Understanding BIPV-T and Market Trends

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DEFINITIONS

Building integrated PV (BIPV) is the integration of solar photovoltaic (PV) power as a multifunctional building component (Prasad and Snow, 2005). BIPV, therefore, ensures the integrity of the building's functionality as a building product as defined by EU Regulation No.305 (EU, 2011). This is distinct from Building added PV (BAPV), also referred to as Building applied PV, where no traditional building material function is displaced and the PV is typically rack-mounted on top of an existing roof.

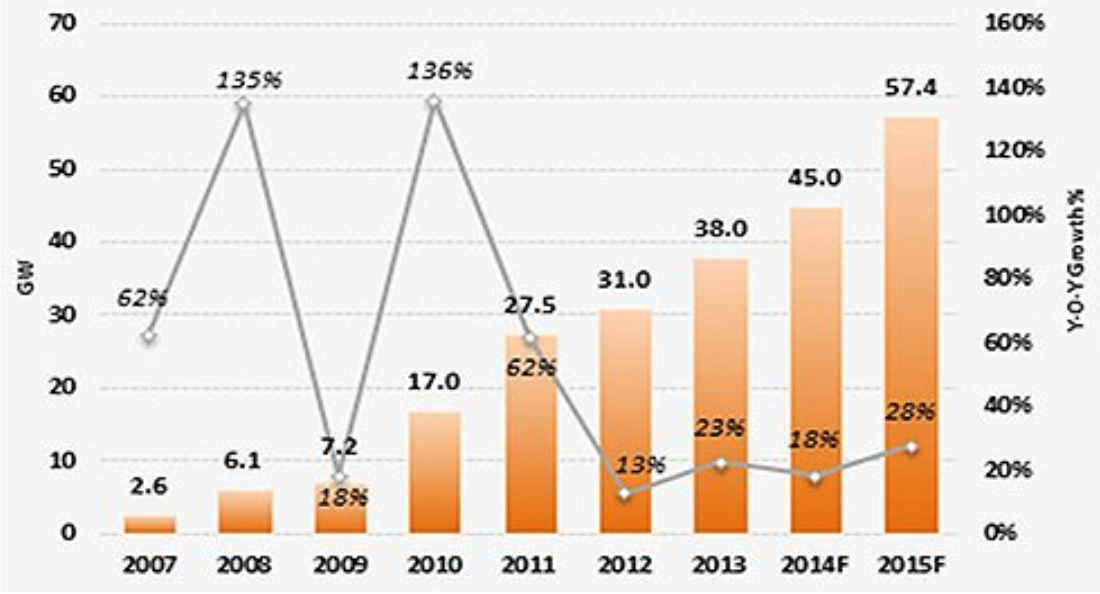
Tractile offers a BIPV product for the roof tile market termed Roof integrated PV (RIPV) and also includes a Thermal (T) component for heating water. This allows for the cogeneration of electrical and thermal energy that can be used to further reduce a building's energy consumption.

PV MARKET GROWTH

BAPV, particularly in the residential sector, has dominated the growth of PV in Australia. 654MWp residential and 171MWp of commercial BAPV was installed in 2014 (APVI, 2015 p.8) accounting for over 90% of new PV capacity in Australia. Grid connected PV has now reached a cumulative capacity of 3,875MWp (94%) nationally.

Globally, the growth of PV production in 2014 rose to a new record of over 40GW per annum (REN21, 2014 p.58), which is a 40 fold increase over a 10 year period with expectations for the industry to reach 100 billion EUR by the end of 2015 (EPIA, 2015). Mercom Capital Group (2015) forecasts are slightly higher, predicting a growth rate of 28% by the end of 2015 compared to the previous year with annual global PV production capacity reaching over 55GW. This is comparable with modelling by Bloomberg New Energy Finance (BNEF, 2014) who estimates 58.3GWp installed capacity by 2015. Furthermore BNEF (2015) new energy outlook to 2040 predicts solar will boom worldwide, accounting for 35% (3,429GW) of capacity additions and nearly a third ($3.7 trillion) of global investment, split evenly between small- and utility-scale installations.

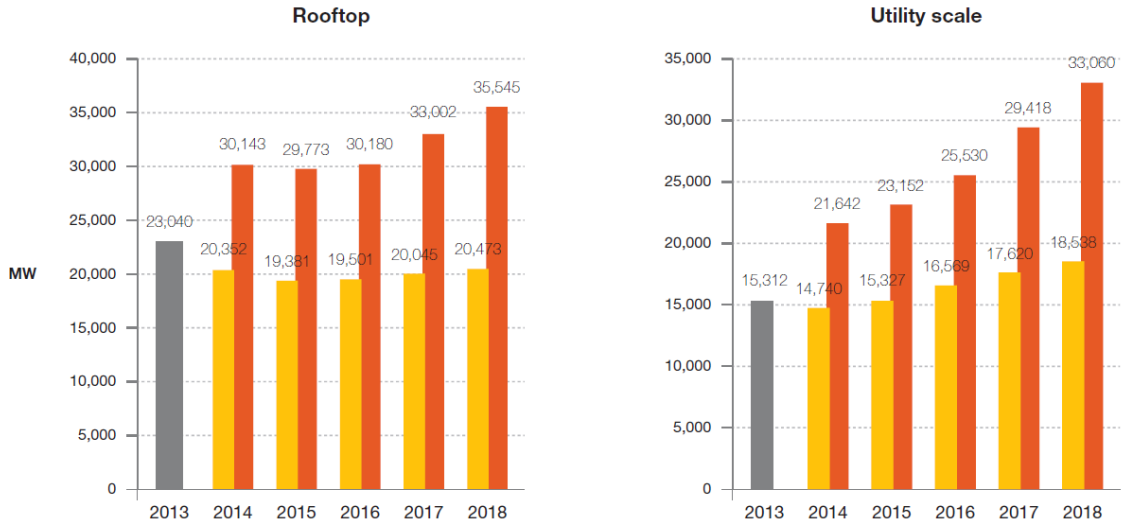
Figure 1 – Global Solar PV Historical Trend (2007-2013) and Forecast 2014, 2015



Source: Mercom Capital Group (June 2015)

In 2013, the international rooftop segment accounted for more than 23 GWp of total installations represented in grey in Figure 2. With projections of more than 35GWp installed by 2018, this segment is predicted to experience ongoing stable growth globally (EPIA 2015).

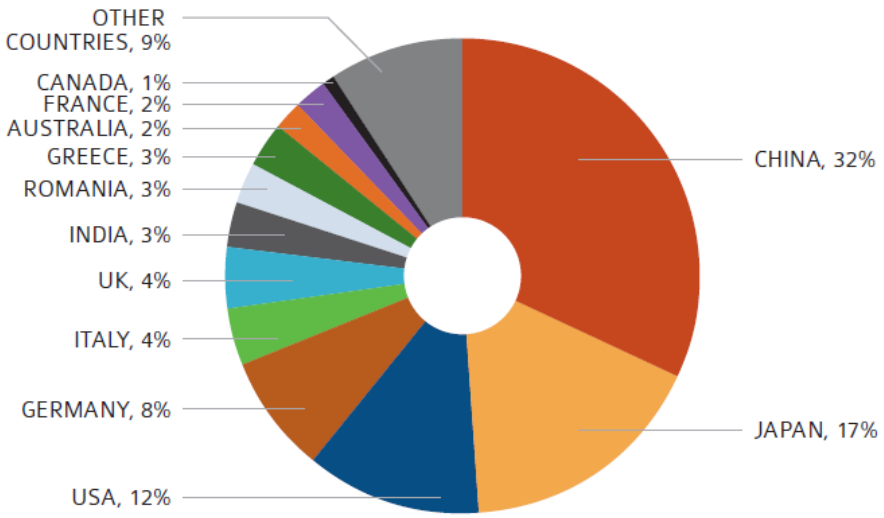
Figure 2 – Scenarios (low-yellow, high-orange) for Rooftop and Utility-Scale Segments Development to 2018



Source: EPIA 2015, p43.

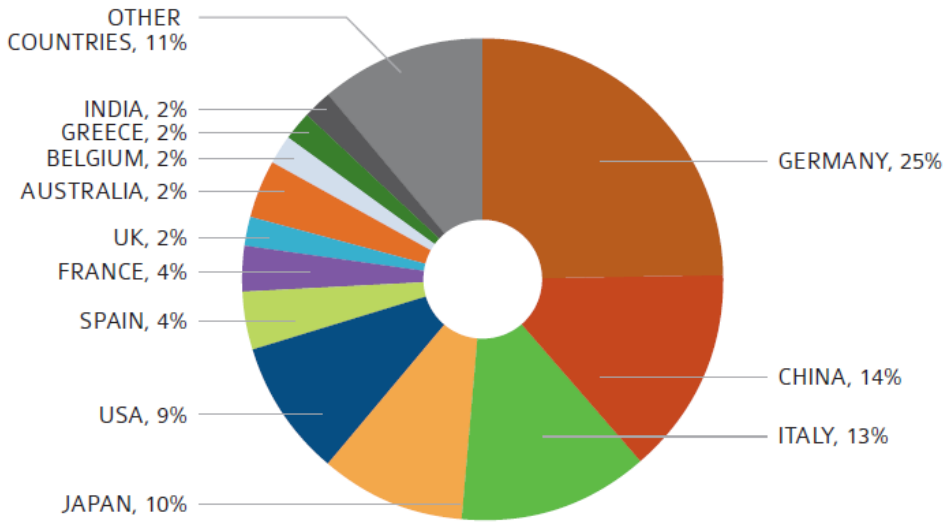
The 2013 Global PV market has shifted towards China (12.92GWp) and more recently to USA (4.75GWp) but with continued growth in Japan (6.97GWp) and established European countries Germany (3.3GWp) and Italy (1.6GWp) despite dramatic cuts in government subsidies. The United Kingdom (1.5GWp), Romania (1.1GWp) and Greece (1.04GWp) were especially strong European performers in 2013 compared to previous years.

Figure 3 – Global PV Market



Source: (IEA PVPS, 2014, p10)

Figure 4 – Cumulative PV Capacities at the end of 2013



Source: (IEA PVPS, 2014, p10)

SOLAR THERMAL GROWTH

Australia's solar thermal market is dominated by unglazed solar water heating for swimming pools and residential hot water. It rates as the 7th largest country for cumulated unglazed and glazed water collector capacity in operation in 2013 per 1,000 inhabitants at 252 kW_{th}, with Austria in 1st place at 430 kW_{th}/1000 inhabitants. A total of 611 MW_{th} of solar thermal was installed in Australia in 2013, covering an estimated 872,200m^2. This compares with a total global supply of 55GW_{th}, corresponding to 78.6million square metres of solar collectors installed worldwide in 2013.

Table 1 below highlights the distribution by type of new solar thermal collectors installed in Australia in 2013. Unglazed water collectors (77%) dominated the Australian market followed by flat plate (20%) and evacuated tube (3%).

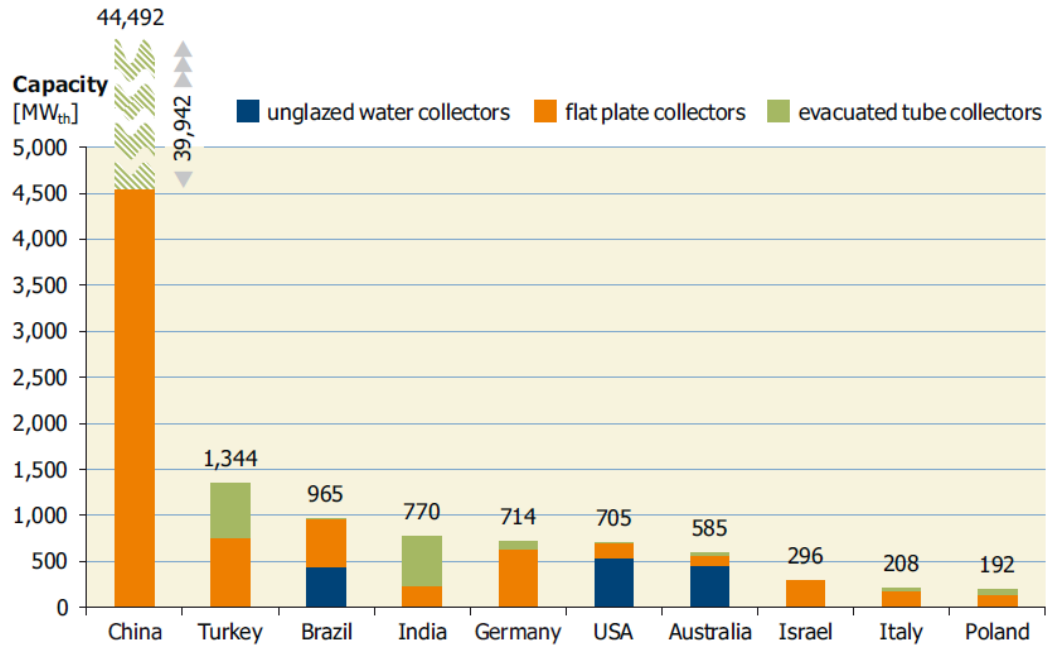
Table 1 - Newly installed collector area in 2013 by m^2/annum

Type	**Water collectors**		**Air Collectors**	
	MW_{th}	*Area (m^2)*	*MW_{th}*	*Area (m^2)*
Unglazed	455	650,000	24.5	35,000
Flat plate	115.6	165,200	0.7	1,000
Evacuated tube	14.7	21,0000	NA	NA
TOTAL	**585.3**	**836,000**	**31.5**	**36,000**

Source: (IEA SHC, 2015, p21)

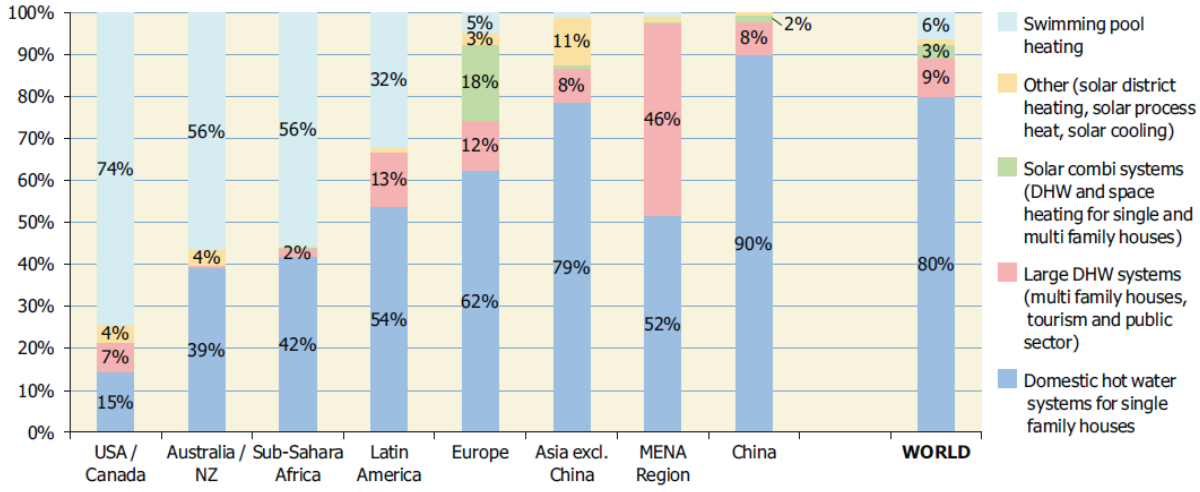
Figure 5 and Figure 6 represent the top 10 countries for glazed and unglazed products in 2013 and also total capacity by type in operation for major economic regions.

Figure 5 – Top 10 markets for glazed and unglazed water collectors in 2013 (absolute figures in MW_{th})



Source: (IEA SHC, 2015, p23)

Figure 6 – Distribution of solar thermal systems by application for the total installed water collector capacity by economic region in operation by end of 2013



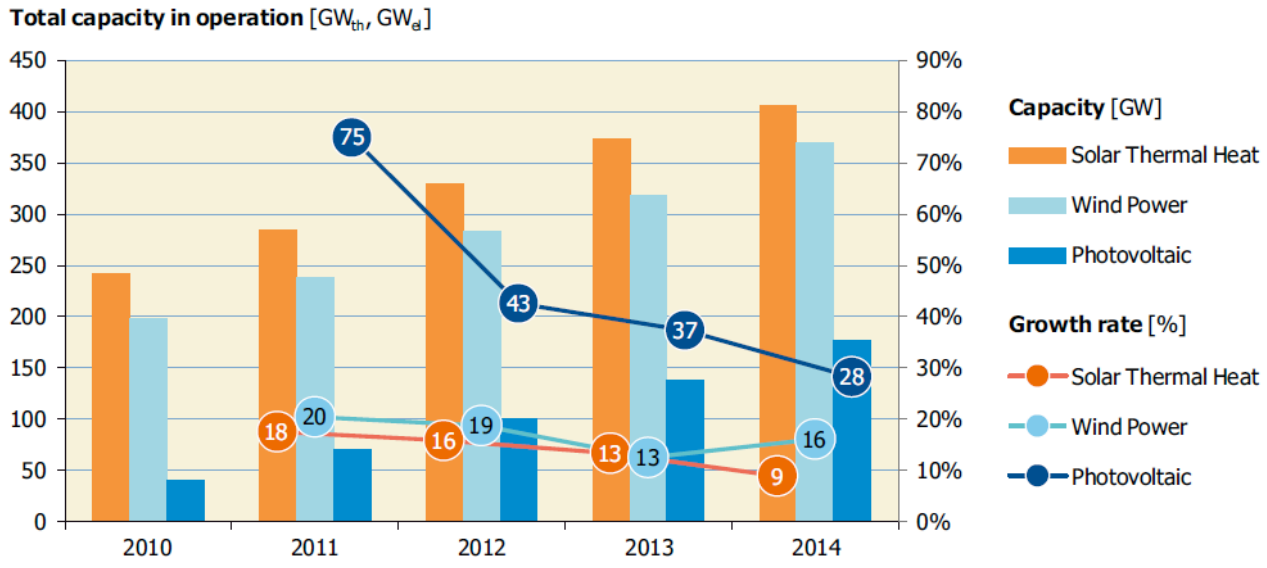
Sub-Sahara Africa:	Mauritius, Mozambique, Namibia, South Africa, Zimbabwe
Asia excluding China:	India, Japan, Korea South, Taiwan, Thailand
Latin America:	Barbados, Brazil, Chile, Mexico, Uruguay
Europe:	EU 28, Albania, Macedonia, Norway, Russia, Switzerland, Turkey
MENA Region:	Israel, Jordan, Lebanon, Morocco, Palestinian Territories, Tunisia

Source: (IEA SHC, 2015, p23)

GLOBAL RENEWABLE ENERGY TRENDS FOR PV, SOLAR THERMAL AND WIND ENERGY

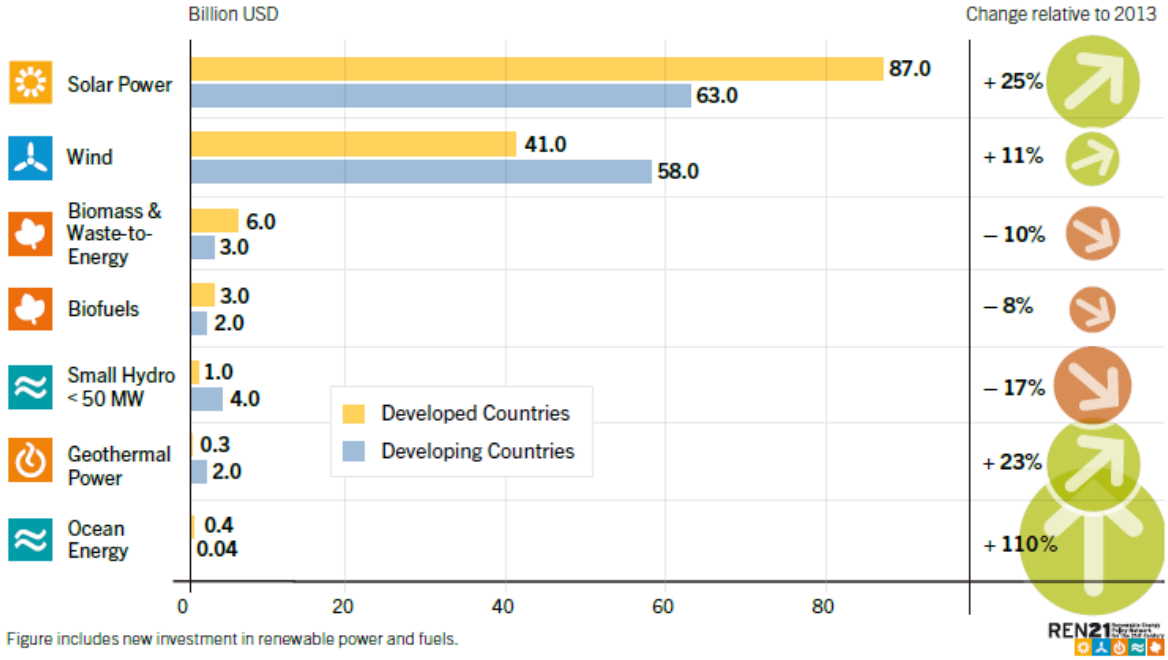
BNEF reported at the end of 2013 that the world added more renewable energy capacity (143GW) compared with 141GW in new coal, natural gas and oil plants. This shift has continued and it is predicted by 2030 there will be more than four times as much renewable capacity added. Solar PV continues to experience accelerated growth as it progresses to market maturity and is gaining ground on more established wind power and solar thermal heat applications who continue to exhibit steady upward growth trends.

Figure 7 – Global solar thermal heat, wind power and PV capacity in operation and market growth rates between 2010 and 2014 (IEA SHC, 2015 p5)



Sources: AEE INTEC, Global Wind Energy Council (GWEC), European PV Industry Association (EPIA), REN21)

Figure 8 – Global New Investment in Renewable Energy by Technology, Developed and Developing Countries, 2014



Source: REN21, 2014 p83 after BNEF data (2014)

BIPV MARKET GROWTH AND FORECASTS

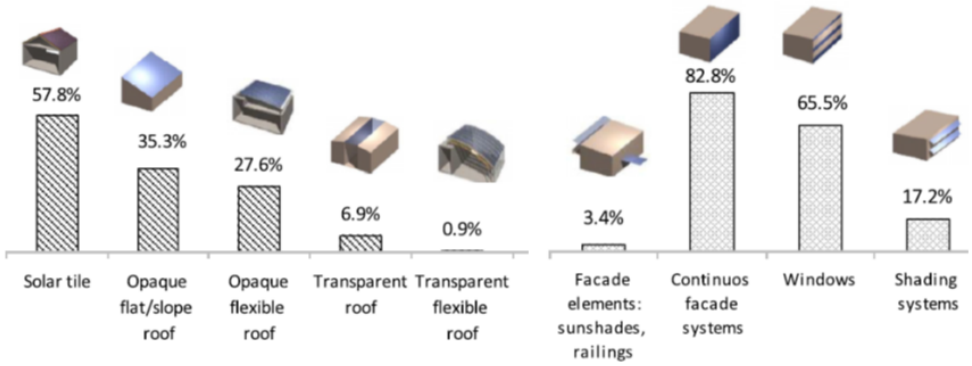
Annual installations of BIPV are anticipated to reach 1,152.3MWp by the end of 2019, up from 343.1MWp in 2012 (Transparency Market Research, 2015). The BIPV industry is predicted to achieve a CAGR of 18.7% between 2013 and 2019. Another recent report (NanoMarkets, 2015) predict the BIPV market will grow from about $3 billion in 2015 to over $9 billion in 2019, and surge to $26 billion by 2022, as more truly integrated BIPV products emerge that are monolithically integrated and multifunctional where there is no clear distinction between the energy and roofing subsystems.

Rooftop PV accounted for approximately 67% of the market share in 2012 to emerge as the fastest-growing segment (Transparency Market Research, 2015). However, other niche segments such as residential and industrial categories are likely to grow at a healthy rate forecast to 2019. In 2012, the global market for BIPV was dominated by Europe, with 41% share of the global market on the basis of annual installations, followed by North America. North America accounted for approximately 27% of the global market share in 2012 (*ibid.)* Rise in demand for BIPV in recent years is driven by

increasing environmental regulations adopted by economies worldwide to curb the effects of carbon footprints.

The global market for BIPV is dominated by C-Si technology (60%) with thin film and other technologies including OPV & DSC. C-Si making up the total share of the market in 2012. Lower production and silicon feedstock costs will allow C-Si to continue its dominant PV technology position. However, thin film is expected to register the fastest growth at a CAGR of 19.1% between 2013 and 2019 (*ibid.)*.
Figure highlights the dominance of solar tiles for roofs and continuous (homogenous) systems or window applications for façades based on the BIPV product survey conducted by Cerón et al. (2013). Solar tiles have to date dominated BIPV roofing systems, as most experience of BIPV has been carried out in Northern Europe where the tile is a typical roofing system and exhibits simple geometry. Rooftops modules for sloped roof were the first fully integrated systems to be developed and many suppliers offer standard products. Nevertheless, globally, the BIPV market still suffers from a lack of standardisation and modularity. Most of the systems have been custom-made and, hence, do not entirely meet the functional, technical, and economical requirements of the architects and engineering consultants, installers, owners and end users (*ibid*).

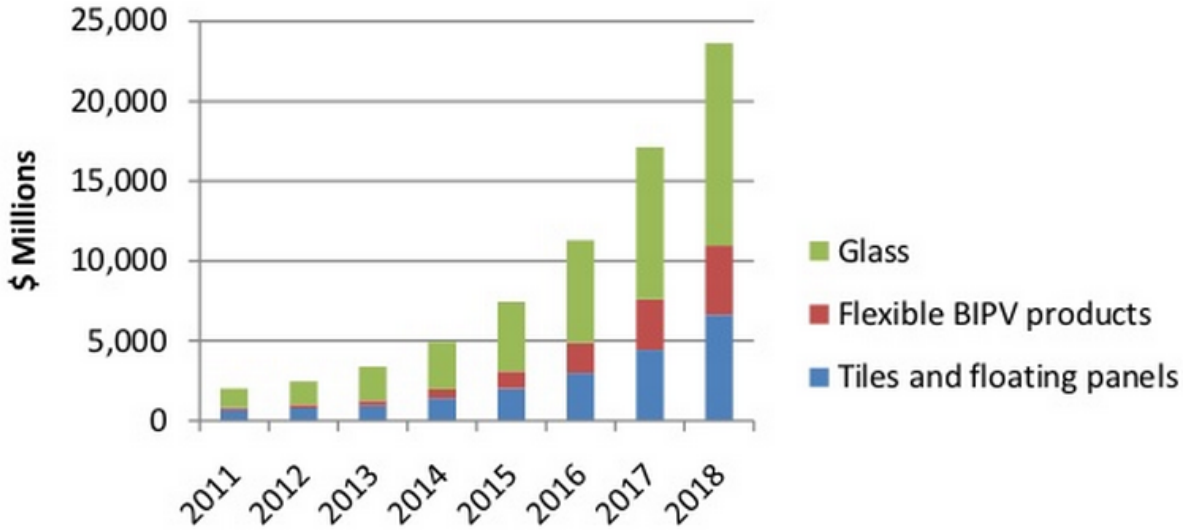
Figure 9 – Proportion of BIPV Roof and BIPV Façade systems by building skin application



Source: Cerón et al. (2013) with BIPV typologies adapted from Prasad and Snow (2005)

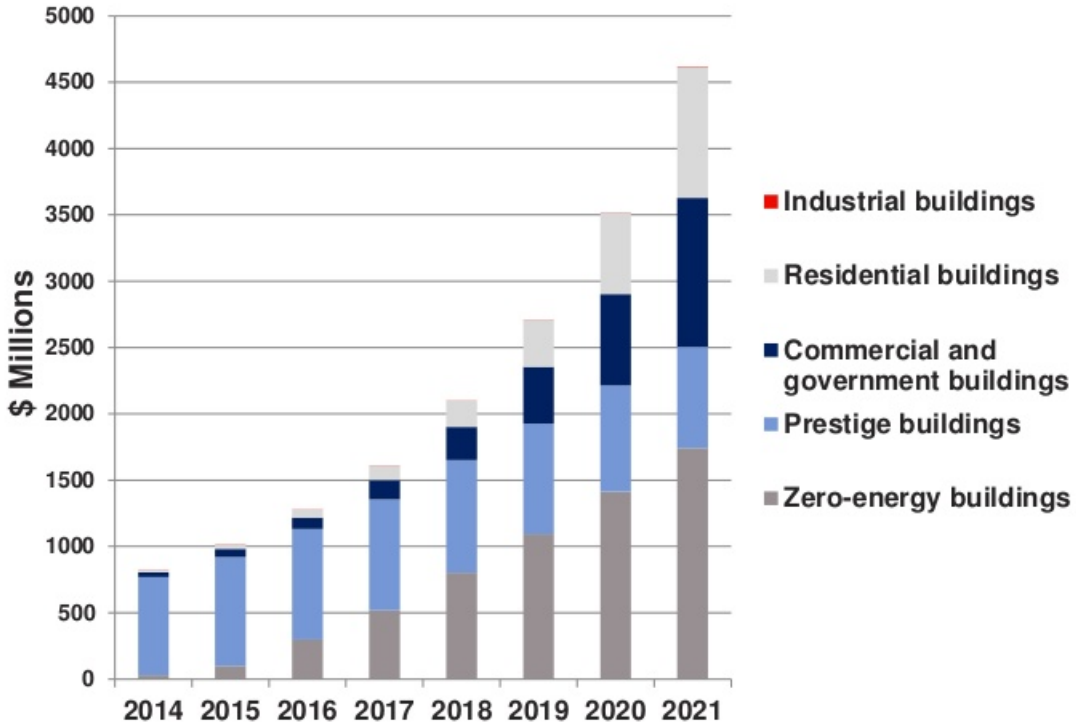
Roof tiles (Figure 10) are expected to continue to grow to US$7 billion market by 2018 with strong projections for BIPV glazing systems as smart window technology and its mature and sophisticated fabrication processes are coupled with improved PV technologies. Given glazing is a large component of commercial building façades and already commands a premium price for sunlight and thermally responsive products the progression to BIPV glass is a less ambiguous one compared to other PV building element options such as opaque BIPV (Quesada *et al.,* 2012).

Figure 10 – Projected growth of rigid, flexible and glazing BIPV



Source: Nanomarkets, 2012

Figure 11 – BIPV market forecast by building typology (2014-2021)



Source: Nanomarkets, 2014

AUSTRALIAN BUILDING STOCK CHARACTERISTICS

- Detached and semi-detached houses still represent around 75% of new residential construction.
- The remaining 25% is mostly multi unit apartment buildings >4 storeys
- Australia builds approximately 180,000 new dwellings p/a, adding to an existing stock of approximately 8 million dwellings.
- 54 million m^2 Australian roofing market (quoted by Bluescope – so may not want to use).
- average roof area for a small house is about 100-150 m2, for a medium house about 150-200 m2, and for a large house it can be 200 m2 or greater

http://www.health.gov.au/internet/publications/publishing.nsf/Content/ohp-enhealth-raintank-cnt-l~ohp-enhealth-raintank-cnt-l-7

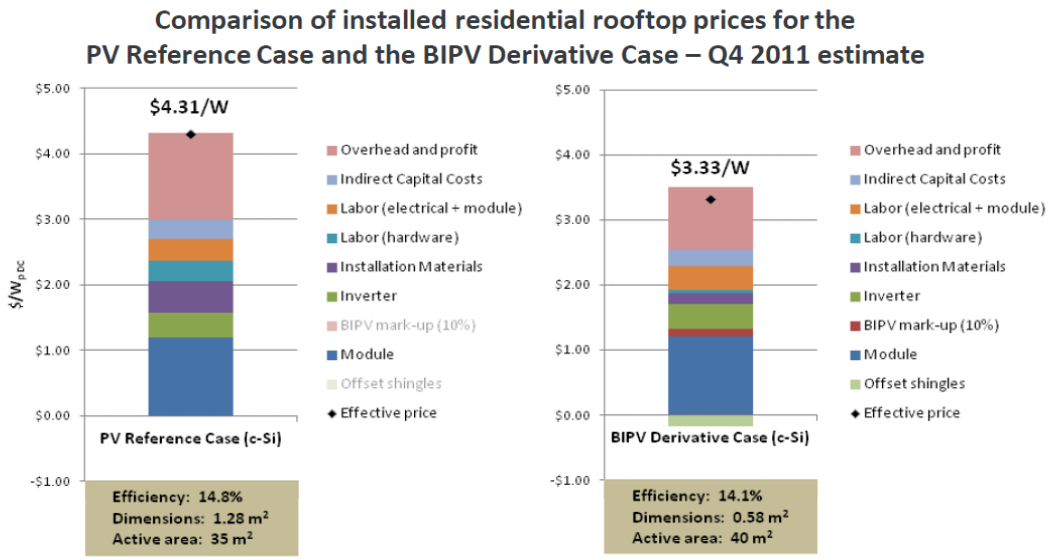
- The average floor area of a new free-standing house in Australia is 243m^2 according to Bureau of Statistics and other data compiled for Commonwealth Securities.
- Over the past few years, the number of people living in each house had risen to about 2.66 per household, up from 2.53 people in the early 1990s, according to Australian Bureau of Statistics estimates.

ADDED VALUE DRIVERS

Through a benefit cost analysis, pitt&sherry (2012) investigated a pathway to 2020 for increased stringency in new building energy efficiency standards. It identified that energy efficient solutions can deliver very cost effective opportunities for energy savings. There is, however, a tipping point where onsite renewables become more economical than, for example, triple glazed windows. Overall, the combination of solar PV plus energy efficiency measures are the most effective means of delivering zero energy or even 'energy plus' building outcomes.

Work from James et. al. (2011) at NREL investigated the levelised cost of BIPV compared to BAPV. Whilst BIPV faces more challenging product development issues and market acceptance than BAPV (rack mounted PV in this instance), the long term value of BIPV is far more promising. Upfront capital outlay is still a barrier for uptake; however, leasing arrangements over a longer-term plan can internalise these costs into the building asset value. Considerations of the cost of the existing building skin will affect the payback on BIPV.

Figure 12 – Levelised cost of BIPV for residential rooftops versus conventional BAPV



"Effective price" values include shingle cost offsets, shown as a negative bar, in the BIPV case (right)

Source: James et. al. (2011)

Cost reductions of the simulated BIPV case are mostly from the elimination of hardware racking and associated labour costs. The possibility of reduced performance may have an impact on the levelised cost of energy but is not likely for reliable, conventional PV cell technologies.

A recent report from Lawrence Berkeley National Laboratory (Hoen, *et.al.* 2015) analysed the sales history from 2002-2013 in eight states for 22,822 homes in total, 3,951 of which have PV on their roof. The study shows that home buyers are consistently willing to pay PV home premiums across various states, housing and PV markets, and home types; average premiums across the full sample equate to approximately US$4/W or US$15,000 for an average sized 3.6kWp PV system.

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