

An aerial photograph of a residential development on a hillside. The houses are arranged in rows, with some in shades of red and orange, and others in brown. They have light-colored, possibly solar-reflective, roofs. The background shows a grassy hillside with some trees under a clear blue sky.

# RESILIENCE AND NET-ZERO ENERGY BUILDINGS IN CHILE

**SHADY ATTIA**

**BEATRIZ PIDERIT**

**GEOFFREY VAN MOESEKE**

RESILIENCE & NET-ZERO ENERGY BUILDINGS



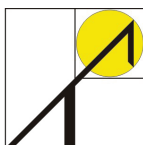


UNIVERSIDAD DEL BÍO-BÍO



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### Colophon

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## **Acknowledgement**

This booklet is the result of a group work that was established with the help of Resilience and Net-Zero Energy Buildings in Chile project members. Several discussions and meetings took place in Belgium and Chile to accomplish this work.

We would like to acknowledge the funding received for this project from Wallonie-Bruxelles International. Also, we would like to acknowledge the effort made from the BioBio University members to generously hosting the project activities and the professional organization. We would like to extend our acknowledgement to Muriel Diaz, Gabriel Balic, Rodriogo Garcia Alvarado, Ricardo Hempel, Isabelle Lopez, Laura Marin Restrepo, Claudia Munoz, Ismael Palacio Mackay, Jesus Pulido and many others we might miss their names.





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Specific objectives:

1. Identify areas of development for applied research in the Chilean context between the group specializing in the two areas declared, to define the way of integration in the field of science and academia.
2. Formulate together a research project that link the experience in the area of scientific communities (Chilean and Belgian) with the lines of development of the participating units of each cooperation unit, Faculty and Ministry of the Government of Chile.
3. Generate an academic exchange of knowledge and "know-how" of the principles applied in international experiences in NZEB and Resilient Architecture.
4. Dissemination of research results in the Resilient Architecture and NZEB to the community.

## INTRODUCTION

This booklet brings together the results of a two years research and collaboration project in the fields of sustainable and resilient architecture with an emphasis on the “Zero-Energy Buildings” goal. The objective of the project was to establish a cooperation network to investigate opportunities of collaboration in different areas of research related to architectural resilience and net zero energy buildings between Belgium and Chile. The project is positioned to respond in an innovative way to climate change and natural hazards.

During the project different activities were implemented to promote academic exchanges between Belgian Universities and Chilean scientific domains through the support of the BibBio University and Wallonie Bruxelles Federation. Exchanges provided a better understanding of local realities, and social diversity of Chile. The intensive exchanges that took place during this project resulted in the development of a vision on the future steps that needs to be taken to maintain the Chilean building stock healthy with a low carbon impact in strong relation to urban resilience.

The project managed to create contact and a bridge that can foster and carry future collaboration in the near future between the different partners mainly the University of BioBio, the UCLouvain and the ULiège. The booklet elaborates on the outcomes of this project.

The collaboration project has two general targets:

1. To establish a network international cooperation to generate academic and investigation exchanges in two areas: Resilient Architecture and Net Zero Energy Building (NZEB) to answer to the climate change and the natural disasters in Chile.
2. Formation of human capital advanced for the strengthening of the postgraduate course in the different areas and publication of the knowledge to the academic community Chilean - Belgium and public institutions of the Government of Chile. The main target of this project of collaboration is to identify tendencies in the international level in order to establish the possible areas of development NZEB and Resilient Architecture in Chile, considering the climatic, technological, economic and social reality. Both of these targets are indicative of the main focus areas of the project. On the one hand, in the project they will get connected to investigators on a global scale who are employed at Architecture Sustainable, Resilience and Energy Efficiency; making the development of excellent investigation possible in the area and establishing an agenda of studies centred on NZEB and resilience opposite to the climate change and the natural disasters. On the other hand, the project will develop concrete actions to promote the formation of human capital that will allow strengthening the scientific community both in Chile and in the Federation Wallonie-Bruxelles.





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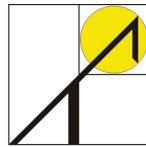
Magister en Hábitat Sustentable y Eficiencia Energética

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## PARTNERS

- Universidad del Bio-Bio, Facultad de Arquitectura, Construcción y Diseño. Prof. Ms.Cecilia Poblete and Prof. Maria Beatriz Piderit (Chile)
- Université catholique de Louvain, Architecture et Climat. Prof. Magali Bodart and Prof. Geoffrey van Moeseke (Belgium)
- Université de Liège, Sustainable Buildings Design Lab. Prof. Shady Attia (Belgium)

## Convention

SUB/2016/284951 – Cooperation bilaterale Wallonie-Bruxelles/Chili – Projet REC 01

The project is funded by the subsidy order SUB / 2016/284951 awarded to the Catholic University of Louvain and signed on July 26, 2016, with effect from 01/07/2016. The deadline for project end is the 31/12/2018, which was the last date of submission of the final activity report.





## MISSIONS

Preparation Visit (June 2016)

**Travelling Expert:** Prof. María Beatriz Piderit, Director of the Architectural Master Programme (Magister en Hábitat Sustentable y Eficiencia Energética)

**Date:** 07-08.06.2016

**Host and Venue:** Université catholique de Louvain, Architecture et Climat and Université de Liège, Sustainable Buildings Design Lab.

Prof. Magali Bodart, Prof. Geoffrey van Moeseke and Prof. Shady Attia

Visit I (January 2017)

**Travelling Expert:** Prof. Shady Attia

**Date:** 07-12.01.2017

**Host and Venue:** BioBio University, Faculty of Architecture, Construction and Design

Prof. María Beatriz Piderit, Director of the Architectural Master Programme (Magister en Hábitat Sustentable y Eficiencia Energética)

### **Meeting Discussions:**

By analysing the cooperation proposal we assume that the proposal received funding from the *Federation Wallonie-Bruxelles* mainly due to the:

- 1) Innovative nature of collaboration topic (Net Zero Energy Buildings) and
- 2) Articulation of the strategical role of the project to reinforce and consolidate the fruitful collaboration/relations that were established earlier between UCLouvain and BioBio University.

### **Bilateral Cooperation Meeting and Project:**

**Date:** 11, 09.01.2017

**Venue:** BioBio University, Faculty of Architecture, Construction and Design

**Participants:** 8 Professors (Rodrigo Garcia, Jesús Pulido, Gerardo Saelzer, Claudia Muñoz, Maureen Trebilcock, Madelyn Marrero, M.Beatriz Piderit, Shady Attia)

The following topics were discussed and are of a common interest between Chile and Belgium: Adaptive thermal comfort, timber construction, passive house standard, heating systems, schools design, materials database and life cycle assessment.

In Chile there are disparities of research topics and serious knowledge gap in several field related to high performance buildings, issues such as adaptive comfort, HVAC systems, air quality, weather analysis and affordability of a strategical importance for Chile.

One of the potential collaboration projects between Chile and Belgium is to work on autonomous buildings for disaster proof neighbourhoods.





Visit II (July 2017)

**Travelling Expert:** Prof. Geoffrey van Moeseke and Shady Attia

**Date:** 20-29.07.2017

**Host and Venue:** BioBio University, Faculty of Architecture, Construction and Design

Prof. María Beatriz Piderit, Director of the Architectural Master Programme (Magister en Hábitat Sustentable y Eficiencia Energética)

**Bilateral Cooperation Meeting and Project:**

**Date:** Various occasions

**Venue:** BioBio University, Faculty of Architecture, Construction and Design

Visit III (January 2018)

**Travelling Expert:** Prof. Geoffrey van Moeseke and Shady Attia

**Date:** 06-16.01.2018

**Host and Venue:** BioBio University, Faculty of Architecture, Construction and Design

Prof. María Beatriz Piderit, Director of the Architectural Master Programme (Magister en Hábitat Sustentable y Eficiencia Energética)

**Bilateral Cooperation Meeting:**

**Date:** various occasions between 08-16.01.2018

Visit IV (July 2018)

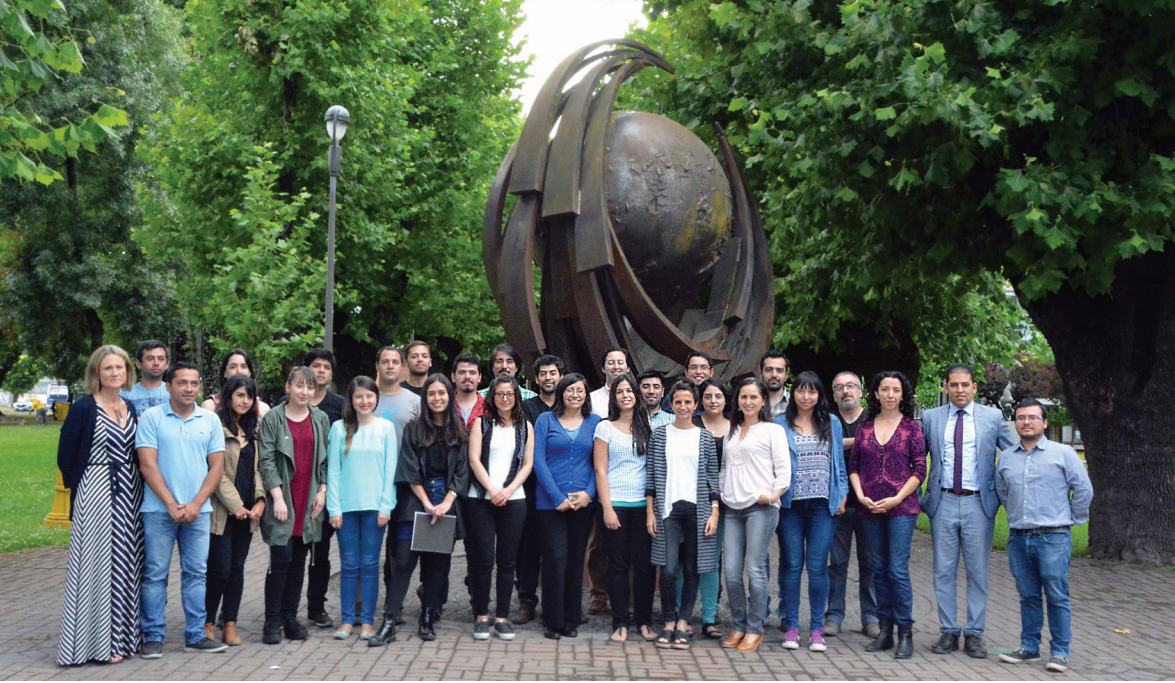
**Travelling Expert:** Prof. Geoffrey van Moeseke and Shady Attia

**Date:** 20-29.07.2018

**Host and Venue:** BioBio University, Faculty of Architecture, Construction and Design

Prof. María Beatriz Piderit, Director of the Architectural Master Programme (Magister en Hábitat Sustentable y Eficiencia Energética)







## EVENTS

Events: Workshops

### **Building Energy Modeling Workshop (Concepción)**

**Date:** 09.01.2017

**Venue:** BioBio University, Faculty of Architecture, Construction and Design

**Participants:** 26 Master I Students

Workshop Outcomes: Chile has outdated thermal regulations for building energy efficiency and the definition of thermal comfort limits needs to be revised. The weather files that were used are not accurate enough and better understanding of local climate is necessary. There is a weak identification of the proper HVAC systems in relation to the strategical choices on the national level for energy mix. The workshop approach and methodology of monitoring based simulation was highlighted by participants as an important and more logical approach to approach building performance simulation.

<http://www.shadyattia.net/academic/WorkshopBEM/index.html>

### **Zero Energy buildings Workshop at UBB (Concepción)**

**Date:** 27-28, 07.2017

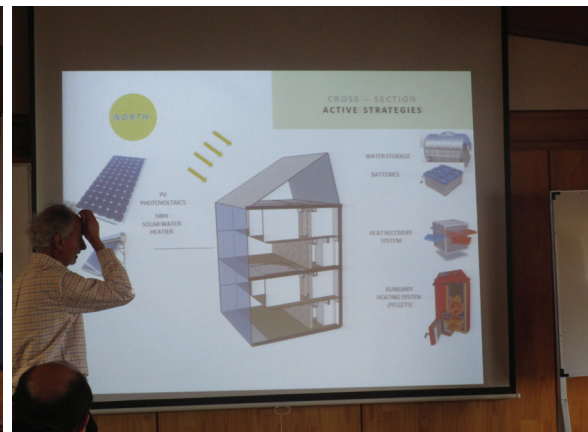
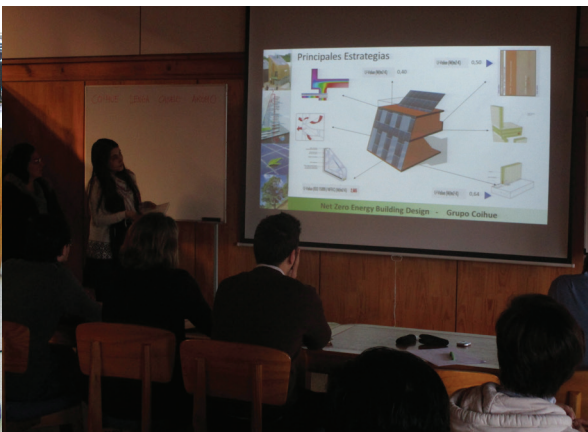
**Venue:** BioBio University, Faculty of Architecture, Construction and Design

**Participants:** 17 Master Students

**Workshop outcomes:** The students are asked to develop a consistent zero energy design for 8 housing units. Details of the exercise may be found at: <http://www.shadyattia.net/academic/WorkshopZEB/index.html>

Students benefited from the exposure to the 'Net Zero Energy Buildings' concept and design decision tools that can be used in real design. The workshop presented active systems and technologies such as the mechanical ventilation with heat recovery and the use of External Thermal Insulated Construction Systems that can be integrated in future design designs. Overall, the training evaluation shows that the satisfaction among student regarding the workshops learning outcomes was 4.5/5 satisfaction.

<http://noticias.ubiobio.cl/2017/07/31/expertos-internacionales-debatieron-edificacion-cero-energia/>







## EVENTS

Events: Lectures at UBB (Concepción)

**Date:** 9-10/01/2018

**Venue:** BioBio University, Faculty of Architecture, Construction and Design – Magister Efficencia Energetica y Edificaction Sustentable

**Content on International standard related to zero-energy:**

- Prof. van Moeseke lectures on the European Energy Performance of Building Directives, its application in Wallonia and Brussels and on the Belgian Passivhaus Standard
- Prof. Attia lectures about LEED certification, emphasizing the multi-objective approach of green buildings

**Content on research experiences in Belgium:**

- Prof. Attia presented the qualities of a good research proposal and method
- Prof. van Moeseke presented examples of energy and green buildings research projects ongoing in UCLouvain

**Expected impact:** to increase the quality of master thesis proposals from the students and to attract them towards Resilient and Zero Energy Building related master thesis subjects, with potential co-supervision between the project's universities (UBB, ULg, UCLouvain)

Events: Seminars

**Title:** Seminario Internacional: Net-Zero y Ecoeficiencia en la edificación

**Facilitator:** Prof. María Beatriz Piderit

**Date:** 12.01.2017

**Venue:** Fundo La Escalera, Concepción

**Participants:** Master I Students and Professional Public

**Website:** <https://welcu.com/universidad-del-bio-bio/seminario-sustentabilidad-en-espacios-educativos>

**Seminar Outcomes:**

- Chile needs to define its energy policy and energy mix.
- The state is not effective enough to carry and push the energy efficiency and climate change agenda. The different governmental authorities work in isolated paths and require a more integrated and collaborative approach from the national policy level to the local neighbourhood governance.
- Chile has developed several passive design guidelines, certification programs
- Chile has a very varying and diverse weather that makes it a testbed for many other Latin American countries.
- The expectations to reach the Zero Energy Buildings Path by 2050 are far away from the current situation.
- There is a serious problem of fuel poverty and comfort deprivation in Chile.
- Indoor Environmental Quality remains a challenge in the building sector.



# 1er Seminario Internacional Net-ZERO y ECO- EFICIENCIA en edificios

12 enero 2017

La primera versión del Seminario Internacional ECOEFICIENCIA Y CERO ENERGIA EN EDIFICIOS 0-eN, que se realizó en Concepción, el 12/01 2017 abordó el tema de la ecoeficiencia y estándar cero energía en edificios. El Seminario se enmarcó dentro de las actividades comprometidas en el proyecto "Resilience & Net-Zero Energy Buildings", que emana de un acuerdo de cooperación bilateral entre Valonia-Bruselas y Chile y que tiene como objetivo principal de avanzar en experiencias relacionadas con edificios que autogeneran energía, mediante fuentes de energías renovables, haciéndolo ecológico y sustentable. Este proyecto es liderado por la Dra. Beatriz Piderit de la Universidad del Bio-Bio, junto a dos universidades belgas: la Universidad Católica de Lovaina-la-Nueva y la Universidad de Lieja. Este evento fue organizado por académicos de la Universidad del Bio-Bio pertenecientes al Departamentos Ciencias de la Construcción y Diseño y Teoría de Arquitectura de la Facultad de Arquitectura, Construcción y Diseño. Desde Bélgica participó, de la Universidad de Lieja, el profesor Dr. Shady Attia, director del "Sustainable Buildings Design (SBD) Laboratory", especialista en cero energía en edificios

<http://mhsee.ubiobio.cl/index.php/2017/01/13/seminario-internacional-net-zero-ecoeficiencia-la-edificacion/>

*La première édition du séminaire international sur l'éco-efficacité "ECO-EFFICIENCE DANS LES EDIFICES 0-eN" a eu lieu à Concepción, le 12/01 2017 et a abordé la question de l'éco-efficacité et des standards « énergie zéro » dans les bâtiments. Ce séminaire fait partie des activités du projet "Resilience & Net-Zero Energy Buildings", inclus dans l'accord de coopération bilatérale entre Wallonie-Bruxelles et le Chili et dont le but principal est de progresser dans la recherche liée aux bâtiments qui auto gènèrent de l'énergie grâce à des sources d'énergie renouvelables, rendant le processus écologique et durable. Ce projet est dirigé par le Dr. Beatriz Piderit de l'Université de Bio-Bio, en association avec deux universités belges: l'Université catholique de Louvain-la-Neuve et l'Université de Liège. Cet événement a été organisé par des professeurs du département des sciences du bâtiment et du département de construction et théorie de l'architecture de la Faculté d'architecture, construction et design de l'Université du Bio-Bio, de construction. Le Dr Shady Attia, Professeur de l'Université de Liège et directeur du Laboratoire de Conception de bâtiments durables (SBD) et spécialiste en zéro énergie dans les bâtiments, venu pour l'occasion, a participé au séminaire.*



COOPERACION INNOVACION



# Construcción sustentable reunió a investigadores locales y extranjeros

El encuentro Net-zero y eco-eficiencia se desarrolló en Chome y fue organizado por la UBB, con profesionales del área de la construcción sustentable de Bélgica y Chile.

## POR SEMANSTIÁN BASSO PLAZA cronista@uzo.cl

Buscando sensibilizar a estudiantes, académicos y profesionales del área de la construcción, se realizó el seminario Internacional Net-zero y eco-eficiencia, reunión que trata la importancia de construir bajo criterios de sustentabilidad.

El evento se realizó en el Fundo La Escalera, camino a Chome en Hualpén, e invitó a actores del sector público y privado relacionados a edificación.

El seminario es parte de un proyecto

**El motivo del seminario fue la construcción sustentable y cómo sentar criterios que aumenten su valorización entre quienes se dedican a la construcción y energía.**

Internacional entre la región de Wallonia, en Bélgica, y el Departamento de Ciencias de la Construcción de la Universidad del Bío-Bío.

### CRITERIOS SUSTENTABLES

El principal desafío de esta actividad es hacer conciencia en los estudiantes de postgrado, profesionales y actores sobre la responsabilidad que implica diseñar y construir bajo criterios sustentables. «Entre Claudia Muñoz, académica e investigadora del Departamento de Ciencias de la Construcción. Algunos de estos puntos a tomar en cuenta al momento de construir son la

temperatura. «En los últimos veinte años se han producido los promedios más altos de temperatura en el mundo, la influencia humana en el medio ambiente es irrevocable», expone el académico Roberto Román, de la Universidad de Chile y especialista en energía solar. La exposición de Román se centró en la relación entre la arquitectura y la eficiencia energética durante este siglo. Es optimista respecto a los cambios en generación de energía, además, afirma que se deben eliminar los carbón y que se debe fomentar una mentalidad que valore la sustentabilidad.

La temperatura también es un tema para Maureen Trebilcock, directora general de relaciones institucionales de la Universidad del Bío-Bío, quien lidera un proyecto que relaciona el tema con los recintos educacionales.

«Los colojos en Chile tienen un estándar de confort térmico muy bajo, en los meses va de 19°C a los 13°C en invierno de uso», comenta la directora.

También asegura que a veces ni siquiera hay calefacción ni sistemas de refrigeración, como ventiladores, por lo que no es un ambiente confortable. «Tiempos establecidas relaciones entre el confort térmico e indicadores socio-



El evento reunió a la Universidad del Bío-Bío y a la Universidad de Lieja y U. Católica de Lovaina, ambas de Bélgica.

les como a sustrato de clases. Para onocar un mejor diseño se deben conocer las distintas realidades locales», enfatiza Trebilcock.

### ALIANZAS

Parte de los ejes estratégicos de la UBB se centran a la eficiencia energética como un pilar en los criterios de construcción

sustentable.

El seminario, realizado en Chome, en Hualpén, se enmarca en un proyecto de cooperación entre las Universidades de Lieja y la Católica de Lovaina de Wallonia en Bélgica, y el Gobierno de Chile llamado «Resilience & Net-Zero Energy Buildings» el cual dura desde 2016 y partirá en 2016. Dicho proyecto es liderado por Beatriz

Piderit, directora del Magister de Hábitat Sustentable y Eficiencia Energética de la UBB.

Respecto a usar un fondo para la realización del seminario, Piderit apunta a que «se realiza el espíritu de la naturaleza eligiendo a un país en nuestro cotidiano para reflexionar el valor de los recursos naturales».

Jueves 12 de enero 2017, 8:30 am a 6:00 pm

Fundo la Escalera, Camino a Chome, Km 3,5, Fundo Las Escaleras Talcahuano (Concepción)

El Seminario internacional Net-Zero y Ecoeficiencia en la edificación, busca sensibilizar a profesionales del sector público y privado del área de la construcción sobre los desafíos que debemos enfrentar al considerar la eco-eficiencia y construcción cero-energía.

Este evento cuenta con expositores internacionales y nacionales pioneros en los ámbitos de Ecoeficiencia y Net-Zero energía en las edificaciones y es organizado por la Universidad del Bío-Bío con el apoyo del proyecto de cooperación bilateral entre la región de Wallonia y el gobierno de Chile, titulado «Resilience & Net-Zero Energy Buildings» en el que participan la Universidad Católica de Lovaina, Universidad de Lieja y la Universidad del Bío-Bío.

Algunos de los expositores son: **Shady Attia**, experto en edificios Net-Zero de Bélgica, **Madelyn Marrero**, experta en eco-eficiencia de España, **Roberto Román** del Centro de Energía (CER) del Centro de Modelamiento Matemático (CMM) de la Universidad de Chile, **Guillermo Hevia** de *Guillermo Hevia y Cia Arquitectura*, entre otros.

El ticket incluye almuerzo y certificación

Más información y venta de Tickets

## Programación

12 de enero de 2017

8:30 AM – 9:00 AM	M. Beatriz Piderit Acreditación y Bienvenida
9:00 AM – 9:50 AM	Roberto Román Arquitectura y Eficiencia Energética en el siglo XXI
9:50 AM – 10:20 AM	Margarita Cordero
10:20 AM – 11:10 AM	Shady Attia Zero Energy Building Design and Construction: Challenges and Recommendation for Robust Performance
11:10 AM – 12:00 AM	Guillermo Hevia
12:00 PM – 12:50 PM	Maureen Trebilcock Los edificios no consumen energía, las personas sí.
12:50 PM – 1:20 PM	Mesa de discusión
1:20 PM – 2:20 PM	Almuerzo
2:20 PM – 2:50 PM	Claudia Muñoz Construcción sustentable en Chile a partir de la Eco Eficiencia
2:50 PM – 3:40 PM	Velux VELUX: Sustainable Living in Buildings
3:40 PM – 4:10 PM	Ariel Bobadilla Materiales de construcción ecoeficientes.
4:10 PM – 5:00 PM	Madelyn Marrero Huella Ecológica y Gestión de RCD para Construcción Ecoeficiente
5:00 PM – 5:30 PM	Marcos Brito Programa estratégico nacional: Productividad y construcción sustentable
5:30 PM – 6:00 PM	Mesa de Discusión



ESCUELA DE CONSTRUCCIÓN CIVIL  
CIUDAD DE INGENIERÍA



Grupo de Investigación Urbano Sustentable junto a la Escuela de Construcción Civil UC , presentan:

21 de Julio  
2017

## Seminario Eficiencia Energética en Edificación : Tendencias y Desafíos

Seminario realizado con el aporte de la Vicerrectoría de Investigación de la Pontificia Universidad Católica de Chile

ORGANIZA



COLABORA



### Objetivos

- Generar análisis y discusión sobre las tendencias y desafíos de la eficiencia energética en el sector residencial.
- Convocar desde la academia a especialistas en Eficiencia Energética, específicamente Edificios Zero Energía, para que comenten acerca de la evolución en edificaciones nuevas y reacondicionadas.
- Reunir a académicos locales para que compartan su visión respecto a la eficiencia energética residencial y su relación con el comportamiento de los usuarios, en un contexto nacional.

¿Deseas conocer más acerca de los desafíos en construcción sustentable?

Ven el  
21 de Julio de 2017

Auditorio Principal del Centro de Innovación UC Anacleto Angellini, Campus San Joaquín, Pontificia Universidad Católica de Chile.



**Events: Seminars (Santiago)\***

**Title:** Seminario Eficiencia Energetica en Edification at UPC (Santiago)\*

**Panel:** Dr. Leonardo Meza, Prof. Shady Attia and Prof. Geoffrey van Moeseke

**Date:** 21.07.2017

**Venue:** Prof. Felipe Ossio, Pontificia Universidad Católica de Chile, Escuela de construction civil

**Participants:** nearly 50 construction Professionals / academics

**Website:** <https://www.seminariogius.com>

**Seminar and associated discussions outcomes:**

- Chile is updating thermal regulations for building energy efficiency, but this effort is limited to reinforced insulation requirements. They are still far from a comprehensive EPB system as implemented in Belgium.
- Concern is rising regarding indoor environmental quality. This topic is seen as a more powerful driver for building improvement and technology development than energy efficiency. The concern of zero energy is considered as subordinated to the prior implementation of adequate comfort and sanitary levels in a large part of the building stock. Belgian experience regarding air quality and thermal comfort is valuable.

\* This activity is not part of the official project program and based on the initiative of Prof. van Moeseke and Prof. Attia



## Events: Seminars

**Title:** International Seminar Simposio Internacional Arquitectura Cero Energía

**Panel:** Eight lectures are given, including Prof. Attia's and Prof. van Moeseke's. Topics are on the legal framework, the design tools, the technologies and the field experience of zero energy building and retrofitting.

**Date:** 27.07.2017

**Venue:** BioBio University, Faculty of Architecture, Construction and Design

**Participants:** Latin American and European Academics, Master Students and Professional Public

**Website:** <https://welcu.com/universidad-del-bio-bio/seminar-io-internacional-arquitectura-cero-energia>

The symposium was held on Thursday, July 27 between 2:30 p.m. and 7:00 p.m. in the auditorium of the faculty of Engineering in Timber, under the modality of discussion tables. The lecturers and experts in the subject were distributed at the tables, each of one with an assigned topic and with a question to guide the discussion. Likewise, a representative was chosen to recording the most important ideas and consolidating the response of each table, which was presented at the end of the event. Here is the summary of the most important ideas presented by each Round Table.

### **Round Table 1 | Technology and Architecture Zero Energy**

What technology to develop or transform for the implementation of Zero Energy buildings in Chile?

Experts: Shady Attia | Andrés Montero | María Elena Soldatti

Representative: Laura Marín Restrepo

There are technologies in Chile that can support the implementation of Zero Energy buildings, as well as the potential for the use of alternative energies and the technical knowledge for its development. Therefore, the implementation challenges are political and cultural, as well as it is essential to educate the end users of the buildings on issues of sustainability and efficiency.

Before thinking about technologies or specific design, the city must be planned. Having a regulated and planned urban growth is necessary for energy efficiency and environmental comfort strategies can work. Likewise, it is important to optimize passive strategies first, since in some regions in Chile it is not necessary to invest heavily in technology so that a building consumes less energy and people are comfortable.

It is also considered that culture is important within the space needs and comfort requirements, so it does not apply the same standard. The concern is generated, for example, how to conserve heat and/or heating without using mechanical ventilation? Is it possible? The Zero Energy standard points to greater isolation

and necessarily involves mechanical ventilation, however, people in Chile, or at least Concepción, are not familiar with airtight and automated spaces. Can Chileans adapt to artificial environments? Is it necessary in this context? It reflects that a balance must be found between the perception of people and their requirements, with the mechanical systems that are implemented.

The role of real estate and state regulation is fundamental since they usually point to interests that differ. There is pressure from real estate and the construction market to reduce energy efficiency requirements. The option of centralized heating systems, for example, should be stated initiatives, because the real estate market does not support it because it is not convenient for it. Remains the concern about how communities would use these systems in a society such as Chile.

On the other hand, mandatory certification is necessary for effective communication with users. If the buildings declare their performance and the users are informed, they will know what decisions to make and could demand efficient buildings.

Similarly, given that there is a gap between the design/technologies and the construction and operation of the buildings, it is necessary to invest in skilled labour and in trained users to make an actual implementation.

Regarding users, strategies should be sought to change the mentality of making decisions based on immediate impacts by decisions based on performance and long-term, to actually make investments. For this, the technology must be durable, because, in that way, the users know that the investment is worth it. Likewise, buildings must be functional, fulfil their basic purpose and be simple, so that people accept and demand Zero Energy buildings. Technologies do not need to be high range, they can be simple and they are already in the market. Simple home automation, for example, can be used to support efficient use.

Finally, regarding the heating requirement, which is the one that demands the most energy in the southern of Chile, it is believed that a change of mentality in people must be pointed out, because, although there are more efficient and less polluting technologies, traditional heating is cheaper and people do not want to change it.

## **Round Table 2 | Zero Energy Retrofit**

What opportunities or restrictions have the application of the concept of Zero Energy Architecture in buildings retrofit in Chile?

Experts: Luis Braganza | Geoffrey Van Moeseke

Representative: Jeremy Piggot



**Opportunities (Cultural / economic)**

- Incorporating the concept of Zero Energy Architecture in buildings retrofit allows improving the hygrothermal, luminous and acoustic comfort for users.
- Long-term energy savings generates significant monetary benefits.
- The incorporation of this type of measures in the building helps to achieve the energy independence in much of the building of the country.
- It generates a synergy that allows the production of jobs in areas already consolidated for professionals and construction workers.
- If this type of rehabilitation is tackled collectively the benefit may become more feasible.

**Opportunities (Urban)**

- Urban Regeneration and Smart Cities. The city can generate a brand associated with the rehabilitation of its older infrastructures.
- The urban centres have suffered decay and the urban expansion for residential purposes occurs mainly in the periphery. The old buildings located in the centre of the city offer the opportunity to be rehabilitated and made more attractive if they integrate bioclimatic variables.
- Environmental
- The reuse of structures decreases carbon footprint.

**Restrictions (Cultural / economic)**

- A change in the mentality of the people is necessary since retrofitting is not usually quite striking because although economic compensation can be quite beneficial in long-term, the initial costs associated can be very high.
- Retrofitting buildings with these criteria need instructed users to make a correct use of this.

**Restrictions (Governmental)**

- Lack of legislation and financial assistance from the government, the incorporation of rehabilitation subsidies with Zero Energy Architecture criteria could encourage the reduction of a large part of the demands on existing buildings in Chile.
- Retrofitting with Zero Energy criteria in heritage buildings can become quite complicated due to the legal restrictions that exist regarding its modification, and the impact on the particular aspirations of the community.

### **Round Table 3 | Architecture Zero Energy Politics**

What opportunities or restrictions have the application of the concept of Zero Energy Architecture in new constructions in Chile?

Experts: Felipe Encinas | Javier del Rio

Representative: Susan Agurto

It is agreed that in Chile is not feasible to implement the Net Zero standard, but what must be done from the scope of the policy is to define its own standard, feasible to implement and according to the Chilean context.

The economic factor, investment and cost of the constructions prevent that a standard like the Net Zero can be implemented. It is necessary to differentiate the solutions considering the conditions of local comfort and not under wide parameters that do not differentiate the exigency according to the climate of each locality.

It is necessary to implement economic incentives that motivate the private to invest in such constructions and at the same time create a system that regulates the value that the private will estimate in their projects since the objective would be that the costs for the users do not increase. The normative change is necessary and complementary to the energetic qualification and certification. Progress must be made in both aspects.

It will be necessary, in addition, to carry out an important diffusion campaign to put in value the implementation of sustainable constructions, creating this awareness in the users.

It is necessary to develop a clear roadmap: to update thermal regulation so that it is a requirement to the private; to consolidate the information in a clear plan and to be a legal instrument, as well as to make the population aware of the concepts of sustainability.

### **Round Table 4 | Comfort, Energy Poverty and Zero Energy Architecture**

What challenges has the implementation of Zero Energy Architecture to achieve environmental comfort in buildings and reducing energy poverty in Chile?

Experts: Cristina Engel

Representative: Paulina Wegertseder

The measures to be implemented must respond to the context in which it is inserted. Perhaps it is easy to reach a Zero Energy standard, but is it enough to achieve it? Are there no other priority problems? Is it what people need?

There are user habits that show that they are not prepared for certain strategies, for example, ventilation. A challenge is to be part of the design process to the user because they will realize its role. Involving the user is key for a correct use of the building and greater awareness.

In general, independent of the building sector that seeks to improve, it is necessary to involve the user from two perspectives: 1. In the design process as a fundamental variable, as well in the construction stage; 2. Educate him for the stage of use of the building.

On the other hand, it is not enough to reach a Zero Energy standard in a building if you do not consider other deficiencies that influence the user comfort. Energy efficiency must be integral, as a strategy or goal.

### **Round Table 5 | Zero Energy Architecture Implementation**

What actions should be taken to ensure that the community demands Zero Energy buildings in Chile?

Experts: Beatriz Piderit | Jesús Pulido

Representative: Matías Tapia

Detecting key stakeholders (individuals and institutions) across the whole society, that are influencing decision-making in the construction sector.

Organizing activities that integrate these actors, communities and private and public institutions, with all intermediate levels needed to be carried out (broadcasting, meetings, conversations). Efforts should be made to include the private sector (real estate, industrial sector, etc.).

Conducting informational workshops for communities, for example, neighbourhood associations, social groups or parent centres, to address the issues of energy efficiency of buildings. Participation of parents in school communities can be used to make broadcasts.



Mesa 4 | Confort, pobreza energética y Arquitectura Cero Energía

¿Qué desafíos tiene la implementación de la Arquitectura Cero Energía para alcanzar confort ambiental en edificaciones y disminuir la pobreza energética en Chile?

SIMPOSIO  
INTERNACIONAL

ARQUITECTURA

**CERO ENERGÍA**

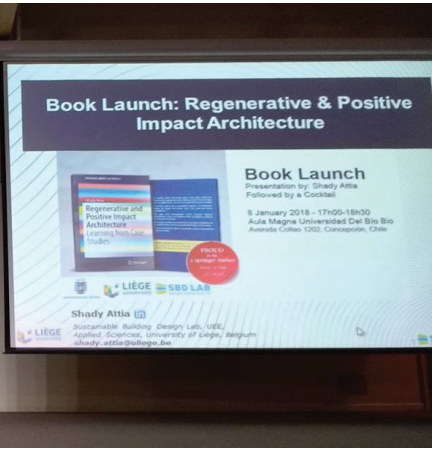
**Round tables are organized. The outcomes of the round tables are the following:**

- Technologies to develop in Chile regarding ZEB buildings: needed technologies are available in Chile. There is a need for raising the population awareness regarding comfort management and energy use. More consistent regulations and certifications framework seem suitable in that perspective, including in situ controls.
- Opportunities of NZEB retrofitting in Chile: opportunities are obvious on the social and economic aspects. Urban regeneration may Profit from NZEB retrofitting operations. So do outdoor air quality. Limitations are identified on the cultural and governmental levels. In particular, there is not understanding of the comfort and efficiency improvements that can be achieved through retrofitting.
- Opportunities of NZEB new buildings in Chile: There is a need for a local definition of NZEB, adapted to local comfort levels. Economic incentives are needed. A communication campaign around NZEB aspects are needed to raise awareness among users.
- Relations of NZEB with comfort and fuel poverty in Chile: NZEB concept should be redefined to include concerns about global comfort (including air quality). In addition, this concept might be perceived as less important than the improvement of comfort or safe, housing safety, security and hygiene.
- Actions to take: Identify stakeholder to reach a critical mass in favour of NZEB buildings in Chile; Organize events for dedicated private and public and large; Organize large scale comfort and energy efficiency events.





**Lanzamiento libro:  
Regenerative and  
Positive Impact  
Architecture**  
17:20 - 18:40  
Dr. Shady Attia



### Events: Accreditation

**Title:** Ceremony of accreditation process closing 2017-2022

**Panel:** Prof. Beatriz Piderit

**Date:** 08.01.2018, 17:00-18:30

Official ceremony celebrating the 5 year accreditation obtained by UBioBio for the Magister Efficencia Energetica y Edificaction Sustentable

The Master in Sustainable Habitat and Energy Efficiency, since its creation until 2017, has aimed to train specialists in the design, integration, analysis and evaluation of projects for the development of sustainable habitat. The year 2008 was accredited by the National Commission of Accreditation (CNA-Chile), which is a public and autonomous organization, whose purpose is to verify and promote the quality of higher education institutions in Chile. On that occasion, the master program was accredited for 4 years and in 2017 again it was granted accreditation for 5 years, until 2022.

The main objective of the MA program is to train a graduate with a high level of specialization in sustainable habitat and energy efficiency in the built environment, with advanced competencies to integrate the climate, energy and well-being of people as a basis for project development and research. Graduates should be able to apply solid knowledge, generated from research, in the design, integration, analysis and evaluation of energy-environmental projects for the benefit of sustainable development and quality of life at National and Latin American level.

### Events: Book Launch Event:

**Title:** Book Launch: Regenerative and Positive Impact Architecture

**Panel:** Prof. Shady Attia

**Date:** 08.01.2018, 17:00-18:30

**Participants:** nearly 30 Professionals, academics and students.

**Website:** <https://welcu.com/universidad-del-bio-bio/lanzamiento-libro-regenerative-and-positive-impact-architecture>

Book presentation of Prof. Attia « Regenerative and Positive Impact Architecture »

Networking event in presence of the rector of the Biobío University and the Dean of the Faculty of Architecture, Construction and Design





## MASTER THESIS AND PHD SUPERVISION

### **Doctoral Seminar UBB**

**Date:** 10/01/2017

- Content
- Prof. Attia took part to the intermediate evaluation of three on-going doctoral theses at UBB.
- Laura Marin: Occupant behaviour in office spaces in Chile (Advisors: Dra. Maureen Trebilcock and Dra. Paulina Wegert-seder).
- A student supervised by Prof. Rodrigo Garcia Alvarado

### **Doctoral Seminar UBB**

**Date:** 11/01/2018

#### **Content**

- Prof. van Moeseke and Prof. Attia took part to the intermediate evaluation of three on-going doctoral theses at UBB.
- Lucas Aranga Diaz (Advisor: Dra. M. Beatriz Piderit)
- Jose Porras: Thermal environment impacts on schoolwork performance and implications for educational architecture in tropical climates (Advisors: Dra. M. Beatriz Piderit and Alexis Perez)
- Laura Marin: Adaptation by coexistence: a comparative study of thermal comfort in individual and shared office spaces in Chile (Advisors: Dra. Maureen Trebilcock and Dra. Paulina Wegert-seder).



# Towards an integrated approach for zero energy schools in Chile: a comparative study with Belgium.

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## ABSTRACT

In Chile, there is a shortfall in the quality of school buildings, that is seen in the low standard of thermal comfort in the classrooms with temperatures as low as 8°C in a city with a Mediterranean climate in winter [1]. The Chilean Government has promoted some policies and investigation projects to improve this kind of buildings, however, none of them have become in a regulation, leaving the decision of what and how to improve in hands of the owners. The aim of this work was to inform and influence decision makers at government level to adopt Net Zero Energy Schools policy. Highlighting the importance for Chile to have strategic NZES to be useful in a catastrophe case, exploring also, the feasibility to become more attractive to owners and administrators, to improve in a right way their buildings and to build new ones with better indoor conditions and high energy efficiency standards. At the present, no study has been carried out related to the NZES goal in Chile. The follow work presents an assessment of the state of the art of regulations, concepts, and technologies to reach the NZEB, to provide a snapshot of the existing scenario of the school buildings and the perspective to apply the NZEB concept in Chile. Several definitions of NZEB, regulations, studies and standards that are in force in Chile were analyzed and put them in perspective. Then a comparative study was made with Belgium in order to establish a pathway of strategies to the implementation of this target in Chile. A holistic analysis of the Strength, Weakness, Opportunities and Threats (SWOTs) was made to establish the lacks, and the feasibility of implement NZES and a group of recommendations was delivered to reach this goal in Chile.

## KEYWORDS

Thermal Comfort – Recommendations – Energy Regulation – Fuel Poverty – Social resilience – Zero Energy Buildings.

## PROBLEM

Chile is having a serious challenge with the educational infrastructure and facilities in the future years and in its expectations of grows.

- A low standard of indoor quality in the scholar buildings, which usually are working as free running even in climates with low temperatures in winter and high temperatures in summer. The year 2012 the Ministry of Education made a cadaster of infrastructure which result was a total of 7538,2 m<sup>2</sup> built in a 5530 schools [2], none of the study variables was indoor comfort or energy efficiency.

- There is a limited regulation on environmental comfort in schools, classrooms only required to achieve a minimum of 12°C when they have a heating system (south latitude 36°) and 2 air changes per hour when mechanical system is required [3], there is no regulation for energy efficiency in schools.

- Due to the constant happening of catastrophes in Chile, it is common that the government use the scholar infrastructure like refuge or operation center. For example for the alluvion of 2015 in the north of the country 15 schools buildings of the Atacama region were use like refuge [4].

- It is projected that Electricity consumption in Chile will increase from 49.518 Gwh in 2015 a 81.652 Gwh in 2035, the energetic matrix of Chile in 2014 it was a 35,3% coal and 31,3% hydroelectric, renewables only reach to 2,7% [5], which is why Chile need to find strategies to diversify its source energy production.

## OBJETIVE / HYPOTHESIS

- Propose a definition of Net Zero Energy Schools for Chile.
- Identify gaps, needs and opportunities to implement Net Zero Energy Schools.
- Share and disseminate the results of the study.

## AUDIENCE

Schools Owners, Government Decision Makers, Design Teams.

## RESEARCH QUESTION

- How to develop an integrated policy for Net Zero Energy Schools in Chile?
- How to influence government entities and regulatory bodies to adopt the NZES Target?

## ORIGINALITY

At present, no study has been carried out related to the Net Zero Energy Schools goal in Chile. The present work seeks to establish recommendations related to the implementation of the NZES target, finding the barriers and potentialities, in this way to influence the decision making regarding this type of buildings.

## METHODOLOGY

1. Literature Review of several topics to establish a base line of the state of the art in Chile about the NZES.
2. A comparative study and lesson learned between the case of Chile and Belgium in order to extract strategies, to implement an integrated policy view.
3. A Holistic analysis of the Strength, Weakness, Opportunities and Threats was made to establish the lacks, and feasibility of implement this target in Chile.
4. Interviews and brainstorming sessions to establish recommendations for implementing the target NZES in Chile.

## RESULTS

SWOT Analysis for apply NZES in Chile	
<b>Strengths</b>	<b>Weakness</b>
<ul style="list-style-type: none"> <li>• Having a holistic concept that embrace Energy Efficiency, comfort and renewables</li> <li>• Can provide refuge during catastrophes for local communities</li> <li>• Improve comfort conditions and IESD for school buildings</li> <li>• Increase operational energy yield</li> <li>• Increase the Architectural, Engineering and Construction industry and increase the leadership for high performance building in Latin-America</li> </ul>	<ul style="list-style-type: none"> <li>• Low dedicated budget for to construct school buildings</li> <li>• Lack of technical information and dependence of imports for technological components</li> <li>• Lack of knowledge competency and skills needed for design and construction of NZES</li> <li>• Lack of technological infrastructure including both necessary systems and controls or building systems, and components, this will force the imports and increase the cost</li> <li>• The absence of agreements regarding the infrastructure, government, different governmental authorities.</li> </ul>
<b>Opportunities</b>	<b>Threats</b>
<ul style="list-style-type: none"> <li>• Accidents, to achieve Chilean goals to increase the national resilience in school buildings</li> <li>• Develop adaptive comfort model for school buildings in Chile</li> <li>• Transforming the built environment, by implementing NZES and integrate it with cases for energy resilient buildings</li> <li>• Can be used to reach the Net Zero concept in Chile</li> </ul>	<ul style="list-style-type: none"> <li>• Not embracing facility management to optimize the quality and operation of buildings</li> <li>• Failing to build consensus among decision maker, families, government and local authorities</li> </ul>

Table 1. SWOT analysis



Figure 1. Roadmap Low-Tech approach to NZEB target

Table 2. Comparison results

• Performance requirements
• Comfort and Air quality
• Envelope and Passive design
• HVAC + RES
• Controls and occupants



Figure 2. Roadmap High-Tech approach to NZEB target

## CONCLUSION

- 1.- In order to implement the NZEB target in Chile, the national building codes has to update to align them with the NZEB requirements.
- 2.- More detailed studies and research should be conducted in the area of thermal behavior of schools .
- 3.- This study present an overview of the state of the art of regulations and standards that are now in force in Chile.

## Resources

Design Builder Software, Data of occupancy measure of the schools studies.

## References

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- [2] Portal web mineduc. Catálogo de infraestructura escolar. [http://portal.mineduc.cl/index2.php?file\\_portal=07&id\\_seccion=4907&id\\_contenido=27664](http://portal.mineduc.cl/index2.php?file_portal=07&id_seccion=4907&id_contenido=27664), 2012.
- [3] DS 548, Aprobada normas para la planta física de los locales educacionales que establecen las exigencias mínimas que deben cumplir los establecimientos reconocidos como cooperadores de la función educacional del estado, según el nivel y modalidad de la enseñanza que impartan. Biblioteca del Congreso Nacional de Chile, Santiago, 2012.
- [4] Reconstrucción de la Región de Atacama. Información del catastro de viviendas y utilidad pública. Ministerio de Vivienda y Urbanismo, Gobierno de Chile, Abril 2015.
- [5] Energy Supply Security, Emergency Response of IEA Countries 2014.

## Master Thesis Supervision

### 1) *Thesis Title: **INTEGRACIÓN DEL CONCEPTO CERO ENERGÍAS PARA ESTABLECIMIENTOS EDUCACIONALES EN CHILE***

*Master student: Franklin VIVANCO*

*Supervisors: Beatriz Piderit and Shady Attia*

*Developed in collaboration between **UBB** and **ULiège***

**Abstract:** In Chile, there is a shortfall in the quality of school buildings, that is seen in the low standard of thermal comfort in the classrooms with temperatures as low as 8° C in a city with a Mediterranean climate in winter [1]. The Chilean Government has promoted some policies and investigation projects to improve this kind of buildings, however, none of them have become in a regulation, leaving the decision of what and how to improve in hands of the owners. The aim of this work was to inform and influence decision makers at government level to adopt Net Zero Energy Schools policy. Highlighting the importance for Chile to have strategic NZES to be useful in a catastrophe case, exploring also, the feasibility to become more attractive to owners and administrators, to improve in a right way their buildings and to build new ones with better indoor conditions and high energy efficiency standards. At the present, no study has been carried out related to the NZES goal in Chile. The follow work presents an assessment of the state of the art of regulations, concepts, and technologies to reach the NZEB, to provide a snapshot of the existing scenario of the school buildings and the perspective to apply the NZEB concept in Chile. Several definitions of NZEB, regulations, studies and standards that are in force in Chile were analysed and put them in perspective. Then a comparative study was made with Belgium to establish a pathway of strategies to the implementation of this target in Chile. A holistic analysis of the Strength, Weakness, Opportunities and Threats (SWOTs) was made to establish the lacks, and the feasibilities of implement NZES and a group of recommendations was delivered to reach this goal in Chile.

*Key Word:* Nearly Zero, Net Zero, Passive House, Energy Policy, Social Resilience, Comfort.

*Thesis Submitted: September 2017*





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## Master Thesis Supervision

### 2) Thesis Title: **METODOLOGÍA para la REHABILITACION ENERGETICA d'EDIFICACIONES PATRIMONIALES RESIDENCIALES EN CHILE: PABELLONES DE LOTA**

*Master Student: Susan AGURTO*

*Supervisors: Beatriz Piderit and Geoffrey van Moeseke*

*Developed in collaboration between UBB and UCLouvain*

**Abstract:** Currently in our country and as a result of new public policies for urban development and quality of life, private investment and public plans and programs have been increasing with a focus on building sustainable buildings in various facilities and in the residential sector. In the National Policy for Urban Development "Sustainable Cities and Quality of Life" of the Ministry of Housing and Urbanism implemented in 2014, it is expressly indicated thematic areas to work in coherence with the environmental care and value of the patrimonial. These correspond to: Environmental Equilibrium (Manage efficiently natural resources, energy and waste) and Identity and Patrimony. In Chile, the valuation of patrimony is a recent and sensitive concern. Due to the large number of natural catastrophes occurring in the country, maintenance of patrimony is a complex task and, in many cases, only the collective memory transmitted through the story from generation to generation has remained. The city of Lota has been at regional and national level an example of the Industrial Patrimonial Carboniferous and its preservation. This coastal settlement was born by the installation of the industry and its urban planning and architectural typology respond to foreign patterns mainly English, adapted to the territory. The complex Industrial carboniferous has a way of life of its own, following prototypes of English mining camps, a model evolved by the incorporation of brick masonry structures, after the earthquake of 1939. The precariousness of the houses, which at first did not count with drinking water, forced to share communal spaces such like ovens, clothes washers and water basins, which originated organizational strategies that made the miners of Lota develop a deep identity, which remains until today.

*Key Word:* energy efficiency, renovation, heritage, housing, architecture

*Thesis Submitted:* March 2018



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## Master Thesis Supervision

### 3) *Thesis Title: **INTEGRACIÓN DE CRITERIOS DE RESILIENCIA Y SUSTENTABILIDAD PARA EL DISEÑO DE EDIFICIOS EDUCACIONALES EN CHILE***

*Master Student: Matías TAPIA*

*Supervisors: Beatriz Piderit and Shady Attia*

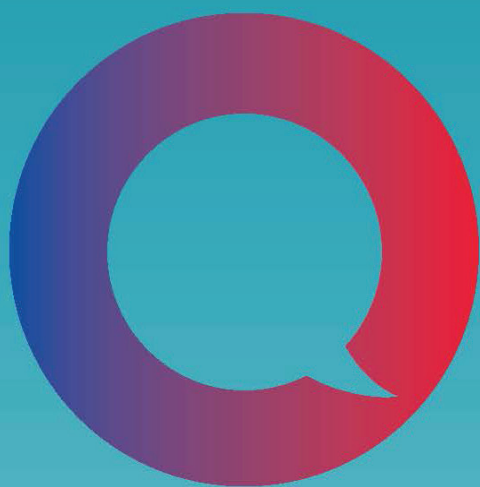
*Developed in collaboration between UBB and ULiège*

**Abstract:** Currently, the application of the resilience concept into edifications context is understood only as the capacity of the buildings to resist the impact of the critical events or natural disasters, what constitutes only a small part of the whole wide concept of resilience. To recognize other dimensions where this concept could be applied into edifications offers the big possibility of design better buildings, more prepared, resistant and adaptable, in the context of climate change and the increase of occurrence of natural disasters in Chile and the world. The objective of this thesis is to expand the actual approach of resilience in edifications through the incorporation of sustainability criteria design, exploring the different synergies that may exist between both in the architectural context. Through an exhaustive literature review and the analysis of the certification system RELI® it was possible to identify four aspects where sustainability and resilience converge in the field of architecture, from where was possible to elaborate ten general design criteria organized in three fundamental aspects of the project: Site; Building and Installations. To determinate the extents and the grade of applicability of these criteria it was developed an educational building project localized in a representative zone of Chile in risk matters. It was selected this type of building because has been historically observed the critical function of these facilities in events of natural disasters in our country.

*Keywords:* Design Criteria, Resilience, Natural Disasters, Educational Buildings, Sustainability

*Thesis to be submitted:* October 2018





# ENERGÍA 2050

POLÍTICA ENERGÉTICA DE CHILE



## PUBLICATIONS

1. *Submitted to: Journal of Renewable & Sustainable Energy Reviews*

**Title: A PATHWAY FOR NET ZERO ENERGY SCHOOLS IN DEVELOPING COUNTRIES**

*Authors:* M. Beatriz Piderit M. and Franklin Vivanco and Shady Attia

**Abstract:** Lately there has been an increasing development of the Net Zero Energy Building (NZEB) concept in developed countries. Europe has established that by 2020, 100% of public buildings will be nearly zero [1]. However, it is evident that there is a difference between the government level, the technological-industrial development, the human capital and the scientific research between developed countries, such as Belgium and developing countries like Chile. The aim of this research is to present a guideline for developing countries to progressively implement the Net Zero Energy Schools concept (NZES). For this, a review of the performance standards state-of-the-art and a case comparison was made. The results of the comparative analysis indicate the need to set out a low-tech concept to reach the NZES target. A focus group with experts was held to establish a roadmap and the most important aspects to consider in its implementation. The role of the different sectors and the standards to be developed in order to implement the NZES concept were discussed.

*Keywords:* Energy policy, Thermal comfort, Energy building, School performance, Nearly Zero Energy Building (nZEB)

2. *Submitted to: Revista de la Construcción*

**Title: NET ZERO BUILDINGS - A NEW CHALLENGE FOR CHILE**

*Authors:* M. B. Piderit, Franklin Vivanco, Shady Attia, Geoffrey van Moeseke

**Abstract:** The potential of CO<sub>2</sub> mitigation related to the building's energy can be achieved through energy policies, progressive goals and support systems to attain sustainable constructions that guarantee the reduction of emissions. Nearly Zero Energy buildings (NZEB) are a system which allows moving forward in this area. This has been demonstrated by more developed countries which have set goals and challenges to progressively approach a nearly-zero energy balance (nZEB). The target of this research is to define the challenges to reach NZEB in Chile, through an exhaustive review of the energy policies, NZEB definitions and components of an NZEB system. It is complemented by a qualitative investigation, through a focus group with Professionals from the area to know the vision, problems and possible solutions regarding integration, focused on policies, implementation and technologies, for NZEB buildings in Chile. It is concluded that we must ad-



vance in public policies to achieve an interaction with the network, with the implementation of a calculation and weighting system that allows integrating the value of the primary energy within the energy balance, being necessary.

*Keywords:* Energy efficiency - Energy policy - Nearly Zero Energy Building - Energy demand - Thermal Comfort.

3. *Under Development:*

*Title:* **THE ENERGETIC REHABILITATION OF RESIDENTIAL HERITAGE BUILDINGS IN LOTA CHILE.**

*Authors:* Susan Agurto, M.B Piderit and Geoffrey van Moeseke

4. *Submitted to:* Journal of Energy and Buildings

*Title:* **DEVELOPMENT OF NEW ADAPTIVE COMFORT MODEL FOR LOW INCOME HOUSING IN COLD CLIMATE**

*Authors:* Alexis Pérez-Fargallo, Jesús A. Pulido-Arcas, Carlos Rubio-Bellido, Maureen Trebilcock, Maria Beatriz Piderit Moreno, Shady Attia

**Abstract:** Adaptive comfort plays an important role in defining comfort standards when considering comfort in buildings in the free-running mode, including adaptation to external temperatures, opening of fenestration and change in clothing. With this respect, two international standards provide the fundamental basis to model the necessary equations: EN 15251:2007 and ASHRAE 55-2017. This research intends to assess the feasibility of the application of such standards to the Chilean context, which is starting to implement a legal framework in order to regulate comfort of occupants in social housing. Extensive monitoring of inhabitants in existing units under free-running mode has been undertaken in several social housing projects in the city of Concepción (Chile) and collected data has been contrasted against the international standards. Results show that users in these houses show more tolerance to cold temperatures, thus, despite being allocated under lower limits of the standards, they are considered to be in thermal comfort. As a consequence, the outcomes of this research can shed light into the feasibility of applying international standards to social housing and low income families in Chile. The study presents a proposition for a novel adaptive comfort model for Chile. The new model proposes the adaptation in the lower limit of thermal comfort threshold in order to develop a national standard that better reflects the needs and socio-economic culture of inhabitants. The study demonstrates how the proposed model best fits the thermal comfort conditions in social housing in Chile.





**CHILE MEJOR**

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Comuna de Tomé, región del Bío Bío.

Inversión: \$ 57.025.841.-  
Fecha Inicio: 16 de Agosto de 2016  
Plazo Ejecución: 120 días  
Contratista: Empresa Constructora Construmil Ltda.



## PROPOSALS DEVELOPMENT

### 1. *Under Development*

#### ***Title: DEVELOPMENT OF A METHODOLOGY TO INTEGRATE RESILIENT ARCHITECTURE IN NATURAL DISASTER AREAS***

*Scope:* The occurrence and amplitude of natural disaster will rise in the coming decades due to climate change and poorly urban development. In case of emergency in urban areas, the existence of safe places might be decisive to help casualties and emergency rescue teams to organize and deploy. Safe places are disaster proof buildings (earthquakes, flooding, etc.) providing basic services such as fresh water, power, medical material, etc. to the neighboring community, while dedicated to other purposes in other times, such as schools, sport facilities, etc. The design of those places has to be managed in order to answer to local context and risks, and to be self-sufficient or autonomous regarding energy and other fluxes, therefore based on zero-energy design principles and technologies.

### 2. *Under Development*

#### ***Title: ICT tool to promote nature based solutions in the urban space***

*Scope:* Develop a platform which allows involving city communities and neighbors on the diagnosis of local and urban problems related to: Floods and micro floods risks, Needing of Green infrastructure and waste management problems. This information can be complemented with information from the local government, risk management offices and other official sources. With this information a GIS maps can be created to allow visualize the data in different layers. Crossing the different information will allow making some correlations between these problems, and identifying them and visualize their location and impact on the community. In a next step, the platform will allow to integrate NBS, through an inventory of Solutions and providers that can suit the solution in an affordable way. In this step, it's possible to integrate municipalities, entrepreneurs and researchers in to pose the different kind of solution, to different problems.

### 3. *Idea*

*Title: Disaster management and autonomous refuge buildings*

### 4. *Idea*

*Title: Design of affordable low energy buildings prototype*







## VISITS















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## CONCLUSION

### Opportunities & Ideas for Future Collaboration:

In Chile, there are disparities of research topics and serious knowledge gap in several field related to high performance buildings, issues such as adaptive comfort, HVAC systems, air quality, weather analysis and affordability of a strategical importance for Chile. Adaptive thermal comfort, timber construction, passive house standard, heating systems, schools design, materials database and life cycle assessment are all areas of potential exchange and research. One of the potential collaboration projects between Chile and Belgium is to work on autonomous buildings for disaster proof neighbourhoods. The following item summarize our reflection:

- There is a need to increase knowledge about safe, secure and healthy housing and indoor environmental quality in fuel poverty situations. Lessons can be learned in Chile and open practical implementations in concerned sectors in Belgium
- Energy efficiency based discourses do not reach the public because of poor indoor comfort conditions.
- Any improvement in the building technology is expected to improve the safety, security and health in housing and comfort levels rather than reduce energy consumptions.
- Various technologies existing in Belgium might be suited for the Chilean environment, in particular ETICS insulation systems, high efficiency wood stoves and natural or mechanical ventilation systems.
- Theoretical knowledge of energy efficient technologies and concept is high among Chilean designers and regulations are strengthening (although they stay weak). However, their building industry suffers from a lack of quality management. Belgium is facing a similar problem, but at a much lower extend.
- Our Chilean partners consider that there is a lack of concern about air quality and thermal comfort, and environmental issues on a larger way, among the Chilean population. Exemplary and well-documented case studies might be suited to raise awareness. There is a need to join the forces with experts in the public health sector.





## PEOPLE

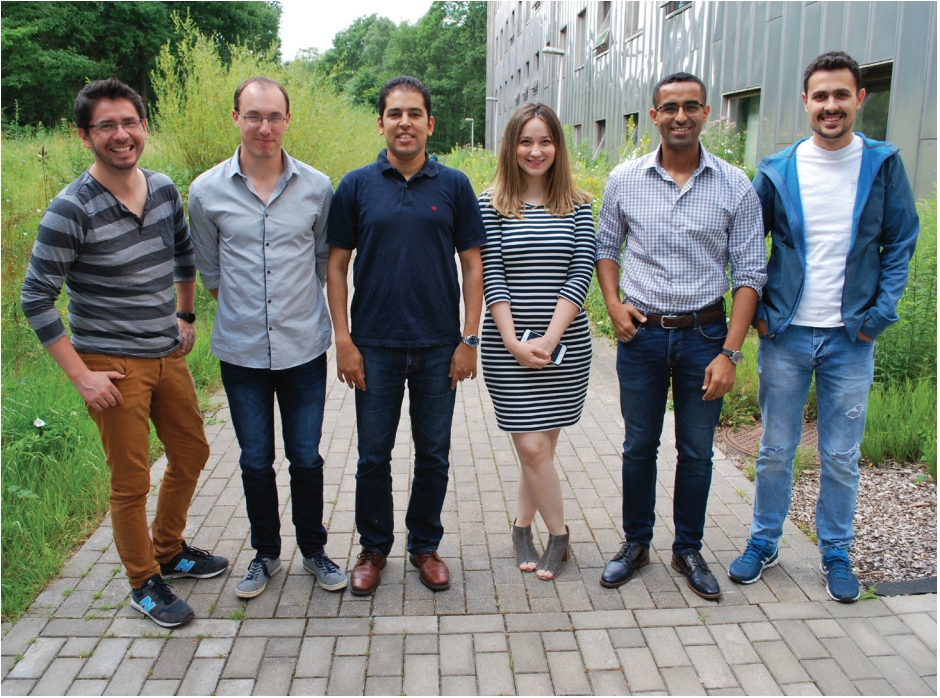
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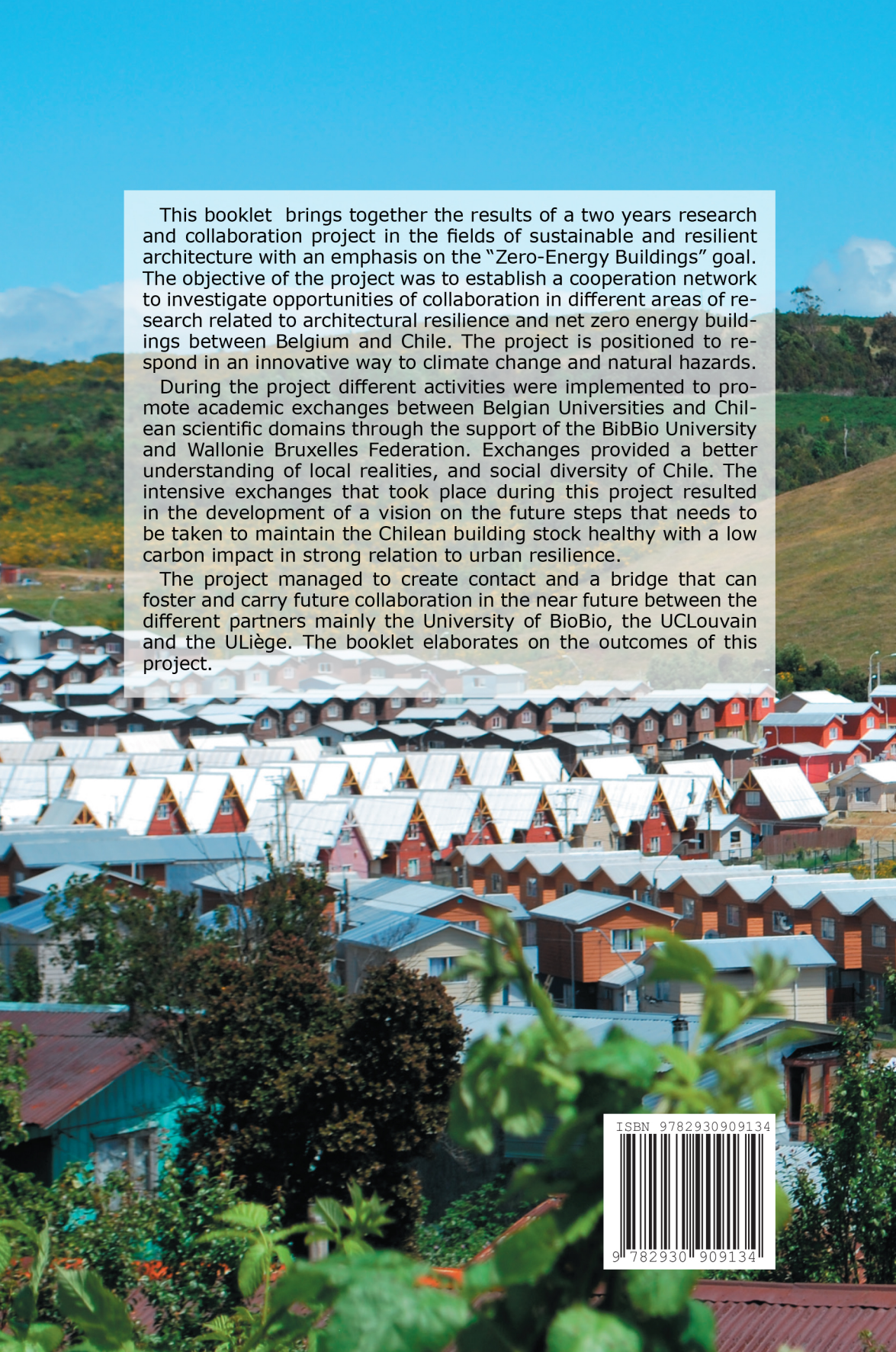




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This booklet brings together the results of a two years research and collaboration project in the fields of sustainable and resilient architecture with an emphasis on the “Zero-Energy Buildings” goal. The objective of the project was to establish a cooperation network to investigate opportunities of collaboration in different areas of research related to architectural resilience and net zero energy buildings between Belgium and Chile. The project is positioned to respond in an innovative way to climate change and natural hazards.

During the project different activities were implemented to promote academic exchanges between Belgian Universities and Chilean scientific domains through the support of the BibBio University and Wallonie Bruxelles Federation. Exchanges provided a better understanding of local realities, and social diversity of Chile. The intensive exchanges that took place during this project resulted in the development of a vision on the future steps that needs to be taken to maintain the Chilean building stock healthy with a low carbon impact in strong relation to urban resilience.

The project managed to create contact and a bridge that can foster and carry future collaboration in the near future between the different partners mainly the University of BioBio, the UCLouvain and the ULiège. The booklet elaborates on the outcomes of this project.

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