



White paper - b-panel® Building System

Abstracts

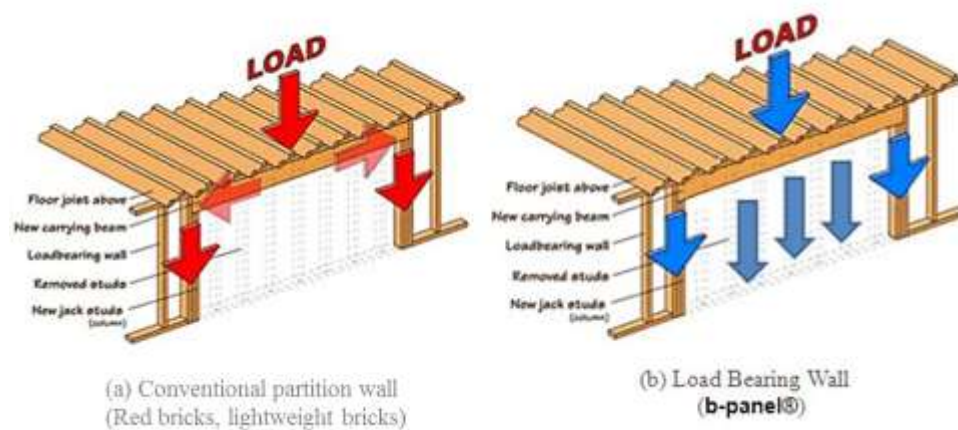
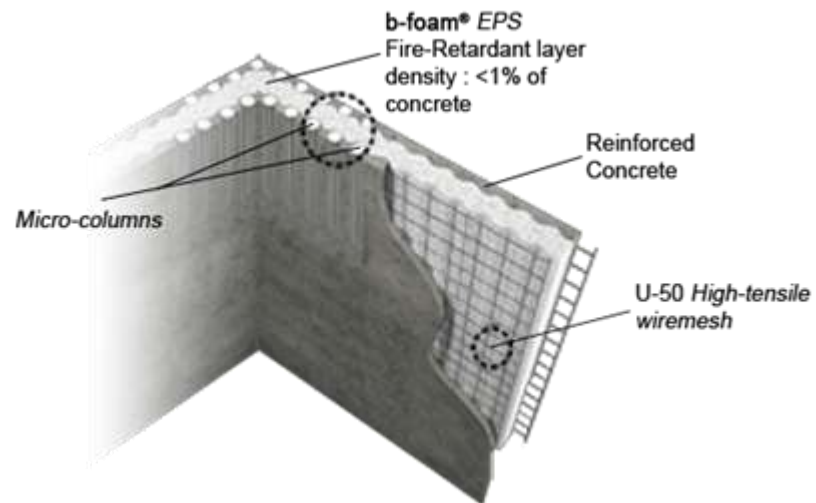
It is about time that we question the relevance and effectiveness of the bricks family (clay/red bricks, concrete blocks “batako”, lightweight bricks/AAC) widely used for construction in the region. Bricks are fundamentally inefficient, both from the point of view of installation process, as well as in regards to its structural function. Whether the heavier, traditional red/clay bricks, or, the lighter aerated/AAC bricks, after they are installed, bricks has no other function but just as filler for a wall. Bricks only add to the weight of the building, do not enhance the strength of the structure, and do not offer significant thermal and acoustic insulation. The most glaring weakness of the bricks family is: the lack of *safety net* during earthquake. By only relying on mortar spacer between the bricks, when the mortar is loosened by seismic vibration, there is absolutely *nothing* that holds the bricks from falling down and potentially endangers the dwelling’s inhabitants, regardless how solidly built is the structure of the building.

Despite the many flaws of the bricks family, and that some of these flaws could be fatal, they are still until today the preferred methods in building for many areas in the region. The key to their success is merely low cost (red bricks, concrete blocks) or familiar installation method similar to bricks (lightweight bricks / AAC).



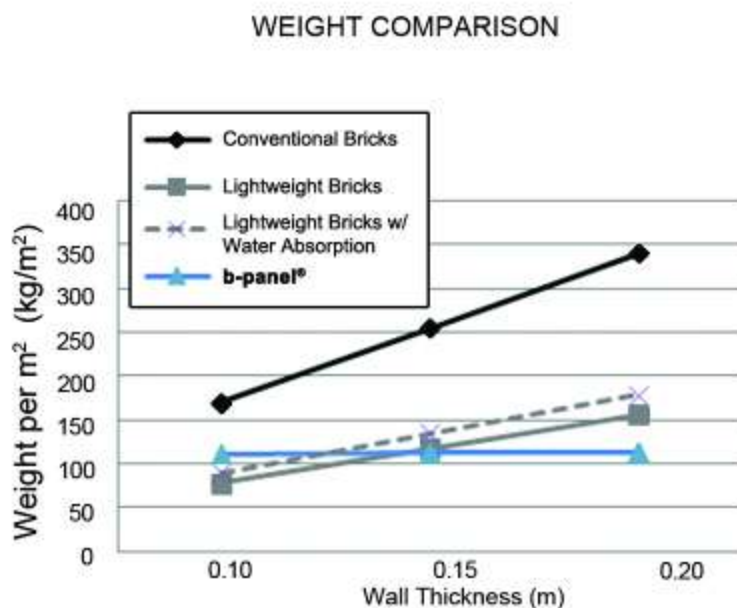
b-panel[®] is a reinforced concrete sandwich panel system, insulated with fire-retardant **b-foam**[®] Expanded Polystyrene (EPS). This offers excellent thermal and acoustic insulation characteristics, superior earthquake resistance, as well as other benefits. The ultra-light **b-foam**[®] EPS functions as formwork for the reinforced concrete during plastering, negating the needs for expensive and time-consuming formwork. Concrete is applied continuously, resulting in a monolithic, extremely rigid lightweight shell. Permanently buried within the reinforced concrete sandwich, the EPS layer forms an exceptional thermal and acoustic barrier.

The earthquake safety performance of **b-panel**[®] is far superior compared to bricks family, afforded by its superior static strength (both compressive and shear), as well as an exceptional catastrophic safety factor, in which all surface of the building is secured by high-tensile wire matrices, and thus eliminates the possibility of falling chunks during earthquakes.



Building Weight Reduction

One of the unique characteristics of **b-panel**[®] is the *non-linear* relation between its weight and the wall thickness. Red bricks and lightweight bricks are homogeneous material: as the wall thickness is doubled, the weight per given area doubles, and so forth. **b-panel**[®] wall, on the other hand, maintain almost constant weight per given area as the wall thickness is increased. This is due to the composite system of **b-panel**[®], where the reinforced concrete thickness is kept constant regardless of the wall thickness, and the thickness of EPS insulation layer, which specific weight is approximately 1/200 that of concrete, is the adjusted variable. Beside maintaining its low weight, thermal and acoustic insulation properties of the wall improves further as the EPS thickness is increased. The benefit of reduced mass is especially relevant for high-end hotels and other development, where optimal insulation and premium feel (from thick walls and door/window frames) are desired. Our calculation so far have shown a total building weight reduction of between 25-35% by using **b-panel**[®], when compared with conventional bricks. Beside the significant improvement in earthquake performance (Lighter *and* stronger than bricks), with the mass reduction comes cost savings from reduction in foundation and structural members requirement.

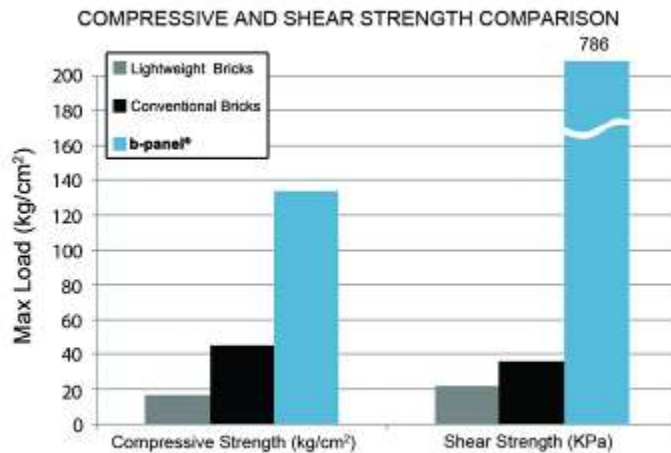


Sources : PT. Beton Elemenindo Putra R&D

Is **b-panel**[®] wall lighter than lightweight bricks/ AAC?

The answer depends on the wall thickness. Less than 12 cm thick, a lightweight bricks/AAC wall is slightly lighter than that a **b-panel**[®] wall. However, this slight weight advantage is irrelevant, considering the much lower compressive and lateral shear strength of lightweight bricks compared to **b-panel**[®], or even red bricks. Secondly, without functioning as load-bearing member, light brick wall is structurally inefficient. Its most critical weakness is that, by only relying on mortar as adhesive for the bricks, in the event that the mortar layer delaminates due

to earthquake, there is absolutely nothing to keep brick chunks from getting loose, fall down, and harm the occupants of the dwelling, regardless how strong is the structural columns.



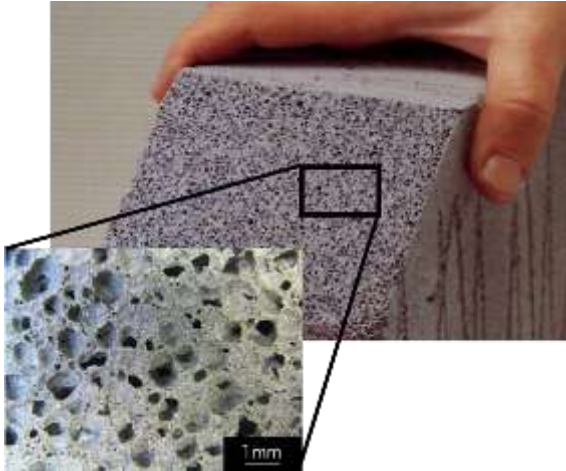
Sources : PT. Beton Elemenindo Putra R&D, ITB Civil Engineering Lab
M. Z. Kabir and M. H. Nasab "Mechanical Properties of 3D Wall Panels Under Shear and Flexural Loading"



Other issues with “lightweight bricks”

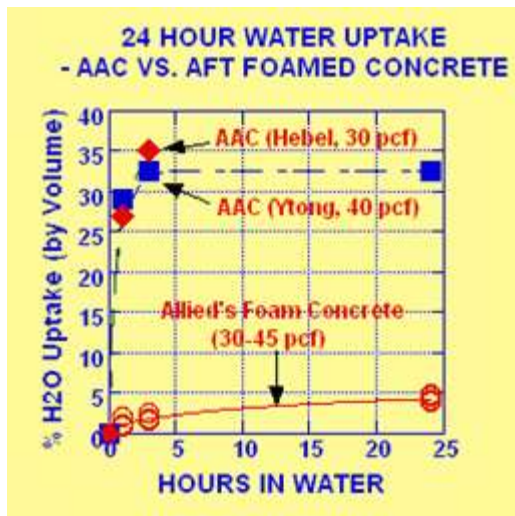
Lightweight bricks – from its naming, clearly emphasizes the relatively lower weight compared to traditional bricks– possess one less-than-ideal characteristic, which is a relatively high water absorption rate (aside from an even lower strengths compared with traditional bricks)

Both our own testing, as well as independent sources available publicly, have shown that within its service life, lightweight bricks can absorb up to 130kg/m³ of water in high humidity/high annual rainfall common in the region. Beside making “lightweight” bricks heavier overtime, water is a good heat conductor, and thus worsening the thermal insulation property of lightweight bricks with the increased water content within the bricks. With the pores which are visible with the naked eyes, lightweight bricks have hygroscopic property: it keeps absorbing water, retains it, until saturation is achieved.



Lightweight bricks sample, sunk under water, BAUMA Munich 2010

Other long-term problem associated with moisture absorption within a wall is that when the humidity reaches the inner side of the wall, fungi and other organism can flourish, increasing the potential for sick-building syndrome. On the contrary, the hygienic EPS layer of **b-panel**[®] consists of many closed cells, where air, as well as water, cannot move across. The small gap between the cells contributes to a low overall water saturation rate of less than 3%.

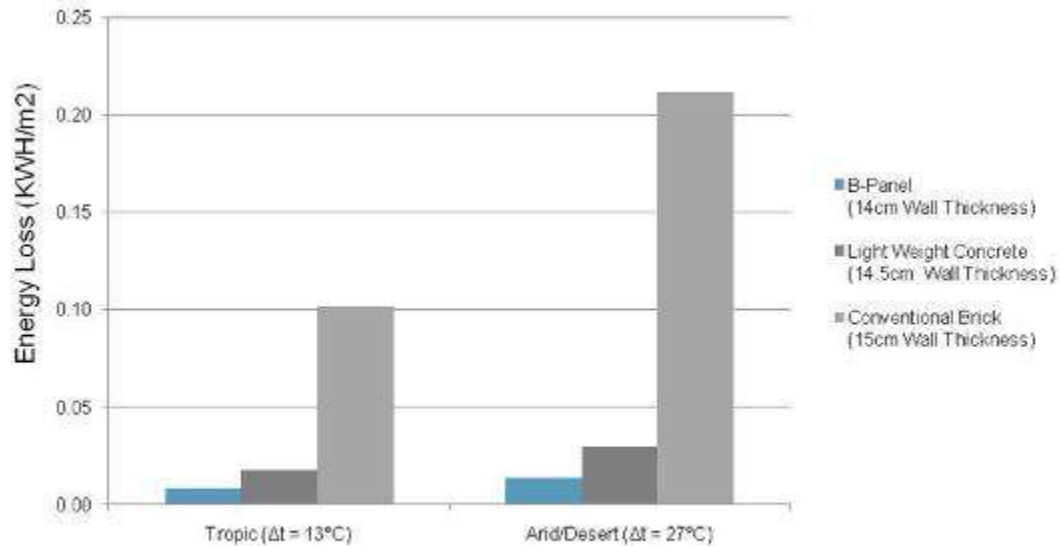


Source: Allied Foam Concrete

Is **b-panel**[®] waterproof?

Despite **b-panel**[®]'s superior resistance to humidity compared to conventional material, for locations which is susceptible to constant water exposure (Such as roof deck, bathroom floor, exterior wall above water channels), **b-panel**[®] needs similar treatment as commonly employed for regular walls, for example, application of waterproofing of suitable type.

Thermal insulation characteristics



Sources: PT. Beton Elemenindo Putra R&D, AAC: A LIME-BASED TECHNOLOGY (Ronald E. Barnett, P.E., 2005), plastics.org.nz

b-panel® fundamentally has excellent thermal insulation property (R-value), far superior to traditional bricks, and clearly better than lightweight bricks. EPS is selected to be the insulation layer for **b-panel**®, due to its cost-effectiveness and this well-known thermal insulation properties. (When we purchase ice cream or frozen fish in large quantity, the container is usually made of “Styrofoam”, never from lightweight bricks!)



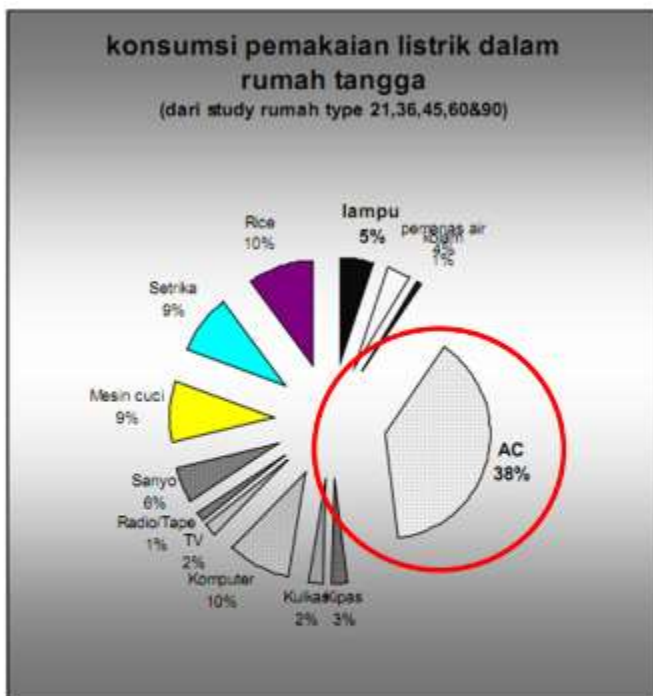
Living in a **b-panel**® dwelling is like this

Wonder why your A/C consumption is so low?

Good thermal insulation is essential in reducing operational cost of building in tropical climate. From an analysis of typical dwellings in Indonesia, air conditioning contributes to nearly 40% of total electricity consumption, more than all lighting, household equipment, and electronics, such as televisions, combined. The A/C load reduction with **b-panel**® has been calculated and tested to be up to 45%+, which means an electric energy reduction of 40% x 45% = 18%. This is a significant and permanent

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savings for the life of the building. (In term of actual cost, this reduction can be even more significant, as many electric utilities charge progressive rates for the larger KWHs)

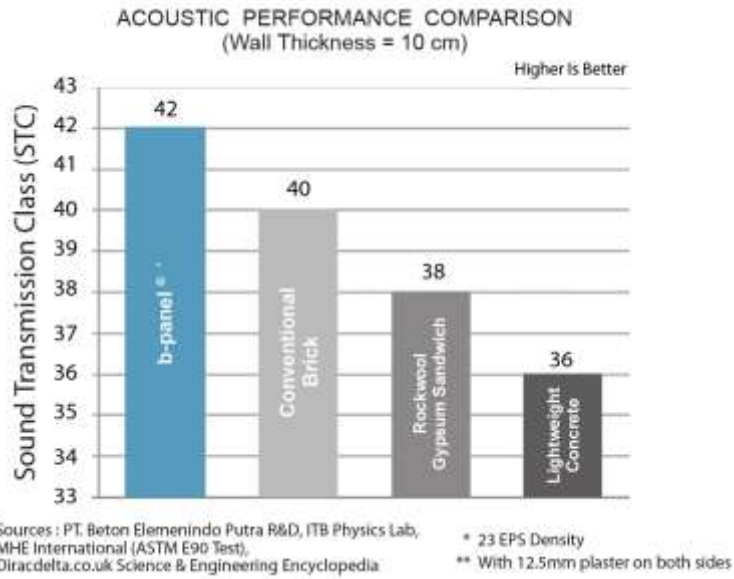


Gambar 01
Profil prosentase konsumsi listrik dalam rumah tinggal

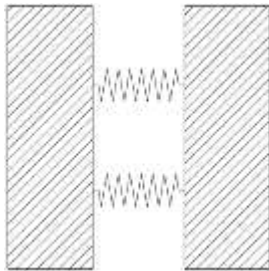
Source: Prianto, E, Rumah Tropis Hemat energi

Acoustic insulation working principle of b-panel®

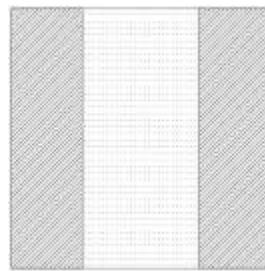
Extensive lab acoustic testing of **b-panel®** as well as **b-coustic+®** (The type of **b-panel®** which are further optimized for high-end acoustic application) were conducted at Bandung Institute of Technology's Physics Lab, under the supervision of Profesor Joko Sarwono, one of Indonesia's prominent experts in acoustic subject. The basic principle in acoustic damping that we learned from Prof. Sarwono was: the heavier the mass, the better the sound insulation property (Thus for example, traditional bricks, with its heavier mass, would have a better STC (*Sound transmission Class*) compared to lightweight bricks). Heavy mass is better able to absorb vibration energy – sound is a form of vibration.



Then why is **b-panel**[®], despite its lighter weight, has better sound insulation (STC-rating) than heavier materials? According to Dr. Sarwono, a combination of two types of materials with highly differing specific weight would give a “mass and damper” effect, in which the heavier material, while absorbing vibration energy (from sound) will also vibrate. The lighter, much more flexible material acts as damper, which in turn block the vibration energy from flowing to the second heavier mass. Secondly, with the multiple layer of different materials results in “decoupling” effect, where each layer act as if they are separate systems, with little connection between them. The “heavy-light-heavy” composite of **b-panel**[®] also provides significant weight savings (already discussed in the previous section)



“Mass and damper”



“Decoupled materials”

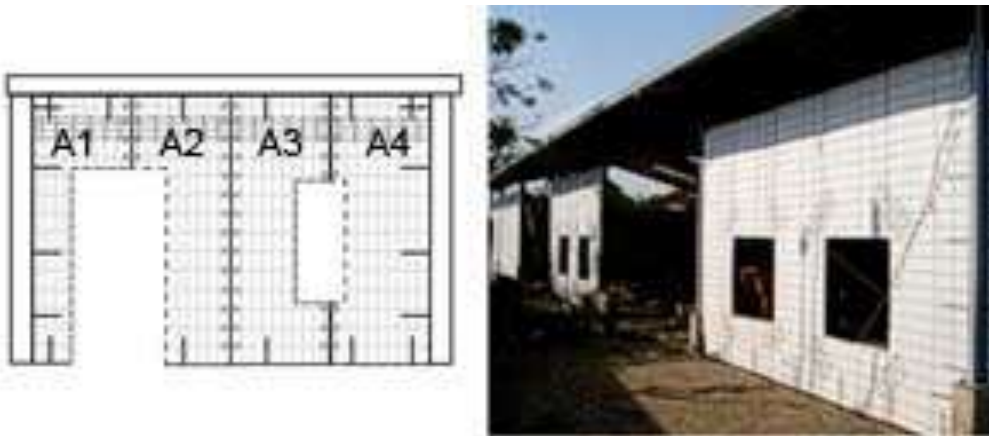
How about thermal and acoustic bridge?

b-panel[®] employs connector wire to bridge the two wire mesh matrices on each side of the EPS layer, to ensure the stiffness of the raw panel during plastering. Although metal is a good thermal and acoustic conductor, but its cross-section is negligible compared to the wall area, and thus the negative effect to **b-panel**[®]'s thermal and acoustic insulation properties is minimal, as proven in various testing. During the shotcrete plastering process, the entire panel surface is fully covered by reinforced concrete, without joint or gap that potentially create thermal and acoustic leaks.

Installation method philosophy

b-panel[®] employs semi-prefab method in its installation. After the panels has been in place, plaster is applied by spraying, which is more rapid compared to manual hand application of plastering. **b-panel**[®] Installation does not rely on any heavy equipment, such as hoist, forklift, or crane . Due to unfinished panel's ultra-light weight (3-4 kg/m²), unloading and transportation of panels from trucks/containers to the job site is easily performed by manual labor.

b-panel[®] installation takes advantage of relatively inexpensive labor cost in many part of the region, but with significantly higher utilization efficiency, as there is no need to stack bricks, no dependency of heavy equipment, and superior end product



b-panel[®] is ordered and delivered in modular cutting-list form, in which panels are produced and cut according to the sizes and shapes specific to a particular project. The benefits of this modular cutting-list system are:

1. **Significant time savings** – the panels delivered pre-cut ready to be installed, and avoid the need to stack (bricks). The panels are produced with high accuracy, and as such, on-site craftsmanship becomes less on an issue in the final result.
2. **Cost savings** – panel cost is based on net area. All cut-offs, door and window openings are not charged. What is ordered, delivered, and charged, is exactly what is needed at the project, not too little nor too much. (We usually add a few pieces of typical modules as spares in case of mishandling on site). Material waste and rejects, which is the norm in brick construction, will be significantly minimized or even eliminated.
3. **Environmentally-friendly** – each EPS cuts are 100% recycled at the factory to make the next batch of panels.



Can we hang picture, furniture, etc., on b-panel® wall?

The outer layer of **b-panel**® is a shotcrete-plaster with 2.5cm and K-150 concrete hardness minimum. With a 60kg per point load capacity, **b-panel**® wall has been proven to be able to hang heavier objects. At Hotel Santika in Jalan Raya Kuta, Bali, which employs **b-panel**® for all the partition walls, there was no major cracks observed throughout the walls used to hang LCD TVs (including a 37" unit at the lobby area), even after a major earthquake, which hit the area on September 2011.



Semi-prefabricated: that means not as fast as precast?

A: Yes and no, depends on the locations and conditions of project site. With precast system, installation can be done rapidly, since there is no need for additional plastering or finishing of the concrete. With **b-panel**® on the other hand, by not needing heavy equipment, logistical challenge can be minimized, especially for low or medium rise projects, where construction activities is not centralized at one place as in the case of most high-rise projects, but spread out over larger area. Other benefits of semi-prefab method, where the concrete is applied by means of shotcrete during plastering, is jointless monolithic structure, and thus monocoque rigidity can be achieved, and thermal and acoustic leaks from joints and gaps will be minimized.



Environmentally-friendly? Styrofoam is environmentally-friendly?

A: EPS, which is often mistaken as “Styrofoam” (This misnomer is because Styrofoam is a trade mark of Dow Chemical Co. for their Extruded Polystyrene (XPS), whereas EPS is Expanded Polystyrene. Unlike XPS which uses HFC, a harmful greenhouse gas in its production process, EPS uses Pentane, which is not a greenhouse gas) is a notorious environmental hazard IF they are employed for one-time use, such as coffee cups, wedding decoration, and packaging. This is due to EPS’s lack of bio-degradability, it takes a very long time for a Styrofoam piece to disintegrate, and for hundreds of years they will keep clogging our waterways and floating on lakes and oceans.



The fact about EPS is as follow: Easily recyclable (In Japan, over 90% of EPS are recycled, supported by their well-developed closed loop recycling program. Our own example: we recycle 100% of our panel's by-product EPS), non-toxic, and does not employ greenhouse gas in its production process. The use of EPS for **b-panel**[®] is ideal, since the high-durability of EPS is aligned with the intended use: buildings are designed to have long service life, if possible even inter-generational in its use.

The more important point is, throughout its use, a **b-panel**[®] dwelling, its A/C electricity consumption will always be significantly lower (Estimated to be more than 30%), as A/C is the largest source of electricity consumption in a dwelling, at almost 40% of total consumption. In Indonesia, specifically the Java-Bali grid, more than 70% of electrical generation is by fossil fuel, and predominantly coal, the most environmentally harmful of all fossil fuels. Thus, by significantly reducing the A/C load, CO₂ emission will significantly be reduced as well. With current **b-panel**[®] project portfolio up to August 2012 (more than 60 projects to date), the CO₂ reduction has almost reached 10 kiloton per annum. This effect is permanent and cumulative, as the project portfolio size increase with the wider adoption of the **b-panel**[®] system.

Majority of electricity generation mode of Java-Bali: Fossil Fuel

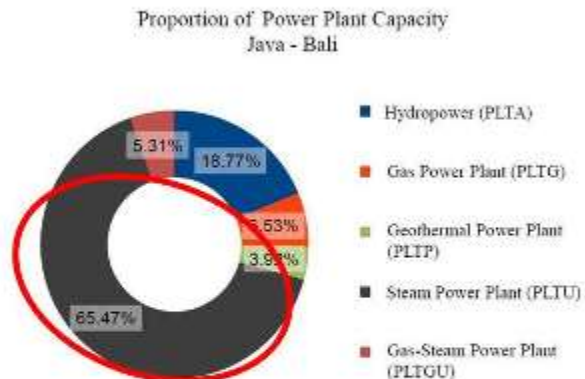
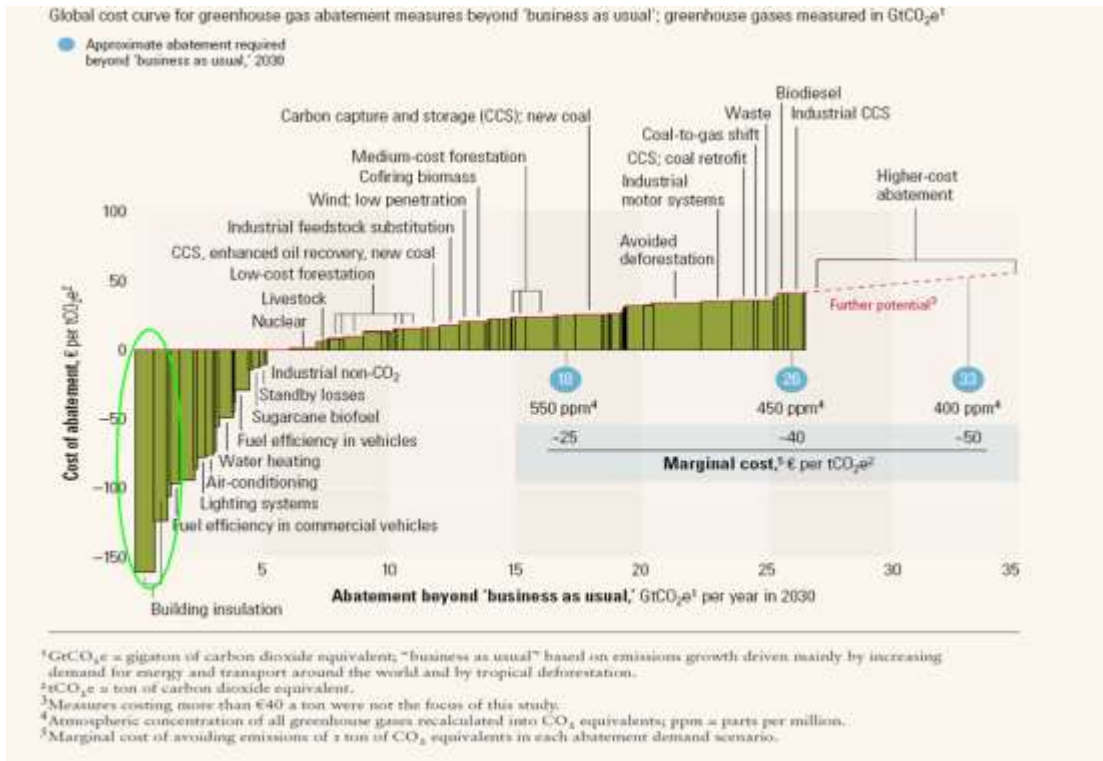


Diagram 3. Power Plant Capacity Proportion of Java - Bali
Source: *List of Power Plants in Indonesia*, http://id.wikipedia.org/wiki/September_2011

Lots of A/C usage = lots of \$\$\$
=lots of CO₂ into our atmosphere

3



An analysis of global consultancy McKinsey & Company suggests that among the hundreds of ways human can reduce their carbon emission, building insulation is the most cost-effective on the per-ton of CO₂ abated basis.

Beside its significant and permanent energy consumption reduction benefits, **b-panel**[®] is produced in a process that ensures end-to-end environmental responsibility. Our factory boiler unit is one of the few in Indonesia that are exclusively powered by palm kernel shell, instead of coal. The entire factory roof is a rain water harvesting surface, significantly reducing our ground water consumption.



Up to 40% permanent A/C electricity reduction in each b-panel[®] buildings



100% EPS recycling for panels



100% biomass boiler (non coal)



Rainwater-collecting factory roof

For its carbon-footprint reducing properties, mindful production process, and methodical installation philosophy, **b-panel**[®] was selected as the Merit Winner for the 2012 Singapore Environmental Achievement Award (SEAA), for the Regional (ASEAN) category.



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Conclusion

b-panel[®] system is an attractive alternative to traditional bricks and lightweight bricks, due to its superior earthquake performance, STC/acoustic rating, R-Value/thermal insulation rating, building weight reduction, and its efficient installation method. What is needed is merely the open mind of the designers and clients to inquiry and transition to this vastly superior system. From traditional bricks to lightweight bricks: evolutionary (it is still laying bricks, a technology and culture from the Egyptian Pharaoh age when they built the pyramids). **b-panel**[®]: “Revolutionary”, because it totally changes the construction method paradigm. With all the benefits enjoyed by the many parties involved (end-user, contractor, and *our earth*), we strive to expedite this paradigm shift.

