The Scope for Cost Reduction in a Mass Solar Heating Market

Stuart Elmes MA, MBA Solar Trade Association 20th June 2013

The opportunity for cost reduction in a mass market for solar heating systems in the UK has been assessed. The costs of customer acquisition, business administration and the physical installation are the greater proportion of the total installed cost and these elements of cost are predicted to respond strongly to scale economies.

If a mass market of around 400 MWth or 600,000 m^2 per year can be stimulated (equivalent in scale to 200,000 residential installations) it is predicted that the installed cost for a residential property will fall by around 30%. This would result in "cost parity", where the cost of energy savings generated by a solar thermal installation equals the cost of heating with fossil fuels, at the following fuel prices - 9.9 pence per kWh for electric heating (normally a mix of day and night rates), and 7.8 pence per kWh for gas or oil heating.

Background

Solar heating is seen by many as a mature technology with little scope for cost reduction. Policy makers have preferred instead to focus their attention upon technologies that appear to offer greater potential to reduce costs over time and eventually compete with carbon fuels.

In this paper the components of cost that make up an installed price of a solar water heating system to the end user have been analysed and the opportunity to reduce those costs in a mass market are quantified.

Current Cost Structure

A panel of solar thermal industry experts was assembled by the Solar Trade Association (STA). The panel was composed of members of the STA's Solar Thermal Working Group and included senior managers from solar equipment manufacturing companies, wholesalers and solar installers.

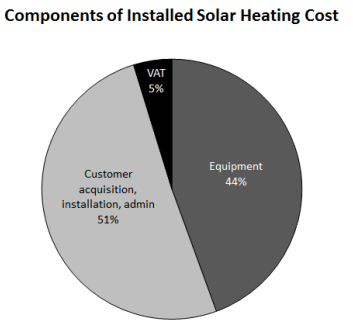

Figure 1 Equipment is 44% of the final installed cost

The group considered a reference domestic installation of four square metres of flat plate solar panel (2.8 kW_{th})[1], pump station, connecting pipework and a replacement twin coil hot water cylinder. The installation was assumed to be straightforward with no special restrictions on roof access, concrete roof tiles and pipe runs through a cold roof space to a top floor cylinder cupboard.

The group arrived at a consensus estimate of the installed cost to the customer of £4,500 (including VAT at the reduced rate of 5%).

The transfer price of the solar equipment from wholesaler or manufacturer to an installation company with a typical level of trade discount was estimated by the expert panel to be £2,000 (excluding VAT).

It is worth noting that a replacement hot water cylinder represents around £700 of the equipment costs. An assessment[2] based on data from an Energy Saving Trust report[3] on hot water generation concluded that a cylinder upgrade would result in average energy savings of 750kWh/year in addition to the solar energy savings considered in this analysis.

For comparison, a report for the Department of Energy and Climate Change by the Sweet Group[4] found the cost (excluding VAT) of domestic solar installations of 3kW_{th}[5] to be in the range of £1,250/kW_{th} to £1,750/kW_{th} with a median of around £1,400/kWth. For the reference system considered this would correspond to a median installed price of £4,116 including VAT and a range of £3,675 to £5,145.

Real world costs can vary for a number of practical reasons including the complexity of roof access, the type of roof covering, the ease of routing connecting pipe runs and the interface with the existing heating system. While the number of installations of a comparable size to the reference system in the Sweet report is small, the median cost was within 10% of the expert group consensus cost.

Scope for Reduction of Equipment Costs

The drivers of cost reduction for solar equipment are:

- Economies of scale in manufacturing
- Purchasing power of installers
- Transportation efficiencies
- Increasing competition among suppliers
- Innovation

The UK currently accounts for less than 2% of the annual solar heating equipment installed each year across the European Union[6]. A recent report[7] found learning rates[8] of 23% for solar thermal panels, with cost reductions of 50% achieved in the 15 years to 2010. Even the significant increase in installation rates envisioned in this paper would have only a modest impact on the total European level of demand and would therefore be unlikely to contribute towards such economies of scale in European manufacturers of solar heating equipment.

In addition, the same report identifies technological improvements with the potential to produce further reductions in equipment and installation costs in coming years. Such innovation gains are rather speculative in nature, and neither these nor the learning rate discussed above have been factored into this analysis.

2012	UK	DE	FR	PL	EU 27
Market Size (m^2 x 10^3)	59	1,150	250	302	3,302
	1.8%	34.8%	7.6%	9.1%	100%

Table 1 Solar heating annual capacity added, selected northern European markets (ESTIF)

An increase in the size of the UK market would allow UK wholesalers to purchase in larger batches, increasing purchasing power with manufacturers and yielding efficiencies in transportation.

Further down the supply chain, solar installation businesses would also benefit from greater purchasing power and reduced transportation costs. The cost to transport one solar panel on a pallet from the wholesaler to the installer is the same as the cost to transport a pallet loaded with 15 panels.

Representatives of solar equipment supply companies on the expert panel estimated that if instead of purchasing one domestic solar heating kit per month a solar installation business were to purchase ten, greater trade discounts amounting to a reduction of 18% could be justified.

The cost of transporting two pallet spaces from warehouse to installer will vary depending on the distance it travels, but for a representative distance of 180 miles it currently costs around £75 with £15 for a 2m pallet for a total of £90, or 4.5% of the equipment cost. If solar kits were combined into efficient shipping quantities of 5 kits (10 panels) per pallet, transportation savings worth up to 3.6% per kit could be realised.

Scope for Reduction of Non-equipment Costs

It is a common belief that the non-equipment costs of a solar installation business are those associated with the physical installation, for example roof access and labour hours on site, costs that are thought unlikely to reduce at scale.

In fact the non-equipment costs must also include the cost of acquisition of that customer and the administration costs of running a business, both of which would respond very strongly to scale efficiencies.

The expert panel identified numerous examples of efficiencies of scale in this area:

- Reduced advertising and promotion costs per customer acquired
- Word of mouth increasing marketing effectiveness
- Reduced travel time between sales visits
- Reduced commission per sale paid to sales people
- Specialisation of roles in sales, surveying, installation
- Specialisation of administration roles as businesses grow
- Investment in automated business processes – estimate, quotation, materials despatch

One installation company was reported to estimate that each solar heating sale currently costs £1,000 to secure[9] because there is so little uptake.

Opportunities to benefit from scale economies in installation were also identified:

- Investment in roof access equipment (tower scaffold)
- Availability of a wide range of roof fixing products (to suit different roof coverings without time consuming lead work)
- Job specialisation, for example roofing and plumbing specialists

In order to arrive at an estimate of the impact such economies of scale might have, an analogue industry was considered.

Prior to the launch of the Feed in Tariffs (FITs) in April 2010 the solar photovoltaic (PV) industry was supported by a grant scheme called the Low Carbon Building Programme (LCBP). This supported 4,428 domestic PV installations[10] over four years, an annualised rate of 1,100 per year. In the first quarter of 2013, the Feed in Tariff has supported 19,203 installations in the sub 4kWp category[11], an annualised rate 70 times greater than that prior to the FIT.

While the path the UK PV industry has followed from cottage industry to its present scale is not necessarily one to provoke envy, its sales and installation process have many similarities to those for solar heating. Both technologies are additional rather than substitutional (in contrast for example to technologies which replace an entire traditional heating system). Both require similar roofing installation tasks. Plumbing works for solar heating would generally require more intervention inside a property, but on the other hand solar heating panels, being of a smaller area, are less visually intrusive to the aesthetics of a property, and have wider applicability.

The reducing price of PV materials due to a global oversupply of manufacturing capacity is widely credited with driving down the installed cost of installations, but in this case the aim is to understand the degree to which scale economies in the installation market have contributed to cost reductions for the consumer.

Date of Web Page Archive	Average System Cost (Incl. VAT)	Average System Size (kWp)	Cost per kWp (Excl. VAT)
13/05/2011	£12,000	2.70	£4,233
18/01/2012	£10,000	3.00	£3,175
19/09/2012	£7,700	3.00	£2,444
01/11/2012	£7,600	3.50	£2,068
25/05/2013	£7,000	3.75	£1,778

Table 2 Energy Saving Trust Guidance on Solar PV Installed Cost

The Energy Saving Trust (EST) is the trusted source of consumer information on energy saving technologies, with advice based on rigorous research. A web archive[12] provided cached copies of the EST web page that details the results of their research on the average cost of a domestic PV installation. Table 2 shows the results from pages cached between May 2011 and May 2013.

It can be seen that the cost of the average installation has reduced by 42%, over the two year period and due to increasing average installation size the cost per kilowatt peak (kWp) has fallen even further, by 58%.

It is possible to assess the change in cost of the non-equipment element of the installed price by subtracting the purchase cost of the equipment for the installer.

A major UK wholesaler of PV equipment provided a kit price[13] for an above roof PV system comprising mid-range modules, roof anchors and racking, inverter, isolation switches and generation meter. The price is the transfer price to a mid-sized installer and includes delivery.

Prices were provided based on quotations as shown in Table 3. Kit sizes were chosen to be close to the prevailing average system size according to the EST information.

Quotation Date	Quote (Excl. VAT)	Kit Size (kWp)	Cost per kWp
07/06/2011	£8,205.80	2.43	£3,377
01/09/2012	£5,464.14	2.94	£1,859
28/05/2013	£4,677.58	3.50	£1,366

Table 3 Equipment cost to solar PV installer

Combining the above information it is possible to estimate the proportion of cost from equipment and non-equipment. Figure 2 shows the make up of installed cost normalised by the size of the installation.

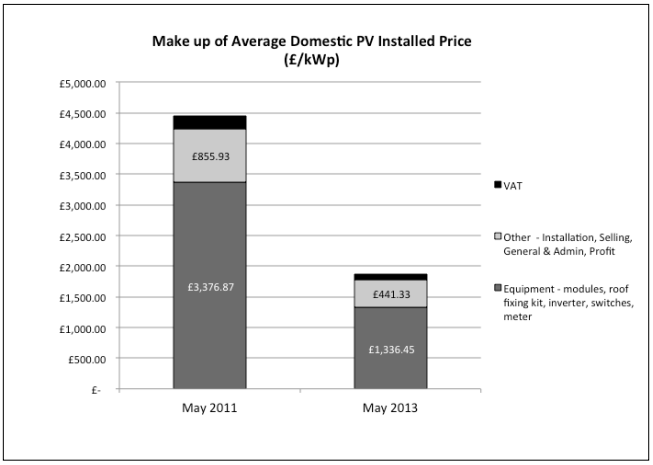

Figure 2 Comparison of normalised cost of the average solar PV installation in 2011 and 2013

The cost of equipment has fallen by 66% over the period, but other costs have also fallen, by 49% per kWp.

The installed size of a typical solar thermal installation is unlikely to increase in the same way that PV installations have, so the absolute cost of the installation is a better comparator. Figure 3 shows the cost of the average installation.

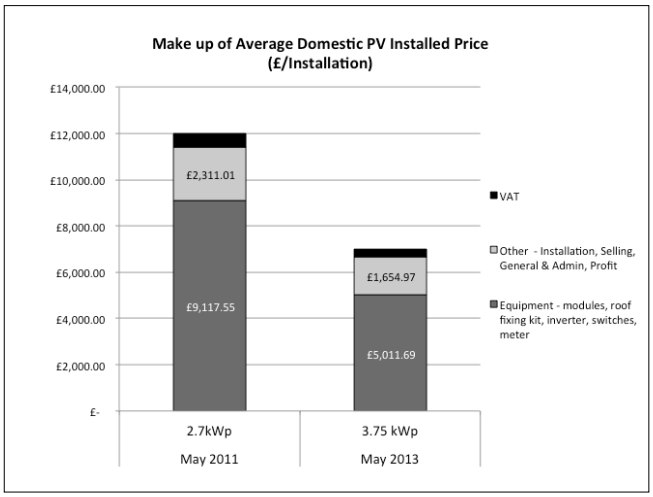

Figure 3 Comparison of absolute cost of the average solar PV installation in 2011 and 2013

This shows that despite the fact that the physical installation itself has increased from around 12 modules to around 15, (taking into account an increase in average module power), the non-equipment costs have also fallen over the period considered in absolute terms (per installation), from £2,311 to £1,655, a reduction of 28.4%, or 35.8% in real terms. (CPI 2011 4.5%, 2012 2.8%)

The fall in these costs are significant and are not linked to the more headline-grabbing falls in the cost of solar PV modules, rather stemming from efficiency gains such as those identified at the start of this section and increased competition from the large number of competitors drawn to engage in the growing market.

Towards a Subsidy Free Market

Current installation rates of 59,000 m^2 per year (41 MW_{th}), equivalent to 20,000 domestic installations, across all market sectors puts solar thermal firmly in the "cottage industry" status.

Support from subsidy schemes for solar thermal such as the commercial RHI and the forthcoming domestic RHI will be crucial in helping increase of take up of solar heating to drive the economies of scale identified in previous sections.

A ten-fold increase to 600,000 m^2 per year (400 MW_{th}) would raise installations to similar levels as are currently enjoyed in the domestic sector of the PV market after three years of subsidy under the FIT.

Taking the buying power benefit and efficient shipping benefits identified above amounts to a 21.6% reduction in equipment costs.

Assuming a level of reduction in non-equipment costs similar to that achieved in the PV market at scale is possible, these reduce by 35.8%.

The overall cost in 2013 prices for solar thermal in a market of scale becomes:

Equipment cost = £2000 x (1-0.216) = £1,568
Customer acquisition, install, admin, profit = £2286 x (1-0.358) = £1,467
VAT = £152

Total Cost to Consumer in Market of Scale = £3,187

Cost Reduction = (£4500 - £3187) x 100% /£4500 = 29.2%

To assess at what fuel price this would achieve "cost parity" with carbon fuels, the cost of a unit of energy saved is calculated for a household of 4 people (with water use of the right size for the reference solar kit considered).

Solar energy yield = 1,617 kWh/year

(SAP 2012, occupancy set to 4 people, 4m^2 flat plate solar collector, S facing at 30 degrees, SAP region 3 East Anglia)

The lifetime energy saving against gas or oil heating is calculated by dividing the solar energy by a summer-biased boiler efficiency[14] and multiplying by 20 years.

20 year energy saving against gas/oil = 1,617 x 20 /0.78 = 41,461 kWh

Cost per kWh = £3,187 / 41,461 = £0.077
(2013 prices)

The lifetime energy saving against direct electric heating is calculated by simply multiplying by 20 years.

20 year energy saving against electricity = 1,617 x 20 = 32,340 kWh

Cost per kWh = £3,187 / 32,340 = £0.099
(2013 prices)

Conclusion

A mass market for solar heating in the UK will deliver cost savings of around 30% for consumers based solely on economies of scale and purchasing power of installers. Innovation in manufacturing and product design could yield greater cost reductions.

These savings would reduce the lifetime cost per kWh of fuel saved to 7.8 pence/kWh against a gas/oil boiler and 9.9pence/kWh against direct electric heating.

The timing of when solar thermal could reach cost parity with carbon fuels depends upon how fast the cost of carbon fuels rise above general inflation in future. Arguably electricity prices are already above this level, even for an economy 7 daytime/night time mix of use.

The Solar Trade Association is the voice of the solar industry in the UK.

Solar Trade Association
2nd Floor
25 Eccleston Place
London
SW1W 9NF
Tel: +44 (0)20 7925 3575
Fax: +44 (0)20 7925 2715
Web: www.solar-trade.org.uk

About the Author

Stuart Elmes is founder and CEO of Viridian Solar Ltd, a UK manufacturer of solar heating and solar photovoltaic panels. He is the current Chair of the Thermal Working Group of the Solar Trade Association, and sits on a number of industry bodies such as the MCS thermal working group, the MCS roofing working group and the NFRC solar focus group.

References

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3 Energy Saving Trust, In-situ monitoring of efficiencies of condensing boilers, June 2009

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5 See Figure 3.10i LZC installed kW =3

6 Solar Thermal Markets in Europe, Trends and Market Statistics 2012, European Solar Thermal Industry Federation

7 Strategic Research Priorities for Solar Thermal Technologies, European Technology Platform on Renewable Heating and Cooling, see: http://www.rhc-platform.org/fileadmin/Publications/Solar_Thermal_SRP_single_page.pdf

8 The learning rate is the cost reduction that comes with a doubling of production volume.

9 Conversation with solar heating installation business owner, reported by Kevin Carling of Secon Solar Ltd

10 Low Carbon Building Programme Final Report, August 2011, DECC, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48160/2578-lcb-programme-2006-11-final-report.pdf

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13 Correspondence with Ian Draisey, Dulas MHH Ltd

14 Draft MCS MIS 3001, consultation 2012