

Impact Case Study

UOA: 16 Architecture, Built Environment and Planning

Applying solar energy research to the winemaking industry: SOLAR

1. Summary of the impact

This case study concerns the long term (energy) sustainability of emerging winemaking regions. Underpinning research in energy efficiency and renewable technologies informs the case study in determining energy usage and benchmarks, development of energy guidelines/policy, implementation by national professional bodies and adoption of energy best practice by the local industry. Impact is through the adoption and application of benchmarks by winemaking associations, directly influencing (through policy, regulations and standards) the energy expended in making wine. The study is underpinned by international publishing accolades (Solar Energy 'Best Full Length Paper in Photovoltaics', Mondol et al, 2005) and a highly prestigious personal Royal Academy of Engineering Global Research Award to Smyth.

2. Underpinning research

Research into solar energy has been a core theme of the Built Environment Research Institute, Centre for Sustainable Technologies (CST) with the link to the wine industry being one specific application of the expertise developed by the submitting unit. The research is underpinned by the activities of a team led by Smyth (currently Reader, previously Lecturer since 1998) and three colleagues Hewitt (Professor since 2007 in post continuously since 1996), Zacharopoulos (Research Fellow appointed 2007), Mondol (Lecturer appointed 2008, previously Research Fellow since 2006). CST's fundamental research in the area of solar materials, novel collector designs, advanced optics and thermal transfer/storage (ref 3.1, 3.2), played a central role in these achievements. CST has long been recognised as a leading research group in UK solar energy. Under the directorship of Professors Norton and Eames in the 1990s/early 2000s, and now Hewitt, CST has developed significant expertise, experience and facilities in the modelling and evaluation of solar technologies such as the development and experimental characterisation of low cost facade integrated concentrator photovoltaics (funded through the EPSRC's Clean Technology, Photovoltaics Programme and the European Union JOULE Programme). The underpinning research conducted by the team at CST, including internationally recognised award winning papers (for example ref 3.3), prestigious grants (grants 3a-g) and international patents, has been instrumental in informing the current case study. Based on a fundamental understanding of the demand driven energy requirements in commercial/industrial buildings and their respective processes, the team has conducted extensive research into those energy related synergies that alternative/renewable technologies, in particular solar technologies, provide coupled with specific energy supply/storage requirements. This research has led to a number of innovative technologies, such as SolaCatcher, a passive solar water heater (ref 3.2) that gained national awareness through the 'Make it in GB' competition 2012 at the Science Museum, London.

The connection between solar energy research and the wine industry started in 2002 when Smyth developed a novel solar quilt to provide passive frost protection to young vines (ref 3.4). To commercialise this technology, Smyth developed a University of Ulster spinout company, SOLVEDNI Ltd (2003) supported by an Invest NI Compete Award (Solar Frost Protection for Vineyards, 2004). A patent was applied for in 2004 and Smyth during a sabbatical period at Victoria University of Wellington (VUW), NZ (with Skates) received a VicLink grant (Passive Solar Water Heating System For Vineyard Frost Protection, Product Research and Development award, 2005) to field trial the solar quilt at two vineyards; Gladstone and Nobillio. The results of

this novel research lead to several publications in 2006 and was the catalyst to further research.

The success of the solar quilt led to a number of solar-agri products involving collaborations with the Agri-Food and Biosciences Institute (NI), Romberg GmbH, Eglantine Vineyard, Plumpton College and Tubex Ltd. Continued research by Smyth (with Russell, Humbolt University, USA) led to publications on solar applications in the wine industry (ref 3.5) and in 2009 with Milanowski (Plumpton College), Smyth published a book 'Solar Energy in the Winemaking Industry' through Springer Publishing (2011). Smyth was awarded a prestigious Royal Academy of Engineering Global Research Award (2010) (grant 3e) to take up a six month secondment with the solar winery, Domaine Carneros in California. This work initially sought to investigate solar system design and its application in winery buildings but rapidly evolved to explore the synergies between solar energy supply and wine production energy demand. The integration of this knowledge base on energy characteristics in wine production with the underpinning research at CST on solar energy has created a unique understanding of energy synergies in the wine industry involving the use of energy audit and monitoring techniques. The expertise has subsequently been applied to the North Carolina wine industry and more recently to the UK wine industry (ref 3.6). In particular Smyth and his colleagues, with the UKVA (UK Vineyard Association) Sustainability Programme, UKVA regional bodies and UK Wineskills Programme, have applied their research in energy monitoring, energy supply and demand relationships to determine the only energy benchmarking standard for the UK wine industry and develop a framework to support guidelines and policy.

3. References to the research

The quality of the underpinning research is apparent in a strong publication record in leading peer-reviewed journals including a prize winning paper in Solar Energy.

- 3.1 Agyenim, F, Eames, P and Smyth, M (2009) *A comparison of heat transfer enhancement in a medium temperature thermal energy storage heat exchanger using fins*. Solar energy, 83 (9). pp. 1509-1520. [10.1016/j.solener.2009.04.007](https://doi.org/10.1016/j.solener.2009.04.007)
- 3.2 Souliotis, M, Quinlan, P, Smyth, M, Tripanagnostopoulos, Y, Zacharopoulos, A, Ramirez, M and Yianoulis, P (2011) *Heat retaining integrated collector storage solar water heater with asymmetric CPC reflector*. Solar Energy, 85 (10). pp. 2474-2487. [10.1016/j.solener.2011.07.005](https://doi.org/10.1016/j.solener.2011.07.005)
- 3.3 Mondol JD, Yohanis Y, Smyth M and Norton B (2005) *Long-term validated simulation of a building integrated photovoltaic system*. Solar Energy, 78. pp. 163-176. [10.1016/j.solener.2004.04.021](https://doi.org/10.1016/j.solener.2004.04.021) (Solar Energy journal - 'Best Full Length Paper in Photovoltaics' 2005-06)
- 3.4 Smyth, M and Skates, H (2009) *A passive solar water heating system for vineyard frost protection*. Solar Energy, 83 (3). pp. 400-408. [doi:10.1016/j.solener.2008.08.014](https://doi.org/10.1016/j.solener.2008.08.014)
- 3.5 Smyth, M and Russell, J (2009) *'From graft to bottle'—Analysis of energy use in viticulture and wine production and the potential for solar renewable technologies*. Renewable and Sustainable Energy Reviews, 13 (8). pp. 1985-1993. [doi:10.1016/j.rser.2009.01.007](https://doi.org/10.1016/j.rser.2009.01.007)
- 3.6 Smyth, M (2012) *Solar photovoltaic installations in American and European winemaking facilities*. Journal of Cleaner Production, 31 (3). pp. 22-29. [10.1016/j.jclepro.2012.02.019](https://doi.org/10.1016/j.jclepro.2012.02.019)

The underpinning research was supported by prestigious grants from a range of funding sources including RCUK, the Royal Academy of Engineering and public sector agencies in Ireland.

3a Norton, Yohanis and Smyth

Monitoring of building integrated photovoltaics at ECOS Millennium Environmental Centre, NI
ETSU

01/10/2000 – 30/09/2005

£44,164

3b Smyth and Hyde

Fellowships in the Built Environment

RCUK – Academic Fellowship Scheme

- 01/10/2006 – 20/09/2011
£125,000
- 3c Hewitt, Griffiths, Huang, Hyde, McIlveen-Wright and Smyth Charles Parsons Award's Programme
Department of Communications, Marine & Natural Resources (ROI)
01/01/2007 – 04/12/2014
£2,853,292
- 3d Smyth
A low cost, easy to install twin vessel Integrated Collector Storage Solar Water Heater using Phase Change Materials and vacuum technology
Invest NI, Proof of Concept
01/01/2009 – 01/04/2010
£99,511
- 3e Smyth
Solar Energy in the Wine Making Industry
Royal Academy of Engineering
01/03/2010 – 28/11/2012
£29,238
- 3f Mondol, Zacharopoulos and Smyth
Energy Efficiency and Auditing Fusion Programme (All-Island Knowledge Transfer Initiative)
InterTradeIreland
13/06/2012 – 12/06/2013
£14,500
- 3g Mondol, Zacharopoulos and Smyth
Building Integration of Solar Thermal Systems (BISTS) COST Action TU1205
EU COST
01/06/2013 – 31/05/2014
£110,755 (€129,000)

4. Details of the impact

The underpinning research in solar energy and energy efficiency, and its contribution to energy benchmarking as part of wider energy policy, has been adopted in a number of wine producing regions (UK, North Carolina and California) and is influencing energy consumption through wine producers changing their production methods. The linkage of the research to wine production and operations has informed policy, regulations and guidelines relevant to the sector through enhanced energy awareness with the main beneficiaries being the local wine industry, their associations and governing bodies. The *reach* of the case study is extensive with individual wineries, vineyards, professional bodies, institutions and the wider supply chain benefitting in different countries including the emerging winemaking industry in the UK.

Local wine industry associations and governing bodies; UKVA Sustainability Programme, UKVA regional bodies SEVA (South East Vineyard Association) (corroborating statement 1, source 5.1) and MVA (Mercian Vineyard Association) (source 5.2) and the UK Wineskills Programme (source 5.3) have benefitted from the underpinning research through increased knowledge of how systems operate in an energy context with consequential cost savings. Collectively, the data accumulated during the case study has led to the development of the first set of UK relevant benchmarks and the establishment of an industry Energy Working Group for UK wine producers and industry stakeholders. The Energy Working Group is the first of its kind in the UK. Smyth is an energy expert for the UKVA and sits on the working group as an expert witness thereby facilitating the process through which research outcomes directly impact on energy policy and subsequent implementation by the UK industry. The UK energy benchmark study

provides an up to date representation of the industry's current energy requirement on which future sustainable programmes are being developed (source 5.4).

Evaluating the energy demand of winemaking facilities through specific auditing procedures developed by the CST team and underpinning research (including solar energy) has had a major impact on individual operating performances, resulting in cost saving and environmental benefits. The underpinning research has contributed to the development of a patented solar water heater (source 5.5) that has particular application to hot water usage in the wine making industry. The solar water heater is being commercialised as SolaCatcher through Solaform Ltd, a University of Ulster spin-out company (source 5.6).

Energy audits conducted for individual wineries have *significance* through a direct impact upon the strategy, operations and management practices of that facility and changing wine production activities to adopt greater sustainability procedures. Information from the energy audits has had a fundamental impact in changing the attitude of the UK winemaking industry. Many wineries have been empowered through the knowledge provided from the audits to review and change their operating policy and management tailored to a greener agenda. This is evidenced through written support from a range of wine producers (SMEs) spanning the full spectrum of wine making in the UK and the USA. As an example, the research enabled senior management at Domaine Carneros in California, to evaluate and compare their systems, processes and plant against accepted Californian benchmark values and provided information that permitted the winery to analyse energy consumption trends and patterns and instigate improvements in energy usage (corroborating statement 2, source 5.7). In the UK, a number of English wineries had an immediate impact from their participation in the study. Following the energy audit, each winery was given a detailed report on their energy usage and benchmark including the award winning Ridgeview Wine Estate (corroborating statement 3, source 5.8). Each winery used this information to implement energy saving measures that led to a reduction in energy usage and economic savings.

The research has also impacted on the building of new wineries in the UK, the wider supply chain and professionals involved in their construction. The UK wine industry is set to expand significantly in the next decade and the building of energy sustainable wine facilities is crucial. This research has already been used by a number of producers with impact apparent through changes in the design of their wineries to reduce the energy requirements in their processes and operations. Ancre Hill Estates (corroborating statement 4, source 5.9) is an example of how the research has directed the design (and energy use) of their proposed new winery and how this research was used by their design consultants.

The research has resulted in the production of wine within stricter, defined energy benchmarks thereby improving the environmental credentials of the industry whilst reducing energy use and associated emissions. This research determined that the collective UK winery operations used 2,008 MWhs of energy in 2011, equivalent to 1181 barrels of crude oil, producing 736.8 tonnes of CO₂. As the industry is in the midst of rapid expansion (production increased fourfold over the past decade), the Energy Working Group, using the energy benchmark established by Smyth at 0.557 kWh/litre, has set this as a desired upper limit for all UK wine production as evidenced by prominent English producers (source 5.4).

The impact of this study is not limited to the wine industry but is applicable to the much larger food and drink industry. Through an Inter-trade Ireland Fusion project, the research team provided expertise to Errigal Seafood, demonstrating the wider *reach* of the accumulated knowledge and expertise. The company's thermal energy bill in 2011 was €445,847. Using the

transferable skills, knowledge and expertise developed in the wine study, the team were able to directly impact savings in the shellfish production facility. The research through streamlining the company's production processes led to a 15% reduction in energy used, equating to €89,184 and 42.3 tonnes of CO₂ saved (corroborating statement 5, source 5.10).

5. Sources to corroborate the impact

The scope of the impacts arising from the case study research is evidenced by a range of sources detailed below. Electronic copies of all sources including web links can be provided.

- 5.1 Corroborating Statement 1 – Chairman, South East Vineyards Association.
- 5.2 Mercian Vineyards Association acknowledges and links Viticultural Services consultancy and advice through the University's Office of Innovation on energy efficiency and renewables. <http://www.ukvines.co.uk/mercia/merlinks.htm>.
- 5.3 The Wineskills website (<http://www.wineskills.co.uk/sustainability/about/acknowledgements>) acknowledges the contribution to the sustainability guidelines, providing information to the UK wine industry and involvement in the development of energy tools to UK wine industry.
- 5.4 UK wine industry benchmarking <http://www.wineskills.co.uk/news/2013-03-01-energy-and-english-wine-production> evidence to the industry.
- 5.5 Bibliographic data: US2011277746 (A1) - SOLAR WATER HEATER. http://worldwide.espacenet.com/publicationDetails/biblio?DB=EPODOC&II=4&ND=3&adjacent=true&locale=en_EP&FT=D&date=20111117&CC=US&NR=2011277746A1&KC=A1.
- 5.6 SOLAFORM LTD, Company Number NI619528, Registrar of Companies for Northern Ireland, Companies House, Belfast, 26th July 2013.
- 5.7 Corroborating Statement 2 – CEO, Domaine Carneros.
- 5.8 Corroborating Statement 3 - Director, Ridgeview Wine Estate.
- 5.9 Corroborating Statement 4 - Vineyard Manager, Ancre Hill Estates
- 5.10 Corroborating Statement 5 – Facilities/Energy Manager, Errigal Seafood