canadian company (Appendix D), and had prepared a few slides to “pre-sell” his innovative ideas (Appendix E).

Earlier that week, Rossi, prudently hesitant about the Board’s final decision, had turned to a team of interns from the local university and asked them to consider all the material and commit to a recommendation for or against adoption.

He now wondered whether the Board would see it that way, and of what hot buttons to push in his presentation.

He was considering many thoughts, including:

- a- What strategy would best present the key advantages of the technology, for FI?
- b- Is there any value for FI to pursue the reduction of its CO_2e footprint? And if so, should FI maximize cost reduction, energy production, brand visibility?
- c- To what extent could this technology be valuable for other corporate users within the group?
- d- What PR advantages, if any, could be expected in leading export markets from the installation of this technology on FI’s headquarters?
- e- Would the proposed technology meet the group’s stringent financial requirements? Could the innovation be justified, given the general financial constraints currently set by the group?
- f- Finally how could Rossi best argue for adoption of the proposed innovation and providing sound considerations for his recommendation?

Part 2: Case Discussion Guidelines

Attributed excerpts of part 1 submissions and presentations were provided to Engineer John Hollick who was impressed and indicated, who knows, he may be in touch. The second part of the case presents a “list of chores” for part 2 of the competition. As normally done at the Leadership in Sustainable Agribusiness, the part 2 case is very short and to the point. As general suggestion, the part 2 discussion documents should start from a quick summary of the key conclusions from part 1 and quickly move to address the additional points from the part 2 case.

The exhibits and reading material are the same for part 1 and part 2.

5 The business developments

John and Duncan have received and reviewed the submissions produced in part 1. They are truly impressed by the sound business sense and thoughtful analysis.

The submissions suggested and properly argued for possible applications of (one of) their technology(ies), and have illustrated and ranked the potential benefits from the different applications. Now it is time to be ready to develop a compelling business strategy to enter the agribusiness market in your country.

John and Duncan have analyzed all part 1 submissions and have assessed the proposed applications to identify possible technical constraints and possible financial challenges; they are impressed and have asked to proceed with the development of a strategy to enter the specific domestic agribusiness market with the application of a given SolarWall technology, as recommended in part 1.

The task is to complete the submission from part 1 with this strategic business plan.

As before, John and Duncan do not want to receive a consultant's report. They will especially appreciate a strong analysis of your submission that addresses its strengths and weaknesses. They do not expect a sharp and complete business plan. They expect to see the capacity to reflect and argue any recommendation; they want to know what is recommended and why it is recommended! They want to be convinced; they want to be able to feel they can trust the presentation, given the demonstrated capacity to address the questions, challenges and opportunities in this case; the capacity to integrate the information in the case with the professional knowledge of agribusiness in each country; the capacity to efficiently present the key findings and recommendations.

For convenience and complete transparency, John has asked to provide again the text of appendix B.1 to B.4 and C.1, and the original submission to Food in Italy (modified to protect privacy).

He has asked for part 2 submissions addressing these questions:

a. Which invention is of more direct potential interest – based on your results – to agribusiness in your own country? Why?
b. What niche can be filled by SolarWall (or other derived technologies)?
c. Is there any other, perhaps simpler, technology that could solve this need?
d. What benefits stem from applying John's invention? Are these just financial benefits or do they have additional, perhaps more relevant, "soft" benefits? In essence, is it going to be just an issue of cost savings, or there are new benefits over and beyond cost savings that may be captured?
e. Finally, what is the most effective manner to ensure that John's invention may in fact be adopted by the identified agribusiness? What should happen in the next one, three, and five years?

You have a clean deck, just draw your strategy.

Note

This case is based on a true business situation, and was prepared to provide material for class discussion; it is not intended to illustrate effective or ineffective handling of a managerial situation. The author may have disguised certain data to protect trade secrets and preserve confidentiality. Interested instructors at educational institutions may request access to a teaching note and additional material by contacting the editor of the IJFSD.

Appendices

Leadership in Sustainable Agribusiness, Innovation, and Solar Thermal Renewable Energy: Opportunities for Sustainable Agribusiness

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List of Appendices

Appendix A

Leadership in Sustainable Agribusiness, Innovation, and Solar Thermal Renewable Energy: Opportunities for Sustainable Agribusiness

A.1. Email from John Hollick to the case author, as the case was finalized in early 2015,
A.2. Short Description of the SolarWall Technology
A.3. SolarWall: Recent recognition from inclusion in the American Society of Mechanical Engineers.

Appendix A.1:
Email from John Hollick to the case author, as the case was finalized in early 2015

Hi Francesco,

The program sounds very interesting. Duncan and I talked about this and as he is more familiar with the *Food in Italy* proposal, he will make himself available for the possible call.

I was in Buenos Aires several times in the mid to late 1990's when the peso was on par with the US$ and it was still difficult to get SolarWall projects for heating of buildings due to the short heating season compared with Canada.

Their cost of natural gas is also very low and seems to be subsidized so more opportunity for displacing propane or diesel fuel or electricity.

There should be good potential in agribusiness for solar drying or process heating as long as they can maximize the number of months of usage. I did explore some coffee drying projects in Brazil but with only a two month drying season for coffee beans, those projects were not operated long enough to get a decent return.

One area that could be ideal is in the tannery industry where they have to wash and dry leather goods and at temperatures below 40 C. Our dealer in Mexico has done a number of these types of installations.

Another possible area of interest is for cooling and my latest invention is called NightSolar where our roof mounted panels, when operated at night, can cool ambient air by as much as 5 C below ambient from sunset to sunrise. During the daytime, the solar heat is collected in the usual way and it also shades the main roof which reduces the cooling demand for that building. A white paper on NightSolar is attached.

Good luck with the program and let us know how it turns out.

John

Source: private email from the Inventor to the author of the case.

Appendix A.2: Short Description of the SolarWall Technology

What is Solar Air Heating?

The SolarWall® technology is a solar air heating system that heats building ventilation air and improves indoor air quality. SolarWall systems deliver huge life-cycle cost savings and require no maintenance over their 30+ year lifespan. They displace 20-50% of the traditional heating load & corresponding GHG emissions. The result is a superstar technology in terms of its economic & environmental impact. SolarWall systems can be used on walls or roofs for a variety of uses and applications, from solar heating buildings, to agricultural and manufacturing process drying. Architects and engineers enjoy the fact that the SolarWall technologies generate up to 10+ LEED® points and are easily integrated into the building envelope.

Our CO_2 Reductions

SolarWall systems offset conventional heating fuels and therefore offer a direct source reduction of GHG emissions. To date, Conserval has supplied & designed millions of square feet of SolarWall® systems all around the world! This means that SolarWall systems are reducing tens of thousands of tons of CO_2 each and every year; helping our clients to cost-effectively achieve GHG emission reductions.

About Conserval Engineering

Conserval has been delivering custom engineered renewable energy solutions to an extensive client base throughout the world for over 30 years. We are the company that developed and commercialized solar air heating for commercial, industrial, institutional, military, multi-residential and agricultural applications. The technology we invented, known as "SolarWall", was praised by the U.S. Department of Energy as being in the "top two percent of energy related inventions", with a solar efficiency over 80%. As the SolarWall technology came to define the global solar air heating sector because of its efficiency and return on investment, our other new products - SolarWall® 2-Stage & SolarWall® PV/Thermal - are also shifting energy paradigms for ultra-high temperature rises & solar cogeneration systems. Conserval is regularly involved with award-winning and/or LEED® projects that use the SolarWall technologies for their exceptional attributes in the areas of solar energy & architectural versatility.

Mission Statement

Continue to be the global market leader in the renewable energy sector we created - ***solar air heating*** - for the benefit of our clients and the planet.

Source: http://solarwall.com/en/home.php

Appendix A3:
SolarWall: Recent recognition from inclusion in the American Society of Mechanical Engineers.

SolarWall® Honored along with Edison, Ford and the Panama Canal in American Society of Mechanical Engineers Exhibit

Released on May 29 2014

New York City: SolarWall® inventor John Hollick has been honored in an exciting new exhibit curated by the American Society of Mechanical Engineers (ASME) that features the best inventions, inventors and engineering feats of the past two centuries, including Thomas Edison, Henry Ford, George Westinghouse, Willis Carrier, the steam engine and the Panama Canal.

Entitled *"**Engineering the Everyday and the Extraordinary**"*, the goal of the exhibit is to *"invite people to rediscover the remarkable; the engineers and inventions that have shaped our world as well as the extraordinary breakthroughs that are already setting the stage for the future."*

ASME focused on nine categories of engineering: Environment, Food, Safety, Manufacturing, Energy & Power, Transportation, Health, Exploration and Communication. The 80 inventors and inventions whose stories they chose to highlight represent the best of those categories.

The SolarWall® technology and inventor John Hollick are featured in the Energy & Power category. The other inventions recognized in this category are the Steam Engine, the Jet Engine, the Transformer, Incandescent Light Bulbs, the Internal Combustion Engine, Alta Wind Energy Center, the Electric Generator, and the Itaipu Dam.

The SolarWall® technology was a breakthrough invention that created the global solar air heating industry. It was ranked by the U.S. Department of Energy as being in the "*top two percent of energy related inventions*" because of its unique technical design and efficiency at converting sunlight into usable thermal energy. It remains the only building-integrated clean energy technology – now used in thousands of commercial, industrial and agricultural applications around the world – that effectively addresses the huge amount of energy used for space and process heating. The SolarWall® technology is now poised for significant growth as solar air heating becomes a mainstream solution to reducing GHG emissions and with new applications for this innovative technology.

The unique display celebrates and promotes these 80 inventors and engineering feats that have made a difference in our world, and will continue to impact our future. It will remain in the lobby of the ASME building in NYC for the next 15 years.

To watch a short video on the unique mechanical design of the ASME exhibit, please click here.

About ASME: Founded in 1880 as the American Society of Mechanical Engineers, ASME is a not-for-profit professional organization that enables collaboration, knowledge sharing and skill development across all engineering disciplines, while promoting the vital role of the engineer in society. ASME codes and standards, publications, conferences, continuing education and professional development programs provide a foundation for advancing technical knowledge and a safer world and are used in over 100 countries. ASME has over 130,000 members in over 150 countries.

Source: *http://solarwall.com/posts/solarwallr-honored-along-with-edison-ford-and-the-panama-canal-in-american-society-of-mechanical-engineers-exhibit-230.php*

Appendix B: Illustration of SW technologies

Leadership in Sustainable Agribusiness, Innovation, and Solar Thermal Renewable Energy: Opportunities for Sustainable Agribusiness

B1 Solar Wall, 2-stage;
B2 Solar Wall in LEED building;
B3 Solar Duct roof top installation;
B4 Solar Wall Photo Voltaic / Thermal (PV/T), used in *Food in Italy* proposed solution;
B5 Process Drying.

Appendix B1: SolarWall

SolarWall® 2-Stage High Performance Solar Air Heating

"It used to take over 3 hours to reheat the hangar when they opened the doors to get an aircraft out. Now its only taking 45 minutes, so they don't have to use all that natural gas from the conventional heating system."
-Tom Long, Airport Manager at Plattsburgh International Airport

The SolarWall® air heating technology has always generated an impressive economic return for commercial & industrial buildings due to its high efficiency & low capital costs. It has been primarily used for ventilation heating or process applications, with a consistent track-record of delivering high energy performance in all projects around the world.

Up to 54% More Thermal Energy
Independent testing & field applications have shown that SolarWall 2-Stage will deliver up to 50%+ more energy than a conventional SolarWall system, with temperature rises over 100°F (55°C) frequently achieved.

* Test Conditions: 1 CFM/ft² and 900 watts of solar radiation

Introducing SolarWall® 2-Stage

SolarWall® 2-Stage is the latest version of the SolarWall® technology and it builds on the technological success of the original solar air heating system. SolarWall® 2-Stage has been configured to deliver a higher temperature rise - up to 36-85°F (20-47°C) above ambient temperature - which makes it more applicable for space heating applications. It is also ideally suited for roof-mount projects and windy locations. [And as the wind speed increases, the energy output of the 2-stage system will continue to increase relative to the conventional SolarWall system.]

It operates on the same premise as the original SolarWall® technology in that outside air is heated and drawn into an air cavity via tiny mirco-perforations in the SolarWall collector. With the 2-Stage system, the air is then heated a second time (which boosts the temperature rise) as it passes though a second stage of the system. The solar heated air is then directed into the building's ventilation system - or through a dedicated SolarWall fan & ducting system - where it is distributed throughout the building.

SolarWall®
by Conserval

www.solarwall.com


SolarWall® 2-Stage
High Performance Solar Air Heating
SolarWall® 2-Stage
2nd Stage
1st Stage
1st Stage - Sun heats SolarWall® collector and fresh air is heated as it passes through the surface
2nd Stage - Air is further heated as it passes behind the glazing and through the second stage
The solar heated air is then distributed via ventilation or SolarWall® fan & ducting system
Features & Advantages
Higher energy output that substantially lowers heating bills
Delivers significantly more thermal energy (up to 50% more) than a conventional low-flow SolarWall® system
Heats air 36-85°F (20-47°C) above ambient on a sunny day
Monitored systems show temperature rises over 100°F (55°C) being achieved on a regular basis
Maintenance free
Up to 10+ LEED® Points
Heats fresh air and improves indoor air quality
Destratification savings for industrial buildings
Provides both space heating & ventilation air heating
Huge life-cycle cost savings
Huge reduction in CO2 emissions
Building integrated - variety of colors
2nd Stage
1st Stage
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SolarWall by Conserval
www.solarwall.com

Appendix B2: SolarWall and LEED

LEED® Categories

The SolarWall® technology is LEED® qualifying in the following categories:

Energy & Atmosphere
EAC1 – Optimize Energy Performance (1-19 points)
EAC2 – On-site Renewable Energy (1-7 points)

Indoor Environnemental Quality
Ventilation Effectiveness (1 point)

Materials and Resources
Recycled Content (1-2 points)

SolarWall® and LEED®

The SolarWall® technology is a wall-mounted solar air heating system that offsets the heating load in commercial, industrial and institutional buildings by heating incoming ventilation air. The technology is also available in a modular rooftop system – SolarDuct® – and can be combined with PV – SolarWall PV/T – to create a hybrid system.

SolarWall® and SolarWall PV/T technologies are favored by architects on LEED® projects because of their;

- Ease of integration into the building envelope
- Sizable amount of renewable energy production
- Architectural versatility
- LEED® point generation (6+ LEED® points under 2.2, and up to 9+ LEED® points under 3.0)

Conserval works extensively with architects & engineers to optimize system design & integration to ensure the success of all projects. SolarWall systems have been used as architectural features on famous and notable projects in 30+ countries around the world, from the Beijing Olympic Village, to the Kristinehamn Museum of Modern Art in Sweden, to the new NREL LEED® Platinum facility in Colorado.

SolarWall by Conserval

www.solarwall.com

SolarWall® Solar Air Heating

Renewable Heating

Heating can typically be one of the largest energy expenditures in the building industry. The ability of a SolarWall® system to address this energy usage and to displace a sizable amount of it – and the resulting greenhouse gas emissions – explains why the technology has such a compelling return on investment.

SolarWall systems produce up to 60 watts/ft² (600 watts/m²) of thermal energy. When the sun warms the surface of the collector, the heated air is drawn through thousands of tiny perforations on the surface and ducted to the existing air intake. The solar heated air is then distributed throughout the building via the conventional ventilation system or dedicated fans and ducting.

Features & Advantages

- Eligible for up to 9+ LEED® Points
- Building integrated & available in a variety of colors
- Significantly lowers heating bills (20-50% on average)
- Used by large corporations around the world
- Compelling ROI + capital cost reduction from offsetting traditional wall material
- Heats fresh air & improves indoor air quality
- Heats air 30-70°F (5-38°C) above ambient on a sunny day
- Maintenance free & 30+ year typical lifespan
- Collector efficiency up to 80%
- Huge reduction in CO_2 emissions

"Our building has blond brick fascia, so the dark brown SolarWall makes a nice contrast. The design of the SolarWall was stylized to have a bit of pizzazz to it with the angle on the side. The building was very institutional looking and we used the SolarWall to give it a bit of architectural interest."
-Tony Mancuso, St. Louis County Property Management, LEED® Certified Hibbing Annex Courthouse, MN

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CANMET Materials Tech Lab LEED® Platinum
NREL Research Support Facility LEED® Platinum
KFC Taco Bell LEED® Gold
Toronto Airport Authority LEED® Silver

SolarWall by Conserval

www.solarwall.com

Source: http://solarwall.com/en/products/download-brochures.php

Appendix B3: SolarDuct

SolarDuct® is based on the highly efficient and award-winning SolarWall® system. The technology has been specifically engineered for roof settings and for applications in which a traditional wall-mounted system is not feasible.

Like the original SolarWall technology, the SolarDuct technology heats ventilation air before it enters the air handling units, which reduces the on-site heating load. Traditional SolarDuct® systems use an all-metal collector as the solar absorber. Micro-perforations in the panels allow the heat that normally collects on a dark surface to be uniformly drawn in through the SolarDuct system, where the air is heated and then ducted into the conventional HVAC system.

The SolarDuct technology is now also available in a "2-Stage" configuration in which the solar collector is partially glazed to deliver higher temperature rises by heating the air twice. SolarDuct 2-Stage produces up to 50% more energy than a conventional SolarDuct system which helps drive a faster return-on-investment.

Features & Advantages

- Displaces the traditional heating load, and targets one of the largest usages of building energy
- High efficiency SolarDuct modules heat ventilation air to improve indoor air quality
- Compelling ROI
- Substantial CO_2 displacement
- Modular units simplify array layouts and connections to HVAC units
- Typical array length is up to 60 feet (18m) long (10 units) and will deliver up to 1000 cfm (1700 m^3/h) of heated ventilation air

SolarWall
by Conserval

www.solarwall.com

Source: [*http://solarwall.com/en/products/download-brochures.php*](http://solarwall.com/en/products/download-brochures.php)

Appendix B4: SolarWall PV/T

SolarWall® PV/T Solar Air Heating & Electricity

SolarWall® PV/T™ system at the LEED® Silver John Molson School of Business at Concordia University in Montreal

A Total Energy Solution

SolarWall® PV/T™ cogeneration system produces both heated air & electricity. It combines the high-efficiency SolarWall® air heating technology with photovoltaics to create a total energy solution with a payback period that is substantially less than a typical PV installation.

A PV/T system will generate 200-300% more energy (in the form of heat and electricity) than a standalone PV system. The patented combination of the two solar technologies in one footprint offsets both heating and electricity costs, and addresses the two main energy requirements in the building sector. This helps to reduce operating costs and maximize CO_2 displacement.

Features & Advantages

- Accelerates PV system ROI
- Cools the PV cells to reduce heat-related energy drop in output
  Performance gain up to 10%
- Captures PV heat energy for ventilation heating
- PV/T system has a total operating efficiency above 50%
- Maximizes usable roof space
- Huge reduction in CO_2 emissions

PV/T Value Proposition

Technology	Watt / m²
PV Electrical Output	100 Watts/m² (10 Watts/ft²)
Hybrid SolarWall® PV/T	300-400 Watts/m² (30-40 Watts/ft²)

SolarWall by Conserval

www.solarwall.com

SolarDuct™ PV/T

Solar Air Heating & Electricity

Capturing the Heat

PV module efficiency is typically between 8-15%. What happens to the rest of the sun's energy that shines on the panels? Most of it is converted into heat energy, which normally is lost and provides no value to the system owner. As well, the heat build-up behind PV modules reduces the electrical output by 0.4-0.5% for every 1°C above its rated output temperature (which is 25°C). Given that roofs can reach temperatures as high as 90°C, the actual operating efficiency of PV systems is often significantly less than the rated output.

For standalone PV systems, high capital costs and low energy production result in very long paybacks. The PV/T cogeneration technology offers a solution that actually makes PV systems financially feasible in standard commercial, industrial, and institutional applications.

SolarWall PV/T™ rooftop system installed in the Beijing Olympic Village.

SolarDuct™ PV/T is a modular rooftop application of the PV/thermal technology. The heat is drawn off the back of the PV modules and is ducted to the nearest rooftop air handler. The 'excess heat' is then channeled into the building's HVAC system where it is used to offset the heating load.

The SolarWall® air heating system serves as the racking system needed to mount the PV modules. This also contributes to the cost-effectiveness of the cogeneration system.

The modular units are easy to install and are angled at an ideal orientation for maximum solar gain.

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SolarWall by Conserval

www.solarwall.com

Source: http://solarwall.com/en/products/download-brochures.php

Appendix B5: Process Drying

SolarWall® Process Drying

No natural gas needed. That's nuts!

Walnuts, that is. Keyawa Orchards in California dries over 12 million lbs. of the delicious crunchies every year. Farmers from miles around depend on the company to wash the nuts, dry them and send them on to the processing companies.

FDA regulations are strict; moisture must be held at less than 8% – which requires a lot of heat. However, if the nuts dry out too quickly, they are ruined. Getting things "just right" is crucial to the taste of Keyawa Orchards' product. Doing so cost-effectively is crucial to profit. Enter SolarWall.

Ron Keyawa, company founder and CEO explains: *"To dry the nuts, I need air that's at 110°F, so if ambient is 80°F, then I need a 30° heat gain. I've got 600,000 cu. ft./min of air to heat, so at night, when things cool down here, I use a lot of natural gas! That's expensive – really expensive – so I looked for ways to reduce my energy costs and found SolarWall. Now there are times when I don't need to run natural gas at all because I'm getting enough heat from the SolarWall panels on the roof to shut off the burners."*

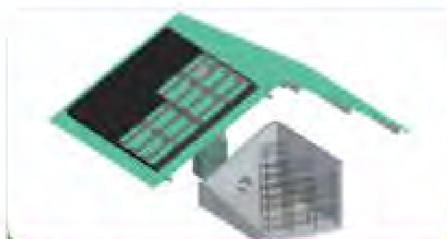
"What happens is that the SolarWall system preheats the air before it reaches the fans. The system modulates itself. The probes sense the temperature of the air coming in and tell the burners not to work so hard. If the SolarWall has already heated it enough, the air goes right past the burner. Frequently I even shut down the system and use total SolarWall [technology] to dry the nuts. What I like about it, it's simple. There's no maintenance, no moving parts. Once you set it up it's real simple."

You don't have an active drying process?

Our modular container-based SolarWall systems are custom tailored for a specific crop including temperatures and internal tray systems. They are shipped with all equipment including fans, photovoltaics (to power fans) and drying racks. Active drying also substantially decreases drying time in addition to reducing the potential for mycotoxins to form on crops.

Rockland County, NY, Composting Facility

SolarWall heating systems are also suitable for a wide range of industrial process and commercial drying operations, from laundry drying to preheating combustion air for furnaces & composting facilities.



SolarWall drying can either act as a stand alone system, or in preheating capacity to traditional mechanical operations. The technology can be easily incorporated into tunnel, trough or conveyor dryers.

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SolarWall by Conserval

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Appendix C

Leadership in Sustainable Agribusiness, Innovation, and Solar Thermal Renewable Energy: Opportunities for Sustainable Agribusiness

C1 The NightSolar White Paper

C2 The Night Solar US Patent

Appendix C1: The NightSolar White Paper

NightSolar®

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NightSolar® - More than Solar

Solar Heating & Cooling

A NightSolar® system provides year round usage with winter heating and summer cooling. NightSolar® utilizes the most efficient and proven solar technology, the SolarWall® transpired collector, in an unique configuration to also take advantage of nocturnal radiation cooling, a previously ignored cooling phenomena. This unique design has additional benefits as it ventilates and shades the roof covering the main roof in darkness all day long and preventing unwanted summer heat from reaching and conducting through the roof. With most roofs responsible for half of the cooling load, a NightSolar system in many cases can reduce the cooling equipment size in half and the associated energy costs.

Roof shading

Roofs can reach 160°F (71°C) in the summer sun and that heat will conduct through the roof at the rate of 160°F (roof temp) – 75°F (indoor temp) x U factor (heat transfer rate which is inverse of R insulation value) = Btu/h.ft2 of roof area. Covering the roof with NightSolar panels shades the roof and lowers the roof temperature to within a few degrees of ambient (see fig.4) which means the heat transfer rate through the roof and corresponding daytime cooling demand is now reduced by as much as 70°F.

Above Sheathing Ventilation (ASV)

Oak Ridge National Laboratory (ORNL) states *"we serendipitously discovered **the second major advance in roofs for our century:** We found that elevating the roof cover from the roof deck to induce above-sheathing ventilation is as important as increasing solar reflectance and may be the stronger player in reducing heat gain into the attic. The two combined can reduce heat gain through the roof by 50% compared to nailed asphalt shingle roofs."*

NightSolar ventilated roofs prevent unwanted solar gain reaching the building and the solar heat dries any condensation or moisture that may have accumulated on the roof. NightSolar takes ASV one step further by not only ventilating the roof but doing it in a manner that either collects or expels the heat depending on the season and time of day. It incorporates a ventilated roof design which has precision micro perforations to collect or discharge the heat or cold boundary layer. A recent field monitored project in Europe is reporting as much as a 50% overall cooling savings on telecom buildings using existing fans and economizers.

Ventilated steep slope roofs rely on thermal stack effect to remove heat. Low slope roofs with long roof runs have insufficient height to remove heat whereas the NightSolar system is vented over the entire surface which eliminates the problem associated with ASV for low slope roofs.

Free Night Cooling

Nocturnal radiation cools roofs as much as 18°F (10°C) below ambient on clear nights and the chilled air adjacent to the roof has the ability to reduce or even displace conventional air conditioning from sunset to sunrise. As warm night air touches the cooler surface of the collector, it transfers its heat to that surface and the cooled air is then drawn in through the perforated surface.

NightSolar® cooling, developed by the inventors of SolarWall, is the first commercially available product that has been specifically designed to take advantage of this free sky energy to cool buildings.

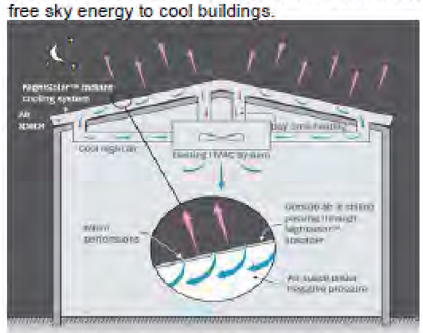

Figure 1: Night cooling air drawn off bottom and winter solar heated air drawn off top

Figure 2: Typical metal roof installation

NightSolar® Energy Savings are a combination of multiple Heating and Cooling benefits

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NightSolar®

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concluded that above sheathing ventilation provides an additional 200% cooling savings when compared with just cool roof colors.

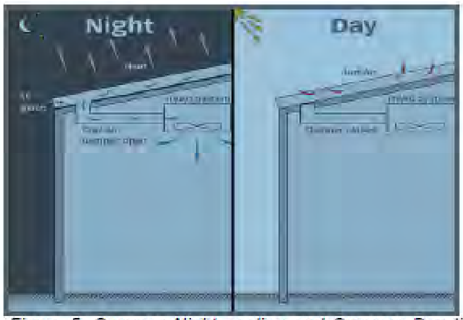

Figure 5: Summer Night cooling and Summer Day time roof shading operation

A NightSolar ventilated roof prevents unwanted solar gain reaching the building and the unwanted solar heat is naturally vented while drying any condensation that may have occurred on the roof or within the air cavity.

ASV also provides a benefit during the winter heating season and negates the heating penalty associated with cool roofs as the air space is an insulating buffer against heat loss to the night sky in the winter.

4. Cooling of ambient air at night

Radiation cooling to the night sky is based on the principle of heat loss by long-wave radiation from a warm surface (roof) to another body at a lower temperature (sky). On a clear night, a typical sky-facing surface can cool at a rate of about 25 BTU/hr.ft^2 (75 W/m^2). This means that a metal roof facing the sky will be colder than the surrounding air temperature, from 10°F to 36°F (5°C to 20°C) colder. Tests confirm that on clear nights at a ventilation rate of 2 cfm/ft^2 of roof surface, the air is cooled an average of 5°F to 10°F (3°C to 5.5°C) below ambient from sunset to sunrise in the Great Lakes region.

The ASHRAE Handbook (2011) references cooling by nocturnal radiation and provides numerous maps illustrating the energy savings potential. See figure 7 for cooling potential in USA for July.

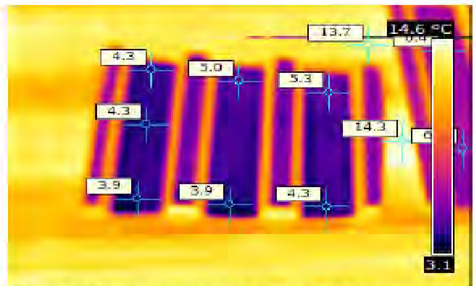

Figure 6: Panel temperature at night (infra-red camera) confirms ASHRAE value for Great Lakes area of 10°C (18°F) cooling below ambient

Figure 7: Average monthly sky temperature depression for July °F (ASHRAE Handbook 2011)

Over a 10 hour night in U.S.A. depending on the climate and location, the nightly average air cooling for the month of July can be 12 Btu/h.ft^2 which means 1 ton of cooling is possible with 1000 ft^2 of panels. Using the example of a 50,000 square foot building, the NightSolar system can displace 50 tons of cooling from sunset to sunrise. Assuming 800 hours of night cooling operation, the cost savings at 15¢/kWh is 50 tons x 1.3kW x $0.15/kWh x 800 hr = $7,800/yr.

Total cooling savings for a 50,000 ft2 building are:
Capital savings: $62,000
Operating savings: $12,090 + $7,800 = $19,890 per year

Now it is possible to obtain year round renewable energy savings with winter heating and summer cooling using the same panels and same ventilation or HVAC system.

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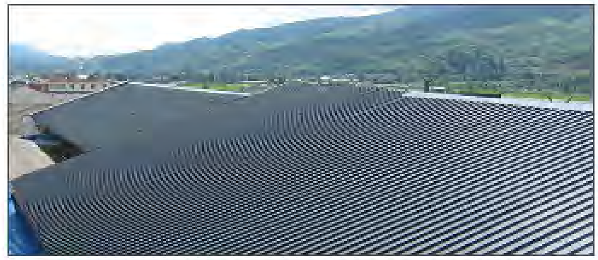
Source: John Hollick email

Appendix C2: The Patent

Solar Cooling Patent Granted to SolarWall® Inventor

Released on Dec 02 2014

The U.S. Patent Office has granted SolarWall® inventor, John Hollick, patent #8,827,779 titled "Method and Apparatus for Cooling Ventilation Air for a Building". The invention uses a transpired solar collector to take advantage of a well-known phenomenon called nocturnal radiation cooling which can cool air below ambient from sunset to sunrise.



"Cooling air below ambient using nocturnal energy has long been known but no one has been able to come up with a simple and economical way to harness this free cold energy, until now. We call the system "NightSolar®" and it connects to HVAC economizers. At the same time, it shades and ventilates roofs preventing the sun's rays from reaching the roof, which can account for half of a building's cooling demand" states Hollick.

The system works day and night in the summer with the daytime solar heat collected the same way as a conventional SolarWall® system, while also simultaneously shading and ventilating the roof. The heat can either be dissipated or used to heat water or industrial processes. At night these same panels will cool air as much as 10 degrees F below ambient when connected to the economizers on typical HVAC units. In the winter, the solar energy heats the air entering the same HVAC units.

Earlier this year Hollick and his SolarWall heating invention were honored by American Society of Mechanical Engineers (ASME) in New York City in a new exhibit as one of 80 of the best inventions, inventors and engineering feats of the past two centuries along with Thomas Edison, Henry Ford, Willis Carrier, George Westinghouse and the Panama Canal. Entitled "Engineering the Everyday and the Extraordinary", the goal of the exhibit is to "invite people to rediscover the remarkable; the engineers and inventions that have shaped our world as well as the extraordinary breakthroughs that are already setting the stage for the future."

The SolarWall transpired collector was a breakthrough invention that created the global solar air heating industry. It was ranked by the U.S. Department of Energy as being in the "top two percent of energy related inventions." It continues to be the most efficient building integrated clean energy technology – now used in thousands of commercial, industrial and agricultural applications around the world – that effectively addresses the huge amount of energy used for space and process heating.

Source: http://solarwall.com/posts/solar-cooling-patent-granted-to-solarwallr-inventor-244.php

Appendix D: Original Offer to *Food in Italy*

Leadership in Sustainable Agribusiness, Innovation, and Solar Thermal Renewable Energy: Opportunities for Sustainable Agribusiness

Appendix D: Introduction - ORIGINAL OFFER to *Food in Italy*

Executive Summary

Objective:
Reduced energy cost and improved energy self sufficiency and environmental sustainability via reduced CO_2e emissions at FI. A brilliant, high profile, world-class technology.

Recommended Solution:
Install 157 SolarDuct PV/T® panels on the roof of the building, to produce a mix of thermal energy and electricity.

Significant Benefits of the SolarDuct PV/T®

- Annual production of 172.7 MWh of free energy, 126 MWh thermal and 46.7 MWh electric.
- This solution supplies up to 50% of thermal energy required by FI and and offsets the cost of 35% of FI's electricity needs thanks to existing governmental financial incentives to photovoltaic.
- A maintenance free installation, for the next 25+ years (thermal), 20+ years (photovoltaic).
- An IRR of 18.8% assuming an energy price inflation of 6%, consistent with current market conditions.
- Significant environmental sustainability improvement, significant reduction of CO_2e emissions.
- Innovative technology, very timely, will attract significant interest from clients and media.
- Will impress FI visitors for its serendipity and simplicity.
- First in Italy, one of the first installations in food industry in Europe.
- A certified, award winning, established technology, rated by the US government as having the highest known solar conversion efficiency, world-wide.
- An outstanding IRR of 40.8% if installed in locations where thermal energy is required year round.

The Technology
SolarDuct® is a modular rooftop solar air heating system based on the highly efficient and award-winning SolarWall® system. The technology has been specifically engineered for roof settings and for applications in which a traditional wall mounted system is not feasible. **SolarDuct®** can convert to usable energy more than 95% of solar radiation, about 6 to 9 times more than the 10-15% converted by conventional Photovoltaic installations.

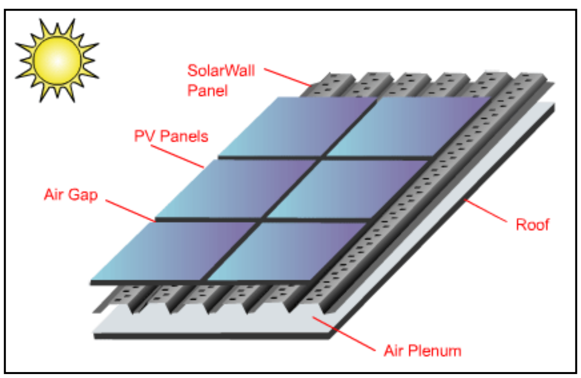


Figure 1: Solar Wall scheme.

SolarDuct PV/T® product is an optimally designed Photovoltaic/thermal cogeneration system, with improved Photovoltaic (PV) efficiency versus typical PV mounting. **SolarDuct PV/T®** can convert to usable energy more than 50% of solar radiation, about 3 to 4 times more than the 10-15% converted by conventional Photovoltaic installations.

With a SolarDuct PV/T system, the all-metal SolarWall® panels double as the PV racking system, while also removing the heat from the back of the PV modules and using it to offset the building's heating load. The SolarWall® PV/T technology solves the overheating problems found in most building integrated PV (BIPV) systems by removing the heat from the back of the PV modules. PV modules are mounted on top of the SolarWall® panels, which act as the PV racking system. The heat is drawn off the back of the PV modules and is ducted into the building's conventional HVAC system where it offsets the heating load. The SolarWall system keeps the air circulating evenly around the PV modules, which can cool the PV modules by as much as 20 degrees C. This can increase the electrical output by 5-10%.

Figure 2: A SolarDuct® PV/T™.

Figure 2 illustrates how PV modules are mounted on top of the SolarDuct® units, and the heat is drawn off the back of the PV modules and then ducted to the nearest rooftop air handler. Since the SolarWall® air heating panels serve as the racking system needed to mount the PV modules, that also contributes to the cost-effectiveness of the cogeneration system. The modular units are easy to install and are angled at an ideal orientation for maximum solar gain.

Outstanding Energy Efficiency

Consider this possible installation alternatives:

1. **A stand alone Photovoltaic installation converts 10-15% of the solar radiation into electricity,** the rest is lost. 10% is lost due to reflection by the PV glass and 75-80% is converted into heat energy which is dissipated. The hotter the PV module becomes, the less electricity it produces. (~0.5% loss per degree above the PV Nominal Operating Cell Temperature of 25°C).

2. **A SolarDuct® installation alone converts 50-80% of the solar radiation into usable heat energy.**

3. **A SolarDuct PV/T® installation, converts 10-15% of the solar radiation into electricity and 35-50% of the solar radiation into usable heat energy. FI will be the first to install it in Italy.**

Our proposal

The FI building

Technical data received by FI staff indicate 2700 m2 of a high quality, highly specialized office building, with annual average consumption (2007-2009) of 252.5 MWh of thermal energy to heat the facility, 55.3 MWh of thermal energy to produce sanitary hot water, and 299.2 MWh of grid purchased electricity. Thermal energy is purchased from the existing district heating system. Due to the specialized nature of the building, fresh air requirements are high, between 15,000 and 45,000 cubic meters per hour. The most recent thermal energy cost is 9.1 cents per kWh; electricity is 19.1 cents per kWh. No indication of an effective efficiency in converting energy from the district heating system was provided. A very conservative 90% was assumed in the analysis, normally this efficiency is 25-70%, depending on a number of parameters; if the actual efficiency were in fact lower than the 90% used in the analysis, the economic results of SolarDuct installation would increase accordingly. The FI building roof is flat and extends for 1300 m2 (a front of 32.5m and depth of 40m) with a central mechanical room 4.5 m from the front of the building. Limited shading is experienced by the roof due to the presence of the mechanical room in its centre and and some nearby buildings; no major shading from trees is noted. This building is suitable for installation of either a standalone **SolarDuct®** or a **SolarDuct PV/T®**, a joint Solar Duct® and PV installation. Thermal energy captured can be fed through the fresh air intake located in the North-West corner (top left) of the building.

Analysis

We conducted a preliminary engineering and economic analysis to determine the preferred installation for AB. Given the much higher efficiency of the **SolarDuct®** compared with that of conventional photovoltaic systems, our proposal reports only on the comparison of a **SolarDuct PV/T®** and a **SolarDuct®** installation. In the analysis it was verified that IRR of a PV installation, despite the large government incentives currently available, is inferior to the IRR available from **SolarDuct®** in situ.

We have short -listed these two proposals:

- **Proposal A is a SolarDuct PV/T® installation, joint SolarDuct® and photovoltaic,** producing 126 MWh of thermal energy during the period Sep 15-May 15, and 46.7 MWh electric throughout the year. The payback period is 7.3 years.
- **Proposal B is a SolarDuct® installation without photovoltaic,** producing annually 214.3 MWh of thermal energy during the period Sep 15-May 15 with a payback period of 5.9 years.

The economic life is a minimum of 25 years for **SolarDuct®**, with essentially no maintenance, and a minimum of 20 years for the PV component, with a new inverter installed in year 10 to 12. Current market prices and incentives levels were used in the calculation.

The empirical results are presented in three tables:

- Table 1.a presents the environmental performance results, in terms of energy produced per year and corresponding reduction in CO_2e emissions calculated at the average Italian grid rate of kg 0.443 per kWh.
- Table 1.b presents the economic metrics results, in terms of annual savings from the proposal at current market prices (inclusive of existing government incentives for PV electricity production), cost of the proposal, pay back, benefit cost ratio, and NPV (all at constant energy prices, a prudent assumption).
- Table 2: presents the IRR of each proposal, over 25 years for the SD and 20 years for the PV, for different projected energy inflation rates. As a reference, during 2007-10 FI experienced an annual inflation of 3.7% for electric kWh and 5.9% for thermal kWh purchased from the grid.

Table 1.a: Environmental performance of the two proposals.

		Thermal	Electric	Total	Emission reduction, CO2e tons
A	157 SolarDuct panels, used 8 months/year, with 157 photovoltaic panels (36.11 kW inst.), used full year	126.0	46.7	172.7	84.9
B	157 SolarDuct panels, used 8 months/year	214.3	na	214.3	105.5

Table 1.b: Economic metrics of the two proposals.

		Annual Savings, 1000 Euro	Installed Cost, 1000 Euro	Pay Back, years	Benefit Cost Ratio	NPV, 1000 Euro
A	157 SolarDuct panels, used 8 months/year, with 157 photovoltaic panels (36.11 kW inst.), used full year	€ 40.0	€ 290.8	7.3	3.0	€ 576.4
B	157 SolarDuct panels, used 8 months/year	€ 23.3	€ 137.0	5.9	4.2	€ 444.8

Table 2: IRR of the two proposals

Energy Cost Inflation Forecast	IRR, Proposal A	IRR, Proposal B
0	12.9%	16.6%
2%	14.9%	18.6%
4%	16.8%	20.6%
6%	18.8%	22.5%
Energy cost inflation, 2007-10, experienced by FI Electric: 3.7% annual, compounded Thermal: 5.9% annual, compounded		

Discussion

As expected given the superior efficiency of the **SolarDuct®** technology compared to photovoltaic, the installation of a pure **SolarDuct®** system (proposal B in table 1.a and 1.b) maximizes conversion of solar energy into usable heat energy, and therefore maximizes the total energy produced, and reduction in CO_2e emissions.

A **SolarDuct PV/T®** installation, **proposal A in table 1**, has a marginally lower environmental and economic performance than a pure **SolarDuct®**.

This is expected as the environmental efficiency of **SolarDuct®** is a multiple of that of PV, and this objective advantage remains even once the economic assessment includes the existing government incentives to the PV sector. Table 1.a and 1.b confirm that **SolarDuct® is without hesitation the best technical option if maximizing energy production is the objective.**

However, given this, one needs to focus on the specific requirements of FI, specifically, its specific energy mix needs. Whereas FI could use all the thermal energy of proposal B on a cold day when its ventilation needs are high due to specific in-house activities, part of the energy produced would be in excess on a modearatly warm day, perhaps a weekend day, when ventilation volumes are lower.

Proposal A, provides 16% of FI's average annual electricity needs (remunerated at the inflated level provided for by the government incentive), and this is 100% usable, representing up to 50% of FI's average thermal energy requirements. Because the current government incentives are almost double the current cost, 45.8 vs. 19.1 Euro per kWh, once the incentive is considered the production of 16% of electricity actually offsets 35% of FI's annual electrical energy costs. **Proposal A, then, would offset the cost of 35% of electrical energy consumption and provide up to 50% of FI's current thermal energy needs.**

Proposal B would provide up to an average of 85% of FI's thermal energy needs, but one must realize the possible timing mismatch of production and requirements of thermal energy, so that it is possible that a percentage of this energy would remain unutilized (for example: a day when ventilation volumes required are low, and/or in an unusually warm day).[1]

Accordingly, and despite its lower overall performance due to the trade-off between PV and SD, we believe that proposal A, **SolarDuct PV/T® installation with its mix of heat and electric energy which may be best suited to**

[1] This was not modelled in this submission; no information was available on actual requirements by the building.

match FI's comprehensive needs during the entire year: high heat energy during the cold months, and a constant supply of electric energy during the entire year.

Recommendation

Our professional opinion is that in this installation it is preferable to diversify the mix of energy produced as this best matches FI's energy requirements, rather than focussing on maximizing thermal energy production, which may not find a full use, year-round, at FI. The installation of a Heat Pump, not considered here, could modify this picture, by allowing the production of sanitary hot water with any excess thermal energy available. It should be noted, however, that the energy required to satisfy the demand of sanitary hot water is reasonably limited (approx 1/5) when compared to FI's thermal requirements.

For illustration purposes only, in an industrial setting where the thermal energy could be used year round to pre-heat a given volume of air required by an industrial process, for example in a product drying process, the payback of **SolarDuct®**, using current market conditions and assumptions, would be an exceptional 2.7 year, with a benefit/cost ratio (with no energy price inflation assumed) of 9.3.

In conclusion, it is our professional opinion that **SolarDuct® is truly an outstanding technology with impressive returns for users who need the thermal energy that is efficiently produced.**

Based on the economic and managerial considerations of a better match between FI's need and Proposal A's energy mix of thermal and electric energy over what would be provided by Proposal B, producing a larger amount of thermal energy, we **recommend the installation of proposal A, the SolarDuct PV/T® system**.

Appendix D1: About Conserval Engineering Inc.

Conserval Engineering Inc. is 33-year old Canadian company headquartered in Toronto-Canada with offices in Buffalo NY, Paris, and Tokyo and dealers in 25-countries.

Conserval Engineering is the inventor of the "transpired-plate" solar air heating technology branded as SolarWall. SolarDuct is a modular rooftop version of the SolarWall technology. SolarWall and more recently SolarDuct have been used by clients on 6-continents and 33-countries for over 20-years.

Clients include government and private sector organizations such as US Army, Canadian Government, NASA, Ford, Federal Express, Wal-Mart, 3M, Auchan, Toyota, Bombardier, Boeing, and thousands more. With over 3 million sqf installed in over 33 countries, every year this technology reduces CO_2e emission by 50,000 tons.

The National Renewable Energy Laboratory, US Department of Energy, has recognized the technology as having "the highest known efficiency of any active solar collector in existence".

About Alpi Marketing and Consulting Services Inc.

Alpi Marketing and Consulting Services Inc., founded in 1991, is a Canadian company headquartered in Guelph, ON, specialized in providing trade, financial and business analysis services to the agribusiness sector, with a particular emphasis on solving marketing and energy, commodity and financial risk management problems. Clients include government and private sector organizations such as the Agriculture and Agrifood Canada, the Italian Ministry of Agriculture, Barilla, Nestle', Better Beef, the City of Parma, the Consorzio Tutela Provolone Valpadana, the Universita' Cattolica del Sacro Cuore, the University of Buenos Aires to mention a few.

Appendix D2: FAQ

Q. Why should I buy SolarWall®?
Many reasons:
• SolarWall heats air for free providing thirty or more years of free heating
SolarWall can improve indoor air quality since more fresh air can be brought into the building without increasing heating costs. New ventilation codes require more air to solve sick building syndrome and SolarWall heats this air for free.
• SolarWall can displace large amounts of energy, and therefore it has a high contribution value to reducing CO_2 emissions.
• SolarWall is maintenance free and has no moving parts
• SolarWall is non polluting and uses renewable energy.
• Solar heating could become mandatory for some government departments, which are committed to lowering greenhouse gases or solving energy shortage issues.
• SolarWall is one of the lowest cost solar energy systems available on the market
• Solar energy offers clients positive public image and shows leadership with renewable energy.

Q. What is the SolarWall® technology?
The SolarWall technology is an unglazed solar air heating system that is usually installed on a wall. The solar panels heat the fresh air that is required in commercial, industrial and institutional buildings. The panels are all-metal and available in a variety of colors. For a detailed introduction to the SolarWall technology view our flash presentation. Also find out more information in our SolarWall products section.

Q. What is the payback?
The payback can be immediate to a few years. SolarWall has one of the best returns on investment of any renewable energy product and a better payback than many other building products such as high efficiency windows, photovoltaic panels and heat recovery devices.

Q. How much heat will it produce?
Each square meter of SolarWall surface can generate 500-600 watts (160 Btu/hr) of thermal energy. A 100m2 SolarWall heater will provide 50kW (160,000 Btu/hr) of thermal energy on a sunny day.

Q. Has the SolarWall technology been tested?
The SolarWall system has probably had more testing and monitoring by governments than any other solar heating product. USA, Canada, Germany, UK, Austria, Japan and others have already spent millions on testing and field monitoring of numerous installations around the world. The independent monitoring has allowed Canada and USA to support the technology. The United States Department of Energy, a strong advocate of SolarWall technology, calls it a transpired collector.

Q. Is there any maintenance?
No! The SolarWall cladding is similar to other metal walls which require no maintenance and is designed to last as long as other metal cladding materials. Any fans or dampers attached to the SolarWall system are required in any event and would have the same maintenance as any other fan.

Q. Is there any cooling benefit?
Yes, the SolarWall cladding stops sunlight from reaching the main wall or roof and acts as a shade for that surface. In fact, in warmer climates, applying the SolarWall cladding to roof as well as the south wall can significantly lower the cooling load of a building. New research is currently underway to allow SolarWall panels to provide night time cooling and day time desiccant cooling.

Q. What is the unique feature of the SolarWall heater?
SolarWall is all metal, a building material and also an efficient heater. It does not need a glass cover which is typical

of other solar designs. For the price of a wall, an owner gets thirty or more years of free heat and better indoor air quality.

Q. Does it work with PV panels?
Yes, in fact, SolarWall panels can be designed to cool PV modules and recover heat that would be otherwise lost in building integrated PV arrays. This co-generation (solar thermal air heating and PV electricity) system is referred to as SolarWall PV/T.

Q. I want to install PV panels to produce electricity and have no extra room for solar thermal panels.
Not a problem with SolarWall PV/T. Just mount the PV panels onto the SolarWall panels and the same surface area will now produce both heat and electricity. If fact, for roof mount systems, use SolarWall as the PV racking system and connect the heated air to the nearest roof top HVAC unit. Best of all, much of the heat from the building integrated PV panels is now removed, improving the PV efficiency, extending the roof life and saving more energy and money.

Q. Can you cool the air in the summer?
Yes. We are currently evaluating drying of desiccants necessary for desiccant cooling. In addition, our roof mounted panels will radiate heat to the clear night sky and a properly designed night cooling system is expected to provide up to 40 watts of cool air per square meter of panel from sunset to sunrise. If you have a potential night cooling project, please contact us at info@solarwall.com or at our contact info site and provide us with details of the project.

Q. How much CO_2 can be displaced with the SolarWall technology?
Every 5 square meters of SolarWall panels displace approximately 1 ton of CO2 emissions every year.

Appendix D3

Assumptions Second Half of 2010.		
Price paid in Q4 10, 1 kWh thermal, Euro per kWh	€ 0.091	As provided by Food in Italy
Observed inflation 2007-2010	5.9%	
Price paid, Q4 10, 1 kWh electrical, Euro per kWh	€ 0.191	As provided by Food in Italy
Observed inflation, 2007-2010	3.7%	
Existing governmental PV incentive, Euro per kWh produced	€ 0.358	Gazzetta Ufficiale della Repubblica Italiana, for 20-200 kW installed, valid up to April 30 2011, guaranteed 20 years
Efficiency of AB heat exchanger from invoiced hot water grid (all inclusive) to actual hot air used in building	90%	Prudent estimate, needs to be verified in situ, could be 70% or even lower (which woudl improve SD results)
Reduction in CO2e emission, price, Euro per ton	€ 15	Current market price, European Climate Exchange.
Solar Ducts panels installed	157	Engineering estimate, needs to be confirmed with in site measurements
Photovoltaic panels, kW installed	36.11	Based on the number of SD installed.
CO2e equivalent electrical footprint kg/kWh, average value published by ENEL for the national grid.	0.443	Source: ENEL . Available at http://www.enel.it/it-IT/azienda/ambiente/enel_ambiente/zero_emissioni/
SD cost, 157 panels, installed 1000 Euro	€ 137	
PV cost, 157 panels, 36.11 kW installed) 1000 Euro	€ 154	
SD life , years	25	
PV life (replacing inverter in yr 10, included in NPV calculation at 5% of initial cost), years	20	
Azimuth of SD panels	45˚	Driven by building shape
Inclionation of SD panels	32˚	Optimal for year-round production
Shading, roof, front of building	0%	Estimate to be verified in loco
Shading, roof, sides of mechanical room,	20%	Estimate to be verified in loco
Shading, roof, mechanical room	0%	Estimate to be verified in loco
Shading, roof, back fo building	10%	Estimate to be verified in loco

Note: the potential “30% contributo in conto capitale” (Capital Cost Contribution) described in the Gazzetta Ufficiale for innovative projects was not considered in the calculation as it is simply impossible to assess its applicability and availability. It is only mentioned here as something worth exploring.

Appendix D4

Proposed position of 157 Solar Duct® panels on the roof of the FI building

MODULAR PROPOSAL, FIVE ZONES

1- Orange (on roof at front of bldg, SW orientation): 32 Solar Ducts in two rows;, no shading.

2, 3- Green and Yellow (on roof at sides of bldg, W-NW and E-SE orientation): each 28 Solar Ducts in seven rows; 20% shading.

4- Blue (on roof of mechanical bldg): 30 Solar Ducts in 5 rows; no shading;

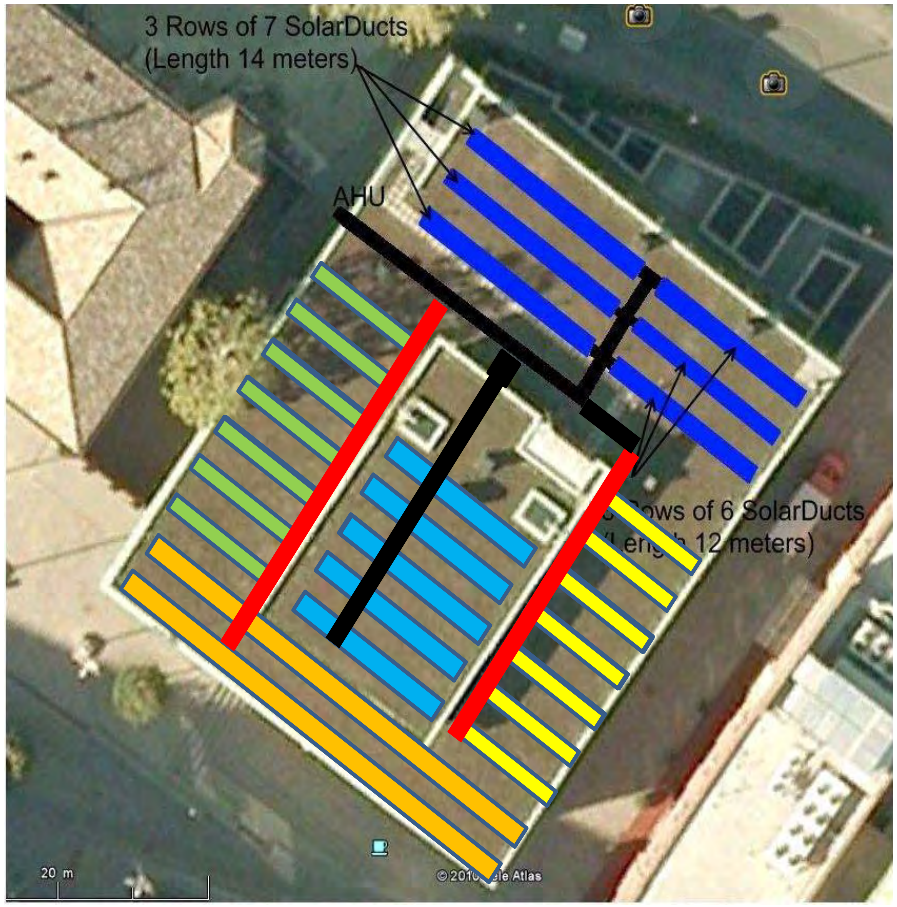
5- Dark blue (roof at back of bldg, NE orientation): 39 Solar Ducts in three rows, 10% shading.

Total for 5 zones: 157 Solar Ducts.

This is designed to provide a volume of pre-heated air of 15k to 50k m3 per hour, as per preliminary building specifications provided by client.

Solar Ducts are placed with a 32 degrees inclination, with minimal visual cluttering of bldg. Panels will be matte black.

Ducts will feed into the existing fresh air intake of the building.



Appendix D5

Essence of our proposal: to add a number of Solar Duct® panels and photovoltaic panels on the roof of AB, to produce both thermal and photovoltaic energy.

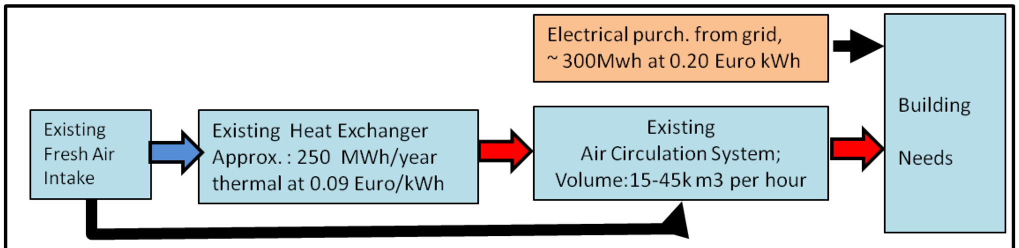


Figure 1: Existing system

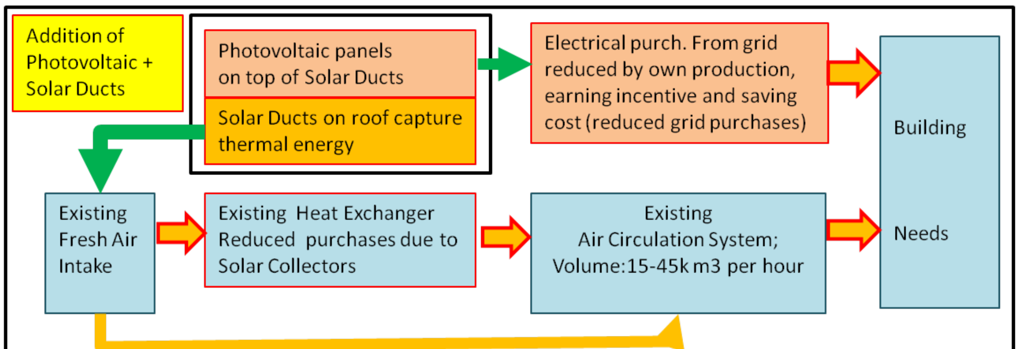


Figure 2: Addition of Solar Duct® feeding pre heated air to the building fresh air intake in the heating season, and photovoltaic panels feeding the building's own electrical consumption (year-round).

Appendix E: Slides for board meeting

Leadership in Sustainable Agribusiness, Innovation, and Solar Thermal Renewable Energy: Opportunities for Sustainable Agribusiness

Executive Summary

Objective:
Reduced energy cost and improved energy self sufficiency and environmental sustainability via reduced CO2e emissions at Academia Barilla. A brilliant, high profile, world-class technology.

Recommended Solution:
Install 471 SolarDuct PV/T® panels on the roof of the building, to produce a mix of thermal energy and electricity.

Significant Benefits of the SolarDuct PV/T®

- Annual production of 518 MWh of free energy, 378 MWh thermal and 140 MWh electric.
- This solution supplies up to 50% of thermal energy required by AB and offsets the cost of 35% of AB's electricity needs thanks to existing governmental financial incentives to photovoltaic.
- A maintenance free installation, for the next 25+ years (thermal), 20+ years (photovoltaic).
- An IRR of 18.8% assuming an energy price inflation of 6%, comparable with current market conditions.
- Significant environmental sustainability improvement, significant reduction of CO2e emissions.
- Innovative technology, very timely, will attract significant interest from clients and media.
- Will impress AB visitors for its serendipity and simplicity.
- First in Italy.
- A certified, award winning, established technology, rated by US government as having the highest known solar conversion efficiency, world-wide.
- An outstanding IRR of 40.8% if installed in locations where thermal energy is required year round.

World-Class Innovation

- Will cut FI's thermal energy cost and relative CO2 footprint in half
- Will cut FI's electricity grid cost by 55%+, with a 16% net drop in footprint
- Is additional to any saving already in effect
- If thermal energy could be sold during the warm season to a nearby potential user, thermal cost would drop to zero, as its relative CO2 footprint

Mapping FI's Energy Opportunity Set

- National Grid
- Own gas powered boiler
- Pro rata large electric and thermal co-generation plant, gas powered
- Municipal utility distrct heating
- This new technology

Base Choice

- The national grid :
  - electricity at 20 euro cents per kWh
  - 3% annual inflation over the last 4 years
  - average CO2 footprint of about 0.45 kg CO2 per kWh produced.

Traditional choice: own gas boiler

- Generate thermal energy with a gas boiler
- significantly lower carbon footprint than otherwise obtainable from the national grid (40% saving), but only for its thermal energy requirements.
- The overall energy efficiency of this solution would likely be less than 50%.
- Natural gas prices relatively low now, but increasing at 4 to 5% per annum in the EU.

Prorated co-generation

- A large advanced gas powered co-generation plant, producing electricity and thermal energy (hot water) with overall energy efficiency of over 50%.
- This plant could offer a footprint closer to what could be found in Ontario,
- Likely determine a 40% reduction in emission when compared to national grid for electricity and 10-20% relative to a local boiler for thermal energy.

Municipal utility district heating system

- A municipal utility had recently launched a district heating system, which FI could join
- year round thermal energy and electricity
- The cost of thermal energy was less than 10 euro cent per kWh equivalent, and had experienced a 6% inflation over the last 4 years
- The cost of electricity was 10% lower than that from the national grid.
- No carbon footprint nor other emission measures were provided by the utility.
- Estimates: close but worse than with co-generation plant (co-generation is optimized, district has difficulty manage fluctuations in demand mix)

FI's own new technology

- Would provide an almost maintenance free (and therefore almost zero cost) solution,
  - with a zero footprint for up to 50% of thermal consumption by ICT, and
  - enough subsidized electricity to offsets the cost of 50% of FI's electricity needs, this thanks to existing incentives to photovoltaic.
- The ensured life of the installed technology exceeds 25 years for the proprietary component and 20 years for the PV installation.
- With sales to nearby user of excess thermal during warm months:
  - cut thermal cost and relative footprint to 0
  - still cut electricity cost by 46% and relative footprint by 16%.

Bottom line

- Closed system, municipal district heating
  - Cut thermal footprint and cost by 50%
  - Cut electrical footprint to 84% of low grid footprint, cost to <50%
- Open system, municipal district heating, sale of thermal energy
  - Cut thermal footprint and cost to 0 (can't beat that)
  - Cut electrical footprint by 16%, its cost to less than 50%

- Open system relative to national grid and conventional boiler, replaced by new tech and district heating
  - Cut thermal footprint and cost to 0
  - Cut electrical footprint by > 55%, its cost by more than 50%

Simplified illustration of the proposed installation of SolarDuct® PV/T™ panels and photovoltaic panels on the roof of ICT, to produce both thermal and photovoltaic energy.

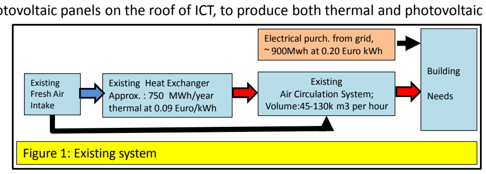


Figure 1: Existing system

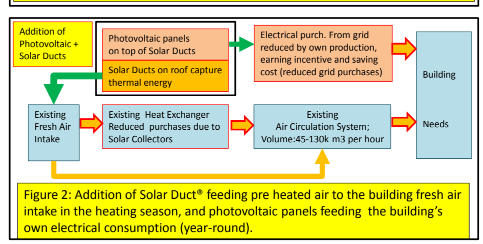


Figure 2: Addition of Solar Duct® feeding pre heated air to the building fresh air intake in the heating season, and photovoltaic panels feeding the building's own electrical consumption (year-round).