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IBM

End-User Power measurement study

Project overview and conclusions

Power Measurement – final report…

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End User Power Measurement study - Overview

IBM enistic

A joint study project with Enistic to evaluate the role of technology solutions for the management of end-user energy consumption.. and to determine effective approaches for engaging IT end-users in environmental awareness and in minimising energy consumption in the workplace …

- **Aim of project**
  - Why..?
  - What we aimed to discover..
- **Findings and Experience**
  - Technology and solution…
  - Analysis…
- **Conclusions**
  - Case for action…
  - Best Practices..

Aim and Background..

Strong focus within the IT arena on Green Data Centres and virtualisation for energy efficiency

How can IT end-users also be effectively engaged in energy management in the workplace and what potential contribution can they make …?

- **Test technology solution**
  - Effectiveness and robustness
  - Infrastructure and reporting analytics
- **Test different approaches and acceptance by users in managing consumption**
  - Guidance - Reporting – Active Management
- **Practical approaches in end-user arena… what will work?**
  - Minimising energy consumption and potential impact
  - Policy approaches and practices…. What 'engages'..? What 'turns off' users..?
- **Contribution to raising end-user awareness from an environmental perspective**
  - 'Entry' and 'Exit' surveys…

Technology and Solution overview..

Enistic - Associate partner of Hursley Innovation Centre

Part of Domia group.. Energy and environmental management solutions

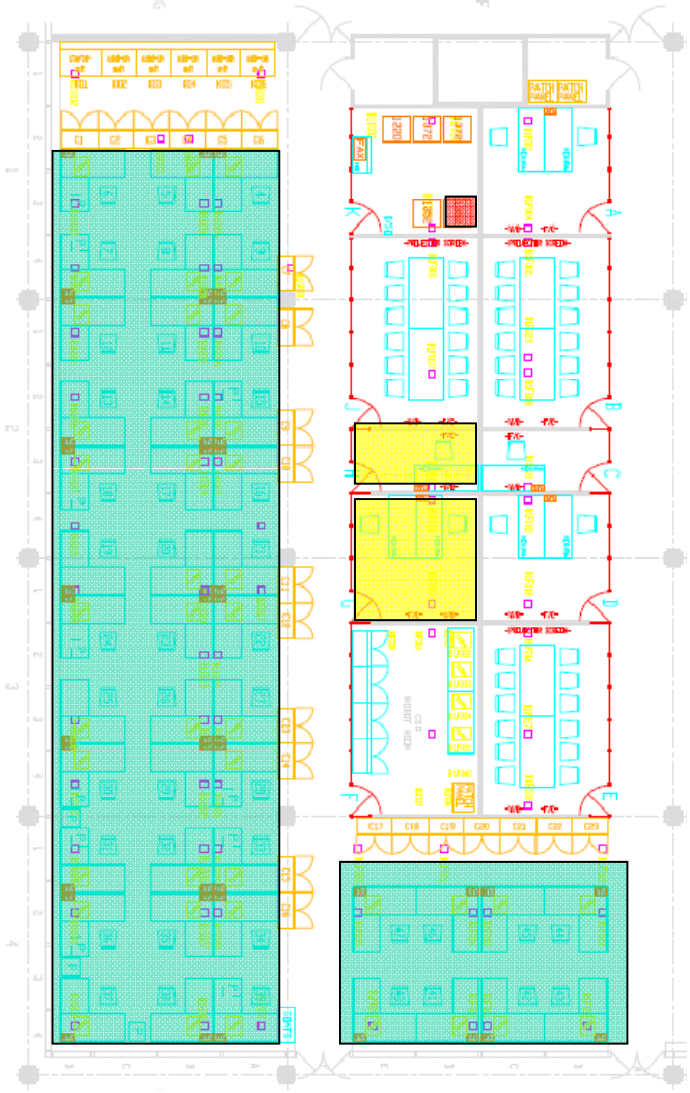
enistic

- **Hardware sensor technology**
  - Power strip with smart sensor for monitoring usage by outlet
    - plug devices into power strip
  - Wireless data transmission of power data to zone controller
    - Zigbee Pro protocol – mesh-based networking
    - data 128-bit encrypted
    - real-time power measurement (10 second polling)
  - Zone controller transmission of data to management infrastructure
    - intranet/internet (http)

- **Hosted reporting and management solution**
  - Web-based interface
    - Reporting and real-time measurement
    - Active Management configuration (automated power policies by outlet)

Population and Site Profile

IBM North Harbour (B1FG) …. Standard Office and desk space

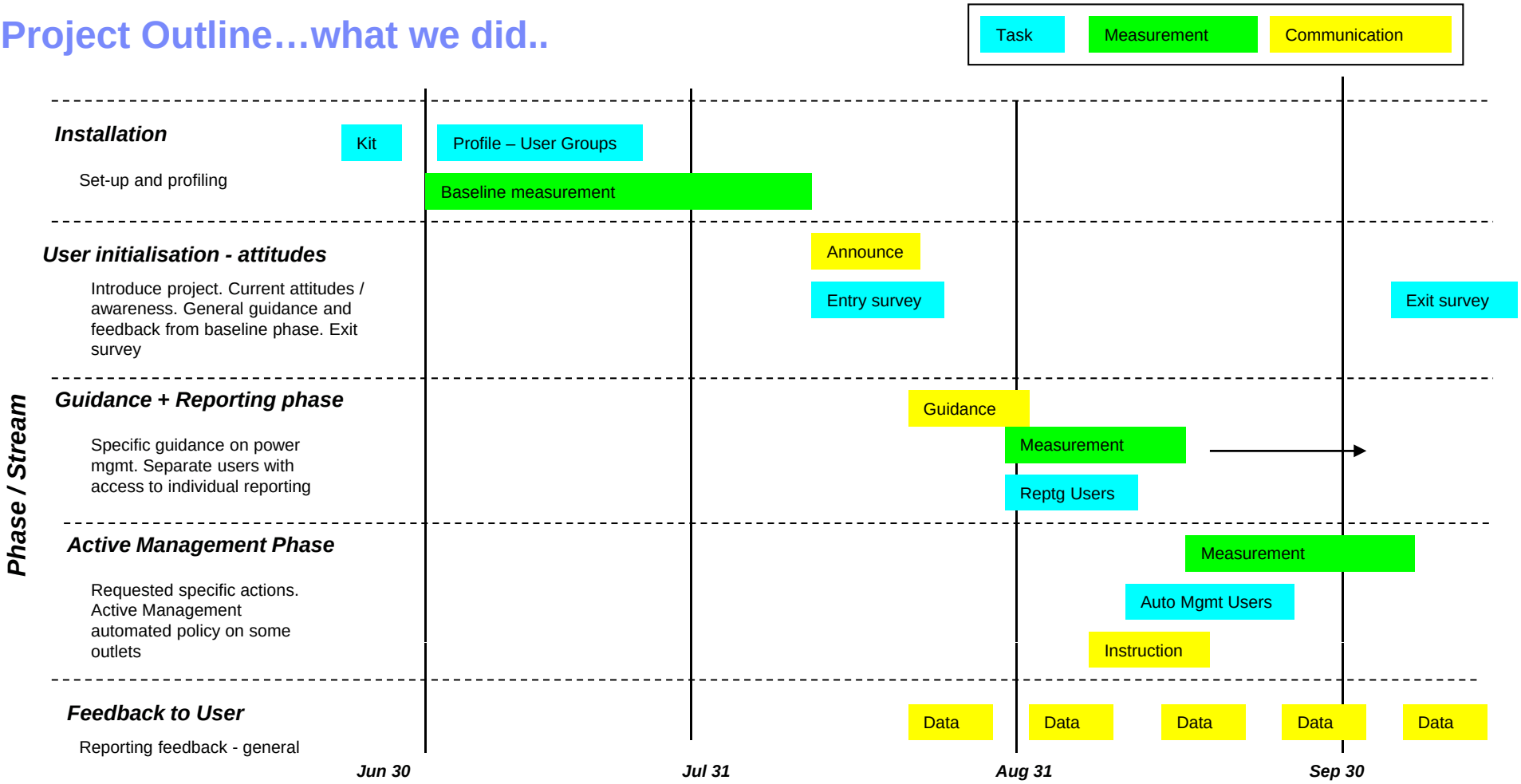


Shared Office space
Workgroup printer
Desk space

Profile

- **Customer Fulfilment - support and technical teams**
  - Mixed work population (Home - Mobile - Office)
  - Desk space usage
    - Mix of ‘fixed’ and shared desk space
  - Laptop population predominantly
    - ‘Clean-desk’ policy
    - Most desks with TFT monitors
- **Installation Profile**
  - 45 desks and one workgroup printer
  - One zone controller
- **Three user groups**
  - Daily (22)
    - office workers primarily – same desk
  - Shared (21)
    - drop-in desk and office space
  - Infrastructure (3)
    - network printer and PC desktop/servers

Project Outline…what we did..



- **Principles and operation**
  - No personal (identifiable) data shared…. Data at user profile group shared with community
  - No interference or disruption of business through test/pilot activities
  - Co-ordination point within the user group… communication, primary interface (Adrian Turner)
  - Monitoring of desk space usage through pilot

Technology solution … installation and experience

How did the technology perform… and how did we use it…?

- **Installation**
  - Approximately 90 minutes to install configure (46 devices + one zone controller)
    - 1x Enistic – 1x IBM….
  - Visual PAT safety inspection (Johnson Controls)
  - No issues/support required – no specialist skill required for basic installation

- **Robustness**
  - No issues during the test period… stable and robust
  - No interference or wireless network issues reported

- **Administration**
  - Automated active management.. set-up and administration
  - User group management and set-up..

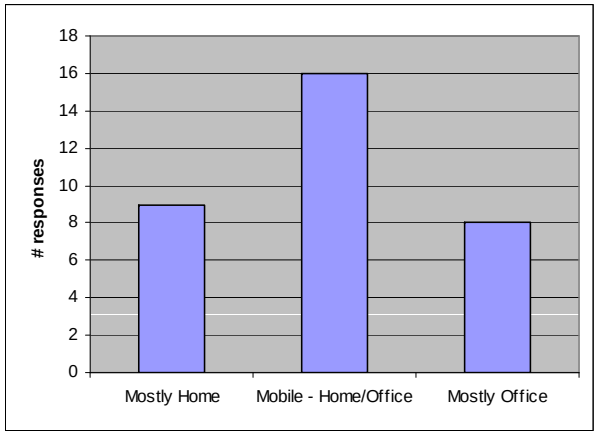
- **Reporting and analytics**
  - Use of standard solution reporting…. Primarily for individual end-users
  - Data export (hourly data) - Analytical DB2 database model, profiling and testing ‘scenarios’

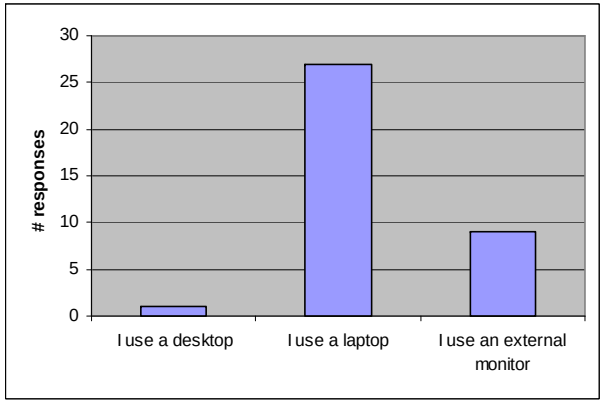
User Attitudes … 'Entry' survey

Initial survey of the user population on announcement of the project…

Attitudes towards environmental issues in the workplace, engagement in them, and to measurement..

Work Profile





Attitudes

- **Environment - Positive**
  - 66% rate environmental issues in workplace as important and the contribution an individual can make
  - More neutral about individual contribution to enterprise energy management

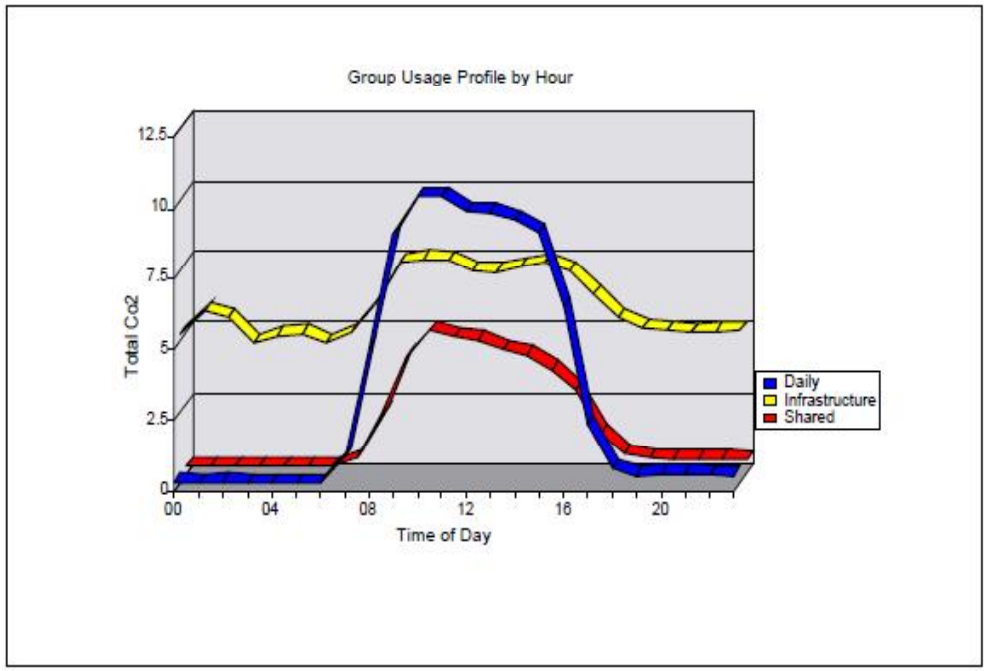
    but….

- **Engagement - Limited**
  - Limited engagement and involvement in internal programmes and using information resources and power management (<15%)

- **Managing and Measuring - Equivocal**
  - Majority belief that reducing personal power consumption would impact their job
  - 40% strongly negative to 'target'-based approaches
  - Not strongly convinced about measurement
  - Generally positive or neutral towards active/automated power mgmt. policies

Baseline phase…

'Silent' measurement to establish base line prior to announcement to user population…



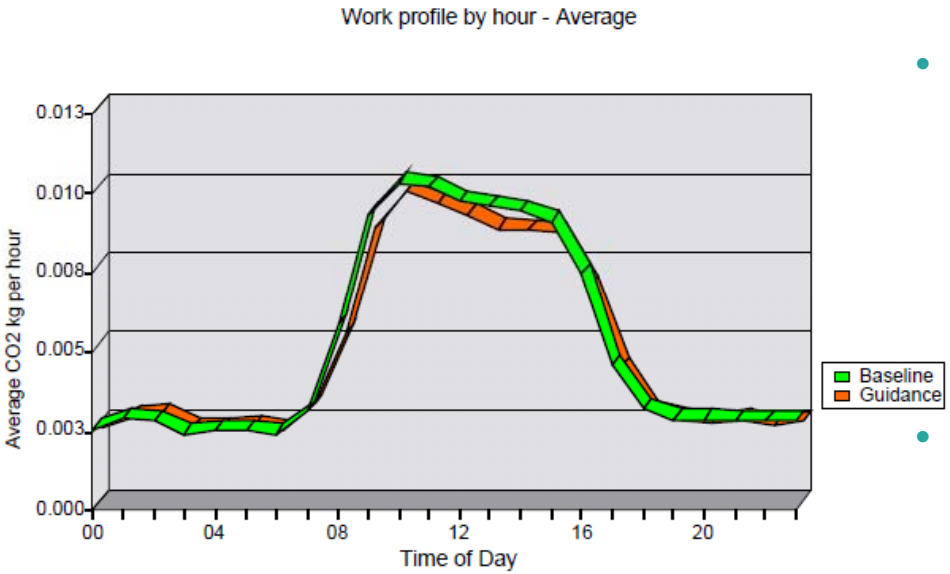
Total Contribution by User Group

User Group	Daily		Shared		Infrastructure		Total	
Use Period	CO2 kg	Percent use	CO2 kg	Percent use	CO2 kg	Percent use	CO2 kg	Percent use
Workday	83.52	43%	37.88	20%	71.54	37%	192.94	100%
Overnight (19:00 - 07:00)	3.52	7%	2.94	6%	42.53	87%	48.99	100%
Weekend	2.13	5%	1.60	4%	35.30	90%	39.03	100%
Total	**89.17**	**32%**	**42.41**	**15%**	**149.38**	**53%**	**280.96**	**100%**

- **General profile**
  - Laptop population, with clean-desk policy gives a generally efficient profile for most users
  - Desk population
    - 25 (out of 45) average used
    - range from 11 to 38 populated
    - consistent weekly pattern but significant daily variation
  - Strong insight into work and energy 'patterns' and different profile groups
- **"Infrastructure"**
  - small number of 24x7 desktop 'servers' and one network printer
    - contributing 53% of total consumption
    - and 90% 'out of hours' consumption
- **Monthly consumption**
  - July month
    - 186kg CO2 – 346 kw hrs - £38/mth

Guidance Phase…

Give guidance to end-users on actions to reduce power – selected access to individual reporting

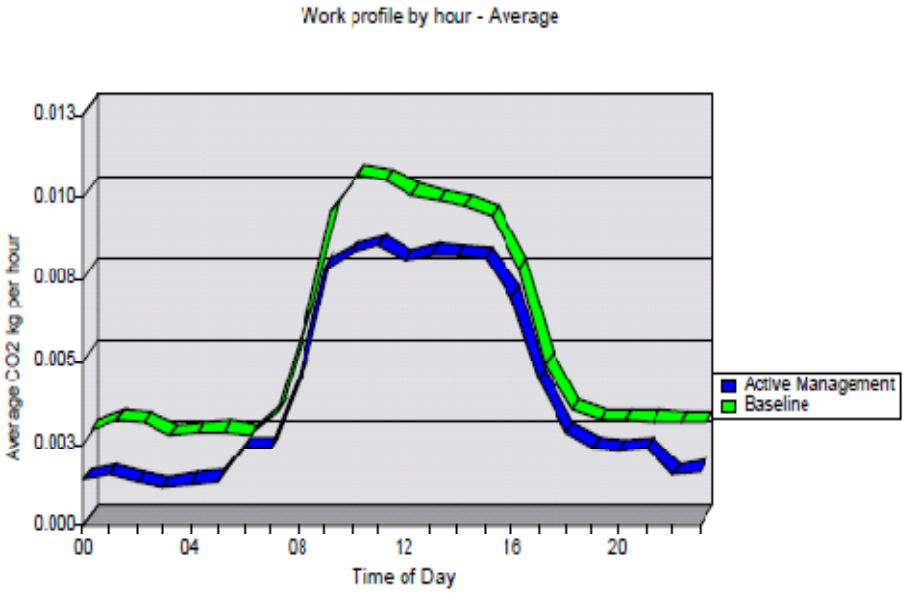


User Group	Phase Name	Baseline	Guidance	%Change
Daily	**CO2 kg**	**89**	**21**	
	Total Days	1078	286	
	CO2 kg per day	**0.083**	**0.073**	**-12%**
Shared	**CO2 kg**	**42**	**11**	
	Total Days	1029	273	
	CO2 kg per day	**0.041**	**0.040**	**-2%**
Infrastructure	**CO2 kg**	**149**	**36**	
	Total Days	147	39	
	CO2 kg per day	**1.016**	**0.924**	**-9%**
Total	**CO2 kg**	**281**	**68**	
	Total Days	2254	598	
	CO2 kg per day	**0.125**	**0.113**	**-10%**

- **Phase Overview**
  - Feedback on baseline phase and summary reporting profiles to all (CO2 measurement)
  - Guidance/Actions to minimise power
  - Selected sample users with access to individual reporting
- **Results**
  - Headline change in consumption rate -10%
    - underlying reduction 7-8% (adjusting for desk population)
    - small/limited change when desks populated
    - reduction in ‘out of hours’ usage -14%
- **Impact of individual reporting**
  - Generally shows greater contribution
    - 4-5% pts difference in reduction

Active Management Phase…

Implement automated active management policy on some outlets.. and request specific actions



User Group	Phase Name	Baseline	Active Management	% Change
Daily	**CO2 kg**	**89**	**36**	
	Total Days	1078	474	
	CO2 kg per day	**0.083**	**0.077**	**-7%**
Shared	**CO2 kg**	**42**	**16**	
	Total Days	1029	452	
	CO2 kg per day	**0.041**	**0.036**	**-12%**
Infrastructure	**CO2 kg**	**149**	**46**	
	Total Days	147	65	
	CO2 kg per day	**1.016**	**0.712**	**-30%**
Total	**CO2 kg**	**281**	**99**	
	Total Days	2254	991	
	CO2 kg per day	**0.125**	**0.100**	**-20%**

- **Phase Overview**
  - Implement and test active automated management on some outlets
    - weekend / out-of-hours
      - based on information / feedback
    - applied to 2 out of 3 ‘infrastructure’ group
  - Request laptop users to turn off power at plug over lunch periods
    - receptiveness and responsiveness
- **Results**
  - Headline change in consumption rate -20%
    - largely driven by ‘Infrastructure’
    - underlying reduction for ‘Daily’ and ‘Shared’ desks continued to increase (-12%)
    - noticeable ‘take up’ to battery use request for ‘Daily’ group..
- **Impact of individual reporting**
  - Continued to reinforce behaviour
    - 5%-10% pts difference in reduction

User population – Exit awareness survey and feedback…

What changes occurred in attitudes and behaviour as a result of this study project…?

What was the feedback on the reporting.. What was useful..?

- **Attitudes**
  - Increased perception in the role of the individual in contributing to reducing environmental footprint
  - Very significant increase in awareness and use of power management schemes
    - 40 point reduction in the ‘unaware’ categories…
  - Still largely neutral in terms of personal power use impact on total IBM footprint..
    - but majority view now for ‘makes some impact’ or greater… versus ‘little’/’minimal’ impact
  - Technology enablement positive
    - strongly positive on active management policies (85%) – positive ‘shift’ on information reinforcement

- **Reporting feedback and use…**
  - Enistic reporting (end-user summary)

    Overall positive…
    - Daily system notifications annoying.
    - On-line graphs a little bit limited. Scales often do not start at zero and therefore pattern can be a bit "misleading".
    - Real time reporting is excellent as you can see immediate results for actions
    - Why does the reporting show power usage, even when all items are switched off?
  - IBM
    - Used hourly data extract data > simple DB2 analytic model…for group analytics and analysis…

Measurement Summary…..

- **Summary of findings and experience through the study**
  - Background end-user environment is largely energy efficient… with ‘hot spots’
  - Overall reduction of around 20% achieved in daily average consumption rate…
    - No ‘coercion’ involved
    - A combination of guidance, reporting and active management achieved the result
    - All user groups showed a reduction… and contribution
    - No reported disruption to normal business activities
  - Guidance-only approach has some direct impact but…
  - The combination of ‘local’ knowledge and analytics provides a catalyst, and gives a strong insight to be able to establish appropriate profile groups, understand patterns and inform and set appropriate active management policies… without disrupting business activities
  - Access to individual reporting appears to be a strong behavioural reinforcement to guidance and awareness in reducing consumption, based on the data…

Conclusion Summary….

Conclusion areas from the study … Environmental and energy management…

- **Technology**
  - It works…
  - How, where and in what contexts would you use this style of solution..?
- **Reporting and Analytics**
  - A strong reinforcer at individual level and a catalyst for action at the group/community level
  - Potential future secondary uses…. Enterprise ‘feedback’ and adaptive active management
- **Financial and business case**
  - Direct solution cost v benefit in energy terms
    - depends on your workplace environment…. and deployment approach
  - Broader business case… use of infrastructure, enterprise energy management, Green engagement
- **People, Policies and Practices**
  - Underlying willingness to contribute in end-user populations… involving the ‘silent majority’
  - Engage and advise, supported by information… don’t dictate or nag...
  - Directly involve local communities… local knowledge + technology gives ‘intelligent’ solutions..

Technology… Conclusions

It works …

How, where and it what contexts would you use this style of solution…?

- **Context**
  - Suitable for a fixed or a mixed mobile/fixed working population in a general office environment…
  - Less suitable for a fully mobile working population and environment…
  - predominantly desktop-based environments have a much greater energy cost per seat…
- **Use**
  - Fixed deployment
    - permanent installation…
  - Mobile deployment
    - use as a ‘forensic’ enterprise tool and habit former in end-user populations…
    - move around enterprise
- **Feedback**
  - Additional flexibility in active management profiles and scheduling….

Reporting and Analytics – Conclusions…

A strong reinforcer at individual level and a catalyst for action at the group and community level …

Potential future secondary uses… enterprise 'feedback' and adaptive active management

- **Reporting and Analytics**
  - Individual end-users like real-time monitors…"you can see immediate results of actions…"
  - They don't like being 'nagged' by automated messages and reporting…
  - At a group/community level…a 'drillable' historical analytic model – using hourly data..
- **Future thoughts**
  - Enterprise 'feedback' on user dynamics… other site infrastructure, enterprise energy demand
  - Adaptive active management… direct feedback loop from analytics…
- **Standards**
  - Primary common data and business standards would accelerate the ability to make extended use of analytics….
    - Data capture/management solutions – different technologies suitable for different environments…
    - Analytic 'engines' and 'appliances'… integration..
    - Cross-enterprise energy management…

Financial and Business Case…. Conclusions…

Direct solution cost versus benefit in energy terms depends on your workplace environment and deployment approach… Broader business case encompasses use of infrastructure, enterprise energy/site management and 'Green' engagement …

- **Direct solution cost versus energy benefit**
  - Dependent on base environment
    - laptop/mobile population v desktop/fixed
  - For larger corporates….
    - 'lift and shift' approach as an enterprise 'probe'…. majority of benefits are realised early..

- **Broader business case**
  - Use of infrastructure
    - local 'server' processes running on local '24x7' desktops > virtualisation
    - SAP production overnight printing on a local network printer
  - Enterprise energy and facility management
    - demand planning and dynamics
    - interaction with other enterprise energy management processes and technology
  - Engagement of individual and enterprise profile
    - awareness and action-enhancer on wider environmental engagement…
    - small numbers x n,000…

People, Policies and Practices…. Conclusions

Underlying willingness to contribute in end-user populations… involving the 'silent majority'…

Engage and advise supported by information.. don't dictate or nag

Directly involve local communities…local knowledge + technology gives 'intelligent' solutions

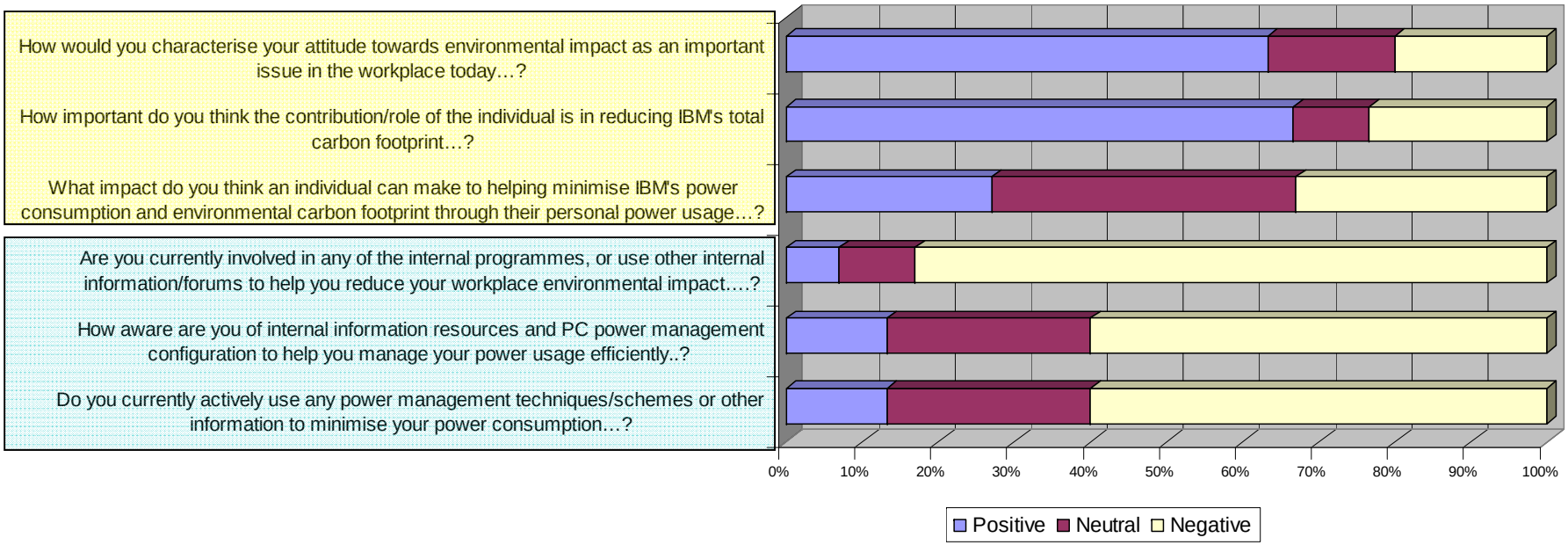
- **People**
  - Openness to the importance of environmental impacts in the workplace and personal contribution
  - Challenge is to engage the 'silent majority'…. Not the 'eco-warrior'
  - Adapt approaches to influence behaviour based on this

- **Policies and Practices**
  - Sufficient opportunity to improve energy consumption profile without draconian policies
  - Resistance to 'hard' policies based on survey responses
  - Use the environmental angle..
    - CO2 as a neutral measurement… to focus on % change
    - small numbers individually…. But multiplied by n,000…
  - Information is a reinforcer of behaviour
  - A community approach…supported by a local focal point is a recommended approach
    - supported by facilities infrastructure/support for set-up, administration..

Backup…

User Entry Attitudes – Environment and Engagement

Generally rate environmental issues in the workplace as important and the role the individual is important in contributing to minimising environmental impacts …

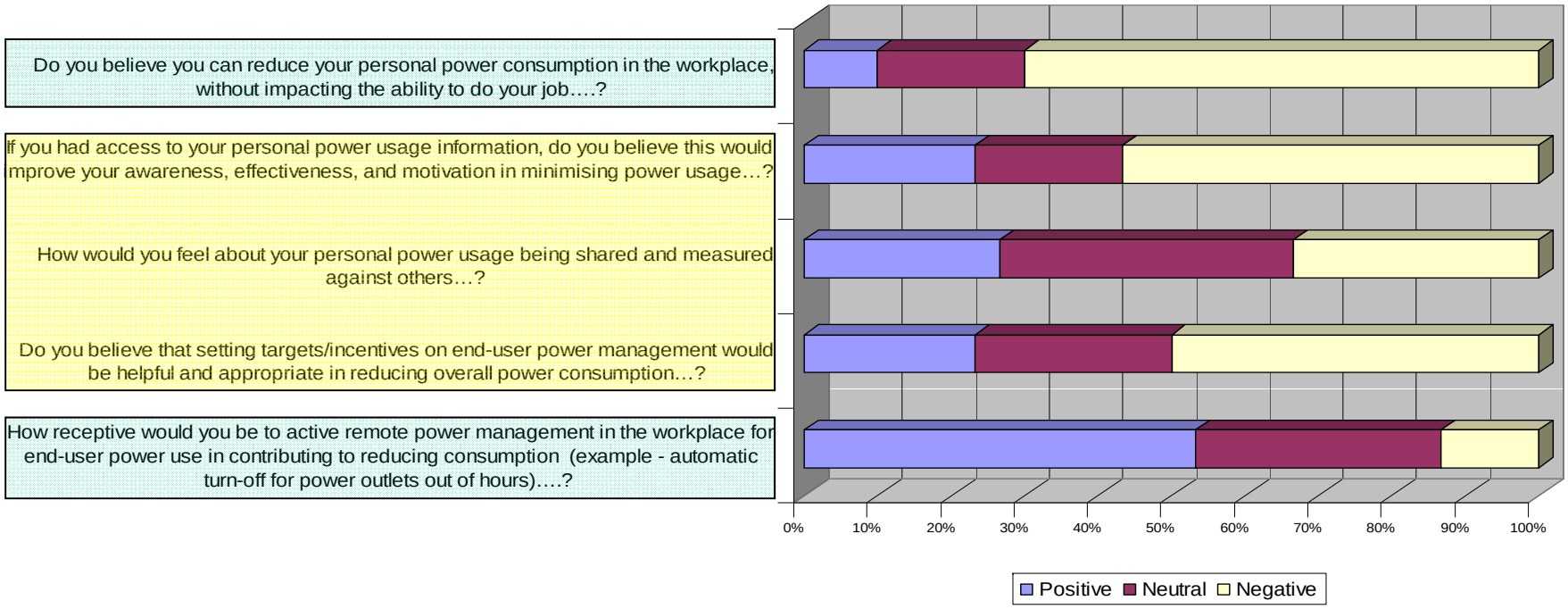


But have limited current direct involvement and awareness in actively contributing …

User Entry Attitudes – Management and Measurement

Generally equivocal about the effect of measurement, with some strong minority negative reaction to sharing of personal data and target/incentive approaches …

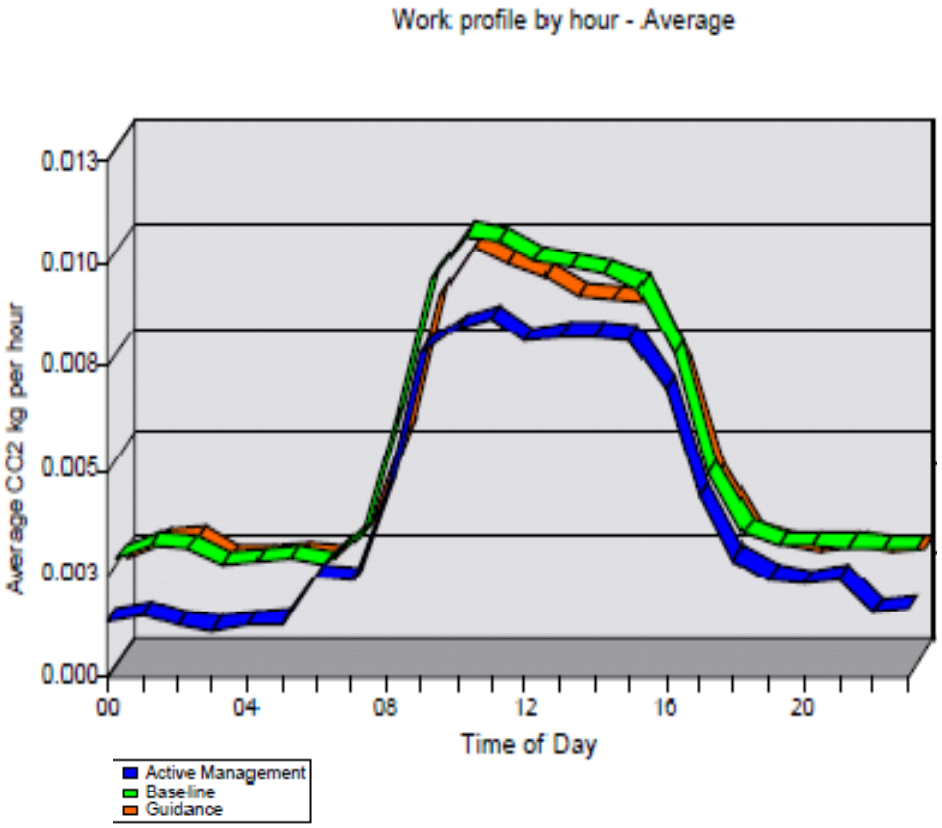
Belief that reducing personal consumption would affect the ability to do their jobs….



However largely open to automated active management approaches…

Overall total profile – by phase…

Comparison of the daily usage profile between the Baseline, Guidance and Active Management phases of the project…



Total Daily Use Profile by Phase

Phase Name	Baseline		Guidance		Active Management	
Use Period	CO2 kg	Percent use	CO2 kg	Percent use	CO2 kg	Percent use
Overnight (19:00 - 07:00)	48.99	17%	11.32	17%	15.20	15%
Weekend	39.03	14%	9.87	15%	6.03	6%
Workday	192.94	69%	46.68	69%	77.40	78%
Total	**280.96**	**100%**	**67.86**	**100%**	**98.63**	**100%**

Average CO2 by Phase

Isoccupied	Phase Name	Baseline	Guidance	Active Management
Yes	CO2 kg	227.47	55.28	84.70
	Total Days	887	226	395
	CO2 kg per day	*0.256*	*0.245*	*0.214*
No	CO2 kg	53.49	12.59	13.93
	Total Days	1,367	372	595
	CO2 kg per day	*0.039*	*0.034*	*0.023*
Total	CO2 kg	280.96	67.86	98.63
	Total Days	2,254	598	991
	CO2 kg per day	*0.125*	*0.113*	*0.100*

based on observed desk occupation during work days

Profile adjusted for desk population…

Underlying change in consumption rate, normalised for desk population through the phases and showing the difference between users with access to individual reporting and those without..

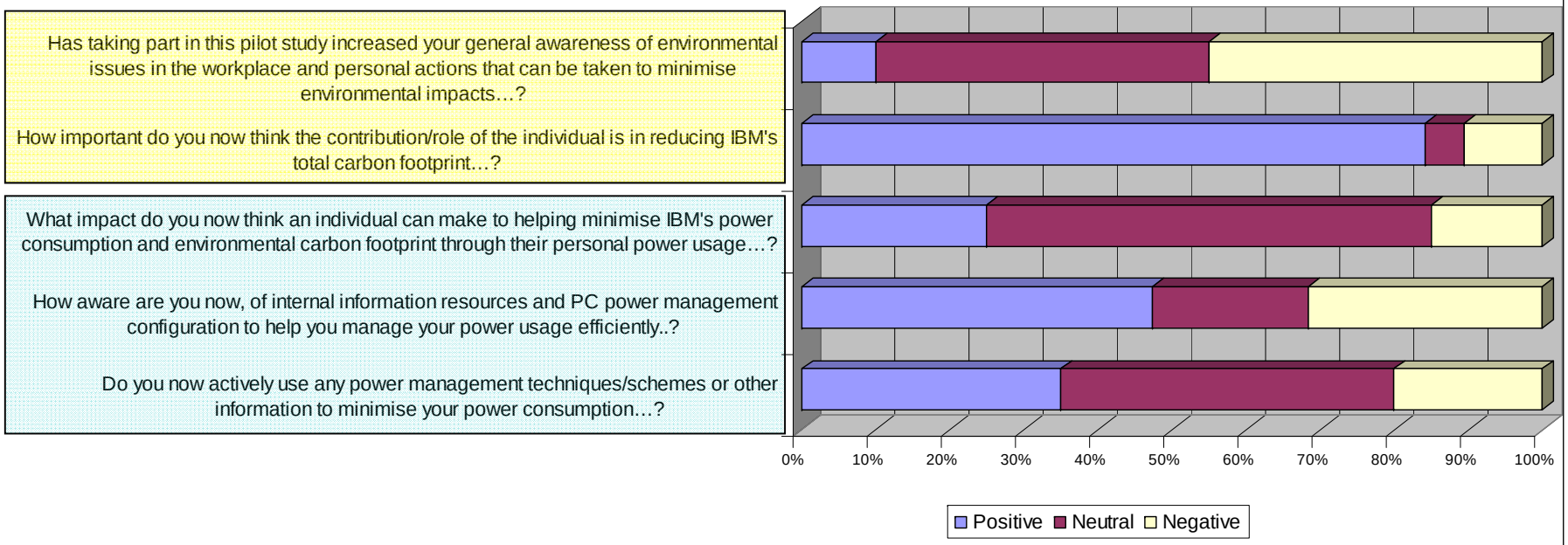
% change in CO2 kg rate per day

Normalised for the desk usage profile between phases for the 'Daily' and 'Shared' user groups..

		Guidance v Baseline	Active v Baseline
Daily	No reporting	-4%	-9%
	Reporting	-11%	-13%
Shared	No reporting	-1%	-9%
	Reporting	-7%	-24%

User Exit Attitudes – Environment and Engagement

No major changes in general environmental awareness through participation in the study but role and the contribution of the individual now strongly positive …



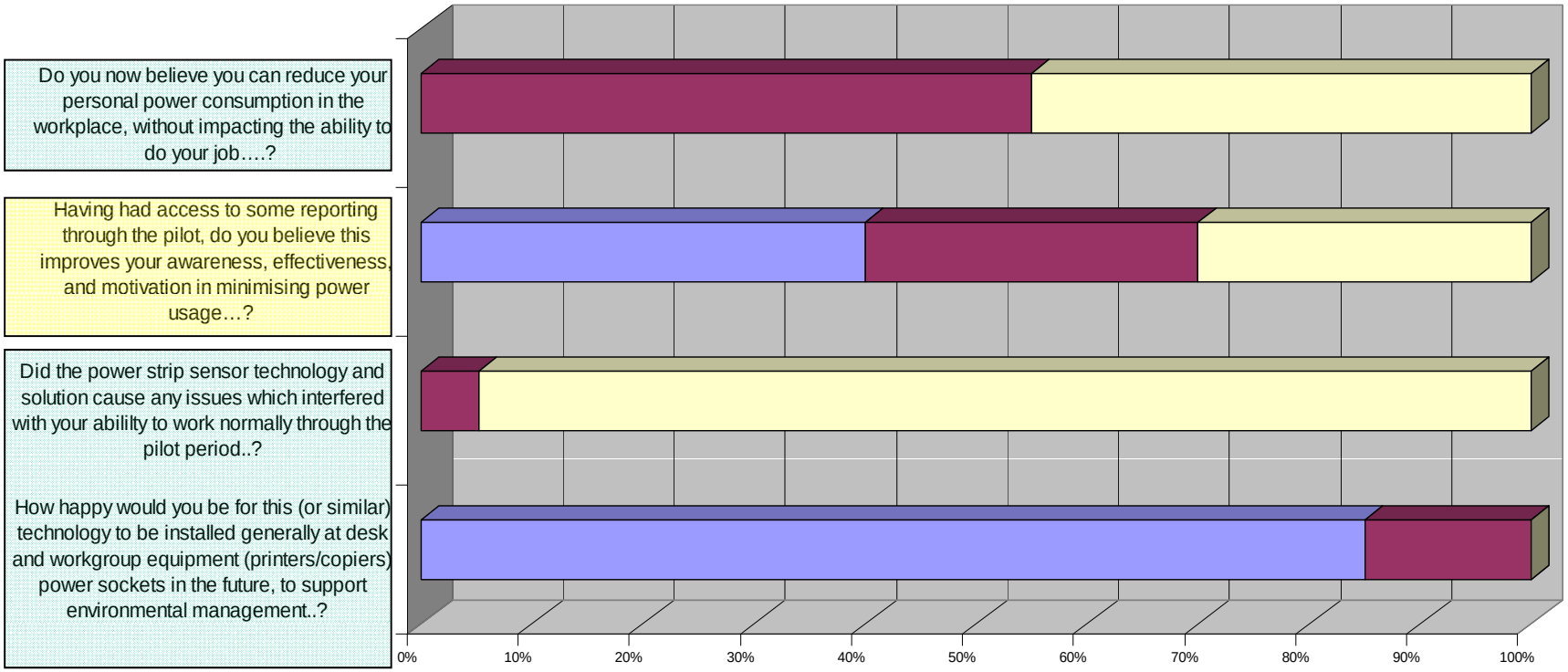
Neutral, but upward shift on personal power contribution - now 85% 'some impact or more'…

Very significant increase in power management awareness…

User Exit Attitudes – Management and Measurement

Still 'protective' about use of power and ability to perform job … but upward 'shift'

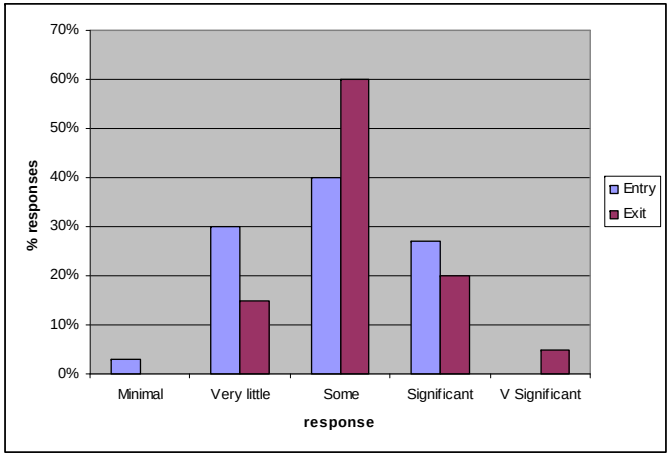
Also increase in supporting role of information from initial view….



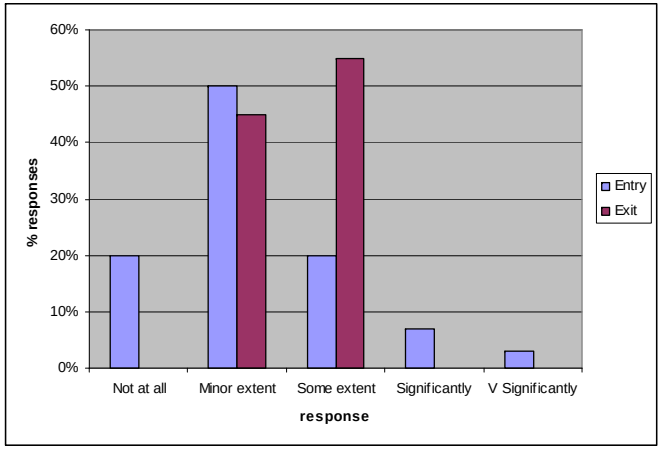
Open to technology and automated active management approaches…

User Attitudes – Entry and Exit comparisons…

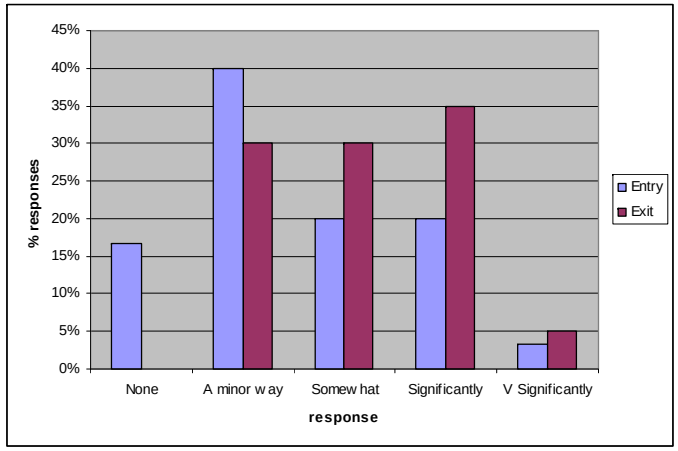
What impact do you think an individual can make to help minimising IBM's power consumption and environmental carbon footprint through their personal power usage?



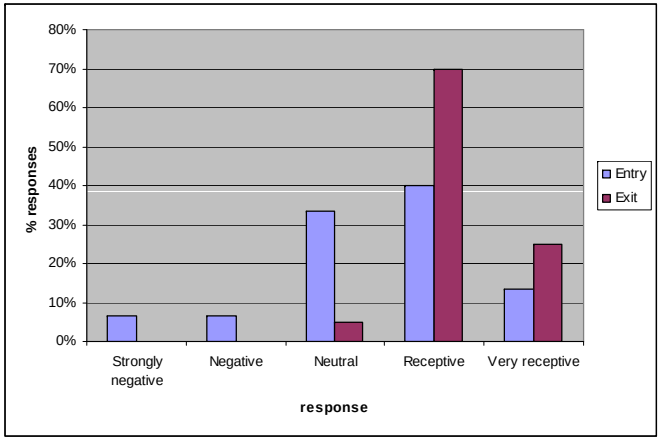
Do you believe you can reduce your personal power consumption in the workplace, without impacting the ability to do your job?



If you had access to your personal power consumption in the workplace, do you believe this would improve your awareness, effectiveness, and motivation in minimising power usage

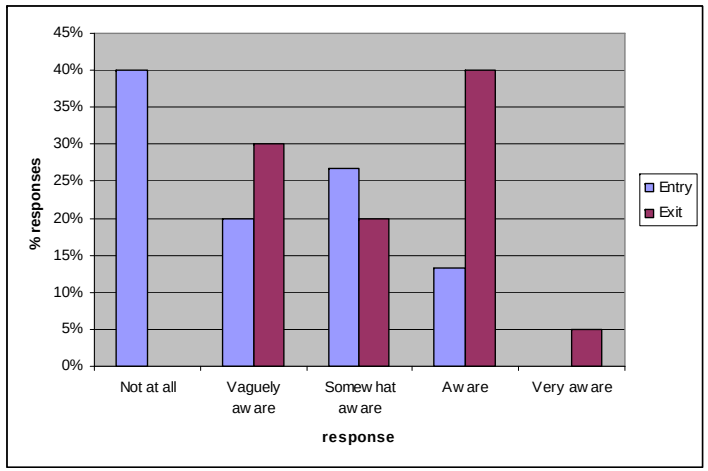


How receptive would you be to active remote power management in the workplace for end-user power use in contributing to reducing consumption

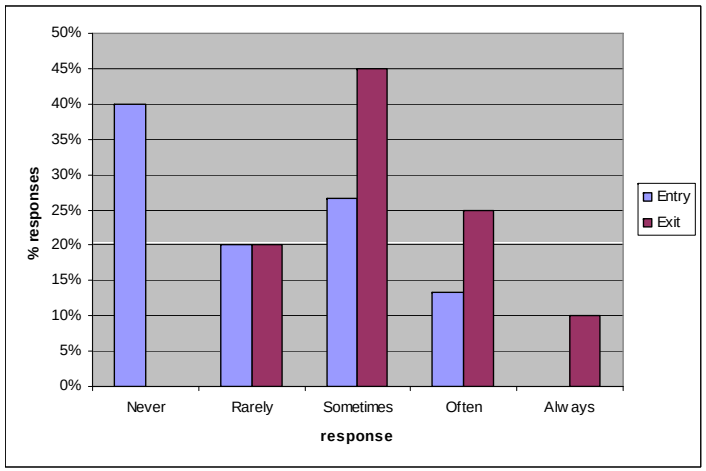


User Attitudes – Entry and Exit comparisons…

How aware you of internal information resources and PC power management configuration to help you manage your power usage efficiently?



Do you currently actively use any power management techniques/schemes or other information to minimise your energy consumption?



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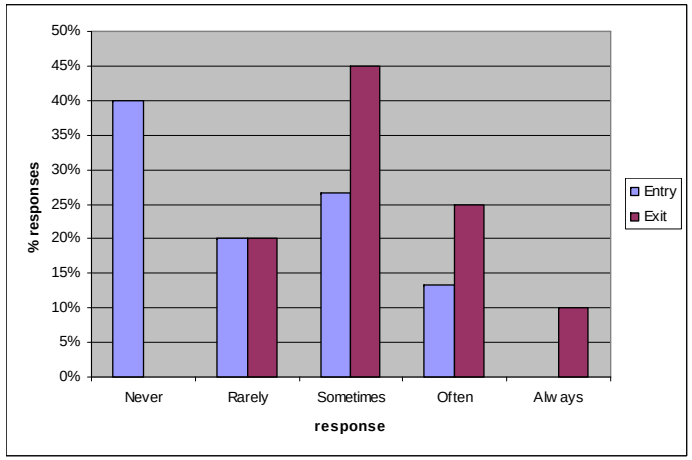

Has taking part in this pilot study increased your general awareness of environmental issues in the workplace and personal actions that can be taken to minimise environmental impacts…?