

**Project title:** GrowSave; Energy & Resource Efficiency Knowledge Transfer for the PC Sector

**Project number:** PE/PO 011a

**Project leaders:** Jonathan Swain & Edward Hardy, FEC Energy

**Report:** Project completion, ending July 2019

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**Location of project:** FEC Energy, Kenilworth, CV8 2LS, commercial nurseries and various meeting venues

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**Project start date:** 1<sup>st</sup> August 2014

**Project end date:** 31<sup>st</sup> July 2019

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## AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Signature Date ...

Report authorised by:

Signature

Date ...

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## Headline

GrowSave delivers a programme of technology transfer and information dissemination activities to AHDB Horticulture protected crops (PC) sector levy payers and provides up-to-date information about energy saving and energy efficiency.

Between August 2014 and July 2019 the project has delivered the following activities:

- Technical presentations at the TGA and BPOA conferences
- Technical seminar on air movement in glasshouses
- Technical seminar on the use of heating and lighting for soft fruit
- Workshop on humidity control in glasshouses
- Seminar on the lessons learned from the Next Generation Growing study groups
- Technical seminar on climate control for soft fruit
- Three editions of the *GrowSave News* newsletter, dedicated to energy topics
- Regular news and updates delivered via *The Grower* magazine and the GrowSave website
- Energy benchmark data via the GrowSave website
- Technical Update publications covering the topics of improving light transmission in glasshouses, air movement, using glass for soft fruit, utilising data for climate optimisation, and irrigation efficiency.

All of the activities were designed to encourage growers to take energy saving actions in their businesses.

## Background & Introduction

GrowSave is AHDB Horticulture's communications platform that disseminates energy saving information and supports the implementation of energy saving technologies by the UK protected cropping (PC) sector. The programme has been running for over 10 years, focused on the PO and PE sectors. In the GrowSave year 2018-19, Soft Fruit was included for the first time as part of the main programme. It is delivered by the FEC Energy team and steered by a group of edible, ornamental and, as of this year, soft fruit growers. The format of outputs and the project programme are deliberately kept flexible, so as to allow the project to respond to the energy issues that the industry is facing at any given time.

The current phase of the project builds on previous activities that were funded under a series of AHDB Horticulture (formerly HDC) projects, the latest of which was project reference PE/PO 011. This report outlines the activities delivered in the term of the project, which ran from 01 August 2014 to 31 July 2019.

## Summary of Work Completed 2014-2019

The following table summarises the deliverables over year five of the project and compares them to the work plan specified in the contract.

Activity area - Website		
Design and publish Soft Fruit specific website to contain relevant content.  Provide at least one update per week per website.	2014 - 2019	News stories added per contract/ Also “blogs” from FEC Energy specialists added on a regular basis.  Website developed specifically for Soft Fruit content as per contract.  News stories added to both websites as per contract. Blogs from FEC Energy specialists added on a regular basis.

Activity area - Grower workshops / technical seminars		
Deliver four workshops / seminars and two specifically for Soft Fruit in 2018-2019.	2014 - 2015	<b>Greenhouse energy saving research update</b> seminar; held at Stockbridge Technology Centre (STC) on 13.11.14. <b>Biomass heating study tour</b> ; held at various venues in Hertfordshire and Bedfordshire on 11.2.15 and 12.2.15. <b>Humidity control workshop</b> ; held at STC on 10.3.15. <b>Optimise your heating system</b> . Two workshops on this subject were held; one near Southport on 9.7.15 and one near Chichester on 15.7.15.
	2015 – 2016	<b>Next Generation Growing</b> : held in East Yorkshire at CMW Horticulture, on 20/04/16. <b>Next Generation Growing</b> : held in Harlow on 21/04/16. <b>Basic computer training</b> : held at Stoneleigh on 21/09/16. <b>Smart use of CO2</b> (pre TGA) scheduled for 28/09/16. at Chesford Grange Hotel.
	2016- 2017	<b>‘What’s Next for Renewable Heat?’</b> held at Vale Golf Club, Evesham, and Springhill Nurseries on 16/05/17. <b>BPOA Technical Conference, 20/06/17</b> - Optimising air movement for protected ornamental crops The remaining event days will be used in 2017-18 for the proposed NGG study group project and a repeat of the Renewable Heat event to take place in Scotland.
	2017- 2018	<b>‘Looking after your biomass boiler’</b> held at Roundstone Nursery, Chichester on 23/11/17. <b>‘What’s Next for Renewable Heat?’</b> held at The Old Manor Hotel, Fife, Scotland on 12/12/17. <b>‘Basic Humidity Control’</b> held at Bordon Hill Nursery on 24/01/18.
	2018 - 2019	<b>‘Air Movement’</b> held at W. D. Smith & Son, Wickford on 09/10/18. <b>‘Heating &amp; Lighting for Soft Fruit’</b> held at Stonebridge Golf Club, Coventry on 19/11/18. <b>‘Basic Humidity Control’</b> held at Roundstone Nurseries on 23/01/19. <b>‘Advanced Humidity Control’</b> held at Roundstone Nurseries on 24/01/19. <b>‘Next Generation Growing – Lessons Learned’</b> held at Mill Nurseries on 14/02/19. <b>‘Climate Control for Soft Fruit’</b> held at New Forest Fruit on 27/02/19.

Activity area - Technical presentation at PC Crop Association conferences / meetings		
Provide presentations / technical support to three Crop Association conferences / meetings, including one specifically for Soft Fruit in 2018 - 2019	2014 - 2015	<ul style="list-style-type: none"> <li>• TGA Conference, 25.9.14</li> <li>• CGA Conference, 16.10.14</li> <li>• Bedding Plant Centre event / HTA Plant Show, 23.6.14</li> </ul>
	2015 – 2016	<ul style="list-style-type: none"> <li>• CGA conference: 08/10/15.</li> <li>• AHDB lighting event: 19/01/16.</li> </ul>
	2016-2017	<ul style="list-style-type: none"> <li>• TGA Conference, Chesford Grange Hotel, 28/09/16. Topics were: an update on the latest issues affecting energy use in greenhouse horticulture, including energy pricing, the viability of renewable heating systems and Climate Change Levy targets.</li> <li>• BPOA Annual Conference, Whittlebury Hall, 18/01/17. Topic was the use of NGG techniques in ornamentals.</li> </ul>
	2017-2018	<ul style="list-style-type: none"> <li>• TGA Conference, Chesford Grange Hotel, 20/09/17. Topics were focused on energy storage, including effective use of heat stores, as well as battery storage and grid support.</li> <li>• CGA Conference, Waltham Abbey Marriott Hotel, 05/10/17. Topic was creating an even greenhouse climate using NGG techniques.</li> </ul>
	2018 - 2019	<ul style="list-style-type: none"> <li>• TGA Conference, 27/09/18. Topics included energy prices, acronyms, renewable energy update.</li> <li>• BPOA Technical Conference, 15/01/19. Topics focused on air movement and climate control.</li> <li>• Soft Fruit Conference – to be delivered in November 2019</li> </ul>

Activity area - Energy benchmarks		
Deliver information and data via the GrowSave website to allow growers to carry out energy use comparisons.	2014 - 2019	Done via the Managing Energy section of the website where information is given on comparison methods using degree-days. Degree-day data and ambient temperature data given to allow comparisons to be made.

Activity area - GrowSave News		
Deliver three editions of the energy specific newsletter	2014 - 2015	Delivered to contract with three editions completed in Dec 14, Apr 15 and July 15.
	2015 – 2016	Delivered to contract with editions published: November 2015, April 2016 and June 2016.
	2016-2017	Delivered to contract with editions published: December 2016, March 2017 and June 2017.
	2017-2018	Delivered to contract with three editions completed in September 2017, February 2018 and June 2018.
	2018 - 2019	Delivered to contract with three editions completed in December 2018, April 2019 and June 2019.

Activity area - <i>The Grower</i> news columns		
Deliver columns of ~750 words in each edition of AHDB's <i>The Grower</i>	2014 - 2019	Delivered to contract.

Activity area – Technical updates		
Publish five new technical updates, including one specifically for Soft Fruit, covering topics relating to recent energy developments; review and update five for Soft Fruit.	2014 - 2015	<p>Updates have been written on the following topics;</p> <ol style="list-style-type: none"> <li>1. Heat pumps for greenhouse heating</li> <li>2. Thermal screens</li> <li>3. Fans for greenhouses</li> </ol> <p>Note – 4th Update has been substituted for the Energy Glossary on the website</p>
	2015 – 2016	<p>Updates were published on the following:</p> <ol style="list-style-type: none"> <li>1. Measuring energy.</li> <li>2. Biomass CHP.</li> <li>3. Diffuse light.</li> </ol> <p>The following update will be published in time to support the event on 28/09/16.</p> <ol style="list-style-type: none"> <li>1. CO<sub>2</sub> sources.</li> </ol>
	2016-2017	<p>Updates have been written on the following topics:</p> <ol style="list-style-type: none"> <li>4. Conventional &amp; Alternative Sources of CO<sub>2</sub></li> <li>5. Sensors</li> <li>6. Cold Storage</li> <li>7. Assimilation Lighting</li> </ol>
	2017-2018	<p>Updates have been written on the following topics:</p> <ol style="list-style-type: none"> <li>8. Modern heat storage</li> <li>9. Thermal storage for horticulture</li> <li>10. Understanding your energy bill</li> <li>11. Seven tips for Next Generation Growing</li> </ol>
	2018 - 2019	<p>New updates have been written on the following topics:</p> <ol style="list-style-type: none"> <li>1. Improving light transmission in glasshouses</li> <li>2. Air movement</li> <li>3. Using glass for soft fruit</li> <li>4. Utilising data for glasshouse climate optimisation</li> <li>5. Irrigation efficiency (in progress)</li> </ol> <p>The following have been reviewed for applicability to Soft Fruit:</p> <ol style="list-style-type: none"> <li>1. Screens</li> <li>2. Modern heat storage</li> <li>3. Thermal storage</li> <li>4. Alternative sources of CO<sub>2</sub></li> <li>5. Conventional sources of CO<sub>2</sub></li> </ol>

In addition to the main programme's contracted activities, FEC Energy has also delivered the following, as outlined in the table below:

Year	Activity Area	Additional Contracted Activity	Delivered Activity
2017 - 2018	Study Tour	Attendance at Automation & Robotics study tour at Wageningen University & Research	
	Attendance at show to market GrowSave to the Soft Fruit sector	Delivered to contract	
2018 - 2019	Videos	Deliver three short videos on Air Movement, paid for by knowledge transfer budget for Protected Ornamentals.	In progress, at Draft 2 stage
	Conferences	Attendance at industry conferences and events beyond contract.	Edible Vine Crop Research Day, 27 February 2019 SmartHort, 06 & 07 March 2019 Mushroom Conference
	Conference	Attendance at industry conference paid for by Protected Ornamentals	Climate Control for Cut Flowers
	Social Media	Beyond contract	Regular updates via Twitter

## Description of Activities

The activities of the GrowSave project were discussed and planned with the Steering Committees. Meetings were held either in person or via conference call. Regular contact was maintained with industry groups including the TGA, CGA and BPOA. These industry inputs formed the basis of the work programme described here.

## Website and Social Media

A new website was launched specifically for the Soft Fruit sector in 2018, which contains information relevant to the industry. Meanwhile, the original GrowSave website continues to be updated for PE and PO. Both websites have been regularly updated with articles and news items, as well as reports from GrowSave events.

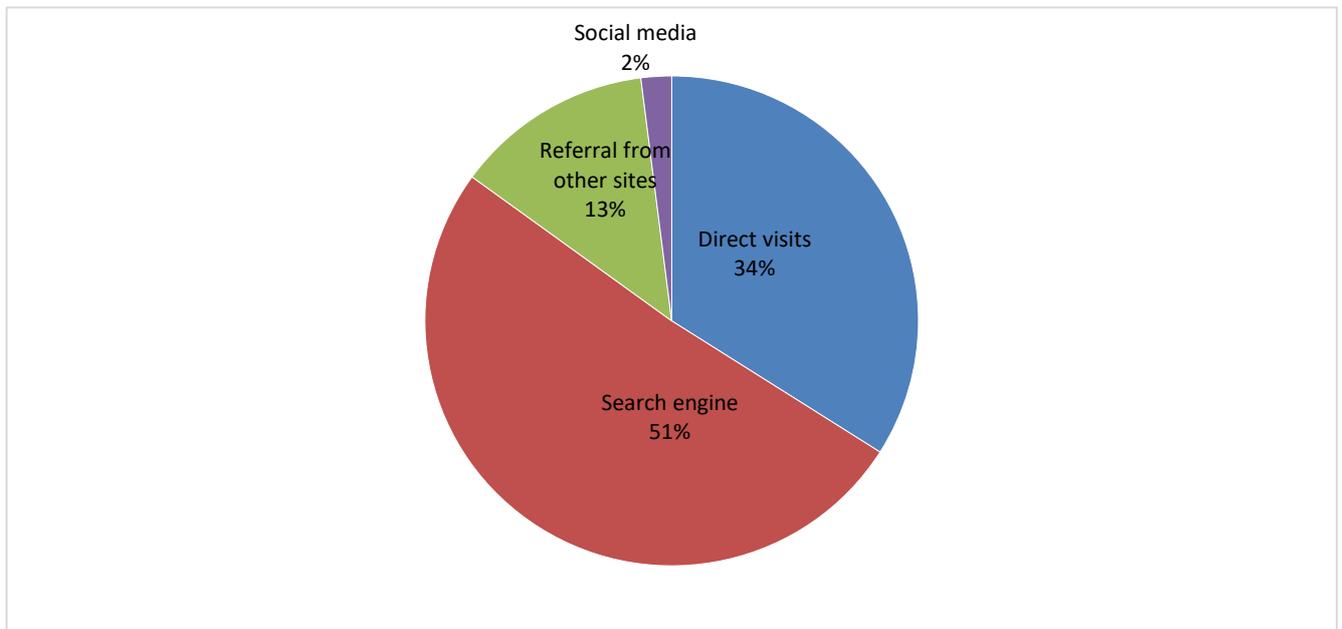
Website metrics have been recorded using Google Analytics. The main website ([growsave.co.uk](http://growsave.co.uk)) received 43,535 visits with 95,490 page views between 01 August

2014 and 31 July 2019. New visitors accounted for 32,613 (75%) of these visits. Direct website visits numbered 5,486, while 8,245 were directed via Google.

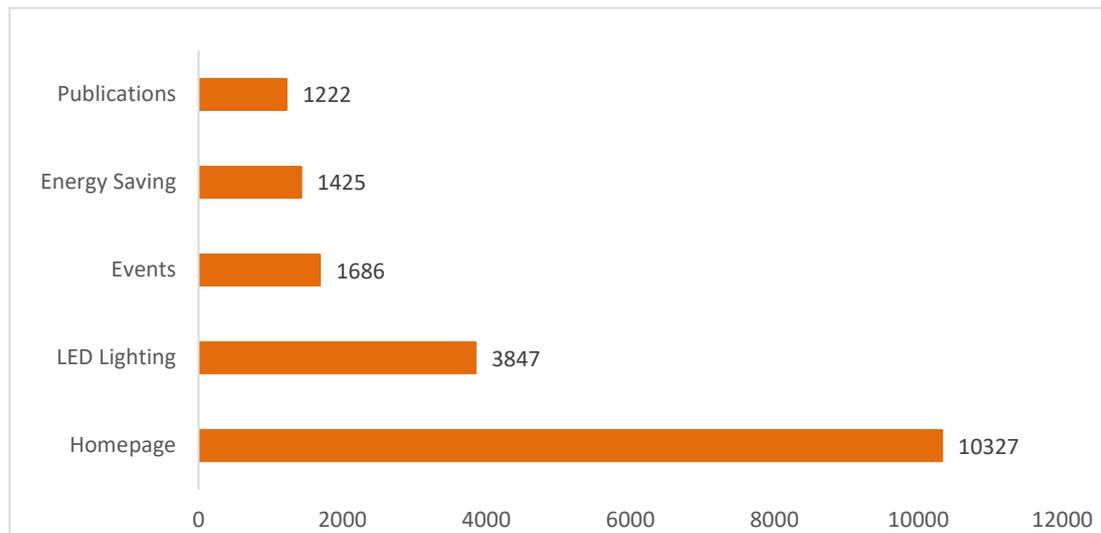
The number of visits to the website has increased by 159% compared to the same period in 2009-2014. Part of this increase is believed to be due to the popularity of GrowSave events, as well as work carried out alongside the marketing team at AHDB. Both AHDB and GrowSave marketing channels have been used to notify AHDB members of new Technical Updates, GrowSave News editions and events.

In addition to the website, GrowSave has been reaching growers through articles and press releases on websites, including HortiDaily, Horti Biz and the AHDB website. The number of website sessions resulting from referral links was 62.57%.

The most popular routes of access to the GrowSave website were:



The top five most popular webpages were:



LED Lighting remains a popular topic, featuring in the top five most visited pages regularly throughout the five years.

Going forward, subject to available funding, GrowSave would like to implement a new digital strategy, with a focus on redesigning the website to bring it up-to-date in terms of both layout and content, making it easier for users to navigate and find the information relevant to them. An increase in the use of social media is also an ongoing focus, and it is hoped that this will drive more people to the website.

Regular contact with the industry has been maintained through social media. The use of Twitter has helped to promote events and notify followers of new publications. GrowSave currently has 173 followers on Twitter.

## Workshops and Seminars

The topics for workshops / seminars were decided based on grower demand and the guidance given by the steering committees. The inclusion of soft fruit into 2018 -2019 programme meant two dedicated Soft Fruit events in addition to the four events contracted for edible and ornamental crop growers.

2014 - 2015

Workshop / Seminar Title	Details	No. of Participants
Greenhouse energy saving research update	This event was designed to update growers on some of the latest energy saving R&D that is being done in various parts of Europe. Topics covered included LED lighting and light management, humidity control methods and novel heating systems including gas driven heat pumps and energy saving greenhouse construction. The presentations were given by STC (on the LED lighting work) and by representatives of a European consortium carrying out a project known as Green Growing. Presenters included Carl-Otto Ottensen from Aarhus University in Denmark who covered both lighting response and humidity topics.	21 growers 1 consultant 3 manufacturers / suppliers 1 journalist
Biomass heating study tour	Interest in the Renewable Heat Incentive (RHI) continued amongst growers who were considering switching to renewable fuels (such as wood and straw) for greenhouse heating. This event was split over 2 days. On day 1 delegates heard from industry experts about topics including the latest RHI payment rates & regulations and how to select a renewable heating system for their business. On day two visits were arranged to three nurseries who had successfully installed biomass heating systems of differing configurations and fuel types.	19 growers 5 manufacturers/ suppliers 2 journalists
Humidity control workshop	René Beerkens from Hoogendoorn Growth Management in Holland gave delegates information on the latest thinking on humidity control. He explained how growers can use absolute humidity measurements to monitor crop activity and control energy inputs. He also emphasised how work in Holland on “The New Way of Growing” has highlighted the importance of an even greenhouse environment. He showed delegates how to implement a thermal screen operation strategy that improved climate uniformity by removing screen gapping.	11 growers 4 manufacturers/ suppliers 1 consultant 1 journalist
Optimising your heating system	This was a series of two workshops, one at a ‘northern’ venue (Lovania Nurseries nr. Southport) and a second at a ‘southern’ venue (Roundstone Nurseries nr. Chichester).  The subjects covered helped growers and their senior supervisors get a better understanding of the operation of a greenhouse heating system. This included explaining the role of the key heating system components.  Delegates were also shown how to maintain and operate a heating system to ensure that optimum efficiency was achieved. The events used a mixture of seminars and a nursery walk round to give a mix of theoretical and practical activities.	<b>Lovania Ltd</b> – 16 attendees, a mix of growers, maintenance staff and support staff  <b>Roundstone Nurseries</b> – 10 attendees a mix of growers, maintenance staff and support staff & 1 consultant

**2015 - 2016**

<b>Workshop / Seminar Title</b>	<b>Details</b>	<b>No. of Participants</b>
<b>Next Generation Growing</b> Venue: CMW Horticulture Ltd. Date 20/04/16	These two events were organised to inform UK growers of the most up to date information about the Dutch Het Nieuwe Telen initiative (Next Generation Growing). This appears to be demonstrating that it's possible to reduce energy inputs significantly, without large capital investments by adopting radically different attitudes to the greenhouse environment. The seminars were led by Jan Voogt of LetsGrow.com. Who co-authored the recently published 'Basic Principles of Next Generation Growing'. He was supported by René Beerkens of Hoogendoorn who advises growers on how to implement NGG techniques and Paul Arkesteijn of screen manufacturers Svensson, who have been closely involved in NGG trials. Peter Kamp outlined the ongoing Priva development of Top Crop Monitoring, which uses measurements and modelling to alter the greenhouse environment in response to actual plant performance.	12 growers 1 consultant 5 manufacturers / suppliers <i>Subsequently, a group of growers from the Hull area have formed a study group to exchange their personal experience with the implementation of NGG principles on their own nurseries.</i>
<b>Next Generation Growing</b> Venue: Harlow Leisure Centre. Date 21/04/16		15 growers 3 manufacturers/suppliers 1 consultant 1 journalist
<b>Smart use of CO<sub>2</sub></b> Venue: Chesford Grange Hotel Date 28/09/16	The increasing popularity of biomass as a heat source, the cost of fossil fuels, changing attitudes to environmental responsibility and the recent uptake of Next Generation Growing techniques all call into question long standing protocols for CO <sub>2</sub> enrichment. Considerable work to investigate more efficient use of CO <sub>2</sub> has been carried out both in Holland at WUR and as a result of project PE 021 funded by AHDB. This seminar was organised to coincide with the TGA conference, in order to update UK growers on the Dutch and AHDB funded work, as well as to revisit the economics of the various CO <sub>2</sub> sources available, and to hear grower experiences of CO <sub>2</sub> produced by anaerobic digestion.	
<b>Basic computer training</b> Venue: Farm Energy Centre Scheduled for 21/09/16	Many growers are faced with challenges in training their staff to use climate controls effectively, particularly when new recruits join an existing team. This one-day seminar has been designed to address that issue, with course content based on the results of an on-line grower survey carried out in the spring of 2016.	15 computer users attended with a cross section from the ornamental, edibles, propagation and educational sectors

**2016 - 2017**

<b>Workshop / Seminar Title</b>	<b>Details</b>	<b>No. of Participants</b>
<b>Soft Fruit Study Tour</b> Location: Belgium & the Netherlands Date: 25 <sup>th</sup> -27 <sup>th</sup> January 2017	The aim of the study tour was to look at growing techniques used by growers in Belgium and the Netherlands, and compare these to current practice in the UK.  The tour included visits to a research facility (Hoogstraten), semi-closed glasshouse (Red Star) and several independent growers. Various technologies and NGG techniques were observed.	<b>Total: 10</b> 6 growers 3 consultants 1 tour guide
<b>What's Next for Renewable Heat?</b> Location: Vale Golf Club, Evesham & Springhill Nurseries Date: 16 <sup>th</sup> May 2017	Information regarding the proposed changes to the RHI scheme was presented to growers and other interested parties, with the aim of highlighting the financial impact of the new regulations on anyone considering installing a renewable heating system in the near future.  Following the presentations, delegates were invited for a tour around Springhill Nurseries, which had recently commissioned a CHP system, comprising of a biomass boiler and steam turbine.  The presentations and site visit were filmed. Videos are available on the website.	<b>Total: 24</b> 11 growers 6 manufacturers / suppliers / installers 4 consultants 3 journalists / marketing

**2016 - 2018**

<b>Workshop / Seminar Title</b>	<b>Details</b>	<b>No. of Participants</b>
<b>NGG Study Group</b> Date: November 2017 - onwards	The aim of the study group was to introduce Next Generation Growing (NGG) techniques, pioneered by growers in the Netherlands, to UK growers.  The programme revolved heavily around the LetsGrow.com online platform, where growers were encouraged to share their climate data. Weekly feedback was provided by a Dutch NGG consultant.  Visits to the individual growers were carried out in February and June. Online training sessions were held in March, April and July.	<b>Total: 6</b> 5 growers 1 crop consultant
<b>Looking After Your Biomass Boiler</b> Location: Roundstone Nursery Date: 23 <sup>rd</sup> November 2017	This event was targeted at biomass boiler operators with the aim of informing them how to get the most out of their equipment. Speakers focused on how to ensure best performance from the system, and ensure all components integrate well with each other.	<b>Total: 15</b>
<b>What's Next for Renewable Heat?</b> Location: Old Manor Hotel, Fife, Scotland Date: 12 <sup>th</sup> December 2017	This was the same topic as the event held in March 2017, but the speakers and content were different. Information was presented on the viability of projects following changes to the RHI scheme, with the aim of highlighting the financial impact of the new regulations on anyone considering installing a renewable heating system in the near future.	<b>Total: 11</b>

**2018 - 2019**

<b>Workshop / Seminar Title</b>	<b>Details</b>	<b>No. of Participants</b>
<p>NGG Study Group Date: November 2017 – November 2018</p>	<p>The aim of the study group was to introduce Next Generation Growing (NGG) techniques, pioneered by growers in the Netherlands, to UK growers.</p> <p>The programme revolved heavily around the LetsGrow.com online platform, where growers were encouraged to share their climate data. Weekly feedback was provided by a Dutch NGG consultant.</p> <p>Visits to the individual growers were carried out in February and June. Online training sessions were held in March, April and July 2017, and a wrap-up session in November 2018.</p>	<p><b>Total: 6</b> 5 growers 1 crop consultant</p>
<p>Air Movement Location: W. D. Smith &amp; Son, Wickford Date: 9<sup>th</sup> October 2018</p>	<p>This event focused on how to achieve good air movement in a glasshouse. Presentation of the theory was given by Dutch industry expert Peter van Weel, who also led visual demonstrations of different fan setups using a smoke machine.</p> <p>The trials considered air movement using horizontal fans as well as a Nivolator (horticulture specific vertical fan) within the ground level ornamentals crop. The trials were filmed for future use.</p>	<p><b>Total: 17</b></p>
<p>Heating &amp; Lighting for Soft Fruit Location: Stonebridge Golf Club, Coventry Date: 19<sup>th</sup> November 2018</p>	<p>GrowSave's first soft fruit specific workshop focused on the technical and financial viability of providing supplementary heat and light to a soft fruit crop. Consideration was given primarily to glasshouse crops.</p>	<p><b>Total: 32</b></p>
<p>Basic &amp; Advanced Humidity Control Location: Roundstone Nurseries, Chichester Date: 23<sup>rd</sup> &amp; 24<sup>th</sup> January 2019</p>	<p>A two-day workshop focusing on the basics of humidity control on day one and more advanced methods on day two. The popularity of the event run in January 2018 meant there was still significant demand for this topic. It was decided to break down the content across two days to cater for a wider audience, with some cross-over required to ensure all attendees started at the same level.</p>	<p><b>Day 1: 16 (fully booked)</b> <b>Day 2: 16 (fully booked)</b></p>
<p>Next Generation Growing – Lessons Learned Location: Mill Nurseries Date: 14<sup>th</sup> February 2019</p>	<p>Following the conclusion of the NGG study group, the outcomes and lessons learned were fed back to the wider industry through this half-day seminar. Presentations were given by GrowSave and Dutch NGG expert, Mark van der Werf, who was instrumental to the study group's success.</p>	<p><b>Total: 26</b></p>
<p>Soft Fruit Climate Control Location: New Forest Fruit, Brockenhurst Date: 27<sup>th</sup> February 2019</p>	<p>The event focused on optimising climate control strategies in glasshouses for soft fruit. Consideration was given to air movement, humidity control and CO<sub>2</sub> supplementation.</p>	<p><b>Total: 22</b></p>

In addition to the specific GrowSave events, technical support on energy topics has been given to several PC sector events / Crop Association meetings. Details of these events are as follows:

<b>2014 - 2015</b>	
<b>Sector Conference</b>	
<b>TGA Conference</b> , 25 September 2014	
<b>CGA Conference</b> , 16 October 2014	
<b>Bedding Plant Centre event/ HTA Plant Show</b> , 23 June 2014	

<b>2015 - 2016</b>	
<b>Sector Conference</b>	<b>Details</b>
<b>CGA Conference</b> , 8th October 2015	Because of the continued low margins for UK grown greenhouse cucumbers, growers are seeking out ways to save energy with little or no capital expenditure. Chris Plackett described how the Dutch "Next Generation Growing" is achieving significant energy consumption reductions, without the need for capital investment. The conference delegates then discussed with Chris how these principles could be used by growers in the UK. Chris also told delegates about recent developments with CHP installations on greenhouse sites. Whilst this might be viewed by many as a high capital approach, the recent desire by investors and energy service providers to secure good CHP sites means that some growers may be able to have CHP, without the need to invest their own money. Delegates interested in this approach were urged to seek out the companies who were offering projects of this type to growers.
<b>AHDB Lighting event</b> , 19th January 2016	Chris Plackett delivered a presentation entitled 'Energy Considerations', which focussed on energy issues related to lighting.

<b>2016 - 2017</b>	
<b>Sector Conference</b>	<b>Details</b>
<b>TGA Conference</b> , 28th September 2016	Chris Plackett from FEC Energy gave delegates an update on the latest issues affecting energy use in greenhouse horticulture. This covered several topics including energy pricing, the viability of renewable heating systems and Climate Change Levy targets.
<b>BPOA Annual Conference</b> , 18th January 2017	Jon Swain talked about whether or not NGG has a place in ornamentals production and considered which techniques might be applicable.
<b>BPOA Technical Conference</b> , 20th June 2017	Jon Swain presented on the topic of optimising air movement for protected ornamental crops.

2017 - 2018	
Sector Conference	Details
<b>TGA Conference,</b> 20th September 2017	Tim Pratt from FEC Energy gave delegates an update on the latest issues affecting energy use in greenhouse horticulture. This covered several topics including energy pricing, the viability of renewable heating systems and Climate Change Levy targets.
<b>CGA Conference,</b> 5th October 2017	Jon Swain presented the topics of NGG, thermal screens and glasshouse maintenance, highlighting the importance of keeping the crop in balance by maintaining a homogeneous glasshouse climate.

2018 - 2019	
Sector Conference	Details
<b>TGA Conference,</b> 27 September 2018	Tim Pratt from FEC Energy gave delegates an update on the latest issues affecting energy use in greenhouse horticulture. This covered several topics including energy pricing, the viability of renewable heating systems and Climate Change Levy targets.
<b>BPOA Technical Conference,</b> 15 January 2019.	Jon Swain presented the topics of air movement and climate control, focusing on how to identify problems and the best solutions.
GrowSave also had a presence at a number of other industry conferences. These were the Edible Vine Crop Research Day, the Mushroom Conference and AHDB's SmartHort conference.	

## Energy Benchmarks

GrowSave continues to provide information to allow growers to benchmark the performance of their nurseries against other similar facilities. However, factors such as the wide range of protected crops grown in the UK and the existence of some established industry initiatives, such as the Tomato Working Party, mean that providing energy use benchmarks is not feasible under the current project.

Two of the largest factors affecting the energy use of glasshouses are the prevailing weather conditions (particularly the ambient temperature) and operating temperature. Therefore, if the information on these two parameters is used by growers alongside their energy use data, they can compare their performance against others.

Throughout the project, the GrowSave website has provided weather data (temperature and solar radiation) and degree-day information so that growers can use this to carry out energy performance benchmarking. The webpages showing graphs for Energy Performance Indicators received a total of 1,144 views during the period 01/08/2014-31/07/2019, while Energy Price Trends received 514 page views.

## GrowSave News and The Grower

Three editions of GrowSave News have been produced and delivered as inserts within AHDB's *The Grower*. The content of each of the editions focused on topical stories and information at the time of publishing. In all cases, the stories were designed to appeal to as wide a cross-section of levy payers as possible.

A short column (500 to 1000 words) with topical news on either the GrowSave project or energy related projects has also been included in all six editions of the bi-monthly publication of The Grower. Topics covered include news on upcoming events, reports of recent meetings, information on the progress of AHDB Horticulture energy projects and general energy developments.

These publications are distributed to a mailing list of around 3300 people affiliated and part of horticultural business' payers. The following tables describe the articles and the publications they appeared in.

2015 -2016		
Date	AHDB Grower Topic	GrowSave News Topic
November 2015		<ul style="list-style-type: none"> <li>• Heat Pumps.</li> <li>• Conference reports.</li> <li>• Energy Jargon explained.</li> <li>• Saving energy by good maintenance.</li> <li>• Energy market update.</li> </ul>
February 2016	Rate cuts in feed-in tariff and renewable heating schemes	
March 2016	Workshops to update you on smart energy use	
April 2016	Go Dutch to save without spending	<ul style="list-style-type: none"> <li>• Biomass CHP.</li> <li>• Geothermal Heat.</li> <li>• CCL Latest.</li> <li>• Energy Market update.</li> </ul>
May 2016	Are your climate settings correct for the changing season?	
June 2016	A better chance of connecting	<ul style="list-style-type: none"> <li>• Next Generation Growing.</li> <li>• The importance of climate.</li> <li>• Increased use of thermal screens.</li> <li>• Plant balance.</li> <li>• Energy market update.</li> </ul>
July 2016	Energy-saving ideas at GreenTech	

2016 - 2017		
Date	AHDB Grower Topic	Energy News Topic
December 2016	CCL discount deadline	<ul style="list-style-type: none"> <li>• Biomass CHP</li> <li>• Heat Networks</li> <li>• Heat Metering</li> <li>• Uncertain Energy Prices</li> <li>• Next Generation Growing</li> </ul>
February 2017	Green Christmas	
March 2017	Opportunities for renewable heating	<ul style="list-style-type: none"> <li>• Reducing CO<sub>2</sub></li> <li>• Vertical Farming</li> <li>• Solar Glass</li> <li>• NGG - Humidity Control</li> </ul>
April 2017	Best practice irrigation management	
May 2017	Renewable Heat event write-up	
June 2017	NGG Study Groups; LED Lighting	<ul style="list-style-type: none"> <li>• End of ROCs</li> <li>• CCL Summary</li> <li>• Energy Efficiency</li> <li>• NGG - Radiation Heat Loss</li> </ul>
2017-18	<ul style="list-style-type: none"> <li>• Understanding Humidity</li> <li>• Soft Fruit Tour</li> <li>• Humidity Control workshop write-up</li> </ul>	<ul style="list-style-type: none"> <li>• Grid Support</li> <li>• Grants</li> <li>• NGG Tips</li> </ul>

2017 - 2018		
Date	AHDB Grower Topic	GrowSave News Topic
Oct – Nov 2017	Cold Storage	<ul style="list-style-type: none"> <li>• Battery Storage</li> <li>• Grid Support</li> <li>• NGG Tip 4</li> <li>• Energy market update</li> <li>• Dates for your diary</li> </ul>
Dec 2017 – Jan 2018	Basic Humidity Control	
Feb – Mar 2018	Energy consumption issues and saving money for Soft Fruit Growers	<ul style="list-style-type: none"> <li>• New grants available</li> <li>• What the grants are worth</li> <li>• NGG</li> <li>• Energy market update</li> <li>• Venting on glasshouse ridge</li> </ul>
Apr – May 2018	Basics in humidity	
Jun – Jul 2018	NGG Study Groups	<ul style="list-style-type: none"> <li>• Heat pumps in horticulture</li> <li>• Don't get caught out by ESOS</li> <li>• RHI Update</li> <li>• Energy market update</li> </ul>

2018 - 2019		
Date	AHDB Grower Topic	GrowSave News Topic
Aug – Sep 2018	The Circular Economy	
Oct – Nov 2018	Climate Settings	
Dec 2018 – Jan 2019	Humidity Control	<ul style="list-style-type: none"> <li>• New facilities opened at STC</li> <li>• Medium Combustion Plant Directive</li> <li>• Capacity market suspended</li> <li>• Energy market update</li> <li>• Updated factsheets</li> </ul>
Feb – Mar 2019	Air Movement	
Apr – May 2019	Vertical Farming	<ul style="list-style-type: none"> <li>• £30m grant fund announced</li> <li>• Summary of workshops</li> <li>• Streamlined Energy and Carbon Reporting scheme</li> <li>• Energy market update</li> </ul>
Jun – Jul 2019	Soft Fruit	<ul style="list-style-type: none"> <li>• New energy efficiency support schemes proposed</li> <li>• Six tips for energy efficiency</li> <li>• CCL results</li> <li>• Energy market update</li> </ul>

## Technical Updates

The technical updates summarise information about the latest energy topics and techniques. They provide information about topics ranging from new commercial developments to the latest research results. In the period covered by this report, text has been prepared for Technical Updates on the following topics:

2014 - 2015	Heat pumps for greenhouse heating	<p>Ground source heat pumps are eligible for the RHI, and as a result they can provide a cost effective and energy efficient way to heat a greenhouse. However, integrating a heat pump into a traditional greenhouse heating system is not straightforward because the maximum water temperature generated is significantly lower than from a boiler.</p> <p>This update examines the current economics of heat pumps in the UK and explains how to overcome the problems of system integration.</p>
	Thermal screens	<p>Thermal screens are now common in UK greenhouses, especially where the crops grown have a significant requirement for heat. However, many installations are quite old, and the screen material has lost some of its effectiveness. This Update helps growers select suitable screen materials and decide if / when the material in an existing installation should be replaced.</p> <p>The economics of side screens are also explained and the differences between proprietary and temporary screen materials (e.g. bubble wrap, Visqueen etc.) are discussed.</p>

	Fans for greenhouses	Fans are a useful tool for helping to achieve an even greenhouse environment, and recent developments have seen the commercial uptake of several new fan designs. This Update looks at the economics and performance of fan systems and describes the key technical features of the leading fan designs for greenhouse applications.
	Note – 4th Update has been substituted for the Energy Glossary on the website	
2015 – 2016	Measuring energy.	The increasing implementation of renewable energy systems, supported by subsidies such as the Feed in Tariff (FiT) and Renewable Heat Incentive (RHI) have resulted in the mandatory installation of energy measurement equipment. This extensive Technical Update describes the measurement equipment available and demystifies the various units of energy measurement.
	Biomass CHP	Biomass CHP offers growers an additional income stream from both the heat and electrical energy produced. However, which of the three technologies currently available will suit a particular grower or nursery? This update describes each technology and summaries the operational and investment pros and cons of each.
	Diffuse light	The sector has become increasingly aware of the potential benefits which arise from diffusing light as it enters the greenhouse. This technical update explains the available processes for diffusing light and explains why it may be important.
	CO <sub>2</sub> sources	In addition to a review of pure CO <sub>2</sub> and CO <sub>2</sub> from conventional gas boilers, this update covers all the implications arising from the increasing popularity of biomass heating, biomass CHP, biogas from anaerobic digestion and renewed investment in CHP. All of which provide both opportunities and challenges as alternative CO <sub>2</sub> sources.
2016-2017	Conventional & Alternative Sources of CO <sub>2</sub>	Evaluation of sources and costs associated with CO <sub>2</sub> enrichment in glasshouses; removing pollutants from self-supply.
	Sensors	Measurement of climate and plant conditions using sensors and technology to allow improved control of the growing environment.
	Cold Storage	An overview of cold stores and a selection of tips on how to improve operating efficiency.
	Assimilation Lighting	A review of developments in the technology over recent years, including changes in costs and unit efficiency.
2017-2018	Modern heat storage	Design features and considerations when choosing a heat store.
	Thermal storage for horticulture	Explanation of what thermal storage is and how it can be of benefit, including the use of phase-change materials.
	Understanding your energy bill	A breakdown of terms and charges found on an electricity bill.
	Seven tips for Next Generation Growing	An overview of the aims of and techniques used in Next Generation Growing.

2018 - 2019	Improving light transmission in glasshouses	Methods of improving light transmission in glasshouses.
	Air movement	The importance of air movement for an optimum glasshouse climate and how to achieve it.
	Using glass for soft fruit	Converting and designing glasshouses for soft fruit.
	Utilising data for glasshouse climate optimisation	How to effectively use sensors and data to control climate for optimum performance.
	Irrigation efficiency (in progress)	This technical update is in progress and seeks to inform growers about how to manage the electrical efficiency of pumping irrigation and heating water around a nursery. Wit consideration of control techniques, efficiency of primary umping equipment, maintenance and variable speed drives.

## Sector Impact – Year 5

The financial impact the GrowSave programme has on UK Horticulture is not easily quantified. One useful metric, however, is Climate Change Levy (CCL) data. The three Target Periods have coincided well with the last five years of the GrowSave programme and can help to gauge impact.

Considering CCL data at the end of 2018, there were 126 glasshouse sites in the scheme. Excluding mushroom facilities, this drops to 111 horticultural sites, which reported in all three Target Periods. These sites represent 88% of those in the data, but only 77% of the glasshouse area, as some large sites have been excluded.

The following table summarises the energy use reported in each TP and how the Specific Energy Consumption (SEC) – i.e. the energy use per unit area – has varied over the years. The total energy use in each case is for the two-year period.

Target Period	Total energy use (GWh)	Cropped area (hectare years)	Energy use per unit area (kWh/m <sup>2</sup> p.a.)	Average energy use per site (MWh p.a.)	Average cropped area each year (m <sup>2</sup> /yr)
TP1: 2013 & 2014	2,306	695	332	10,608	31,977
TP2: 2015 & 2016	2,512	733	343	11,316	33,021
TP3: 2017 & 2018	2,538	751	338	11,434	33,822

As can be seen from the data, the total energy used by the sector has increased by around 10% over the three Target Periods. However, the cropped area has also increased, meaning SEC has remained relatively stable. The aim of the CCL scheme is to incentivise improved energy efficiency, which can be measured as kWh/m<sup>2</sup> or kWh/kg of produce. While there appears to have been a small increase in energy per unit area across the sector since 2013, this does not reflect any increase in produce. With many growers now using lighting, or extending the growing season through the winter, for example, it is possible that crop output has risen at a greater rate than energy usage.

It is also important to consider where the energy has come from, with many growers now using renewable technologies to provide heat and electricity. The availability of government incentive schemes, such as the Renewable Heat Incentive and Feed-in Tariff, has meant energy has been 'cost-neutral' to a large number of self-producers.

Of the 111 sites considered, 32 are making use of renewables: 10 producing electricity only (e.g. solar and wind), 13 heat only, and nine producing both electricity and heat. This gives 22 sites using renewable heat. These sites are most affected under CCL rules, which assume a higher calorific value of biomass than is actually the case, potentially resulting in higher energy usage figures being reported than in reality.

It may also be the case that many growers producing their own heat are, in fact, using more energy than before. However, many businesses have found themselves financially better off as a result, due to both incentives and increased crop yields.

## **Discussion and sector impact, project term**

GrowSave, a collaboration between AHDB and NFU Energy, has been around for thirteen years. This current project has been around for five years.

Born originally out of a desire to help horticultural businesses save energy and reduce their environmental impact, GrowSave has become a valuable resource for the UK sector. The volatility of energy prices over the last half decade, as demonstrated by gas prices fluctuating between less than £0.30/therm and over £0.70/therm, coupled with the increased demand for year-round produce, has been a significant driver in the desire of businesses to carefully manage their energy consumption. To help the industry keep abreast of the latest developments in energy saving techniques, as well as to advise on alternative (and often 'greener') sources of energy, GrowSave has provided numerous workshops, publications and articles.

The availability of the Renewable Heat Incentive scheme since 2011 has been key to helping businesses reduce their carbon footprint by adopting renewable technologies. While significant investment is often required to take advantage of the scheme, the advice and expertise provided by GrowSave has allowed many to realize the long-term financial benefits of government incentives. Furthermore, adopting renewable energy sources can result in reduced reliance on fossil fuels, making production more sustainable in the long-term.

While switching energy source can be a good start to reducing environmental impact and lowering energy bills, further financial savings can be achieved by improved energy efficiency, as advocated by GrowSave since its inception. By helping businesses recognise areas of potential energy efficiency improvements, whether through the use of thermal screens in glasshouses or by adopting more effective climate control strategies, for example, GrowSave has significantly reduced the amount paid out by the industry in the form of the Climate Change Levy.

In addition to advising on the optimisation of established UK growing methods, GrowSave has spent a significant amount of time investigating best practices in other European countries, particularly Belgium and the Netherlands. The findings have been

fed back to UK growers through seminars, study tours and a pilot study group programme, which trialled Next Generation Growing (NGG) techniques. Through this close collaboration with growers, those involved were able to understand the potential benefits of NGG and were given the confidence to implement techniques which may previously have left them feeling uncomfortable. Anecdotal evidence from the programme suggests that adopting the NGG approach has helped to increase yield, improve crop quality and reduce losses, reflecting outcomes seen in Dutch horticulture. In the same way that the use of thermal screens and temperature integration have become standard practice for many successful commercial growers over the last couple of decades, GrowSave believes that the NGG techniques will also filter through the industry over time, with recognised 'best practice' continuing to evolve.

Another important factor in increasing the impact of the GrowSave programme has been its expansion into other sectors. Originally focused on Protected Edibles and Protected Ornamentals, GrowSave has recently also incorporated Soft Fruit. Investigations have already been carried out into how the UK industry compares to that of some of its European neighbours, and work continues in helping growers implement proven strategies for more profitable crop production.

## Summary & Highlights – 5 years

2014 – 2015

- The GrowSave website has continued to be regularly updated with the latest energy information for growers. Also, the materials from GrowSave events such as technical meetings have been made available via the website. Statistics show that there were 9,182 website visits over the period covered by this report and the most popular topics included LED lighting, Biomass & energy saving.
  - A series of seminars and grower meetings have been delivered. These have concentrated on working with growers to identify the best energy efficiency solutions for their business. Biomass heating and the RHI, humidity control and setting up heating systems for optimum efficiency are the main topics that have been covered in these events
  - Three Technical Updates and a website based energy terms glossary have been written which give information on some of the latest developments in greenhouse energy saving. These feature information on heat pumps, thermal screens and greenhouse air movement fans.

2015 - 2016

- The GrowSave website has been regularly updated with the latest energy information for growers. Materials from every GrowSave event, such as presentations and handouts, have been made available via the website.
- A series of seminars and grower meetings have been delivered. These have concentrated on informing growers about the best energy efficiency solutions for their business.

- Relatively radical Next Generation Growing techniques are likely to rise to prominence in the near future. Expert Dutch speakers provided UK growers with a clear message about the first steps to implement Next Generation Growing. A group of growers from East Yorkshire were inspired by the seminar on 20th April to begin implementation of selected NGG techniques and share their experiences.
- Smarter use of supplementary CO<sub>2</sub> is high on the agenda of many leading growers. So GrowSave has arranged an afternoon seminar, led by industry experts, to coincide with the TGA conference which will explore the key issues.
- Successful management of the climate in the greenhouse depends on a thorough understanding of the control system, a workshop to introduce the basic principles has been arranged.
- Four Technical Updates which feature useful and relevant information on Measuring Energy, Biomass CHP, Diffuse Light and CO<sub>2</sub> sources, have been published.

#### 2016 – 2017

- The GrowSave website has continued to be regularly updated with the latest energy information for growers. The materials from GrowSave events, such as technical meetings, have also been made available via the website. Statistics show that there were 18,891 website visits over the period covered by this report and the most popular topics included LED lighting and the Smart Use of CO<sub>2</sub>.
- A series of seminars and grower meetings have been delivered. These have concentrated on working with growers to identify the best energy efficiency solutions for their business. The main topics covered included biomass heating and the RHI, as well as air movement and NGG techniques.
- Four Technical Updates have been written, which give information on some of the latest developments in greenhouse energy saving. These feature information on sources of CO<sub>2</sub>, sensors, cold storage and assimilation lighting.

#### 2017 – 2018

- The GrowSave website has continued to be regularly updated with the latest energy information for growers. The materials from GrowSave events, such as technical meetings, have also been made available via the website. Statistics show that there were 19,193 website visits over the period covered by this report and the most popular topics included LED lighting and variable speed drives.
- A series of seminars and grower meetings has been delivered. These have concentrated on working with growers to identify the best energy efficiency solutions for their business. The main topics covered included biomass heating and the RHI, as well as air movement and NGG techniques.
- Four Technical Updates have been written, which give information on some of the latest developments in greenhouse energy saving. These feature information on heat storage, understanding your electricity bill, and Next Generation Growing.

2018 - 2019

- The GrowSave website has continued to be regularly updated with the latest energy information for growers. The materials from GrowSave events, such as technical meetings, have also been made available via the website. Statistics show that there were 19,321 website visits over the period covered by this report and the most popular topics included LED lighting and variable speed drives.
  - A bespoke soft fruit website was designed and launched.
  - A series of workshops and grower meetings has been delivered. These have concentrated on working with growers on identifying issues and how to rectify them with energy efficient solutions. In particular, the main topics covered focused on glasshouse climate control through air movement and humidity control.
    - Two specific soft fruit skills and knowledge workshops were held.
    - Four Technical Updates have been written and one is to be completed, which give information on how to optimise the glasshouse climate, featuring the topics of air movement, light transmission and the use of sensors and data.
    - With the addition of soft fruit one Technical Update has been written specifically for this sector on how to design a glasshouse, while five existing Technical Updates were targeted specifically at Soft Fruit.
    - Other contracted and non-contracted activities have taken place to cement GrowSave's reputation as the go-to place for horticultural energy saving.