ICTs for climate and environmental action in the developing world

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Consider the current situation – a rapidly changing climate
Rising CO2 levels: global tipping point

• If > 2 C warming → Possible irreversible global change!
  – Melting of Greenland ice sheet
  – Large scale weather system shifts
  – Collapse of global ocean current system (THC)
  – Release of natural GHG stores (methane hydrates, etc.)
Causes of climate change & environmental degradation

• Fossil fuel emissions:
  – Power generation (electricity)
  – Transportation

• Emissions from unsustainable land use:
  – Land use changes (vegetation clearing, land degradation)
  – Agriculture (CH4, NOx, etc. from soil)
Scenarios and options for fossil fuels
World primary energy demand

World primary energy demand by scenario

1. Compound average annual growth rate.

Some solutions
Policy solutions? (1)

• Apply the “precautionary principle” to climate change → action must be taken

• Encourage transition to clean energy
  – Promote renewable energy
Policy solutions? (2)

• Remove fossil fuel subsidies
  – USD 523 B @ 2011  up 30% over 2010
  – 6 x subsidies for renewables

• Encourage energy conservation
Policy solutions? (3)

• Diversify energy sources & technologies
  – Promote different types of renewable energy
  – Distributed energy resources (DER)
    • Solar PV, wind, micro hydro, fuel cells, biofuels, geothermal, etc.
Policy solutions? (4)

• Facilitate the creation of energy markets
  – Energy trading
  – Distributed energy resources

• Develop weather proof energy generation technologies
  – Distributed energy resources
  – Renewable energy: fuel cells
Policy solutions? (5)

• Promote sustainable technologies (cleantech)
  – Including clean & renewable energy

• Promote tech transfer

• Consult & collaborate: participate in the UNFCCC & similar
  – Operationalize the Climate Fund & related
Energy policies to keep the 2 degree C target alive (IEA 2013)
Technical solutions

• Promote sustainable technologies (cleantech) & the role of ICTs in such
  – Renewable energy a priority

• Identify, test and adapt for use in the developing world
  – Tech transfer essential
What are the technical solutions to deal with climate change & what role for ICTs?
Kachan cleantech sectors

Eight categories of cleantech

- **Clean energy**
  - Wind
  - Solar
  - Renewable fuels
  - Marine
  - Biomass
  - Geothermal
  - Fuel cells
  - Waste-to-energy
  - Nuclear
  - Emerging
  - Measurement & analytics

- **Energy storage**
  - Batteries
  - Thermal storage
  - Mechanical storage
  - Super-ultracapacitors
  - Hydrogen storage

- **Efficiency**
  - Smart grid
  - Green building
  - Cogeneration
  - Data centers & devices
  - Semiconductors
  - Collaborative consumption systems

- **Transportation**
  - Vehicles
  - Traffic management
  - Fueling/charging infrastructure

- **Air & environment**
  - Carbon sequestration
  - Carbon trading/offsets
  - Emissions control
  - Bioremediation
  - Recycling & waste
  - Monitoring & compliance

- **Clean industry**
  - Materials innovation
  - Design innovation
  - Equipment innovation
  - Production
  - Monitoring & compliance
  - Advanced packaging

- **Water**
  - Production
  - Treatment
  - Transmission
  - Efficiency
  - Monitoring & compliance

- **Agriculture**
  - Crop farming
  - Controlled environment agriculture
  - Sustainable forestry
  - Animal farming
  - Aquaculture

Source: Kachan & Co., 2012
Value of the sustainable tech market

• $7 trillion annual market for energy and transportation alone

• Sustainable tech market valued at $1 trillion now, growth to $3 T by 2020

• In Canada, potential of $60 B / year
  – @ 2010: ~ $9 Billion
  – ~ 700 firms with IP @ sustainable tech sector
  – 80% export or invest abroad


Value of the sustainable tech market


Boudreau, J. 2010. Silicon Valley faces fierce global competition in sustainable tech. mercurynews.com
What can ICTs do?

• Increase the efficiency of energy generation and use, reduce energy losses

• Increase process efficiency to reduce energy & resource losses / waste
  – ICTs are the cornerstone of energy efficiency

• Enhance system integration
How can ICTs do this? By... (1)

• Speeding things up
  – Speed up workflow

• More powerful data analysis & modeling
  – Better intelligence, forecasting & early warning

• Increasing accuracy, reliability and reproducibility
How can ICTs do this? By... (2)

• Dematerialization:
  – e-government
  – e-commerce
  – Travel replacement

• Empowering local decision making
  – Cloud / grid computing

• Facilitating use of renewable energy
How can ICTs do this? By... (3)

• Connecting everything
  – Things, processes & places

• Measuring everything

• Controlling everything
  – Smart controls
  – Connect & control all motors & energy consuming devices (embedded controls)
Trends in ICT development (1)

• Digitization & dematerialization
• Microprocessors
• Internet diffusion
• IPv6
• Broadband
• Cloud computing
• Nanotechnology
Trends in ICT development (2)

• Wireless & mobile device uptake: handheld devices

• Innovations in display technologies:
  – Displays everywhere, bendable displays, etc.

• GIS, CAD/CAM & related visualization technologies
  – Building information modeling (BIM – CAD/Cam for sustainable architecture / design)
Trends in ICT development (3)

• Improved & greener batteries (to power devices)

• The Internet of Things (IOT) & M2M communications
Trends in ICT development (4)

• Sensor technology
  – Wireless sensor networks (WSNs)

• Social networking
  – Create content, apps,
  – Share everything
  – Instantaneous
Sensor technology

- Connect any Sensor
- Using any wireless technology
- To any Cloud Platform

Features
- Ultra low power (0.07uA)
- 80 Sensors available
- 8 Radio Technologies
  - Long range: 3G / GPRS
  - Medium range: Zigbee / 802.15.4 / WiFi
  - Short range: RFID / NFC / Bluetooth
- Over the Air Programming (OTA)
- Encryption Libraries (AES, RSA)
- Encapsulated line available

Early Forest Fire Detection

6LoWPAN / IPv6 Development Platform
Get IPv6 connectivity for each sensor node

Start Here!
- Quick Start Guides
- Complete Documentation
- 2000+ Developers Community!
Examples of sensor applications

http://www.libelium.com/top_50_iot_sensor_applications_ranking/
Application areas with greatest potential, i.e. greatest enabling effect (1)

- World wide early warning systems
  - Sensor platforms & networks: early warning, emergency communications, etc.
  - Macro & micro scale

- Earth observation
  - Sensor platforms & networks:
    - Weather observation & reporting
    - Ecosystem monitoring
    - GEOSS: The Global Earth Observation System of Systems
    - Community / geo mapping: Google Earth, Microsoft Virtual Earth, etc.
  - Macro & micro scale
Application areas with greatest potential, i.e. greatest enabling effect (2)

- Energy efficiency:
  - Green design: building information modeling (BIM) & related
  - Smart grid, smart meters, smart buildings, smart transportation including electric vehicles (EVs)
How does a smart building work? (1)

- Various sensors connected to the BMS measure and report on:
  - Occupancy
  - CO2, CO, NH4, etc.
  - Smoke levels
  - Light levels
  - Temperature
  - Humidity
  - Air flow
  - Video surveillance, etc.
How does a smart building work?

(2)

- Readout of data from sensor networks: done by a smart meter
- Network of smart meters involving embedded sensors called advanced meter infrastructure (AMI)
- All brought together under a building management system (BMS) using SCADA type software
Sensor technologies for monitoring electric power transmission and sub stations


Value proposal for the smart grid according to ABB

Smart grid value proposition
Four main areas of emphasis

- Capacity for increasing demand
  - Economic
  - Effective
  - Interlinked

- Reliability of electricity supply
  - Available
  - Attuned
  - Safe

- Efficiency along the value chain
  - Producing
  - Transporting
  - Consuming

- Sustainability by integrating renewables
  - Connected
  - Steady
  - Stabilized

Large impact on the required performance of the grid

Future electrical systems will be different from those of the past
- Receiving power from for all types and sizes of generation
- Tuned to cope with environmental challenges
The past contribution of energy efficiency

Energy efficiency is the most important “fuel”

Without energy efficiency improvements, total energy use would have been 58% higher in 2005 than it actually was

Energy efficiency will have major role to play in achieving low C future (IEA)

In moving from the New Policies Scenario to the 450 Scenario, more expensive abatement options such as CCS play a growing role

Conclusions (1)

- ICTs essential for climate & environmental action to meet 2 degree Celsius limit (450 scenario)

- ICTs put the smart into sustainable technologies
  - Smart grid, smart meters, smart buildings, smart transportation, smart cities, smart motors, sensors, WSNs, M2M, IOT, etc.
Conclusions (2)

- ICT essential for system integration
  - Renewable energy, storage, smart cities, advanced metering infrastructure, etc.
  
  - Can help emerging / developing countries transition to “Green Economy” more easily than OECD countries
Conclusions (3)

- Limited legacy technologies in developing countries so can leapfrog
  - Smart grid, smart buildings, etc.

- Distributed energy resources (DER) will be norm for electrification
  - ICTs for control & integration of different energy sources
Conclusions (4)

- Tech transfer via UNFCCC & related processes essential
  - Green Climate Fund, etc.
Recommendations (1)

- Tech transfer via UNFCCC & related processes essential
  - Green Climate Fund, etc.

- Remove fossil fuel subsidies
Recommendations (2)

- Assess potential of cleantech & ICTs
  - Undertake e-sustainability readiness assessments
    - Reducing energy consumption
    - Reducing GHG emissions
  - Measure potential for renewable energy
    - Solar energy maps / inventories, wind energy maps / inventories, enhanced geothermal, etc.
Recommendations (3)

- Develop climate change mitigation plans
  - Adaptation plans already in place
  - Countries to assess potential
Recommendations (4)

- Priority areas for ICTs:
  - Distributed energy resources
    - Solar PV, wind, micro hydro, etc. & ICT control systems
  - Building energy management system (BEMS):
    - HVAC, lighting, etc.
  - Smart grid, smart metering infrastructure
Recommendations (5)

- Priority areas:
  - Smart transportation
  - Smart logistics
  - Smart manufacturing
Recommendations (6)

- Priority areas:
  - Green design: building information modeling for energy efficiency & conservation
  - Agriculture:
    - Famine Early Warning System (FEWS)
    - Irrigation control
Thank you!

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Richard Labelle profile

• Background in bio / environmental sciences
• Private & public sector experience in Ca & abroad
• Experience in sustainable agriculture (Agroforestry), knowledge management, and ICT for development
• Worked in 58 developing countries
• More recently:
  – Focus on strategic planning for development using ICTs
  – Using ICTs for e-com, trade enhancement, e-gov, institutional modernisation, local and community development
  – ICTs for environmental & climate action
Richard Labelle profile

- Digitization & dematerialization
  - Smaller environmental sensing device
  - More powerful sensing devices
  - More digitization (e-government, e-commerce, etc.) → less need for travel for rural dwellers, more energy efficiency
  - More downloads: video, music, P2P,
  - Telepresence
  - Virtualization (servers, networks, etc.)
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