EXECUTIVE SUMMARY

A Consultation Workshop with invited experts and stakeholders met on 5th February 2018 to discuss “research and innovation activities (2020-2030)” concerning Green ICT - specifically in relation to data centres and telecommunications networks.

The objective was to identify areas of research and innovation which justified intervention at European level (where national programmes were either non-viable or likely have diverging outcomes).

To provide some idea of scale of investment, trials of new technologies in data centres specifically constructed to assess their effectiveness are known to cost in excess of 300 million Euros.

Following a request for contributions in advance of the workshop, a series of “headline” topics were considered and discussed to determine their viability. These topics generally fall into the following categories:

- a) improvements in the design and operation of data centre facilities and infrastructures (power supply, power distribution and environmental control);
- b) improvements in the energy efficiency of the processing, storage and transport of data by ICT equipment;
- c) improvements in the energy efficiency of the software operating on the ICT equipment;
- d) improvements in the system-level capacity/resource management of the ICT equipment.

Before summarising the outcomes of the Consultation Workshop the following key points are made to allow greater understanding of the topics selected as relevant.

Point 1: Data centres exist in a wide range of sizes, levels of energy consumption and support a variety of business models.

Point 2: The majority of data centres are comparatively small in both size and energy consumption and tend to serve “enterprises”. These data centres may not have identified levels of energy consumption (being incorporated within the consumption of the enterprise they serve) and will generally be the least energy efficient. Equally importantly, many of the personnel constructing and operating such data centres will not benefit other enterprises from any lessons learned.

As a result, these data centres would benefit the most from all the actions a) to d) above but are likely to be least aware of the opportunities offered by the improvements.

Point 3: There is a trend for small and medium-sized enterprise data centres to migrate to both co-location facilities (point 4) and co-hosting or Cloud facilities (point 5).

Point 4: Co-location data centres are operated as profit-centres by their owners and provide space to accommodate third-party ICT equipment and represent one part of the migration from enterprise data centres. These data centres tend to feature increasingly energy-efficient facilities and infrastructures as a matter of commercial advantage. The market actors owning co-location data centres will generally operate an increasing number of such sites. The rate of change of design philosophies employed, which indeed focus on energy efficiency and management of other resources, is rapid with changes of approach being considered on a two- to three year cycle.

However, as the co-location owner has no control over the selection and operation of the third-party equipment, there is a limit as to what can be achieved.
Point 5: Co-hosting or Cloud data centres are operated as profit-centres by their owners and provide space and services to third-parties and represent the other part of the migration from enterprise data centres. As for co-location data centres, the market actors owning this type of data centre will generally operate an increasing number of such sites. These data centres have the same approach to facilities and infrastructures as co-location sites but can also benefit from the greatest range of improvements in terms of the design and operation of ICT equipment.

Point 6: Co-location and Cloud data centres are obviously the largest and most clearly identifiable users of energy but they are also those that actually consider the energy consumed as a cost that needs to be controlled. The consumption of the smaller enterprise data centres, which far outnumber the co-location and Cloud data centres, may be invisible to any studies of the subject except by approximation and/or extrapolation. Accessing these data centres to influence their behaviour represents a substantial challenge that needs to be addressed.

Point 7: Future trends, including the advance of the Internet of Things (IoT) may support the development of small distributed data centres with many of the features of Cloud data centres.

The demand for networked data (both for corporate and societal purposes) is only going to increase and measures need to be employed to control the amount of energy required to fuel that demand.

Taking the seven points above as a basis for the discussions of the Consultation Workshop, the following projects were unanimously agreed:

Research Project 1: An investigation into new forms of data processing technology to improve “energy consumption per transaction”.

Research Project 2: An investigation into new forms of data storage solutions to reduce energy consumption both to access and to transmit the stored data.

In addition, there was unanimous support for a change of approach to such research activities based upon experience of previous projects where research projects have been successful proof of concept but have not been made known to industry. These projects including Fit4Green and All4Green, DC4Cities and RenewIT, looked at resource throttling and consolidation, heat reuse, etc. However, no projects so far looked at education regarding the energy efficiency of IT systems at design time. In practice, system architects do not consider energy efficiency due to the lack of tools and frameworks.

Research Project 3: Identification of tools and frameworks to allow designers make trade-off analysis between efficiency, usability, performance and other quality attributes.

There was a call for short research projects, of duration two years, within which industry mentors are involved, followed by independent testing phases for successful projects (and other similar work undertaken elsewhere) to provide proof of implementation, followed by formally defined market awareness activity (to include dissemination and also training and up-skilling of industry-scale implementation).

Innovation Project 1: The application of new energy storage solutions (on a scalable basis) to maximise the use of low carbon energy supply solutions - this project, coupled with Research Projects 1 and 2, can support the development of autonomous data centres with low (or no) carbon impact.

Innovation Project 2: The application of new cooling technologies to reduce the energy consumption of environmental control systems.

Innovation Project 3: The application of dynamic environmental control to allow more granular control enabling wider ranges of operating conditions to be considered.

There has to be some effective mechanism for assessing whether the aims and objectives of the European Union sustainability targets are being achieved and it is clear that some aggregation of trend information based on specific Key Performance Indicators is required. While it was unanimously agreed that the standardised KPIs cannot be used to compare data centres (with so many different scales and business models) it is critical to obtain relevant data.

In addition, the mechanisms to address the “iceberg under the waves”, i.e. the many small enterprise data centres for whom energy efficiency is of little direct importance, was discussed briefly. There was particular criticism of the effectiveness of the European Commission Code of Conduct for Data Centre Energy Efficiency operated by DG JRC and initiated in 2009. While the “Best Practices” developed under the project was very
much welcomed (and been translated in standards-based text linked to other European standards for data centres by CENELEC), the management of the submission of data to the JRC and the resulting statistical information is non-functional.

As a result, two further small projects should be considered.

**Research Project 3:** An investigation into how and using what tools, data can be gathered at a de-centralised, national level, from the widest range of data centre operators in an anonymous manner.

**Research Project 4:** A short project (perhaps ongoing) to provide a Europe-wide mapping of connectivity resources (in terms of bandwidth) to power supply capacity.
DETAILS OF THE CONSULTATION WORKSHOP

1 INTRODUCTION

The meeting opened with a short speech from Eddy Hartog, Head of Unit Smart Mobility and Living of the European Commission welcoming the attendees.

Svetoslav Mihaylov, Policy Officer of the European Commission presented the agenda and delivered additional information as listed in Annex A.

Those contributing to the meeting, either by attendance or by submission of comments to Call for the Workshop are listed in Annex B.

2 RAPPORTEURS OPENING SUMMARY

The primary focus of the Workshop is to identify research and innovation opportunities which will have radical impact of Green ICT, particularly in the areas of data centres and telecommunications networks - and which would need the support of European Commission funding rather than self-investment by industry to meet an identified need.

The rapporteur opened by highlighting the definitions adopted by international and European standards bodies as follows:

**data centres**
structure, or group of structures, dedicated to the centralized accommodation, interconnection and operation of information technology and network telecommunications equipment providing data storage, processing and transport services

... together with all the facilities and infrastructures for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability

**access networks**
functional elements (i.e. equipment and infrastructure) that enable communication between an operator site and a customer network

The above definition of “data centre” does not limit either its size or business model and a discussion ensued regarding the true assessment of data centre energy consumption. While it is recognised that a move from enterprise to Cloud (hosted) solution will generally improve energy efficiency other factors need to be considered:
- the energy consumption of the enterprise data centre may not have been separately recorded and the resulting global data centre energy consumption increases;
- the enterprise may not fully decommission their activity;
- the networking element of the enterprise energy consumption remains.

It was highlighted that relevant research and innovation opportunities would be found in software (improving task effectiveness), ICT equipment (improving energy efficiency) and in facilities and infrastructures (both in terms of improving energy efficiency and improving resource utilisation). Sustainability in terms of life cycle analysis (LCA) and End-of-Life would also have a role to play.

As a basis for discussion the rapporteur provided a summary of the existing relevant activity in European Standards Organisation (ESOs) covering ICT equipment, facilities and infrastructures. This is included in the following graphic.
As one of the topics to be discussed in the Workshop related to KPIs it was highlighted that a great deal of work had already been done in international and European standards concerning not only Power Usage Effectiveness (PUE) but also other critical elements of Green ICT.

KPIs were separated into three types: technical, objective and global using the following general definitions:

**Technical KPI**
KPI assessing an aspect of energy performance under specific operating conditions typically as part of product type testing

**Objective KPI**
KPI assessing one of the objectives of operational energy performance which is subsequently used to define a Global KPI for energy management

**Global KPI**
KPI, combining two or more Objective KPIs, which reflects the overall energy management performance of an operational infrastructure

As can be seen in the graphic above, PUE is correctly described as an Objective KPI but other standards are in place e.g. REF to address renewable energy objectives and ERF for re-use of energy. There are many other possible objective KPIs for water, carbon etc. which are listed on ISO/IEC roadmaps and CENELEC is expected to approve work on KPIs for infrastructure availability.

The impact of specific research and innovation opportunities also has to be considered and the point was made that while all types and business models of data centres can be impacted by initiatives on facilities and infrastructures, co-hosting and co-location may not feel the same impact from activities on software and ICT equipment since the data centre owners are not able to control those aspects of their clients activity. The following graphic was not shown at the Workshop but was discussed as a means of highlighting this issue.
Before addressing the Objectives and Example Questions listed in the Call for the Workshop, it was pointed out a substantial amount of work had not only been undertaken by the publication of relevant standards. This included, as examples, the work of:
- The Green Grid and the creation of new metrics to capture measurements and improve energy efficiency;
- the CEN/CENELEC/ETSI Coordination Group on Green Data Centres;
- the European Codes of Conduct on Uninterruptible Power Supplies (UPS) and Data Centres;
- the FP7 initiatives led by DG Connect with 10 different projects having produced excellent deliverables;
- the ErP projects for UPS;
- other European and national initiatives with the same goal of mitigating carbon emissions.

In recognition of this there was a general support to:
- harmonize current major projects and standardize with recognised European standard bodies;
- disseminate the projects explaining their value propositions, promote and educate.

There was general agreement that there was limited market awareness of many of these activities outside the groups directly involved. A question was raised as to the assessment of the success of previous funded programmes.

It was felt that many of these activities that had been undertaken were not explained to the market and were not associated with clear “value propositions”. It may be that future European Commission activity could consider improving this situation.

### 3 RESPONSES TO INDICATED OBJECTIVES

Submissions were received to the specific Objectives and Example Questions contained in the Call for the Workshop. Other more general submissions were also received.

**OBJECTIVE 1: Identification of research and innovation areas for radically more efficient technologies and business models for Green ICT**

The detailed submissions from the contributors are summarised as headlines in the following schematic.

- Using “edge” and “distributed” solutions for specific applications in order to reduce energy consumption associated with high availability data centres
- Integration of low-carbon local provision coupled with energy storage
- “Zero idle consumption” equipment solutions
- Pooling of processing and storage resources and capacity utilization
- Minimise duplication of software-based activity – databases etc.
- Improvements in power distribution e.g. 400 VDC
- Recognise multiple objectives - not just low carbon solutions
- “Volatile” ICT resources
- Innovative cooling solutions (e.g. based on HPC projects)
- Innovation of data storage solutions
- Locate data centres to maximise use of natural resources

Each of the headlines was discussed to determine their value against the objective,

The discussions are summarised below.
Using “edge” and “distributed” solutions for specific applications in order to reduce energy consumption associated with high availability data centres

Although there was a lack of accurate definition for “edge” and “distributed” data centre solutions it was understood that future applications of data centres e.g. to support particular aspects of Internet of Things (IoT) technologies may involve an increase in the number of remote “low availability” data centres rather than relying on high availability monolithic solutions. However, the energy efficiency of the distributed data centres would generally follow the general improvements in facilities and infrastructure seen elsewhere.

It was noted that the reduction of energy consumption by using distributed resources had already been the subject of previous European Commission programmes such as Fit4Green and All4Green. Suggestions for improvements in future project structures and controls in order to attain substantive market implementation for such projects are discussed under Objective 3 below.

Integration of low-carbon local provision coupled with energy storage

The move away from diesel generators as additional supplies to data centres was discussed in some detail and enthusiasm. It was suggested that diesel generators were a “requirement” of ANSI/TIA-942, BICSI and the tiering approaches of the Uptime Institute.

NOTE This is not a requirement of EN 50600-2-2 or the future ISO/IEC TS 22237-3 which allows all forms of additional supplies including independent utility supplies.

The key research and innovation aspects concern the development of energy storage technologies to allow low carbon supplies (wind, solar, wave, etc) to be stored in such a manner to avoid the use of generators and their consumption and storage of carbon-based fuels.

Scalable storage solutions, matched to appropriate low-carbon supply technologies would also enable the “edge” and “distributed” solutions discussed above and the autonomous data centre solutions listed under Question 1 below.

It was also suggested that this and other topics resulting from this Workshop should be discussed with the High-performance Computing group.

There was also a suggestion that Energy Storage was, in its own right, a generic research and innovation topic and that data centres would be just one application of it - outreach may be required.

“Zero idle consumption” equipment solutions

This was not considered a viable topic since a focus on idle state consumption could mask other inefficiencies.

Pooling of processing and storage resources and capacity utilization

It was noted that the reduction of energy consumption by using distributed resources had already been the subject of previous European Commission programmes such as Fit4Green and All4Green.

Minimise duplication of software-based activity - databases etc.

The fundamental issue here is that software engineers are not taught to consider energy efficiency in their coding activities. The solution to this is neither a research nor an innovation action.

Improvements in power distribution e.g. 400 VDC

It was noted that after many years, IEC TC64 had received a New Work Item Proposal for their Low Voltage Electrical Installation standard dealing with 400 VDC in Data Centres. The NWIP had been drafted by Japan and is the first discussion of higher voltage DC installations in the complete series of standards produced by IEC TC64.

The Workshop considered that although gains in energy efficiency were possible, the scale of such gains was debatable and could be at the expense of safety, working practices etc.

It was felt that the section of DC as a power distribution system may have merit but should focus on the DC energy storage solutions that come out of the Integration of low-carbon local provision coupled with energy storage discussed above.
Recognise multiple objectives - not just low carbon solutions

This topic, taking into account LCA and End-of-Life issues is already addressed by multiple standards, Directives (WEEE) and European schemes (e.g. EMAS and eco-Passport). This was not considered a viable topic.

“Volatile” ICT resources

This was not considered a viable topic.

Innovative cooling solutions (e.g. based on HPC projects)

This is considered to be relevant objective. Liquid-based solutions are already under development. However, other aspects such as utilisation of rejected heat may be worthwhile.

Innovation of data storage solutions

This is divided into storage technologies and data compression techniques.

This is considered to be relevant as part of a research project into longer term solutions (immediate or shorter term solutions for storage technologies are already in development by key suppliers).

Locate data centres to maximise use of natural resources

Discussion of this topic transformed into one of selection of location based on many different drivers.

One aspect which was note worthy was some type of mapping of applications to “distance” based on latency but once again it was difficult to define a viable research or innovative project associated with it.

There was a suggestion of a short project (perhaps ongoing) to provide a Europe-wide mapping of connectivity resources (in terms of bandwidth) to power supply capacity.

OBJECTIVE 2: Definition of possible accompanying metrics (e.g. new indicators and measurement methodologies for Green ICT)

The detailed submissions from the contributors are summarised as headlines in the following schematic.

- Use dPUE (design PUE) as a pre-requisite of new data centres
- Use “global KPIs” which combine several “objectives”
- Develop metrics incorporating LCA aspects - perhaps within “global KPI” approach

Each of the headlines was discussed to determine their value against the objective,

The discussions are summarised below.

The headlines to this Objective are not really topics for research or innovation. The three primary standards bodies for data centre KPIs are CENELEC TC215, ETSI and ISO/IEC JTC1 SC39. If there was desire for specific KPIs they should be contacted.

dPUE is already part of EN 50600-4-2 (ISO/IEC 30134-2) and could be used a “pre-requisite” with ongoing control of PUE in conjunction with other Objectives such as REF and ERF. These in turn could be monitored using global KPIs such as those developed by ETSI.

However, it is a fundamental rule of the KPIs already standardised that they should not be used for comparison - only for trend analysis and therefore there is no KPI that is really viable for legislation or regulation.
With regard to contextual KPIs and domain-specific KPIs there is existing standardisation in terms of IT Service Management Systems (ISSM) in ISO 20000 and also proprietary activity such as the eBay™ Digital Service Efficiency (DSE) methodology.

**OBJECTIVE 3: Creation of the best possible funding instruments: e.g. small projects versus large scale demonstration projects (e.g. the current IoT pilots or Smart Cities light house projects funded under Horizon2020)**

The detailed submissions from the contributors are summarised as headlines in the following schematic.

<table>
<thead>
<tr>
<th>Headline</th>
<th>Description</th>
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<tbody>
<tr>
<td>A single focus is too restrictive - both approaches have value</td>
<td>Learn lessons from previous funding projects</td>
</tr>
<tr>
<td>Large scale projects are capable of demonstrating greater energy</td>
<td>Focus funding on energy efficient data centres which include energy reuse</td>
</tr>
<tr>
<td>efficiency outcomes for lower investment</td>
<td></td>
</tr>
<tr>
<td>Create EU procurement rules to advantage organisations that</td>
<td>Use university infrastructures and human resources for small projects</td>
</tr>
<tr>
<td>outsource to energy efficient data centres</td>
<td></td>
</tr>
<tr>
<td>Distribute computing into societal infrastructure to maximise use of</td>
<td></td>
</tr>
<tr>
<td>spare capacity</td>
<td></td>
</tr>
</tbody>
</table>

Each of the headlines was discussed to determine their value against the objective.

The discussions are summarised below.

There was some confusion about the meaning of the terms “large” and “small” with some participants considering the terms to apply to the length of the project period whereas other assumed to related to the cost/complexity of the task.

However, there was general agreement that lessons learnt from previous projects suggested that some modification of approach was required.

There was no preference for small or large in relation to cost/complexity. However, there was a distinct preference for projects that bean with research and then, based on define and assessed outcome, those projects would move to industrial/commercial engagement and then to marketing.

There was a call for industry mentors at the research level and an increased involvement of industry commercial rather than just engineering involvement.

**OBJECTIVE 4: Finding the minimum number of actions to have an impact at EU level and corresponding budget.**

The detailed submissions from contributors did not result in a series of headline items.

The Executive Summary proposes two major research projects each of which would use a new approach as shown in the graphic below.

Each major research project should be considered across 3 or 4 individual programmes to maximise successful outcomes. At the end of the research period, outcome has to be assessed as being viable for testing. A similar number of the testing programmes in industrial implementations would be open not only to those successful programmes of the first phase but also to other external research programmes. A successful testing phase would then require a marketing phase to disseminate the information and practices (in terms of training etc).
It is important that research does not stop after the first two years and this requires a rolling process of research, testing and marketing. To this end, a Testing Programme should be considered in Year One of any overall programme in order to both gain experience of and prove the viability of the approach. Such an early testing programme can be applied to the outcomes of research projects prior to 2020.

Innovation projects would be handled differently - primarily with the absence of the research programme phase.

QUESTION 1: What are the research areas that would be key to address within the next decade to radically increase efficiency and reduce carbon emissions in ICT, including Data Centres and telecom networks? Where are the major energy hotspots?

The detailed submissions from the contributors are summarised as headlines in the following schematic.

| New computing technologies to reduce energy consumption |
| Component-level research, immersive computing |
| Integration of renewable energy and energy storage - to provide autonomous operation |
| Integration of cooling containment system with management software |
| Pooling of processing and storage resources and capacity utilisation |
| Innovation in cooling solutions: liquid on chip etc. |
| “Overall (end-to-end) application” energy consumption as a driver |
| Integration with heat networks |
| System level management of distributed data centres |
| Workload placement management software |
| Dynamic cooling management |
| Identification and correction of anomalous operating conditions in infrastructure equipment to minimise energy consumption |
| Hotspots! FLAP - Frankfurt, London, Amsterdam and Paris |

Each of the headlines was discussed to determine their value against the objective,

The discussions are summarised below.
New computing technologies to reduce energy consumption e.g. component-level research, immersive computing

The proposal to study new computing technologies to minimise energy consumption is clearly an important contribution and should be listed in the potential research project list. It also is part of the bigger picture of lowering energy consumption to a level where low carbon source matched to the correct energy storage technologies can support autonomous operation.

Integration of renewable energy and energy storage - to provide autonomous operation

This links to both energy storage, new computer and data storage solutions.

Integration of cooling containment system with management software

This links to dynamic environmental control system management.

The topic of high temperature operation was also discussed but no clear outcome resulted.

Pooling of processing and storage resources and capacity utilisation

It was noted that the reduction of energy consumption by using distributed resources had already been the subject of previous European Commission programmes such as Fit4Green and All4Green.

Innovation in cooling solutions: liquid on chip etc.

An innovation project to qualify new cooling solutions would be worth considering.

“Overall (end-to-end) application” energy consumption as a driver

This was not considered a viable topic.

Integration with heat networks

If we have more efficient computing and storage technologies then the heat developed (and therefore to be cooled) will reduce undermining any opportunity for effective re-use. However, the vast majority of energy use in ICT equipment is converted to heat.

Nevertheless, the idea that data centres should locate with re-use as a specific driver is contradictory with the more relevant driver of effective connectivity considered at the Workshop.

The other viewpoint is to use waste heat as an energy source for data centres. This could be considered under the low carbon (since waste heat is essentially zero carbon) energy storage topic discussed under Objective 1.

System level management of distributed data centres - Workload placement management software

It was noted that the reduction of energy consumption by using distributed resources had already been the subject of previous European Commission programmes such as Fit4Green and All4Green.

Dynamic cooling management

This topic is better described as “dynamic environmental control management”.

Data centres with Granularity Level 3 in accordance with EN 50600-2-3 incorporate a higher than normal level of environmental sensors to enable energy efficiency improvements. It would be interesting to identify if this Granularity Level was implemented with a control system - or perhaps to determine if an even finer granularity is required.

Identification and correction of anomalous operating conditions in infrastructure equipment to minimise energy consumption

Data centres with Granularity Level 3 in accordance with EN 50600-2-2 already allow such identification by the use of distributed and interconnected meters (and other useful resource management efforts).
Hotspots! FLAP - Frankfurt, London, Amsterdam and Paris

The purpose of this question was not clear but it did suggest a short project (perhaps ongoing) to provide a Europe-wide mapping of connectivity resources (in terms of bandwidth) to power supply capacity.

QUESTION 2: What should future efficiency metrics consider? Do existing ones (e.g. PUE) suffice?

The detailed submissions from the contributors are summarised as headlines in the following schematic.

Recognise PUE but consider other “Objective KPIs” including REF and ERF

Consider “global KPIs” (combining objectives) and micro-KPIs (e.g. carbon trail)

Consider micro-KPIs to report software efficiency

Migrate to “ASHRAE allowable range” or ETSI Class 3.1

Any data centre metric to be applied in a regulatory manner shall attain international agreement

“Uptime” or “infrastructure availability” as a metric

Actual vs. virtual usage of renewable energy - disadvantaging RECs

Data centre “task efficiency” rather than PUE

Identification of aggregated capacity

“Available capacity” for software optimised systems

Each of the headlines was discussed to determine their value against the objective,

No additional results were obtained (see Objective 2).

QUESTION 3: Is it better to support small projects/pilots or large-scale demonstrators? How many actions (projects) do you think would be needed to address the identified challenges?

The detailed submissions from the contributors are summarised as headlines in the following schematic.

Focus on multiple small projects

Starting with research (with minimal industry involvement) followed by transfer into industrial trials

Longer research terms with conditional outputs to industrial transfer

Funding shared testing facilities which grow past infancy

Focus on limited number of large-scale demonstrator projects

Each of the headlines was discussed to determine their value against the objective,

No additional results were obtained (see Objective 3 and 4).

4  CONCLUSIONS

The conclusions of the Consultation Workshop are contained in the Executive Summary of this document.
ANNEX A: PRESENTATION FROM SVETOSLAV MIHAYLOV

Expert & Stakeholder Consultation Workshop on Green ICT – Research and Innovation activities 2020-2030

Svetoslav Mihaylov
Policy Officer
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Directorate-General Communications Networks, Content and Technology
European Commission

European Commission premises, Brussels 2018

Agenda

09:30-10:00 Welcome coffee and registration
10:00-10:30 Welcome and Introduction by the European Commission
10:30-12:30 Presentation of the draft report by the rapporteur and panel discussion
12:30-13:30 Lunch in the meeting room
13:30-16:00 Presentation of the draft report by the rapporteur and panel discussion
16:00-16:30 Summary of main conclusions and close
Why is the European Commission interested

- Paris Agreement & EU sustainability objectives
- Strong cross-border dimension of the cloud
- Contributing to the Sustainable Development Goals

### EU sustainability targets compared to 1990 levels:

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<th>2020</th>
<th>2030</th>
<th>2050</th>
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<tbody>
<tr>
<td>Decrease in GHG emissions</td>
<td>20%</td>
<td>40%</td>
<td>80-95% (100% for energy sector)</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>20%</td>
<td>27-&gt;35%</td>
<td>75-97%</td>
</tr>
<tr>
<td>Improvement in Energy efficiency</td>
<td>20%</td>
<td>27-&gt;35%</td>
<td>41% (vs 2005-6 peak)</td>
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</table>

What is the problem

- European data centres consuming more than 104TWh (2015) per annum representing 3% of total electricity (PEDCA project)
- This could grow with 20% by 2020 (35% over 9 years (Smart 2012/0064)) – compared to falling or flat rest of ICT
- Even worse for networks – growth in consumption 150% in 9 years (Smart 2012/0064) – compared to falling or flat rest of ICT
- Some new trends such as IoT, edge computing, SDN/NFV, etc. not taken into account in above growth figures
- The percentage (and if no action the total consumption) will only go up as the other sectors become more efficient with ICT (smartening)
- Some member countries/cities are hitting the limit of their power grids
- There is an ongoing improvement, but pace is slow with potential to get slower
What is the problem - continued

...and these figures are from 2013 and do not include new tendencies such as IoT, edge computing, SDN/NFV, etc.

Efficiency improvements not enough.

Disruptive innovation needed!

EU-27 electricity consumption in 2011 & 2020 (excluding ICT manufacturing)
Source: SMART 2012/0064 study on the practical application of the new framework methodology for measuring the environmental impact of ICT – cost/benefit analysis

EU FP7/H2020 initiatives on sustainable data centers

Project Cluster
Common Metrics and Methodologies
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