

IEEE Sustainable ICT Initiative White Paper
A Smart and Sustainable World through ICT



Summary of the Inaugural Greening through ICT Summit
Sustainability in a Connected World

IEEE Sustainable ICT initiative
<http://sustainableict.ieee.org>

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Executive Summary

Information and Communication Technologies (ICT) offer today both an opportunity and a challenge. The more widespread its use, the more productive and connected we become. Yet, if its energy consumption, the type of energy sources it uses as well its life cycle management are not addressed, the digital cage could lead us to a dark and polluted future. On the other hand, with proper leadership on these issues, ICT can be best the tool at humanity's disposal to reconcile economic growth with environmental stewardship and social benefits, i.e. ICT can be a key lever to achieve sustainability. ICT must also be recognized as a key element in the fight against climate change as it can enable large reductions in global greenhouse gas emissions.

To do so will mean overcoming technological, economic, and public policy hurdles. This was the *raison d'être* for creation of the IEEE Green ICT Initiative (re-branded as the [IEEE Sustainable ICT Initiative](#) in 2018), and the focus of its first global event, the [Greening through ICT Summit \(GtICT\)](#) that was held in Paris under the theme, ***"Sustainability in a Connected World."***

A group of 60 industry, academic and policy community leaders and advocates gathered during the event to actively participate in identifying technical, economic and policy challenges and solutions to achieve sustainability in ICT as well as sustainability through ICT in various spheres of human activity. As opposed to a traditional "speaker and listener" event, the Summit was held using the "World Café" (<http://www.theworldcafe.com>) approach, which fostered a productive open dialogue in a relaxed and casual atmosphere. All participants thus contributed to the discussion throughout the event.

Following a keynote address by the Chair of the Global e-Sustainability initiative (GeSI), the Summit was segmented into four interactive sessions respectively addressing perspectives on the issue from the ICT industry, the public policy community, ICT vertical markets as well as from IEEE. With 430,000 members worldwide bringing together a broad set of technical competence in the ICT, energy and materials domains, IEEE thus becomes a key player to provide the holistic approach required to properly address the sustainability through ICT challenge.

This document presents a detailed description of the discussions and consensus generated during the Summit. These were condensed into a set of eight specific actions for the industry and public policy communities to leverage ICT as a major catalyst of sustainability.

Industry actions:

- Develop sustainable ICT standards and certification processes
- Introduce sobriety in design (e.g. eco – software engineering) and leverage ICT evolution (e.g. virtualization, AI, battery technologies, etc.) for sustainability purposes
- Promote new ICT-enabled business models and best practices deriving added value from sustainability such as adoption of business KPIs and calls for tender incorporating

sustainability metrics, standard compliance testing as well as raising awareness that sustainability is good for business.

- Move the ICT industry towards the circular economy (e.g. e-waste reduction)
- Promote in the public sphere, e.g. through GeSI and IEEE's large global membership, the sustainability-enabling opportunities of ICT
- In the smart city environment, leverage automated data analytics and context awareness to address the scalability and seamless integration of heterogeneous sustainable ICT solutions for different verticals
- Design testbeds for holistic system testing, business democratization and public awareness purposes
- Break down the silos between IEEE Societies and leverage the organization's comprehensive, neutral ecosystem of technical competence across the materials, energy and ICT domains to become the premier source of advice to industry, government and global organization leaders with respect to the impact of the digital revolution and the ensuing sustainability through ICT opportunity.

Policy actions:

- Recognize ICT infrastructure not just as a basic critical infrastructure (just as water mains, sewers, transport and energy infrastructures) but also as a fundamental sustainability-enabling infrastructure
- Ensure policy makers are cognizant of difference between "smart" (interconnected, ubiquitous, dynamic, real-time) and "sustainable" (economically-viable, eco-friendly and yielding social benefits). This implies ensuring that both communications and computing are sustainable not only through their design (industry's job) but also in their application and adoption
- Link and ultimately integrate policies and regulatory frameworks in the telecommunications and energy sectors, with a focus on sustainability
- Drive, in collaboration with industry, social acceptance of sustainable ICT solutions through education, public awareness and incentives (for both consumers and industry)
- Synchronize and harmonize global efforts and accountability with respect to sustainability by ICT, in the context of differing approaches to ethics and to the balance between regulatory forces and market forces
- Develop fiscal and other types of incentives that reconcile short-term business imperatives (particularly in ICT vertical markets) with longer-term expected return on investments in sustainability
- Adopt proactive policies to ICT-enabled disruptions and stimulate adoption of the corresponding ICT solutions in different economic sectors to avoid social disruptions
- Address privacy challenges in the broader context of data life cycle management

Overview

Information and Communication Technologies (ICT) has produced a global revolution in how billions of people work, socialize, manage their finances, and take care of their health. ICT allows people to process and analyze mounds of data that can be used to make our lives better and more efficient. However, therein lies a two-edged sword: ICT enables unprecedented benefits, yet it currently consumes unsustainable levels of energy. This in turn results in contributions to greenhouse gases including carbon dioxide. Moreover, ICT must be properly managed throughout its entire life cycle, from manufacturing to use and to disposal; as such, the e-waste challenge must also be addressed.

Therefore, ICT offers both an opportunity and a challenge. The more widespread its use, the more productive and connected we become. Yet if its energy demands are not drastically reduced, the digital age could conceivably go dark, stunting progress as we know it. The solution, then, is for ICT to go green.

To do so will mean overcoming technological, economic, and public policy hurdles. This was the *raison d'être* for creation of the IEEE Green ICT Initiative (re-branded as the [IEEE Sustainable ICT Initiative](#) in 2018), and the focus of its first global event, the [Greening through ICT Summit \(GtICT\)](#) that was held in Paris under the theme, ***“Sustainability in a Connected World.”***

IEEE and Sustainable ICT

Currently transforming all spheres of human activity, ICT is emerging in the 21st century as the dominant driver of sustainability with the potential to reconcile economic growth, environmental protection and societal benefits. It is a key tool in the fight against climate change as it can enable a 20% reduction in global carbon emissions by 2030. However, achieving these outcomes will require a holistic approach to the proper design, broad application, widespread adoption and social acceptance of ICT products and solutions.

This “green” potential of ICT thus requires a complete rethinking of how not only we design but also how we use ICT. It’s a huge challenge that can only be addressed by bringing together the research community, ICT equipment and solution providers, practitioners in ICT vertical markets, the standards community as well as public policy influencers and decision makers.

As the world’s largest technical professional organization dedicated to advancing technology for the benefit of humanity, the Institute of Electrical and Electronics Engineers (IEEE) and its 430,000 members from around the globe, is committed to providing leadership on these issues. In this context, the mission of the IEEE Green ICT Initiative, launched in January 2015 by the [IEEE Future Directions Committee](#) and the [IEEE Communications Society](#) and re-branded as the [IEEE Sustainable ICT Initiative](#) in 2018, has been defined as to *“build a holistic approach to sustainability by incorporating green metrics in all IEEE technical domains”*. Viewed through the triple bottom line of sustainability (economic, environmental and social), the Initiative offers a compelling opportunity for IEEE to demonstrate the full impact of the technology innovation it supports.

The IEEE Sustainable ICT Initiative

Much work has been devoted over the last two years by a dedicated group of initiative academics and industry leaders from around the world to develop new IEEE activities to raise awareness of the Green ICT opportunity. **The Sustainable ICT initiative's mission is to *develop a holistic approach to sustainability by incorporating green metrics in various IEEE technical domains.*** Its objective is to identify the key technological, commercial and public policy challenges that must be overcome to achieve sustainability in an increasingly connected world. Focusing on product life cycle, carbon footprint and energy efficiency, the Sustainable ICT Initiative brings together the research community, ICT practitioners, equipment, technology and vertical application providers, the ICT standardization community, as well as public policy influencers and decision makers.

Since its launch in 2015, the initiative has made substantial progress namely on:

- **Standards:** Creation of working groups for the development of nine standards related to energy efficiency and carbon footprint assessment and mitigation.
- **Publications:** Transactions on Green Communications and Networking launched and proposals are under review for a Sustainable ICT newsletter and a Sustainable ICT magazine.
- **Events:** The 1st "Greening through ICT" Summit in Paris, October 3rd, 2017, addressed stakeholders' specific issues, challenges and solutions to develop a holistic approach.
- **Sustainable ICT Web Portal:** Promotion of green-related events, conferences, publications, webinars, standards development activities, tutorials, etc.

In fact, although they may not always be labeled as such, the huge interest in various themes of Sustainable ICT is spurring a growing number of activities in IEEE and in other global organizations, which speaks eloquently to the relevance of the theme. Through interfaces with various IEEE societies and other technology initiatives (e.g. Cloud Computing, IoT, Smart Cities, etc.), the Sustainable ICT initiative seeks to foster the incorporation of green metrics and standards in design concepts for various technical domains.

Nonetheless, this explosion of interest can also lead to the creation of technical interest "silos". While encouraging the development of various activities on the theme, the Sustainable ICT initiative therefore seeks to develop holistic awareness on this topic, avoid duplication or overlap of activities, and provide a forum to build a cross-society and cross initiative IEEE consensus on outreach to other organizations.

Launched in early 2015 through the support of IEEE Future Directions' new initiatives committee, the Sustainable ICT initiative's (<http://sustainableict.ieee.org>) is headed by two Co-Chairs:

- Prof. Charles Despins, École de Technologie Supérieure (Université du Québec), Canada
- Prof. Jaafar Elmirghani, Professor, University of Leeds, United Kingdom

The Paris GtICT Summit

Sustainability in a connected world

Recent major developments in the Paris Climate Change agreement heighten the importance of IEEE’s role and actions in the sustainable development sphere. Important government, industry and academic stakeholders in the climate change issue and the adoption of related public policies, were invited to attend a first major dialogue between those who design technology, those who use it and those who regulate it (see appended list). Their participation at the *Greening through ICT Summit (GtICT)* in Paris last October 3rd, helped contribute to this vision by sharing their experiences and challenges that impact energy efficiency, greenhouse gas emissions, technology life cycle management, policy or social issues. This conversation is key to humanity’s well-being in the 21st century and beyond.

GtICT Forum

A preliminary strategic GtICT Forum session was conducted in May 2017 in Paris between 25 invited speakers and Initiative volunteers. Its aim was to discuss synergies on achieving sustainability through ICT and define the program of the October Summit’s that would conclude on a call for action declaration for “A sustainable future through ICT”.

The 1st Summit in Paris

The Co-Chairs of the IEEE Sustainable ICT Initiative invited engineers, scientists, business leaders as well as public policy specialists to speak at 1st “*Greening through ICT*” (GtICT) Summit that was held in Paris on Tuesday October 3rd, 2017. Held under the theme “**Sustainability in a Connected World**”, this new 1-day summit brought together 57 high profile delegates of the scientific, industrial and public communities. Most were IEEE members and all were familiar with IEEE. The participants’ list for the October 3rd event is appended.

Specialists from various backgrounds and disciplines thus examined opportunities both where ICT is used as a tool to improve environmental and societal functions at



large, while also improving the energy efficiency, carbon footprint and life cycle management of ICT itself. The program can be found at <http://greenict.ieee.org/summit/gtict-summit-2017>.

Objectives

The *Greening through ICT Summit (GtICT)* examined opportunities both where ICT is used as a tool to improve energy efficiency and environmental and societal functions, as well as to reduce the carbon footprint and optimize life cycle management of ICT itself. While ICT is transforming the work place and society as a whole, it is a double-edged sword:

- Negative impacts such as job losses, possible social distrust, increased carbon footprint, additional e-waste, cyber-security issues, etc.
- A unique opportunity: significant increases in productivity and energy efficiency, as well as a reduction of carbon footprint within ICT and by ICT throughout industry and society.

The Summit's objective was thus to identify the combination of key technological, commercial and public policy challenges that must be overcome to achieve sustainability in our increasingly connected world. As such, the overall effort seeks to build a broad multidisciplinary dialogue among the research community, ICT practitioners and its vertical application sectors, equipment and technology providers, the ICT standardization community, and with public policy influencers and decision makers.

Addressing this complex issue involves a broad range of actions such as developing public policies at all levels of government, changing citizen behaviour, encouraging digital literacy, as well as creating technical standards for which compliance will enable industry and society to green the ICT sector itself and, most importantly, green society by ICT. This list of actions is far from being exhaustive.

The digital revolution is not going away and will only accelerate. If it is to be leveraged for sustainability, a holistic approach to implementing these actions will be required namely for the design, application and adoption of ICT products and solutions. ICT can then be the best tool available in the 21st century to reconcile economic growth with environment and social objectives.

Patronage

The Summit organizers warmly thank TÜV Rheinland, our Platinum Sponsor, for its key support in the organization of the Summit.

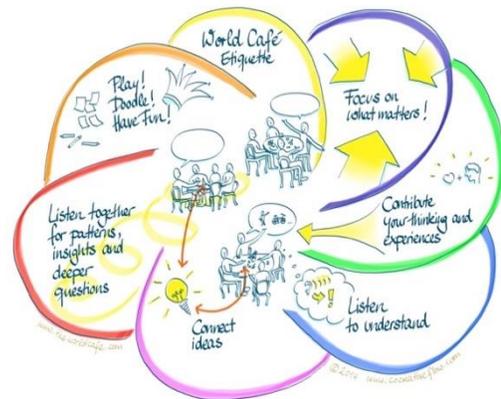
TÜV Rheinland is a leading international provider of technical services. Its goal is to be the world's best sustainable and independent provider of technical services for testing, inspection, certification, consultation, and training.

Since 1872, TÜV Rheinland has been developing solutions to ensure the safety and quality of the interaction between man, technology, and the environment. TÜV Rheinland firmly believes that social and technological progress are intrinsically tied together.



The World Café approach

As opposed to a traditional “speaker and listener” event, the Summit was held using the “World Café” (<http://www.theworldcafe.com>) approach, which fostered a productive open dialogue in a relaxed and casual atmosphere. All participants thus contributed to the discussion throughout the event. The morning portion targeted government and industry perspectives. The afternoon discussions between industry experts and exchanges with the participants enabled the identification of challenges and solutions in various industry verticals such as transport, manufacturing, health, agriculture, etc.



Within a series of one-hour segments, one or two questions were presented to the participants and initially discussed for 15 minutes in a panel of 4 specific subject matter experts among the attendees. Clustered into groups of 4 around small tables, they then all discussed for 45 minutes and scribbled their ideas and comments on paper tablecloths.

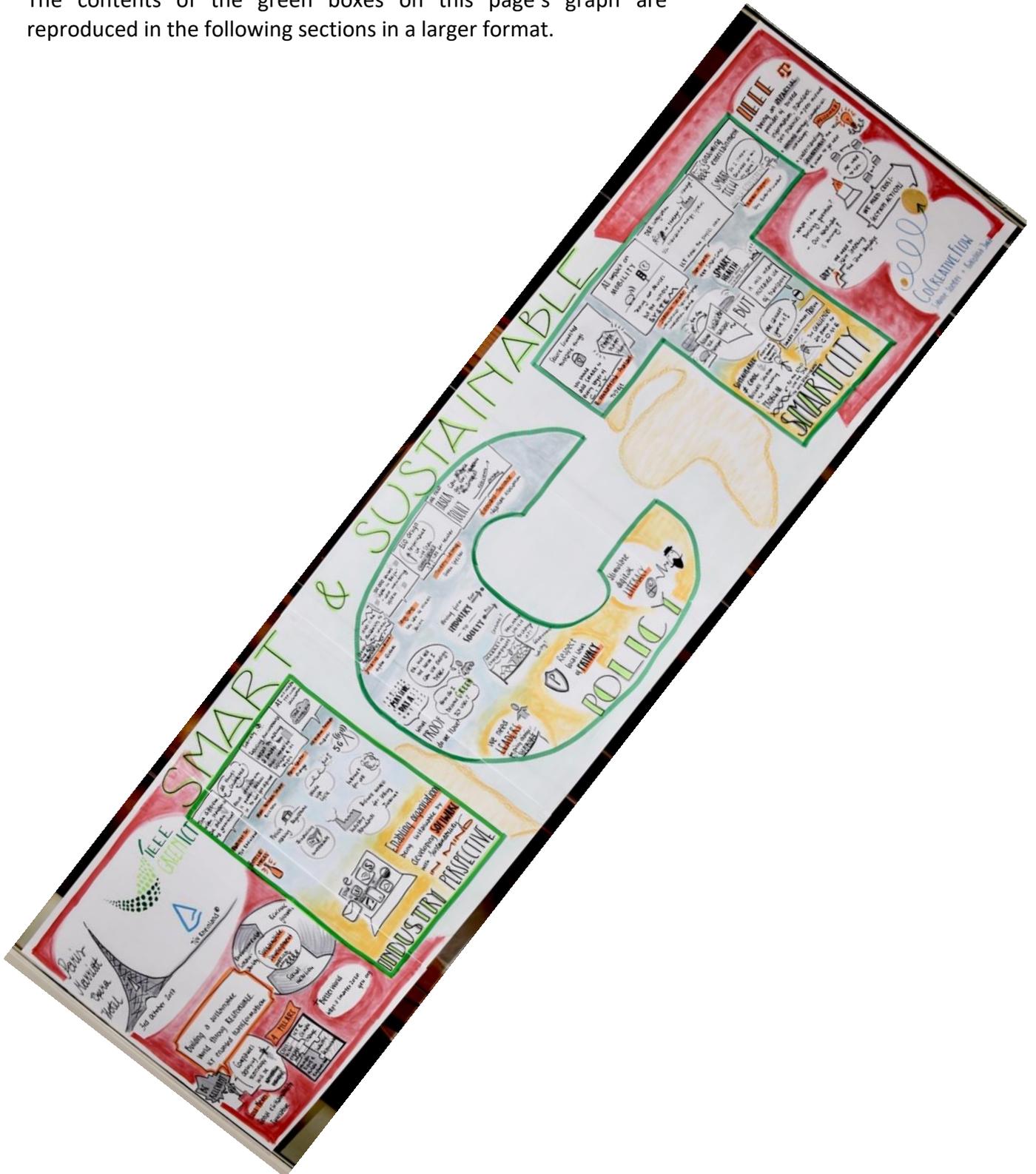
At the end of these segments, the moderators brought out the ideas with the assistance of a rapporteur per table and assisted in building a consensus. As the event progressed from one segment to the next, participants were asked to switch tables and find new discussion partners.

The GtICT Summit Program

Graphic description of the GtICT discussions

As the discussions were ongoing, a graphic artist among the World Café moderators gradually built up a visual representation of the key points raised at various tables.

The contents of the green boxes on this page's graph are reproduced in the following sections in a larger format.

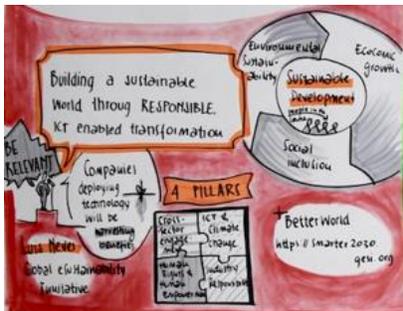


Keynote address: A Global Perspective:

What's the connection between Sustainable Development Goals, ICT and planetary risks?

Sustainable ICT can play a critical role in understanding and managing planetary risks.

- **Luis Neves**, Group Sustainability and Climate Protection Officer, Deutsche Telekom and Chairman of GeSI, the Global e-Sustainability Initiative



Building a sustainable world through responsible ICT-enabled transformations:

- Four pillars:
 - Cross-sector engagement
 - ICT & Climate Change
 - Human rights and human empowerment
 - Industry responsibility
- Companies deploying technology will harvest benefits
- Sustainable development with people in the center:
 - Environmental sustainability
 - Economic Growth
 - Social Inclusion

Implementation of the Paris agreement and achievement of the Sustainable Development Goals are both significant challenges for the world. The cross-cutting nature and great potential of ICT make it an indispensable tool for the transition to a sustainable, low-carbon economy.

Sustainable development is a multi-faceted challenge offering a wide array of tangible benefits:

- Dimensions: environmental sustainability, economic growth and social inclusion;
- Opportunities: reducing polluting emissions and resource consumption, increasing savings and revenue opportunities, connecting the global population.

Sustainability is a universal human goal:

- The more we connect, the more we empower;
- The more we empower people through ICT, the more we break the linkage between economic growth and energy consumption.

Applying the GeSI “SMARTer2030” findings to the UN Sustainable Development Goals (SDGs), one can assess where and how ICT can contribute to achieving these goals by 2030.

ICT solutions are required if we are to achieve all 17 SDGs and >50% of the 169 targets.

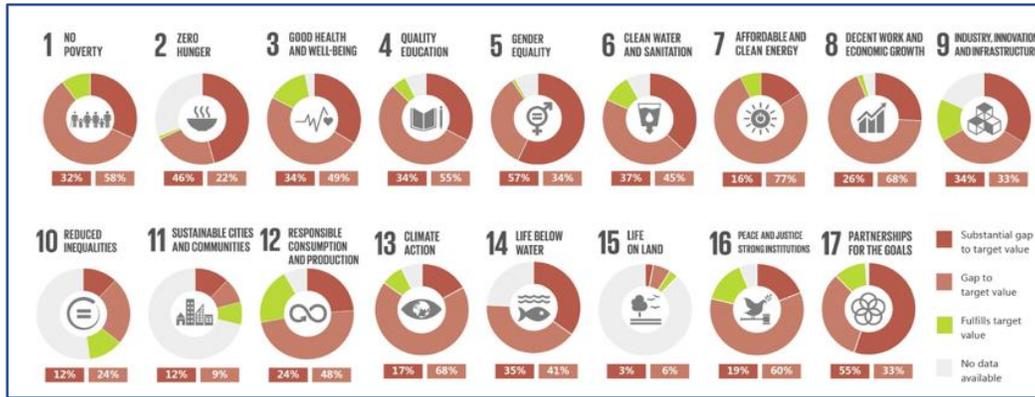


Image courtesy of GeSI

Raising awareness of ICT’s enabling potential should be a priority (<http://gesi.org>) :

- ICT has the potential to enable a 20% reduction of global carbon emissions by 2030;
- At the same time, ICT can reduce the consumption of scarce resources.

In business terms, ICT is also a driver of growth. An assessment of eight economic sectors shows that it could generate:

- Over 6 trillion USD in new revenues in 2030;
- Close to 5 trillion USD in cost savings in 2030, including 2.3 trillion USD from energy efficiency.

For people, ICT could connect:

- 2.5 billion previously unconnected people to ICT services by 2030 including 1.6 billion more people connected to e-health and 0.5 billion e-learning participants.

Why Digital as a solution to the sustainability challenge?

1. Diffusion Speed and reach:
 - 23x higher adoption rate for mobile networks vs. grid electricity in Sub-Saharan Africa;
 - 90% of world’s data created in last two years.
2. People Centric:
 - 100 billion connected devices by 2030;
 - Three-figure growth rates for wearable health.
3. New Business Models - 2 examples:
 - 326% growth rate for smart watches, taking over market share from Swiss makers;

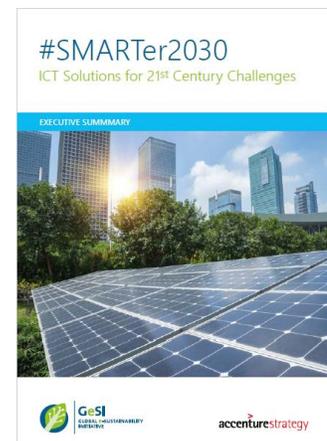


Image courtesy of GeSI

- 100% growth rate for Kenya's M-Kopa (www.m-kopa.com), delivering solar-based, off-grid lighting solutions.

Connectivity & digital solutions are essential to achieve the SDGs for 8.5bn people by 2030. GeSI thus favors joint action to harness the transformative power of digital solutions for SDGs.

Panel No 1: ICT Industry Perspective:

How can we 'Green' using ICTs?

What paradigm shift is needed to green using ICT? What industry transformations are required to achieve sustainability through ICT?



What are the enabling organizations?

Drivers of sustainability through ICT – key takeaways:

- Policy making, regulations, investments;
- Focus on the entire life cycle;
- Industry standards;
- Identification of bottlenecks;
- Development of software for sustainability;
- Business models;
- 5G
- Internet for all.

First panel participants:

- Fallight Xu, Principal Energy Efficiency, TUV Rheinland, China
- Mats Pellbäck Scharp, Head of Sustainability, Ericsson, Sweden
- Marc Vautier, Innovation & Technologies, Orange, France
- Mérouane Debbah, Vice-president, France R&D Center, Huawei, France

The panel's response targeted standards and certification, sobriety in design as well as opportunities in network evolution.

Develop standards and certification processes:

- The development of standards as well as ensuing testing and certification processes are critical to enable ICT to make contributions to the accomplishment of sustainable development goals around the world.
- Stimuli for the adoption of emerging technologies vary substantially around the world. In some countries (e.g. China and some western countries), governmental policies and regulations play a critical stimulus role. In these cases, governments allocate funding to incentivize the early adoption of emerging technologies such as ICT, while in other

countries and regions, pure market forces play a more critical role to promote the penetration of new technologies in the marketplace.

- Standards and certification processes have started to be used as an important tool to engage market forces roll out new technologies. To visualize how ICT technologies induce sustainability can be a challenging endeavor as different users of ICT technology might have disparate perception and expectations. Standards and certification process can offer “salience, legitimacy, and credibility” to the link between ICT and sustainability. And as standards and certification sometimes act as a so-called “hard law” with, to a certain extent, coercive authority, if used appropriately, they can catalyze the adoption of ICT technology in sustainability initiatives.

Introduce sobriety in design:

- The concept of sobriety is based on reducing environmental impacts by “making smaller boxes”.
- In ICT, software and its multiple layers should be a key focus area. In our battle to reduce the environmental impact of ICT products and solutions, we must reduce resource consumption due to software. Software is in many ways ubiquitous and consumes significant resources (CPU & RAM).
- Attention to the full life cycle, and not only energy consumption during the use phase, is also a critical element. Issues related to the disposal phase must be addressed, such as raw materials, recycling and increased lifespan of equipment.
- Consideration of rebound effects associated with each innovation should help us to reduce our environmental impact.
- Sobriety and sufficiency concepts should be incorporated into the design of a new ICT service or product, with a target of delivering only the requested functionalities.

Leverage opportunities in network evolution:

- Networks are becoming increasingly complex to manage with the explosion of traffic. Artificial Intelligence and the recent advances in Big Data algorithms can provide an efficient framework for sustainable networks.
- Machine learning is important to make networks greener. Huge amounts of data are available with respect to the real-time state of network infrastructure and end users. Networks can thus be more pro-active in the allocation of resources.
- Significant progress on energy efficient networks was achieved through the GreenTouch project with the objective of improving the energy efficiency of networks by a factor of 1000. This goal has been maintained for 5G networks but is the most complicated to achieve, particularly as the goal of reducing latency to 1ms is another difficult challenge.
- Key technologies that can be leveraged to reduce energy consumption in networks are related to massive MIMO and small cells. Massive MIMO enables a huge factor reduction

in the uplink (by having more antennas that can receive the signal) and downlink (through beamforming technology).

- Finally, the move toward the cloud (with Cloud-RAN and Cloud Computing) enables the operator to flexibly pool resources and therefore reduce energy consumption.

World Café Round 1: Industry Perspective:

What is the industry doing already and what more could it do to make ICT even more smart and sustainable?

As participants discussed in groups of four, three dominant themes emerged. Under each theme are listed the key ideas captured at each table.

- **Promotion of new business models and best practices:**
 - ✓ Democratization of business through ICT
 - ✓ Business opportunities to revitalize industries such as the automobile sector
 - ✓ Green metrics must be translated into key business indicators for industry adoption
 - ✓ Green standard compliance testing and management is a significant business opportunity
 - ✓ How to engage SMEs? Security, convenience and ecosystems are key
 - ✓ Improve public awareness of industry efforts
 - ✓ Sustainability is good for business: embed sustainability mindset in the core of the business, notably through “C-level” responsibility
 - ✓ Develop standards by involving competitive companies
 - ✓ Green opportunities in ecommerce and in the sharing economy
 - ✓ A lot being done already – but we lack a proper understanding of status and data. Accurate modeling and measurement of Sustainable ICT metrics is required for different vertical ICT application sectors
 - ✓ Sustainable ICT must be a higher priority (for product innovation and to reduce costs)
 - ✓ A smarter electrical grid can reduce the carbon footprint (still a lot to be implemented)
- **Development of new ICT products and services**
 - ✓ Increase life span of hardware and devices
 - ✓ Leverage virtualization and collaboration with electric grid utilities to reduce the carbon footprint of communication networks; Greenstar: reduce GHG in networks through virtualization
 - ✓ Energy efficiency should not be an afterthought in the design of products and services
 - ✓ With improved battery capacities and an evolved transport infrastructure, electric vehicles can offer a myriad of greening through ICT opportunities
 - ✓ Technology should be interoperable across borders and international adoption of standards should be promoted
 - ✓ AI, machine learning and analytics offer both greening ICT and greening through ICT opportunities

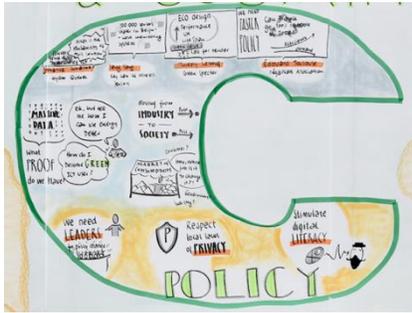
- ✓ Foster the use of general purpose hardware
 - ✓ Preloaded software reduces integration time
 - ✓ Limit consumption by avoiding useless functionalities and performance (e.g. number of pixels)
 - ✓ Greater interaction is required between stakeholders and ICT designers
- **Social Acceptance of ICT products and solutions:**
 - ✓ Privacy and security concerns could derail initiatives that attempt to achieve sustainability by ICT
 - ✓ You don't get what you don't pay for (in some way or another)
 - ✓ Should initiatives be driven by the profit motive in industry or should government constraints be applied?
 - ✓ Many Greening through ICT solutions are available now: if they are not used, identify why (awareness, digital literacy, digital divide in terms of broadband access, etc.)
 - ✓ Education & public awareness are constant challenges
 - ✓ A focus on helping less fortunate people fosters social acceptance on a broad scale
 - ✓ Address pollution in developing countries through ICT
 - ✓ Moving the ICT industry towards the circular economy: a major challenge
 - ✓ Electricity prices based on level of consumption (large consumption gets penalized)
 - ✓ Government incentives not only for industry but also for consumers
 - ✓ Local actions are very important: municipal governments play a key role
 - ✓ Local government regulated pricing for energy usage as in California
 - ✓ Government-initiated research activities, both academically and industrially, can be a catalyst
 - ✓ Redistribution of an International tax on carbon – how to achieve this?
 - ✓ Reconcile differing country philosophies such as China's top down, government regulation with the west's profit driven industry model: can international sustainability through ICT initiatives be defined and succeed in this context?
 - ✓ Government & industry must interact much more to define business and regulatory models which enable greening and sustainability through ICT
 - ✓ Benefit from expertise of other sectors to position ICT's impacts more properly

Panel No 2: Public Policy Perspective:

Challenges of the 21st century - ICT as a driver of sustainability and the fight against climate change.

Moving from Industry (push) to Society (pull)

The consumer market: Whose job is it to change it? Governments? Industry?



We need leaders with respect to policy changes

OK, but:

- How do I become a “Green” ICT user?
- How can I make better use of energy with ICT?
 - Will local laws in terms of privacy be respected?
- How do we stimulate broad digital literacy?

Second panel participants:

- **Johanne Duhaime, VP ICT, Hydro-Québec, Canada**
- **Thierry Leboucq, Chairman, GreenSpector, France**
- **Édouard Toulouse, Executive member, négaWatt Association, France**
- **Yang Yang, Director, Key Lab of Wireless Sensor Networks and Communications, Shanghai Institute of Microsystem and Information Technology, China**

The panel’s response targeted organizational transformations, ecodesign of ICT products and the acceleration of public policies driving sustainability.



Transform organizations to drive sustainability all the way to the “bottom line”

- Identify green transformations that add value (tangible & intangible)
- Integrate green metrics in the evaluation of internal return on capital investments
- Request green and sustainable value-add in calls for tender

Ensure ecodesign of ICT products and services

- Recognize that software is the first cause of obsolescence of hardware
- Require reusable solutions at every opportunity

- Introduce design requirements that support sufficiency: APD by default, scalability, upgradability, definition of ‘eco-modes’, etc.
- Actively support IT professionals to change

Accelerate the development of public policies that drive sustainability

- Introduce efficiency regulations more quickly: e.g. ecodesign and energy labelling
- Integrate business and “green” value in public policy
- Introduce institutional and legal frameworks to drive and favor ICT applications towards sustainability: greener mobility, sharing, homeworking, building automation, smart grids, etc.
- Support greenest exemplary initiatives: 100% renewable approaches and sustainable projects (e.g. 100,000 water sensors in Beijing).

World Café Round 2: Public Policy Perspective:

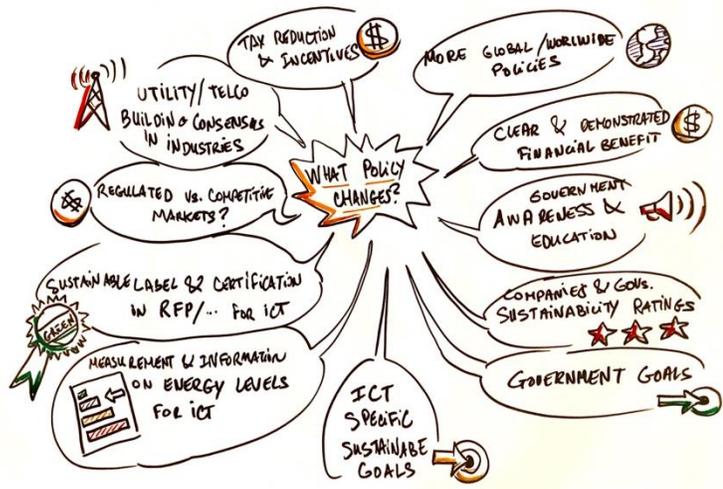
What policy changes should be adopted at national, regional and municipal levels to achieve sustainability through ICT? What changes has been already made?

What were the most important insights from your conversations?

Participants again discussed these issues in groups of four but with different partners than in round 1. Both policy changes and broader insights emerging from interaction between various stakeholders at the tables were discussed. Under each of these two themes are listed the key ideas captured at each table.

Insights

- Execution of green initiatives in organizations must be secured through regular follow-ups & tracking of progress
- Green and sustainable metrics must be integrated into core business offerings as opposed to features & niche projects
- What is really “green”? What is real “footprint”? Standardized definitions are required.
- The ICT industry must be fully integrated into the circular economy
- Consumers must be further empowered to promote sustainable innovation
- We don’t need more sustainability strategies. We need sustainable business strategies.
- Global efforts must be synchronized



- People will only act according to the metrics used to assess their behavior and performance: change the metrics to change the behavior
- True Leaders will do things they know will cause them trouble; and are usually low on the totem pole 😊
- Swedish ICT CO2 trend skyrocketed from 2010 to 2015
- A study has predicted a 20% increase in energy use due to 4K TV in the UK
- Energy savings are readily available by lowering/controlling voltage in the grid
- Sustainable software implies a higher battery life of the phone
- IEEE should be advocate for sustainable ICT in elections throughout the world
- Energy efficiency information should be made more available to ICT device consumers

Suggested public policy changes

- Introduce green (e.g. carbon) taxes
- Public policy must support the definition and adoption of new business models based on sustainability through ICT, i.e. business models leveraging ICT to reconcile corporate bottom lines with environmental well-being and social benefits
- Are taxes and subsidies really needed to drive these new ICT-enabled business models?
- Public procurement must be based on sustainability metrics
- Total cost of ownership must incorporate environmental and social costs
- CO2 emissions and energy consumption are not always directly related and require distinct set of policies
- “Green inside” requires new KPIs
- Identify SDGs where ICT can be most effective
- Recognize ICT as fundamental enabling infrastructure, like energy, water, roads, etc.
- Large global funds (e.g. World Bank) must increase focus on ICT infrastructure investments which can support sustainability through ICT
- Policies must be developed to make ICT infrastructure access ubiquitous, available and affordable as well as with adequate performance (latency, speed, security)
- Adopt proactive policies to ICT enabled transformations to avoid social disruptions
- Policies must address the entire technology life cycle in a holistic fashion
- Policy changes must be in line with multi-country agreements, e.g. Climate Agreement or UN SDGs
- “Standardize standards” (which can differ from one region of the world to another)
- Adapt policies to find the right geographical level (global vs regional vs country)
- Find appropriate policies (e.g. financial incentives) for SME’s
- Adapt policies to accommodate various perceptions of privacy
- Stimulate digital literacy
- Are tightly regulated or openly competing markets best for telcos and utilities to drive sustainability through ICT?

Panel No 3: Perspective from ICT Verticals:

Are Smart Cities sustainable?

How can we achieve sustainability in an increasingly connected world?

Challenges to achieve sustainability? Tangible examples?



Smart City: The challenges are about to emerge!
 Smart Use = Smart “No Use”
 Sustainable not equal to “Cool”: Business solutions in the making
 Put ethics into the DNA: No more “Green washing”
 Automated transport opens the door to sustainable transport but it will increase use of transport.
 Smart health will allow us to sleep longer!

Third panel participants:

- **R Venkatesha Prasad, T U Delft, Netherlands**
- **Joachim Taiber, CTO, International Transportation Innovation Center**
- **Kieren Mayers, Director Environment and Technical Compliance, Sony Entertainment**
- **Patrick Graves, IEEE Smart Cities Initiative and Power Engineering Society**

The panel’s response targeted technological, economic and policy challenges and solutions to achieve sustainability in smart communities and more broadly in a connected world.

Technological challenges and solutions

- **Challenges:**
 - Heterogeneity: enabling the seamless integration of a large number of different devices (operating conditions, functionalities, etc.)
 - Scalability: handling the growth of devices (sensors & actuators) → managing the resulting load of data
 - Interoperability: enabling the interaction of heterogeneous smart objects
 - Security & Privacy: in the IoT frame, every connected ‘thing’ must be considered a potential threat to data protection
 - Testing not devices but the entire system
 - For sustainable mobility, developing and validating AI-based sustainable multi-modal mobility solutions in Smart City environments
- **Solutions:**
 - Automation: with respect to data collection, processing and decision-making
 - Intelligence & Dynamicity: situation/context awareness & adaptation

- Zero configuration: operation with minimal human intervention, plug-and-play principle
- In terms of testing mobility, certify not only the individual vehicle but the whole ecosystem for safety, security and emissions
- Creating an ecosystem to develop templates for intelligent mobility solutions following open source software development principles and leverage a global network of cyber-physical testbeds
- Accessing a global network of open and closed testbeds in order to leverage a large developer community, share test methods and test data

Economic (business model) / policy challenges and solutions

- Challenges
 - Adding “Smart” (the fusion of communications and computing i.e. of connectivity and intelligence) to every layer of a city, to an ecosystem of IoT devices that co-exist in space and time, belong to different networks, perform different tasks and often share the same resources:
 - E.g., **smart** grid, **smart** waste management, **smart** homes/buildings, **smart** parking (e-cars), **smart** traffic lights, etc.
 - When is the combined artificial intelligence of vehicle and infrastructure superior to human-based driving?
 - How do we manage the transition from human-centric driving to AI-based transportation?
 - For consumer entertainment, do I stream, download or buy my game to achieve maximum sustainability?
- Solutions
 - Always remember the overarching goal of contributing to significant improvements of the living conditions of people: in education, transportation, work, sleep, entertainment, etc.
 - Being cognizant of the difference between “smart” (interconnected, ubiquitous, dynamic, real-time) and “sustainable” (economically-viable, eco-friendly and yielding social benefits). This implies making both communications and computing sustainable through their design, application and adoption.
 - In terms of the development of mobility services, the violation of traffic rules and regulations by human beings can lead to safety risks but also generate revenue
 - AI-based multi-modal transportation can yield many benefits through the integration of bicycles, low-speed mini shuttles, robotaxis and transit buses in a smart road system where all moving objects are aware of each other
 - Dedicated infrastructure is required to support vehicle automation and vehicle electrification

- Recognize the potential of the shared IoT economy and increase the demand for those services. This must not lead to a deterioration of services given infrastructure limitations.
- Recognize ICT as a fundamental enabling infrastructure much like water access, sewers, transport and energy infrastructures.
 - ICT system providers must not rely on government funding alone to build the infrastructure base even if private funding is typically limited to the most profitable ICT services and regions.
 - Government must balance market forces where private sector invests in ICT infrastructure and subsidize ICT infrastructure for social reasons.
- Standards are essential, leading to competition between different ICT service providers and a balance between demand and supply.
 - Innovation is a key driver to improve ICT services (quality/cost)
 - Innovation requires new standards or redesign existing standards.
- Large companies need to proactively understand how ICT-enabled innovations can impact their business and help them to achieve sustainability. Instead of trying to fight the changes that come with innovation, they need to embrace them
- IEEE should develop use cases for various ICT vertical markets & work with universities and private companies to develop prototype solutions which can be showcased at suitable IEEE events/conferences of the participating Societies in the Sustainable ICT initiative

World Café Round 3: Smart Cities Perspective:

Once again, participants discussed these issues in groups of four but with different partners than in the previous two rounds.

What technical challenges remain to make sustainable ICT a reality in these verticals?

- Life Cycle Management
- Too much data; do we need it all? Will we be able to manage and use it effectively?
- It's not only a technical issue but mainly a behavior change issue (consuming less & better)
- Standards – will solutions be compatible when taken from one vertical to another?
- Challenge in having the same standards & protocols between different suppliers
- Some technologies are already mature – we can/need to tap the existing potential
- Consumers and citizens must understand the benefits – why should I do it?
- Cross fertilization between the ICT and power ecosystems with different lifecycle time scales e.g. power (20+ years) while ICT (as low as 2-3 Years)

- Reliability of solutions
- Variability of legal frameworks throughout the world
- Green Washing as opposed to real change and continuous improvement
- Conscious ethical commitment
- Thinking big is not always the solution
- Smart Villages: Connectivity, Big Data Analysis, Security, Platforms
- Innovative Frugality: Innovation, Financial constraints, Standards, Business Opportunity, Foster Social Acceptance
- A marketing challenge: making sustainability “cool” or necessary
- We need to show concrete examples with tangible benefits
- Identify industry opportunities in multiple different vertical markets
- Policy challenges due to ICT-driven disruptions are just starting: the problems will get exponentially more challenging without increased science-society dialogue
- Fully integrate the ICT industry into the circular economy (e.g. e-waste)

What are the related business opportunities and how can they foster social acceptance of sustainable ICT solutions in these verticals?

What have been the most important insights from your conversations?

- Would a fair price for CO2 emissions solve all financing problems for SDG?
- Funding & Taxes – lifecycle issues: e.g. ICT 18 to 36 months Vs Roads 20 years
- In the future, should some (or all) ICT-enabled services be considered as essential services?
- Should governments pay for ubiquitous ICT infrastructure? Or are private – public models (e.g. open access) adequate?
- In a globalized world, how can digital services be effectively regulated?
- The proper balance must be achieved between and regulation and deregulation
- ICT-enabled transformations will quickly grow demand for new types of jobs and therefore new skills. However, governments generally do not seem to even be questioning which skills will be needed and thus what new training/education programs should be put in place. Universities have a key role to play in this transition and must proactively engage industry (ICT and vertical markets) in this regard
- Ethical challenges will greatly increase: who sets the limits?
- A focus on sustainability changes the scope of values. Value for money remains essential but is not sufficient as environmental and social value are of equal importance.
- Trust in the big ICT players (e.g. Facebook, Google, etc.) is an issue: What are the benefits & for whom?

Young Professionals Green ICT Awards

Young Professionals were invited to contribute to this open dialogue about Earth's future. The

first IEEE Young Professional Green ICT Idea Competition focused on contributing ideas on Greening ICT itself and Greening through ICT various application sectors of ICT, i.e. with a goal of not only creating “Sustainable ICT” but also enabling transformative change across society through “Sustainability by ICT”. 30 proposals were received from around the world, including: Australia, USA, Pakistan, India, Finland, Canada, Kingdom of Bahrain, Sri Lanka, Italy, Germany, Madurai, South Africa, Spain and South Korea. Both winners received free attendance, trip and 2 nights’ accommodations to attend the *IEEE Greening through ICT Summit* in Paris, 500 Euros cash reward; and 5 minutes of time for publicly presenting her/his idea at the *IEEE Greening through ICT Summit*. Exceptionally, a third winning proposal was also selected as shown below.

- **Hasan Farooq: Improved Energy Efficiency in/by ICT**
 - Hasan Farooq and Ali Imran (USA) proposed the following project under the Energy Efficiency Theme: *the AURORA Framework (spAtiotemporal User activity and mobility pRediction empowered prOactive eneRgy sAving)*, which builds on a proactive approach to maximize the energy efficiency in emerging ultra-dense networks.
- **Alis Daniela Torres: Improved technology life cycle management**
 - Alis Daniela Torres, Spain, proposed the following project under the Life-cycle Management Theme: *City E-waste Platform: towards a sustainable management of E-Waste in Smart Cities*.
- **Srividya V Prasad: A special 'Very' Young Future Professional idea**
 - 12-year-old Miss Prasad presented a most compelling project on reducing the impact of car pollution by proposing emission sensors to be positioned at toll booths to charge access fees to highways according to vehicle emission levels.



- Develop standards to promote the design and implementation of sustainable ICT; and facilitate ICT for sustainability
- Further the development of Sustainable ICT standards in the Sustainable ICT initiative as well as in the Computer Society's Technical Community on Sustainable Computing
- Sustainable ICT targets:
 - Objective: Energy efficiency and minimal greenhouse gas emissions across the lifecycle of ICT equipment and processes
 - Metrics and methodologies
 - Models and methods, best practices
- Greening through ICT:
 - Use of ICT to improve the sustainability of non-ICT equipment and processes
 - In a major vertical application domain such as Smart Cities, identify and further develop technical best practices across the following functional and application domains of urban infrastructure systems: sensors and Intelligent electronic devices, communication networks & cyber security, systems Integration, intelligence & data analytics, and management & control platforms (Smart Cities initiative)

Break down silos between the research communities of various IEEE Societies

- Fundamentally reducing power consumption in the world's ICT backbone requires contributions from not just the hardware designers (where the power dissipation happens that leads to low efficiency) but also from the signal designers and the network operations communities.
- The entire community within IEEE must be involved.
- Before this can happen though, the entire community within IEEE must be in a position that all individual research efforts directly contribute to the overall objective. As of now, this does not happen because research happening in one set of Societies does not 'plug-in' to the research of other Societies.
- We within IEEE are actually at cross-purposes, and this is a fundamental problem. A Board-directed mechanism should to be established to incentivize Societies to have research results that do mesh cleanly among each other. At a minimum, this requires that Societies agree on units of measure for research results.
- This fragmentation also makes it difficult for IEEE to speak with a unified voice to external groups and namely non-technical (e.g. policy) communities.

Leveraging the trusted IEEE brand

- IEEE offers a recognized brand in the research and industry communities, known for the quality of its trusted content.
- IEEE is not usually a creator of content, but more a curator: IEEE publishes papers, organizes conferences, and helps prepare standards; the people who actually write the papers, come to conferences and develop the standards are the specialists, the subject

matter experts such as the ones participating in this event. It is important for all those involved to realize that IEEE is a facilitator.

- As such, IEEE offers significant added value to develop standards and notably sustainable ICT standards for which a broad set of competencies is typically required.
 - Standards provide clear and consistent environmental performance criteria for the design of ICT products thereby providing an opportunity to secure market recognition for efforts to reduce the environmental impact of ICT products.
 - Standards provide tools for governments, institutional, corporate and consumer purchasers. Product manufacturers may use this tool to earn recognition in these markets, recognizing that certain criteria may not be applicable to all types of purchasers. Applicability can be specified in each individual standard.
 - Standards offer a defined and measured environmental leadership in the design and manufacture of ICT products, the delivery of specified services that are associated with the sale of product, and in associated corporate performance characteristics.
 - IEEE provide opportunities to network with industry peers and broaden understanding of industry and technology, as well as gain familiarity with the content of standards in which one is involved - facilitating early compliance and anticipating market requirements.
 - IEEE provides a globally open, inclusive, and transparent environment for market relevant, voluntary consensus standardization
 - Some standards innovation spaces to target for sustainable ICT and sustainable through ICT:
 - ✓ Internet of Things
 - ✓ Augmented Reality
 - ✓ e-Health
 - ✓ Smart Grid
 - ✓ Cloud Computing

World Café Round 4 on IEEE Perspective:

Participants discussed these issues in groups of four for a final fourth round and, as always, with different table partners than in the previous three rounds. In the spirit of a strategically-oriented session, the discussion was organized as a *SWOT* (strengths, weaknesses, opportunities and threats) analysis of IEEE with respect to the sustainability through ICT challenge.

What are IEEE's strengths with respect to the sustainability through ICT challenge?

- IEEE's consensus process is core to its credibility: moves quickly once established
- Strong reputation for competence, knowledge and skills: technical expertise on a very broad list of themes required to fully address sustainability through ICT
- Massive, worldwide membership (430,000)
- Neutrality

- Trusted brand with strong recognition in the academic and industry communities
- Networking medium between academia and industry
- Core assets (publications, events, standards and education) have a large customer base

What are IEEE's weaknesses with respect to the sustainability through ICT challenge?

- Lack of sufficient integration and common set of services throughout Societies (different Societies "*speak a different language*")
- Volunteer leadership and standard consensus processes can delay development
- Resulting consensus can be suboptimal
- Academic and industry views can be difficult to reconcile
- Individual members may defend employer's specific interests
- Lack of broad life cycle view, too focused on use phase
- Lack of social, environmental and economic expertise
- Lack of public policy community membership and involvement
- Organization may be seen as too technical and too complex by the policy community

What are the opportunities for IEEE with respect to the sustainability through ICT challenge?

- Develop a flagship IEEE conference on insights with respect to technology and technology impacts specifically for non-technical communities
- Seek to be the "Go To" source of technical advice to policy makers at all levels of governments and develop products (education / training, events, publications) specifically for them
- Seek a presence and have a voice at major international events (e.g. Davos World Economic Forum)
- Create an continuous, bidirectional information flow process with the policy community and provide them support to be more proactive with respect to the impact of disruptive technologies
- Target and involve more young professionals on the sustainability through ICT challenge as it is typically a very relevant issue to them
- Work with the business community and management academia on new business models enabled by disruptive technologies
- Increase the promotion of standards, "labels" and certification processes defined in IEEE
- Work with advocacy, policy & economic groups to further promote IEEE ideas
- Provide leadership in new areas of sustainability for IEEE such as the circular economy, sourcing of raw materials, etc.

What are the threats for IEEE to be a credible voice with respect to the sustainability through ICT challenge?

- Time to define, apply and adopt standards in a world that changes very quickly

- Lack focus – may dilute results
- Lack of collaboration between Societies, silo fragmentation
- Complexity to organize the overall solution
- Remaining too theoretical
- Reduction in industry membership
- Funding variability of targeted actions within IEEE
- Variable industry interest in specific standards
- Diverging goals of stakeholders within IEEE

Next steps - A call for action – A Co-creation exercise

A Smart and Sustainable World through ICT

Summarizing the different perspectives: Wrap-up and 'now getting real' discussions

The Greening through ICT Summit's main objective was to identify challenges and solutions to achieve sustainability in ICT and more broadly, through ICT in various fields of human activity. The issues discussed were generally either of the technological, economic or public policy type and of greatest importance either for the ICT industry, its vertical markets, governments (policy community) and IEEE.

As the event came to a close, the participants provided further input in a final plenary session and agreed that identifying a short list of tangible actions from the co-creation exercise with such diverse communities proved to be somewhat of a challenge in itself. Following the event, the organizers thus built upon the trends identified in that final session as well as the issues raised throughout the event to present the following concise list of eight industry actions and eight policy area actions that can help us “get real” about ensuring for our world a digital transformation which will truly be sustainable.

Industry actions:

- Develop sustainable ICT standards and certification processes
- Introduce sobriety in design (e.g. eco – software engineering) and leverage ICT evolution (e.g. virtualization, AI, battery technologies, etc.) for sustainability purposes
- Promote new ICT-enabled business models and best practices deriving added value from sustainability such as adoption of business KPIs and calls for tender incorporating sustainability metrics, standard compliance testing as well as raising awareness that sustainability is good for business.
- Move the ICT industry towards the circular economy (e.g. e-waste reduction)
- Promote in the public sphere, e.g. through GeSI and IEEE's large global membership, the sustainability-enabling opportunities of ICT
- In the smart city environment, leverage automated data analytics and context awareness to address the scalability and seamless integration of heterogenous sustainable ICT solutions for different verticals
- Design testbeds for holistic system testing, business democratization and public awareness purposes
- Break down the silos between IEEE Societies and leverage the organization's comprehensive, neutral ecosystem of technical competence across the materials, energy and ICT domains to become the premier source of advice to industry, government and global organization leaders with respect to the impact of the digital revolution and the ensuing sustainability through ICT opportunity.

Policy actions:

- Recognize ICT infrastructure not just as a basic critical infrastructure (just as water mains, sewers, transport and energy infrastructures) but also as a fundamental sustainability-enabling infrastructure
- Ensure policy makers are cognizant of difference between “smart” (interconnected, ubiquitous, dynamic, real-time) and “sustainable” (economically-viable, eco-friendly and yielding social benefits). This implies ensuring that both communications and computing are sustainable not only through their design (industry’s job) but also in their application and adoption
- Link and ultimately integrate policies and regulatory frameworks in the telecommunications and energy sectors, with a focus on sustainability
- Drive, in collaboration with industry, social acceptance of sustainable ICT solutions through education, public awareness and incentives (for both consumers and industry)
- Synchronize and harmonize global efforts and accountability with respect to sustainability by ICT, in the context of differing approaches to ethics and to the balance between regulatory forces and market forces
- Develop fiscal and other types of incentives that reconcile short-term business imperatives (particularly in ICT vertical markets) with longer-term expected return on investments in sustainability
- Adopt proactive policies to ICT-enabled disruptions and stimulate adoption of the corresponding ICT solutions in different economic sectors to avoid social disruptions
- Address privacy challenges in the broader context of data life cycle management

The Summit organizers and the IEEE Sustainable ICT initiative volunteers first wish to thank all attendees for the scope and breadth of their contributions during, and even prior to, as well as after the event. In this sense, they were truly “*participants*” and not just “*attendees*”. With a view towards a second Greening through Summit, the list of actions thus provides a tangible path to move forward the sustainability through ICT agenda. The organizers also acknowledge the continuous support of IEEE and the leadership of its Communications Society and staff in the Sustainable ICT initiative. They also specifically thank Ms. Sabine Soeder and Ms. Karolina Iwa of Co-Creative Flow Inc. for leading the participants through the World Café method and as well to Mr. Jacques McNeill (Technoprise inc.), who not only contributed to the organization of the event but also collected, compiled and organized a great part of the text that formed the basis of this document.

Charles Despins and Jaafar Elmirghani
IEEE volunteers and Sustainable ICT initiative co-Chairs

Let's make the Planet Great again!



Appendix 1 – Post-Summit comments from participants

The following lists, anonymously and in the order they were received, verbatim comments from various participants after the Summit.

Participant 1

First feedback sent right after the Summit:

1. Green ICT as an enabler to a sustainable world will be delivered using a diverse set of services. Standard that support integration and sharing are key to make this happen
2. On Tuesday, we all have great ideas. We need to define the packages these ideas into papers and standard to support transition to a more sustainable world
3. Commercialise our standards. Develop the industry and pass our knowledge on to others as it will take consensus and critical mass before it becomes accepted

Additional comments: I responded a few weeks ago and have been thinking a little bit about what are the important elements in defining Green from the perspective of IEEE.

4. It has to be the ability to develop a set of standards and frameworks which can be reused by anyone in the development of green sustainable solutions.
5. The standards should be generic enough to allow implementation across a wide variety of solutions.
6. Simple enough that we have the ability to define them.
7. Ideally, they should already exist in some form so they have already been developed and proved to be robust.

Participant 2

Here is a summary of my points:

1. Machine learning is now playing an important role for making networks greener. We have now a lot of data on how networks/users move and the networks are becoming more pro-active in the way they manage the allocation of resources
2. All networks are not targeting energy efficiency communications. The work started with the project GreenTouch with the objective of reducing the energy consumption of Networks by a factor of 1000. This goal has been maintained in 5G networks but is the most complicated one to achieve (the goal of reducing the latency of 1ms is also another difficult target to achieve)
3. The key technologies with the aim to reduce the energy consumption are related to Massive MIMO and small cells. Massive MIMO enables a huge factor reduction in the uplink (by having more antennas who can receive the signal) and downlink (through a technology called beamforming)
4. Finally, the move toward the cloud (with Cloud- RAN and Cloud Computing) enables to flexibly pool the resources and therefore reduce the energy consumption

Participant 3

Here are two topics, I think, are interesting:

1. In Greening through ICT, it became clear to me post summit that many would like to sense, measure physical quantities (vehicle flow in city, parameters in a factory, parameters in agriculture or healthcare etc.). This will generate huge data sets. So there is a question of “Greening Big Data”. In essence, if these large data sets are transmitted, they will consume large power in networks. We are however only interested in the “knowledge” contained in the Big data, so how can we extract this knowledge through appropriately located processing nodes to reduce the power consumption of the communications and processing used in “Greening through ICT”.
2. “Cyber-Physical-Environmental-Economic Systems”. It occurs to me post summit that Greening through ICT is an exercise in designing optimum “Cyber-Physical-Environmental-Social-Economic Systems”. So I would like to contribute an article in this area. If you were to consider Greening Transport via ICT. Then the physical system is composed of vehicles, road signals etc. Our ICT networks and processing are the cyber part. The solutions are not going to be adopted unless if we consider social angles, acceptability etc. (Social can be in the acronym, we can add it). The solutions have to benefit the environment and have to make economic sense. So ,casting our Summit “Smart must be Sustainable” moto into a CPEES or CPSEES framework can help researchers and practitioners come together and develop joint models and approaches that ensure the success of GtICT by jointly considering in one mathematical model or one policy framework, or one implementation etc. to the 5 components: Cyber, Physical, Economic, Environmental and Social angles.

Participant 4

As for my feedback, I would like to back to some of the point I shared earlier:

1. Since the concept of Green ICT concept can be applied over a large spectrum (from ICT/telecom sector itself e.g., efficient service provider equipment, user equipment, ICT/Telecoms processes, design, to the use of ICT for other sectors/ sustainability), it is important to define what aspect/part to tackle first.
2. The second point is: how to measure Green ICT and what are the incentives/rewards for going green with ICT. Unless people feel like there is an incentive/reward, green in general feels like responsibility.
3. The third point is about the support system. What would be the system that supports green ICT? It may be important to define the whole (end-to-end) concept/system of Green ICT.
4. As for the verticals, I think it can be good to define some priority verticals such as (maybe) agriculture, transport.
5. Finally, policy is important to achieve Green ICT at scale. A

For the White paper, I will be happy to contribute.

Participant 5

Thank you for organizing such an interesting event. It was great to see so many fellow Canadians as well. Two points that come to mind that I would highlight if it is not too late:

- The need to look at the full lifecycle of connected devices. Device energy and environmental footprint is dominated by production and disposal, so we must also look at improving efficiency during manufacturing as well as safe and efficient recycling/disposal. Another area of interest is standby power consumption of connected devices.
- The need to better understand and characterize the potential rebound effects of digital technologies – direct and indirect. A good paper that explores this topic is [Horner, Shehabi and Azevedo \(2016\)](#). For example, highly automated cars are likely to reduce perceived cost of time of driving (i.e. users will be able to work / do other things) and could substantially increase travel activity (and energy and emissions). Same goes for IoT and smart appliances/thermostats in the home – this could offer greater comfort but could mean greater energy use to provide new ‘services’ or energy for networked standby. Policy and regulations will need to play a role here if we are to limit these rebounds to maximize the greening potential of ICT.

IEA has just released our first report on the wide-ranging impacts of ICT across the energy system (it includes a chapter estimating energy use of data centres and networks as well). I would appreciate it if you could share the report through your networks: <http://www.iea.org/digital/>. Or re-tweet, e.g. <https://twitter.com/IEA/status/928548038767009792>.

Hopefully our report will be a helpful resource for the whitepaper as well. Thank you!

Participant 6

Thank you again for the invitation. Very good Green ICT launch meeting. Not being an IEEE member, I do not know to what extent I can make an official contribution. I am interested to bring the subject of eco-responsible software and see how for example:

- IEEE can continue a contribution by use case, on the methodological guide of the ACV that we co-authored with Orange including Marc Vautier. Attached English version
- IEEE can also get closer to label or label initiatives
- I think that the weight of the IEEE can be decisive in the credibility, the deployment and the adoption of a future certification.

I remain at your disposal for further exchanges.

Participant 7

It is clear that fundamentally reducing power consumption in the world’s ICT backbone requires contributions from not just the hardware designers (where the power dissipation happens that leads to low efficiency) but also from the signal designers and the network operations communities.

In other words, the entire community within IEEE must be involved. Before this can happen though, the entire community within IEEE must be in a position that their individual research efforts directly contribute to the overall objective. As of now, this does not happen because the research happening in one set of Societies does not 'plug-in' to the research of other Societies.

We within IEEE are actually at cross-purposes, and this is a fundamental problem. A Board-directed mechanism needs to be established to 'force' Societies to have research results that do mesh cleanly among each other. At a minimum, this requires that Societies agree on units of measure for research results.

Participant 8

I would go for White paper titled:

- One Planet, One IEEE and One Goal
- One IEEE and One Green Planet
- Let us make the Planet Great again!

I would like to concentrate on building a framework around various verticals. It is important to look at the issue of "Green" holistically rather than in a segmented way. Segmented view is easy to address but not really useful in a long run.

- What are the non-technology aspects?
- Who are the non-technology players?
- Who are the binding agents?

I would like to provide some directions for these. And would be happy to support in making this whitepaper.

Many thanks for organizing the exciting IEEE GtICT Summit. The world café workshop concept has been very inspiring.

Participant 9

I am looking forward to the White Paper draft/ skeleton. Personally, I would be interested in contributing to White Paper sections covering:

- (Accurate) modeling of the sustainability balance of ICT
- Mobile communication standards (4G, 5G, ...) as part of sustainable ICT

Participant 10

Thank you very much for including me in the IEEE Green ICT Summit. It was a true pleasure working with the participants and the mix of different skills and expertise levels were well chosen. Here are some thoughts which you can consider for the white paper:

> Overarching goal:

ICT can contribute to a significant improvement of the living conditions of people (education, transportation, work, sleep, entertainment) in general (make the planet a

nice place to live for everybody). In order to operate the necessary ICT infrastructure, we need to ensure that we are using green/renewable energy sources as much as possible. In order to make the ICT infrastructure affordable, the application of standards is essential, this will lead to competition between different ICT service providers and lead to a balance between demand and supply of ICT services. However, innovation is a key driver to improve ICT services (quality/cost) and innovation typically requires establishing new standards or redesign existing standards.

> The impact of the shared IoT economy

There is no doubt that shared IoT services can increase the demand for those services and we need to ensure that this does not lead to a deterioration of services given infrastructure limitations.

> The funding of ICT infrastructure

It is important that ICT system providers do not rely on government funding alone to build the infrastructure base, however – private funding is typically limited to the most profitable ICT services. The government needs to create a balance between stimulating market forces where private sector invests in ICT infrastructure itself and to subsidize ICT infrastructure when for social reasons the ICT service needs to be provided in a certain quality.

> The power of innovation

Importance sources for innovations are universities as well as VC-funded start-up's. They quite often follow technology approaches which are striving to disrupt existing solutions. Large companies need to proactively understand how innovations can impact their business. Instead of trying to fight the changes that come with innovation, they need to embrace them.

> What can IEEE do ?

It is important to involve multiple IEEE societies to support the IEEE Green ICT initiative. I strongly suggest to develop use cases which could be visualized via a short movie which could be promoted via IEEE. Furthermore, we could work with universities and private companies to develop prototype solutions which can be showcased at suitable IEEE events/conferences of the participating societies (or organize an interdisciplinary conference lead by the initiative).

> What can ITIC do?

My suggestion is to develop a partnership between the ITIC Testbed Alliance and the IEEE Green ICT initiative. The testbed alliance addresses AI-based sustainable mobility services for smart city environments. That means that the different testbeds require ICT infrastructure to validate the mobility services which in return need to be optimized from an energy perspective.

Hopefully my comments were helpful. Thanks again for the opportunity to attend a well-organized conference in Paris.

Participant 11

I found that the World Café was very well organized and interesting as a format, favoring meetings and exchanges. I saw that the angle of attack varied according to the speakers, there were those who insisted on the "greening" of the ICT (notwithstanding the "rebound" effect ...), those which insisted on the potential of the ICT for the greening of society (notwithstanding the development of superfluous services ...), and those who were rather on a sales approach. It was interesting to have all these points of view.

Participant 12

- Think « life cycle » and not only energy consumption during use phase - but raw material, recycling, reuse, increase lifespan.
- Consider the rebound effect associated to each innovation that should help us to reduce our environmental impact
- In our battle to reduce environmental impact of electronic & ITC solution we have to reduce resources consumption to software.... Software is everywhere and software consume more and more resources (CPU & RAM)
- Think sufficiency when we must develop a new service or product... deliver only the requested services

Appendix 2 – Comments from the World Café rounds

This appendix lists raw Summit participant comments scribbled on the paper table cloths during the four World Café rounds. The numbers in bold are irrelevant and simply refer to digital pictures of the tablecloths.

World Café Round 1: Industry Perspective:

What is the industry doing already and what more could it do to make ICT even more smart and sustainable?

- **DSC-4928**
 - ✓ Preloaded Software to Reduce Integration Time
 - ✓ Education
- **DCS_4945**
 - ✓ Business Models: Secure/Convenient/Ecosystems
 - ✓ Social Acceptance: Privacy/security – divide society, Uncertainty – fear
 - ✓ Technology is out there already – use it smartly
 - ✓ Business Opportunity – “democratization of business”
 - ✓ Nothing is as brilliant as an idea at the right time
 - ✓ Sales acceptance is about reducing uncertainty: Simplicity, security, contingency
 - When timing is right
- **DCS_4966**
 - ✓ Cyber Security: Data protection
 - ✓ Education of population
 - ✓ E.V.: Battery capacity: thermal
 - Infrastructure (charging Station)
 - Industries need to offer more choices
 - ✓ Interoperability of the technology is a challenge (technologies, borders, etc.)
 - ✓ Business Opportunity to revitalize industries, ex automobile services and goods
 - ✓ Analytics:
 - Better machine learning, sensors: maintenance
 - AI
- **DCS_4968**
 - ✓ TCO Approach
 - ✓ Change the model
 - ✓ Functionally
 - ✓ Increase life span of material, hardware, devices
 - ✓ Translate Green into key business indication for industrial
 - ✓ Profit by opportunities for business or wait for constraint?
 - ✓ Top-down strategy in organization and comply management
 - ✓ Make it key indicator in company.

- **DSC_4974**
 - ✓ To challenge a room of key experts: then as more intelligent questions:
 - New Material for lifecycle
 - Have a better understand of the impact of the technology
- **DSC_4976**
 - ✓ Energy efficiency was an afterthought in some systems.
 - ✓ You don't get what you don't pay for
 - ✓ What is industry doing already?
 - ✓ Corporate Commitment
 - ✓ What can be done to make ICT more sustainable?
- **DSC_4979**
 - ✓ Educate people in the company.
 - ✓ Improve communications of industry efforts
 - ✓ Embed sustainability mindset in the core of the business
 - ✓ Business models
 - ✓ What in it "ICT even more smart and sustainable!"
 - ✓ Different visions
 - ✓ Promote entrepreneurship
 - ✓ Solar energy in the services
 - ✓ Recycling promotion
 - ✓ Definition of sustainability evolves!
 - New thoughts
 - More commitment
 - Align
 - Embedding Education in the organization
 - Diversity
 - How to map individuals to concrete action
- **DSC_4982**
 - ✓ Lifecycle
 - ✓ Lifetime of products
 - ✓ Evolve product
 - ✓ Incorporate standards between competitive companies
 - ✓ Compatibility between product and connectivity
 - ✓ International standards
 - ✓ Increase the rate of software in hardware/software models
 - ✓ Design and drive innovation
 - ✓ Inter-disciplinary
 - ✓ Smart sustainable
 - Stop incompatibility (with standard interfaces to restrict company business)
 - ✓ Increase lifetime (stop re-descriptive of product)
 - ✓ Minimize hardware – maximize software (no waste); common use of hardware (avoid doubling)

- ✓ Public Policy = contains or work in
- ✓ Limit consumption = avoid useless: data, functionalities, performance (number of pixels)
- **DSC_4970**
 - ✓ ICT (in a circle with the following bullets surrounding the circle)
- ✓ **IMG_0722**
 - ✓ Public sector
 - Education & public awareness
 - Policy, education programs
 - Governance
 - ✓ €\$
 - ✓ New business models including: ecommerce, sharing economy
- Helping less fortunate people
 - ✓ Performance – Focused Software Code
 - ✓ Can ICT help VOC Reduction?
 - Volatile organic compound
 - Strong pollution in developing countries
 - ✓ And more?
 - ✓ Social Aspect
- Bridging the digital gap
 - ✓ Circular Economy ?
 - ✓ Whole life cycle to consider for ICT
 - ✓ Accelerate the adoption of renewable energy
 - ✓ Doing already
 - ✓ Energy saving – a lot – CO2 reduction
 - ✓ Waste !!!
 - ✓ Improves efficiency
 - ✓ Energy – Renewable energy
- Hardware
 - ✓ Waste – Software
 - ✓ Social education
- ✓ **DCS_4975**
 - ✓ Industry doing well on green IT?
 - 4/10
 - 5/10
 - 3/10
 - 3/10
 - ✓ What to do?
 - Industry takes the leadership
 - More connections between stakeholders/designers
 - Green ICT must be a higher priority (innovation, costs...)
 - More consistency in industry strategies/practices

- ✓ How to engage SMEs
- ✓ **DCS_4917**
 - ✓ Electricity prices based on level of consumption (large consumption gets penalized)
 - ✓ Global policy: global carbon price
 - ✓ Country level – framework to allow green solutions
 - ✓ 2000 Watt socially
 - ✓ Sell PV electricity to your neighbor
 - ✓ Who should take responsibility for policy changes, industry, customers, government?
 - ✓ Governments discipline the industrial responsibilities, meanwhile educate the consumers to address the industries to adjust the business models.
 - ✓ Education is very important to change the way to think.
 - ✓ Government's incentives not only for industries and consumers too.
 - ✓ Not just regulated but market frameworks.
 - ✓ Define the business models.
 - ✓ Local actions are very important.
 - ✓ Government regulate the price/incentives.
 - ✓ Government's initiatives lean to the projects more greener and sustainable to impact the research activities both academically and industrially
- ✓ **DCS_4972**
 - ✓ International tax for carbon redistributed – how to achieve this
 - ✓ Country philosophies:
 - ✓ China – top down, government to regulate
 - ✓ North America – profit driven business industry to drive
 - ✓ Education – government, consumers
 - ✓ Government & industry define a business model which leads to green ICT
 - ✓ Local government regulated pricing for energy usage as in California bigger users pay higher price.
- ✓ **DCS_4972**
 - ✓ A lot being done already – but lack exact/accurate understanding of status and data
 - ✓ Accurate modeling (e.g. by ICT Green) for different sectors of consumption and reduction of energy CO₂ / resources
 - ✓ Holistic picture & analysis
 - ✓ EC major factor of OPEX ↑
 - ✓ Mobile networks initiatives = Energy saving SON Use case
 - ✓ AI + Data analytics = Way to go
 - ✓ Make the electrical grid smarter could reduce the carbon footprint
 - ✓ Apply ICT in other sectors which could get more impacts.
 - ✓ Benefit from expertise from other sectors to position ICT's impacts more property.
 - ✓ How to measure the ICT's impacts not just for ICT sector, also for other sector? (GHG Protocols).

World Café Round 2: Public Policy Perspective:

What policy changes should be adopted at national, regional and municipal level to achieve sustainability through ICT? What changes has been already made?

What policy changes need to be done?

What have been the most important insights from your conversations?

- **DCS_4934**
 - ✓ Reduce Duplicate Data – no need to take 10 photos of same building/same shot
 - ✓ Green Tax
 - ✓ Global Synchronization
 - ✓ Clarify/Prioritize what is really green, what is the real footprint
 - ✓ Create label for better lifetime
 - ✓ Start by education, be green “focus on Useful”
 - ✓ Must really cut down standard
 - ✓ What changes in the policy
- **DCS_4936**
 - ✓ Locally -- Policy can have impact on Mobility, food, pollution
 - ✓ Check Policy Implementation
 - ✓ Adaptive Regulations
 - ✓ Full Life Cycle Regulations
 - ✓ Improving Policies influencing business models (fees, rewards ...)
 - ✓ More quality data and research modeling
- **DCS_4940**
 - ✓ Study: 20% increase of data and energy due to 4K TV in UK
 - ✓ Increase Solar: Demand on supply & storage
 - ✓ Distribution System Operator – independent systems operator – command affects (opening) in production and loss connected distribution operations
 - ✓ 1# Energy Savings by lowering/controlling voltage (8%V) in the grid
 - ✓ Carbon Tax – BC Example
- **DCS_4942**
 - ✓ Empower consumers to promote innovation
 - ✓ Encourage consumers to engage
 - ✓ Energy Efficient – maybe more sustainable
 - ✓ Standardization
 - ✓ Innovation
 - ✓ Public Procurement
- **DSC_4970**
 - ✓ ICT (in a circle with the following bullets surrounding the circle)
 - Policy
 - Enables for sustainability
 - Education
 - Society

- Green Outside
- Green Inside = A propriety / Operators
- Needs to be Green inside to be credible
 - Proof? Is ICT really doing what it takes?
- Hardware Manufacturers
- Besides all the process – green like to the other left
 - All the lifecycle = all the actions
 - Top down approach
 - Green impact and business impact
 - TCO
 - Circular Economy
 - Consider social impact = customer
- **DCS_4987**
 - ✓ 2 policies
 - ✓ Sustainable Software = higher batter life of your phone – Where does the energy consumed, in the software or the display?
 - ✓ Business Case: How do we put sustainability into:
 - ICT projects are very difficult to deliver
 - Everyone (most) believe in sustainability but they have to deliver
 - Paris will be created not by a country project.
 - Paris will be delivered by millions of small projects
 - How do we get sustainability into these millions of views
 - ✓ What is the industry? Too Simple
 - ✓ How to integrate sustainability?
 - Focus: Core element from a lifetime perspective
 - Early involvement: Get direction from start & clear management acceptance including business impact & cost
 - Follow-Up: Secure execution through regular follow-ups & tracking of progress
 - Utilize benefits: Communicate, engage interaction & externally.
 - ✓ Swedish ICT CO2 trends skyrockets from 2010 to 2015
 - ✓ No more sustainability strategies. Focus on sustainable business strategies
 - ✓ Integrate into core business offerings as opposed to features & niche projects
 - ✓ Measure CO2 Vs Energy efficiency
 - ✓ Have developers integrate and label showing the energy efficiency
 - ✓ How to enable policies to be updated quickly when needed
 - ✓ Consumers are pushing to have better products
 - ✓ Energy consumption in Sweden has been flat since 2010
 - ✓ What is industry doing and what can it do more?
 - ✓ GeSI Break linkage between economic growth and energy consumption
 - ✓ Need to deploy more connectivity to non-connected locations in order to capitalize on benefits from Green ICT

- ✓ How can IE be an enabler& Robots: start clean slate
- ✓ Architecture of network
- ✓ Need to focus on policy eg world bank infrastructure not going to ICT today
- ✓ Consider end of life equipment
- ✓ Tax Vs subsidies needed to drive also need new business model
- **IMG_0728**
 - ✓ People will only do what they are measures against:
 - Change the measurements to change the behavior
 - True Leaders will do things they know will cause them trouble; and are usually low on the totem pole ☹️
 - Local, not global tendency
 - Education: Lessons/Inform on Green IT
 - ✓ Where do we start?
 - Politicians? Economic issues
 - An ecological man to be elected (true leaders)
 - Big companies?
 - People?
 - ✓ How break it? Education, Ecology, cheaper
 - ✓ What policy changes need to be done
 - Global
 - Regional
 - Local
 - ✓ National
 - Support education programs
 - Policy must provide new KPI measurements incentive
 - ✓ VP in local optima global?
 - Global: Long-term perspective, "Education"
 - IEEE should participate in Elections
- **DSC_4952**
 - ✓ What policy changes need to be done?
 - Need to find the right geographical level (global vs regional vs country)
 - Don't limit innovations
 - Remove "bad" products
 - Find appropriate policies (e.g. financial incentives) for SME's, with easy registration processes
 - Make sure that policy changes are in line with macro objectives, e.g. the Paris Climate Agreement or UN SDG
 - Policies must promote education/raising awareness on all levels, individual to companies
 - ✓ Needed infrastructure
- **DSC_4961**
 - ✓ Technology Impacts / Green, Health Impacts

- ✓ Norm, label, Business Driver
 - IOT: User experience, Maintenance, Battery
 - Mobile:Autonomy (user experience)
 - DTC\$, costs
- ✓ Valuable for consumer = Acceptance, Commitment
- ✓ Local technology impacts ≠ Global Technology Services Impacts
- ✓ Think global
- ✓ Connectivity between electricity actor and IT actors (interoperability)
- ✓ LCA impact of new service (label driven by city? Lab)
- **DSC_4932**
 - ✓ What policy changes have to be done?
 - Standardize standards
 - Recognize ICT's as a fundamental enabling infrastructure (much like energy, water, roads, etc.)
 - Develop policies, private-public partnerships to make ICT infrastructure access available, affordable, performing (latency, speed and secure)
 - Stimulate digital literacy
 - Adopt proactive policies to ICT enabled transformations to avoid social disruptions
 - Adapt policies to accommodate various perceptions of privacy
 - ✓ Long-term, Short-term, Build to last
 - ✓ "Approval" ↔ Advocacy groups
 - ✓ ICT is 5 Y infrastructure and Gov. 10-20 years
 - ✓ COS (profit /unit sold) – ICT (profit/ ?)
- ✓ **IMG_0719**
 - ✓ What policy changes?
 - ICT specific sustainable goals
 - Tax Reduction & Incentives (\$)
 - Utility/Telco
 - Building consensus in industries
 - Regulated vs competing markets?
 - Sustainable label & certification in RFP/... for ICT
 - Measurement & information on energy levels for ICT
 - More global/worldwide policies
 - Clear & demonstrated financial benefit
 - Government awareness & education
 - Companies & Gov's sustainability ratings
 - Government goals

World Café Round 3: Smart Cities Perspective:

What technical challenges remain to make sustainable ICT a reality in these verticals?

- **DSC-4919**

- ✓ Life Cycle Management
- ✓ Its a must due to volume and natural resources +
- ✓ Challenge on the need to increase lifetime of equipment, etc.
- ✓ Data – too much data; do we need it all? Will we manage and use it effectively?
- ✓ Not only technical issue but mainly a behavior change (consume less & better)
- ✓ Standards – Compatibility between solutions?
- ✓ Difficulty in having same standards & protocols between different suppliers
- ✓ What technical challenges Remain?
- ✓ Technologies are already well advanced – we can/need to tap the existing potential
- **DSC-4921**
 - ✓ People can fly key
 - ✓ Paris – policy – ISO – 5001
 - ✓ Benefit Type – GOP – additional cost – why do it – Consumers must know – why should I do it
- **DSC-4923**
 - ✓ Tech Challenges Remaining
 - ✓ Cross Fertilization – 2 ideas and capabilities eg power systems and ICT
 - ✓ Different timescales – eg, power (20+ ears lifetime); ICT (2-3 Years)
 - ✓ Reliability
 - ✓ Brokers = eg, electricity company resells energy to solar cells
 - ✓ ICT Challenges are being addressed by proper legal frameworks.
- **DCS_4947**
 - ✓ Green Washing – Real change, continual improvement
 - ✓ Conscious ethical commitment
 - ✓ Insight understanding
- **DCS_4949**
 - ✓ The technologies are already there
 - ✓ Green must be profitable and go into money thinking
 - ✓ Green is too much a consequence and not a strategy yet
 - ✓ Develop the service economy
 - ✓ Optimize algorithm
 - ✓ Mobile operators for 5G – more data, more energy consumption
 - ✓ Think big is not always the solution
- **DCS_4956**
 - ✓ Smart Villages
 - Connectivity
 - Big Data Analysis
 - Security
 - Platforms
 - Related industry opportunities in different verticals? - Smart Applications
 - Car sharing
- **DCS_4958**

- ✓ Think Lifecycle
- ✓ Innovative Frugal
 - Innovation
 - Financial constraints
 - Standards
 - Fair Phone
 - Business Opportunity
 - Foster Social Acceptance
- ✓ Not Green – Frugal City
- ✓ **DCS_4926**
 - ✓ Avoiding cross-communication
 - ✓ Energy efficiency must be measured
 - ✓ Energy harvesting: There should be no need to change batteries
 - ✓ Upgradability
 - ✓ Security
 - ✓ A marketing problem: Make sustainability “cool” or necessary – the ice is melting (parents/kids); Sustainability = Status
 - ✓ Must put an example in people’s hands
- ✓ **DCS_4954**
 - ✓ Cities: Cars, Buildings, Trash
 - ✓ Cloud → Big data analysis (big data centers)
 - ✓ Edge: Small little area, Quick results
 - ✓ What all the data for?
 - ✓ How to change our habits?
 - ✓ APIs
 - ✓ Smart Cities → Smart Villages: Connectivity, Big data analysis, Security, Platforms
 - ✓ Related industry opportunities in different verticals?
 - ✓ Smart applications (car sharing)
- ✓ **DCS_4930**
 - ✓ What technical challenges remain to make sustainable ICT a reality in (these) verticals But the challenges are just starting, all the problems remain and get exponentially more challenging
 - ✓ Uncomfortable disruptive
 - ✓ What technology will exist in five years?
 - ✓ What are the new opportunities
 - ✓ Investigate, educate, create
 - ✓ Comfortable: Circular economy & Green ICT

What are the related business opportunities and how can they foster social acceptance of sustainable ICT solutions in these verticals?

What have been the most important insights from your conversations?

- ✓ **DSC_4981**

- ✓ Would a fair price for CO2 emission solve all financing problems for SDG?
- ✓ Funding & Taxes: ICT 18 months Vs Roads 20 years
- ✓ Not = technology drive
- ✓ Commodity Vs Essential services
- ✓ Government should pay for the infrastructure
- ✓ Public services (just like roads) – regulated
- ✓ Policies
- ✓ Better labelling of the products
- ✓ Awareness
- **DSC_4938**
 - ✓ Financial incentive (taxation)
 - ✓ Responsive policy formulation
 - ✓ Winner takes all
 - ✓ Governance of the web, governance of the blockchain
 - ✓ Taxation – bonus – value on use of energy
 - ✓ Eco functionality
 - ✓ Changing landscape: different actors and different goals
 - ✓ Think global – regulation on digital services
 - ✓ KPI eco-design, score
 - ✓ Not hardware economy driven – services, functionality, economy Happy & \$
 - ✓ Fair competition
 - ✓ Bonus, marketing for green/dirty
 - ✓ Services access – tax ?
 - ✓ Right balance: regulation/deregulation
 - ✓ Market choice, law opportunity/constraints
 - ✓ TCO in public
 - ✓ Call for tender
- **DSC_4964**
 - ✓ Business opportunity / Social acceptance
 - ✓ Pack of integrated solutions
 - ✓ Pay as you use: choice in terms of usage Vs cost
 - ✓ Manage risk on employment
 - ✓ New skills needed – New jobs but new training/education impact
 - ✓ Ethics: Who sets the limits?
 - ✓ Value for money: Change of scope or values: Environmental, social, benefiting not only the individual but also the community
 - ✓ Trust in ICT players: What benefit & for whom? Not only google...

World Café Round 4 on IEEE Perspective:

What are the Strengths?

- **DCS_4991**
- **DCS_4993**

- ✓ Consensus process is core to credibility: Moves quickly once established
- ✓ Flexible: Technical expertise on broad subjects to lead & support
- ✓ **DCS_4994**
 - ✓ 400,000 people base
 - ✓ Skills
 - ✓ Networking with academic & Industry
- ✓ **DCS_4995**
 - ✓ Education: Journal, Xplore, conference
 - ✓ Standards
 - ✓ Trusted source for science
- ✓ **DCS_4996**
 - ✓ Can make standards
 - ✓ Neutral
 - ✓ Brand value
- ✓ **DCS_4997**
 - ✓ Good industry-academic balance
 - ✓ Publication & knowledge
 - ✓ Expanded network
 - ✓ Reputation
 - ✓ Neutrality
 - ✓ worldwide

What are the Weaknesses?

- ✓ **DCS_4991**
 - ✓ Not sufficient integration or common set of services
- ✓ **DCS_4993**
 - ✓ Volunteer basis delays action / development
 - ✓ Lack of Policy maker audience
 - ✓ Consensus process delays decision
- ✓ **DCS_4994**
 - ✓ Too focused on ‘Use phase’
 - ✓ Not enough broad life-cycle view
 - ✓ Sustainability is not enough operational yet
- ✓ **DCS_4995**
 - ✓ Academic Vs Industry
 - ✓ Lots of old farts...
 - ✓ Different language amongst societies
- ✓ **DCS_4996**
 - ✓ Volunteer based
 - ✓ Individual members may defend specific employer interest
 - ✓ Perceived as too technical for policy makers
 - ✓ Complexity of organization
 - ✓ Standard process may converge to suboptimal consensus

- ✓ Lack of open access to products
- ✓ **DCS_4997**
 - ✓ Social, environmental, economic expertise

What are the Opportunities?

- ✓ **DCS_4991**
 - ✓ Better promote standards defined by IEEE
- ✓ **DCS_4993**
 - ✓ Work with advocacy, policy & economic groups to further promote and advance IEEE ideas – Influencers
 - ✓ Flexible structure allows for advancement of ideas based on merit
 - ✓ I.D. stakeholders that will use the results to guide efforts
- ✓ **DCS_4994**
 - ✓ New fields of sustainability: circular economy, raw materials, human factors
 - ✓ Becoming even more credible
 - ✓ Developing new business models
 - ✓ Greening the image of ICTs
- ✓ **DCS_4995**
 - ✓ 450,000 members
 - ✓ Unknown in Europe
 - ✓ Global growth
 - ✓ Academic & Industry & Government (Davos, etc.)
- ✓ **DCS_4996**
 - ✓ Certification, validation, training
 - ✓ Leverage international nature
 - ✓ Reduce number / unify standards
 - ✓ Create information flow to policy makers (less technical papers)
 - ✓ Flagship IEEE conference on insights for non-engineers
- ✓ **DCS_4997**
 - ✓ Consumer of ICT
 - ✓ Engagement
 - ✓ Services / products
 - ✓ Lead standardization activities & Label
 - ✓ Synergy with standardization bodies

What are the threats?

- ✓ **DCS_4991**
 - ✓ Time to define and apply standards in a world that changes too quickly
- ✓ **DCS_4993**
 - ✓ Need definition of sustainability
 - ✓ Lack focus – May dilute results
- ✓ **DCS_4994**
 - ✓ Losing credibility if too narrow minded

- ✓ Lack of collaboration
- ✓ Being too slow, Remaining too theoretical
- ✓ Having too short-term vision
- ✓ **DCS_4995**
 - ✓ Silo fragmentation
 - ✓ Drop of industry membership
 - ✓ Funding inconsistency
- ✓ **DCS_4996**
 - ✓ Specific industry interests in standards
 - ✓ Is there actual will from industry& (\$ Vs principle?)
- ✓ **DCS_4997**
 - ✓ Diverging goals & Stakeholders of IEEE
 - ✓ Adoption & Standards
 - ✓ Complexity to organize the overall solution
 - ✓ Local customization of solutions
- ✓ **DCS_4989**
 - ✓ Where can we find the science?
 - ✓ Mostly academic papers
 - ✓ Journal, less academic
 - ✓ Governments: no too much
 - ✓ ISO Vs IEEE – What is the limit of ISO governance?
 - ✓ Standards are defined
 - ✓ Communications ICT-IEEE (Smart City) Standards
- **DCS-4889**
 - ✓ We need them to integrate to believe in a common solution.
 - ✓ Communications IoT-IEEE (Smart)
 - ✓ IEEE
 - Where can find the science
 - Mostly academic papers
 - Journals – less academic
 - Governments – not too much
 - Standards: ISO vs. IEEE