Tropically Adapted Green and Energy Efficient Residential Building: A Universal Trial based on Holistic Passive Technology

Results and Conclusions of a Longitudinal Study

in the

Triple Green
Mock-Up Building Park Research

at the

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CHAPTER 1: Introduction and all Appendices

Prof. Dr. Karl Wagner
1) School of Business, Universiti Kuala Lumpur, 50250 Kuala Lumpur, Malaysia
2) Technical University of Applied Sciences, 83024 Rosenheim, Germany

Dr. Siti Fatihah Salleh
Universiti Tenaga Nasional, 43000 Kajang, Selangor, Malaysia

Abstract / Preface

Several attempts had been made in tropical countries to conduct green mock-up research on which parameters can better withstand the heat. Walls, windows, roofs, floors and even shadings have been tested in mainly so-called contrived experiments. The challenge is to bring all relevant parameters into play in different weather situations *whilst expelling* the interference of the *outside* air. This is happening anyway for most commercial buildings and integrated passive houses in other hemispheres alike, but it is not common for tropical residential building strategies which are focus in this publication.

Based on this integral approach in Malaysia with sidelines of Singapore, our team could make use of a database of 250 days from 2014-2019. We cross-examined mainly 4 typically hot months in the year 2017 in detail with 3 adjacent real mini-residential green and 1 red building(s) with the same positioning. One of these months, August 2017, surprisingly turned out to be a cool *transition month* in retrospect, with different yield features compared to those typical for three more rampant transition months in 2017 and 2018.

Out of the real hot months studies we received indications that the well insulated, basically almost *airtight* and optimum *shaded* building is cooler in almost all cases during the wet and the increasing number of transition periods. The same research pattern accounts for 2/3 of all cases during the 6 remaining months of the “hot” and transition season as well. However, in 1/3 of the cases under observation during the hot seasons of 3+ days with no rain interference, the green Passive Holistic building tends to become equally hot as the red building – and sometimes even hotter. This is an odd that most tropical passive buildings in a low altitude without the assistance of active cooling might have to face.

Under the weather conditions of **t**ropical Malaysia from the standards and literature we derived a **r**esidential **t**hermal **c**omfort (TRTC) level of not exceeding 28.6°C. This astonishingly maximum temperature included reasonable ventilation of maximum 0.7m/second. The Passive Holistic design will work best in a combination of nighttime active usage of green cooling (i.e. ventilation or water-based cooling ceilings). During daytime, among other related modules we will look in, cooling is based upon insulating PLUS shading – best of course without occupants as interfering heat generators. If air condition units (A/Cs) are still used which is undoubtedly correct, even in a “red” building 26% daytime and 62% nighttime of the energy can still be saved by a simple smart power interrupter system without focusing on passive elements like insulation and shading.

As the authors we are aware of the fact that the results are temporary and not fully satisfactory for researchers who follow strictly the positivist scientific paradigm. On purpose, and by default with restricted resources, our approach is different. At the expense of accuracy, we have taken on one of the most challenging research tasks to walk on the thin line of creating a sensitising concept (Herbert Blumer) for green & energy efficient tropicalized residential buildings. Of course, it is hoped that other researches will follow with more accurate positivistic research to verify or falsify our preliminary findings by testing hypotheses for a much more sustainable triple green living concept in the age of global warming. As long as the mock-up buildings are still there, they can be used at anytime for further testing, 24/7 or 365 days a year to open the door for a holistic understanding of the best option of sustainable high quality affordable homes represented by the integral passive house approach. We have a secret passive recipe, but no secret: They can be rebuilt and optimized in different latitudes and altitudes.

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List of Symbols and Abbreviations

BCA	:	Building Construction Authority Singapore
BEX	:	Building Exposition Singapore
HIGH4	:	Walls, Windows, Roofs/Ceilings and Floor as independent variables
IPHA	:	International Passive House Association
IPHS	:	International Passive House Simulation Software
GBI	:	Green Building Index
HDB	:	Housing Development Board Singapore
TRTC	:	Tropical Residential Thermal Comfort
TEPC	:	Tropical Energy Performance Certificate
WWR	:	Windows-Wall Ratio

Chapter 1: Introduction to Triple Green

The Concept of Triple Green Bottom Line

The original triple bottom line was issued as a generic guideline by the United Nations 25 years ago[i]. It comprises of 3 simple angles as a yardstick of which needs societies and mankind altogether should fulfil on planet Earth:

Ecology/environmental issues (and respective needs)
Economic needs
Social needs

The authors have explicitly translated the triple green bottom line into the *magic* triangle of green and energy efficient buildings for Passive Holistic design. The triangle can be considered “magic”, because its three angles in real life often are believed to exclude and stand against each other:

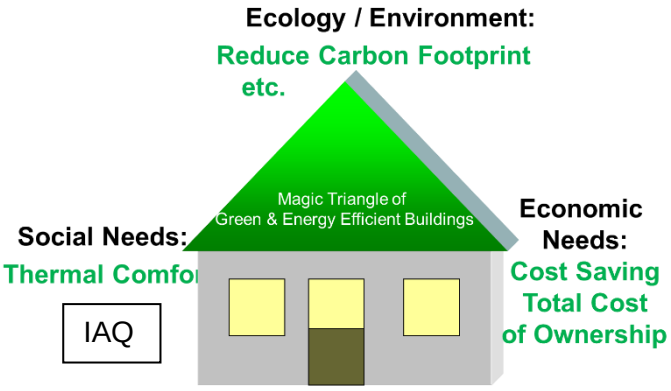

Figure Error! No text of specified style in document.**.1: Magic Triple Green Bottom Line Triangle of a Green and Energy Efficient Building**

This book moves another pathway blending all three together. Clearly, TRIPLE GREEN has an added value compared to SINGLE GREEN and DOUBLE GREEN.

SINGLE green would mean we would like to satisfy EITHER contribute towards a greener environment which reaches back to the original meaning of green our own “green” needs to feel comfortable, OR to save costs for a green sustainable budget.

DOUBLE green will balance and reconcile at least 2 of the 3 angles, typically to make it thermally comfortable AND help to protect our environment at the same time, but it will face higher investment costs until the implementation. Double green is the most common standard the diverse spectrum of green building certifications around the globe thrive on.

By neglecting economic needs, however, it is commonly believed that an owner who invests into a green building ultimately needs a painstaking budget. A person who has high economic needs will probably not embark into green and energy efficiency. As our own green building awareness study (2012f.) shows, it is believed that the magic triangle on this count is irreconcilable. As a consequence, a green and energy efficient building may not be deemed payable for mass appreciation.

Finally, **TRIPLE GREEN** as the summit and final motivation for buyers to venture into green, tries to find and probe tailored ways to make especially ***affordability / Total Cost of Ownership (TOC) and operational costs*** absorbable for almost everyone[ii].

As a conclusion, the magic triangle (in a positive sense of meaning) reconciles the angles for the building's stakeholders (inventors, constructors, developers and occupants). How can we combat climate change from the building perspective which accounts to an ever increasing 1/3 of tropical? Thinking the triple bottom line of the UN thrust further, how can we generate green in terms of environment protection, indoor health and comfort PLUS affordability. So we turned the thrust into an action plan for green & energy efficient buildings in the tropics by creating the Triple Green Mock Up Building Park with "green" and conventional "red" houses. Their purpose is to showcase systematically how to reduce CO2 and other triggers of climate change that threaten the built environment, relating them back to indoor air quality and affordability at the same time.

The Creation of the Triple Green Mock Up Building Park

The story of the Triple Green Mock Up Building Park begins already 2009 when me (KW) was asked to import a fully fledged study program called "Master of Green & Energy Efficient Buildings" (MGEEB) to Malaysia. In a partnership with UniKL, the German Academic Exchange Service (DAAD) spent more than 430,000 EUR to build up the program and bring in a flying Faculty from Germany to teach. But what I found there was no holistic product such as a "GEEB". What we had was just the idea of exporting profound tested knowledge based on technology of the Passive House from my home University of Applied Sciences in Rosenheim / Germany which since the Solar Decathlon competition in Madrid appears a global champion in green building technology. Most lecturers exported primarily their particular knowledge in their subjects, but not an explicit *holistic* approach as Passive Houses stand for.

Between 2010 and 2018, we visited almost all green building fairs and expos, starting 2010 from Greentec Asia, IGEM, EcoBuild and Archidex in Kuala Lumpur and BEX in Singapore to find partners for business match making of what we call ***the tropically adapted Passive House***. By a simple survey with selected exhibitors we found a growing number of providers with green components to become partners in our project. Symptomatic became my icebreaker question during visiting expos in Malaysia, Singapore, Thailand and Cambodia: "You are selling walls?" The answer was "undoubtedly we do sell *green* walls with high insulation features". When I asked "What about the windows, and the frames?" The answer was "this is none of our core businesses. We just sell one component which is the wall (OR vice versa any other green module)".

Green tropical certification tools like the Green Mark or the Green Building Index adapted the idea of measuring carbon footprints of a residential dwelling as one unassuming criterion and not the real bottom line of. Else they followed and still follow the same particular track to look into things. The developers of Green Mark and Green Building Index did not fully consider the universal interplay of the 7 or 8 constitutive parts of a holistic passive house and never looked into Triple Green's costs and affordability. And they, altogether motivated green-hearted professionals I got to know, got trapped in their overwhelmingly increasing rules and regulations. The World Green Building Council will not interfere. As a whole, we all want the same, but the way forward is blocked since the uphill struggle of the Kyoto protocol and the Paris agreement.

I guess nobody minds if we jive technologies from different areas. For instance, one of our attempts to liaise a locally leading sensor company with appropriate shutter technology for shading led into a typical impasse of organizational hurdles, and their own regulations of business development. No action was taken towards *joint* product development, because due to company's policies strategic partnerships are rarely to be forged. With one exception, no tropical supplier in all fair between 2010 and 2018 thought about selling a universal green building in its entirety. The company, managed by a British citizen that tried so, were not understood and rejected as the costs were not laid out and anyway seemed to be soaring. So their main sellable particular product ever remained insulation material for walls and roofs.

Hence, the target of our joint project where we gathered wall, windows, roof and floor providers is the entirety of a tropically adopted low energy or passive house. It is not about testing singular elements, but as mentioned their interplay in a system adapted from the Passive House. To summarize, these are the three main objectives

- Assist countries in focus of this research like Malaysia and Singapore to invent and practise strategies to reduce global warming for the built environment. Even for Singapore, even though the activities are well advanced, backlogs to practice triple green as a benchmark are evident.
- Research and develop a tropically adopted green & energy efficient building which is comfortable inside and more affordable as is commonly believed
- Help the sponsors to explore, benchmark and promote their products as an entire system with reasonable inputs and payback periods.

The former Deputy President of the University of Kuala Lumpur (UniKL), Prof. Dato Dr. Mazliham Mohd. Su'ud, was one of the first people I chose as visionary supporter of the Malaysian mock-up building park in 2012. That was the time when he was approached to assist the project, inspired by the former President of UniKL, Prof Dato' Dr Abdul Hakim Juri. Even in his position as the incumbent President of the University, Prof. Mazliham, was still involved with his support.

Business School and Electrical Engineering students of UniKL were there to make the project happen. Their assignments were to develop green information material for the sponsors out of the research that has been conducted until November 2019. They gave their full support for Malaysia's green future. The support from Singapore was more like waiting for the results, which might be today. Addressed as partners, we have two training providers among us, who can probably set our knowledge gained into short courses and create applicable knowledge for practitioners, how to build new and green existing buildings.

Finishing the story, me and my co-author Dr. Siti Fatihah Salleh may express a BIG thanks to our team, first and foremost Dr. Mohd Khairil Rahmat (now Director of the University's Research Unit) who supported this project continuously in a professional and cooperative manner. I need to mention Dr Yanawati who spearheaded the recent research in 2019 when I was about to phase out. A further 'thank you" reaches out to all our 15 sponsors and partners who were willing to donate their green building material or equipment from Malaysia and Singapore for the construction of 3 green mock-up buildings and one conventional. Without you people we would not be privileged to be here to organise this meaningful groundbreaking triple green setup at an exciting moment in history when Global Warming exceeds the digestible carbon footprint and allowable average temperature in the years 2016 and 2017. A deeply felt gratitude goes

also to our team, staff, 200 Business students who measured the data and some MGEEB-students who were and are the users of this promising project by their Master theses. Thanks to the sponsors/partners, to the supporting lecturers of the Green Building Master at the University of Applied Sciences in Rosenheim, who all helped me together with Dr. Jürgen Schnieders from the International Passive House Institute in Darmstadt. Thanks to the architects Gernot and Rena Valentin in München and to Prof. Dr. Helmuth Gesch and Stephanie Bacon, who inspired me with their application and technical knowledge of their own Passive Houses. Thanks to Gregers Reimann, green building engineer and Managing Director in tropical Singapore and Malaysia, who paved the way by his profound knowledge and openness to discuss with me. Finally, to the UniKL team, and everyone involved in the activities around the Mock Up Buildings.

We as authors do not know about your involvement in single, double or triple green. Single - people who want to be environmental-friendly. Double - people who invent or practice green certification tools. And triple - people like many of us, who would like to invest, if it is somehow financially rewarding. Yes, people tend to put the environment at second place after they think of themselves. Sounds egocentric, but realistic, and if we can prove it is working especially for residential housing… many deals can be forged to combat global warming from bottom up. Then double green, the precious work of the certifiers, can come in with revamped standards of economic benchmarks like capital and operational costs.
Having provoked that way, now let us turn the clock forward to “Friday for the future” and for every day of the future! We will see below that often it occurs that we do not have to invent the wheel again.
In order to combat global warming by triple green, it is not only the time to retrieve solutions. Furthermore, we need to get the message across for developers, architects, civil engineers and of course for the buyers. We find plenty of instructions and videos in this complexity of information.
Only a few are up to the point, like the Youtube video clip “Passive House in 90 seconds”, or other clips which are related to practitioners. Academics who present excellent or so not excellent papers, often cannot reach out “to whom it may concern”. So let us all find our way to Triple Green, or give it up, if you feel it is not striking.

Before we start talking about our idea of global warming in the tropics, let me try to do my part after 10 years experience with my understanding of a **real green sustainable reducing carbon emission Triple Green building**, based on what I learnt from the “Dean of Sustainable Buildings” in America, Prof. Joe Lstiburek.

A building is an “artificial separator between outside and inside”.

Easy as that, except maybe for the natural dwellings of cavemen….A sustainable triple green building, I would like to add on with Joe’s consent, is a building that does not only separate, but also can ***connect or reunite outside and inside*** at reasonable acceptable costs. It should be properly insulated and airtight to separate, but also provide opportunities to let occupants feel that they are connected with outside’s mother nature. This is where the trouble began, when in our chapter on windows we refer to architects in love with daylighting: They became also “façadists” (to paraphrase them again with Joe Lstiburek), providing window-wall ratios of up to 100%, especially for commercial buildings.

What might be applicable in countries of the cold hemisphere, was 1:1 copied to warmer (sub)tropical countries. And it was likeable for the buyers, because glazing seemed to the only way to make especially a commercial building look state-of-the art. Didn't they know that every square centimeter of sun onto created window space depending on its features weighs many times more than if it hits just even a thin-layered wall? The whole architectural concept of 50-100 years ago were thrown over board, because it looks more esthetic and sexy to sell glaze palaces rather than narrower window spaces like in the traditional architecture in Mediterranean countries. There the windows-wall ratio is 1:9 which still creates visibility during the daytime, but restricts the influence of the sun tremendously. So façadists became trouble makers, they should know that even green building standards take ample glazing for granted and inspire them to venture into glazing. Despite extremely low heat resistance values of R2, certification tools LEEDS will not punish the certified body by investing into a high windows to walls ratio. The list of green certified glaze palaces is almost endless, but ecologically it makes no sense to reward buildings with ample glazing façades. The pain pressure is low, because energy efficient air conditioners will kill any heat, and pretend the world inside the separator is in order. What I am expressing is no inquisition, but a desperate cry to revamp practice and standards with a concept of single PLUS double PLUS triple green for the masses of population. Every glaze palace will not help to reduce global warming. It is worth with the sunshine duration and direct intermittence of the sun through the window panes. How much more air conditioners do we need if we just set up the same architecture in Singapore or Rio de Janeiro like where it came from in cities like Paris or New York? In these cities of the North, people are mostly grateful for the sun shining. Even though this gets probably less true in the decades of unstopped Global Warming with the atmosphere on average heated up by 1.5 °C since 1880.

Putting emphasis on the windows in the beginning, that means we have not forgotten the traditionally most "separating" factor of a building, which are the walls. In ancient times, when humans came from caves, stone dwellings or igloos, the walls were often the only separators. Up to the second half of the 20th century, when Global Warming exacerbated, walls predominated and windows were there to provide daylighting (I doubt that otherwise due to more artificial lighting the electric bill soared..). Now what are *green passive walls*? Or should I ask first, what are common walls (our chapter 4.1.1)? Demolishing old buildings which do not longer serve their purpose or are financially no longer sustainable, makes visible how buildings were. Still they are being constructed in counties without or insufficient green regulations: most commonly bricks or concrete walls, plaster outside, plaster inside and paint. That's all. I may guess that in those just 10 cm thickness comprising tropical walls the situation the heat rejection is shallow. The alternative of a professional **wall, floor** and **roof** as the still missing components to create any green building envelope is more sophisticated. Together with the **windows**, we will call these the "HIGH 4" basic passive elements of a building, with roofs as ceilings in double and more storey buildings, and windows including also doors (chapter 3 on methodology).
Let us begin the journey, or jump aboard at whichever chapter you would like to..

IT WOULD BE AN HONOUR AND PLEASURE IF YOU LIKE OUR IDEAS AND/ OR GET IN TOUCH WITH US TO DISCUSS WITH US EVEN IF YOU DISLIKE. THE BEST, HOWEVER, IS BELIEVED IF YOU GO

ALONG YOUR OWN WAY TO CREATE, REFURBISH AND LIVE IN A TROPICAL RESIDENTIAL BUILDING. THE VERY BEST IS WE BELIEVE THAT IN THE END IT IS ENTIRELY PASSIVE BUILDING AND CAN REDUCE YOUR ENERGY BILL BY UP TO 80% AT REASONABLE INVESTMENT COSTS AND PAYBACK PERIODS. NOW GOOD LUCK FINDING THE CHAPTERS WHICH YOU THINK ARE THE MOST PROMISING FOR YOU.

REFERENCES

[i] First coined in 1994 by John Elkington, the founder of a British consultancy called Sustainability http://www.economist.com/node/14301663.
[ii] Total Cost of Ownership (TCO).