ADAPTING TO THE FUTURE

Suffolk County Council has been piloting radar-based traffic-dependent dynamic streetlight dimming on arterial routes across Ipswich, as part of a wider research project into how carbon emissions associated with public lighting can be reduced. It is also potentially an important step on the council's smart city 'journey'

By Dr Hannah Steventon, Richard Webster, Andy Alberry and Prof Nicholas Caldwell

Suffolk County Council has been a sustainability trail-blazer in the management of street lighting carbon emissions, with a decade of part night lighting, switch off, CMS monitoring and management for faults and metering. These advances support Suffolk's 'creating the greenest county' agenda, and have been recognised with a range of awards across the industry.

This environmentally-focused, trials-led approach enabled Suffolk to be selected as one of seven pilot partners (with nine project partners) in the international 'Smart Lights Concept' project, as this journal reported last year (*'Future thinking', Lighting Journal,* June 2020, vol 85 no 6).

That project, to recap, was set up to test innovative solutions to reducing the carbon emissions associated with public lighting, which can be responsible for about a third of public authority carbon emissions.

The Interreg 2 Seas Smart Lights Concept (SLIC) is a collaborative European Union-funded project between two universities and seven organisations in the UK, Belgium, France and the Netherlands. It has been tasked to develop and test a range of approaches to enable energy efficiency and carbon savings in public lighting.

As part of this, Suffolk County Council is investigating the potential for using traffic-dependent dynamic traffic adaptive lighting to reduce street lighting-related carbon emissions.

This is the use of real-time traffic counting to adjust the street lighting levels, enabling dimming at periods of low road usage, whilst being able automatically to raise lighting levels when required for higher volumes of traffic. Traffic-adaptive lighting enables the local authority to adjust the lighting levels of a group of streetlights based on real-time data from traffic counting systems.

Suffolk is building on several years of

research in using these techniques. In 2016, the council collaborated with BT Futures Research in its first trial of dynamic dimming. This proof-of-concept pilot project was installed on a main traffic route in west Suffolk and used vehicle recognition cameras for traffic counting. Street lighting dimming was automatically applied to streetlights on that length of road, dependent on traffic volume. Success in the pilot project enabled expansion in Suffolk's largest town, supported by a European Regional Development Fund grant with an environmental focus.

DYNAMIC ADAPTIVE LIGHTING IN IPSWICH: HOW DID WE DO IT?

Ipswich was selected as the location for expanding this concept trial into deployment across a town. Ipswich, for those who have not been there, is the largest town in Suffolk, with a population of 180,000, and urban overspill making it the fourth largest urban area in east England.

In this deployment, traffic counting is by Black CAT radar from TagMaster (formerly CA-Traffic) mounted on lighting columns, from which they are powered. Data from these radar systems provides input into real-time adjustment of dimming levels via the PLANet CMS supplied by Telensa, which has developed this capability working closely with the council. This project was briefly highlighted in David Orchard's article on CMS last month ('*Locally responsive*', May 2021, vol 86 no 5) but, here, is a more in-depth analysis.

A total of 25 radar systems have been installed on arterial routes across Ipswich. Routes for this trial were selected on the basis of a combination of factors. Firstly, the lights are lit all night (part-night lighting is not applied on these streetlights), which presents greatest potential for energy savings.

Secondly, traffic flow on the routes is expected to be sufficiently variable through →

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The test area in Ipswich. All photographs by Dr Hannah Steventon

the night, so that traffic counting would have an impact. Finally, the streetlights to be controlled by those radar were already fitted with dimmable LED lanterns.

Whilst high-pressure sodium lanterns can be dimmable, they are slower to react than LED lanterns. When an increase in traffic flow causes the lighting level to increase, sodium lanterns would brighten too slowly. The radar were located on clear, straight sections of road with good visibility for traffic counting. The locations of each radar also take into account road safety, including the safety of radar from damage in road traffic accidents.

The radar sends data in real time via mobile cellular data to TagMaster's database, which means the only communication system required for the traffic data connectivity is a commercial mobile network.

This data is then accessed from TagMaster by Telensa's PLANet CMS via a reliable application programming interface (API). It is also made available via TagMaster's dashboard within seconds of collection. This allows it to be used for other traffic management and planning purposes within the local authority, so increasing the value of the scheme to the local authority.

Each radar is linked to a specified group of streetlights within the PLANet CMS. The streetlights selected for association with each radar have been selected based on local road knowledge, working with the traffic data team.

Each radar currently controls around 20 to 35 lights. To date, around 700 lights are controlled via the dynamic adaptive dimming scheme, which is 1% of Suffolk County Council's controlled streetlights.

The CMS enables a custom dimming algorithm to be implemented connecting the lighting levels to the traffic volumes. The dimming profile has been designed using several considerations, and further development is planned.

Early traffic-flow data from the radar was reviewed prior to designing the dynamically adaptive dimming profile. Initial review of traffic volumes, peaks and troughs through the night-time period over several weeks indicated that there was a significant reduction in traffic after 9pm.

Therefore, for this trial, the original static dimming profile has continued to be applied prior to 9pm, and the dynamic dimming profile applied after. The dynamically adaptive dimming profile is then applied until 6am, when the static dimming profile is applied until daylight switch-off. In summer months, early daylight means the daylight switch-off occurs during the dynamic dimming phase.

The algorithm design and dimming process minimise changes, so as to avoid driver distraction. Lighting level changes triggered by the dynamic adaptation are introduced over approximately 30 seconds so they are not visually noticeable, particularly by moving traffic.

The adaptation algorithm has been programmed to avoid rapid adjustments so the changes in lighting levels should not be visually distracting to drivers. It also avoids 'flip-flopping' lighting levels back and forward between dimming levels when the traffic levels vary across a boundary setting (referred to as hysteresis). Currently for the trial, lighting levels are reduced when traffic counting reveals that fewer than two cars per minute are passing the radar.

This dimming profile, and the real-time dynamic rules that are controlled by the traffic counting, are set up in Telensa's PLANet CMS. The engineers setting the controls are already familiar with this widely used system.

Dimming uses a percentage of total light levels and is applied at 50% in static dimming and 30% in adaptive dimming. This does not use standard lighting classes, which were not applicable in a meaningful way for adaptive dimming.

DYNAMIC ADAPTIVE LIGHTING IN IPSWICH: WHAT DID WE FIND?

Installation of the system was straightforward, as the luminaires were selected to have dimmable LED lanterns installed prior to this project. Installation of radar on lighting columns minimised works required, and

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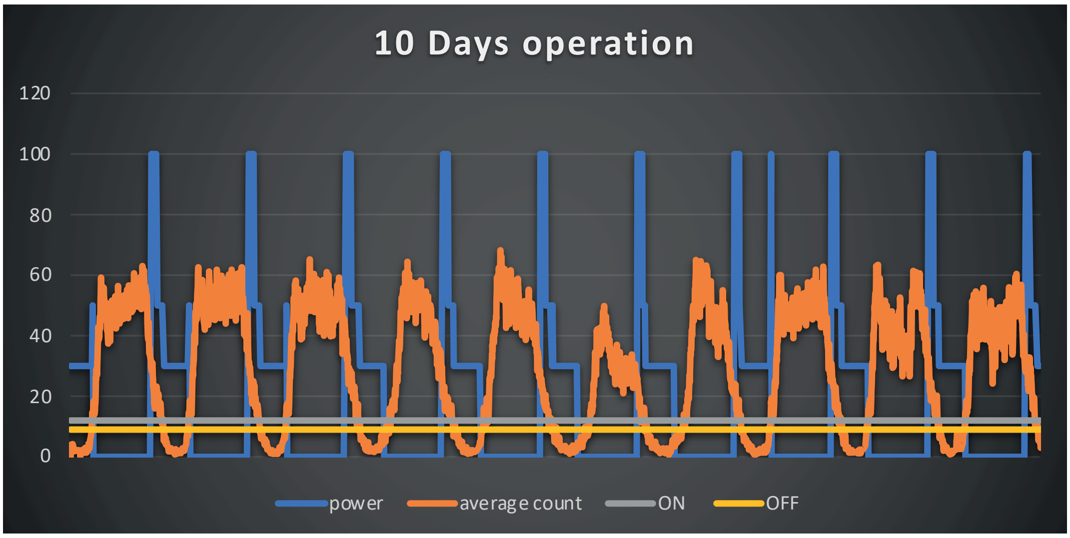

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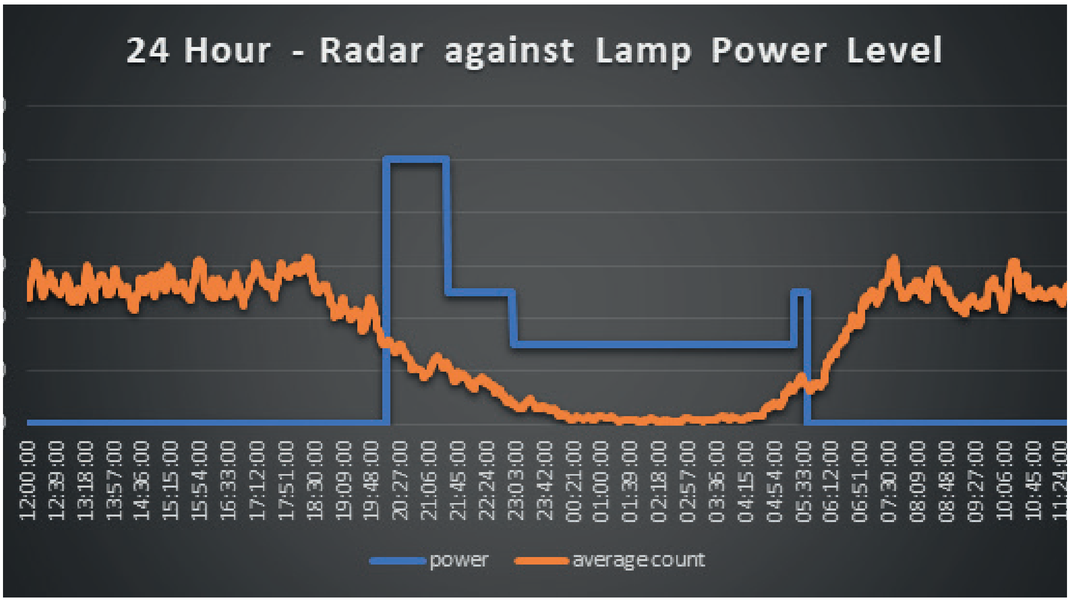

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enabled power for the radar to be easily gained from the street lighting network.

As arterial routes were selected for the trial, lighting columns were all of the appropriate structure for the additional weight and windage of the radar, so there was no structural concern. The radar themselves are low maintenance, sealed units with a guarantee of ten years and anticipated lifetime of longer.

Public communication was deliberately minimal, so that any community reaction was driven by public observations rather than concerns from information rather than experience. That there was no community reaction or comments from the public is considered a significant achievement for a scheme of this significance.

The streetlights remain on during the dimmed period, and so few people are aware of or able to discern the lighting difference when the dimming is applied. As dimming is applied gradually, observed vision can adapt to some extent during the dimming phase. Even when a misunderstood instruction led to lights being dimmed by 80% rather than to 80%, Suffolk County Council did not receive any comments from the public. Whilst dimming to 25% is visually observed noticed by trained engineers, they did not consistently notice dimming to 50%, although light meter measurements indicated the change.

Running the scheme since 2018, Suffolk County Council's lighting systems manager Andy Allberry has observed the streetlight dimming profile adapt to bring the lighting levels up during events which cause higher levels of late-night traffic (at least prior to Covid-19), such as Christmas markets and evening football matches.

Some of these events could be anticipated, but dynamically adaptive dimming means that manual intervention or pre-programming these specific events is not required; the system automatically identifies higher traffic levels and raises the lighting levels accordingly.

This meant that the time period of the adaption was exactly as required by the event – whether it went on later, or drew a smaller crowd than anticipated. The adaptive lighting also responded to unpredictable events. For example, a local trunk route with

a long, high bridge is subject to occasional closures due to high-speed wind gusts, which increases the traffic flow through the town. The lighting levels increased automatically with this higher volume of traffic.

The data is easily accessible from the data platform supplier's dashboard, from where it can be of wider use and interest to the local authority, potentially replacing manual traffic surveys.

A key part of the SLIC research partnership is to explore ways to reduce public authority carbon emissions by targeting the 35% of public authority carbon emissions that are associated with public lighting. In the case of the Suffolk trial, this showed four tonnes of carbon savings per year, with potential to further increase that.

This carbon saving relates to annual electricity savings of more than £12,000, which offset the operational and communications costs of running the traffic-counting platform. Alongside carbon savings, reduced lighting can of course have benefits to wildlife and nature and to wider human wellbeing.

CHALLENGES AND LEARNING POINTS

Like all innovation projects, some unexpected challenges have been encountered.

Whilst the closure of the bridge on the trunk route bypassing Ipswich has demonstrated that lighting levels will automatically rise with increased traffic through the town, there have been occasions when this has not happened.

Andy Allberry's investigation of the data associated with this has suggested that very heavy traffic in the town arterial routes can cause congestion such that traffic speeds reduce significantly. As the radar systems count numbers of vehicles per unit of time, queueing traffic during periods of congestion is identified as a low traffic count and therefore does not trigger the lighting level rising. Approaches to address this challenge to the algorithm are currently being considered.

The placement of radar is a key element of the success of the scheme. Even with the planning and design described above, as with all street furniture, there are incidents.

One radar, for example, has required replacement because of a road traffic accident in the location. Another required moving due to consistently having its line of sight to the road obscured by parked vehicles at night, which was not observed when the radar was installed during the working day.

WHAT'S NEXT?

Richard Webster at Suffolk County Council is considering a range of further developments for the scheme.

We consider there to be potential to expand the application of the dimming more widely for the installed radar. Increasing the application of the dynamic dimming can include applying it over a wider timeframe during the night period, starting the adaptive period earlier in the evening, or running it later in the morning.

Research work is exploring the potential to increase the dimming amount or to associate dimming levels with different road classes. Increasing the number of adjustments per night sent by the CMS control could increase the total dimmed period during nights with variable traffic levels.

Data analysis is also exploring increasing the number of lights controlled by each radar, including expanding into adjoining residential streets (which already have part-night lighting). Extension into residential areas may require the combination of more than one radar for confidence on traffic levels in the adjoining areas, and the possibility of including that in the algorithm is being explored.

Finally, Suffolk County Council is also running further research trials testing other traffic-counting systems for street lighting control.

These vary from adaption of traditional inductive loop systems through to innovative video analytics. Video analytics enables provision of a much wider range of data, including a wide range of vehicle class, identification of bicycles and pedestrians.

On the other hand, if using loops for vehicle counting to inform streetlight dimming is feasible, it would reduce the cost of rolling out the scheme more widely both in Suffolk and for other local authorities.

Like many local authorities, Suffolk County Council has existing loops traffic counting installed in wider locations across the county. Use of these could be beneficial in wider rollout of dynamic lighting – and enable effective cost sharing.

As with all new Internet of Things technologies, as dynamic lighting level adaptation becomes more common, economies of scale will make it increasingly affordable.

This will include lower cost of the sensors, as more sensors are designed for the specific purpose. These sensors will increasingly have the data analysed at the roadside, in the sensors themselves. Then only the required data is transmitted from the sensor, via the communications network, to the management system. This is a technique known as edge computing.

Communications networks will also become cheaper, and integration directly into the lighting supplier's system and communications network is in development. Suppliers are working to minimise platform and integration charges. In addition, data gathered will be more easily integrated with information gathered for other purposes. All these innovations will enable dynamically adaptive lighting to provide a more rapid return on investment.

As more experience is built up in different settings, the algorithmic design decisions will become standardised. We are interested to hear from other people how they address profile design.

CONCLUSIONS

Public lighting provides scope for energy savings for environmental and economic benefit.

Suffolk County Council has been at the forefront of streetlighting innovation, and we have been delighted to share our experience in deploying traffic-dependent dynamic dimming across a major town in this article.

This project is a building block towards Suffolk's increasing use of smart technology for public service decision-making: look out for our second article later this year!

In sum, we consider that dynamic dimming will become a key partner to static dimming in street lighting management, for environmental and economic stewardship.

- This project has received funding from the Interreg 2 Seas programme 2014-2020, co-funded by the European Regional Development Fund.

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