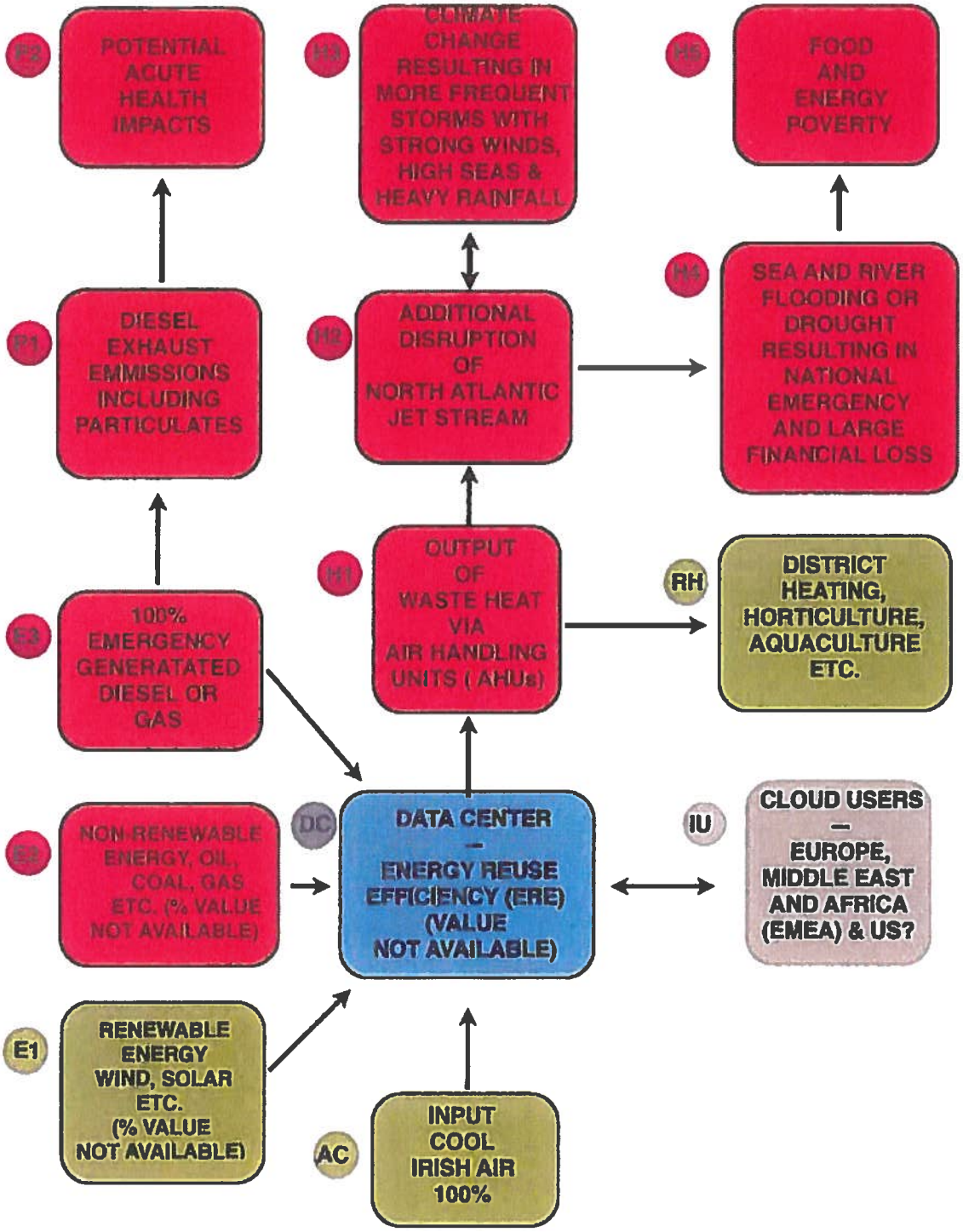
DCCAE CONSULTATION ON DISTRICT HEATING

RESPONSE RECEIVED FROM [redacted]



Data Centre - Energy Flow Diagram

Data Center Farm - Energy Flow Diagram

To show the existing and possible effects on the environment as set out above

AC Use of Outside Air to Cool the Data Center

(a) Microsoft (MS) claims innovation for their use of outside air to cool their data centre at almost zero cost. (see Greening the Dublin data center on their web site at http://www.microsoft.eu/2009/08/31/greening-the-dublin-data-center/)

DC Data Center Energy Use and Reuse

(a) America's Data Centers consuming and wasting growing amounts of energy according to Natural Resource Defence Council (NRDC) to be found on their recently revised web site. http://www.nrdc.org/energy/data-center-efficiency-assessment.asp

(b) Washington Post has an article (http://www.washingtonpost.com/news/energy-environment/wp/2015/01/30/an-urban-climate-double-whammy-more-heat-less-wind/) in their newspaper Note particularly the graph presented on U.S. Data Centre Electricity use 2000 to 2013. Also note in the bar chart titled Comparison of U.S. Residential and Commercial Electricity Uses by Type 2011 that data centers consumed as much electricity as home and office PC's in 2011.

(c) Ceres Roadmap rates the Operational Performance of energy-intensive data center operations.

(d) EUROTECH provides definitions on the correct way to calculate the power usage effectiveness (PUE) and energy reuse efficiency (ERE) of data center operations.

(e) A report by Maxwell Cooter on European Union's many data centre projects are presented and the question is asked why six data centre efficiency projects are needed?

(f) While the datacentre operators will tell you what the power usage effectiveness (PUE) of the centre is they are less likely to tell you what the energy reuse efficiency (ERE) is for their operation. EirGrid should be aware of how much energy is heat wasted as it also effects the capacity/efficiency of the transmission lines they maintain.

E1 Renewable Energy - Wind etc.

(a) The growth of renewable electricity production from wind shows a rapid rise in electrical output since 1997. It is noted that the historic peak recorded wind power output was 1,967 MW delivered on Wednesday, 7th January 2015 at which point wind contributed 52% to the instantaneous system demand. (Source EirGrid)

(b) US firms plan wind farm data centres according to an article by Mark Paul in the Irish Times on 25th March 2015 and it states that the Irish Wind Energy Association (IWEA) says other multinationals with operations here will follow Apple's lead.

E2 Non-Renewable Energy - Oil, Coal, Gas etc.

(a) "SmartGrid snapshot of energy position at 8am on 26th March 2015. (Source EirGrid)

(b) Ireland should look for carbon credits for the service provided to International users of the data centers.

H1 Output of Waste Heat

(a) A good answer to "Why is waste heat capture important?" can be found here: http://science.howstuffworks.com/environmental/green-science/waste-heat-capture.htm

(b) A paper "Waste Heat" a Potential Threat to the Climate published in THE FUTURIST is presented here.

(c) Waste heat affects climate in summer. See "An urban climate double whammy: more heat, less wind"

(d) "As part of the initial development of the project, MS considered the offload/reuse/exchange of waste heat from cooling of the data centre with neighbouring industrial facilities or other potential users within the environs of the business park. However at that time of no feasible outlet could be found. In order to move a step closer to achieving such a system, the design of the proposed development has been amended such that waste heat can be collected and supplied to 3rd parties in future.

(e) Has any data centre operator discussed with personnel at Baldonell Aerodrome about the use of the waste heat to heat the airplane hangers? I'm sure they would be interested if the data center operator paid them to reuse it.

(f) Heat Mapping of heat potential versus heat demand. The Dutch ask the question "Isn't it more sustainable to use waste heat first?" EirGrid could be more efficient by carrying out heat mapping so that heat potential can be supplied to where the heat demand is required.

H2 Additional Disruption of North Atlantic Jet Stream

(a) A recent study by climate scientists looks at how waste heat and unpredictable jet streams are interacting and contributing to global warming. (See interview with Veerabhadran Ramanathan, professor of atmospheric and climate sciences at the Scripps Institution of Oceanography on the Living on Earth show.)

(b) A paper recently published called Multifold increase in heat extremes by 2040 by Potsdam Institute for Climate Impact Research (PIK) is attached and highlight the urgency of addressing these climate problems. (PIK have also produced a report in Nov. 2012 for the World Bank called Turn Down the Heat - Why a 4°C Warmer World Must be Avoided.

H3 Climate Change resulting in more frequent storms with strong winds, high seas and heavy rainfall.

(a) SEAI's Chief executive talks about how local communities are taking action to become masters of their own sustainable energy destiny while creating local jobs and saving money in the process.

(b) Full text of climate changed statement signed by 26 European mayors.

(c) "Storm repair costs hit profitability at ESB" states that in 2014 Storm Darwin repair cost €25 million. (source Irish Times 26th March 2014)

RH Horticulture, District Heating, PURPLE etc

(a) Database cluster development proposed for PEELHOUSES LOCKERBIE in the planner's Sustainability Statement in Table 5: Minimise the Use of Energy, Water and Resources set out their sustainable objectives.

(b) Seattle Office of Sustainability & Environment is developing a plan to reuse waste heat from nearby data centres and other sources to power a so-called "district heating" system.

(c) Examples where Data Centre's Waste Heat that can Heat Offices, Greenhouses,Pools

(d) PURPLE - Topic Paper Number 1 Discusses food security which refers to the availability of food and one's access to it could become an important issue in the near future. Examine the possibility of realising the potential of Dublin's peri-urban regions by researching Peri Urban Regions Platform Europe (PURPLE). This group proposes that specific policies are needed to ensure a balanced development of peri-urban areas with the aim of bringing multiple benefits both for the citizens of the EU's cities, as well as those living and working nearby. In particular PURPLE seeks policies which recognise the need for viable peri-urban agricultural and horticultural production linked to short food chains, and sustainably managed open space which nourishes local biodiversity and provides access and recreation for all. Documents from their website www.purple-eu.org are included below:

(e) PURPLE - Dublin Region - Climate Change

(f) PURPLE - Conference in Dublin - County Architect says SDCC is working with key local stakeholders with a view to agreeing an approach to addressing the energy and climate change challenge at a local level. This includes investigating the feasibility of district heating in the town centre.

P1 Air Dispersion Emissions

(a) Smoke from MS database flues have been recorded with photos.

(b) Note extract from submitted EIS. Section 11. "Extremely unstable conditions can cause plume looping and elevated concentrations close to the stack. Under stable conditions elevated concentrations can occur due to the emissions being trapped below the boundary layer. Neutral conditions, characterised by cloudy skies and strong winds, are most favourable for dispersion due to the mechanical mixing of the lower atmosphere. The wind direction determines the direction in which the plume is blown, and for a particular stability, higher wind speeds will result in reduced plume rise so causing the plume to reach ground level closer to the stack with elevated emission concentrations. The boundary layer height determines the total vertical distance over which the plume may spread."

P2 Potential Acute Health Impacts

(a) Has the Environment (Miscellaneous Provisions) Act 2011 been taken into account here? Particularly Section 4 (2) that refers to the fact that damage to the environment includes damage to all or any of the following:

(a) air and the atmosphere

(g) health and safety of persons and conditions of human life.

AC(a) Use of Outside Air to Cool the Data Center Greening the Dublin data center

The internet is developing at a tremendous pace as more businesses and peopleworldwide gain access to an ever greater range of online services including online office functionality, video and music downloads and more.

Experts predict a continuous growth towards 'cloud computing', i.e., the provision of software plus services over the internet, which will provide companies with an opportunity to save money on ICT infrastructure, and software developers with an advanced interoperable platform to create innovative software for the future.

Official Partner

To support this projected growth, the software industry is building more data centers. This represents a challenge as data centers consume a significant amount of energy. For example, in the UK, data centers presently represent 3 percent of energy consumption and this is expected to double by 2020 if nothing changes, leading to more CO2 emissions and huge electricity bills for ICT companies that host data centers.

To tackle this challenge, Microsoft has adopted a strategy to dramatically improve its data centers' energy efficiency. In May 2009 the company signed the EU Code of Conduct for Green Data Centres, which includes a commitment to comply with European standards and best practices. Then in July 2009, Microsoft opened a new data center in Dublin, Ireland, that has a Power Use Effectiveness (PUE) of 1.25, on a scale where 1 is the optimal (the average in the industry is approximately 2.0 and Microsoft data centers globally presently have an average of 1.6). An important function for

Program Fast Facts

Situation
Data centers are vital for tomorrow's economy but are at risk of consuming high volumes of energy.

Solution Microsoft built the Dublin data center using advanced energy efficient technology in accordance with its commitment to the EU Code of Conduct for Green Data Centers, which promotes best practices for

- energy efficiency and

sustainability in the ICT sector.

Reduced energy consumption

Benefits

Reduced CO2 emissions

AC(a) Use of Outside Air to Cool the Data Centre (cont.)

the Dublin data centre will be to host web conferencing tools like Microsoft's Office Live Meeting that enable customers to reduce business travel, and thereby reduce costs and emissions.

- Reduced CO2 emissions
- Increased capacity and performance.

Moreover, Microsoft is working on additional methods to eliminate 50 percent of data centers' energy consumption (e.g. through reductions in artificial cooling, lighting and electricity transformers) and to reduce by 50 percent the need for new IT equipment.

The new Microsoft data center in Ireland already consumes approximately 50 percent less energy than a traditional data center of comparable output. In the Dublin facility, Microsoft has applied all of the expected and most of the optional best practices under the EU Code and will only employ artificial cooling on a few days per year.

The data center is an officially recognized best practice by the European Commission meeting the requirements of the Sustainable Energy Europe Campaign (www.sustenergy.org) in contributing to the achievement of making a voluntary commitment to the EU energy policy goals in the field of energy efficiency.

This is possible due to a range of innovations, one being the use of outside air to cool the data center at almost zero cost. This provides dramatic environmental savings as artificial cooling normally consumes approximately 38 percent of the facility's electricity consumption and 18 million liters of water per month. In addition, the latest generation of servers and 24/7 monitoring will help to create further energy savings.

Beyond the Dublin data center, Microsoft has already implemented, or is planning to implement, the majority of the EU Code's best practices in its data centers in Europe and across the globe. The company is also exploring the innovative use of shipping containers as flexible and portable housing for servers which provide 10 times the density for data centers and drive dramatic savings in power usage. Finally, Microsoft
Research, the company's in-house research branch, is supporting these

AC(a) Use of Outside Air to Cool the Data Centre (cont.)

efforts by constantly looking for innovative ways to improve energy efficiency. For example, the Green Project looks for new algorithms that avoid unnecessary precision. In Microsoft's search engine Bing, a new algorithm gives more emphasis on the first pages of results than in the later pages, thus reducing the amount of energy needed to provide similar results. Another research project is Everest, which allows data written to an overloaded volume to be temporarily off-loaded to underutilized storage resources in the data center, with an energy saving of up to 60 percent.

"We need to do three things," says Jean-Philippe Courtois, President of Microsoft International. "One, address the issues in our own industry; two, work to find technological answers to the environmental problems we are all facing today and tomorrow; and three, help individuals and organizations to change their behavior. Signing up to the EU Code of Conduct is just a small part of Microsoft's commitment to environmental sustainability, but with the projected growth of cloud computing it's important. We are also working with our network of partners, customers, environmental groups, industry groups, and leading environmental scientists and academics to drive global action on climate change and share best practice."

ABOUT THE EU CODE OF CONDUCT:

The European Union Code of Conduct on Data Centers is a European wide voluntary initiative aiming to develop energy efficiency performance standards

for data centers. Participants will commit to implementing a subset of expected best practice, to meeting minimum procurement standards and to annually reporting energy consumption. The Code of Conduct will be continuously developed and updated in consultation with stakeholders to follow technological development.

America's Data Centers Consuming and Wasting Growing Amounts of Energy

Environmental Issues > Energy Main Page > All Energy Documents

Critical Action Needed to Save Money and Cut Pollution

Data centers are the backbone of the modern economy -- from the server rooms that power small- to medium-sized organizations to the enterprise data centers that support American corporations and the server farms that run cloud computing services hosted by Amazon, Facebook, Google, and others. However, the explosion of digital content, big data, e-commerce, and Internet traffic is also making data centers one of the fastest-growing consumers of electricity in developed countries, and one of the key drivers in the construction of new power plants.

In 2013, U.S. data centers consumed an estimated 91 billion kilowatt-hours of electricity, equivalent to the annual output of 34 large (500-megawatt) coal-fired power plants. Data center electricity consumption is projected to increase to roughly 140 billion kilowatt-hours annually by 2020, the equivalent annual output of 50 power plants, costing American businesses $13 billion annually in electricity bills and emitting nearly 100 million metric tons of carbon pollution per year.

While most media and public attention focuses on the largest data centers that power so-called cloud computing operations -- companies that provide web-based and Internet services to consumers and businesses -- these hyper-scale cloud computing data centers represent only a small fraction of data center energy consumption in the United States. The vast majority of data center energy is consumed in small, medium, and large corporate data centers as well as in the multi-tenant data centers to which a growing number of companies outsource their data center needs.

These data centers have generally made much less progress than their hyper-scale cloud counterparts due to persistent issues and market barriers, such as lack of metrics and transparency, and also misalignment of incentives.

DC(a) Data Center Energy Use and Reuse (cont)

Recommendations

While many tactical actions can improve data center efficiency, we recommend systemic measures to create the conditions for best-practice efficiency behaviors across the data center industry, including:

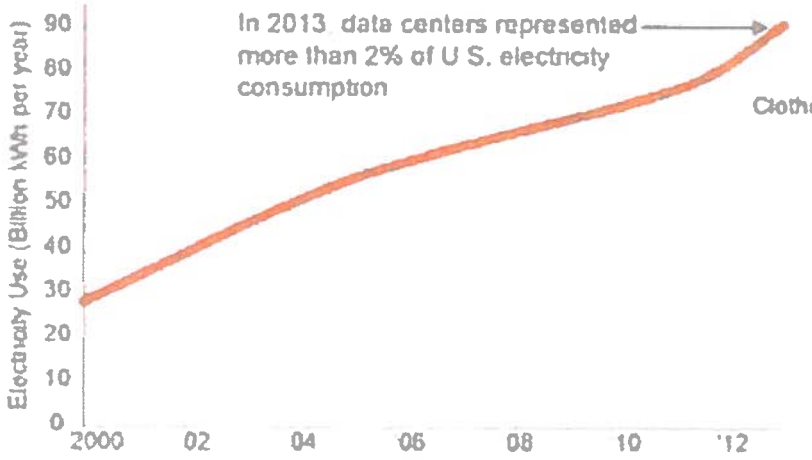
- **Adoption of a simple server utilization metric.** The data center industry should adopt a simple metric, such as the average utilization of the server central processing unit(s) (CPU), to help resolve one of the biggest efficiency issues in data centers: underutilization of servers. Measuring and reporting CPU utilization is a simple, affordable, and adequate way of gauging data center efficiency that could be used immediately to drive greater IT energy savings in data centers.
- **Alignment of incentives between decision-makers.** Data center operators, service providers, and multi-tenant customers should review their internal organizational structure and external contractual arrangements and ensure that incentives are aligned to provide financial rewards for efficiency best practices. Multi-tenant data center stakeholders should develop a "green lease" contract template to make it easier for all customers to establish contracts that incentivize rather than stand in the way of energy savings.
- **Disclosure of data center energy and carbon performance.** Public disclosure is a powerful mechanism for demonstrating leadership and driving behavior change across an entire sector. In their corporate and social responsibility reports, industry leaders in data center efficiency should voluntarily disclose operational performance metrics (such as fleet-wide server utilization levels) and organizational performance (e.g., how they address split incentive issues internally and externally).

If just half of the technical savings potential for data center efficiency that we identify in this paper were realized (to take into account the market barriers discussed), electricity consumption in U.S. data centers could be cut by as much as 40 percent. In 2014, this represents a **savings of 39 billion kilowatt-hours annually** -- equivalent to the annual electricity consumption of nearly all the households in the state of Michigan. **Such improvement would save U.S. businesses $3.8 billion a year.**

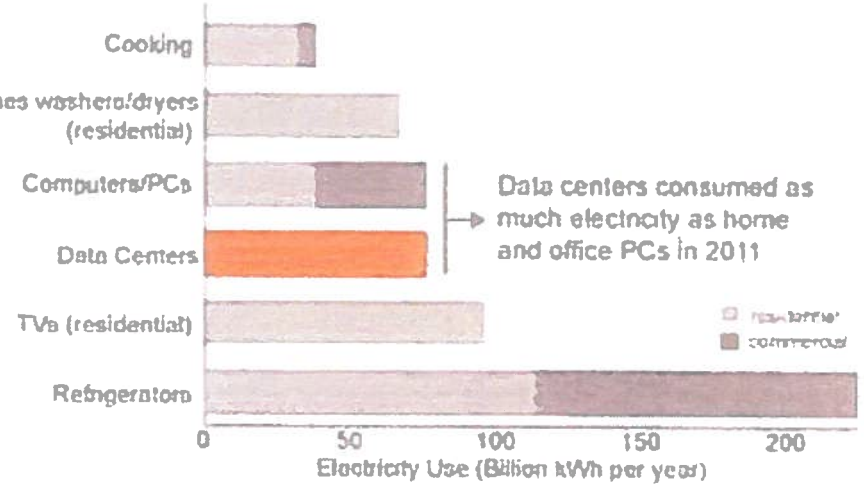
last revised 2/6/2015

DC(b) Data Center Energy Use and Reuse

U.S. Data Center Electricity Use, 2000 to 2013



Comparison of U.S. Residential and Commercial Electricity Uses by Type, 2011



While U S electricity use has flattened in recent years, data center electricity use - overall and as a portion of U S consumption - has tripled since 2000 As cloud computing replaces personal computing, data center electricity use has been rising while personal and work computer use has been dropping

Data Center Electricity Sources 2000 and 2005 Koomey (http://www.analyticspress.com/datacenters.html), 2011 and 2013 are NRDC estimates based on Koomey (http://www.nrdc.org/energy/files/data-center-efficiency-assessment-IP.pdf) Other Electricity Consumption Sources EIA Annual Energy Outlook 2014 tables A4 and A5 (http://www.eia.gov/forecasts/aeo/index.cfm)

DC(c) Data Center Energy Use and Reuse

THE CERES ROADMAP FOR SUSTAINABILITY

A strategic vision and practical framework for sustainable corporations in the 21st century economy

Performance: Operations

- **With sixty percent of the sector falling in Tier 4 for the Ceres Roadmap's expectations on GHG emission reductions, there is much room for improvement, particularly to mitigate the impacts of energy-intensive data center operations.**

The most significant opportunity for GHG emission reductions for Software & Services companies is in the large data centers that power cloud computing and the Internet. These centers, at times spanning acres, have extraordinary heating and cooling needs because the equipment must be maintained in a carefully controlled environment. While most of the software companies in this sector have one or two data centers, colocation company Equinix has more than 100.

Overall, only nine companies (compared to seven in 2012) perform within the Ceres Roadmap's Tier 1 or 2 expectations for reducing GHG emissions and sourcing renewable energy. Sixty percent (24 companies) fall into Tier 4. And while 63 percent (25 companies) have a program and/or goal to reduce GHG emissions, only 35 percent (14 companies) take the additional step of establishing a quantitative, time-bound target.

Adobe moved from Tier 3 to Tier 1 performance based on a strong commitment to reduce GHG reductions as part of its Net Zero plan for 2015. The company aims to achieve net zero emissions at its owned and controlled facilities (equivalent to 50 percent of operations), which would require a 75 percent reduction by 2015 from a 2000 baseline.

Microsoft, to meet a similar net zero emissions commitment, set an internal price on carbon for each business unit to incorporate into their planning cycles. This is a mechanism to drive accountability for carbon reductions within the business and incentivize teams to contribute to a central fund for renewable energy and offsets. Microsoft has publicly shared its methodology so other companies can implement a similar carbon-pricing model.

While efficiency gains play an important role in reducing emissions, the growth trajectory for data centers makes it critical for companies to turn to renewable energy alternatives. Only six companies in the Software & Services sector — **Accenture, Adobe, CA Technologies, Google, IBM,** and **Microsoft** — source more than 10 percent of their primary energy from renewables. Several companies have made commitments toward using 100 percent renewable power for their data centers, including **Apple, Facebook, Salesforce.com, Rackspace** and **Google**. Additional companies should follow suit and, ideally, set deadlines in order to establish greater accountability for these targets.

Google currently meets 33 percent of its electricity needs using renewable energy sources. In order to continue to expand access to renewable energy at its present and planned data centers, Google joined together with Facebook and Apple to persuade Duke Energy to offer additional renewable electricity purchasing in North Carolina through a program called the Green Source Rider, which was approved in 2013 as an offering for its largest customers.

DC(d) Data Center Energy Use and Reuse

Definitions

Some definitions may help the reader to better understand the remaining of this paper.

TCO

TCO stands for **total cost of ownership**. It is the sum, adjusted for the time value for money, of all of the costs that a customer incurs during the lifetime of a technology solution. Talking about an HPC data center, a common breakdown of those costs includes:

- Purchase of hardware, including cabling and switches
- Purchase of software licences
- Building work for new constructions or extensions, including power adaptation
- Air conditioning and cooling
- Electrical, including power distribution units, transformers, patch panels, UPSes, auto transfer switches, generators ...
- Installation of hardware, software, electrical and cooling
- Hardware, software, electrical and cooling maintenance
- Software upgrades and recurring (monthly, yearly) software licences
- Any additional form of lease
- Energy costs
- Disposal costs

PUE

PUE stands for **power usage effectiveness**. It measures how much of the electrical power entering a data center is effectively used for the IT load, which is the energy absorbed by the server and usefully used to compute. The definition of PUE in formula is as follows:

$$\mathrm{PUE} = \frac{\textit{Total Facility Energy Consumption}}{\textit{IT Equipment Energy Consumption}}$$

The perfect theoretical PUE is equal to 1, that means all of the energy entering the data center is used to feed IT equipment and nothing is wasted.

ERE

It stands for **energy reuse efficiency** and it is the ratio between the energy balance of the data center and the energy absorbed by the IT equipment. The data center energy balance is the total energy consumed by the data center minus the part of this energy that is reused outside the data center. A typical example is liquid cooling where water is used to cool the IT equipment, heating up and consequently moving some energy outside the data center

$$\mathrm{ERE} = \frac{\textit{Total Facility Energy Consumption} - \textit{Recovered Energy}}{\textit{IT Equipment Energy Consumption}}$$

The ERE can range between 0 and the PUE. As with PUE the lower the value, the better is for the data center. Practically speaking, ERE as a metric helps in those situations where the PUE is not enough to explain reuse. It mends situations where it was common habit to factor the energy recovery into the PUE, talking about a PUE lower than 1, which makes a mathematical non sense.

DC(e) Data Center Energy Use and Reuse

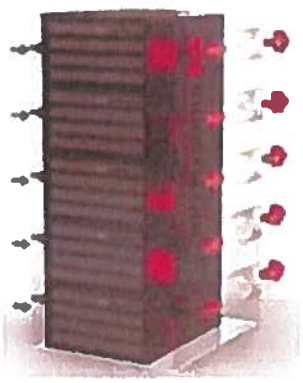
THE EU'S MANY DATA CENTER PROJECTS

Why does the European Union need six data center efficiency projects?

The European Union is a strange beast. Different departments cover similar areas, and within those departments, different nationalities and power groups jostle for power

Given that, it's hardly surprising that when the EU decided to investigate power conservation within data centers, it didn't set up just one initiative. It set up six.

The six projects - DOLFIN, GENiC, GEYSER, GreenDataNet, DC4Cities and RenewIT - are part of the Framework 7 Programme (FP7) set up by the outgoing European Commission, which left office in autumn 2014. In total, the Framework Programme has considerable resources - its a total budget is over €50 billion, an increase of 41 percent over the previous program, FP6.



Two earlier projects

But all these are predated by two original projects - All4Green and CoolEmAll – which kicked off the EU's efforts in this area. Both were started early in 2011, and finished early in 2014.

These two projects had straightforward aims. All4Green was set up to develop SLAs between data centers and the users they serve, the idea being that different forms of computing would have individual energy saving policies. CoolEmAll was established to work on tools that would help data center operators make more efficient use of their facilities.

Among the current crop of project, RenewIT (October 2013 to September 2016) sounds similar. Its goal is to develop a tool that can be used by data centers as a way of measuring energy efficiency. It shares many of the same partners, but those involved say RenewIT is not a continuation of CoolEmAll.

"These are distinct projects. CoolEmAll was about 30 months from October 2010 to March 2013, while RenewIT started in October 2013 for 36 months," says Philip Inglesant, EU analyst at The 451 Group, one of the partners in both CoolEmAll and RenewIT. "There are obvious overlaps between the two; but the focus is different. CoolEmAll was particularly looking at cooling techniques within the datacenter.

RenewIT is looking wider than that, at energy use as a whole, and not only within the datacenter but also at things like energy reuse for local heating."

What about the other five projects? They cover similar ground but, according to Fabrice Roubet, data center automation product manager with Eaton - one of the leading players in the GreenDataNet consortium, they all have clear goals and their own identity. "There is some overlap, of course," he says, "but the projects are all very different with their own particular areas to work in."

DC(e) Data Center Energy Use and Reuse (cont.)

Survival of the fittest?

"It is quite unique to have six different projects all covering the same area," says Andrew Donoghue, research manager for 451 Research, one of the partners in the RenewIT group. But this could be part of a plan to increase the chances of success. "By having multiple approaches to the same problem, the Commission is increasing the possibility of a successful outcome," he says.

The other projects tackle different elements of the data center. DOLFIN takes a holistic approach pulling together the management of virtual machines as well as the data centers themselves. The DOLFIN project aims to monitor and measure energy consumption and promote seamless migration of virtual machines between servers within the same data center.

This should allow loads to be consolidated and reduce the number of servers on standby, thereby cutting overall energy consumption.

There's an Irish flavour to GENiC, which reflects that country's long-established data center industry. The project is co-ordinated by the Cork Institute of Technology and other partners include University College Cork and United Technologies Research Centre Ireland.

GENiC (Globally optimised ENergy efficient data Centers) aims to allow a datacenter to operate more efficiently, by targetting cooling when and where it is needed. The partners want to develop a control and management platform for the energy producing/consuming components: computation, communication, and data storage, cooling, local power generation, energy storage, and waste heat recovery.

Data centers in smart cities

The other EU projects all relate to the Smart Cities concept. DC4Cities relates the energy used by the data center to the constraints of the city where it is located. It aims to make data centers adaptive, managing workload using improved hardware and software which can adapt so that power consumption will conform to the limits placed by the managers of Smart City projects.

To do this, DC4Cities will develop a new set of metrics to complement the usual data center ones like PUE, CUE and WUE. These new metrics such as Software Execution Energy Efficiency and Renewable Energy Utilisation Efficiency will allow data centers to be compared.

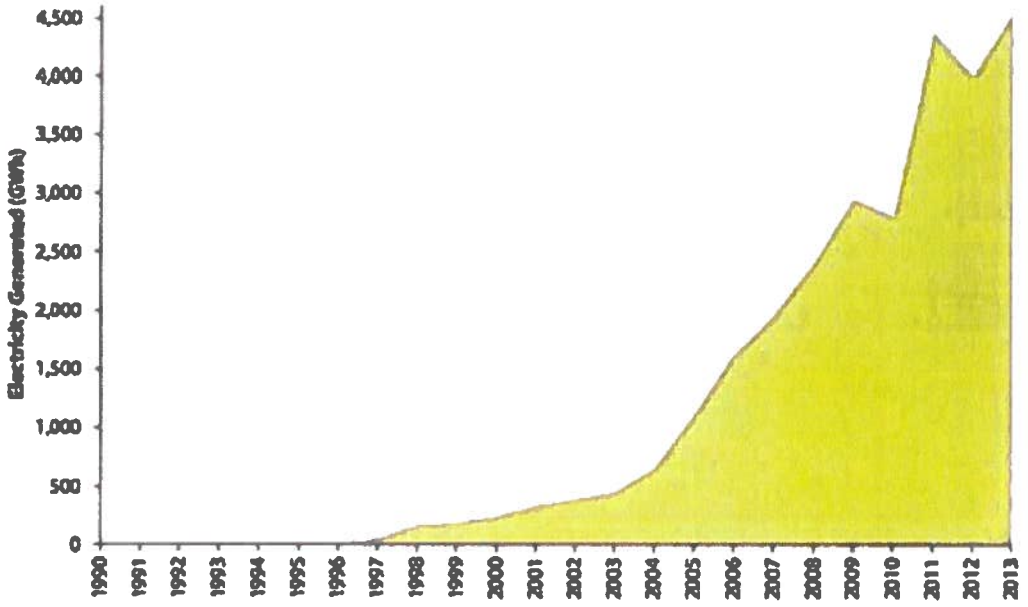
Geyser looks to combine management of the IT infrastructure with better management of power grids, particularly as the demands of each Smart City will be very different. The project aims to improve AC/DC working practise and to ensure that computing workloads are better matched with energy provision so Smart Cities and their supporting data centers work better together.

E1(a) Renewable Energy - Wind etc.

5.2.2 Wind Energy

Figure 11 and Table 5 show the electricity generated from wind and illustrate the rapid rise in electrical output since 1997 when the first of the wind farms supported by the Alternative Energy Requirement (AER) programme came on line. Total electrical output from wind in 2013 was 4,542[36] GWh representing an increase of 13.2% on 2012. Total electrical output from wind in 2012 was 4,010 GWh representing a fall of 8.4% on 2011 due to the wind resource being lower (less wind blew). Wind was responsible for 16.3% of gross electrical consumption in 2013 or 16.5% on a normalised basis. The peak recorded wind power output in 2013 was 1,564 MW, delivered on 20th November. At the time of writing the historic peak recorded wind power output[37] was 1,967 MW, delivered on Wednesday, 7th January 2015 at which point wind contributed 52% to the instantaneous system demand.

Figure 11 *Electricity Generated by Wind (GWh) 1990 - 2013*



Source: EirGrid

Table 5 *Renewable Electricity Production from Wind*

	1990	1995	2000	2005	2010	2011	2012	2013
Wind (GWh)	0	16	244	1,112	2,815	4,380	4,010	4,542

Source: EirGrid

E1(b) Non-Renewable Energy - Oil, Coal, Gas etc.

US firms plan Irish wind farm data centres

IWEA says other multinationals with operations here will follow Apple's lead
MARK PAUL
A lobby group for the wind energy sector expects "several" large US multinationals with operations here to announce major investments in windfarm-powered data centres in Ireland over the coming months, following Apple's recent announcement of an €850 million facility in Galway.

The Irish Wind Energy Association (IWEA), which holds its annual conference in Dublin on Wednesday, says it has had contact from a consultancy working on behalf of some of the multinationals, which is scouting locations.

When asked who are the multinationals planning wind-powered data farms, Kenneth Matthews, the chief executive of the IWEA said they are "the usual big name companies with major operations in Ireland".

He declined to provide further details.

Cool climate
Likely candidates would include Google, which already has data facilities in Ireland and is rumoured to be planning further such investment. It recently struck a deal in Holland to power a data centre there with wind energy.

Microsoft also has data facilities in Ireland, which is an advantageous location for such facilities as the climate here is cool, requiring less air conditioning of the the data farms, which expel significant heat from the servers.

The IWEA has also commissioned a report by international engineering consultants, Pöyry, that suggests the influx of data centres will boost electricity demand in Ireland by about 20 per cent by 2020.

Pöyry maintains that if the State allows the construction of enough windfarms to provide the electricity for these data centres, in addition to the capacity required for Ireland to meet its 2020 renewables targets, it could also reduce the cost of electricity for households.

The report concludes that Irish consumers' electricity bills could fall by up between €26 and €33 per household if enough investment in wind energy takes place by 2020.

Seismic change
The report maintains that, without new wind generation capacity, fossil fuel imports to provide the extra electricity will increase by 11 per cent.

"Seismic change is coming in terms of data centres and electricity demand," said Mr Matthews, who pointed to a report by Eirgrid that suggests at least 700MW of new data centres are planned in Ireland in coming years.

"These companies want to power their facilities with wind for reasons of corporate social responsibility and price. If we choose to add to our system by adding wind generated capacity, they want to buy it."

Mr Matthews pointed to a suggestion in the report that the extra investment in windfarms called for by the IWEA would "lower overall cost by €55 million across the system".

E1(b) Non-Renewable Energy - Oil, Coal, Gas etc. (cont.)

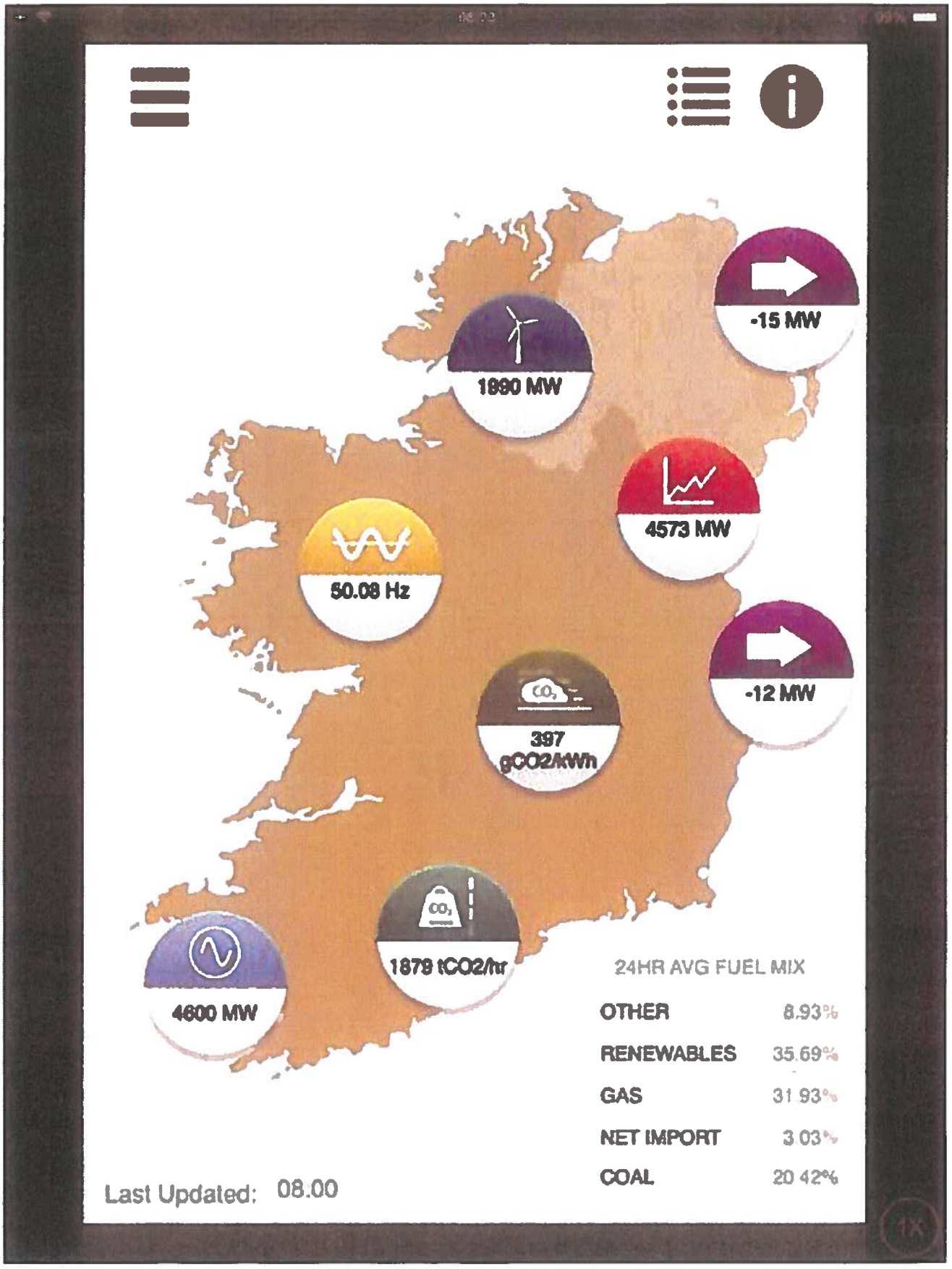
Opponents of large-scale development of windfarms regularly criticise their perceived impact on the environment and have also questioned their true economic impact, criticisms that the IWEA rejects.

Mr Matthews said there is sufficient capital washing around the sector to facilitate the development he says is required, and that the Government is also generally supportive.

"But some other things are needed," he said.

Mr Matthews criticised proposed increases in the commercial rates payable by windfarms, suggested by the Rates Valuation Office.

E2(a) Non-Renewable Energy - Oil, Coal, Gas etc.


-15 MW
1890 MW
4573 MW
50.08 Hz
-12 MW
397
gCO2/kWh
1879 tCO2/hr
4600 MW
24HR AVG FUEL MIX
OTHER 8.93%
RENEWABLES 35.69%
GAS 31.93%
NET IMPORT 3.03%
COAL 20.42%
Last Updated: 08.00

H1(b) Output of Waste Heat

"Waste Heat" a Potential Threat to the Climate

A new paper argues that cutting greenhouse gas emissions, switching to nuclear or geothermal power, and even sequestering carbon in the earth won't stave off massively disruptive climate change. Greenhouse gases are less a threat to stable climate than is the excess heat produced when fuel is burned to create energy, say Swedish researchers Bo Nordell and Bruno Gervet.

About half of the energy that humanity creates becomes waste heat. Depending on the method of energy creation or manner in which it's used, such as to raise the temperature of water, waste heat can be as high as 70% or 80%. In terms of electricity usage, even extremely efficient devices, appliances, and gadgets give off a lot of warmth in their operation. This is why your laptop needs a fan and why a car that's been turned off is still hot to the touch after it's been driven. But most of this excess thermal activity comes from energy generation itself: the burning of fuel to create electricity. It's commonly believed that this excess heat escapes into space, but that's only true at very high temperatures, Nordel and Gervet contend.

"In most cases," they write in the International Journal of Global Warming, "net heat emissions mean that low-temperature waste heat is dumped into sea water or the atmosphere or heat leakage from buildings is transferred to the surrounding air or ground."

According to this view, nuclear power, which doesn't create any carbon emissions, is still a contributor to global warming. One of the primary byproducts of nuclear fuel generation is hot water, since water is used to cool the nuclear reactor and heats up during the process. Much of that hot water is dumped into lakes and streams; the process could potentially raise the temperature both of these bodies of water and of the ground.

"All this energy dissipates into heat when consumed and must contribute to the heating of our planet," they write.

Nordell and Gervet's idea breaks from mainstream thinking on global warming. Most experts see extraterrestrial heat, namely from the sun, trapped inside the earth's atmosphere by greenhouse gases as the singular cause of rising temperatures. However, the two Swedish scientists aren't alone in their contention that heat itself, not just gas, could change the climate.

"The second law problem says that if you create and use energy you have to eject waste heat," says Dennis Bushnell, chief scientist at the NASA Langley research facility. He says that, as more humans create and use more energy, eventually the waste heat "will reach a level, that in order for the planet to reject it into space, the whole planet will have to warm up."

Only wind and solar power don't produce significant amounts of waste heat, Bushnell adds. Although photovoltaic systems use the sun's heat already being sent to earth, they're extremely inefficient: Only about 10%–20% of the heat that hits a photovoltaic panel is converted into energy. Even photovoltaic systems that have been improved through nanotechnology won't ever be more than 70% efficient due to thermodynamic barriers.

Bushnell's assessments are supported by Tufts University astrophysicist Eric J. Chaisson, whose July 2008 paper titled "Long-Term Global Heating From Energy Usage" concluded that waste heat — including waste heat from nuclear power generation — would continue to warm the earth even if humans were able to arrest the greenhouse effect. Because we're dependent on energy and the vast majority of human energy production also produces waste heat, human civilization will eventually reach a limit in terms of how much it can grow without destroying itself.

"It just came to me as a no-brainer," Chaisson said in a interview with the Boston Globe.

H1(c) Waste Heat Affects Climate in S ummer

An urban climate double whammy: more heat, less wind

A man protects himself from the sun with an umbrella during a hot day in Sao Paulo January 19, 2015. REUTERS/Nacho Doce

It is hardly news that in a warming world, there is a greater risk of increased hot temperatures, including truly extreme heat days that push the boundaries of what people are used to experiencing.

But according to new research, most major cities across the world are not only experiencing more days and nights with extreme heat; they're also seeing less overall strong wind. That's a potential double whammy, in that on extremely hot days, you need breeze to help cool the body down.

"If you're standing outside, and it's 110 degrees, and you're sweating, the heat that gets removed from your body is largely by evaporation. And that's proportional to the wind strength," explains geographer Dennis Lettenmaier of the University of California, Los Angeles, one of the study's co-authors.

H1(c) Waste Heat Affects Climate in S

The new paper, just out in Environmental Research Letters, examined the changing climates of fully 217 large urban areas between 1973 and 2012, ranging in size from a

ummer (cont.)

population of 250,000 all the way up to true megacities featuring populations above 5 million. The work, which was led by Vimal Mishra of the Indian Institute of Technology in Gandhinagar, India, examined long range weather records for temperature, precipitation and wind. That's how the researchers homed in on these two major trends — which don't go well together.

For days with extreme temperatures — defined as a temperature exceeding that of 99 percent of days for that particular location — the change was particularly strong at night. Forty-eight percent of the cities showed an increased trend toward more extreme hot days (vs. only 2 percent that saw a decrease). And 63 percent showed the same for hot nights.

Not surprisingly, this also translated into more heat waves, defined as at least aix days in a row in which every single day exceeded the 99th percentile. Heat waves can be deadly — particularly for the elderly. A 2013 summer heatwave in England, for instance, led to an estimated 650 deaths, according to an analysis performed at the London School of Hygiene and Tropical Medicine.

It's important to emphasize that not all of this trend is global warming related. Part of it is due to the nature of urban areas themselves, which trap heat due to the higher concentrations of surfaces like pavement. These tend to be darker in color, and thus have a lower albedo (or reflectivity), meaning that they bounce away less sunlight than surfaces that are lighter in color — pooling more heat in urban areas.

"We have an overall warming trend, but the central focus of this study is to try to understand the relative contributions in cities of the general warming, and the exacerbation of the cities themselves as heat islands, and it's clear you've kind of got both in there," said UCLA's Dennis Lettenmaier.

And then there was the trend in wind. Fully 75 percent of the urban areas saw declines in extreme windy days — while only 10 percent saw an increase. This does not seem to be a change driven by global warming, but rather, by the urban environment which, of course, features numerous very large structures that block the flow of air. "My hypothesis is that it's increased drag, because of the cities," said Lettenmaier.

H1(c) Waste Heat Affects Climate in S

Lettenmaier also thinks that the decrease in wind may explain part of the trends in heat — especially at night. In other words, the two may be interconnected.

The work is particularly crucial because in today's world, humanity is stampeding into

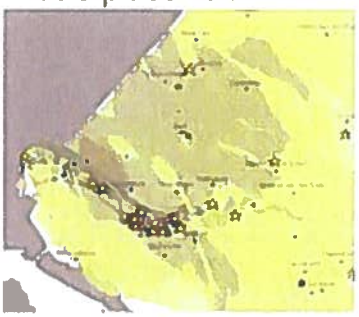
ummer (cont.)

urban areas, which now contain more than half of our global population of 7.2 billion and growing. By 2050, it's projected that 70 percent of humanity's masses will live in cities.

H1(f) Heat Mapping - Heat Potential v Heat Demand

Heat mapping

Heat potential



Heat demand

Possibilities and usage

Heat potential

•Waste heat of all large industrial and power plants (one point per plant)

- with indication of temperature
  - <120 °C
  - 120 200 °C
  - >200 °C with indication of
- amount of heat
  - <50 TJ
  - 50 500 TJ
  - >500 TJ

•Potential Geothermal heat

•Potential Biogas

Heat demand

•Heat usage Industry with

- indication of temperature
  - <120 °C
  - 120-200 °C
  - >200 °C with indication of
- amount of heat
  - <50 TJ
  - 50-500 TJ
  - >500 TJ

•Heat usage Residential area's

- Including number of houses
- Including number of habitants
- Including construction year, m² floor area and addresses of individual houses

•Heat usage Greenhouses

•Heat usage Buildings

H1(f) Heat Mapping - Heat Potential v Heat Demand (cont.)

Heat mapping, data collection and associated legislation

- E-PRTR and European directive on industrial emissions.
  - Definition "emission" and "pollutant" include emission of heat to water
  - and air *But* no emission limit value is given for waste heat.
- Arhus convention
- European Energy Efficiency Directive art 14: new installations with waste heat look for useful applications> maps of heat usage are given from industry, utility, residential area and greenhouses
- ETS Emission Trading System (use of waste heat has a value)
- Member State target on renewable energy in 2020 (subsidies of renewable gives competition with industrial waste heat); > potential maps of biogas, geothermal heat, heat storage, waste heat from
- European Inspire Directive; EU initiative to establish an infrastructure for spatial information in Europe that will help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development. • NL National Open source policy

Reality: Financial and policy discrepancy renewables and waste heat

- Exchange of steam already occurs because no discrepancies exist.
- Renewable heat and waste heat have the same heat consumers (greenhouses and residential area's)
  - Greenhouses:
    - »with the existing CO2-price, often renewable heat has a competitive advantage compare to industrial waste heat.
  - Residential area:
    - »present gas pipes are not yet depreciated.
    - »consumers often not appreciate the dependency to a district heating.
    - »consumers prefer renewable heat
- Member State targets of renewable energy
  - »the use of fossil waste heat has no impact; not on the renewable energy and not on the final energy use.

H1(f) Heat Mapping - Heat Potential v Heat Demand (cont.)

With the cooperation of :

- Ministry of Economic Affairs
- Ministry of Infrastructure and Environment
- IPO Inter Provinciaal Overleg (provinces)
- Province of Zuid-Holland
- RIVM
- Tennet
- CBS
- DCMR
- TNO
- If-technologie

Items for discusion

. Include a emission limit value in the European directive on industrial emissions to increase waste heat monitoring data.

. Competition between CO2 emission reduction by using fossil waste heat and geothermal "heat mining". Isn't it more sustainable to use waste heat first?

H2(a) Additional Disruption of North Atlantic Jet Stream

Scientists find waste heat affects climate in winter

Cirrus clouds linger perpendicular to the jet stream over Canada. (Photo by NASA's Goddard Space Flight Center.)
In a recent study, climate scientists learned that the amount of waste heat large global cities produce influences regional climates. Now, scientists are using the study to explain how the planet is warming.

As cities around the world burn energy to keep the lights on and heaters running, waste heat is released into the atmosphere and picked up by powerful jet streams.

A recent study by climate scientists looks at how waste heat and unpredictable jet streams are interacting and contributing to global warming.

Veerabhadran Ramanathan, professor of atmospheric and climate sciences at the Scripps Institution of Oceanography, says heat from car engines, homes and factories ends up in the air as waste heat.

"During wintertime, we have this so-called jet stream, fast winds blowing around the planet," he said. "This wind is able to carry the heat we dump over cities like New York, Chicago, Tokyo, Beijing, Shanghai — and blows this heat, within a few weeks, around the planet. That's why what we think is a local phenomenon can become a regional and global phenomenon."

The jet stream is dominant during the winter and as the waste heat moves, the heat changes temperature patterns, affecting the climate and even the weather.

"In the wintertime, we are under the firm grip of the jet stream in terms of when it snows, when you have high-pressure and warm climate," he said. "Since it's changing the jet stream its effect is particularly strong and visible during wintertime."

Ramanathan said waste heat particularly affects the northern latitudes, the United States, particularly the northeast, as well as Canada, Europe and northern Asia. The study, "Energy Consumption and Unexplained Winter Warming over Northern Asia and North America," shows that in these regions, there's an abnormal warming during the winter. Ramanathan said waste heat is the likely cause of warming across the entire continent.
"What this study is showing is that this waste heat might have moved the jet stream a little bit southwards. When the jet stream moves south is when you get huge cold spells in areas like Florida, Texas," he said.

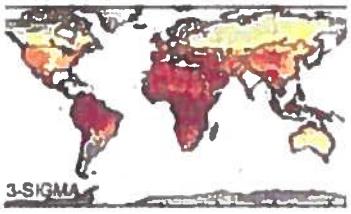
There are other sources contributing to the unpredictable movement of the jet stream, Ramanathan said, but the addition of waste heat adds to the jet stream's movement.
"The warming you see in these regions during spring and summer and fall is still largely due to global warming," he said. "The good news is that our models are able to explain very closely how our planet has been warming. The bad news is, it confirms that our models may be right after all, and that global warming is as large as they think it is."

Hosted by Steve Curwood, "Living on Earth" is an award-winning environmental news program that delves into the leading issues affecting the world we inhabit. More "Living on
Earth."

H2(b) Additional Disruption of North Atlantic Jet Stream

Multifold increase in heat extremes by 2040

08/15/2013 - Extremes such as the severe heat wave last year in the US or the one 2010 in Russia are likely to be seen much more often in the near future. A few decades ago, they were practically absent. Today, due to man-made climate change monthly heat extremes in summer are already observed on 5 percent of the land area. This is projected to double by 2020 and quadruple by 2040, according to a study by scientists of the Potsdam Institute for Climate Impact Research (PIK) and the Universidad Complutense de Madrid (UCM). A further increase of heat extremes in the second half of our century could be stopped if global greenhouse-gas emissions would be reduced substantially.



Heat extremes at the end of our century might cover large parts of the global land area - more detailed information can be found in figure 3 of the study. Graph: PIK

"In many regions, the coldest summer months by the end of the century will be hotter than the hottest experienced today – that's what our calculations show for a scenario of unabated climate change," says Dim Coumou of PIK. "We would enter a new climatic regime." The scientists focus on heat waves that exceed the usual natural variability of summer month temperatures in a given region by a large margin, namely so called 3-sigma events. These are periods of several weeks that are three standard deviations warmer than the normal local climate – often resulting in harvest losses, forest fires, and additional deaths in heat-struck cities.

Information for developing short-term adaptation measures

Such heat extremes might cover 85 percent of the global land area in summer by 2100, if CO_2 continues to be emitted as it is today, the study shows. In addition to this, even hotter extremes that are virtually nonexistent today would affect 60 percent of the global land area.

While climate change mitigation could prevent this, the projected increase up to mid-century is expected to happen regardless of the emissions scenario. "There're already so much greenhouse-gases in the atmosphere today that the near-term increase of heat extremes seems to be almost inevitable," Coumou says. This is important information for developing adaptation measures in the affected sectors.

As the study defines a heat extreme based on the natural variability a region has experienced in the past, the absolute temperatures of this type of event will differ in different regions of the world. For instance the observed Russian heat wave brought an increase of the monthly average temperature by 7 degrees Celsius in Moscow and daily peak temperatures above 40 degrees. In tropical regions like e.g. Southern India or Brazil, natural variability is much smaller than in the moderate zones, hence 3-sigma events are not as large a deviation in absolute temperatures.

"In the tropics, even relatively small changes can have a big impact"

"In general, society and ecosystems have adapted to extremes experienced in the past and much less so to extremes outside the historic range," Alexander Robinson of UCM says. "So in the tropics, even relatively small changes can yield a big impact – and our data indicates that these changes, predicted by earlier research, in fact are already happening."

The scientists combined results of a comprehensive set of state-of-the-art climate models, the CMIP5 ensemble, thereby reducing the uncertainty associated with each individual model. "We show that these simulations capture the observed rise in

heat extremes over the past 50 years very well." Robinson points out. "This makes us confident that they're able to robustly indicate what is to be expected in future."

Article: Coumou, D., Robinson, A. (2013): Historic and future increase in the global land area affected by monthly heat extremes. Environmental Research Letters 8 034018. [doi:10.1088/1748-9326/8/3/034018]

H3(a)

Climate Change resulting in more frequent storms with strong winds, high seas and heavy rainfall.

Action on energy helps Ireland financially and saves us money

Published 02/06/2014
| 00:00

Open Gallery 1

SEAI's Chief executive, Brian Motherway

SUSTAINABLE Energy activity is benefiting Ireland by €1 billion per year as well as enhancing energy security, reducing emissions, and improving people's lives.

SEAI's Chief executive, Brian Motherway, pictured below, talks about how local communities are taking action to become masters of their own sustainable energy destiny while creating local jobs and saving money in the process.

Every time we use energy to heat our homes, run our cars, power our devices, not only is money leaving our own pockets, but it is leaving our country. We import nearly all the energy we use, and that means we are dependent on others, and our energy use makes their economies richer, not ours. What if we could keep that money in our local communities?

That's exactly what communities all over Ireland are doing right now – taking money that used to leave the country to buy oil and gas, and spending it instead on local jobs and technologies. They are upgrading homes and community buildings so that they waste less heat, they are updating equipment that costs much less to run, and they are making greater use of local, clean energy sources. All of this is saving them and Ireland as a whole, huge amounts of money.

It's not all about money. Making Ireland more energy independent is also part of the solution to our greatest environmental challenge – climate change. When we use less energy, and use cleaner energy, we make a dent on Ireland's emissions of harmful greenhouse gases, an investment in the lives of our children and grandchildren and the world they will inherit from us.

H3(a) Climate Change resulting in more frequent storms with strong winds, high seas and heavy rainfall. (cont.)

As the world increases its understanding of the science of climate change, the sense of how big the crisis is and how soon it will affect us , just grows. Our recent experience of severe storms reminds us of the devastating impact they can have, and our vulnerability to the weather. Are we ready to bequeath a world to the next generation where such events are more frequent and more severe? All of our discussions about energy - how we use it and where it comes from -- have to take place in the shadow of this great environmental threat.

Irish people are taking action. A quarter of a million homes have made use of our financial supports to upgrade their homes and reduce their bills, and we have also helped thousands of businesses do the same. Each time someone acts like this, they benefit and Ireland benefits. It means more local jobs and money staying within the local economy spent on upgrading buildings and services rather than paying for expensive imported fuels. In total, sustainable energy is keeping more than one billion euros in the Irish economy that would otherwise leave the country.

Ireland's great strength is in its local communities, and they are answering the call to take back control of our energy. You will read in these pages about local community organisations, business and public bodies working together to reduce everyone's bills. Whenever I visit these initiatives and meet the people driving these fantastic projects I am always struck by the local pride and spirit that makes them happen. When a community group manages to bring together a range of people to work together to save energy. When a local business decides to spend the money it saves on funding upgrades local sport clubs and community buildings. When a community hall that used be almost too cold to use is now warm and cosy all year round. These are the real stories of what Irish communities are achieving.

The local stories you will read about here are just a few examples of what is possible when local people are willing to take on the challenge and achieve lasting benefits for the community. It is a great privilege for me and my colleagues to be able to help these communities achieve these dreams. For any community looking to take up this baton, we in SEAI can provide advice and support, and often funding too. Contact us to find out more by email at communities@seai.ie.

We all have a choice about Ireland's future. We need energy to live our lives. Do we want it to be expensive and harmful to the environment? Do we want to be dependent on others for our needs? Led by local communities taking action for themselves we can create a new energy for Ireland.

New Ross Standard

Climate Change resulting in more frequent storms with strong winds, high seas and heavy rainfall.
H3(b)

Full text of climate change statement signed by 26 European mayors

If climate change is global, solutions are first and foremost local. Because large cities are at the crossroads of these two levels, they are at the forefront of the fight against climate change.

This is why, we, the European capitals and metropolises that represent more than 60 million inhabitants and have significant investment capacity (€2tn GDP), have decided to join forces and strengthen the instruments that will lead us toward the energy and environmental transition.

We are addressing the major causes of greenhouse gas emissions: polluting transport, old and/or poorly isolated buildings and energy supply.

In parallel, we are launching ambitious projects such as tackle urban sprawl, (re)introduce nature and biodiversity in our cities, improve recycling, fight against waste, move us towards a circular economy, prioritize public transport, increase electrical mobility, refurbish buildings and improve energy efficiency.

Job creation and the seeking of partnerships with rural neighbouring territories are a crucial challenge to succeed. During this meeting in Paris, on March, 26, 2015, we pledge to move further with our respective climate plans.

The second level of action is the European level. Time has now come for European capitals and metropolises to pool our efforts to tackle climate change. This requires a closer dialogue between cities through a more regular exchange of expertise and good practices.

The European diplomacy of cities, respectful of the diversity of territories and local cultures intends to gain rapid and sustainable momentum. Within the European Union, it must be better supported by the European parliament and commission and should benefit from direct European funding.

We must proceed even further by promoting the coordination of public investments on a voluntary basis. Together, European metropolises represent a very substantial public procurement market of about €10bn per year and this has a leverage effect on the private sector that very often aligns its own requirements with the public sector.

These investment expenditures should be concentrated on the "green" sectors of the economy and "low carbon" industries (modernisation of production tools and innovation) and services. This is the initiative we are launching tomorrow in Paris: we strive to coordinate our public procurements to bring about the emergence of a more ecological offer. The Europe of cities is going to take shape through this bold and collaborative approach.

Climate Change resulting in more frequent storms with strong winds, high seas and heavy rainfall.

H3(b) Climate Change resulting in more frequent storms with strong winds, high seas and heavy rainfall. (cont.)

Lastly, we must be more involved at the global level. The efforts we are making, the policies we are pursuing in our cities must contribute to the adoption of a global agreement on climate. We must build on our networks of cities and local governments involved in climate action to create new global governance.

Since the Earth Summit in Rio de Janeiro in 1992, 23 years ago, the United Nations has been trying to achieve an international consensus on the issue of climate change while its effects continue to worsen. Today, we have no alternative. The next climate summit in Paris in December 2015 must show that we are fully aware of what is at stake. European metropolises are already acting by proposing local solutions to tackle climate change.

Tomorrow, we will join other cities across the planet - in North and South America, in Africa, in Asia - which implement innovative local solutions. Together, thanks to the cities gathered in networks and in collaboration with citizens, NGOs, the scientific community, entrepreneurs and businesses we will make a difference.

Because cities are amongst the major contributors to climate change, it is our duty to find viable paths for our future. This is the full measure of the synergy between the mayors who are determined to share globally the solutions they have found locally.

Anne Hidalgo, mayor of Paris; **Michael Häupl**, mayor of Vienna ; **Yvan Mayeur**, mayor of Brussels; **Jordanka Fandakova**, mayor of Sofia; **Constantinos Yiorkadjis**, mayor of Nicosia; **Frank Jensen**, mayor of Copenhagen; **Jussi Pajunen**, mayor of Helsinki ; **Alain Juppé**, mayor of Bordeaux ; **Yiorgos Kaminis**, ayor of Athens ; **István Tarlós**, mayor of Budapest; **Christy Burke**, mayor of Dublin; **Giuliano Pisapia**, mayor of Milan; **Ignazio Marino**, mayor of Rome; **Artūras Zuokas**, mayor of Vilnius; **Antonio Costa**, mayor of Lisbon; **Sorin Oprescu**, mayor of Bucarest; **Boris Johnson**, mayor of London; **Zoran Janković**, mayor of Ljubljana; **Karin Wanngård**, mayor of Stockholm; **Sami Kanaan**, mayor of Geneva; **Ana María Botella Serrano**, mayor of Madrid; **Alexiei Dingli**, mayor of Valletta; **Dario Nardella**, mayor of Florence; **Edgar Savisaar**, mayor of Tallinn; **Gérard Collomb**, mayor of Lyon; **Roland Ries**, mayor of Strasbourg,

H3(c)

Storm repair costs hit profitability at ESB

MICHAEL MACSWEENEY/PROVISION
FIONA REDDAN, MARK PAUL
FIONA REDDAN A combination of storm repair costs, declining wholesale electricity prices and impairment costs in the UK hit profitability at energy supplier ESB in 2014.

Operating profits fell by €132 million in 2014, down to €552 million, while pretax profits slumped by 80 per cent to €82.6 million, according to its annual report.

ESB's chief executive, Pat O'Doherty said that "In the face of some challenges in 2014, these results reflect a solid performance across the group."

The hit to earnings is, however, unlikely to dissuade ESB's trade unions from pursuing a claim for a pay increase of 3.5 per cent annually for three years, backdated to last March.

ESB and its unions are currently awaiting a ruling from an internal industrial relations tribunal over the claim, which management has rejected. The company confirmed that the tribunal's ruling is non-binding.

Donal Flynn, group finance director, said it would "not be very helpful" to comment upon the pay claim. "But in general terms, we need to keep the cost base at a sustainable level," he said.

Storm Darwin
Revenues at ESB fell by 4 per cent to €3.3 billion last year. ESB said the hit on profitability was as a result of Storm Darwin repair costs of €25 million and a decline in wholesale electricity prices.

It also suffered impairment costs of €50 million in its generation and wholesale markets, primarily relating to a decline in wholesale electricity prices in the UK, and plant outage costs of €15 million at its Moneypoint power plant.

Mr Flynn said its performance is likely to improve in 2015, however, as it has recently boosted the availability of Moneypoint and suffered less storm damage of late.

The future consolidation of figures from its Northern Ireland business should also be boosted by the strength of sterling versus the euro.

ESB paid a dividend of €214 million to the exchequer in January 2015, completing the special dividend programme of €400 million agreed with the Government in 2012. This brings the total dividends paid during the past 10 years to almost €1.5 billion, ESB said.

Dividends
Mr Flynn said that ESB has committed to paying 40 per cent of its after-tax profits in dividends by 2017.

He also said the company "would like to do more" investment in wind energy, although he insisted it would take a "disciplined" approach to capital deployment.

Climate Change resulting in more frequent storms with strong winds, high seas and heavy rainfall.
RH(a) Horticulture, District Heating, PURPLE etc.

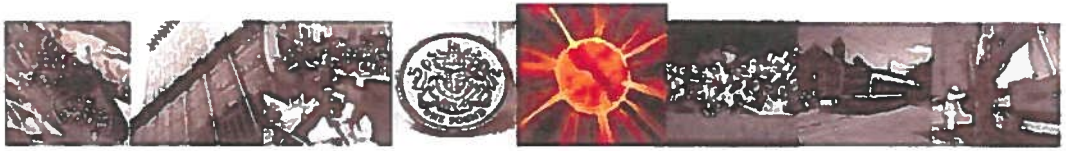
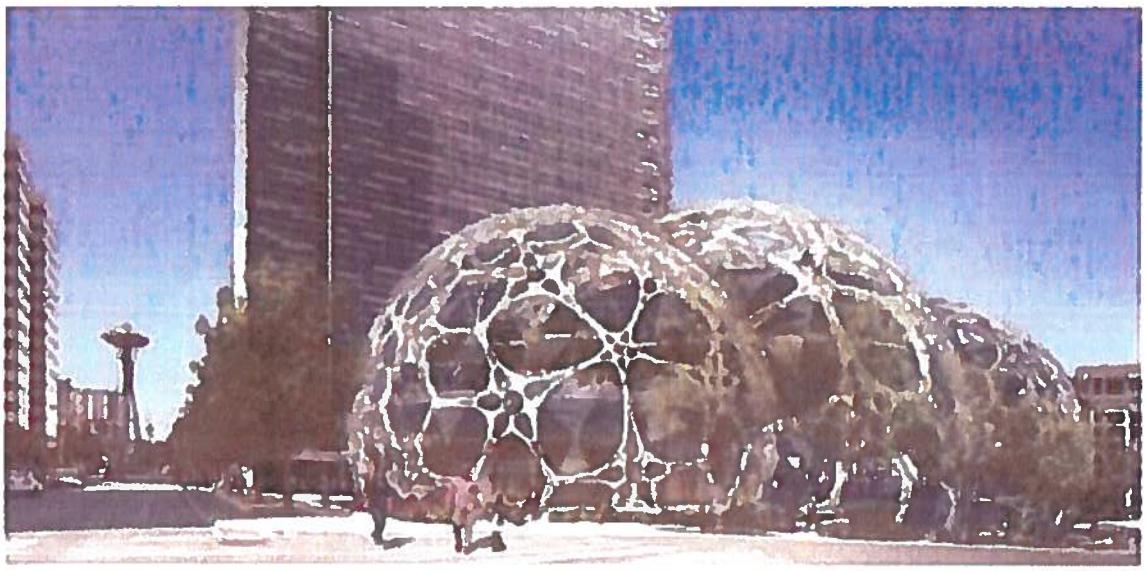


Table 5: Minimise the Use of Energy, Water and Resources

Sustainability Objective	Relevant Planning Policy	Commentary
Promote energy efficiency through design	**LOCAL PLAN POLICY GP7: Siting and Design** The Council will require development to: h) have regard to the need for energy conservation and efficiency in the design, orientation and layout of the site or buildings.	The overwhelming energy demand within the proposed development would be from the data centre buildings. Options studies are currently being undertaken by the design team to develop innovative building form solutions that would aid in achieving a 'best in class' energy performance taking full advantage of the local climate. This work is being supported by Carbon Trust. The layout and planning of the residential buildings will aim for at least the equivalent to Code for Sustainable Homes Level 4 and, perhaps, Level 5. The team is being supported by the Energy Savings Trust (EST) and the Building Research Establishment (BRE) in the development of construction options to achieve enhanced thermal insulation and airtightness. The data centre buildings would unavoidably be large energy consumers and a major contribution to energy efficiency would be made by the re-use of waste heat from these buildings by the residential and various commercial enterprises within the proposed development.
Utilise renewable energy sources	**STRUCTURE PLAN POLICY S21: Renewable Energy** Development proposals for renewable energy sources will be considered positively provided they do not have a significant adverse impact on: 1. the built and natural heritage; 2. areas and routes important for tourism or recreational use in the countryside; 3. water and fishing interests; 4. air quality; and 5. the amenity of the surrounding area. All proposals will be required to provide detailed information on associated infrastructure required, including roads and grid connections, impact during construction and operational phases of the development, including visual impact, noise and odour issues and provisions made for restoration of the site.	The siting of the data centre would take full advantage of the proximity of the Steven's Croft biomass power station (approximately 2.5km to the north-west of the site) and of nearby existing and proposed windfarms, including Newfield (approximately 1km to the north at its closest point) and Minsca (approximately 7km to the south-east). The importation of off-site and the development of on-site renewable energy (in the form of district heating) would lead to significantly reduced overall carbon emissions as the project develops. The use of small scale building integrated renewable energy systems would be reviewed on a regular basis to take make maximum advantage of evolving technologies and the buildings would be designed to be 'renewable enabled'. The available renewable energy options for the site are continuing to be assessed and would be finalised during the detailed design stage of the development. Rainwater harvesting has been proposed to provide water for irrigation of the allotments and greenhouses. The CIRIA W12 report 'Sustainable Water Management in Schools' (Ref. 18) states that rainwater harvesting can provide schools with educational, financial and environmental benefits. The proposed location of the primary school and other community facilities is in the low lying, relatively flat area to the south west corner of the site, where it is proposed to discharge the flows from the school roof and paved area to an educational wetland feature.

RH(b) Horticulture, District Heating, PURPLE etc.

How Amazon's new Seattle office buildings will recycle 'waste heat' from nearby data centers



A rendering of Amazon's new campus north of downtown Seattle. (Credit: NBBJ)

The biodomes Amazon is planning for its new Seattle campus aren't the only green aspects to the company's expansion in the area.

Amazon is moving ahead with a unique plan to use heat generated from data centers in the nearby Westin Building to warm some of its new buildings downtown. The system transfers the heat from the data centers via water piped underground to the Amazon buildings. The water is then returned to the Westin Building once it's cooled down to help cool the data centers.

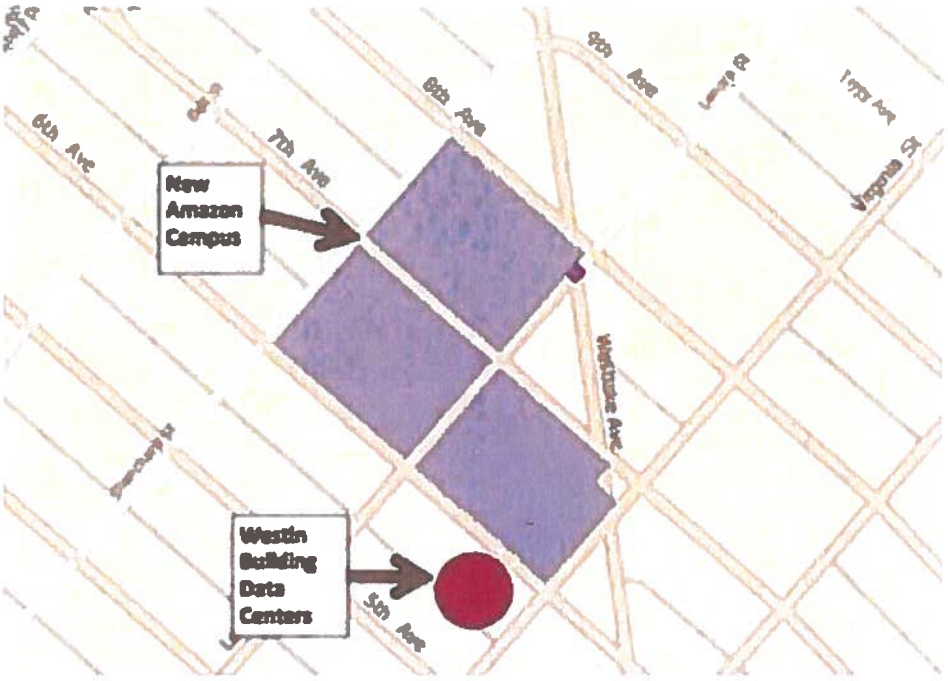
The setup will be unusual. "Certainly there are other people using waste heat from server farms but you don't hear a lot about tying it in with buildings across the street from each other," said Seattle City Councilmember Mike O'Brien.

Amazon hasn't been willing to talk about the plan but two resolutions, approved by the Seattle City Council on Monday, offer a few details and not only confirm the plan, but indicate it could be more ambitious than initially thought.

Eco District, an LLC formed by Clise Properties, which owns the Westin Building, and McKinstry, the construction and energy service company, are named in the resolution along with Acorn Development, Amazon's development arm.

For now, the plan is to use the system to heat buildings on the three-block Amazon campus going up north of downtown Seattle, starting with a building Amazon plans to occupy at the end of next year. The resolutions approve the idea of running the pipes under and across Virginia Street, between 5th Avenue and 6th Avenue; and 6th Avenue, between Virginia Street and Lenora Street. In addition, pipes will run under and across Lenora Street, between 6th and 7th Avenue; and 7th Avenue, between Lenora and Blanchard Street.

RH(b) Horticulture, District Heating, PURPLE etc. (cont.)



The resolution also opened the door to future expansion "in the area bounded by Virginia Street, Westlake Avenue, 6th Avenue, Bell Street, and 3rd Avenue." The two new buildings for which Amazon recently submitted proposals are in these boundaries.

"My understanding is the waste heat from this facility is significant enough to support more than just those three," O'Brien said. "I see this project as a first step toward what I hope to be a district wide energy system, that we can build off this as a catalyst."

I see this project as a first step toward what I hope to be a district wide energy system, that we can build off this as a catalyst.The city has identified a couple of other sources of wasted heat, including the data centers at Fisher Plaza and a sewer line running through South Lake Union, that it hopes building owners will tap into.
To encourage this kind of thinking, the city is offering credit to owners of new construction who build in so-called hydronic heat systems, O'Brien said. Such systems use hot water to heat buildings. Initially, a building can use on-site boilers to heat the water. But if pipes get built to bring hot water from a wasted heat source, like a data center, the building can be easily added to the system. Using water from otherwise wasted heat sources can require about a quarter of the energy required to boil water, he said.

The system is considered green because it reuses heat that's otherwise wasted rather than requiring the generation of new energy. In addition, such local heat systems are efficient compared to electric which loses energy as it's transferred from far-off power plants.

The Amazon setup riffs on the original way that many cities heated building, through a process called combined heat and power. Small electricity plants in cities generated excess heat and harnessed it, typically as steam, to heat nearby buildings.

O'Brien wasn't sure what kind of arrangement Amazon, Clise and McKinstry set up. "Right now, the Westin Building data centers have to pay money to cool their machines," he noted. They may get the cool water back in exchange for the hot water, which they currently also have to pay to offload.

Amazon has one more hurdle to pass. Following the approval of the resolutions today, it will have to do some engineering work to create a more formal proposal to the council. O'Brien said it would "likely" be approved.

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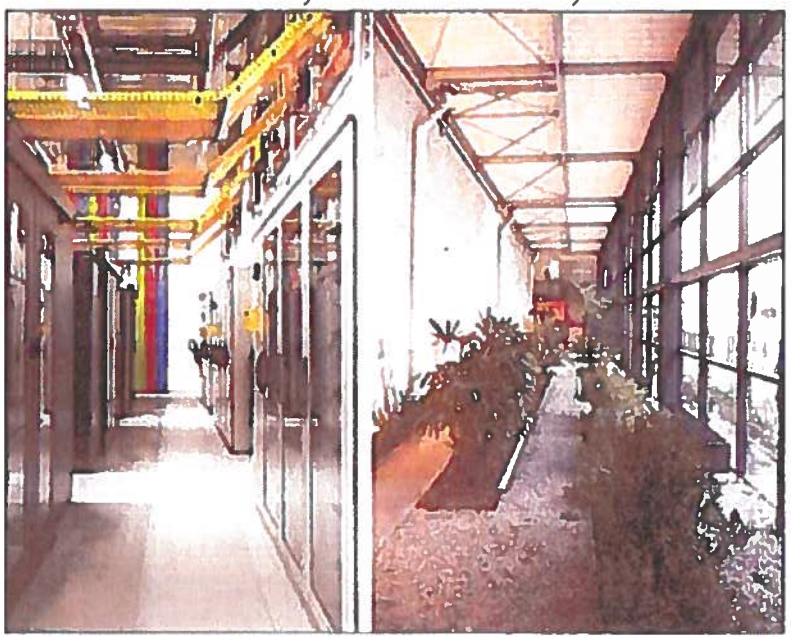
Data Centers Heat Offices, Greenhouses, Pools



Waste heat from servers at the new Telecity Paris data center (left) is being used to heat an on-site arboretum (right).

A growing number of data centers are redirecting the heat from their hot aisles to nearby homes, offices, greenhouses and even pools. The ability to re-use excess heat from servers is being built into new data centers, helping to improve the energy efficiency profile of these facilities.

The latest example comes from **Telecity**, which is using waste heat from its new Condorcet data center in Paris to heat an on-site Climate Change Arboretum, where scientisits will recreate the climatic conditions expected to prevail in France in 2050. Société Forestière and the French National Institute for Agricultural Research (INRA) will use the arboretum to grow and research plants from around the world with the aim of selecting those species most adaptable to changes in the prevailing climatic conditions.

Temperatures in most data center hot aisles range from 80 to 115 degrees Fahrenheit (27 to 46 degrees Celsius), still fairly low temperatures for some heat recovery strategies. But we're seeing more facilities finding ways to capture and reuse this heat. Here are some examples:

- Excess heat from servers at the new Telehouse West data center in the Docklands section of London will soon be used in nearby houses and businesses. The waste heat from the $180 million Telehouse colocation facility will be used in a district heat network, which

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is expected to produce up to nine megawatts of power for the local Dockland community. • An IBM data center in Switzerland is being used to heat a nearby swimming pool. Hot air generated by the Uitikon center will flow through heat exchangers to warm water that will be pumped into the nearby pool.

- Waste heat from a data center in Finland underneath Uspenski Cathedral will warm up water pipes and channel it to nearby homes fro heating. The planned data center for information technology services firm Academica would be capable of providing enough heat to warm up 500 large private houses.
- A data center built by IBM and Syracuse University uses gas-powered microturbines to generate on-site power. During the winter, the 585 degree F (307 C) exhaust from the microturbines flows through heat exchangers to produce hot water, which is then piped to a nearby office building to be reused in the building's heating system.
- The Notre Dame Center for Research Computing has placed a rack of high-performance computing (HPC) nodes at a local municipal greenhouse, the South Bend Greenhouse and Botanical Garden, to help heat the flowers and plants in the facility.
- Quebecor channels excess heat produced by servers at its data center in Winnipeg, Canada to the nearby offices of a local newspaper. The company ran a second duct out of the exhaust plenum to the intake duct of the editorial office upstairs. The process was controlled by pneumatic baffles that open and close depending on readings of thermometers within the ducts.

IBM's Elisabeth Stahl noted the benefits of using the data center as an energy producer in a recent Industry Perspectives column. "Through adopting this final level of the IT energy efficiency hierarchy, we can build a scalable, flexible, and green data center that is dynamic in its infrastructure," Stahl wrote. "Through this 'self-actualization' we can potentially save on energy costs; as a producer we might also even be able to make money as well."

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~~PURPLE TOPIC PAPER Number 1~~

Climate Change and peri-urban areas

Purple

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RH(d) Horticulture, District Heating, PURPLE etc. (cont.)

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RH(d) Horticulture, District Heating, PURPLE etc. (cont.)

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5. Some questions for policy makers

- Do we need an integrated energy/mitigation/adaptation strategy for each peri-urban area?
- Where should this be managed - at local, city, city-region, or regional level?
- Does this need financial investment from the public sector? Or can it be delivered solely by the private sector (water, energy, waste, transport, housing, landowners, etc)?
- Do we need territorial carbon markets to help bridge the gap between investment and return?
- Can we use the model of the Water Framework Directive, which aims for policy integration?
- Can this be done mainly through land use planning?
- How best can we retrofit areas which are already in some kind of 'urban sprawl'?
- Should EU Cohesion Funds be conditional on climate change policy criteria?

6. Next steps

The PURPLE network wishes to promote debate and facilitate the exchange of best practice on this topic.

We would like to hear from other regions, networks and organisations working on climate change strategies in a peri-urban context.

We have made a start by uploading relevant examples, projects, initiatives, and policy and research documents on to our website at:

http://www.purple-eu.org/publications

This paper has been produced by the PURPLE network which is working to raise awareness of peri-urban regions in the EU and the issues they are facing.

PURPLE Member Regions: Catalonia, Dublin, Flanders, Frankfurt Rhein-Main, Ile-de-France, Mazovia, MHAL (Maastricht/Heerlen, Hasselt, Aachen, and Liège), Nord-Pas-de-Calais, Randstad, Rhône-Alpes, South-East England, Stockholm, West Midlands and ZealandDenmark.

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Further PURPLE Topic Papers will be available shortly.

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DUBLIN REGION - CLIMATE CHANGE

Introduction

With respect to climate change in Ireland, the Dublin Region is first and foremost guided by the National Climate Change Strategy (NCCS) 2007-2013. The targets set out within this Strategy should be considered in the context of the EU's current climate change policy which was adopted in December 2008 and seeks:

- A 20% cut in emissions of greenhouse gases by 2020, compared with 1990 levels (possibly rising to 30%)
- A 20% increase in the share of renewables in the energy mix, and
- A reduction in energy consumption of 20% through an increase in energy efficiencies.

Market demands which are directing policy towards developing renewable energy potential, both from a sustainable socio-economic perspective and an environmental protection perspective, have resulted in a current 40% national target for renewable generation by 2020 in Ireland (up from 33% in the NCCS, 2007). Notwithstanding this, Ireland's National Climate Change Strategy (NCCS) 2007-2012 sets out its policy direction, and relative sectoral reduction rates envisaged, through projects such as Transport 21 (national transport infrastructure policy), biofuels obligation, greener homes initiatives, increasing carbon sequestration, diversion of biodegradable waste, renewable energy generation, and so forth. Upon adoption later this year, the NCCS's "National Adaptation Strategy" will provide the framework for the integration of adaptation issues into decision-making at the national and local levels of government.

Climate change in peri-urban regions

Building a local and regional strategy to address the challenges of climate change is a key requisite to ensuring buy-in at the individual level. Climate change adaptation is a moving target and has many uncertainties about impacts, the challenge, therefore, for peri-urban regions is to ensure cognisance of the varied impacts of climate change on the sustainable development and growth of the regions and to develop a co-ordinated response and approach to addressing these impacts at the level of the peri-urban region.

For example, local climate change scenarios and effects for specific geographical areas and sectors and associated adaptive measures to deal with both positive and negative effects will need to be developed over time and in line with best evidence. The existing and/or potential effects (both direct and indirect) are numerous and **will vary across regions.** These potential effects can appear contradictory and may include issues such as: increased flooding; drinking water shortages; an increase in invasive species; failed harvests; increased agricultural yields; weather related impact on mortality rates; in the longer term a greater need for air conditioning and higher insurance premiums, among others.

In the Dublin context, climate change mitigation and adaptation is an issue of central importance. The greatest concentration of population is based within the greater Dublin Region which is the economic driver of national economic prosperity[1].

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[1] The GDA contributes just under half of GVA output nationally and represents approximately 40% of the national population

National estimates therefore provide proxies heavily weighted towards the greater Dublin area's economic and social activity.

Climate Change and the Dublin Region

This is not to undermine the importance of acting locally and the role of community initiatives - " **thinking globally and acting locally.**"

Energy Action Plans at local level can play a significant role, for example, in bringing about a body of evidence and the data required to accurately measure per capita contribution to Green House Gas emissions at local and regional level. The Dublin Region currently has one such action plan developed for the Dublin City area and it is expected similar plans will follow for other municipalities within the Region. While action plans provide targets for carbon reduction and more sustainable living, **Energy Master Plans** will supply a logical next step in **spatial mapping** of regional energy consumption, heat loss and so forth. This will visually identify opportunities for energy savings.

In terms of peri-urban influence - carbon reduction, energy savings and more sustainable living is often reflected in terms of supply of fresh local produce and shorter travel distances to supply food to urban markets. These are noteworthy impacts, however, peri-urban areas (and policies) have a role to play not only in terms of the city-edge but also in terms of growing arms into the city physically and metaphysically both in terms of connecting with green and blue corridors and then also through inspiring garden allotments and self sustenance amongst urban

dwellers.

Next Step Actions:

The Dublin Region suggests the following actions (these suggestions are based on the climate change paper of the PURPLE Network):

1. Undertaking a spatial mapping exercise for the peri-urban regions of PURPLE utilising existing spatial data, such as, Corine data. This will prove valuable to the regions in terms of highlighting peri-urban areas as carbon sinks, as areas of importance in terms of water retention and flood absorption, as providers of local food supply, and so forth.

2. As local, regional and central governments continue to shift policy towards carbon budgets, the PURPLE network should pursue a policy of promoting locally managed carbon budgets. This will highlight the value of peri-urban areas in terms of opportunity for renewable energy and related entrepreneurial activity. It will furthermore give value to peri-urban areas in terms of linking carbon values to monetary units within localised carbon budgets.

3. PURPLES's peri-urban areas should be marketed and branded as areas of climate change resilience in two ways -

    a. Their adaptability in terms of extreme weather, e.g. absorption of flooding events, heat sinks, etc.
    b. As areas of sustainable urban practice with a capacity to contribute to sustainable socio-economic and environmental growth.

RH(e) Horticulture, District Heating, PURPLE etc. (cont.)

4. The PURPLE network should develop and tailor, through existing available research within respective member regions, a series of policy recommendations to outline a pathway to creating less carbon intensive peri-urban regions. This might include more sustainable farming practices, energy and water conservation, building codes, utilisation of renewable resources and technologies, etc. These policies should be customised but unified - customised to the needs of each region but unified in terms of overall policy direction.

RH(f) Horticulture, District Heating, PURPLE etc.

Purple
Peri-Urban Regions Platform - Europe

DUBLIN REGIONAL AUTHORITY
UDARAS REIGIONDA ATHA CLIATH

PERI-URBAN REGIONS PLATFORM EUROPE / DUBLIN REGIONAL AUTHORITY

CONFERENCE: ENABLING SUSTAINABLE COMMUNITIES – THE ROLE OF PERI-URBAN AREAS

Date: Tuesday 24th May, 2011
Venue: Finnstown House, Lucan, Co. Dublin

Context:
At the heart of sustainable communities is the idea that we, as communities, must live within our resources and aim to achieve more with less, which requires a change in the way we design, use, consume and dispose of products and services while maintaining our environment.

The Dublin Region's approach to 'Enabling Sustainable Communities' is two-pronged (1) we are developing, at the regional and local government levels, policies which provide the background to sustainable living and (2) we are engaging with local communities, schools and business to develop joint community/government action to achieve local progress and buy-in.

This conference will address this two-pronged approach and provide a European perspective.

PROGRAMME:

9.00am WELCOME ADDRESS
Councillor Peter Coyle, Cathaoirleach (Chair), Dublin Regional Authority

SESSION 1:

EUROPEAN PERSPECTIVE - BUILDING SUSTAINABLE COMMUNUTIES

9.10am **The challenges for Europe's peri-urban regions: lessons learned from the PLUREL project**
SPEAKER: Dr. Kjell Nilsson, University of Copenhagen and project leader of PLUREL

PLUREL - Peri-urban Land Use Relationships - Strategies and Sustainability Assessment Tools for Urban-Rural Linkages - was an EU funded research project which ended in December 2010. www.plurel.net

LOCAL POLICIES TO DRIVE SUSTAINABLE COMMUNITIES

9.30am Green Infrastructure
SPEAKER: Mr. Gerry Clabby, Heritage Officer, Fingal County Council

Green Infrastructure (GI) is a generic term encompassing the protection management and enhancement of urban peri-urban and rural environmental resources (natural and managed) through the identification and provision of multi-functional and interconnected green spaces The Green Infrastructure approach provides an opportunity to reassess the manner in which we plan, manage and use our many different types of green spaces.

9.55am Sustainable energy
SPEAKER: Mr. Eddie Conroy, County Architect, South Dublin County Council

South Dublin County Council has embraced the role of Local Authority as social focus and leader in energy and sustainable drive South Dublin County Council has been successful in it's bid to participate in the multi – city EU project 'LEAP' under the Intelligent Energy Europe Programme Team members have begun the process of calculating the carbon emissions base line for all sectors in the County. In the process of establishing Tallaght

Town Centre as a local sustainable community, South Dublin County Council is working with key local stakeholders, with a view to agreeing an approach to addressing the energy and climate change challenge at a local level. This includes investigating the feasibility of district heating in the town centre.

RH(f) Horticulture, District Heating, PURPLE etc. (cont.)

10.20am **Smart Travel**
SPEAKER: Mr. Paul Hogan, Senior Planner, South Dublin County Council

Adamstown Strategic Development Zone is a developing urban district situated 16km west of Dublin City Centre in the heart of Dublin's peri-urban area and on the Dublin to Cork rail corridor. South Dublin County Council in conjunction with the National Transport Authority developed a travel programme for Adamstown residents called Smarter Travel Adamstown. The pilot was supported by Dublin Bus and the Adamstown Developers. Smarter Travel Adamstown was launched in May 2009, on the same day as the inaugural Adamstown 8K Road Race which promotes a range of travel options for work, school, shopping, leisure and sporting activities

10.45am QUESTION AND ANSWERS

11.15am **Break**

SESSION 2:

LOCAL COMMUNITY INITIATIVE – CARBON/SOCIAL CREDIT SCHEME

11.45am **Carbon/Social Credit Scheme in the Dublin Region**
SPEAKER: Ms. Patricia Potter, Director, Dublin Regional Authority

People tend to see sustainable behaviour as inconvenient and expensive. Trying to limit the environmental impact of our day-to-day shopping, travelling and waste disposal requires thought, time and effort to change existing habits. Government and campaigners, service providers and industry are all searching for ways to motivate people to behave more sustainably. One of the difficulties in bringing about change is that people are usually not rewarded for their efforts in any tangible way. The Carbon/Social Credit Scheme (2CS) is a Dublin based initiative with the aim of providing the mechanism for citizens/communities to participate in sustainable behaviour and to be rewarded for these actions.

12.10pm **Local Engagement – Community Credit Scheme**
SPEAKER: Ms. Mary Keegan, Fettercairn Community Centre

Fettercairn Community Centre is in the process of developing a community garden on the community centre's grounds in association with South Dublin County Council. The local residents have identified a number of projects in their working plan to develop the area. South Dublin County Council and Veolia are also liaising with the community centre with a view to developing the surrounding lands.

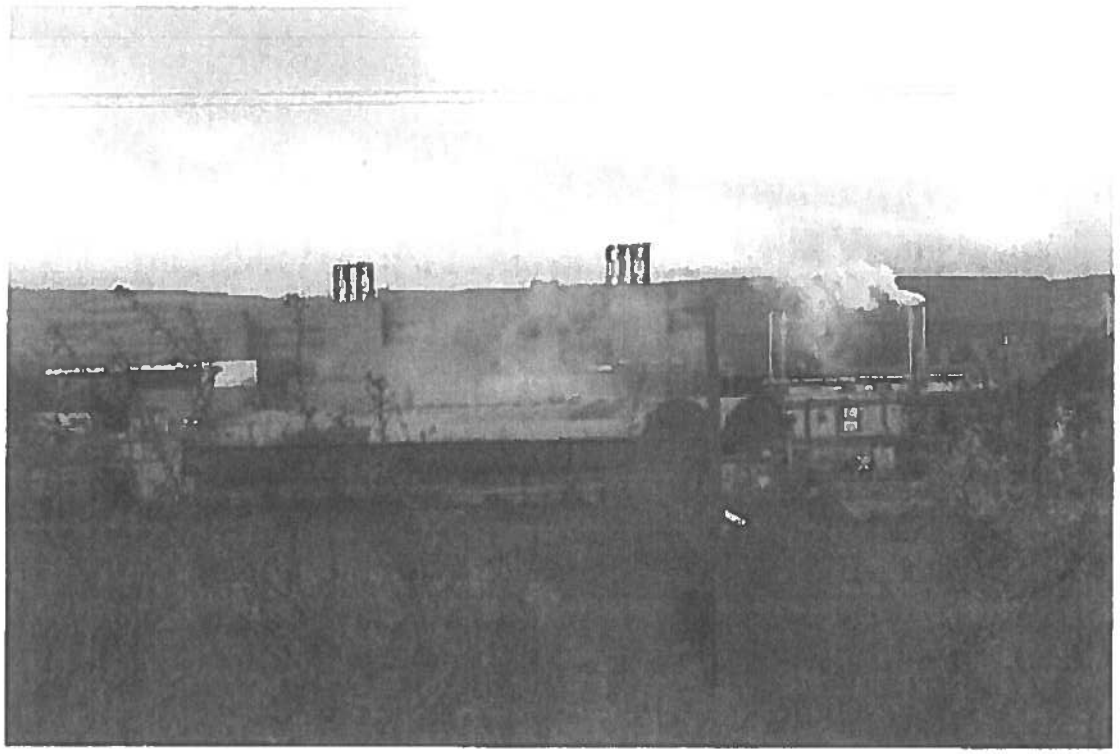
12.30pm **Local Engagement - Schools Gardening Initiative**
SPEAKER: Mr. Tom Moriarity, School Principal, Educate Together, Adamstown

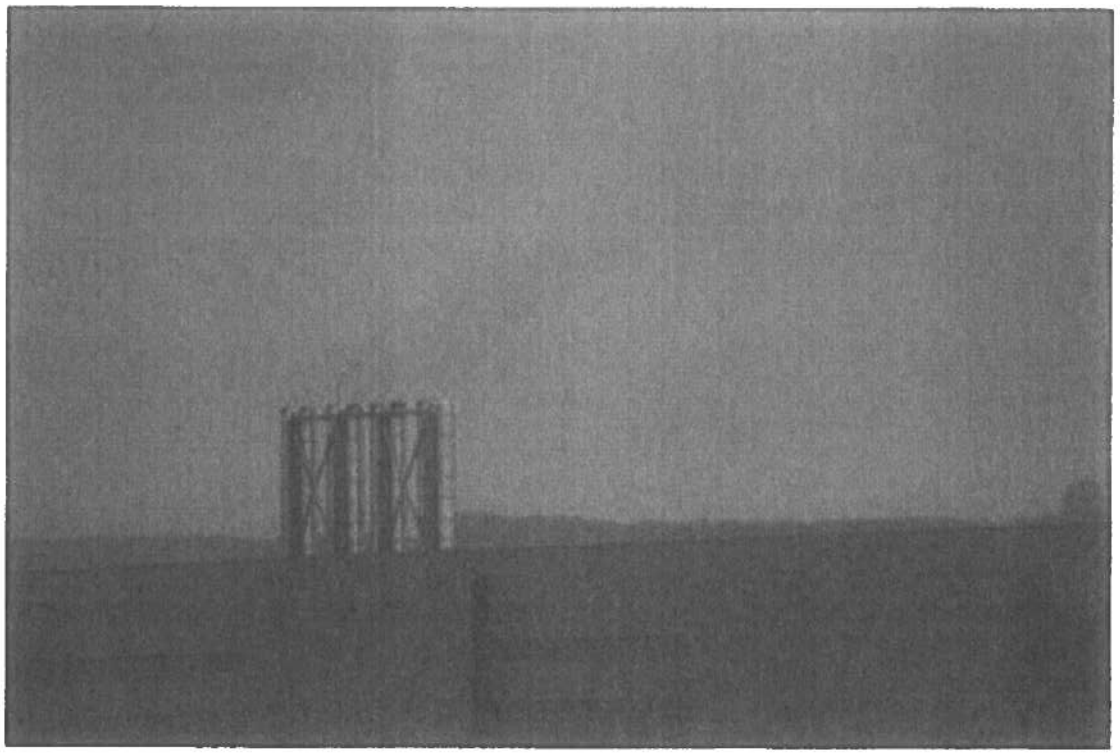
Adamstown Castle Educate Together National School (1st level) is working with four other national schools and South Dublin County Council in the Lucan area to create, develop and maintain a school garden which will be maintained and tended by the schools' pupils and parents. A balanced approach to nutrition is the key to good health and studies suggest that gardening not only results in improved physical and mental well-being but also raises awareness of healthy eating and appreciation for nature. This initiative proposes to measure the perceived differences in attitude to diet and health amongst pupil's pre and post participation.

12.50pm **Question & Answers**

1.30pm **Close**

P1(a) Air Dispersion Emissions





P2(a) Potential Acute Health Impacts

Focus on Diesel Exhaust Health Risks

DEPARTMENT OF ECOLOGY
State of Washington

Air Quality Program — February 2011

Diesel-powered Backup Generators for Data Centers in Grant County

Data centers house the servers that provide e-mail, manage instant messages, and run applications for our computers. In 2006, data center companies started to become interested in Grant County as a good place to build. Grant County has a low-cost, dependable power supply. Also, in 2010, the Washington State Legislature approved a temporary sales tax exemption for data centers building in Grant County and other rural areas. To qualify for the tax exemption, the data center must have at least 20,000 square feet dedicated to servers and start construction before July 1, 2011.

To build or expand, a data center company must first apply to the Washington Department of Ecology (Ecology) for a permit called a "notice of construction approval order" (NOC). Its purpose is to protect air quality. The NOC is needed because data centers use large, diesel-powered backup generators to supply electricity to the servers during power failures. Diesel exhaust contains toxic air pollutants. As part of the permit review process, Ecology carefully evaluates whether the diesel exhaust from a data center's backup generators cause health problems.

Health effects of diesel engine exhaust

The toxic air pollutants in diesel engine exhaust include nitrogen dioxide, carbon monoxide, organic compounds and tiny particles called diesel engine exhaust particles. Ecology evaluates the levels of all these pollutants during the permit review process. The ones most likely to be produced in high enough amounts to potentially affect health are diesel exhaust particles and nitrogen dioxide (NO_2). The possible health issues caused by these pollutants are discussed in this document.

When Ecology staff review the permit application for a data center, they look very carefully at how much the project will add to the air pollutants in the area. Ecology cannot approve a permit that allows pollutants to be emitted often enough or in high enough levels to cause health problems.

Diesel exhaust particles

The tiny particles in diesel exhaust are too small for our noses and upper respiratory systems to filter from the air we breathe. The particles go deep into our lungs, where they can cause damage and chemical changes. Studies show that certain levels of these particles can cause immediate health problems, including inflamed and irritated lungs and breathing passages, which may lead to coughing, chest tightness, wheezing, and difficulty breathing in some people.

Publication Number: 11-02-005 1

WHY IT MATTERS

Data centers need an Ecology permit to install diesel-powered generators that emit diesel exhaust.

Diesel engine exhaust is a toxic air pollutant that, at high enough levels, can cause health problems. As part of the permit process, Ecology reviews emissions of diesel engine exhaust and other air pollutants to see if they are a health concern.

This focus sheet gives information about the health effects of diesel exhaust, and how Ecology assesses health risk.

Contact information:
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Special accommodations:
If you need this publication in an alternate format, call the Air Quality Program at 360 407-6800. Persons with hearing loss, call 711 for Washington Relay

Service. Persons with a speech disability, call 877833-6341.

P2(a) Potential Acute Health Impacts (cont.)

The particles increase the chance of a person getting a lung infection, such as pneumonia or bronchitis, and they can cause more frequent and more severe asthma attacks in people who already have asthma. Among people who have allergies, the particles can cause allergic reactions to be worse than usual, and they can cause heart disease and stroke in people who already have heart disease. Other conditions that might occur because of the particles are male infertility, birth defects, and reduced lung growth in children. Even small amounts of particles, breathed over a long period of time, can cause lung cancer and other forms of cancer.

Nitrogen dioxide (NO_2)

Short exposures – 30 minutes to 24 hours – to NO_2 above a safe level can cause breathing problems for some people. In addition, NO_2 may make breathing harder for people who already have trouble with their lungs, such as people with asthma.

When NO_2 combines with other gases and sunlight, ground-level ozone forms. Health effects of groundlevel ozone are similar to those for diesel exhaust particles. They include inflamed and irritated lungs and breathing passages, which may lead to coughing, chest tightness, wheezing, and difficulty breathing. This reduced lung function may limit a person's ability to exercise. Ozone can also cause allergic reactions to be worse than usual. If a person is exposed to ground-level ozone day after day for a long time, the lungs can be permanently damaged.

NO_2 also hurts the environment. It contributes to acid rain and to smog.

How Ecology evaluates diesel engine exhaust

How the evaluation is done

1. Ecology's air quality experts rely on computer models to estimate where the wind will carry the pollutants in the exhaust from diesel-powered backup generators. They predict the amount of toxic air pollutants that could be in the air.
2. Ecology toxicologists review the information from the computer models. (Toxicologists specialize in understanding how pollution and chemicals affect people's health.)
3. The toxicologists then use risk assessment (see the heading "Risk assessment" below) to estimate possible health problems. They base these estimates on the predicted amounts of toxic air pollutants in the areas studied.

Risk assessment

Ecology toxicologists use risk assessment as a tool to estimate increased risk to human health. The purpose is to identify any potential health effects so we can prevent illness. Risk assessment is best used as a ruler to help us decide how we can best protect peoples' health. Risk assessment can't predict exact rates of a certain disease in an exposed community. However, it is a good tool for estimating potential risk and is based on current medical knowledge.

How the results are evaluated

The risk assessment divides health risk into two broad categories: cancer risk and non-cancer health risk. These two categories are evaluated differently. When Ecology staff assess diesel engine exhaust, they look at cancer risk from exposure to the particles in diesel exhaust.

P2(a) Potential Acute Health Impacts (cont.)

They also look at non-cancer health risk caused by breathing these particles over a long time and by breathing the nitrogen dioxide in diesel exhaust over shorter times.

Cancer risk

When assessing cancer risk, Ecology assumes that any exposure to a cancer-causing chemical results in some degree of risk. The highest acceptable risk that Washington State regulations allow from any one project is a rate of 10 additional cancers in one million people. The highest risk usually allowed by the U.S. Environmental Protection Agency (EPA) for cancer-causing chemicals is 100 additional cancers in one million people exposed.

Non-cancer health risk

For non-cancer health risks, toxicologists calculate a "hazard quotient." This is a mathematical way to estimate how harmful a chemical might be to human health over a given period of time. The hazard quotient is the comparison of the estimated concentration of a chemical to what toxicologists term a "reference concentration." The reference concentration of a chemical is the amount below which health problems are not likely to occur. A hazard quotient of more than 1 means that a chemical has the potential to cause health problems. It does not mean that the chemical will definitely cause health problems, but the higher the hazard quotient, the more likely there will be health effects.

For NO_2, the hazard quotient is based on the amount of NO_2 that would cause some – but not all – people with asthma to have trouble breathing. The risk assessment takes into account the size of the hazard quotient, the severity and likelihood of a health effect, and the likelihood of exposure to NO_2.

What does health risk really mean?

Health problems like cancer and asthma may be due to many factors in addition to pollution, such as lifestyle, age, and exposure to viruses. But this does not mean there is no risk at all, even if pollution levels are within acceptable limits. Because there are many uncertainties involved in risk assessments, Ecology's estimate of increased health risk is not exact. To account for uncertainty, we design our risk assessments to use cautious assumptions – we are careful not to under predict human health risk. Actual

health risks from diesel exhaust produced by any data center may be lower than our estimates, but we want to make sure we don't underestimate the risk when we make decisions based on health risk.

For more information, see Ecology's report, "Concerns about Adverse Health Effects of Diesel Engine Emissions" available online at http://www.ecy.wa.gov/pubs/0802032.pdf. Information about Washington data centers and air quality is available online at http://www.ecy.wa.gov/programs/air/quincydatacenter/.