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The Unexpected Applications of Sensors: Home Energy and Lifestyle Analysis

Prof Alan Smeaton
CLARITY: Centre for Sensor Web Technologies
Dublin City University

Funded by Science Foundation Ireland under grant 07/CE/I1147

Alan Smeaton is ..

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- Text-based IR, then image, then video IR
- Founded and still co-runs TRECVid for 10 years
- Previously HoS and Dean of Faculty, now Dep. Director of CLARITY
- Works in managing data aggregated from sensors in a wide range of domains – environmental monitoring, sports, AAL, real time web (social networks), and energy
- Is typically seen at conferences like ACM MM, ECIR, various sensor evens in env, energy, sports, AAL, social networks

The Sensor Web

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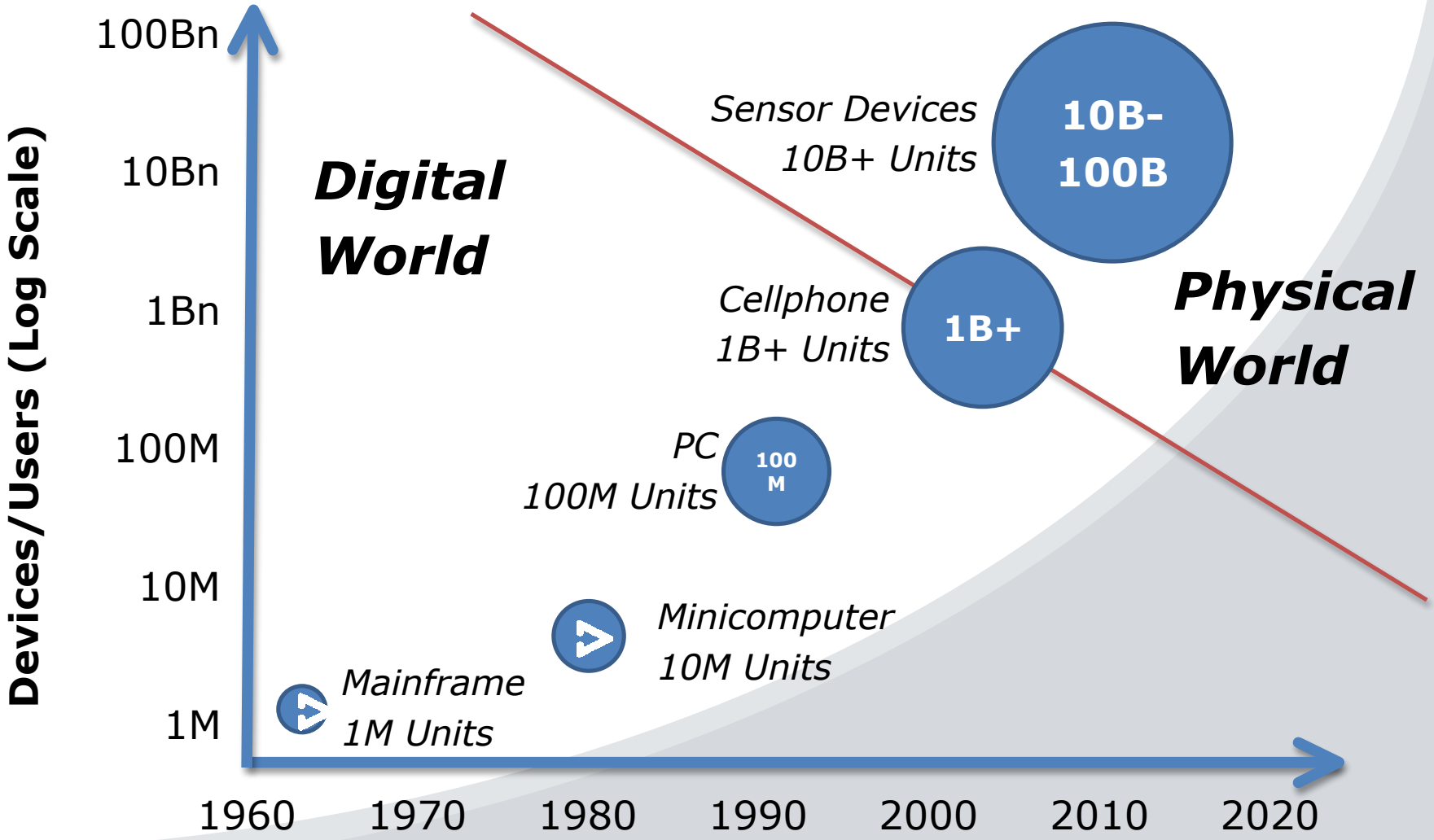

CLARITY Overview

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UCD / DCU / TNI

100+ (PhD/PD) Researchers

Diverse Expertise

Health / Environment / Media

Strong Industry Focus

Award-Winning Research & Commercialization

Research Team

Almost a decade of working together

Prof. Barry Smyth
CLARITY Director
RP 6 Leader
Personalization, Recommender Systems, User Modeling

Prof. Alan Smeaton
Deputy Director
RP 5 Leader
Information retrieval, multimedia Information, video retrieval,…

Dr. Donnacha O'Driscoll
Centre Manager

Prof. Dermot Diamond
RP1 Leader
Materials science, novel sensor Technologies, wearables.

Prof. Greg O'Hare
RP3 Leader
Middleware, agent oriented computing, mobile computing.

Prof. Noel O'Connor
RP4 Leader
Signal processing, audio/video processing, data analysis.

Dr. Brian Caulfield
RP3, RP6
Physiotherapy, Human motion, Body sensing technologies,…

Prof. Niall Moyna
RP1
Sports science, human Performance, ….

Dr. Cian O'Mathuna
RP2 Leader
Sensor platforms and hardware, Power management, …

CLARITY Centre & Ecosystem

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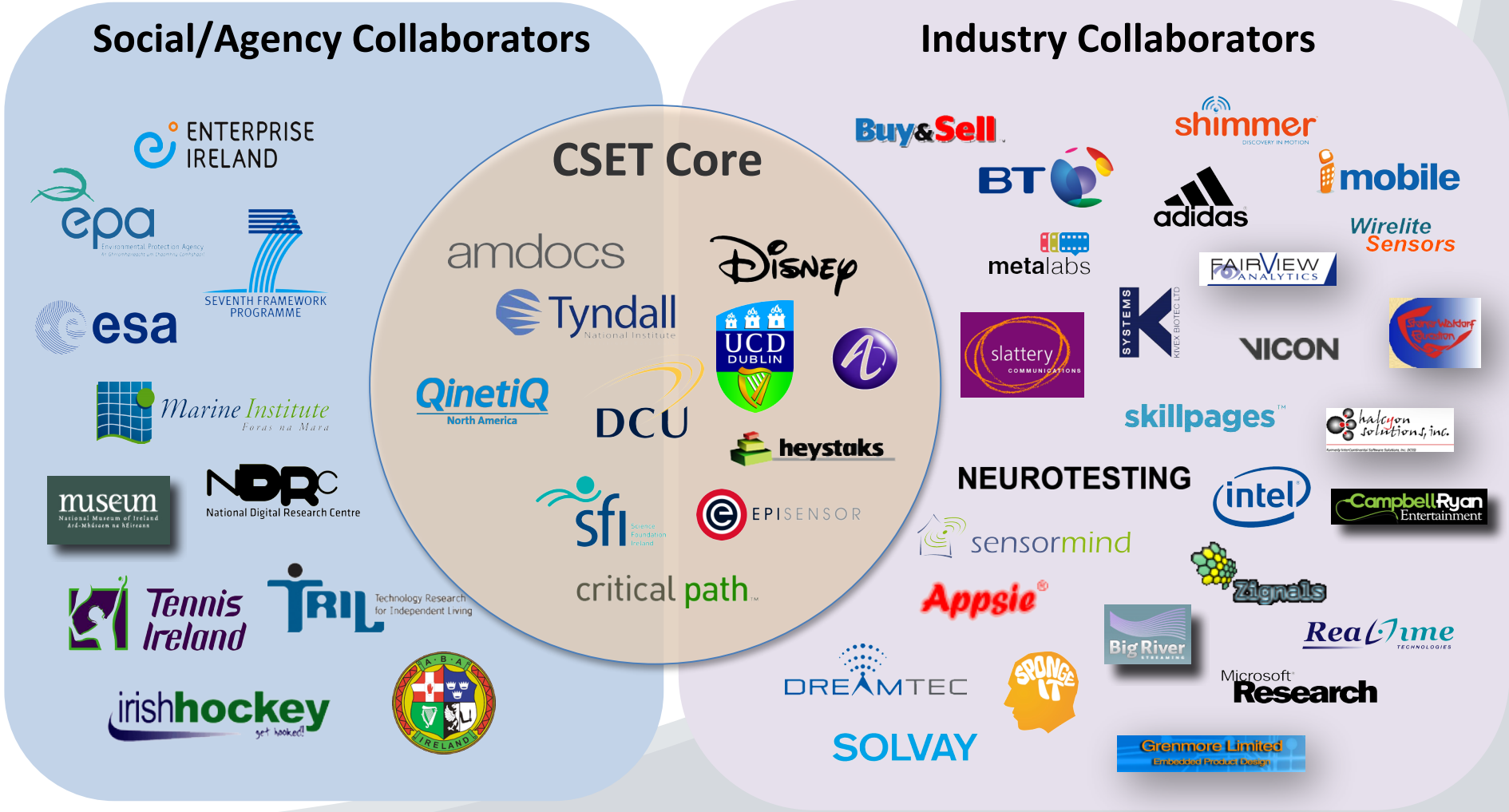

January 2011

CLARITY Demonstrators

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Personal Health & Sports

Energy & the Environment

Ambient Assisted Living

Sensing the Real-Time Web

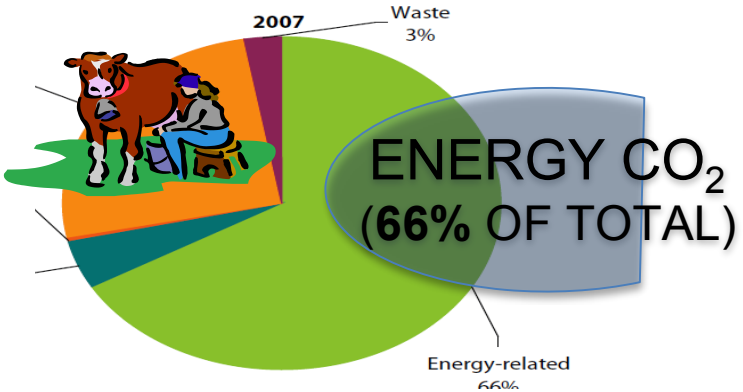
CLARITY Demonstrators

Energy and the Environment

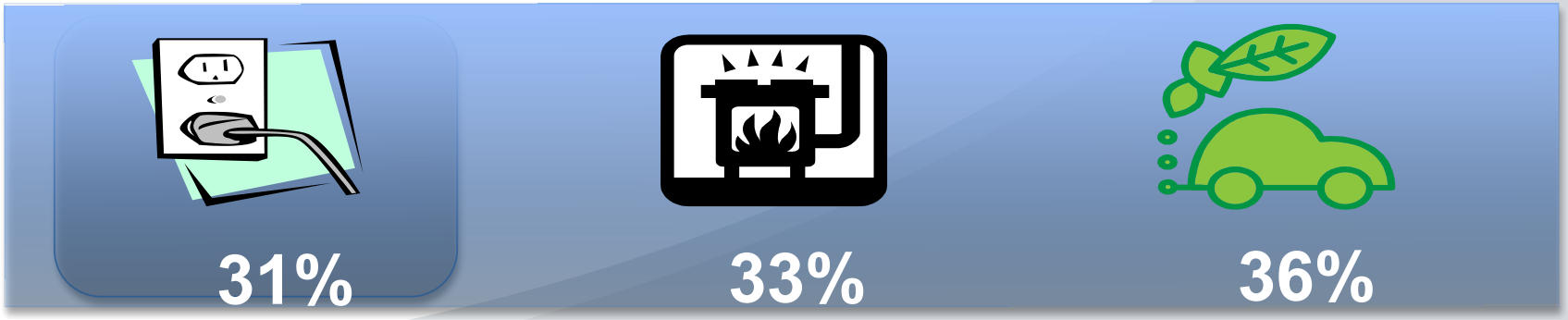
- To sense and to provide feedback on personal and societal environmental habits and impact;
- Fundamental breakthroughs on microfluidics and in material sciences for environmental sensing, plus novel, prize-winning work on monitoring home energy, appliance recognition, and feedback of carbon footprints;
- Company involvement from IBM Ireland, Episensor, Veutility;

Environmental Landscape

IRELAND CO_2 EMISSIONS (SOURCE: SEAI)



ENERGY-RELATED CO_2 EMISSIONS (SOURCE: SEAI)



Electricity in Ireland

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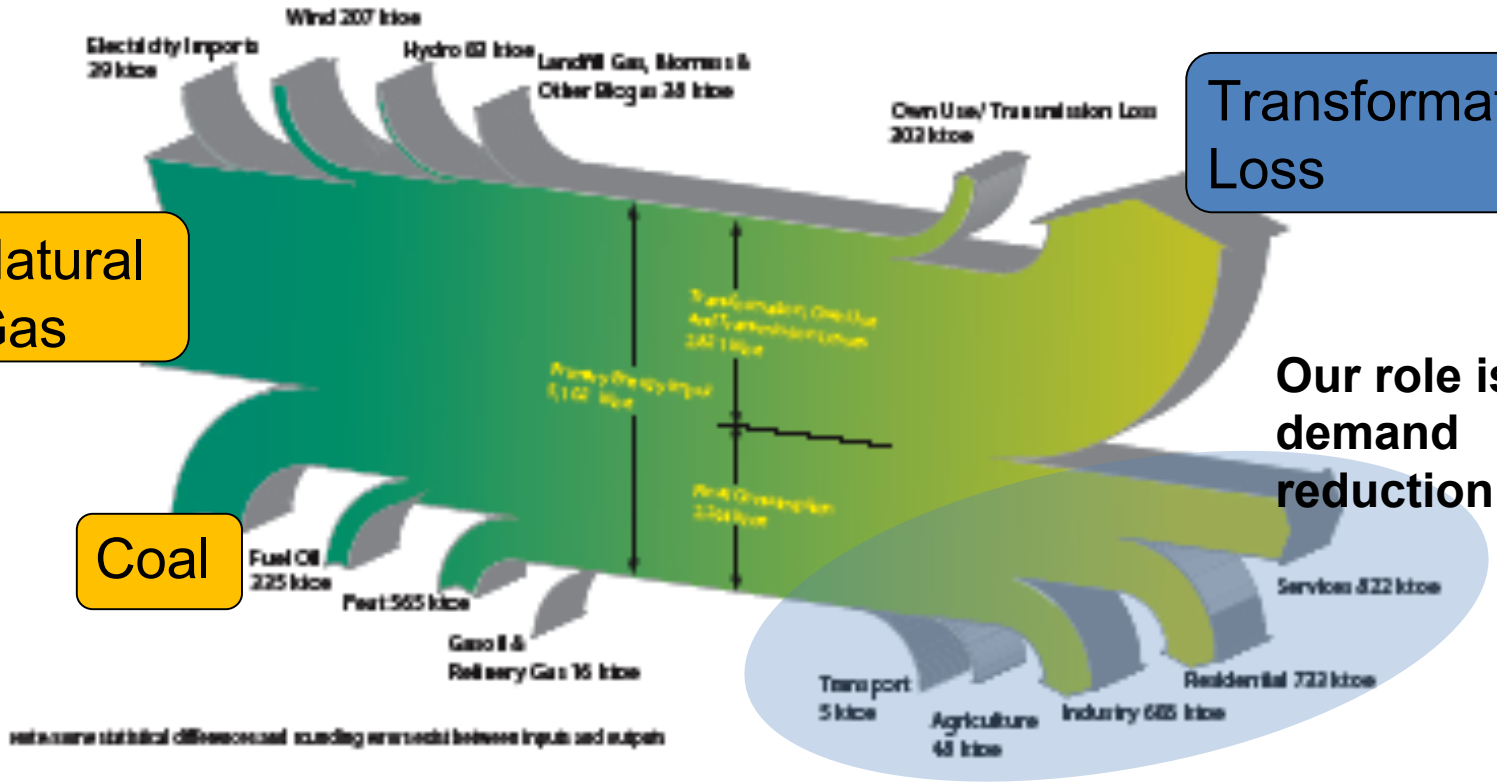
Figure 10 Flow of Energy in Electricity Generation 2008



Natural Gas

Coal

Transformation Loss

Our role is in demand reduction

Personal feedback reduces demand ?

- Olympic Peninsula Project
- Darby Review Paper
- ENEL 27 million smart meters
- Microsoft Holm & Google power meter
- Irish Energy Regulation behavioural trials on 8,000 people

CLARITY Deployments

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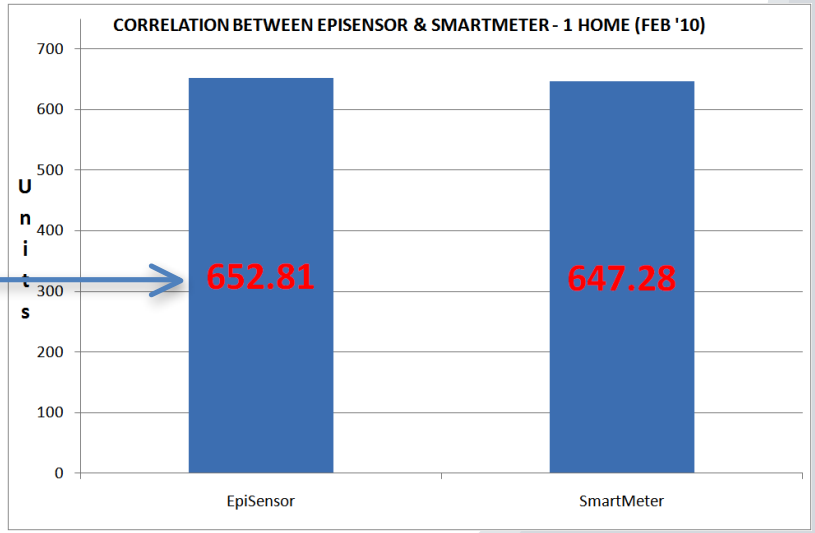
- 24x domestic participants & 2 lab settings
- Data accurate to within 1% of National Smart Meter
- Normal 5-7pm peak in electricity consumption



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Mon	23.30%	10.27%	2.29%	0.41%	1.70%	9.66%	17.55%	29.96%	38.69%	38.50%	39.92%	34.18%	36.60%	29.62%	32.49%	43.57%	51.69%	71.31%	91.22%	83.01%	71.93%	61.94%	54.76%	44.15%
Tue	29.29%	6.49%	0.50%	0.30%	4.10%	6.27%	10.33%	32.53%	36.70%	45.49%	42.51%	36.06%	33.77%	35.37%	41.86%	42.16%	52.22%	75.31%	100.0...	77.10%	71.93%	73.14%	60.81%	44.28%
Wed	20.00%	7.48%	0.01%	0.00%	3.66%	8.78%	15.70%	29.18%	43.00%	39.66%	37.49%	34.90%	30.08%	27.72%	34.92%	34.47%	50.77%	68.57%	99.50%	91.12%	76.78%	60.16%	53.13%	40.88%
Thu	21.24%	5.30%	1.93%	1.41%	3.92%	7.47%	16.15%	43.85%	44.76%	45.73%	43.50%	41.94%	47.68%	35.01%	50.02%	53.48%	69.46%	86.10%	98.74%	95.09%	70.76%	55.37%	49.95%	39.99%
Fri	21.27%	9.18%	4.50%	1.90%	2.00%	7.33%	14.02%	29.99%	45.46%	40.45%	35.79%	28.99%	27.58%	37.63%	43.37%	38.67%	47.61%	58.54%	76.15%	75.50%	74.42%	65.59%	52.69%	41.93%
Sat	28.16%	18.36%	6.12%	3.75%	3.07%	9.19%	6.31%	7.59%	22.78%	41.62%	48.43%	45.68%	49.70%	53.88%	60.18%	47.98%	55.20%	75.86%	84.03%	70.21%	61.38%	51.15%	45.15%	42.90%
Sun	27.93%	18.69%	9.97%	10.04%	4.21%	12.08%	7.45%	7.73%	20.35%	32.55%	53.73%	63.35%	57.50%	49.85%	49.29%	59.99%	68.39%	76.22%	93.03%	82.27%	80.68%	67.26%	61.48%	37.75%

Aims of deployment

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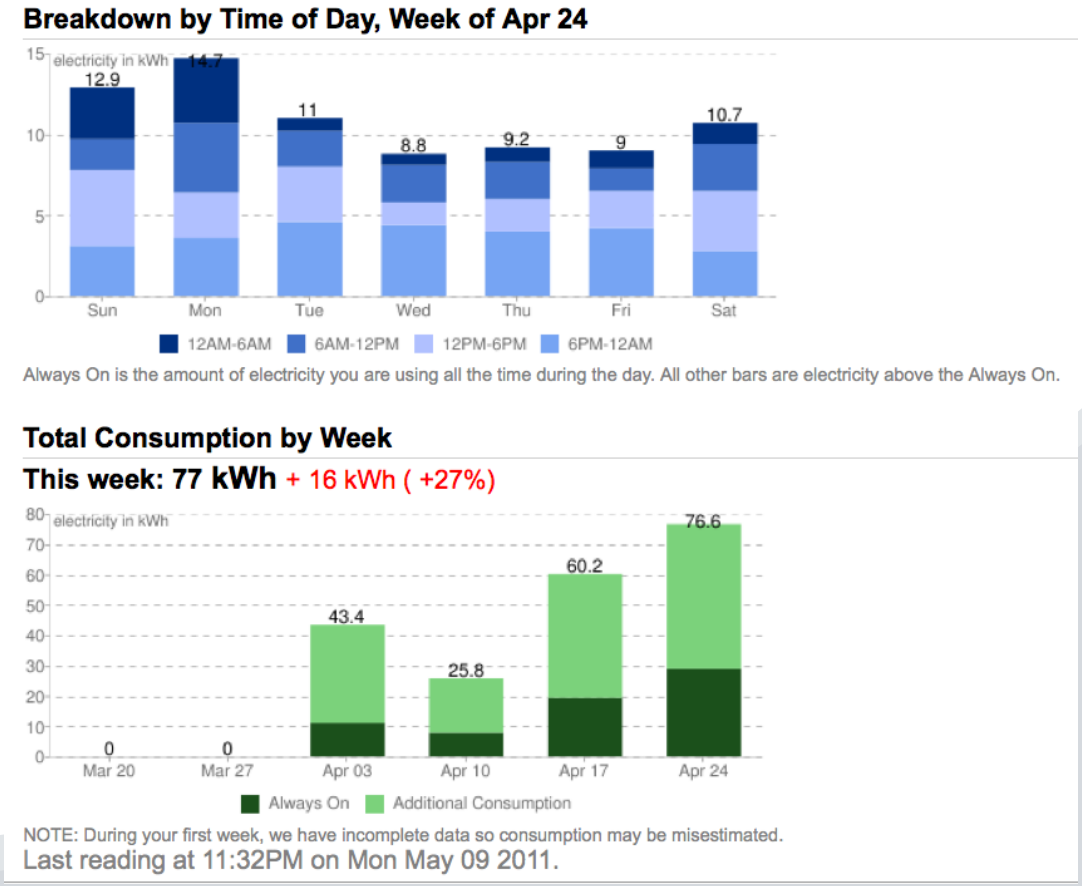
Three strands of activity around the deployments (apart from technical challenges) …

1. Incentivise and inform people of usage, through interventions
2. Appliance recognition, genres of appliance, working across homes/models
3. Lifestyle analysis or information

Intervention 1

- Weekly email … Google Powermeter do this now … but with comparisons against others



Intervention 2

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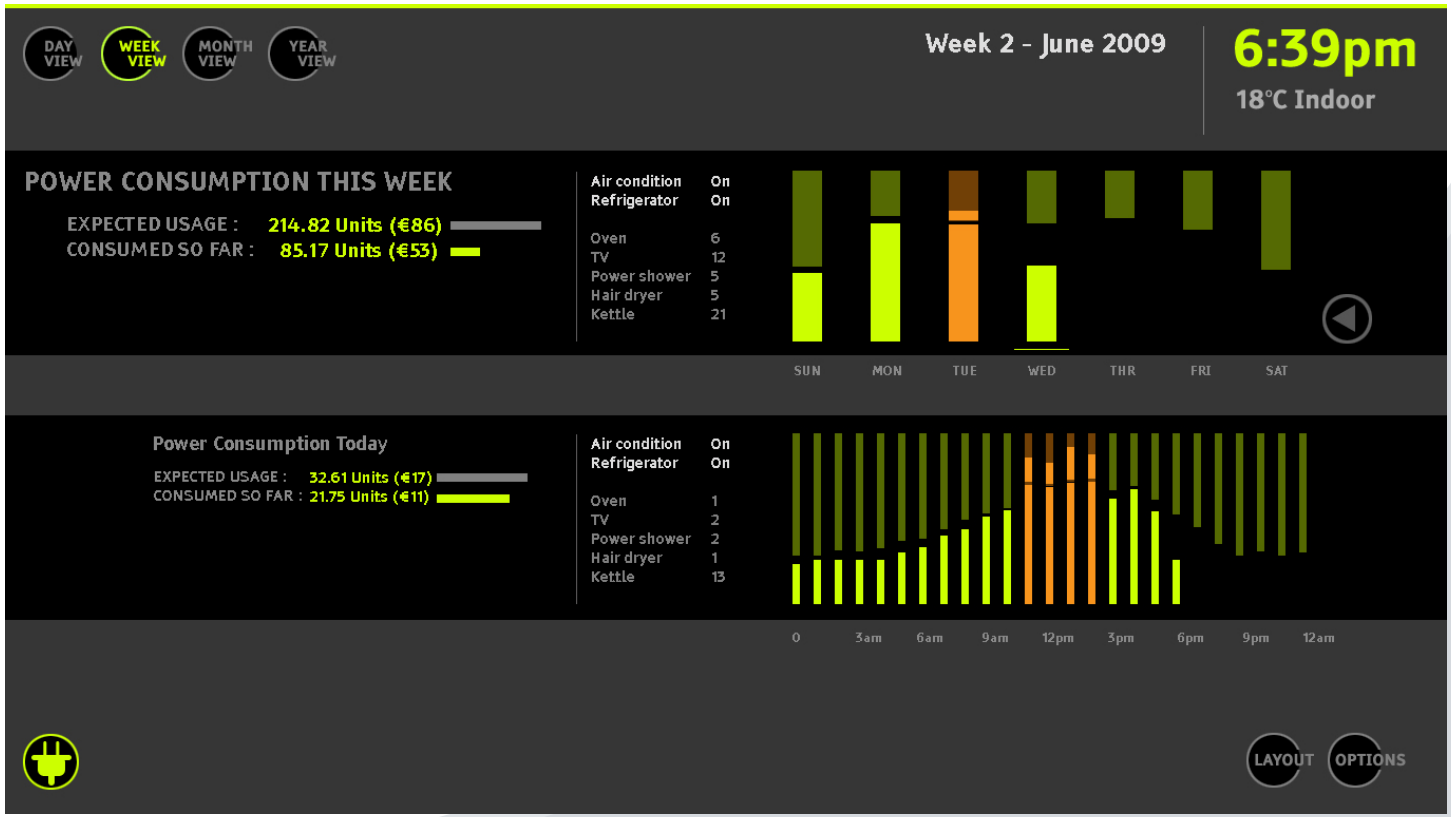
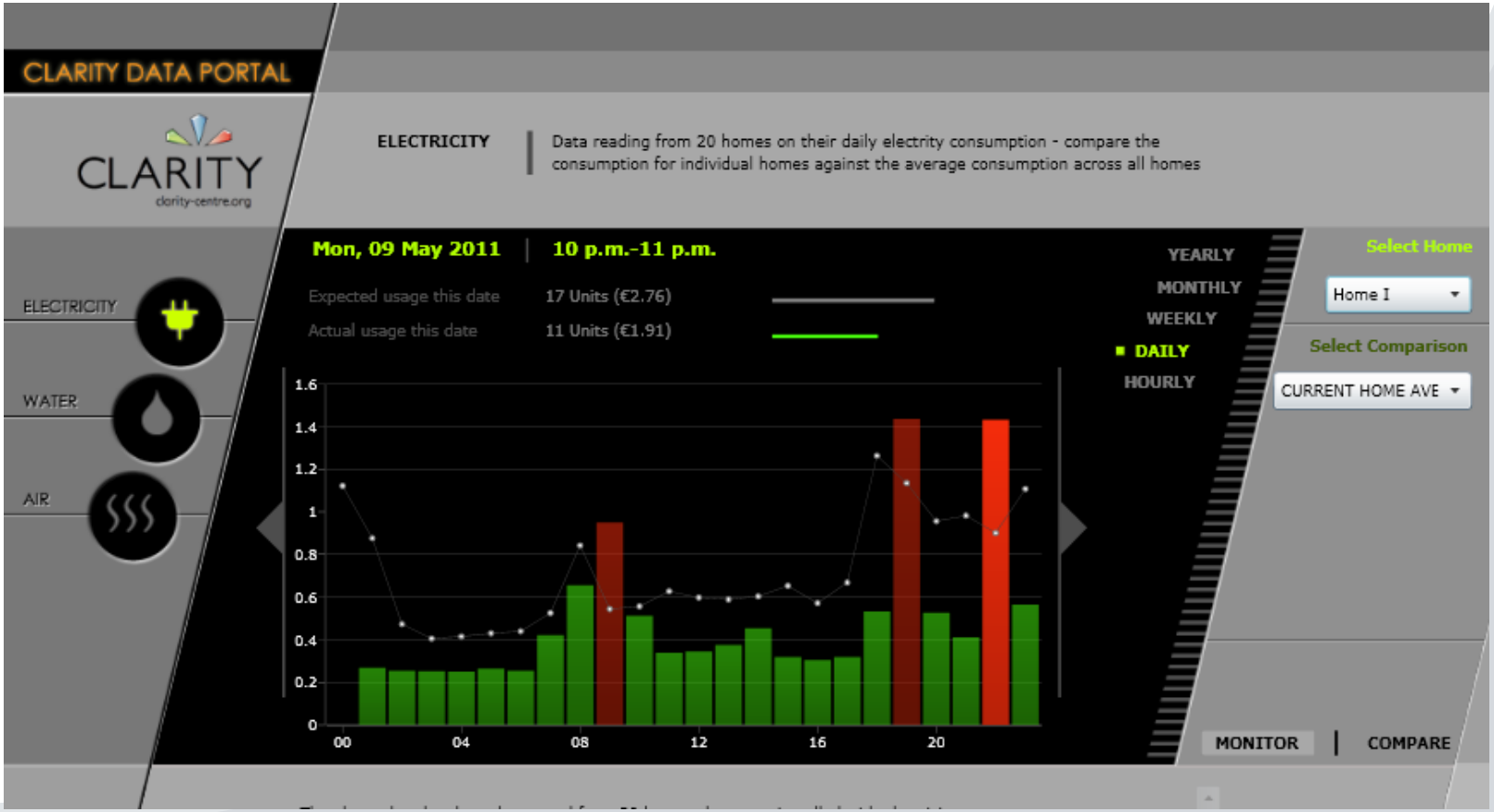
- Touchscreen display



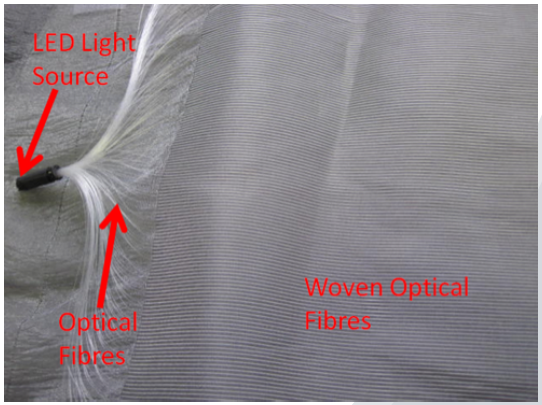
Intervention 3

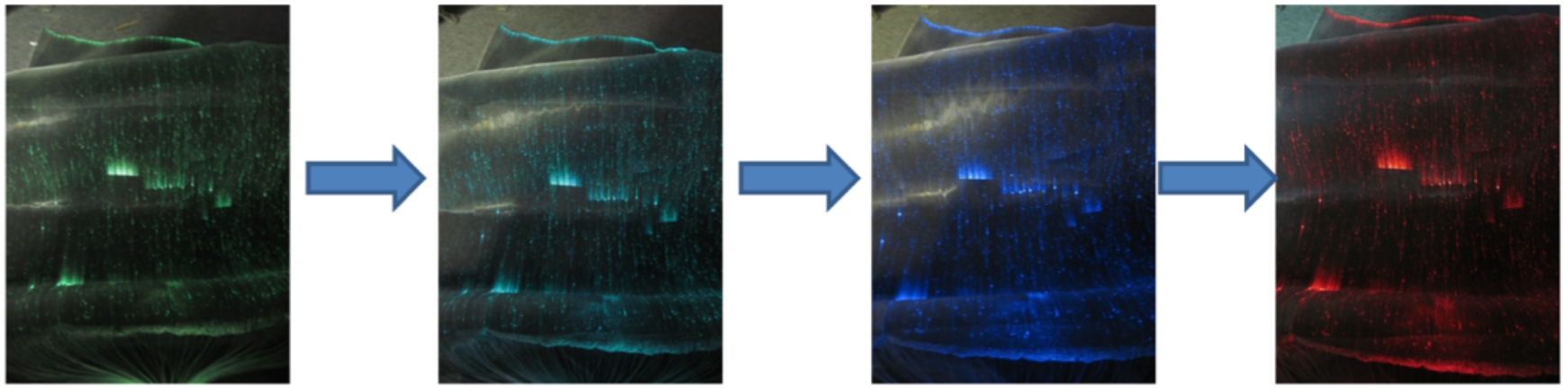
- Web portal



Intervention 4

- Colour-changing soft furnishings
- Tablecloth, cushions, etc. - where colour changes ambiently reflect the +/- energy usage vs. typical historical norm for that day/time





Interventions ?

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- Guess what ? We found the same as everyone else … initial enthusiasm gives way to bad habits - need to continuously inform
- Real role for captology here

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Mon	36.05%	11.22%	4.73%	6.32%	4.63%	1.49%	5.29%	31.90%	31.38%	37.40%	39.66%	46.33%	60.82%	45.43%	32.53%	32.26%	50.88%	52.74%	50.43%	53.50%	53.23%	68.12%	92.75%	97.37%
Tue	41.19%	15.70%	4.46%	4.05%	1.88%	1.82%	6.56%	31.54%	29.12%	21.67%	24.48%	22.65%	36.02%	32.87%	19.80%	32.65%	54.86%	64.98%	52.90%	49.37%	51.28%	70.39%	91.02%	90.70%
Wed	37.71%	14.97%	6.68%	3.78%	3.09%	0.13%	1.75%	29.23%	36.75%	20.32%	20.05%	24.75%	29.13%	31.81%	24.61%	39.12%	47.50%	63.46%	55.79%	51.03%	60.46%	65.74%	85.59%	92.93%
Thu	44.40%	18.11%	8.59%	3.61%	3.96%	0.82%	1.74%	30.08%	33.57%	31.51%	15.20%	32.55%	30.45%	20.19%	25.77%	40.99%	56.56%	66.75%	59.48%	52.65%	45.67%	55.80%	91.20%	88.08%
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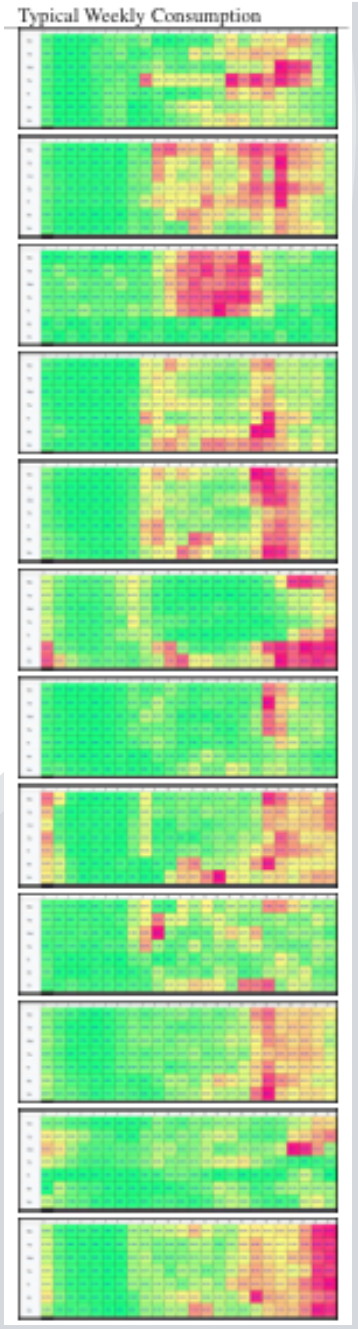
Sat	53.70%	23.30%	9.38%	5.86%	4.43%	2.55%	3.48%	14.39%	32.96%	34.00%	42.05%	50.08%	53.63%	35.96%	36.36%	33.34%	53.01%	93.85%	65.80%	62.48%	56.57%	66.27%	77.16%	82.63%
Sun	33.99%	11.86%	9.62%	10.61%	4.91%	1.19%	0.00%	9.86%	28.99%	25.74%	34.50%	34.39%	71.74%	66.26%	33.99%	27.97%	28.28%	40.24%	57.15%	61.59%	60.73%	73.62%	96.86%	91.41%

Strange outcome

- A strange outcome was the interest in the heatmaps as a tool to summarise lifestyles;
- One ambient, cheap sensor can tell a lot about living patterns;
- Now working with ethnographers and geriatricians on monitoring the lifestyles of people;
- Don’t need high resolution energy sensing so cheap €100 option does



Strange Outcome

- This will be even cheaper with rollout of smart meters, where this can be done for free;
- Could allow easy inter-user comparisons, comparison across peers, long-term deviation detection