

INTERNATIONAL TELECOMMUNICATION UNION

**REPORT ON THE
ICT & CLIMATE CHANGE TRAINING PROGRAMME
(ICT&CC TP)**

HUMAN CAPACITY BUILDING DIVISION



TABLE OF CONTENTS

SUMMARY.....	4
LIST OF ABBREVIATIONS AND ACRONYMS	5
1 BACKGROUND AND JUSTIFICATION.....	7
1.1 The role of an ICT & Climate Change Training Programme.....	7
1.2 Overview of existing study resources and courses on ICT & Climate Change	8
1.3 conclusions from analysing existing training and certification options	11
1.4 Choice of immersion levels and professional specialization for the ICT&CC TP	12
2 THE ICT&CC TP CONCEPT AND PROGRAMME OUTLINE.....	13
2.1 Target audiences.....	13
2.2 Course Structure	14
2.3 Course delivery options	16
2.4 Partner institutions	16
3 Overview MODULE	18
4 Foundation MODULES	20
4.1 Foundation Module 1: Introduction to ICT & Climate Change.....	20
4.2 Foundation Module 2: Roles of Stakeholders	23
4.3 Foundation Module 3: Developing ICT Service Provider Strategies.....	25
4.4 Foundation Module 4: Assessing the Impact of ICT on Climate Change.....	27
4.5 Foundation Module 5: Applying Green ICT strategies	29
4.6 Foundation Module 6: E-waste and The Circular Economy	30
5 Advanced MODULES	33
5.1 Advanced Module 1: The Global Picture: Climate Modelling, Monitoring and Global Frameworks for Emissions Reduction.....	33
5.2 Advanced Module 2: Understanding the range and types of Stakeholder	38
5.3 Advanced Module 3: ICT Service Provider Strategies in depth	42
5.4 Advanced Module 4: Life Cycle Assessment.....	47
5.5 Advanced Module 5: Green ICT Strategies in different Sectors.....	50
5.6 Advanced Module 6: The End-of-Life stage in Life Cycle Assessment	57
6 SETTING UP THE COURSE AND PREPARING SYLLABUSES	59

6.1	Possible contributing institutions and experts	59
6.2	Remaining Time required to set of the ICT&CC TP	60
7	PRINCIPLES OF STUDENT ASSESSMENT AND GRADING	62
8	CONCLUSIONS.....	64
9	REFERENCES.....	65



SUMMARY

This report describes the structure and content of a proposed ICT & Climate Change Training Programme to be made available to the ITU membership for training, including industry, regulators, government organisations and service providers. The TP has a modular structure so that the content of the modules can be changed and new modules added as required. Each module should take around 4 weeks for the student to complete including final assessment with the student aiming to complete 8 modules over two semesters. This could be followed by the completion of a Masters Thesis in a relevant subject which would be assessed by an external body accredited to offer degrees at MSc level.

The modules described cover the whole scope of ICT & Climate Change. Six Foundation Modules introduce the concepts behind ICT & Climate Change and provide students with a sufficient level of detail to understand these, even though they may not yet be able to carry out a full LCA or fully assess the emissions from a CDM project. 15 Advanced modules provide the student with a much greater depth of understanding and more practical experience in each subject area.

It is entirely possible, and would be highly desirable, for the ITU to develop an ICT&CC TP based on the structure and content of the modules described in this report. This would complement the existing professional training options and promote common approaches to using ICT to tackle climate change. Due to the resources held by the ITU and partner institutions, and the constant updating that should be possible due to on-going activities in the three ITU sectors, the TP should be able to establish itself as the “gold standard” of training in the ICT & CC area.

This format of this report was based on the ITU Spectrum Management Training Programme but the content has been completely revised and rewritten.

LIST OF ABBREVIATIONS AND ACRONYMS

ADEME	(French) Environment and Energy Management Agency
AM	Advanced Module
BDT	Telecommunication Development Bureau (ITU)
BR	Radiocommunication Bureau (ITU)
CDM	Clean Development Mechanism
CITIC	ITU Centre of Excellence for the Americas Region in ICT and Climate Change
CoC	Code of Conduct (on Energy Efficiency)
CoE	Centre of Excellence
COP-21	21 st meeting of the Conference of Parties to the Kyoto Protocol - United Nations Climate Change Conference, Paris, December 2015
CRC	Carbon Reduction Commitment
DECC	(UK) Department of Energy & Climate Change
DEFRA	(UK) Department for Environment Food & Rural Affairs
DSM	Demand Side Management
ECTS	European Credit Transfer and Accumulation System
EPA	Environmental Protection Agency
EU	European Union
EV	Electric Vehicle
FERC	(US) Federal Energy Regulatory Commission
FM	Foundation Module
GeSI	Global e-Sustainability Initiative
GHG	Greenhouse Gas
GSMA	Global System for Mobile communications Association
ICT	Information and Communications Technology
ICT&CC	ICT & Climate Change
INDC	Intended Nationally Determined Contribution
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
ITU	International Telecommunication Union
ITU-D	Telecommunication Development Sector (ITU)
ITU-R	Radiocommunication Sector (ITU)
ITU-T	Telecommunication Standardization Sector (ITU)
JRC	(EC) Joint Research Centre
KPI	Key Performance Indicator
MOOC	Massive Open Online Course
NAMA	Nationally Appropriate Mitigation Action
NGN	Next Generation Network
RA	Radiocommunication Assembly
RET	Renewable Energy Technologies
SG	Study Group (ITU)
SSDM	Smart Sustainable Development Model
TP	Training Programme
TSP	Telecommunications Service Provider (fixed or mobile)

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WRC	World Radiocommunication Conference
WSIS	World Summit on the Information Society
WTDC	World Telecommunication Development Conference
WTSA	World Telecommunications Standards Assembly
WWF	World Wide Fund for nature



1 BACKGROUND AND JUSTIFICATION

1.1 THE ROLE OF AN ICT & CLIMATE CHANGE TRAINING PROGRAMME

Information and Communication Technologies (ICTs) are now used by the whole of society to improve quality of life and ensure sustainable development. Whilst ICTs enable deployment of an underlying fast broadband infrastructure and the coming 'Internet of Things', they will also play a pivotal role in developing technologies to reduce GHGs in other sectors including power generation, transport, health, education and commerce. Thus a wide range of ICT stakeholders are now in the front line of the response to climate change at all levels.

As long ago as 2008, the importance of ICT & Climate Change was recognised by the ITU, and a Resolution on ICT&CC was passed by WTSA 2008 recommending action in this area. This led to the setting up of a new Working Party on ICT&CC in ITU-T Study Group 5. It also led to the setting up of a series of ITU Symposia on ICTs and Climate Change, and the 3rd of these, held in Quito in Ecuador in July 2009, recommended the setting up of educational programmes in this area to raise awareness among its Member States on climate change and the role ICTs can play in combating it.

The importance of ICTs in combating climate change has since been recognised by ITU in Resolutions from all of its three sectors (ITU-R, ITU-T and ITU-D):

- The World Telecommunications Standards Assembly (WTSA) in 2012 agreed Resolution 73 "ICT and Climate Change" and Resolution 79 "The role of ICTs in handling controlling e-waste for ICT equipment and methods of treating it". These put a high priority on developing new Recommendations on ICT & Climate Change in order to reduce GHG emissions globally while extending the previous mandate to cover e-waste as well as energy and water consumption.
- The World Telecommunication Development Conference (WTDC) in 2014 agreed Outcomes and KPIs relevant to ICT, Environmental Protection and Climate Change to make ICT solutions more available to Member States, to enhance their capacity and to develop an e-waste policy.
- The World Radiocommunication Conference (WRC) in 2012 allocated spectrum for use by earth observation, lightning detection and hydrological cycle components. The Radiocommunication Assembly (RA) in 2012 adopted a number of Resolutions relevant to ICT & Climate Change, in particular for disaster prediction, detection, mitigation, response and relief.

The ITU-T has a Study Group on Environment & Climate Change which has been developing Recommendations on ICT & Climate Change for over 6 years, including on energy efficiency, mitigation, adaptation and e-waste. ITU-D studies climate change in SG2 and has relevant work being carried out in Q6/2 on ICT and Climate Change as a whole and in Q8/2 specifically on the proper treatment of e-waste. ITU-R creates the regulatory and technical bases for the development and effective operation of satellite and terrestrial climate modelling by allocating the necessary radio-frequency and satellite orbit resources.

The importance of this topic to a wide range of stakeholders and the range of relevant activities being carried out in ITU mean that an ICT & Climate Change Training Programme (ICT&CC TP) should have a wide take-up by relevant stakeholders including industry, regulators, government organisations and service providers. An ICT&CC TP would build skills on the possible actions mitigate and adapt to Climate Change and the role that ICT plays in bringing this about. It would explain the underlying concepts and the role that a wide range of stakeholders must play in developing the policies, technologies and standards that will:

- a) improve energy efficiency,
- b) reduce GHG emissions through a range of mitigating technologies,
- c) enable countries and societies to better adapt to climate change.

Formal academic certification on successful completion of the course would also increase its appeal. If the course provided an equivalent qualification to a Master's (MSc) degree, many employers would find it suitable for on-the-job training as most prospective students would already have an undergraduate (BSc) degree. Employer acceptance of the course might also enable prospective students to improve their career prospects through on-the-job training rather than needing to stop working to do this. To employers it would offer a clear benchmark reference, simplifying and giving certainty to the process of recruitment while at the same time facilitating the mobility of ICT & Climate Change professionals.

1.2 OVERVIEW OF EXISTING STUDY RESOURCES AND COURSES ON ICT & CLIMATE CHANGE

In this section, currently available resources for training on ICT & Climate Change are reviewed in order to identify potentially useful material that could be combined to design a unique ICT&CC TP.

It should be noted that, due to the resources that have already been developed by the ITU and partner institutions, and the constant updating that should be possible due to on-going activities in all three sectors, the ITU is well placed to establish a well-regarded training programme in this area

1.2.1 Written sources

Written texts (online and offline) will enhance the content of the ICT&CC TP and can be used in self-paced study. The following are examples, from both inside and outside ITU:

- Published by ITU-T:
 - “Using ICTs to Tackle Climate Change”, in conjunction with GeSI, 2010 - www.itu.int/dms_pub/itu-t/oth/4B/01/T4B010000010001PDFE.pdf
 - Toolkit on Environmental Sustainability for the ICT Sector, September 2012 - www.itu.int/ITU-T/climatechange/ess/
 - “Boosting energy efficiency through Smart Grids”, 2012 - www.itu.int/ITU-T/climatechange/report-smartgrids.html
 - “Sustainable Buildings”, September 2012 – www.itu.int/ITU-T/climatechange/ess.
 - “The case of Korea - The quantification of GHG reduction effects achieved by ICTs”, April 2013 – www.itu.int/pub/T-TUT-ICT-2013-08

- “Resilient pathways: the adaptation of the ICT sector to climate change”, April 2014 - www.itu.int/en/ITU-T/climatechange/Documents/Publications/Resilient_Pathways-E.PDF.
- “Sustainable Management of Waste Electrical and Electronic Equipment in Latin America”, May 2015.
- Recommendation ITU-T L.1400, “Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies” – www.itu.int/rec/T-REC-L.1400.
- Recommendation ITU-T L.1410, “Methodology for the assessment of the environmental impact of ICT goods, networks and services” - www.itu.int/rec/T-REC-L.1410
- Recommendation ITU-T L.1420, “Methodology for assessing the energy consumption and GHG emissions impact of ICT technologies in organisations” – www.itu.int/rec/T-REC-L.1420
- Recommendation ITU-T L.1430, “Methodology for assessment of the environmental impact of ICT greenhouse gas and energy projects” - www.itu.int/ITU-T/recommendations/rec.aspx?rec=11904
- Recommendation ITU-T L.1440, “Methodology for environmental impact assessment of information and communication technologies (ICT) at city level” – will be available at www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=5
- Published by ITU-R:
 - ITU/WMO Handbook: “Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction”.
 - UNOOSA: “Space and Climate Change: use of space-based technologies in the United Nations system”.
 - ITU-R Radiocommunication: “Climate Change Brochure”.
 - Report ITU-R RS.2178, “The essential role and global importance of radio spectrum use for Earth observations and for related applications”.
 - Recommendation ITU-R RS.1883, “Use of remote sensing systems in the study of climate change and the effects thereof”.
 - “Handbook on Earth Exploration-Satellite Service”.
 - Recommendation ITU-R RS.1859, “Use of remote sensing systems for data collection to be used in the event of natural disasters and similar emergencies”.
 - Recommendation ITU-R M.1849, “Technical and operational aspects of ground-based meteorological radars”.
 - Recommendation ITU-R M.1874, “Technical and operational characteristics of oceanographic radars operating in sub-bands within the frequency range 3-50 MHz”.
 - Recommendation ITU-R M.2002, “Objectives, characteristics and functional requirements of wide-area sensor and/or actuator network (WASN) systems”.
 - Report ITU-R M.2013, “Wind Profiler Radars”.
 - Report ITU-R RS.2184, “Arrival time difference lightning detection systems in the meteorological aids service in operation below 20 kHz”.
- Published by ITU-D:
 - Final Report from ITU-D Q24/2 on “ICT and Climate Change”, 2014.

- “Smart Sustainable Development Model”, Smart Sustainable Development Model Advisory Board, 2015.
- Published outside ITU:
 - David JC MacKay: “Sustainable energy without the hot air”, UIT, Cambridge, England, 2009 – also available on-line at www.withouthotair.com
 - SMARTer2030 “ICT Solutions for 21st Century Challenges”, GeSI, 2015 – www.gesi.org/portfolio/project/82
 - GSMA: Mobile’s Green Manifesto, 2012 - www.gsma.com/publicpolicy/wp-content/uploads/2012/06/Green-Manifesto-2012.pdf
 - WWF, “The potential global CO₂ reductions from ICT use” - www.wwf.se/source.php/.../identifying_the_1st_billion_tonnes_ict.pdf
 - “Energy Solutions for Smart Cities and Communities: Recommendations for Policy Makers”, Concerto Initiative, Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology.
 - UK Buildings Research Establishment BREEAM Energy Assessment Methodology – www.breeam.org/index.jsp
 - German Passivhaus Building Standard - www.passivhaus.org.uk/index.jsp

1.2.2 ICT & Climate Change courses

- Courses and projects offered by ITU Centre of Excellence for the Americas Region in ICT and Climate Change Mitigation and Adaptation (CITIC):
 - “Telecommunications, ICT and global warming” (basic course).
 - “Climate accounting challenges and opportunities for the Telecommunications and ICT sector” (advanced course).
 - “Environmental impact assessment of waste from analogue television sets based on Life cycle assessment” (basic course).
 - Project on “Telecommunication, ICT and Climate Change”. There is already progress on:
 - Telecommunications, ICT and Climate Change Policies and Regulations
 - Environmental Law for Telecommunications, ICT and Climate Change
 - Telecommunications and ICT impact on renewable energy
 - Telecommunications and ICT Green Standards
 - E-health
 - E-waste management
- University courses.

For example:

 - The University of East Anglia (Climatic Research Unit, School of Environmental Sciences) offers a 1 year full time MSc on “Climate Change”. The School of International Development also offers an MSc on “Climate Change and International Development” over 1 year full time or 2 years part time.
 - The University of Liverpool offers an MSc on Environment and Climate Change.
 - Brunel University offers an MSc on Climate Change and Sustainability.
 - The University of Bristol offers an MSc on “Climate Change Science and Policy”.

- The University of Exeter runs a Massive Open Online Course (MOOC) “Climate Change: Challenges and Solutions” which lasts for 8 weeks and is free to enter – see www.futurelearn.com/courses/climate-change-challenges-and-solutions. The course is delivered entirely on-line and covers a different topic each week. It focuses on Climate Change not ICTs.
- The University of Geneva (jointly with UNEP) offers a free on-line course (MOOC) “Pathways to Climate Change Adaptation” focusing on Small Island Developing States. The course lasts 5 weeks and students who successfully complete the course receive a Statement of Accomplishment.
- On-line training courses. For example:
 - The One UN Climate Change Learning Partnership: www.unclearn.org/training-package
 - UNEP environment for development: www.unep.org/training/news_events/eet_related.asp

1.3 CONCLUSIONS FROM ANALYSING EXISTING TRAINING AND CERTIFICATION OPTIONS

Although several universities already offer courses on related subjects such as the Environment, Climate Change, and Adaptation, a training programme organised by the ITU specifically on ICT & Climate Change would complement the existing professional training options and promote common approaches to using ICT to tackle climate change. The ICT&CC TP should meet the following criteria:

- The programme should be broad in scope and international in character, with tutors and participating institutions of the highest quality, to ensure the value of the programme and the reputation of its diploma. It should aim to establish itself as the global “gold standard” for ICT & Climate Change training.
- The programme should be comprehensive and well-rounded, addressing all theoretical aspects of ICT and Climate Change to some level of detail.
- The programme should also have a practical basis so that students can become proficient at, for example, calculating the carbon footprints of their organisations, sectors or countries, or calculating the energy or GHG emission savings arising from the introduction of an e-service.
- The programme should offer a higher level of professional knowledge than is available from existing self-study resources or short courses.
- An essential differentiator for an ICT&CC TP would be the formal assessment necessary for the course to be recognised as the equivalent of a Master’s degree.

1.4 CHOICE OF IMMERSION LEVELS AND PROFESSIONAL SPECIALIZATION FOR THE ICT&CC TP

It is likely that an on-the-job training programme would interest people with differing levels of work experience and differing current job requirements. Two entry levels to the ICT&CC TP are therefore proposed:

1. Foundation level, for students with little or no prior work experience in ICT & CC. Successful completion of a set of foundation modules would normally lead to an interim certificate but not a full diploma equivalent to an MSc.
2. Advanced level. For admission at this level the student would need to have passed the Foundation level successfully or, alternatively, demonstrate an equivalent understanding of the principles by means of an entry level examination or project.

In both cases, the studies would lead to the same qualification which would make it easier to build brand recognition for the “Master’s in ICT & Climate Change”. The industry would then grow accustomed to the idea that an ICT&CC TP offered some specific guaranteed “gold standard” of professional qualification.

2 THE ICT&CC TP CONCEPT AND PROGRAMME OUTLINE

The ICT&CC TP is designed to fit within the European Credit Transfer and Accumulation System (ECTS). ECTS is a standard for comparing the study attainment and performance of students of higher education across the European Union (EU) and other European countries. ECTS credits are awarded for successfully completed studies. One academic year corresponds to 60 ECTS credits that are equivalent to 1500–1800 hours of study in all countries irrespective of qualification type, and so can facilitate transfer and progression throughout the EU. The objective will be to extend this globally for the ICT&CC TP. Formal (external) assessment would be needed for the qualification to be recognised externally, as described later.

The ICT&CC TP is designed to be modular, with each successfully completed module requiring around 125 hours of study and generating 5 ECTS credits. 8 modules (1500 hours of study) + a Master Thesis would therefore be required to complete a course of 60 ECTS credits and receive a diploma. The duration is designed to be around one calendar year for students aiming to take the complete course, but this can be extended to allow part time study.

The Regional ITU Centres of Excellence (in particular CITIC) and partner universities should play an active role in supporting the organization and coordination of ICT&CC TP activities. In particular, they should be encouraged to contribute to ITU technical standards in their areas of knowledge and expertise.

2.1 TARGET AUDIENCES

The ICT&CC TP is designed for anyone wishing to enhance their professional knowledge while working in an area related to ICT & Climate Change, for example, environmental engineering, energy efficiency, climate modelling or adaptation to climate change. The TP would be aimed at broadening of skills in this complex field and could be taken by any professional who has previously graduated with a first-level university degree (e.g. BSc). Students entering the ICT&CC TP will be from different institutional levels, from technical to managerial, and from different backgrounds (engineering, legal, regulatory, economic, etc.).

Those wishing to join at the advanced level would need to have at least one year of relevant experience and pass an entrance examination and/or submit a project or essay to assess their level of knowledge. The advanced level entrance examination would be similar to the assessment taken on completion of the Foundation course by students starting from that level, although it may need to take account of cultural differences from different regions.

2.2 COURSE STRUCTURE

As the ICT&CC TP is intended to be an on-the-job training option for working professionals, it should consist of a sequence of modules spread over a calendar year. A modular structure would allow new modules to be added or existing modules to be changed readily. A modular structure also has the following benefits:

1. They are a convenient way to combine study options with daily work commitments, as students would only need to focus on one study topic at a time;
2. They simplify the logistics by minimizing the coordination needed between different partner institutions: only the organization managing a particular study module would be responsible for daily operations in any given time period;
3. Time commitments are more predictable for teaching staff (assuming each tutor is assigned the same module(s) in successive years and each module is offered annually in the same time-frame);
4. Clear break-points in the sequential flow can be used as different entry points; in the case of multiple sets of study paths and/or certification levels, the breaks allow different combinations of entry and exit points. This option is discussed in more detail below.

Each module will last 4 weeks, including the formal assessment at the end of each module, and the student will be required to pass 8 modules in order to pass the course.

The ICT&CC TP is made up of a number of Foundation Modules (FMs) and a number of Advanced Modules (AMs). Each Foundation Module is designed to be followed up by one or more of the options in the related Advanced Module in order to obtain more depth and the numbering scheme reflects this. This structure allows new modules to be added or existing modules to be changed, as long as the logical progression between the foundation modules and from the foundation modules to the advanced modules is respected. There must always be some overlap between modules, in order to allow students to start the course at several points and to pursue options which are most relevant to their jobs or career ambitions. However, the overlap must not be so great that students feel they have had to repeat work unnecessarily.

Module durations of four weeks have been used throughout, which are short enough for focused study of one topic but long enough to give instructors flexibility in planning their syllabuses. This also allows for a succession of different modules to fit within one year. Periods of self-directed study may fit in with holidays, major industry events, work-related travel, etc.

Two options towards the completion of the ICT&CC TP with a duration of one year are shown in Figure 1 (Note that students may only be offered one of these if resources do not permit). Option 1 is intended to provide a broadly based training course (with some more detailed study) while Option 2 would allow the student to go into more depth in particular areas of interest. **Note that Foundation Modules 1 and 2 are Obligatory and must be completed successfully in order to move on to the other modules.** These provide the basic grounding in the background to ICT & CC and the stakeholders who should be involved and consulted.

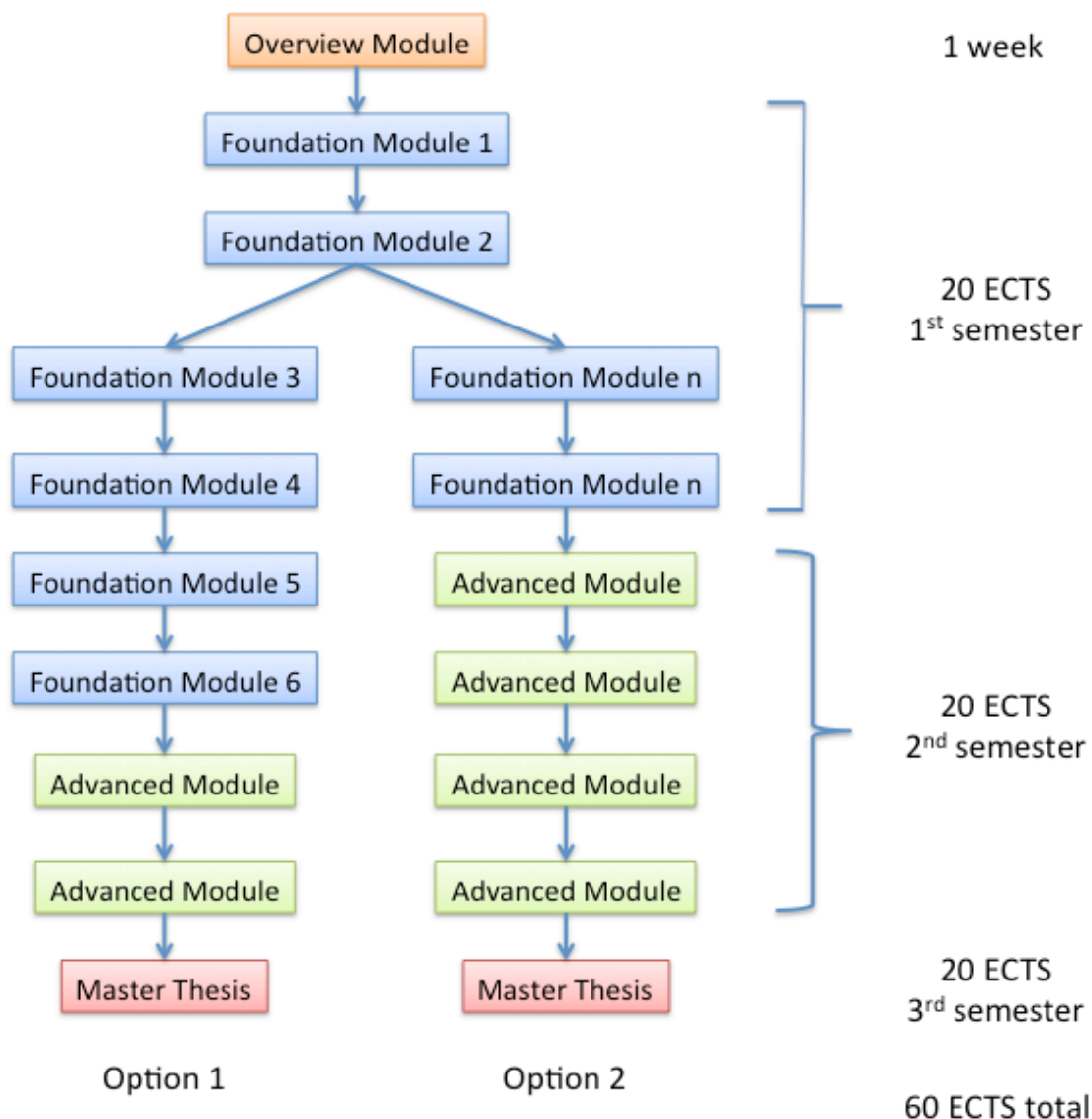


Figure 1. Options leading to the award of an MSc in ICT & Climate Change.

Note also that it is assumed that an Advanced level module will take the same amount of study time as a Foundation level module. Therefore, a student can take a larger number of Foundation modules (Option 1) to gain a broader qualification in ICT & CC, or more Advanced level modules to go more deeply into certain aspects of the topic (Option 2). However, the award will be the same in each case.

If formal academic certification is required, such as a Master of Science (MSc) qualification, the ICT&CC TP should be planned to offer the equivalent of 60 ECTS credits, including:

- 20 ECTS credits for a selection of (4-6) Foundation-level modules. Alternatively these may be granted for a minimum of one year of active professional experience subject to formal assessment of the professional competences acquired;

- 20 ECTS credits for a selection of (2-4) advanced-level modules. A minimum of 2 advanced level modules must be successfully undertaken to be awarded a full diploma;
- 20 ECTS credits for the final thesis based on a substantive case study and recommendations in the chosen area of professional specialization.

The proposed composition of the ICT&CC TP modules is shown in Sections 3-5.

2.3 COURSE DELIVERY OPTIONS

The ICT&CC TP structure presented in Figure 1 is based on the assumption that Foundation modules will be primarily classroom driven, with face-to-face tuition, whereas Advanced modules could rely primarily on e-learning including some real-time, web-based seminars with experienced tutors to introduce the subjects, set a structure for the module, present best-practice case studies and set challenges for the students. The emphasis would be on actively teaching the well-established general subjects in classroom situations, drawing on pre-prepared presentations and reference materials, while the Advanced modules could rely more on self-paced e-learning, including in-depth research and study of specialized literature sources. The flexibility of Advanced modules oriented toward instructor-led self-study would be especially useful if the student's organization required some special type of knowledge in a given subject.

Consequently, all modules might benefit from exploiting different delivery modes adapted by the tutor. For example, the time allocated to a module might be divided between:

- Classroom teaching and physically attended seminars and workshops.
- Case studies and practical exercises which should be included in all modules.
- Instructor-led remote lectures (live or pre-recorded).
- Self-study of textbooks and reference material.

Classroom instruction could be coordinated by the ITU Academy and conducted at ITU Centres of Excellence or other partner institutions.

2.4 PARTNER INSTITUTIONS

The ITU Academy should become a convenient coordinating point for devising and then implementing the ICT&CC TP. However, it would need to involve skilled partners in preparing teaching content, decide how and what to test for in the certification procedure, design entry-level examinations that could confer academic credit for work experience, and eventually determine how to staff, deliver and manage the programme. While it may not be necessary to pre-define at the outset the types of partner institutions that might be considered for participation in the ICT&CC TP, suitable institutional partners could be found among the following categories:

- ITU BDT and TSB departments as "founding fathers", together with the ITU Academy.

- ITU-T and its study groups (e.g. those dealing with relevant technological standards).
- Organizations participating in the running of the ITU Centres of Excellence (CoEs) in various regions (e.g. CITIC).
- Universities and research centres.
- Organizations and companies which currently run educational programmes on ICT&CC (e.g. UNEP).

All potential partners should be consulted in order to gauge their interest in an ICT&CC TP, both with regard to the possibility of their participating in training and with regard to the potential demand for ICT&CC TP-certified specialists. The level of demand will surely influence the number of students accepted onto the programme, which will in turn influence the budget and staffing requirements. These consultations will provide a better understanding of the types of institution that are interested in participating and their level of engagement, as well as the overall scale of the undertaking, which will help in forming the consortium.

Another important consideration in terms of support and participation should be the establishment of a pool of well-qualified ICT experts. These experts may be involved first of all in the process of developing the teaching content and assessment exams; some may continue their engagement in the delivery of the classroom-based modules and remote tutoring of students, as well as supervision of their progress and eventual Master's thesis.



3 OVERVIEW MODULE

The proposed composition of the ICT&CC TP is shown below. An overview module will provide a brief summary and introduction to each module of the training programme. This can be implemented as a 1-day training course or taken by the student as an on-line web-based training course with examination via an automatically marked questionnaire.

- OM: Overview Module.
- FM1: Introduction to ICT & Climate Change.
- FM2: Roles of Stakeholders in ICT & Climate Change.
- FM3: Developing ICT Service Provider Strategies.
- FM4: Assessing the Impact of ICT on Climate Change.
- FM5: Applying Green ICT Strategies.
- FM6: E-waste and the Circular Economy.
- AM1: The Global Picture: Climate Modelling, Monitoring and Frameworks for GHG Emissions Reduction
 - Option 1: Climate Modelling
 - Option 2: The role of Satellite & Radio Communication in Environmental Modelling
 - Option 3: Global/Regional Frameworks for GHG Emissions Reduction
- AM2: Understanding the range and types of Stakeholders
 - Option 1: Policy Makers & Regulators
 - Option 2: TSPs and IT Service Providers
- AM3: ICT Service Provider Strategies in Depth
 - Option 1: Telecom Service Provider (TSP) Strategies
 - Option 2: IT Service Provider Strategies (including Cloud Services)
 - Option 3: Adaptation for Infrastructure Providers.
- AM4: Life Cycle Assessment
 - Option 1: How to carry out a full LCA
 - Option 2: How to measure the Carbon Footprints of Sectors, Countries and Regions
- AM5: Green ICT Strategies in different sectors
 - Option 1: Improving the Energy Efficiency of ICT Products and Services
 - Option 2: GHG reductions in the Power Sector
 - Option 3: Decarbonising Transport
 - Option 4: Smart & Sustainable Cities
- AM6: The End-of-Life Stage in Life Cycle Assessment

The main function of the Overview Module is to allow the student to get up to speed with the course concepts before joining the course. However, it may also be taken as a stand-alone introduction to the field of ICT&CC without necessarily attending the course itself.

4 FOUNDATION MODULES

A set of proposed Foundation Modules that would fit into the course structure shown in Figure 1 is described in this section. These modules would cover the whole area of ICT & CC to a level of detail such that the students will be familiar with all the relevant concepts, even though they may not yet be able to carry out a full LCA or fully assess the emissions from a Clean Development Mechanism (CDM) project.

Each Foundation Module is associated with one or more Advanced Modules which would allow the student to obtain a greater depth of understanding and more practical experience in each subject area. The Advanced Modules are described in Section 5.

4.1 FOUNDATION MODULE 1: INTRODUCTION TO ICT & CLIMATE CHANGE

This is the first of two obligatory modules in the ICT&CC TP as it introduces the whole area of Climate Change and explains the relevance and importance of ICT to it. This background will be necessary for the student to undertake the other modules successfully. This module is designed to be followed up by one of the options in AM1 if more depth is required.

It should cover the following subjects and concepts:

- Why should we care about Climate Change and Energy Saving?
- The evidence for Climate Change and for human influence on it.
- What are ICTs?
 - Who provides them?
 - Who uses/owns them?
 - Why are they so important in tackling Climate Change?
- Evolution of ICT & CC principles and strategies
 - International and regional cooperation structures in areas related to ICT & CC
 - ITU's role, structure and mandate
- The role of ICTs in tackling climate change in the three areas of:
 - Improving the energy efficiency of the ICTs themselves.
 - Applying ICTs to reducing emissions in other sectors (mitigation), e.g. in the power sector.
 - Applying ICTs to improving adaptation to climate change
- The role of regulators and policy makers in ICT&CC
 - Impact of regulatory obligations, targets and KPIs.
- Energy, where it comes from and where it goes.
 - Understanding of the difference between energy and electricity and the GHG emissions from each.
- Case study looking at best practises on energy/electricity generation and use in various countries.

- Exercise on the design of a National Energy policy (preferably applied to a student's home country):
 - What primary factors need to be considered?
 - What practical considerations will influence the chosen outcome?
 - What proportion of renewable energy would you aim for and where would this come from?
 - What are the practical limits to the amount of renewable energy that can be used?
 - How could you increase this limit?
 - Who might you need to influence or lobby to achieve the desired result?

- Exercise to participate in an ICT & CC related international event (see below).

PROPOSED DELIVERY MODE AND DURATION

This module will set the stage and context for the rest of the ICT&CC TP teaching. It is therefore important to start it on a high note with carefully orchestrated instructor-led teaching, e.g. as a full-time, five-days a week, lecture-based classroom presentation. This could be followed by three weeks of instructor-led e-learning with self-study of reference materials (primary documents whenever possible). At the end of the final week, an interactive seminar should be held to enable students to strengthen their knowledge and understanding by discussing and resolving problems based on real-life situations.

It would also be useful if students were required as part of completing this module to attend in person some ICT&CC-related **international event** (seminar, workshop or policy-making conference) such as an ITU Green Standards Week event, the Global Symposium in Telecommunication, ICT and Climate Change, organized by the ITU and the CITIC as a Centre of Excellence of the Americas Region to be held in Quito, Ecuador on 23 October 2015, or even the United Nations Climate Change Conference (COP-21) to be held in Paris from 30 November to 11 December 2015. Students could choose a suitable event themselves, in consultation with their employer organization, subject to approval by the module instructor or course coordinator.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completing this module, students should demonstrate an understanding of the overall scope and objectives of ICT & Climate Change and the way these are realized in a multi-stakeholder structure at international, regional and national level. Students should understand in broad terms how policy makers and regulators can make a difference, although may not understand all the 'levers' they can pull or how best to do this (even the policy makers and regulators themselves may not fully understand this).

As a part of the overall module assessment, students could be required to substantiate the results of their distance learning by writing a short essay of around 10 pages describing the institutional framework and functioning of ICT & Climate Change in their country or the problems and solutions discussed at the international ICT&CC event they have attended.

Students could also take part with their papers in the annual Scientific Conference in Telecommunication, Information Technology and Communication organized by the CITIC, the ITU Centre of Excellence for the Americas Region in ICT and Climate. This conference has a section on Telecommunication, ICT and Climate Change.

STUDY RESOURCES

The reference sources for this module include:

- ITU Reports on ICT & Climate Change including:
 - “Climate Change Adaptation and Information & Communications Technologies (ICTs): The Case of Ghana”.
 - “Enabling Energy Efficiency through ICTs: The Case of Pakistan”.
 - “The Case of Korea - The quantification of GHG reduction effects achieved by ICTs”.
- UNFCCC documents including the Kyoto protocol and its successor agreements.
- National policy documents including UK Climate Change Act 2008.
- National Energy Yearbooks providing figures for energy and electricity consumption.
- Real time information on energy consumption, e.g.
<http://www2.nationalgrid.com/uk/Industry-information/Electricity-transmission-operational-data/Data-Explorer/>
- Examples of National electricity generation mixes (renewables and non-renewables), e.g. www.unendlich-viel-energie.de/media-library/charts-and-data/germanys-power-mix-in-2013.
- ITU-T Recommendation L.1500 “Framework for information and communication technologies (ICTs) and adaptation to the effects of climate change Adaptation”.
- “Las TIC y los Derechos Humanos de Tercera Generación”, CITIC - Journal Telecomunicaciones & TIC ISSN: 13903934
- “Políticas y tendencias regulatorias de las telecomunicaciones globalizadas”. CITIC - Journal Telecomunicaciones & TIC ISSN: 13903934
- “Política del mercado de dióxido de carbono y la regulación de telecomunicaciones”. CITIC - Journal Telecomunicaciones & TIC ISSN: 13903934
- “Regulación por impacto ambiental”. CITIC - Journal Telecomunicaciones & TIC ISSN: 13903934

In addition, students may be required to review some actual documents being prepared by ITU-T study groups at the time of study, and/or the Final Acts of the most recent WTSA, WTDC or RA.

4.2 FOUNDATION MODULE 2: ROLES OF STAKEHOLDERS

This is the second of the two obligatory modules in the ICT&CC TP as it introduces the full range of stakeholders that are relevant to ICT&CC and the impact that they can have on reductions in GHG emissions. It will be necessary for the student to understand the range of stakeholders in a very complex landscape, especially when a smart and sustainable city is the being considered. This module is designed to be followed up by one of the options in AM2 if more depth is required on the roles of various types of policy makers and regulators (Option 1) or of TSPs and IT service providers (Option 2).

This module should cover the following topics:

- The role of policy makers including:
 - UNFCCC and COP globally.
 - UN World Summit on the Information Society (WSIS).
 - Smart Sustainable Development Model (SSDM) Initiative.
 - Regional and national policy makers including DG ENERGY (EC), AEDB (Pakistan)
- The role of regulators including:
 - National telecoms regulatory authorities, e.g. FCC (US) and Ofcom (UK).
 - National power regulatory authorities, e.g. Ofgem (UK), FERC (US).
 - Exercise on how regulators can use targets and KPIs effectively?
- Other relevant organisations including Environmental Protection Agencies (EPAs), GeSI and UNEP.
 - Who are their members/stakeholders?
 - What has been the impact of these organisations?
 - Case study on the impact that GeSI has had on reducing GHG emissions.
 - What additional stakeholders are involved in a smart, sustainable city?
- The role of Telecommunications Service Providers (TSPs), e.g. AT&T, BT, Orange, Verizon and their environmental policies.
 - Case study on the effectiveness of the targets set by a range of TSPs.
 - Leverage of TSPs on equipment vendors.
- The role of IT Service Providers (including Cloud service providers) and their equipment vendors.
- Role of standards bodies and technical standards (including but not limited to ITU-T).
- Case study on the regulatory environment in the EU and if this has led to lower GHG emissions.
- Case study on a developing country (e.g. China) and how they have managed to start reducing their GHG emissions while still maintaining growth targets.

PROPOSED DELIVERY MODE AND DURATION

This module should start with instructor-led teaching, e.g. as a full-time, five days a week lecture-based class, followed by three weeks of instructor-led e-learning and self-study of reference materials. During the self-study period the students should be given individual assignments to prepare a module project addressing some specific problem that has arisen in their country as a result of specific regulatory conditions (e.g. establishment of Openreach in UK).

In the final week, a series of interactive seminars may be held to review the results of the module. Students would present their projects on a regulatory issue in their home country for discussion with their instructor and peers.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completing this module, students should understand how energy and telecoms policy is set and the aims of regulators in both the energy and telecoms markets.

STUDY RESOURCES

The study resources for this module include the reference documents available from ITU and ITU-T reports and handbooks:

- ITU Global Symposia for Regulators: www.itu.int/ITU-D/treg/Events/Seminars/GSR/
- ITU World Telecommunication/ICT Indicators database
- ITU Symposia on ICT and Climate Change 2007 – 2014

It would be useful for the student to have read examples of TSP environmental policies such as:

- BT Group plc. “Better Future Report”, London, UK.
- Verizon Sustainability Policy - www.verizon.com/about/responsibility/sustainability

These could be complemented by text books such as:

- European Energy Policy: An Environmental Approach
- Decarbonisation in the European Union: Internal Policies and External Strategies (Energy, Climate and the Environment).

In addition, students may be required to review recent Recommendations and other material from various ITU study groups, in particular ITU-T Study Group 5 “Environment & Climate Change” and the new Study Group 20 “Internet of Things and its applications, including smart cities and communities”, as well as regional best practices on infrastructure sharing and renewable energy generation.

4.3 FOUNDATION MODULE 3: DEVELOPING ICT SERVICE PROVIDER STRATEGIES

ICT service provider equipment located in a country contributes over 1% to the country's total energy emissions (e.g. a major TSP such as BT contributes 0.8% to UK emissions). The students should understand why that is the case, what it is made up of and what is being done to improve the energy efficiency of the ICT equipment over the last few years and, more importantly, what could be done in the future. This module is designed to be followed up by one of the options in AM3 if more depth is required in any of these areas.

This module should cover the following subjects and concepts:

- Types of Telecommunications and IT Service Provider Equipment that will have an impact on GHG emissions:
 - Telecommunications Equipment (e.g. switches and routers)
 - IT Equipment (e.g. Cloud Servers)
 - Personal devices (e.g. TVs, laptops and iPads)
- Energy Efficiency:
 - How do TSPs measure their carbon footprint and set targets for reduction (if they do)?
 - How are TSPs improving the energy efficiency of their equipment and services and what more could they do in the future?
 - How will next generation networks reduce energy consumption?
 - The role of the supply chain in improving energy efficiency.
 - Case study on GreenTouch: Has it achieved its aims?
- Mitigation:
 - How are the services being provided by TSPs and ICT service providers reducing GHG emissions in other sectors?
 - How is the impact on GHGs measured?
 - Exercise on measuring the GHG emissions from an ICT service and the GHG emissions that this might save in another sector. Do they balance?
 - Focus on Broadband rollout and how it is improving the ability to mitigate climate change.
 - Case study on what a particular service provider (in the student's home country) is doing to roll-out e-services.
 - Exercise on mitigation: are GeSI's suggested potential reductions feasible?
- Adaptation:
 - How are TSPs modifying their equipment and networks to take account of climate change in terms of rising sea levels, flooding, increases in temperature, humidity, lightning strikes, etc.
 - Case study on adaptation arising from the impact of Hurricane Sandy in US.
 - Exercise on what more could be done to help adapt to climate change.

PROPOSED DELIVERY MODE AND DURATION

This module should start as an instructor-led course, i.e. full-time classroom lectures five days per week, followed by three weeks of instructor-led e-learning and self-study of reference materials.

In the final week, practical visits could be arranged to various TSPs and/or ICT service providers to see at first hand the types of telecommunications switching centres, data centres etc. and how these measure up in terms of energy efficiency.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completing this module, students should demonstrate knowledge of the different types of ICT equipment, an understanding of the principles underlying the improvements in energy efficiency of ICT equipment and the impact this will have on a country's carbon footprint.

To demonstrate this understanding and as a part of the overall module assessment, the students could be requested to write an essay of around ten pages (or as an interactive exercise) describing how a specific TSP (preferably one based in their home country) has improved the energy efficiency of their network over the last 5 years. This work would be graded by the instructor and account for a proportional part of the overall final grade for the module.

STUDY RESOURCES

There are many literature sources and standards describing energy efficiency of ICT equipment including:

- European Commission, Joint Research Centre, Institute for Energy and Transport. Codes of Conduct on Energy efficiency, Ispra, Italy.
- EU-US Energy Star technical specifications Version 5.0.
- The GreenTouch Consortium. Deliverables are available at www.greentouch.org.

Mitigation:

- SMARTer2030 "ICT Solutions for 21st Century Challenges", GeSI, 2015 – www.gesi.org/portfolio/project/82

Adaptation:

- ITU Report: "Resilient pathways: the adaptation of the ICT sector to climate change".
- ITU-T Focus Group on Smart Sustainable Cities Technical Report: "ICT for climate change adaptation in cities".
- ITU-T Recommendation L.1500 "Framework for information and communication technologies (ICTs) and adaptation to the effects of climate change Adaptation".

4.4 FOUNDATION MODULE 4: ASSESSING THE IMPACT OF ICT ON CLIMATE CHANGE

This module focuses on energy consumption and the GHG emissions arising from these. This module is designed to be followed up by one of the options in AM4 if more depth is required in any of these areas. In particular, FM4 does not consider other environmental loads such as resource and water depletion, which are covered in more detail in AM4.1.

This module should cover the following topics:

- What methodologies are available to assess the impact of ICT on Climate Change and what is the role of each?
- Use of Embodied Carbon databases, e.g. DEFRA, ADEME, EC JRC.
- How to measure a carbon footprint at many levels including:
 - Personal level
 - Household level
 - Building level
 - Company level
 - Sector level
 - City level
 - Country level
 - Regional level
 - Global level
- What is the ITU doing to provide a set of methodologies to help measure the above?
 - Standardisation of methodologies and best practises by ITU-T and other bodies.
- Exercise on the principles for assessing the carbon footprint of the building the course is being held in.
 - What assumptions and approximations have to be made?
- Exercise on the principles for assessing the carbon footprint of the city that the course is being held in (this goes beyond ICT and a full analysis will not be possible).
 - what would be problems establishing the boundary of the city for GHG emissions?
 - what assumptions and approximations have to be made?

PROPOSED DELIVERY MODE AND DURATION

This module should start with instructor-led teaching, e.g. as a full-time, five days a week lecture-based class followed by three weeks of instructor-led e-learning and self-study of reference materials.

In the final week, a series of interactive seminars may be held to review the results of the module. Students will present their projects on assessing the carbon footprint of a specified city and a discussion held with their instructor and peers to identify opportunities arising.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completing this module students should understand the principles behind and reasons for using methodologies and tools for the assessment of the impact of ICT on climate change. Students should be able to demonstrate their understanding of how a carbon footprint is calculated, what the underlying assumptions and sources of possible error have been and how these might have influenced the results.

Students should be assessed on the depth of understanding and quantification demonstrated by their carbon footprinting projects.

STUDY RESOURCES

The reference sources for this module include:

- Cervi R. (2008). Can you calculate the carbon cost of your shopping? IET Engineering & Technology, Volume 3 Issue 20 - available from <http://eandt.theiet.org>
- David JC MacKay: "Sustainable energy without the hot air", UIT, Cambridge, England, 2009 – also available on-line at www.withouthotair.com
- ITU-T Recommendations L.1400 – L.1440 – available from www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=5
- GHG Protocol "A Corporate Accounting and Reporting Standard (Corporate Standard)". Available at www.ghgprotocol.org
- UK Buildings Research Establishment BREEAM Energy Assessment Methodology – www.breeam.org/index.jsp
- German Passivhaus Building Standard - www.passivhaus.org.uk/index.jsp
- Guidelines to DEFRA/DECC's GHG Conversion Factors for Company Reporting. Available at www.ukconversionfactorscarbonsmart.co.uk
- Hammond G and Jones C. (2011). "Embodied Carbon – the Inventory of Carbon and Energy (ICE)". BSRIA Guide Edited by Lowrie F and Tse P. Available at www.bsria.co.uk

The following ISO Environmental Management standards are also available. However, they are not free and copies cost around \$80 each. Therefore, it is recommended to rely on the ITU-T L.1400 series recommendations where possible.

- ISO 14040:2006, "Environmental Management–Life Cycle Assessment – Principles and Framework". Describes the principles and framework for life cycle assessment (LCA)
- ISO 14044:2006, "Environmental Management–Life Cycle Assessment – Requirements and Guidelines". Specifies requirements and provides guidelines for life cycle assessment (LCA).
- ISO 14064-1:2006, "Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of Greenhouse gases emissions and removals".

- ISO 14064-2:2006, “Greenhouse gases — Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements”.
- ISO 14064-3:2006, “Greenhouse gases — Part 3: Specification with guidance for the validation and verification of Greenhouse gas assertions”.

4.5 FOUNDATION MODULE 5: APPLYING GREEN ICT STRATEGIES

This module covers a wide range of green technologies used to mitigate against climate change. It builds on FM3 but investigates a broader range of technologies and e-services including Smart Cities. This module is designed to be followed up by one of the options in AM5 if more depth is required in any of the sectors where Green ICT Strategies can be applied (including the ICT sector).

Other foundation modules, in particular FM1 and FM3, introduce the concepts behind green ICT strategies but this module should cover the following subjects in more detail:

- How to improve the energy efficiency of network equipment and CPE.
- How a range of technologies can be used to reduce GHG emissions including:
 - Smart Metering and Smart Grids
 - Sustainable Buildings
 - Sustainable Transport, including real time navigation (RTN) and e-logistics
 - E-commerce
 - E-government, including e-civil service
 - E-learning
 - Telepresence
- What are the potential GHG savings from the introduction of green technologies
 - how should these be calculated?
- Exercise on the barriers to the introduction of green technologies.
 - Examples of commercial barriers
 - Examples of regulatory barriers
- How policy makers and regulators can promote and enable the introduction of green technologies.
- Case study based on the student’s home country identifying the opportunities and barriers to the introduction of green technologies and the amount of GHGs that could be saved.
- Case study on best practises in Smart Cities
 - How to provide a wide range of innovative new services.
 - How to integrate their infrastructures to provide services more efficiently.
- Project on assessing the energy and GHG savings from the introduction of an e-service (see below).

PROPOSED DELIVERY MODE AND DURATION

This module should start with instructor-led teaching, e.g. as a full-time, five days a week lecture-based class followed by three weeks of instructor-led e-learning and self-study of reference materials.

In the final week, a series of interactive seminars may be held to review the results of the module. Students would present the results of their projects on calculating the energy consumption and GHG emission savings that could arise from the introduction of a specific e-service (agreed with tutor in advance). These tentative e-services could be discussed with instructors and compared between peers to identify the most likely candidates for implementation.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should demonstrate an understanding of the philosophy and options behind green ICT strategies and why a particular strategy has been chosen.

Students should be assessed on the understanding demonstrated by their e-service projects and the suggestions for implementation.

STUDY RESOURCES

The reference sources for this module include:

- European Commission, Joint Research Centre, Institute for Energy and Transport. (2013). Code of Conduct on Energy Consumption of Broadband Equipment v.5.0. Ispra, Italy.
- “European Roadmap for Moving to a Competitive Low Carbon Economy in 2050”. Available at http://ec.europa.eu/clima/policies/roadmap/index_en.htm.
- ITU Report: “The case of Korea - The quantification of GHG reduction effects achieved by ICTs”, April 2013 – www.itu.int/pub/T-TUT-ICT-2013-08
- ITU Report: “Boosting energy efficiency through Smart Grids”, 2012 - www.itu.int/ITU-T/climatechange/report-smartgrids.html
- ITU Report: “Sustainable Buildings”, September 2012 – www.itu.int/ITU-T/climatechange/ess

4.6 FOUNDATION MODULE 6: E-WASTE AND THE CIRCULAR ECONOMY

This module is a very important part to the ICT&CC TP due to the emphasis placed on e-waste by WTSA-2012 and WTDC-2014. It examines how we currently deal with e-waste and what options and opportunities we have for the future. It also covers Eco-design which applies product life cycle thinking to minimize environmental impacts as early as possible in the product design and development process. Eco-design involves minimizing material and energy use and maximizing reuse and recycling. The concept of “cradle to cradle” and the

circular economy are introduced. This module is designed to be followed up by AM6 if more depth is required.

This module should cover the following subjects and concepts:

- How is e-waste currently dealt with?
 - Who are the key stakeholders?
 - What are the opportunities for improving rates of re-use?
 - What are the opportunities for improving recycling rates?
- Impact of e-waste on energy consumption and GHG emissions.
- ITU policies and standards relevant to e-waste.
 - The role of universal chargers.
 - Recycling of rare metals.
- Eco-design and best environmental practices.
 - Minimisation of rare and hazardous substances.
 - Design for re-use or disassembly and recycling.
 - Packaging - design for reuse or return.
 - Use of eco-design checklists.
- Case studies on countries / regions where e-waste is a particular problem (e.g. EU, US, Japan, Ghana).
- Exercise on the strategy being employed by the government of the student's (or another specific) country to reduce its e-waste including:
 - Developed country (exporting e-waste)
 - Developing country (importing e-waste)

PROPOSED DELIVERY MODE AND DURATION

This module should start with instructor-led teaching, e.g. as a full-time, five days a week lecture-based class followed by three weeks of instructor-led e-learning and self-study of reference materials.

In the final week, a series of interactive seminars may be held to review the results of the module. Students would present their projects on the e-waste strategy of their home country (or a specified country agreed with the tutor) and their suggestions for improvement. These ideas could be discussed with instructors and between peers and compared to identify those that could be implemented most effectively.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should understand the principles behind the circular economy, the gap between this and existing practises, and what is being done (or should be done) in various countries and regions to meet the problem.

STUDY RESOURCES

The reference sources for this module include:

- “Cradle to Cradle: Remaking the Way We Make Things”, Michael Braungart and U.S. architect William McDonough, Paperback: 208 pages, Publisher: Vintage (29 Jan. 2009).
- ITU Report on Sustainable Products – www.itu.int/ITU-T/climatechange/ess.
- EU Directive 2002/96/EC “Waste electrical and electronic equipment” (WEEE).
- EU Directive 2005/32/EC “Energy using Products” (EuP).
- China’s law on recycling: www.china-embassy.org/eng/xw/t510019.htm.
- “Circular Economy” at: www.ellenmacarthurfoundation.org/about/circular-economy.

5 ADVANCED MODULES

In this section, a set of Advanced Modules is described which build on each Foundation Module to give the student a greater depth of understanding with more emphases on case studies and practical exercises.

There is some overlap between the Advanced Modules in each series as it is not expected that a student would take more than four of them (out of the 15 possible). In particular, there may be an overlap between different options of the same Advanced Module (e.g. AM2) as these generally offer different perspectives on similar issues.

There is room for expanding the scope of the course with further Advanced Modules, in order to take advantage of proposals made by partner institutions based on their particular competencies, specializations and capacities.

5.1 ADVANCED MODULE 1: THE GLOBAL PICTURE: CLIMATE MODELLING, MONITORING AND GLOBAL FRAMEWORKS FOR EMISSIONS REDUCTION

The options available for AM1 are designed to follow up the topics introduced in FM1. They are largely independent with little overlap in their content, and so students could take more than one of these options if required.

5.1.1 AM1 Option 1: Climate Modelling

The purpose of this advanced module is to provide students with an understanding of the ways in which climate models are built and the evidence, assumptions and approximations that underlie them. This module should be seen as a logical extension to the material provided in FM1.

The topics to be covered in this module include:

- The evidence for Climate Change
 - What is this based on and is it convincing?
- The Physics of Climate Change:
 - Balancing the sun's and earth's radiation
 - The 'atmospheric window'
 - How important is CO₂?
 - Impact of water vapour, clouds and methane
 - A global average with regional chaos?
- The variety of Climate Models.
 - The climate models used by UNFCCC and IPCC.
 - Why have they chosen the ones they have?
- How much do you believe and how much do you understand?
 - The IPCC assessment reports.

- The Kyoto Protocol and Metrics.
- Exercise looking at the last 15 years of climate change records.
 - Do these provide incontrovertible evidence for climate change?
 - If not, what other evidence has been taken into account and what assumptions have been made?

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss the latest understanding and assumptions behind climate models (especially those used by IPCC). In order to reinforce their understanding of the material, students may be given individual coursework assignments, e.g. to look at the metrics and reporting required by the Kyoto protocol and how effective this is.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, the students should demonstrate an understanding of why IPCC has chosen the climate models they have used and how these models have been used to determine a figure of 2°C for the 'acceptable' global temperature rise that is achievable using proposed targets and restrictions on GHG emissions and can be sustained. Also, students will gain an understanding of the uncertainties that have led to the main points of disagreement amongst experts and why water vapour and shipping have been excluded from the calculations.

Students would be assessed via an interactive exercise on climate models using data from the last 15 years and the various conclusions that could be reached.

STUDY RESOURCES

The reference sources for this module include:

- www.earthobservatory.nasa.gov/Features/EnergyBalance/
- "Meteorology for Scientists and Engineers": Technical Companion Book to C. Donald Aherns' Meteorology Today, Ed 2–Roland B Stull, Pub Brooks/Cole.
- "Atmosphere, ocean, and climate dynamics: an introductory text" By John Marshall, R. Alan Plumb, Elsevier Academic Press 2008.
- IPCC 4th & 5th Assessment reports.

5.1.2 AM1 Option 2: The role of Satellite and Radiocommunication in Environmental Monitoring

This module is an extension to the material presented in module FM1 and focuses on environmental monitoring using satellite and radiocommunication technologies. ITU-R creates the regulatory and technical bases for the development and effective operation of satellite and terrestrial climate monitoring and data dissemination systems. It does so by: allocating the necessary radio-frequency spectrum and satellite orbit resources; analyzing compatibility between new and existing satellite systems; carrying out studies and developing international standards for space-based and other radiocommunication systems and networks; and providing guidance and support on the use of satellite and terrestrial systems for environmental monitoring.

The topics to be covered in this module include:

- Role of satellites in gathering climate data.
- Terrestrial remote sensing systems.
- Alert systems.
- ITU-R's role in regulation and technical standards for environmental monitoring.
- How are spectrum and satellite slots allocated?
- Disaster relief systems.
- Exercise on new services that could be provided for disaster prediction, detection, mitigation, response and relief.
 - Would new spectrum allocation be required for these services?

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss the latest technology for satellite and radiocommunications. In order to reinforce their understanding of the material, students may be given individual coursework assignments, e.g. to look at how satellite slots and spectrum are allocated for specific services.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of the importance of satellite and radiocommunication technologies and the way they contribute to environmental monitoring.

Students would be assessed using an interactive exercise to design and implement a new service for disaster prediction or relief.

STUDY RESOURCES

The reference sources for this module include:

- ITU/WMO Handbook: “Use of Radio Spectrum for Meteorology: Weather, Water and Climate Monitoring and Prediction”.
- UNOOSA: “Space and Climate Change: use of space-based technologies in the United Nations system”.
- ITU-R Radiocommunication: “Climate Change Brochure”.
- Report ITU-R RS.2178, “The essential role and global importance of radio spectrum use for Earth observations and for related applications”.
- Recommendation ITU-R RS.1883, “Use of remote sensing systems in the study of climate change and the effects thereof”.
- “Handbook on Earth Exploration-Satellite Service”.
- Recommendation ITU-R RS.1859, “Use of remote sensing systems for data collection to be used in the event of natural disasters and similar emergencies”.
- Recommendation ITU-R M.1849, “Technical and operational aspects of ground-based meteorological radars”.
- Recommendation ITU-R M.1874, “Technical and operational characteristics of oceanographic radars operating in sub-bands within the frequency range 3-50 MHz”.
- Recommendation ITU-R M.2002, “Objectives, characteristics and functional requirements of wide-area sensor and/or actuator network (WASN) systems”.
- Report ITU-R M.2013, “Wind Profiler Radars”.

5.1.3 AM1 Option 3: Global/Regional Frameworks for GHG Emissions Reduction

The purpose of this advanced module is to provide students with a complete understanding of the role of global frameworks and conventions in mitigating climate change and how these impact on a country’s freedom of manoeuvre to implement it’s own measures. It includes a more detailed look at European and other regional climate change initiatives and agreements. This module should be seen as a logical extension to the material on global policy makers presented in module FM2.

The topics to be covered in this module include:

- Kyoto Protocol and its successor agreements.
 - Objectives.
 - Implementation.
 - The importance of the Doha Amendment
- The role of UNFCCC and IPCC.
 - Nationally Appropriate Mitigation Actions (NAMAs) and Intended Nationally Determined Contributions (INDCs).
 - Funding for Climate Change mitigation measures – the Green Climate Fund and what it can be used for.
- The EU Framework for Energy Reductions.

- Exercise on whether we really need Carbon Credits and the Clean Development Mechanism (CDM)?
 - Case study on who is and who isn't claiming carbon credits?
 - How would other countries (e.g. Pakistan) benefit from claiming carbon credits?
 - What are the downsides to the CDM?
- Exercise on Carbon Credits.
 - How much could be claimed for a hydroelectric or a community renewable energy generation project?
 - What would and wouldn't be allowable within the mechanism?

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss the latest trends and review selected case studies. In order to reinforce their understanding of the material, students may be given individual coursework assignments, e.g. to look at carbon credits and the CDM in more detail and say how a specific country is using them and they might use these more effectively.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of the various global frameworks, treaties and agreements that have been put in place to limit the rise in GHG emissions globally. The student should be able to say what the next steps are and the impact that these will have on restricting the rise in global temperature to 2°C.

Students' understanding should be assessed using an interactive exercise based on the use of carbon credits and if they are effective.

STUDY RESOURCES

The reference sources for this module include:

- United Nations Framework Convention on Climate Change. National Inventory Report. Available at https://unfccc.int/national_reports/items/1408.php
- UNFCCC documents including the Kyoto protocol and its successor agreements.
- Certified emission reduction units by country - <http://cdm.unfccc.int/Statistics/Issuance/CERsIssuedByHostPartyPieChart.html>
- National policy documents including UK Climate Change Act 2008.
- CDM Methodologies Booklet, 6th edition, Information up to EB 79, November 2014 <https://cdm.unfccc.int/methodologies/documentation/index.html>.

5.2 ADVANCED MODULE 2: UNDERSTANDING THE RANGE AND TYPES OF STAKEHOLDER

The options available for AM2 are designed to follow up the topics introduced in FM2. Two options are available containing similar content from different perspectives. It is therefore not expected that a student should take both of these options.

5.2.1 AM2 Option 1: Policy Makers & Regulators

The purpose of this advanced module is to provide students with an understanding of the role of relevant policy makers and regulators in ICT & Climate Change. For example, in the setting of targets and KPIs for TSPs and ICT service providers to follow.

The topics to be covered in this module include:

- Identification of all relevant policy makers and regulators.
 - Which market sectors will have an impact on climate change?
- Examples of different types of regulatory mechanism used in different sectors.
 - How regulators can increase energy efficiency.
 - Case study on the Indian Bureau of Energy Efficiency.
- Impact of targets and KPIs:
 - When can targets and KPIs be used most effectively?
 - Role of requests for data e.g. % of base stations using renewable energy, or average power originating from fossil fuels per customer connected.
- Role of the telecoms regulatory authority with examples from different countries:
 - FCC (US)
 - PTA (Pakistan).
 - Ofcom (UK) with the example of Openreach.
 - TCRA (Tanzania)
 - How similar / different are the problems each of these faces?
- Role of the energy (power) generation regulatory authority with examples from different countries:
 - CER (Ireland)
 - NEPRA (Pakistan)
 - Ofgem (UK)
 - How similar / different are the problems each of these faces?
- Infrastructure sharing from a regulator's perspective.
 - Passive and active sharing of mobile base station sites.
 - Incentives for TSPs.
 - Impact of charges on site sharing.
- Case study on infrastructure sharing in Malaysia.
- Exercise on the introduction of infrastructure sharing in the student's home country.

- What would be most effective?
- What barriers might be faced and how might the regulator overcome them?
- Should BTS sharing be active or passive?

PROPOSED DELIVERY MODE AND DURATION

It is recommended that this module be delivered as an instructor-led e-learning module, including live web-based seminars moderated by the tutor, to discuss the most relevant new policy developments and review best practises in regulation. In order to reinforce understanding of the material, students should be given individual coursework assignments, e.g. to develop a strategy and timescale for the introduction of infrastructure sharing in the student's home country.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of how regulation affects the market, the different types of market mechanisms and how each has been selected to reach a policy derived target.

Students should be assessed using an interactive exercise assessing the market benefits of regulatory intervention in a specific case (to be agreed with tutor). What KPIs and targets would be required to the regulation to be effective?

STUDY RESOURCES

The reference sources for this module include:

- ITU Global Symposia for Regulators: www.itu.int/ITU-D/treg/Events/Seminars/GSR/
- European Commission, Joint Research Centre, Institute for Energy and Transport. (2013). Code of Conduct on Energy Consumption of Broadband Equipment v.5.0. Ispra, Italy.
- Indian Bureau of Energy Efficiency - www.beeindia.in
- Energy Solutions for Smart Cities and Communities: Recommendations for Policy Makers from the 58 Pilots of the CONCERTO Initiative.
- UK Climate Change Act 2008. London, UK - www.legislation.gov.uk/ukpga/2008/27/contents.

5.2.2 AM2 Option 2: Telecoms and IT Service Providers

The purpose of this advanced module is to provide students with an overview of the role of Telecoms and IT Service Providers in ICT and Climate Change and the problems that they face. This module covers a similar range of topics to AM2 Option 1 but from the TSP perspective. A deeper understanding of the role of the TSP can be obtained from AM3 Option 1 and of the role of the IT Service Provider from AM3 Option 2.

The topics to be covered by this module include:

- The roles of service providers in energy efficiency and mitigation.
- Infrastructure sharing – fixed and mobile.
 - Use of Renewable Energy Technologies (RET).
 - Exercise on the benefits of setting up a Renewable Energy Service Company (RESCO) as in India.
- Energy saving in ICT facilities:
 - Data centers.
 - Telecommunications buildings (exchanges).
 - Access network (remote cabinets, fibre to the home).
- How the following technologies can be used to reduce GHG emissions:
 - Smart Metering and Smart Grids
 - Sustainable Buildings
 - Sustainable Transport, including real time navigation (RTN) and e-logistics
 - E-commerce
 - E-government, including e-civil service
 - E-learning
 - E-health care
 - Digital content
 - Home energy management systems
 - Smart motors
 - Telepresence
 - Remote (or smart) work
 - Others invented by the students.
- What are the potential GHG savings arising from the introduction of these technologies (and how should these be assessed)?
- What are the barriers for the TSP to the introduction of these technologies?
 - How much would it cost upfront to put these e-services in place?
 - How much revenue could be expected over what period?
 - What might the RoI be?
 - How to stimulate uptake.
- How the rollout of high speed broadband access can help to mitigate climate change.
- Exercise on the introduction of infrastructure sharing in the student's home country.

- What additional costs might be faced by the TSP?
- What other problems have to be overcome?
- Should the TSP offer active or passive sharing for BTS sites?

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss the latest e-services that have been deployed and best practises for their implementation. In order to reinforce their understanding of the material, students may be given individual coursework assignments, e.g. to identify the barriers and opportunities to the introduction of a specific e-service.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of the benefits and barriers to infrastructure sharing as well as an understanding of a wide range of ICT technologies that can be used to mitigate climate change by reducing GHG emissions in other sectors.

Students should be assessed using an interactive exercise on how to roll out and stimulate uptake of a specific e-service in the student's home country. What would it cost the TSP and would the RoI be sufficient to meet accounting targets?

STUDY RESOURCES

The reference sources for this module include:

- ITU Technology Watch Report 7: "NGNs and Energy Efficiency".
- ITU Future Networks Focus Group Report: "Overview of Energy-saving of Networks".
- ITU Report: "The case of Korea - The quantification of GHG reduction effects achieved by ICTs", 2013 – www.itu.int/pub/T-TUT-ICT-2013-08.
- ITU Report: "Enabling Energy Efficiency through ICTs: The case of Pakistan".

5.3 ADVANCED MODULE 3: ICT SERVICE PROVIDER STRATEGIES IN DEPTH

The options available for AM3 are designed to follow up the topics introduced in FM3. The first two options focus on the TSP and the IT service provider, although in some countries these will offer an overlapping range of services. There will be some overlap between these, especially in the methods used to assess savings in energy or GHG emissions. Therefore it is not recommended that a student takes both options. The 3rd option follows up the topic of Adaptation to the impact of climate change, focusing on infrastructure adaptation.

5.3.1 AM3 Option 1: Telecom Service Provider (TSP) Strategies

The purpose of this advanced module is to provide students with a full understanding of the role of Telecoms Service Providers (TSPs) in mitigating and adapting to Climate Change. This module builds on the learning undertaken in FM3 and AM2 Option 2.

The topics to be covered in this module include:

- How to calculate the carbon footprint of network infrastructure components (e.g. switches and routers).
 - Impact of network architecture on GHG emissions.
- Infrastructure sharing from a TSPs perspective.
 - Fixed and mobile infrastructure sharing.
 - Passive and active sharing of mobile base station sites.
 - Incentives for TSPs.
 - Impact of charges on site sharing.
 - Case studies on infrastructure sharing in UK and Pakistan.
- Use of renewable energy.
 - Case study on the Renewable Energy Service Company (RESCO) in India.
- Impact of the Next Generation Network (NGN) and optical infrastructures.
 - Exercise on how much energy these will save.
- The provision of e-services.
- The role of the TSP in adapting to climate change.
 - How to ensure resilience by protecting equipment from the impacts of climate change.
 - Case study from Telefónica on how a TSP can adapt to Climate Change.

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss the latest trends and review selected case studies. In order to reinforce their understanding of the material, students may be given individual coursework assignments, e.g. on the role of a TSP in adaptation.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of the role of TSPs to delivering national reductions in GHG emissions, the various Green ICT strategies being adopted by TSPs, and why each has been selected. Also an appreciation of how much these will cost (including RoI) and how effective these are likely to be in reducing overall GHG emissions.

Students should be assessed using an interactive exercise based on setting up a renewable power generation company to service BTS sites (similar to RESCO in India) and if the principles could be effective elsewhere.

STUDY RESOURCES

The reference sources for this module include:

- ITU Report: “Climate Change Adaptation and Information & Communications Technologies (ICTs): The Case of Ghana”.
- ITU Report: “Enabling Energy Efficiency through ICTs: The case of Pakistan”.
- The GreenTouch Consortium. Deliverables available at www.greentouch.org.
- ITU Report: “Resilient pathways: the adaptation of the ICT sector to climate change”.
- Draft ITU-T Recommendation L.Infrastructure: “Best practices for Adapting ICT equipment and networks to the effects of Climate Change”.

5.3.2 AM3 Option 2: IT Service Provider Strategies (including Cloud Services)

The purpose of this advanced module is to provide students with an understanding of the role of IT Service Providers in Climate Change mitigation and adaptation. This module is complementary to AM3 Option 1 and builds on the outcomes of modules FM3 and AM2 Option 2.

The topics to be covered in this module include:

- The role of IT in providing e-services.
 - How much could these save and what proportion on National GHG emissions would this amount to?
 - What would be the most effective e-services to roll out over the next 5 years?
- The need for an e-government Cloud based infrastructure
 - Design for a National roll-out plan.
- The need for an e-commerce payment gateway
 - What would be the benefits?
 - Who would be the stakeholders?
 - How could this be achieved?
- Energy efficiency of data centres.

- Exercise on calculating the carbon footprint of a data centre.
- How much is the footprint likely to grow over the next 5 years (to 2020) and what impact will this have on the country's carbon footprint?
- What improvements could be made to improve this (with justification/quantifications)?
- Telecommuting and hot-desking:
 - What facilities are needed?
 - Calculating the carbon emission benefits.
 - What are the upsides and downsides?

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss the latest trends and review selected case studies. In order to reinforce their understanding of the material, students may be given individual coursework assignments, e.g. identifying requirements for an e-government cloud in the student's home country (or another specified country agreed with the tutor). What services should this provide to citizens and civil servants? How much GHG emissions might be saved?

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of the role of IT service providers in delivering National reductions in GHG emissions and what is currently being done. Also an appreciation of how much these strategies will cost and the ROI that could be achieved, and how effective these strategies are likely to be in reducing overall GHG emissions.

Students should be assessed using an interactive exercise on carbon footprinting of a data centre and how (and by how much) this could be reduced using the latest techniques.

STUDY RESOURCES

The reference sources for this module include:

- SMARTer2030 "ICT Solutions for 21st Century Challenges", GeSI, 2015 – www.gesi.org/portfolio/project/82
- ITU-T Recommendation L.1300 "Best practices for green data centres" Edition 2.
- ITU-T Recommendation L.1200 "Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment".
- "The Enabling Technologies of a Low-Carbon Economy: A Focus on Cloud Computing", GeSI, 2013.
- GeSI cloud computing impact app - www.gesicloudimpact.org.
- ITU Report: "The case of Korea - The quantification of GHG reduction effects achieved by ICTs", 2013 – www.itu.int/pub/T-TUT-ICT-2013-08.

5.3.3 AM3 Option 3: Adaptation for Infrastructure Providers

The purpose of this advanced module is to provide students with an understanding of the role of infrastructure providers in adapting to Climate Change. It is essential to protect infrastructure from the impacts of climate change such as increased temperatures, flooding, humidity and other extreme weather events as failure will have a much greater impact on wider society including increased risk of deaths and injuries. It will build on the information learned in Foundation module FM3 and advanced module AM3 (if taken).

The topics to be covered in this module include:

- The need for climate change adaptation.
- ICT and climate change adaptation.
- Climate change impacts, challenges and opportunities for the ICT sector.
- The role of the Power Generator and TSP in adapting to climate change.
- How to ensure resilience by protecting equipment from the impacts of climate change.
 - Power Generator/Distributor measures
 - TSP measures
- Case study on adaptation arising from the impact of Hurricane Sandy in US.
- Case study from Telefónica on how a TSP can adapt to Climate Change.

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to review and discuss best practices in infrastructure adaptation. In order to reinforce their understanding of the material, students may be given individual coursework assignments, e.g. on adaptation in their home countries.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of the various impacts of climate change on ICT equipment and infrastructure and how these could be mitigated.

Students will be assessed using an interactive exercise on frameworks for adaptation and who the stakeholders are.

STUDY RESOURCES

The reference sources for this module include:

- ITU-T Recommendation L.1500 “Framework for information and communication technologies (ICTs) and adaptation to the effects of climate change Adaptation”.
- ITU Report: “Resilient pathways: the adaptation of the ICT sector to climate change”.
- Draft ITU-T Recommendation L.Infrastructure Adaptation: “Best practices for Adapting ICT equipment and networks to the effects of Climate Change”.
- ITU-T Focus Group on Smart Sustainable Cities Technical Report: “ICT for climate change adaptation in cities”.
- MacLean, D. (2008), “ICTs, Adaptation to Climate Change, and Sustainable Development at the Edges”, International Telecommunication Union Symposium on ICTs and Climate Change. London: International Institute for Sustainable Development.

5.4 ADVANCED MODULE 4: LIFE CYCLE ASSESSMENT

The options available for AM4 are designed to follow up the topics introduced in FM4. Two options are available. However, there will be some overlap between the content, especially in the methods used to assess GHG emissions, and a student would not normally be expected to take both options when undertaking the ICT&CC TP.

5.4.1 AM4 Option 1: How to carry out a full LCA

The purpose of this advanced module is to provide students with a full understanding of how to carry out an LCA and to apply this to an ICT project and its relevance for funding under the CDM. This option includes environmental loads other than energy consumption and GHG emissions. It goes beyond GHG emissions generated by ICT and should focus on how ICTs are responsible for these other environmental loads and how it can help to monitor and mitigate them.

The topics to be covered by this module include:

- How to carry out a full LCA on an ICT project including:
 - Setting project boundaries.
 - Using emission factors from embodied carbon databases.
 - How to estimate the emission factor to be used from power generation.
 - Making assumptions – when these are and aren't justified?
 - Setting cut offs, what is significant and what isn't.
- How to carry out a full environmental assessment including the following environmental loads:
 - global warming potential (GWP)
 - ozone depletion potential (ODP)
 - acidification potential (AP)
 - nitrification potential (NP)
 - human toxicity, cancer effects (HTC)
 - human toxicity non-cancer effects (HTNC)
 - respiratory inorganics/particulate matter (RI/PM)
 - ionizing radiation, human health (IRH)
 - ionizing radiation, ecosystems (IRE)
 - eutrophication, aquatic (EA)
 - eutrophication, terrestrial (ET)
 - photochemical ozone formation (POF)
 - ecotoxicity, freshwater (ETFW)
 - land use (LU)
 - resource depletion, water (RDW)
 - resource depletion, mineral, fossil, and renewable (RDMR).
- Background project to carry out a full LCA over 4 weeks:
 - Students to select a project – Week 1

- Students to identify system boundary and main components and information required to complete LCA – Week 2
- Students to search for information needed for LCA. Where information is not available show assumptions and approximations used – Week 3
- Students to complete and write up LCA – Week 4

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to look at best practises in life cycle assessment. In order to reinforce their understanding of the material, students may be given individual coursework assignments, which should make up parts of their background project so that after 4 weeks this is complete with a full LCA.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of how to carry out an LCA, using appropriate assumptions and approximations where necessary. They should also have a briefer understanding of how to carry out a full environmental assessment including the full set of environmental loads, although this is a specialised area and it will not be possible to go deeply enough in the time available for the students to become fully qualified in this area.

Students should be assessed via their background project and how complete the LCA is.

STUDY RESOURCES

The reference sources for this module include:

- David JC MacKay: “Sustainable energy without the hot air”, UIT, Cambridge, England, 2009 – also available on-line at www.withouthotair.com.
- ITU-T Recommendations L.1400-L.1440 Methodologies for assessing the environmental impact of ICT – available from www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=5
- Guidelines to DEFRA/DECC’s GHG Conversion Factors for Company Reporting. Available at www.ukconversionfactorscarbonsmart.co.uk
- Emission factors from the French database published by ADEME - www2.ademe.fr/servlet/KBaseShow?catid=24826
- UK DEFRA source of CO₂e emission factors - www.ukconversionfactorscarbonsmart.co.uk/DCFCarbonFactors_11_4_2014_10222_9.xls
- BSI PAS 2050. Specification for the assessment of the life cycle greenhouse gas emissions of goods and services. British Standards Institute. Available at <http://shop.bsigroup.com>

5.4.2 AM4 Option 2: How to Assess the Carbon Footprints of Sectors, Countries and Regions

The purpose of this advanced module is to provide students with an understanding of how to assess and report GHG emissions on a National and regional basis. It could build on the learning undertaken in Foundation module FM2 and advanced module AM1-Option 2 (if taken). It is wider than ICT and would have to use the UNFCCC methodology for countries as well as the ITU-T L.1400 series recommendations.

The topics to be covered in this module include:

- How should National GHG emissions be calculated and reported under the Kyoto protocol?
 - Which countries have to provide full reports and what arrangements are in place for the others?
- What are Scope 1, Scope 2 and Scope 3 emissions?
 - What assumptions and approximations needs to be made?
- Contribution of Cities to National GHG Emissions.
 - How much of the total do cities contribute?
 - How to set the boundary of a city.
 - How can cities contribute to reducing National GHG emissions?
 - What targets and KPIs are appropriate for cities (with examples)?
 - Exercise on setting targets and KPIs for a specified city.
- Exercise on the principles behind assessing the carbon footprint of the student's home country:
 - What are the most significant components?
- (For a developing country) Exercise on how to draw up a NAMA for the student's home country or a specified developing country.

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss best practises in assessing the carbon footprint of cities, e.g. Bristol. In order to reinforce their understanding of the material, students may be given individual coursework assignments, to look at aspects of carbon footprints for different purposes.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of the how GHG emissions are calculated and reported on a National basis, what are the main contributors to these, and how they could be reduced. For countries that don't have an obligation to report GHG emissions under the Kyoto protocol, an understanding of how a

NAMA or INDC is put together. Also an understanding of how cities contribute to the emissions reported under the Kyoto protocol and how KPIs for cities can be set most effectively.

Students should be assessed via a project chosen and agreed with the tutor. Marks will be awarded for how complete this is, whether the assumptions and approximations are shown, and how well it is aligned with relevant standards.

STUDY RESOURCES

The reference sources for this module include:

- UNFCCC documents including the Kyoto protocol and its successor agreements.
- Examples of Nationally Appropriate Mitigation Actions (NAMAs) and Intended Nationally Determined Contributions (INDCs).
- National Energy Yearbooks.

5.5 ADVANCED MODULE 5: GREEN ICT STRATEGIES IN DIFFERENT SECTORS

The options available for AM5 are designed to follow up the topics introduced in FM5. Four options are available for different sectors: energy efficiency (in the ICT sector), power generation, transport and finally smart sustainable cities. There is some overlap between the content of Options 2 and 3 and students should not normally be expected to take both options as part of a balanced ICT&CC TP.

5.5.1 AM5 Option 1: Improving the Energy Efficiency of ICT Products and Services

The purpose of this advanced module is to provide students with a full understanding of the energy consumption of ICT equipment and services, how the energy efficiency of ICT could be improved in order to reduce consumption and the impact this would have on a country's GHG emissions.

The topics to be covered in this module include:

- How much does ICT contribute to energy consumption and GHG emissions at global and country level (with variations and extremes)?
- Using eco-design standards in procurement.
- Using energy efficient network architectures.
 - e.g. NGN or mobile network BTS sharing.
- Emissions and ownership
 - Operator.
 - Supplier.
 - Consumer.
- Encouraging best practices in ICT equipment design.
 - e.g. use of low power states for equipment.

- Using local renewable power supplies.
 - e.g. using wind and solar power generation on mobile BTS.
- How to set targets for reduction of energy consumption of ICT equipment.
 - Examples of existing targets (e.g. EC CoCs and US EnergyStar).
 - What equipment is covered by these?
- Case study on the Indian Bureau of Energy Efficiency.
- Exercise on how much energy could be saved per year by 2020 as a result of applying the EU CoCs.

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss the latest trends and review selected case studies. In order to reinforce their understanding of the material, students may be given individual coursework assignments, e.g. to look more widely at eco-design standards or the use of renewable energy supplies.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of many ways to reduce the energy consumption of ICT equipment and what impact this would have (over what timescale) on National and Global GHG emissions.

Students should be assessed using an interactive exercise, e.g. on use of low power states in equipment and the potential impact on QoE.

STUDY RESOURCES

The reference sources for this module include:

- Worldwide energy consumption of ICT Equipment and Services.
- EC Joint Research Centre, Institute for Energy and Transport, ICT Codes of Conduct - http://re.jrc.ec.europa.eu/energyefficiency/html/standby_initiative.htm
- Indian Bureau of Energy Efficiency - www.beeindia.in

5.5.2 AM5 Option 2: GHG Reductions in the Power Sector

The purpose of this advanced module is to provide students with an understanding of how improvements to the power sector through the introduction of renewable energy technologies and smart grids could contribute to GHG emissions Nationally and Globally. It will also cover the downsides, such as increased threats from terrorism and the need for CyberSecurity. It will build on but go into more depth than module FM5.

The topics to be covered in this module include:

- How Smart Metering and Smart Grids can reduce energy consumption.
- How is a Smart Grid built?
 - The components of a smart grid, how much they cost and how they are put together.
 - When and how they can be deployed.
 - Who are the stakeholders and what are the barriers?
- Vulnerability and CyberSecurity
- Use of renewable energy technologies in the power network:
 - Most effective sites for Solar PV.
 - Most effective sites for wind turbines (onshore and offshore).
 - Large scale hydro.
 - Small scale hydro.
 - Geothermal.
 - Waste to power.
 - Case study on renewable energy in a student's home country.
- Nuclear power
 - Is this the silver bullet for increasing power generation without increasing GHG emissions?
 - What is the environmental impact?
- Use of storage in the power network.
 - Case study on best practises in energy storage in different countries.
 - Exercise on what is practical now and how much storage could eventually be provided.
 - What is coming along in the future – democratisation of energy?
- Introduction of electric vehicles (EVs) into the power distribution network.
 - What impact will this have on the grid?
 - What opportunities does this create for energy storage?
 - What measures would need to be taken to stimulate the market for EVs?
- Exercise to design a smart grid for the student's home country:
 - What are the components and where should they go?
 - What are the barriers (including regulatory)?
 - Who would have to buy-in to the plan?
 - How much would it cost?
 - How much energy and GHG emissions would it actually save and over what timescale?
 - Roadmap.

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to examine best practises in smart grid deployment and review selected examples. In order to reinforce their understanding of the

material, students may be given individual coursework assignments followed up with study at home including interaction with appropriate stakeholders to complete the project.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate an understanding of the importance of improving the power system, not only to ensure that blackouts do not occur but to make a significant reduction in GHG emissions. The students should be able to name the important stakeholders (including the users), design a smart grid for their country, calculate the costs and ROI and any GHG emissions savings on the improvements suggested.

Students should be assessed on the completeness and results of their smart grid project in the student's home country (or another country agreed with the tutor). How well have the barriers been identified and the costs and benefits quantified?

STUDY RESOURCES

The reference sources for this module include:

- “Smart Power: Climate Change, the Smart Grid and the Future of Electric Utilities”, Peter S Fox-Penner, 2014.
- ITU Report: “Boosting energy efficiency through Smart Grids”, 2012 - www.itu.int/ITU-T/climatechange/report-smartgrids.html
- SMARTer2030 “ICT Solutions for 21st Century Challenges”, GeSI, 2015 – www.gesi.org/portfolio/project/82
- Country Energy Yearbooks showing total power generated.
- Real time information on energy consumption, e.g. <http://www2.nationalgrid.com/uk/Industry-information/Electricity-transmission-operational-data/Data-Explorer/>
- Sizewell power stations A, B and C environmental impact assessments, e.g. - http://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/projects/EN010012/1.%20Pre-Submission/EIA/Scoping/Scoping%20Request/Sizewell%20C%20EIA%20Scoping%20Report_Main%20text.pdf.
- Tesla Powerwall - www.teslamotors.com/en_GB/powerwall.

5.5.3 AM5 Option 3: Decarbonising Transport

The purpose of this advanced module is to provide students with an understanding of how to reduce energy consumption and GHG emissions in the Transport sector. This module will build on module FM5 but will go into significantly more depth in the area of transport technologies, their cost and their potential to reduce GHG emissions.

The topics to be covered by this module include:

- How much does the Transport sector contribute to National and Global GHG emissions?

- What opportunities are there to reduce GHG emissions in the Transport sector using, e.g. Real Time Navigation, e-logistics or bus information systems.
 - What infrastructure changes would have to be made to enable these technologies to be used effectively?
 - How much would the introduction of these technologies actually save in practice in a specific country?
- What lifestyle changes would have to be made by citizens?
 - Use of alternative transport options.
 - Modal shifts.
 - Use of EVs.
- Project on the introduction of EVs
 - What are the barriers?
 - How can the government encourage uptake?
 - What will the impact on the power sector be?
 - What collaborations are needed?
 - What technical standards are needed?
 - Roadmap for their introduction.
- Exercise: How do EVs compare with internal combustion (e.g. petrol and diesel) engine vehicles in countries with a grid system using / not using fossil fuels?

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to discuss the latest trends and review selected case studies. In order to reinforce their understanding of the material, students may be given individual coursework assignments, on a mitigating technology of their choice (agreed with the tutor).

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should appreciate the contribution that the Transport sector plays in total GHG emissions, to be able to demonstrate an understanding of the ways these could be reduced and the impact on lifestyles and power requirements that might result.

Students should be assessed on the completeness and results from their EV project, how well have the barriers been overcome, the costs quantified and the benefits elaborated.

STUDY RESOURCES

The reference sources for this module include:

- ITU Report: “Enabling Energy Efficiency through ICTs: The case of Pakistan”.

- ITU Report: “The case of Korea - The quantification of GHG reduction effects achieved by ICTs”, April 2013 – www.itu.int/pub/T-TUT-ICT-2013-08
- “Greening Growth in Pakistan through Transport Sector Reforms: A Strategic Environmental, Poverty, and Social Assessment”, World Bank Publications, 2013.

5.5.4 AM5 Option 4: Smart Sustainable Cities

The purpose of this advanced module is to provide students with an understanding of how to reduce energy consumption and GHG emissions in a Smart & Sustainable City. It will build primarily on modules FM2, FM3 and FM5 but will show how all of the aspects covered by the course are relevant and can be combined in a Smart & Sustainable City. For example, the range of stakeholders is broader than in the other areas and the options are more complex.

The topics to be covered by this module include:

- How do cities contribute to National, Regional and Global GHG emissions?
- Who are the stakeholders in a Smart & Sustainable City?
- What opportunities are there to reduce GHG emissions in Cities using Green ICT Technologies?
 - But what barriers are there to improvements?
- What does a Smart & Sustainable City look like?
 - What sort of services are provided?
 - What is the architecture of a Smart & Sustainable City?
 - Are there any new features that aren't present in existing cities?
- What standards are available to build Smart & Sustainable Cities?
 - The ITU-T Smart & Sustainable Cities Focus Group and SG12.
 - Other relevant standards from regional standards bodies, fora and consortia.
- Exercise on the implementation of a Green ICT project in a city.
 - How would you select a Green ICT project?
 - How would you assess the GHG emissions that might be saved?
 - Who would you have to convince?
 - Who would you get to lead the project?
 - How would you set targets and KPIs?
 - What resources would be needed to implement it?
- Project looking at a specific city in a student's home country.
 - What are the main problems?
 - How are these changing over time?
 - What is the impact on quality of life?
 - How could you overcome the problems using Smart & Sustainable City technology?
 - Who are the key stakeholders?
 - What are the barriers?

- How would you assess the benefits of the changes?

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to present and discuss case studies and best practises of Smart & Sustainable Cities worldwide. In order to reinforce their understanding of the material, students may be given a project on a city in their own country (as above).

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should appreciate the role cities play in total GHG emissions, to be able to demonstrate an understanding of the ways that cities could be improved and the reductions in GHG emissions that might result.

Students should be assessed on the completeness and results from their smart city project, their understanding of the range of stakeholders involved and how well the costs have been quantified and the benefits assessed.

STUDY RESOURCES

The reference sources for this module include:

- ITU-T Focus Group on Smart & Sustainable Cities Deliverables, e.g.:
 - Overview of Smart Sustainable Cities and the Role of ICTs.
 - Technical Report on Smart Sustainable Cities Infrastructure.
 - Overview of key performance indicators (KPIs) in smart sustainable cities
 - KPIs related to the sustainability impacts of ICTs in smart sustainable cities.
- “Energy Solutions for Smart Cities and Communities: Recommendations for Policy Makers”, Concerto Initiative, Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology.

5.6 ADVANCED MODULE 6: THE END-OF-LIFE STAGE IN LIFE CYCLE ASSESSMENT

This module relies on and builds on module FM6, and is a very important part of the ICT & CC TP due to the importance placed on e-waste by WTSA-2012 and WTDC-2014. The purpose of this advanced module is to provide students with an understanding of the issues surrounding e-waste and how these can be mitigated by a move towards the 'circular economy', where all e-waste is recycled and provides the materials needed for the next generation of products.

The topics to be covered in this module could include (need to go into much more depth than module FM6):

- How is e-waste currently dealt with?
 - Who are the key stakeholders?
 - What are the opportunities for improving rates of re-use?
 - What are the opportunities for improving recycling rates?
- Impact of e-waste on energy consumption and GHG emissions.
- What regulations apply to e-waste?
- ITU policies and standards relevant to e-waste.
 - The role of universal chargers.
 - Recycling of rare metals.
- What is the circular economy?
 - To what extent is it achievable?
- Eco-design and best environmental practices.
 - Minimisation of rare and hazardous substances.
 - Design for re-use or disassembly and recycling.
 - Packaging - design for reuse or return.
 - Use of eco-design checklists.
- Case studies on countries / regions where e-waste is a particular problem:
 - Countries that export e-waste (e.g. EU, US).
 - Countries that import e-waste (Japan, Ghana).
- Exercise on the strategy being employed by the government of the student's home country to reduce its e-waste, including:
 - Developed country (exporting e-waste)
 - Developing country (importing e-waste)

PROPOSED DELIVERY MODE AND DURATION

This module should be delivered as an instructor-led e-learning module, including a live web-based seminar moderated by the tutor to review and discuss best practises in e-waste

recovery and recycling. In order to reinforce their understanding of the material, students may be given individual coursework assignments and to work on a project at home.

Total duration: four weeks.

STUDY OBJECTIVES AND ASSESSMENT

On completion of this module, students should be able to demonstrate a full understanding of the issues surrounding e-waste and to propose ways that the situation in their country could be improved, including possible changes to their regulatory framework.

Students could be assessed using an interactive exercise to identify and analyse the content of a particular domestic appliance (to be agreed with the tutor), state where the materials came from and provide an estimate of how much of this could be recycled economically.

STUDY RESOURCES

The reference sources for this module include:

- “Circular Economy” at: www.ellenmacarthurfoundation.org/about/circular-economy.
- Basel Convention (2006). The Control of Transboundary Movements of Hazardous Wastes and their Disposal.
- EU Directive 2002/96/EC “Waste electrical and electronic equipment” (WEEE).
- EU Directive 2005/32/EC “Energy using Products” (EuP).
- EU Directive 2002/95/EC “Restriction of certain Hazardous Substances (RoHS) and its Recast (RoHS II); and its associated implementation into the European Economic Area, such as Norway and Switzerland.
- EU Regulation 2006/1907/EC – Restriction, Evaluation and Authorization of Chemicals (REACH).
- ITU Report on Sustainable Products – www.itu.int/ITU-T/climatechange/ess.
- PRC Management Method (China RoHS) – PRC Management Methods for Controlling Pollution by Electronic Information Products.
- USA/California AB-826 – Perchlorate Contamination Prevention Act of 2003 (for “CR” type Coin Batteries containing perchlorate).
- China’s law on recycling: www.china-embassy.org/eng/xw/t510019.htm.
- ITU-T Recommendation L.1100 “Procedure for recycling rare metals in information and communication technology goods”. Available at http://www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=5

6 SETTING UP THE COURSE AND PREPARING SYLLABUSES

6.1 POSSIBLE CONTRIBUTING INSTITUTIONS AND EXPERTS

6.1.1 Universities

If the idea of conferring a university degree upon completion of the ICT&CC TP is adopted, partnerships will need to be established with suitable teaching partners. It will be important to find a lead university willing to act as the diploma-issuing institution (or primary diploma-issuing institution, if more than one institution is involved).

Table 1 provides a list of universities which could be contacted with a proposal for them to become a lead university for the ICT&CC TP. This list is deliberately limited to universities in Western Europe because they are accustomed to the ECTS framework and international multi-university courses.

Choosing a prominent Western European university as the diploma-issuing institution would enhance the image of the programme and foster truly global recognition of the degree awarded.

The universities in the table all have strong credentials in the field of ICT & Climate Change.

University	Department
University of East Anglia (UK)	Climatic Research Unit
University of Exeter (UK)	Climate Change
University of Geneva	In conjunction with UNEP/UNITAR

Table 1. Universities that could be asked to become an ICT&CC TP diploma-issuing institution

The suggested list is not exhaustive and should not limit ITU/BDT in its search for suitable university partners. In particular, the world ranking of any candidate institution should not be regarded as an essential consideration, since the ranking process itself, which attempts to gauge the performance and comparative reputation of some 20 000 institutions of higher education worldwide, is inexact.

The proposed partners may offer to teach some particular module(s) and/or grant certificates/credits for completion of a given module. Depending on the ultimate composition of the consortia and the overall teaching and examination arrangements, the other partnering universities could even consider joining as co-sponsoring institutions for the diploma granted at the end of the course.

6.1.2 Experts to develop the programme syllabuses

In order to ensure a uniformly high quality of different modules, with strong professional and international foundations, a team of international experts in different sub-fields of ICT&CC will be appointed. These will develop:

- Syllabuses for the respective modules:
 - the list of topics that should be covered by each module,
 - apportionment of the instructor-led/self-study time needed to complete the study topics, from the overall time (ECTS credit-based) allocated to a given module,
 - complete the list of ITU and other international study materials, textbooks and similar references to be used by tutors and students. The material should be sufficient to complete the projects and exercises.
- Associated sets of module completion/examination requirements:
 - minimum set of knowledge and skills to be obtained on completion of the module
 - proposal for formal assessment of knowledge/skills acquired, through a combination of examination and practical tests.

The experts responsible for developing module syllabuses could be selected from existing BDT experts and ITU study group leaders, rapporteurs and editors in the topics related to ICT & CC (a list of potential experts has been applied under separate cover). It is recommended that the team responsible for developing the syllabuses of the ICT&CC TP modules should consist of at least 5 experts from different sub-fields of ICT & CC taking into account:

- the initial complement of the ICT&CC TP consists of around 20 Foundation and Advanced modules (including options);
- the list of Advanced modules may be expanded with additional specialized modules;
- the topics of some modules are sufficiently close to allow some experts to cover at least two related topics.

6.2 REMAINING TIME REQUIRED TO SET OF THE ICT&CC TP

The remaining steps required to set up an ICT&CC TP include:

- a) Completing and agreeing the draft ICT&CC TP.
- b) Recruiting the Experts to develop the modules.
- c) Experts to draft the full set of modules.
- d) Agreement by ITU Academy to each module.
- e) Testing of a representative set of modules by ITU Centres of Excellence Network for the Asia-Pacific Region in Bangkok (15-18 September 2015).
- f) Reviewing the results of the Green ICTs and Smart Grids training course in Bangkok.
- g) Amending the TP based on this review.

It is expected that once appropriate and knowledgeable experts have been appointed it will take around 5 days to draft and agree the presentation slides and other materials for each module.



7 PRINCIPLES OF STUDENT ASSESSMENT AND GRADING

Student assessment must ensure that diplomas are only awarded for work that merits it. It must not be possible for the student to copy large amounts of text from the Internet or from other students in order to complete their projects or assignments. Therefore, a mixture of assessment methods should be used:

- Multiple choice questionnaire.
These are simple to administer and should ideally be used to check understanding part way through a module so that a student can go back a repeat any parts that they have not assimilated. They should not be used as the only way used to assess a complete module.
- Examination.
An examination could be used to assess a complete module, especially the Foundation modules where students are either physically present face-to-face or electronic (on-line) tools can be used. However, this method may not be flexible enough to cover Advanced modules, where understanding demonstrated through projects and exercises will be much more important.
- Essays.
An essay can be used to demonstrate a student's understanding of the content of a particular module. This would demonstrate a student's ability to assimilate a subject in depth and objectively analyse the material that has been provided. However, marking of essays can be time consuming for the course tutor and lead to a degree of subjective assessment which depends, for example, on the student's command of English rather than on their level of knowledge of the subject.
- Projects.
A project can be set which requires the student (or a group of students) to research a subject in more depth than has been provided on the course. The thoroughness with which a project has been completed and the adequacy of the results obtained could be an excellent way to assess whether a student has fully understood the concepts and methods used in the module. Ideally, around 50% of the marks for a particular module should be based on the results of projects or interactive exercises if these can be set in the required context and timescale.
- Seminars.
This involves grading of the student's active participation in seminars. However, note that this should not be used as an assessment method on its own, as some students may be reluctant to put forward their ideas in a competitive classroom (either virtual or face-to-face) situation. This could be due to cultural, gender or English language competency issues
- Interactive exercises.
These can be a fun way of quickly allocating marks to a student or a group of students. A problem can be outlined and the student or group of students asked to work out the best way of solving it (e.g. how to reduce GHG emission levels in a

specific context). Enough scope should be given to allow the student to come up with innovative ways of solving the problem.

The following is an example of an assessment scheme that uses a combination of assessment methods, with the maximum marks that can be obtained by a student from this method given in brackets:

- Attendance (10%)
- Interactive exercises and class participation (20%)
- Examination through on-line multiple choice questionnaires (30%)
- Longer (1 week) project (40%)



8 CONCLUSIONS

This report has scoped out the structure and an initial set of Foundation and Advanced modules required for an ICT & Climate Change Training Programme that could be offered to the ITU membership including industry, regulators, government organisations and service providers. The TP has a modular structure so that the content of existing modules can be changed and new modules can be added as required. Each module should take around 4 weeks for the student to complete including final assessment. The student will be required to pass 8 Foundation and Advanced modules over two semesters (8 months) in order to receive a diploma in ICT&CC. To qualify for an MSc in ICT&CC the student must also complete a Master Thesis based on undertaking a project related to ICT&CC whose scope and objectives have been agreed in advance with the course tutor. This thesis should be assessed by an external professional institution accredited to provide degrees at MSc level.

On this basis, it is entirely possible and desirable that ITU develop an ICT&CC TP based on the structure and content of the modules described in this report. This would complement the existing professional training options and promote common approaches to using ICT to tackle climate change.

9 REFERENCES

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