



SIF CoolDown Alpha

WP6 Trial Design

D6.1: High level approach to trial design

8th April 2025

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Introduction to CoolDown



CoolDown project context



Context

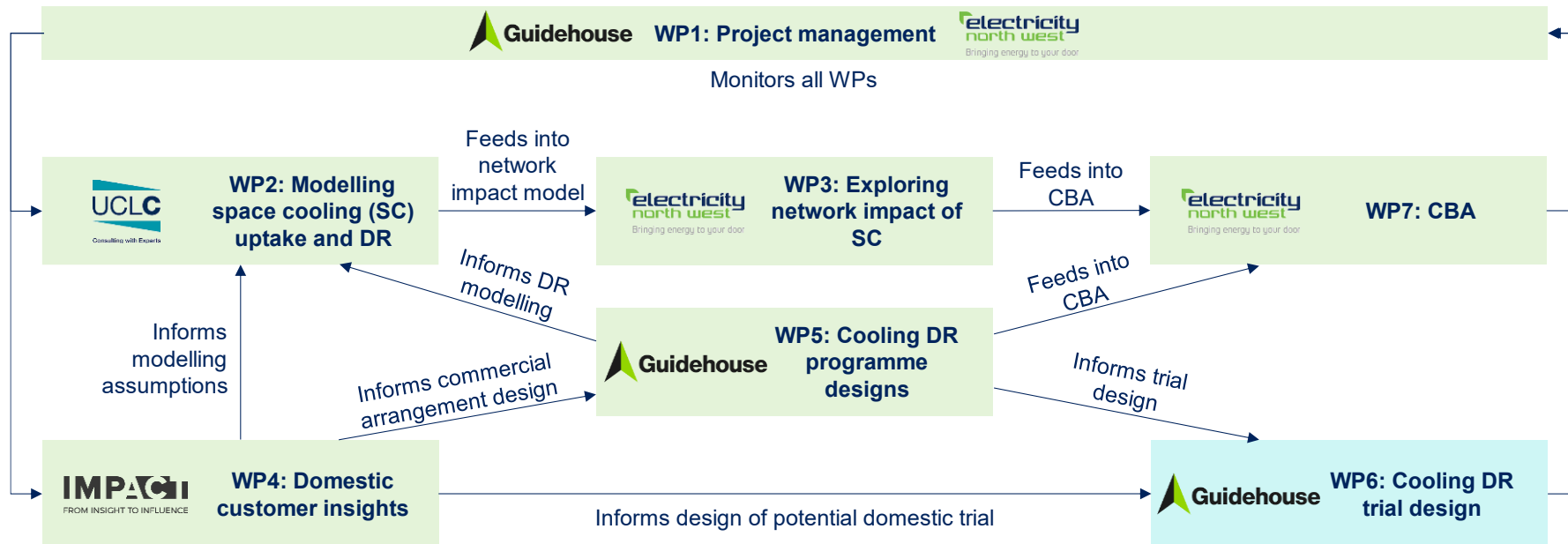
- Space cooling (SC) already makes up 10+% of UK electricity demand¹.
- As the UK warms, SC demand will increase.
- It is unclear how much network flexibility SC can provide, and what is needed to unlock it.

CoolDown assesses

- The bounds of the increase in SC demand.
- Its impact on distribution networks.
- The potential flexibility associated with it and how it can be harnessed.

Focus of CoolDown Alpha Work Package (WP) 6

- Deliver high-level trial design of the cooling demand response (DR) programmes designed in WP5 for both domestic and commercial customers.
- Define high-level criteria for a future cooling DR trial and assess feasibility.
- Design high-level logistics for a trial e.g., locational bounds, priority commercial arrangements, etc.



WP6 objective: Design a high-level approach to trial cooling DR programmes



This report presents a high-level design for future cooling DR trials. It includes criteria to assess the feasibility of both commercial and domestic cooling DR trials and explores the logistical requirements for a successful trial.

Objectives of CoolDown Alpha WP6

- Deliver high-level trial design of the cooling DR programmes designed in WP5 for both domestic and commercial customers.
- Define high-level criteria for a future cooling DR trial and assess feasibility.
- Design high-level logistics for a trial e.g., locational bounds, priority commercial arrangements, etc.

Approach

1

Assess feasibility of trialling cooling DR and develop initial trial criteria through group workshops.



2

Explore high-level trial logistics for domestic and commercial customers through group workshops.



3

Summarise approach cooling DR trial design in this report.

Why are cooling DR trials needed?

- Improve confidence in the knowledge gathered on cooling consumption behaviour.
- Validate amount of cooling flexibility that cooling DR can unlock.
- Assess customer comfort and ease of participation in different cooling DR programmes.
- Validate the network benefits cooling DR can unlock.
- Optimise cooling DR parameter such as event length, notice periods and tariff structures to maximise flexibility.
- Refine the designs to ensure a seamless BaU transition.

Partners involved in WP6

1) Electricity North West Limited (ENWL)	Distribution Network Operators (DNOs)
2) National Grid Electricity Distribution (NGED)	
3) OakTree Power	Flexibility Service Provider (FSP)
4) Guidehouse Europe Limited	WP lead









Trial logistics exploration



Cooling DR trials should be network-wide and build over time to reflect business as usual (BaU)



We explored eight cooling DR trial elements through a series of workshops with WP partners, and made the following decisions on what would be most feasible or suitable for domestic and commercial trials:

Element		Decision made
	Trial location	Network-wide. Focus on ENWL's license areas initially. Expand into NGED's, and potentially additional license areas in future trial phases.
	Recruitment criteria	Commercial DR trials should initially target office and retail buildings with split system A/Cs and Variable Refrigerant Flow/Volume (VRF/VRV) systems. As a proof of concept, the domestic DR trial recruitment should have no restrictions.
	Priority DR designs	Scheduled Direct Load Control and Peak Time Rebates for commercial customers are most suitable to be trialled. Peak Time Rebates and Time of Use Tariff programme designs for domestic customers are most suitable to be trialled ¹ .
	Payment approach	Payment approach should mirror that of the commercial arrangement. However, added participation incentives on top of these will likely be needed to maximise recruitment in initial trial stages. These can be ramped down in later trial phases.
	Trial variables	Trials should vary the following elements across events, in order of priority: External temperature, DR event length and frequency, DR event payment amount and the notice period given to customers by the FSP/supplier.
	Impact evaluation	Preference to conduct the trials as a Randomised Control Trial (RCT) and use the Differences in Differences (DiD) approach to calculate the aggregate flexibility unlocked in each event. Elexon's Ofgem approved p376 methodology ² should be used as a reference for baselining and customer settlement.
	Customer engagement	Regularly engage with participants through surveys, focus groups and interviews before, during and after the trials to maximise learnings and ensure participants are not being put / putting themselves in positions of extreme discomfort or harm.
	Vulnerable customers	Clearly establish comfort/safety envelopes within which domestic customers should operate their air con before and during the trial. Post trial, check if customers, especially fuel poor/vulnerable customers, have not exceeded these limits.



Context: Trial participants could either be recruited from anywhere across ENWL's license areas (network-wide) OR buildings connected at specific summer peaking substations could be targeted.

	Network-wide trial (preferred option)	Summer peaking substations only
Benefits	<ul style="list-style-type: none">• Larger pool of cooling customers to recruit from. A greater number of participants could result in more learnings.• Potential for greater diversity in participating buildings, also offering more learnings.	<ul style="list-style-type: none">• Potentially more focussed analysis of network benefits attainable from cooling DR.
Pitfalls	<ul style="list-style-type: none">• Recruitment is more scattered, which may make it harder to identify certain behavioural patterns.	<ul style="list-style-type: none">• Limits customer recruitment pool, limiting potential for learnings.• Usable analysis depends on having a critical mass of customers recruited.

Decision

The trial should be **network-wide**, focusing on ENWL's license areas initially and then expand into NGED's, and potentially additional license areas in future trial phases. However, this may be driven by where participating FSPs' customers are located.

Reasons for a network-wide trial

1. Since this would be a first-of-its-kind cooling trial in the UK, the aim should be to recruit as many cooling customers as possible.
2. Additional DNOs, including NGED, will be more likely to offer their license area up for future trials after successful initial proof-of-concept trials.



Recruitment criteria – commercial buildings



Context: The commercial trials could either focus on thoroughly understanding the cooling DR potential of major cooling demand archetypes OR look to gather broad learnings from multiple cooling demand archetypes.

	Office and retail only (preferred option)	Include other building types
Benefits	<ul style="list-style-type: none">• Make up ~70% of commercial space cooling demand – they should be priority for initial trials.• Recruiting multiple buildings of these target sectors reduces risk of unrepresentative results for these sectors.	<ul style="list-style-type: none">• Potential for greater diversity in participating buildings, also offering more learnings about different building types.
Pitfalls	<ul style="list-style-type: none">• Limits understanding of cooling demand and flexibility potential of the remaining 30% of commercial space cooling demand.	<ul style="list-style-type: none">• May result in recruiting just 1-2 customers per building type. Learnings of the building type's cooling demand and flexibility potential may be biased/ unrepresentative.

Decision

An initial trial should target **office and retail buildings** to understand the limits of their cooling flexibility potential. Once understood, future trials can pivot towards conducting proof-of-concept cooling flexibility trials in additional sectors like hospitality.

Reasons for recruiting office and retail buildings only

1. DNOs and FSPs need a more granular understanding of the majority sources of commercial space cooling demand. It therefore makes sense to focus on office and retail first.
2. Later trials can then expand the lens to other building types, which may be able to provide significant individual demand response, but less on aggregate.



Recruitment criteria – cooling technologies



Context: The trials could focus on thoroughly understanding the DR potential of the majority cooling technologies that exist in the market OR gather broad learnings on a variety of cooling technologies.

	Target technologies only (preferred option for commercial trials)	Technology agnostic (preferred option for domestic trials)
Benefits	<ul style="list-style-type: none">Split system ACs and Variable Refrigerant Flow/Volume (VRF/VRV) systems account for ~93% of UK commercial space cooling and most domestic space cooling technologies.Recruiting multiple buildings of these target sectors improves the chance of getting statistically significant results, and of having a representative participant pool.	<ul style="list-style-type: none">Targeting specific building types rather than cooling technologies offers better learnings on customer cooling consumption behaviour and flexibility potential.Potential to gather learnings on how cooling tech. used influences the building type's consumption patterns and flexibility potential.
Pitfalls	<ul style="list-style-type: none">Risk of missing out on learnings on less ubiquitous cooling technologies.	<ul style="list-style-type: none">May result in recruiting only a few customers per cooling technology. Learnings may be limited for each technology.

Decision

The trial should focus on recruiting **commercial** buildings with **split system ACs** and **VRF/VRV systems**. The recruitment criteria for **domestic** buildings should be **technology agnostic**.

Reasons behind decisions made on cooling technologies

1. Split system AC systems and VRF/VRV systems account for nearly all commercial cooling demand.
2. There are only 3 prevalent technology types for domestic cooling. Furthermore, domestic cooling is nascent and being technology specific will limit the customer recruitment pool.



Context: In CoolDown WP5, we designed 3 DR programmes¹ targeting commercial cooling customers: **1) Scheduled Direct Load Control, 2) Peak Time Rebates, 3) Fixed Time of Use (ToU) tariffs.**

	Trial all DR programmes	Deprioritise trialling the Fixed ToU tariff (preferred option)
Benefits	<ul style="list-style-type: none">• Trialling a greater number of DR programmes could result in a greater volume of learnings for all involved stakeholders.• Ability to compare the programmes against one another, providing insights as to which performs best and is most appropriate for BaU.	<ul style="list-style-type: none">• WP5 revealed that Fixed ToU tariffs are less likely to work for commercial customers. Not trialling this could free up time/budget to conduct more trials and vary more parameters for the other two programmes.
Pitfalls	<ul style="list-style-type: none">• Duplication of learning that ToU tariffs are not amenable amongst commercial customers from OakTree Power's BaU operations.	<ul style="list-style-type: none">• Order of preference was determined by a single FSP and qualitative judgement of project team. Others may have a different view.

Decision

Initial trials should prioritise the **Scheduled Direct Load Control** and **Peak Time Rebates** programmes for **commercial customers**. Fixed ToU tariffs for commercial customers are a lower priority as they are likely less suited to commercial customers.

Reasons for deprioritising the Fixed ToU tariff programme

1. Commercial buildings are typically less amenable to tariff-based programmes from OakTree Power's experience. Trialing the Fixed ToU tariff risks duplication of learnings.
2. It would therefore be better to focus on optimising design of the other two programmes.



Context: We designed 2 DR programmes¹ targeting domestic cooling customers in WP5: **1) Peak Time Rebates, 2) Fixed Time of Use (ToU) tariffs.**

	Trial all DR programmes (preferred option)	Deprioritise trialling the Fixed ToU tariff
Benefits	<ul style="list-style-type: none">• Trialling a greater number of DR programmes could result in a greater volume of learnings for all involved stakeholders.• Ability to compare the programmes against one another, providing insights as to which performs best and is most appropriate for BaU.	<ul style="list-style-type: none">• Impact's survey in WP4 revealed that domestic cooling customers are less accepting of the Fixed ToU tariff. Not trialling this could free up time/budget to conduct more trials and vary more parameters for the other programme.
Pitfalls	<ul style="list-style-type: none">• Risk of duplication of learnings from customer surveys in CoolDown WP4, which uncovered that customers hypothetically prefer the Peak Time Rebates design over the ToU tariff.	<ul style="list-style-type: none">• Potentially unrepresentative conclusion on preference between programmes if based on a single survey of hypothetical views.

Decision

Both programme designs should be trialled, but a **flexibility service provider who is also an energy supplier (E.ON, Octopus Energy, etc.) would need to be involved** in the project if we wish to trial the fixed ToU tariff programme.

Reasons for trialling both domestic DR programmes

1. Maximising learnings on domestic cooling DR should be priority given its nascency in the UK.
2. Only 1000 domestic air con users and considerers were surveyed in WP4. Conclusions on customers' preferences towards ToU tariffs are potentially unrepresentative and need further verification through trials.

£ Payment approach



Context: The payment approach and amounts in the trial could either mirror the DR arrangements and represent the market value for flexibility to be as reflective of BaU as possible OR include added incentives to help with recruitment.

	Payment approach mirrored at market rate*	Payment approach mirrored above market rate*	Payment approach mirrored + one-off participation fee (preferred option)
Benefits	<ul style="list-style-type: none"> Results and learnings will be as reflective of BaU as possible. 	<ul style="list-style-type: none"> Potentially increased demand turn-down/shift behaviour from participants, resulting in more learnings on the operational aspects of the trial. 	<ul style="list-style-type: none"> Potentially improved recruitment from added incentives results in improved, more representative understanding cooling behaviour and flexibility potential.
Pitfalls	<ul style="list-style-type: none"> No additional incentive for participation means customers are less likely to sign up for the trials. 	<ul style="list-style-type: none"> Flexibility delivery during the trials may be greater than in BaU, resulting in unrepresentative learnings. May struggle with initial recruitment as the added incentives are only realised during/after the trial. 	<ul style="list-style-type: none"> Flexibility delivery during the trials may be greater than in BaU, resulting in unrepresentative learnings.

*On average, ENWL award flexibility service contracts at a **£0.40/kW/hr availability price⁴** and **£0.70/kWh utilisation payments⁴**

Decision

The payment approach should mirror the commercial set up of the programme designs being tested. However, participation incentives on top of these will be needed to maximise recruitment in initial trial stages. These can be ramped down as in later trial phases to approach BaU.

Reasons for including a one-off participation fee

1. The risk of not recruiting enough customers and diminishing learnings outweighs the risk of achieving unrepresentative results, given domestic cooling's nascency. Future trials can tweak payments to approach BaU levels, as seen in projects like EQUINOX¹.
2. Recent trials of domestic flexibility such as Crowdflex² and EQUINOX have found little evidence of price sensitivity. However, it should be noted that a drastic reduction in payments offered in NESO's Demand Flexibility Service (DFS) has resulted in a 50% drop in household participation for one FSP³.

↕ Trial Variables – Prioritising parameters to vary



Context: Various parameters could be varied across trials. These need to be prioritised based on their expected impact on DR participation and network conditions.

Decreasing priority ↓	Parameter	What can we learn from varying this parameter
	1 External temperature	Understand the dependency of achievable cooling flexibility on external temperature.
	2 DR programme	Understand which DR programmes customers respond best to.
	3 Event time, length and frequency	Validate learnings from CoolDown WP4 and WP5 on these parameters. Enable BaU DR programmes to unlock as much cooling flexibility as possible.
	4 DR event payment amount	Understand the price signals required to incentivise cooling DR from customers.
	5 Notice period given to customers by FSP/supplier	Validate learnings from WP4 and WP5 on notice period. Enable BaU DR programmes to unlock as much cooling flexibility as possible.
	6 Domestic ToU tariff structure (Do not vary)	Understand what kind of tariff structure domestic customers are most responsive to.

Decision

Trials should vary five parameters, in priority order listed in the table, to understand their impacts on the amount of cooling flexibility achievable.

Reasons for shortlisting the 5 parameters

1. **External temperature** is expected to have the most influence in thermal discomfort and willingness to turn down cooling demand.
2. Different **DR programmes** incentivise cooling flexibility through different market signals, thus having a significant impact on customer willingness to turn down cooling demand.
3. **DR event times, length, notice periods and frequency** will impact customers' ability to provide flexibility.
4. Optimising **DR event payment amounts** enables them to be set appropriately to provide benefits to both networks and consumers.
5. Learnings from other **ToU tariffs** on the market and DR trials can inform which tariff structures customers respond best to. Varying this may not provide additional learnings.

↔ Trial Variables – Defining how the parameters will be varied



Context: Below is an indication of how the five top-priority variables can be altered across cooling DR trials. We have based these on partner experience, CoolDown WP4 and WP5 insights and Met Office data.



1) External temperature

Event days will be chosen to achieve a wide external temperature spread using weather forecast data.

- **Very hot :** >28°C, e.g., 6 events per trial.
- **Hot:** 23-28°C, e.g., 12 events per trial (due to it being more likely)
- **Mild:** <23°C, e.g., 6 events per trial.



2) DR programme

- **Commercial:** Scheduled direct load control, Peak time rebates, as per the *Priority Arrangements* decision
- **Domestic:** Peak time rebates, Fixed Time of Use (ToU) tariffs, as per the *Priority Arrangements* decision



3) Event time, length and frequency

- **Commercial:** Morning, afternoon, early evening. 30 - 90 mins long. At least 60 mins between events.
- **Domestic:** Afternoon, early evening, late evening. 1–4 hours long. 1-2 events per day.



4) DR event payment amount

- Higher participation payments and above market rate availability + utilisation payments in the initial trials.
- Reduced participation payments and close-to-market rate availability + utilisation payments in the later trials.



5) Notice period given to customers by FSP/supplier

- **Commercial:** 4 hours ahead, morning ahead, day ahead
- **Domestic:** 2 hours ahead, morning ahead, day ahead



Context: A crucial part of any flexibility trial is a robust approach to evaluating the impact of the flexibility events and the variables underpinning them on an individual customer basis. Customer performance during events must be compared to an authoritative baseline and the kWh of turn down calculated in an appropriate manner.

Randomised Control Trial Approach

- 1 **Recruit** participants for both domestic and commercial trials and split them into 2 groups – A and B.
- 2 **Randomly assign** the 2 groups as **treatment and control** for each DR event. Switch up between events. Only the treatment group are asked to participate in DR.
- 3 **Baseline demand** for each participant using the [p376 baselining methodology](#). If possible, measure cooling specific demand, else use smart meter data.
- 4 Conduct trials and **calculate aggregate demand response unlocked** in each event using difference-in-differences (DiD) approach¹.
- 5 **Settle with treatment group participants** based on kWh flexibility delivered.

Decision

Preference to conduct the trials as a Randomised Control Trial (RCT) and use the Differences in Differences (DiD) approach¹ to calculate the aggregate flexibility unlocked in each event. Elexon's Ofgem approved [p376 baselining methodology](#) should be used as a reference for baselining and customer settlement.

Reasons for choosing a RCT and DiD approach

RCT is known to produce an unbiased estimate of programme impacts. Because participants are randomly assigned into a treatment group or a control group, they are expected to be equivalent in every way except programme treatment.

What is required for this to work

1. Large enough group of domestic and commercial buildings to have a statistically significant control and treatment group.
2. Asset level monitoring for participating customers' cooling devices.
3. Understand mitigate against the impact weather may have on baselining.

To scale up from individual to network impact: average results per customer per event and scale up to substation level. Compare with modelled DR reduction²



Customer engagement



Decision: Regular engagement with participants through surveys, focus groups and interviews is important before, during and after the trials to maximise learnings and ensure participants are not being put / putting themselves in positions of extreme discomfort or harm.

Before the trial

- **Sign-up:** FSPs will lead the recruitment of their customers for the trials, in line with the recruitment criteria outlined.
- **Asset level monitoring:** FSPs/tech. companies will be responsible for installing asset level monitoring equipment on their cooling devices.
- **Pre-trial information dissemination:** Participants will be informed of the aim of the trial, an overview of the DR programme they will be participating in and how their data will be used and protected.
- **Pre-trial survey:** Understand the motivations for participating in the trial, participant pool demographic and the type of cooling technologies involved.



During the trial

- **Availability and utilisation instructions:** Participating customers will receive availability and utilisation instructions in line with the DR programme design.
- **Asset operation instruction:** Participants will be reminded that demand turn down from coolth only will be measured and compensated for.
- **Post event surveys:** Participants will be shared a short survey after each event to understand behaviour during the event.
- **Focus groups and interviews:** These will help understand the impact of the DR programme and improve the programme design accordingly.
- **Mid-point alteration stage gate:** The results from the post event surveys, focus groups and interviews can be used to alter the trial designs if any major flaws or safety concerns have been identified.



After the trial

- **Post trial survey:** Participants will be shared a short survey after each trial to understand their satisfaction with the DR programme design and payment amounts.
- **Data collection and analysis:** Collect data from asset level monitoring devices to quantify cooling flexibility unlocked and compare programme design and trial results.
- **Fuel poor/vulnerable customers:** Fuel poor and vulnerable customers behaviour during the DR events will be analysed using the data from asset level monitoring devices. If they are deemed to be providing flexibility in an unsafe manner, they will be engaged and advised not to do so in future trials.



Decision: Any trial should clearly establish comfort/safety envelopes within which domestic customers should operate their air con before and during the trial. During and after the trial, there need to be checks that customers, especially fuel poor/vulnerable customers, have not exceeded these limits.

Preferred option

#	Options to ensure fuel poor/vulnerable customer safety	Peak Time Rebates	ToU Tariff
1	Establish comfort/safety envelopes within which customers should operate their air con	<ul style="list-style-type: none"> Advise all trial participants, especially fuel poor and vulnerable customers, about safe temperature limits. Emphasise these limits in the dispatch/utilisation instructions provided and feedback surveys. Use asset level monitoring data during the trial to verify that participants are not operating their air con outside these comfort envelopes. If they are, send them a notification recommending them to operate within the comfort/safety envelopes. 	
2	Tweak payment structure to disincentivise customers operating their air con outside the established comfort/safety envelopes	<ul style="list-style-type: none"> Should we cap the max utilisation payments individual customers can receive on very hot days? Should we adopt a tiered utilisation payment structure, where beyond X MWh, the £/MWh payment drops? 	<ul style="list-style-type: none"> Should the peak time surge electricity prices be reduced on very hot days/heatwave days?
3	Allow customers to opt out of participating without being penalised	In the current programme design, customers are not penalised for failing to flex their cooling demand during the event.	<ul style="list-style-type: none"> Should there be a different tariff structure for fuel poor / vulnerable customers which only includes discounted electricity prices outside peak times? Should fuel poor / vulnerable customers not be allowed to participate in this DR trial?






Proposed trial criteria



These criteria will help drive meaningful, BaU replicable learnings



These five criteria for the trials are focused on ensuring cooling DR trials are large and diverse enough to deliver meaningful, BaU replicable learnings on cooling flexibility GB-wide. They were developed by the work package partners collaboratively via a group workshop.

Trial Criteria		Importance of meeting this criteria
	At least 1 MW aggregated cooling demand amongst participating commercial buildings	Recruiting too small a group of commercial and domestic trial participants will lead to statistically insignificant results. Results may be biased and likely unrepresentative of GB as a whole, meaning that the cooling DR programmes tested will be less fit for BaU rollout.
	At least 200 participating households/domestic buildings with air conditioning (fixed or portable) installed.	
	At least 2 participating DNOs .	Widens pool of potential trial participants and will ensure the learnings are not ENWL and/or FSP specific. This will support refinement of the cooling DR programmes so they can unlock cooling flexibility GB-wide in BaU.
	At least 2 participating FSPs – one with commercial customers and one with domestic customers who is an energy supplier too.	
	Participating commercial buildings must be willing to allow Direct Load Control over their cooling assets.	One of the demand response programmes for commercial cooling customers involves Direct Load Control of cooling assets by the FSP.

Stakeholders needed for initial commercial and domestic cooling DR trials



Additional stakeholders will need to be involved to deliver initial commercial and/or cooling DR trials, either as delivery partners or as interested parties to engage and disseminate learnings with.

Stakeholder type	Proposed involvement in a cooling DR trial	Justification
Domestic FSP/ energy supplier	Trial delivery partner	Needed to enable a cooling DR trial with domestic customers. Can provide the customers and handle customer relations, including delivery of flexibility payments.
Commercial FSP	Trial delivery partner	Needed to enable a cooling DR trial with commercial customers. Can provide the customers and handle customer relations, including delivery of flexibility payments.
Technology companies	Potential trial delivery partner	Would be responsible for the installation of asset level monitoring and direct load control technologies, if FSPs cannot do it themselves.
Local Authorities / Councils	Engage as an interested party, unless domestic customers are social housing residents.	Could expand communication avenues regarding a trial and maximise potential participation, particularly among vulnerable/fuel poor domestic cooling consumers
Additional DNOs	Engage as an interested party, unless trial participants are in their license areas	All networks can benefit from the learnings developed across the trials, so these should be disseminated appropriately
Community groups and charities	Engage as an interested party	Can inform vulnerable/fuel poor customer engagement and support trial design to ensure these customers are not put in positions of harm.

	Trial partner		Engage as interested party
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Illustrative trial designs for cooling DR trials



Illustrative design for an initial proof of concept trial for commercial cooling DR



Trial 1 could be a proof-of-concept trial that aims to understand how temperature and DR programme impacts participation in and amount of DR. It would take place between May and August. Event length and notice period would be fixed.



DR programmes:

1. **M1:** Scheduled Direct Load Control
2. **M2:** Peak time rebates.



Temperature archetypes:

1. **Very Hot** (>28C)
2. **Hot** (23-28C)
3. **Mild** (<23C)



Notice period:

1. Day ahead



Payment mechanisms:

1. **M1:** Availability (£/hr) + Utilisation (£/kWh) payments.
2. **M2:** Higher Utilisation (£/kWh) payments.



Event lengths and frequency:

1. **Event lengths:** 60 mins and 90 mins.
2. **Frequency:** No more than 2 event days per week.

Randomised Control Trial (RCT) set up																										
Temperature			V. hot days (>28C, 6 events)					Hot days (23-28C, 12 events)												Mild days (<23C, 6 events)						
Notice period			Day ahead																							
Event Length + Frequency			60 mins			90 mins			60 mins						90 mins						60 mins			90 mins		
DR Programmes	M1	Treatment group ¹	A ²	B ³	A	B	A	B	A	B	A	B	A	B	A	B	A	B	B	A	B	A	B	A		
		Control group ¹	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	A	B	A	B	A	B		
	M2	Treatment group	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	B	A	B	A	B	A		
		Control group	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	A	B	A	B	A	B		

One event

One event

Illustrative design for a deeper trial of commercial cooling DR which optimises event parameters



Trial 2 could aim to understand whether customers prefer turning down their cooling for shorter stretches more frequently or longer stretches less frequently, and how the weather and notice period received impacts this.



DR programmes:

1. **M1:** Scheduled Direct Load Control
2. **M2:** Peak time rebates.



Temperature archetypes:

1. Randomly selected, targeting the **hot (23-28C)** and **very hot (>28C)** days.



Notice periods:

1. 4 hours
2. Day ahead



Payment mechanisms:

1. **M1:** Availability (£/hr) + Utilisation (£/kWh) payments, varies by notice period.
2. **M2:** Higher Utilisation (£/kWh) payment, varies by notice period



Event lengths and frequency:

1. 60 mins, 5 event days per week for 2 weeks
2. 90 mins, 3 event days per week for 2 weeks

Randomised Control Trial (RCT) set up																						
Notice period			Day ahead										4 hours									
Event Length + Frequency			60 mins, 5 events per week for 2 weeks					90 mins, 3 events per week for 2 weeks					60 mins, 5 events per week for 2 weeks					90 mins, 3 events per week for 2 weeks				
DR Programmes	M1	Treatment	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
		Control	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
	M2	Treatment	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
		Control	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A

Illustrative design for an initial proof of concept trial for domestic cooling DR



Trial 1 could be a proof-of-concept trial that aims to understand how long customers are willing to turn down their cooling consumption for and how the weather impacts this. It will take place between May and August.



DR programmes:

1. **M1:** Peak time rebates
2. **M2:** Time of Use Tariffs.



Temperature archetypes:

1. **Very Hot** (>28C)
2. **Hot** (23-28C)
3. **Mild** (<23C)



Notice period:

1. Day ahead



Payment mechanisms:

1. **M1:** Availability (£/hr) + Utilisation (£/kWh) payments.
2. **M2:** Time of Use Tariff.



Event lengths and frequency:

1. **Event lengths:** 1 hour and 2 hours.
2. **Frequency:** No more than 2 event days per week.

Randomised Control Trial (RCT) set up																										
Temperature			V. hot days (>28C, 6 events)						Hot days (23-28C, 12 events)												Mild days (<23C, 6 events)					
Notice period			Day ahead																							
Event Length + Frequency			1 hour			2 hours			1 hour						2 hours						1 hour			2 hours		
DR Programmes	M1	Treatment group	A ¹	B ²	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	B	A	B	A	B	A
		Control group	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	A	B	A	B	A	B
	M2	ToU tariff customers would not be delivering event-based flexibility so would need to be assessed and compared with the peak time rebates in a different way																								

Illustrative design for a deeper trial of domestic cooling DR which optimises event parameters



Trial 2 could aim to understand whether customers prefer turning down their cooling for shorter stretches more frequently or longer stretches less frequently, and how the weather and notice period received impacts this.



DR programmes:

- 1. **M1:** Peak time rebates
- 2. **M2:** Time of Use Tariffs



Temperature archetypes:

- 1. Randomly selected, targeting the **hot (23-28C)** and **very hot (>28C)** days.



Notice periods:

- 1. Day ahead
- 2. 4 hours



Payment mechanisms:

- 1. **M1:** Availability (£/hr) + Utilisation (£/kWh) payments.
- 2. **M2:** Time of Use Tariff.



Event lengths and frequency:

- 1. 2 hours, 5 event days per week for 2 weeks
- 2. 4 hours, 3 event days per week for 2 weeks

Randomised Control Trial (RCT) set up																				
Notice period			Day ahead								4 hours									
Event Length + Frequency			2 hours, 5 events per week for 2 weeks					4 hours, 3 events per week for 2 weeks			2 hours, 5 events per week for 2 weeks					4 hours, 3 events per week for 2 weeks				
DR Programmes	M1	Treatment	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
		Control	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
	M2	ToU tariff customers would not be delivering event-based flexibility so would need to be assessed and compared with the peak time rebates in a different way																		

Appendix: Commercial and domestic cooling DR programmes from CoolDown WP5



We designed three cooling DR programmes for commercial buildings



CoolDown Work Package 5 (WP5) has designed three cooling Demand Response (DR) programmes for domestic buildings. WP6 (High-level trial design) will consider which of these could be most appropriate for an initial Beta stage trial of domestic cooling DR.

		DR programmes for commercial customers		
	Parameters	1) Scheduled direct load control	2) Peak time rebates	3) Fixed Time-of-Use tariff
DNO-FSP Interaction	ENWL flex product	Operational Utilisation & Variable Availability		Peak Reduction
	DNO-FSP payment structure	Availability: £/MW/h Utilisation: £/MWh		Utilisation: £/MWh
	Notice period given to FSP	Availability terms agreed at time of trade, refined week-ahead. Utilisation instruction issued day-ahead.		Utilisation agreed at time of trade
FSP-Customer Interaction ¹	Technology eligibility criteria	Centrally controlled cooling tech. only	Any cooling tech.	Any cooling tech.
	FSP/supplier-customer payment structure	Will vary by FSP/supplier. Examples include fixed upfront payments, £/MWh compensation for flex delivered, etc		FSP/supplier designs tariff to incentivise cooling usage outside these windows
	DR event length and frequency	30 mins – 2 hours, with at least 60-90 minutes between events to allow for recovery. Will be a variable parameter in the trials		
	Notice period given to customer	DR event schedule released week-ahead. Day-ahead utilisation instruction given to FSP by DNO. FSP will inform customer at least 4 hours ahead of the event. Will be a variable parameter in the trials		Tariff structure agreed upon sign-up
	Likely customer response to event	FSP will turn down/off their customers' cooling. Customer override is allowed.	Customers will turn down/off their cooling themselves.	

¹ Note that the FSP may not necessarily have direct contact with the consumer. The FSP may partner with an electricity supplier that deals directly with customers.

We designed two cooling DR programmes for domestic buildings



CoolDown Work Package 5 (WP5) has designed two domestic Demand Response (DR) programmes for commercial buildings. WP6 (high-level trial design) will consider which of these could be most appropriate for an initial Beta stage trial of commercial cooling DR.

		DR programmes for domestic customers	
	Parameters	1) Peak time rebates	2) Fixed Time-of-use tariff
DNO-FSP Interaction	ENWL flex product	Operational Utilisation & Variable Availability	Peak Reduction
	DNO-FSP payment structure	Availability: £/MW/h Utilisation: £/MWh	Utilisation: £/MWh
	Notice period given to FSP	Availability terms agreed at time of trade, refined week-ahead Utilisation instruction issued day-ahead	Utilisation agreed at time of trade
FSP-Customer Interaction ¹	Technology eligibility criteria	Any cooling tech.	
	FSP/supplier-customer payment structure	Will vary by FSP/supplier. Examples include fixed upfront payments, £/MWh compensation for flex delivered, etc.	Supplier designs tariff to incentivise cooling usage outside these windows
	DR event length and frequency	Up to 4 hours, with up to 4 events per day depending on event length. Will be a variable parameter in the trials	
	Notice period given to customer	Availability terms agreed upon sign-up, months in advance of event. Utilisation instruction issued up to day-ahead. Will be a variable parameter in the trials	Tariff structure agreed upon sign-up
	Likely customer response to event	Customers will turn down/off their cooling themselves	

¹ Note that the FSP may not necessarily have direct contact with the consumer. The FSP may partner with an electricity supplier that deals directly with customers.