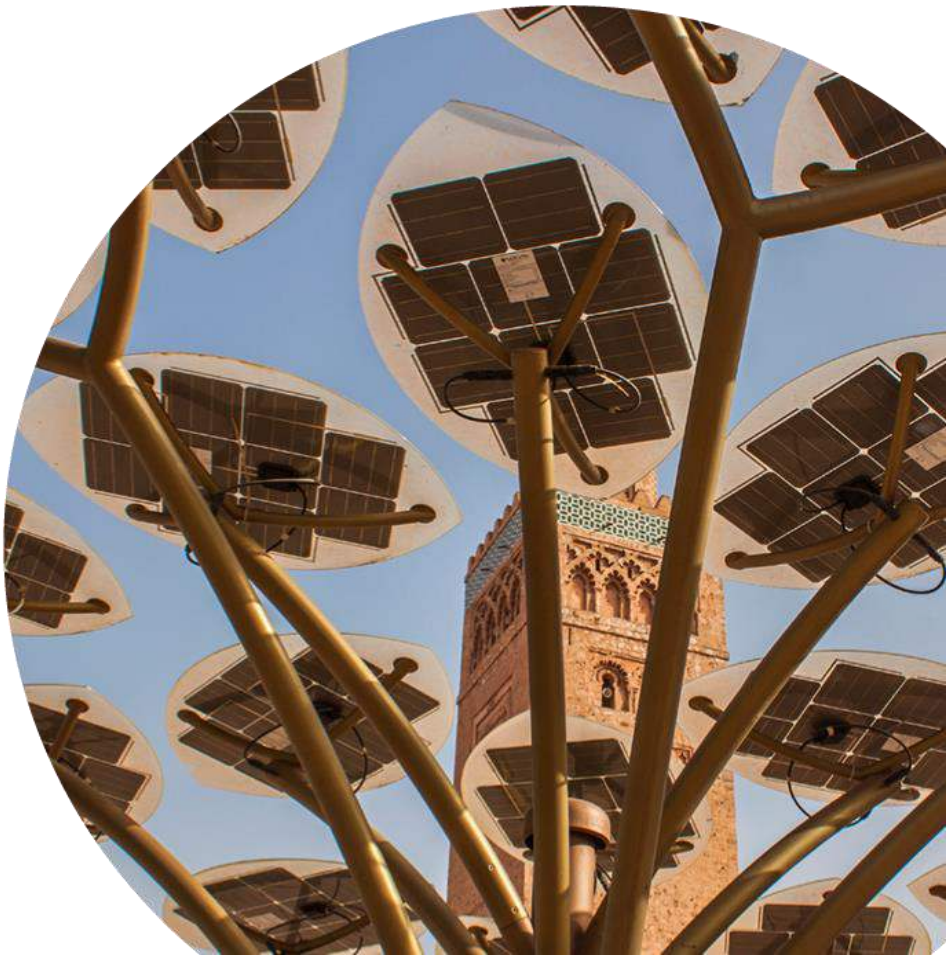
PAGE PARTNERSHIP FOR ACTION ON GREEN ECONOMY

Inclusive Green Economy (IGE) Modelling

Facilitator Guide for a Higher Education Course



UN environment United Nations Environment Programme

ILO

UNDP

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unitar United Nations Institute for Training and Research

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1 Introduction

1.1 About the course

Following the adoption of the 2030 Agenda for Sustainable Development and the Paris Agreement on climate change, many countries have set ambitious goals and targets for themselves to foster economic growth, create income and jobs, reduce poverty and inequality, and promote environmental sustainability.

Inclusive green economy (IGE) modelling is a powerful tool that allows people to assess the investments required to deliver on these goals and targets in an integrated and synergistic manner. IGE modelling is used to inform policy and investment assessments and decision-making processes, employing existing techniques commonly used by economists and public policy specialists, and adapting them to provide analysis of economic, social and environmental impacts.

Questions IGE modelling can help to address include:

- What policy measures will help to achieve a national emission reduction target?
- How will Gross Domestic Product (GDP) change when implementing climate mitigation interventions?
- What is the value of the ecosystem services being provided by nature?
- Will new jobs be created under an IGE strategy?

This course familiarizes students with various methodologies and models, and provides an opportunity for them to start using modelling tools, such as input-output, general and partial equilibrium, systems engineering, system dynamics and spatially explicit models, in an area of interest to them. The type of skills acquired through this course are usually needed in institutions that deal with medium to long-term planning, across sectors. These include forecasting departments in Ministries of Finance, (for economic analysis); Ministries of Infrastructure (e.g. energy or water, to determine the needs for improved and expanded infrastructure to provide adequate services to the population); Ministries of the Environment (to assess the environmental impacts of policy interventions and plan for complementary measures), among others.

The course materials were developed through the Partnership for Action on Green Economy (PAGE), a One UN initiative that brings together five United Nations agencies – the UN Environment Programme, the International Labour Organization, the UN Development Programme, the UN Industrial Development Organization and the UN Institute for Training and Research.

1.2 How to use this guide

This guide has been developed for course lecturers/professors. It provides information on the structure of the course, as well as indications on (i) learning objectives; (ii) essential content to be covered; (iii) approaches to prepare and deliver the course; (iv) proposed exercises and facilitation techniques; and (v) suggested background readings. Complementary materials are (1) PowerPoint presentations and (2) handouts for each module.

Since the IGE has to be adapted and defined according to the local social, economic and environmental context of each country, teachers are strongly encouraged to customize the materials, including methodology and content. This will ensure that the course is aligned with national development priorities and policy debates. We also recommend using national/local data and introducing simulation models currently being employed by governments to inform decision making at sectoral and macro levels.

1.3 General suggestions for delivering the course

Thematic focus

There are many definitions of the IGE. However, the core message is that we need a new approach to allow the economy to grow differently: by increasing investment in or redirecting investment towards a new generation of capital. This includes natural capital, clean tech/produced capital and green skilled human capital. Enabling policies/institutions are needed to support this transition.

We recommend creating a dialogue with students, to allow them to present their views on the IGE. This is important because there are many ways to define and measure sustainability, from a social, economic and environmental perspective, and students with different educational backgrounds are likely to define the IGE differently, depending on whether they have received an education based on, for example, economics, engineering or physics. Through an open discussion, the class develops a common understanding at the outset, as a basis for working effectively with simulation models.

We also recommend emphasizing the (a) measurement; (b) forecasting and scenario creation; and (c) policy dimensions of the IGE. This is to allow students that have different backgrounds and interests to participate actively in the course, depending on whether they are more interested in indicators and monitoring of performance, in policy interventions, or in the use of simulation models for policy formulation and assessment. Measurement is critical because it allows us to identify problems and opportunities. Forecasting, related to the use of simulation models, allows for the estimation of the likely outcomes of different intervention options. Policy identification and analysis is crucial, as it allows students to inform decision making for sustainability.

Finally, we suggest emphasizing the need for the use of a systems approach. This entails considering outcomes of action and inaction for (1) various economic actors; (2) economic sectors; (3) dimensions of development; (4) over time; and (5) in space (i.e. for specific locations). Thinking in systems is critical to understand the IGE approach and then analyse its outcomes with simulation models.

Learning methodology

Overall, we propose a “flipped classroom” approach for the delivery of this course. In a “flipped classroom”, face time in the classroom is used for discussions and activities to explore topics in greater depth and create meaningful learning opportunities. Students are expected to acquire knowledge about the course content through background readings outside class hours. You will obviously have to adapt the use of this approach to your teaching style and class. In an ideal situation, students will come prepared, but this might not always be realistic. In other cases, more time may be needed during class to cover basic content.

The sample presentations included in this package still include some essential content but try put the students at the centre through various reflection and discussion points. If you and your students are comfortable with the flipped classroom approach, you can reduce the time spent on presenting content in class even further and spend more time on exercises and discussions.

2 Guidance for Module 1

2.1 Learning objectives of Module 1

After completing Module 1, students will be able to:

- Define the concept of an Inclusive Green Economy (IGE) and explain its value, in relation to the 2030 Agenda/the Sustainable Development Goals (SDGs) and the Paris Agreement.
- Identify intervention options, such as investments and policy instruments, that could be implemented to achieve sustainable development targets, using an IGE approach.
- Explain the role of simulation models in the decision-making process, especially in the context of sustainable development.

2.2 Essential content to be covered

Module 1 introduces the concept of Inclusive Green Economy and its main policy instruments. It highlights the role of simulation models in understanding interdependencies across (i) sectors and variables (within sectors); (ii) economic actors; (iii) dimensions of development (social, economic and environmental); (iv) over time (short, medium and longer-term); and (v) in space.

The main content covered by Module 1 includes:

- Definition of IGE, as well as Green Growth/Circular Economy/Low Carbon Development and other relevant concepts, and its contribution to the SDGs.
- Opportunities that can be realized with the use of an IGE approach, highlighting why such an approach is suitable for planning in the context of sustainable development.
- Policy instruments, both investment and enabling policies, for IGE strategies, by sector and by thematic area, across sectors.
- Potential contribution of models to IGE assessments[1]
    - Models help forecast the outcomes of IGE interventions; set and respond to targets; and support a systems view;
    - Models also provide exploratory scenarios to help manage uncertainty and risk, such as filling knowledge gaps;
    - Models can create a conducive, collaborative environment for different experts to work together.

[1] We define an IGE assessment as a study that estimates investment or policy outcomes using a systemic approach. This includes determining outcomes across sectors, economic actors, dimensions of development (society, economy and environment), over time and in space (i.e. for specific locations).

2.3 Preparing and delivering classes in Weeks 1 and 2

The course introduction should aim to engage students actively, for instance, by having a conversation on the students' expectations for the course. Or you could propose a more interactive experience, for instance, Syllabus Speed Dating.

Two rows of chairs face each other (multiple rows of two can be used in larger classes). Students sit across from each other, each with a copy of the syllabus that they've briefly reviewed. The teacher asks two questions to two students, sitting opposite each other: one about something in the syllabus and one of a more personal nature. The pair has a short period of time to answer both questions. The teacher checks to make sure the syllabus question has been answered correctly. Then students in one of the rows move down one seat and the teacher asks the new pair two different questions. Not only does this activity get students acquainted with each other, but it's a great way to get them reading the syllabus and finding out for themselves what they need to know about the course.
Source: https://www.teachingprofessor.com/for-those-who-teach/first-day-of-class-activities-that-create-a-climate-for-learning/

In delivering the module, emphasis should be put on inspiring students to reflect on the concept of IGE and how it relates to their local context. This allows them to start from a solid basis on the needs for sustainable development, such as in relation to the Earth's finite resources, and to then transition to specific local challenges and opportunities, such as potential to invest in new production practices and technology. Practically, this approach will illustrate how the IGE definition and strategy need to be adapted to local circumstances for informing decision making effectively.

Typically, the module would be taught over two weeks. In Week 1, the class would start with an expert lecture about the rationale for advancing inclusive green economies, including current economic trends and opportunities. The presentation will also cover international definitions of the IGE and related concepts, such as green growth, circular economy and green jobs, and how the IGE is connected with climate change mitigation and adaptation, and sustainable development. This is to ensure that the students understand how to interpret publications on IGE and related concepts, emerging from different fields and countries. After the presentation of each definition, a small debate could be initiated on how the IGE definition captures current and upcoming sustainability challenges. Then specific policy instruments would be presented, including grouped in investments and enabling policies, such as incentives, mandates and awareness raising activities. Examples should be ideally derived from the national and local context. The lecturer could also consider presenting a news article about an IGE-related policy that has been recently discussed or introduced in the country or region and animate a discussion around it. Another possibility would be to invite a policymaker or other relevant stakeholders for a discussion with the students on IGE in the country. Then opportunities to inform policy decisions could be presented, followed by a short debate.

In Week 2, different models will be introduced, with an explanation of how these can support the policymaking process. The lecturer can choose to kick-off the class with a discussion of some fundamental questions, such as 'Why do we need economic models for IGE?' Following the discussion/presentation, students will engage in an exercise to start identifying the many social, economic and environmental indicators that are necessary to accurately assess the emergence of problems or opportunities, with an IGE approach. This is the first exercise that will allow students to apply a systemic approach.

Week 1 – Module 1	**90 minutes total**
Course introduction, active engagement of the students, such as through a conversation on expectations for the course.	15 minutes
Presentation of the rationale for IGE, and related definitions and concepts, as well as opportunities to inform policy decisions. This includes discussion in class on the use of different definitions (see polls and reflections in the PPT).	30 minutes
Presentation on the policy instruments.	30 minutes
Discussion in class on policy instruments and their use in the country.	15 minutes

Week 2 – Module 1	**90 minutes total**
Presentation on available models for IGE analysis, with an explanation of how these can support the policymaking process.	30 minutes
Discussion in class on the experience of students in using different models in previous courses.	15 minutes
Guided exercise on the identification of the many social, economic and environmental indicators that are necessary to accurately assess the	30 minutes

emergence of problems or opportunities, with an IGE approach using Causal Loop Diagrams.	
Introduction of the group exercise on the creation of Causal Loop Diagrams.	15 minutes

2.4 Facilitating the group exercise under Module 1

Objectives of the exercise

Throughout the exercise, students will learn how to identify the causality among social, economic and environmental indicators for an IGE assessment.

They will develop a qualitative system map, which could be a Causal Loop Diagram or a tree diagram, by sector, for a specific geography, such as a country, city or landscape, and identify the main drivers of change, both internal and external. This includes the identification of problems that could emerge for social, economic and environmental indicators, and the formulation of solutions, such as policy interventions. Part of the objective is that students are able to agree on which specific problems of the many potential problems that can be analysed they would like to concentrate on.

Instructions for students

The following are practical steps that should be followed for the creation of a Causal Loop Diagram (CLD):

- Identify an issue and then a target, which represents an opportunity to solve the issue, and describe these with one sentence, such as 'GHG emissions are on the rise, an emission reduction target of 30% by 2030 should be assessed; water quality is deteriorating, a target of 90% on-site water treatment for industries should be established'.
- Open Vensim (www.vensim.com), or draw the diagram in PowerPoint or manually on a flipchart.
- Identify the key indicator representing the problem or the target and add it to your diagram, which is blank at this stage.
- Add the causes of the problem, one by one, linking them to the first variable considered, and determine the polarity of the causal relation.
- Continue identifying and adding the cause of the cause and so forth.

The basic knowledge needed to build a CLD includes the polarity concept, which is the sign of the causal relation between two variables, whether positive or negative, and the feedback concept, which reinforces or balances.

On the former (polarity concept), causal loop diagrams include variables and arrows, called causal links, with the latter linking the variables together with a sign, either + or −, on each link, indicating a positive or negative causal relation (see Table 1):

- A causal link from variable A to variable B is positive if a change in A produces a change in B in the same direction.
- A causal link from variable A to variable B is negative if a change in A produces a change in B in the opposite direction.

Variable A	Variable B	Sign
↑	↑	+
↓	↓	+
↑	↓	-
↓	↑	-

Table 1: Causal relations and polarity

With the latter, the feedback concept, as the diagram grows and new variables are added, circular relations are formed. These are feedback loops, representing closed loop thinking. There are a few methods to determine whether a feedback loop reinforces or balances. The two most commonly used are:

- Reading the CLD. Starting with the assumption that the first variable in the loop will increase when the loop is followed: 1) we end up with the same result as in the initial assumption, that is that the variable increases, and the feedback loop reinforces; 2) we end up contradicting the initial assumption, that is that the variable decreases, and the feedback loop is balanced or opposes change.
- Counting plus and minus signs. 1) Reinforcing loops have an even number of negative links, where zero is also even; 2) balancing loops have an uneven number of negative links.

Once the diagram is complete, the analysis can begin. Normally the starting point is the first variable added to the diagram or the key problem to be solved. It is good practice to 'read' the diagram to understand the extent to which simultaneous factors influence the causes of the problem. Further, reading the diagram helps to check its consistency and validity, and also identifies the overall system pattern and the main feedback loops responsible for it.

The critical aspect for an IGE exercise is the inclusion in the diagram of social, economic and environmental variables. In other words, the analysis has to be systemic and comprehensive, and include all the indicators that are relevant for an IGE assessment in relation to the IGE definition used. Examples include social aspects, such as employment creation, income distribution and inclusiveness,

economic aspects, such as GDP, natural capital as a factor of production and the economic contribution of ecosystem services, and environmental aspects, such as CO2 emissions, air and water quality, and natural resource availability and use. If the diagram includes indicators that are key for an IGE exercise, the resulting analysis will be relevant and useful. If the diagram misses key indicators, the resulting analysis will be partial and possibly biased, and hence not relevant nor useful.

Background notes for the facilitator

You might want to start with a guided exercise for 30 minutes, to show students how the exercise can unfold. In this case, it is recommended that you choose an example that is related to the IGE but not controversial or difficult to interpret, so that the students can focus fully on the process of creation of a CLD or tree diagram, rather than on the content discussed.

The exercise completed by the students themselves, either individually or in small groups of two or three, should be on a topic, either a problem or an opportunity, more closely related to the IGE at the local level. Examples include what are the main drivers of GHG emissions and how will employment change with the introduction of a carbon tax?

Common challenges

A few common challenges emerge when creating a CLD. The following recommendations should be followed in the guided exercise and shared with the course students for them to create a high-quality causal diagram (Sterman, 2000):

- Add variables one by one., Don't start with a long list of variables as this may constrain the boundaries of the analysis, leading to a tendency to focus only on this initial list of variables and not on an organic process where relevant variables emerge from the process.
- Use nouns or noun phrases to represent the elements rather than verbs. That is, the links (arrows) represent the actions in a causal loop diagram and not the elements. For example, use 'cost' and not 'increasing cost' as an element.
- Use an element (or variable) name in a positive sense. For example, use 'growth' rather than 'recession'.
- A difference between the actual and perceived states of a process can often be important to explain patterns of behaviour. In many cases, there is a lag (delay) before the actual state is perceived. For example, when there is a change in actual product quality, it usually takes a while before customers perceive this change.
- There are often differences between short-term and long-term consequences of actions and these may need to be distinguished with different loops.
- Keep the diagram as simple as possible, subject to the earlier points. The purpose of the diagram is not to describe every detail of the management process, or the system, but to show those aspects of the feedback

structure that lead to the observed problem. In other words, model the problem, not the system.

2.5 Suggested background reading

Essential reading

Eaton, D., & Sheng, F. (Eds.), 2019: Inclusive Green Economy: Policies and Practice. Dubai, Shanghai: Zayed International Foundation for the Environment & Tongji University.

This textbook attempts to offer a systematic framework for the green economy model. It builds on and extends from the traditional economic growth model by articulating the contributions to productivity from investing in natural capital, clean technologies and green skills, enabled by fiscal, finance, trade and labour policies. It also addresses the importance of institutions and progress measurement for ensuring that transition towards a green economy is pro-poor.

United Nations, 2015: Transforming our world: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015.

The Agenda 2030 for Sustainable Development is an action plan for people, the planet and prosperity. The Agenda 2030 proposes 17 Sustainable Development Goals with 169 associated targets, which are integrated and indivisible. It recognizes that poverty eradication is the greatest global challenge and a crucial requirement for sustainable development. This declaration provides an overview of the 17 development goals including a documentation of the indicators associated with each.

UNEP, 2011: Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.

This analytical report demonstrates that the greening of economies is not generally a drag on growth but rather a new engine of growth. It can also be a net generator of decent jobs and a vital strategy for the elimination of persistent poverty. The report seeks to motivate policy makers to create the enabling conditions for increased investments in a transition to a green economy. It makes a compelling economic and social case for investing two per cent of global GDP in greening 10 central sectors of the economy in order to shift development, and unleash public and private capital flows onto a low-carbon, resource-efficient path.

UNEP, 2015: Uncovering pathways towards an inclusive green economy: A summary for leaders.

This summary document provides an overview of the key challenges in achieving the Sustainable Development Goals and provides solutions for addressing them. The report illustrates why Inclusive Green Economy modelling provides a vehicle

for sustained economic development and enables the transition to what is called an “Economy of Permanence”.

United Nations, 2012: The Future We Want. Rio+20, Rio de Janeiro, 20-22 June 2012.

The 2012 UN Conference on Sustainable Development adopted the outcome document, The Future We Want, which addresses a range of global issues to advance sustainable development. The document calls for a wide range of actions, among many other points, including: launching a process to establish sustainable development goals; detailing how the green economy can be used as a tool to achieve sustainable development; and strengthening the UN Environment Programme and establishing a new forum for sustainable development.

Optional reading

Green Growth Knowledge Platform (GGKP) (UNEP, OECD, WB, GGGI), 2013: Moving towards a Common Approach on Green Growth Indicators: A Green Growth Knowledge Platform Scoping Paper.

This report makes a contribution towards developing a comprehensive framework to monitor progress on green growth (GG) and green economy (GE), and is a joint effort by the OECD, UNEP, the World Bank and GGGI as part of their collaboration on the Green Growth Knowledge Platform (GGKP). The report first offers a conceptual framework to help select and organize indicators, then proposes a “long list” of indicators selected from among the multitude of indicators that are currently used. Then it explores a proposed dashboard of headline indicators to be used in order to monitor progress towards set goals. The final section looks at the limitations of these approaches and the challenges ahead.

Probst, G. & Bassi, A.M., 2014: Tackling Complexity. A Systemic Approach for Decision Makers.

This book analyses real-world strategy and policy challenges, addressing the interconnectedness of the markets/systems we live in. It provides a step-by-step approach using systems thinking to solve complex problems in socio-political as well as business environments. It proposes a technique with which to better understand problems and the context in which they arise, and tools to directly inform each step of the decision-making process. The book explores the main innovation that systemic thinking introduces - the emphasis on defining the problem-creating system, which is made up of interacting parts, rather than prioritizing events that need immediate fixing.

Organization for Economic Co-operation and Development (OECD), 2011: Putting Green Growth at the Heart of Development.

This publication explains why green growth is vital to secure a more sustainable future for developing countries. Covering 74 policies and measures from 37 countries and five regional initiatives, this publication outlines an action-oriented

twin-track agenda to guide national and international policies and practices to successfully tackle green growth.

OECD, 2011: Towards Green Growth.

This publication summarises the work done by OECD on development of a green growth strategy. As a lens through which to examine growth, the analysis presented here is an important first step to designing green growth strategies while at the same time providing an actionable policy framework for policy makers in advanced, emerging and developing economies.

Barbier, E. B., 2010: A Global Green New Deal: Rethinking the Economic Recovery.

A Global Green New Deal (GGND) is an economic policy strategy for ensuring a more economically and environmentally sustainable world economic recovery. This paper puts forward the case of why a GGND strategy is essential to the sustainability of the global economy. It provides an overview of the key national policies and the global actions necessary to allow national policies to work. The paper also discusses the wider implications for restructuring the world economy towards “greener” development.

3 Guidance for Module 2

3.1 Learning objectives of Module 2

After completing Module 2, students will be able to:

- Identify the key indicators (social, economic and environmental) required to carry out an IGE assessment for sectors or assets, policies or investments.
- Distinguish between indicators for problem identification, policy formulation, policy assessment, and policy monitoring and evaluation.
- Describe how to use indicators for IGE assessments, for various sectors and countries.

3.2 Essential content to be covered

Module 2 discusses the variety of indicators required to carry out an IGE assessment and a method to identify them. Indicators are key to determining what type of model is required, and what the boundaries of such models should be, such as sectoral vs. integrated.

The main content covered by Module 2 includes:

- Assessment of the indicators of performance that are required to properly capture the characteristics of the definition of IGE, specifically for the definitions used at the global and national, or landscape level.
- Overview of the process to identify key indicators, such as use of Systems Thinking, for issue identification, policy formulation and assessment, and for monitoring and evaluation.
- Assessment of the domains or sectors in which these indicators are calculated, such as for emissions, found in energy and land use.
- Lessons learned from IGE country studies, especially on what indicators were chosen and how these were used.

3.3 Preparing and delivering classes in Weeks 3 and 4

We suggest using the Integrated Policymaking Cycle (UNEP, 2009) as the framework to introduce the need for indicators that support each step of the decision making cycle. This allows students to identify indicators that can be used to define the problem, or development agenda to support policy formulation and assessment before implementation, and to monitor and evaluate performance after implementation (UNEP, 2012; UNEP, 2014b). For example, carbon emissions can be used as an “issue identification” indicator; investment in R&D can be used

as a “policy formulation” indicator; employment and access to resources, such as water and energy, can be used as “policy assessment” indicators.

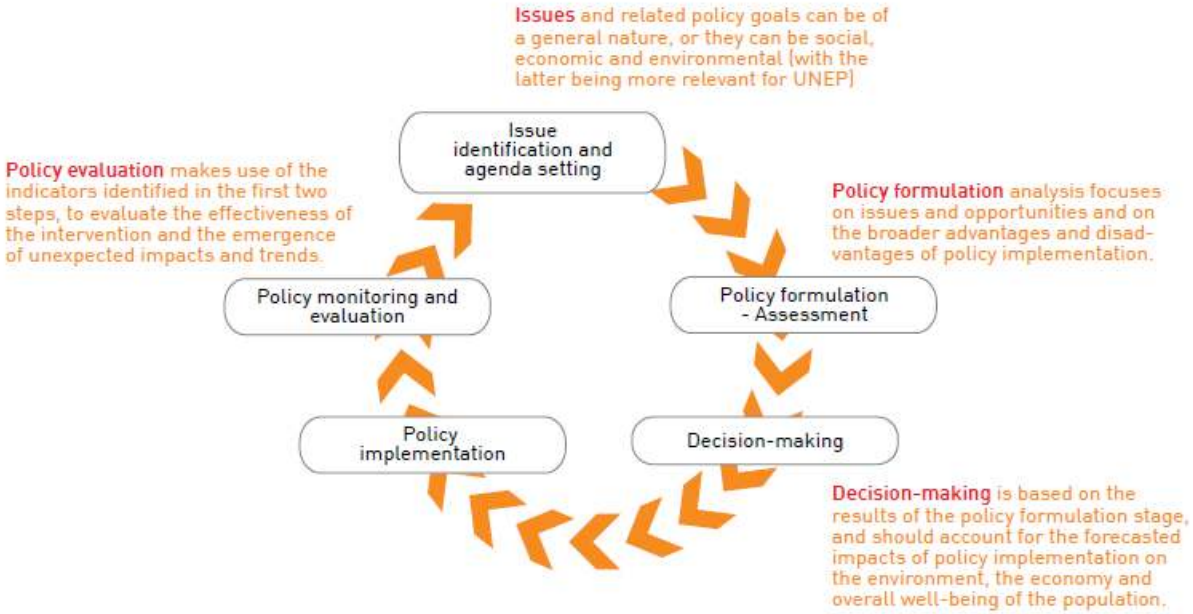

Figure 1: The Integrated Policymaking Cycle. (UNEP, 2009)

In selecting the indicators, emphasis should be put on (a) international datasets, such as the 169 SDG indicators; (b) national statistics; and (c) specific dynamics connected to the problem or opportunity analysed, such as certain issues may be affected by local dynamics, at subnational level, for which official statistics may not be collected. This will allow the students to begin assessing potential data availability and gaps for IGE assessments, as well as for their final assignment.

The professor should create an explicit link between the creation of a system map (CLD or tree diagram) presented in Module 1 and used for the exercise of Weeks 1 and 2, and the identification of relevant indicators. In fact, the use of a systemic approach is crucial for the correct definition of the problem or opportunity, and hence for the correct identification of indicators. For instance, the cause of the problem could be social, economic, environmental or due to a combination of interconnected factors.

Typically, the module would start in Week 3 with a 30-45 minute lecture, which also includes discussions related to polls and group reflections, on the Integrated Policymaking Cycle and indicators for problem identification or agenda setting, policy formulation, policy assessment, and policy monitoring and evaluation. Examples of relevant indicators for specific policy priorities will be provided and the link with the SDGs will be discussed. It is advised that you have a small debate on this topic, perhaps for 30 minutes, addressing how local policy priorities and related indicators are connected with the SDGs and their indicators. The process

for identifying relevant indicators, including the creation of system maps or tree diagrams should be highlighted next, in a 30 minute session that includes both a short presentation on the method, as a recap of the exercise completed for Module 1, and a discussion on the role of causality, that is the identification of causal relations in the system, for the identification and selection of relevant indicators. It should be stressed that indicators should not be identified only using a theory or already available knowledge. Instead, an investigation as systemic as possible of the problem or opportunity, and intervention options should be carried out.

A second presentation of 30 to 45 minutes is proposed for Week 4. This presentation should focus on the cross-sectoral and cross-dimensional nature of the indicators included in the Green Economy Performance (GEP) Measurement Framework at the country level. This will highlight that an IGE assessment has to consider outcomes for social, economic and environmental indicators, as well as for various sectors, such as economy, water, energy and population. A discussion of 30 minutes can follow, to identify what indicators of performance are found in sectoral analysis, and how the performance of a given sector is impacted by – and at the same time impacts – other sectors.

Figure 2: Graphical representation of the GEPI. (PAGE, 2017)

You can propose an exercise to assess what indicators are included in the models that students have used in previous courses or may be familiar with. This is an initial step to start determining whether existing models are fit for purpose, in relation to specific issues and policy priorities that are addressed with such models at the sectoral level. Students should also study how key modelled indicators are estimated in various fields.

It can be expected that students are familiar with sectoral indicators or with the ones that were discussed in the modelling classes they attended. After the presentation, the professor can ask students about their experiences with indicators and whether, in previous classes, emphasis was put on the selection as well as use of indicators, or only on the latter.

Week 3 – Module 2	**90 minutes total**
Presentation on the five steps of the Integrated Policymaking Cycle and relevant indicators for each step, including the cross-sectoral and multi-dimensional nature of IGE indicators.	30 minutes
Discussion in class on the linkages between indicators for problem identification or agenda setting, policy formulation, policy assessment, policy monitoring and evaluation, and the indicators for the SDGs.	30 minutes
System maps and tree diagrams as tools for the identification of relevant indicators.	30 minutes

Week 4 – Module 2	**90 minutes total**
Presentation on the GEP Measurement Framework at the country level.	30 minutes
Discussion in class on the indicators used for sectoral analysis, such as what indicators of performance are found in sectoral analysis and how the performance of a given sector is impacted by and, at the same time, impacts other sectors.	30 minutes

Introduction of the exercise on the identification of indicators that are included in the models that students have used in previous courses or may be familiar with.	30 minutes

3.4 Facilitating the group exercise under Module 2

Objectives of the exercise

The exercise will allow students to assess whether all required IGE indicators are included in existing/ongoing modelling exercises they have been exposed to or are involved in. They will review data availability and data gaps, from global and national databases, to learn about where to find data when model customization starts later in the course.

Instructions for students

The group exercise comprises three main tasks:

1. Assess whether key IGE indicators are included in existing/ongoing modelling exercises that the students have been exposed to or are involved in.
2. Study and document how key sectoral indicators are estimated in their respective fields and models.
3. Review data availability and data gaps, from global and national databases.

The specific goal of task 1 of the exercise is to create a list of key output indicators for a given sectoral model and compare it with the list of indicators required to analyse a problem typical of the sector chosen.

The second task examines both available and required indicators. The goal is to identify how these indicators are estimated.

The third task concerns data collection. This task is proposed to allow students to familiarize themselves with national and international databases before the final assignment, which is when they will need data to improve the calibration of existing models.

Background notes for the facilitator

The exercise will be carried out in small groups of two or three students. If possible, it is suggested to form groups with students from different educational backgrounds and with experience in working with different models. This will allow each student to learn from others and to pass on their own knowledge from previous courses. This also replicates the multidimensionality of the Inclusive

Green Economy approach that is needed to tackle different challenges from different perspectives and with different integrated tools.

You might want to start from the discussion of Week 4, where examples of sectoral indicators are provided for a specific problem or target. It is also suggested that you stimulate the students to share their thoughts on the subject with one another, especially if they have different educational backgrounds, and to carry out research to explore how relevant indicators are estimated in fields that they may not be familiar with.

Two examples are provided to clarify tasks 1 and 2 listed above.

Example for task 1:

An energy optimization model generates, as main outputs, the power generation capacity, investment required for such capacity and emissions from power generation. On the other hand, if the issue to analyse is the occurrence of power shortages, the list of indicators required may include power generation capacity, as indicated above, but would also require the location of such capacity and transmission losses, and rainfall and water availability in dams, in the case of hydropower, or water temperature, in the case of thermal generation (the cooling of power plants can't happen if water temperature reaches above 26°C) and the impact that power shortages have on society, such as through access to electricity.

Example for task 2:

Annual electricity supply is estimated in energy models by multiplying power generation capacity, measured in MW, by the number of hours per year and by the load factor of each technology. Not available in energy models, but necessary to understand the issue of power shortages, water balance for hydropower generation is estimated in hydrological models based on rainfall, evapotranspiration, percolation and water use. Similarly, social indicators can be added regarding employment and income creation from the various power generation options available.

Examples for task 3:

The following databases, amongst others, provide valuable information to assist students:

- Population: https://population.un.org/wpp/;
- Energy: https://www.iea.org/classicstats/relateddatabases/worldenergystatistics/;
- Water: http://www.fao.org/aquastat/en/;
- Agriculture: http://www.fao.org/faostat/en/#home;
- Economy: https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/index.aspx;
- Cross sectoral databases:

- WDI: https://databank.worldbank.org/source/world-development-indicators;
- UN: http://data.un.org/.

Common challenges

Often students will only identify a subset of indicators, such as only economic indicators for students that are following a programme on economics. It is important to emphasize the need to identify several social, economic and environmental indicators for any given problem analysed. In this respect, it could be proposed to develop a new and more detailed CLD or tree diagram to better identify all relevant indicators.

Students with different backgrounds may use different definitions for the same indicators or use the same indicators but with a different definition. It is important to stimulate an active exchange between students to avoid misunderstandings and to support knowledge dissemination. For example, an economics student could share knowledge on how GDP can be calculated and an engineering student could share knowledge on the process of power generation. Both could then discuss the extent to which power generation affects GDP and economic performance more generally.

3.5 Suggested background reading

Essential reading

UNEP, 2014: Using indicators for Green Economy Policymaking.

This manual provides guidance to users at the country level on the selection of indicators for Green Economy (GE) assessments. Specifically, it supports the development of indicators across the stages of the UN integrated policymaking cycle for sustainable development (UNEP, 2009). It allows the user to develop GE indicators and describes how they can be used as tools for the identification of priority issues, the design and assessment of GE policies, and for monitoring and evaluation of policy performance. A step by step description for the development of indicators and their use in the respective stage of the policymaking cycle is provided.

PAGE, 2017: The Green Economy Progress Measurement Framework – Methodology.

This handbook describes the development of the Green Economy Progress (GEP) Measurement Framework as a vehicle for bridging indicator-based measurement initiatives at the global level. Technical guidance is provided for the evaluation of progress on a single indicator case, the composition of the GEP Index for multidimensional assessments and the development of a dashboard. The integration of indicators for identifying priority issues, designing and assessing GE policies, and monitoring and evaluating their performance into a progress

measurement framework is described. A description of the theoretical framework, the weighting of the GEP Index in various countries, and the process of aggregating information from the dashboard and the GEP Index into a single measurement framework is provided.

UNEP, 2014: Using models for Green Economy Policymaking.

This report describes the rationale behind choosing models for Green Economy assessments. Modelling for Green Economy generally requires the appreciation of local context factors, and the choice of models determines the type of assessment that can be conducted and the results obtainable. Different modelling methodologies and models are presented and information is provided about their applicability on sectoral, cross-sectoral and national levels.

United Nations Economic Commission for Africa (UNECA), 2016: Integrated Assessment Methodologies and Tools for Inclusive Green Economy Analysis in Africa.

This technical document provides an overview of methodological frameworks and tools applicable to an IGE analysis. It constitutes a comprehensive review of different modelling disciplines, providing a description of each tool, the supported stages in the policymaking cycle and the respective strengths and weaknesses. Through its comprehensive review of methodologies, this document can serve as a source book and a go-to guide when planning an IGE assessment.

PAGE, 2017: The Integrated Green Economy Modelling Framework – Technical Document.

This document presents a methodology on how to integrate three of the main modelling techniques used for green economy policy assessment (system dynamics, computable general equilibrium models, and input-output and social accounting matrix) to refine impact analysis of green policies and investments in the economy. It aims to respond better to countries needs in terms of analysing the cross-sectoral impacts of green economy policies.

PAGE, 2019: Indicators for an Inclusive Green Economy – Manual for Introductory Training.

This course is intended to introduce the concept of indicators to support policymaking for an Inclusive Green Economy (IGE) and to illustrate the use of methodologies for selecting and applying indicators. It seeks to contribute to the capacity of countries to choose indicators for IGE relevant to their country contexts, particularly in light of the pursuit of the Sustainable Development Goals. Potential participants in this training include policymakers in governments and international and regional organizations; policy analysts and statisticians in these organizations; and academics from a range of disciplines concerned with the economy, environment and society.

PAGE, 2019: Indicators for an Inclusive Green Economy – Manual for Advanced Training.

This course builds on the concepts and processes described in the Introductory Training. It focuses particularly on the application of the Partnership for Action on Green Economy's (PAGE) Green Economy Progress (GEP) Measurement Framework. The GEP Measurement Framework has been supported by PAGE and developed by its partner UN agency, the United Nations Environment Programme (UNEP). This framework provides a methodology for comparing performance on IGE over time.

Optional reading

Neugarten, R.A., Langhammer, P.F., Osipova, E., Bagstad, K.J., Bhagabati, N., Butchart, S.H.M., Dudley,N., Elliott, V., Gerber, L.R., Gutierrez Arrellano, C., Ivanić, K.-Z., Kettunen, M., Mandle, L., Merriman, J.C., Mulligan, M., Peh, K.S.-H., Raudsepp-Hearne, C., Semmens, D.J., Stolton, S., Willcock, S., 2018: Tools for measuring, modelling, and valuing ecosystem services: Guidance for Key Biodiversity Areas, natural World Heritage Sites, and protected areas.

Increasing interest in measuring, modelling and valuing ecosystem services (ES), and the benefits that ecosystems provide to people, has resulted in the development of an array of ES assessment tools in recent years. Selecting an appropriate tool for measuring and modelling ES can be challenging. This document provides guidance for practitioners on existing tools that can be applied to measure or model ES provided by important sites for biodiversity and nature conservation. This guide builds on existing reviews of ES assessment tools but also has an explicit focus on assessing ES for sites of importance for biodiversity and nature conservation.

World Resources Institute, 2018: A Guide to Selecting Ecosystem Service Models for Decision-Making. Lessons from Sub-Saharan Africa.

This guide was developed for technical advisors to government officials, business people, investors and others who need to draw on ecosystem assessments to inform decision-making. It assesses several types of ecosystem service modelling tools, discusses issues involved in modelling ecosystem services and provides guidance on how to choose the right model to address a specific policy question.

PAGE, 2017: The Green Economy Progress Measurement Framework – Application.

This report describes the integration of indicators for identifying priority issues, for designing and assessing GE policies, and for monitoring and evaluating their performance into a progress measurement framework. It describes the design of the Green Economy Progress Index (GEP) and its uses. This technical report provides guidance on the assessment of GE performance on individual indicator scales and the use of the Index as a tool for evaluating multidimensional

performance. Results of the GEP Measurement Framework between 2004 and 2014 are provided, together with information about country performance and the applicability of the GEP framework for policy analysis.

UNEP, 2011: Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication.

This flagship report on the transition towards a green economy demonstrates how indicators can be used for reporting on IGE assessments. Each section contains information about key challenges at sectoral level, potential policies for addressing them and monitoring requirements that enable decision-makers to assess policy performance. The report seeks to motivate policy makers to create the enabling conditions for increased investments in a transition to a green economy.

Herrero, Carmen, José Pineda, Antonio Villar, and Eduardo Zambrano, 2020: The Inclusive Green Energy index of progress. Manuscript under submission.

This paper presents the Inclusive Green Energy index to evaluate progress in achieving the key dimensions of the Sustainable Development Goal 7, which entails ensuring “access to affordable, sustainable and modern energy for all”. The key aspects of this index are: (i) it focuses on the change of the corresponding variables, rather than on their levels; (ii) it exhibits a decomposability feature that permits integrating several dimensions in a simple way, allowing for the inclusion of “goods” and “bads”; and (iii) the evaluation of progress is made relative to some reference values, such as targets and thresholds, that can differ between countries. It calculates the Inclusive Green Energy index of progress for 183 countries using data from 2000 to 2014 on three indicators, intended to capture inclusiveness, greenness and efficiency regarding energy use. The results show that progress has, on average, been positive across the world, with more than 88 per cent of the sample of countries experiencing some degree of progress.

4 Guidance for Module 3

4.1 Learning objectives of Module 3

After completing Module 3, students will be able to:

- Identify relevant modelling approaches and models for an IGE assessment, and describe their advantages and disadvantages.
- Identify data requirements for the use of different methods and models.
- Interpret the results of various modelling exercises, based on the modelling approach and simulation model used.
- Provide examples of the use of simulation models, both sectoral and integrated, for IGE assessments and explain how these models can support assessing progress towards the SDGs.

4.2 Essential content to be covered

Module 3 first provides an overview of the methodologies and models available for IGE assessments. It distinguishes between sectoral, narrowly focused models, such as an economic model or one that focuses on electricity supply, and cross-sectoral, integrated models, such as energy-economy models or cross-sectoral national development planning models. Secondly, Module 3 gives details on the characteristics of each model analysed, covering both outcomes generated and requirements for customization and use. Finally, Module 3 provides information on how to assess model results, based on the methodology and models used. For example, partial equilibrium models are likely to overestimate outcomes, while general equilibrium models may underestimate policy and investment outcomes. The analysis will be presented by thematic area, such as policy, concerning subsidy removal and renewable energy incentives.

The main content covered by Module 3 includes:

- Overview of methods, both qualitative and quantitative, such as optimization, econometrics and simulation.
- Overview of models:
    - Overview of available models in each of the key domains and sectors analysed, such as economy, energy and land use.
    - Overview of system/nexus models available, linking several sectors or IGE indicators together.
- Description of the main characteristics of these models:
    - General introduction.
    - Scope.
    - Data needs.
    - Steps for customization and timing.
    - Complementarity with other models and analyses.
    - Limitations.

    - Case studies.
- Interpretation of results, depending on the methodology and model used, such as general vs. partial equilibrium assessments and sectoral vs. systemic analysis.
- Lessons learned from IGE country studies, not only case studies on the use of models, but also documentation on their use and success factors, as well as their main challenges.

4.3 Preparing and delivering classes in Weeks 5 and 6

In delivering the module, emphasis should be put on the extent to which each model can support the creation of an IGE assessment, not on specific pros and cons of the model. In fact, each model is built for a purpose and is effectively used to support a specific set of issues or opportunities. However, the IGE aims at addressing several problems and opportunities simultaneously, in a systemic way. As a result, there is no existing model that perfectly fits the IGE concept. The elements to consider for assessing whether and how a model can contribute to the IGE include the underlying method used, the boundaries of the model, the treatment of time and the type of decisions it can support.

A second critical factor is the importance of the interpretation of results. The results of each model should be analysed based on the extent to which a model can support an IGE assessment. For instance, a sectoral water model may identify optimal options to allocate water across different uses, including ecological water requirements. On the other hand, if the model does not consider the economic implications of such a scenario, including for instance the costs and benefits of different irrigation infrastructure and the forecast of revenues for farmers, there is a risk that the analysis will not effectively support decision making and hence won't result in actual investments or action more generally. The results of the model in this case are still useful but not sufficient. Instead of endorsing or discarding the results, the analysis should be expanded by including a socioeconomic assessment.

We suggest you use a participatory approach when presenting models, asking questions about students' perspectives or opinions on certain types of models. This is to allow students to engage in a conversation, to contribute their knowledge on the models already explored in previous courses and, as a result, make the presentation of models more engaging.

The module starts in week 5 with a 45-minute presentation, which also includes discussions related to polls and group reflections, on modelling methods and models, including an overview of the models used at the country level to support various types of policy analysis in various sectors. A discussion follows, to exchange thoughts about the (almost exclusive) use of certain modelling approaches for policy analysis in certain sectors, such as modelling work in the energy sector is largely based on the use of optimization models; and economic assessments for fiscal policy make use primarily of computable general

equilibrium models, also based on optimization. A second presentation is then proposed, to review in more detail one or two case studies at the national level.

Week 6 begins with an in-depth presentation of simulation models, including scope, strengths and limitations from an IGE approach, data needs, steps for customization and time effort required, and complementarity with other models and analyses. This presentation is followed by a discussion on the potential to link of different models together, either through coupling or by creating a new integrated model. A second presentation is then proposed, on the interpretation of model results. This is presented in relation to the underlying methodology used, such as econometrics, optimization or simulation, the boundaries of the model and treatment of time. At the end of week 6, the final assignment is introduced.

Week 5 – Module 3	**90 minutes total**
Presentation on modelling methods and models (initial overview), including national models.	45 minutes
Discussion on the use of certain types of models for certain sectors and types of analysis.	30 minutes
Presentation of case studies, including in depth examples for models used in the country.	15 minutes

Week 6 – Module 3	**90 minutes total**
Presentation on the main characteristics of models, including an in depth presentation.	30 minutes
Discussion in class on the potential joint use of models as an alternative to the creation of new integrated models.	15 minutes
Presentation on the interpretation of results, using various models.	30 minutes
Introduction of the final assignment.	15 minutes

4.4 Suggested background reading

Essential reading

UNEP, 2014: Using models for Green Economy Policymaking.

This report describes the rationale behind choosing models for green economy assessments. Modelling for green economy generally requires the appreciation of local context factors, and the choice of models determines the type of assessment that can be conducted and the results obtainable. Different modelling methodologies and models are presented and information is provided about their applicability on sectoral, cross-sectoral or national level.

UNECA, 2016: Integrated Assessment Methodologies and Tools for Inclusive Green Economy Analysis in Africa.

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This document presents a methodology on how to integrate three of the main modelling techniques used for green economy policy assessment, such as system dynamics, computable general equilibrium models, and input-output and social accounting matrix, to refine impact analysis of green policies and investments in the economy. It aims to respond better to countries needs in terms of analysing the cross-sectoral impacts of green economy policies.

Optional reading

The following list provides references to publications and reports for various modelling methodologies applied to Green Economy and sustainable development policy analysis:

Country application of Integration between System Dynamics and CGE

Ibarrarán, María Eugenia, Andrea M. Bassi, and Roy Boyd, 2015: Analysing green growth: integrating models to assess green economy – methods and applications to Mexico. In Ruth, M. (Eds.), 2015: Handbook of Research methods and Applications in Environmental Studies.

System Dynamics

UNEP, 2013: Green Economy Modelling Report of South Africa (SAGEM) – Focus on Natural Resource Management, Agriculture, Transport and Energy Sectors.

UNEP, 2014: Green Economy Assessment Report – Kenya.

Bassi. A.M., 2017: Introduction to Linked Indicators for Vital Ecosystem Services (LIVES) work and System Dynamics modelling in the Mekong Flooded Forest.

IISD, 2019: An Application of the Sustainable Asset Valuation (Savi) Methodology to Pelly's Lake and Stephenfield Reservoir, Manitoba, Canada.

IISD, 2019: Sustainable Asset Valuation (Savi) of the Contournement De Rabat (Morocco).

IISD, 2019: Lake Dal in Srinagar, India: Application of the Sustainable Asset Valuation (Savi) Methodology for the Analysis of Conservation Options.

EaP Green, 2018: Supporting the Development of a Green Growth Economic Strategy in Georgia.

Econometrics

Meyer, B., Meyer, M. & Distelkamp, M., 2012: Modelling green growth and resource efficiency: new results. Mineral Economics Vol. 24.

Cambridge Econometrics, 2019: E3ME Technical Manual v6.1.

Computed General Equilibrium

Joint Research Centre (JRC), 2013: GEM-E3 Model Documentation.

OECD, 2018: ENV-Linkages applied: Impacts of Green Growth Policies on Labour Markets and Wage Income Distribution: A General Equilibrium Application to Climate and Energy Policies.

International Energy Agency - Energy Technology Systems Analysis Program (IEA-ETSAP), 2016: Documentation for the TIMES Model.

Input-Output Matrices and Social Accounting Matrix

International Labour Office (ILO), 2017: How to measure and model social and employment outcomes of climate and sustainable development policies - Training guidebook.

Global General Circulation Models

The World Bank, 2010: Economics of Adaptation to Climate Change - Ethiopia - Annexes. Washington: The World Bank Group.

Food and Agriculture Organization of the United Nations (FAO). 2018. AquaCrop Reference Manual v6 - Chapter 1 - FAO crop-water productivity model to simulate yield response to water.

Water Evaluation and Planning

Stockholm Environment Institute (SEI), 2015: Water Evaluation and Planning System (WEAP) - User Guide. Somerville MA: SEI U.S. Center.

Yates, D., Sieber, J., Purkey, D. & Huber-Lee, A., 2013: WEAP21 - A Demand-, Priority-, and Preference-Driven Water Planning Model. Water International Volume 30.

Marginal Abatement Cost Curves (MACC)

Food and Agriculture Organization of the United Nations (FAO), 2012: Using Marginal Abatement Cost Curves to Realize the Economic Appraisal of Climate Smart Agriculture Policy Options.

Agent-based modelling

Berger, T. & Troost, C., 2013: Agent-based modelling of climate adaptation and mitigation options in agriculture. Journal of Agricultural Economics 65(2).

Ecosystem services

Neugarten, R.A., Langhammer, P.F., Osipova, E., Bagstad, K.J., Bhagabati, N., Butchart, S.H.M., Dudley, N., Elliott, V., Gerber, L.R., Gutierrez Arrellano, C., Ivanić, K.-Z., Kettunen, M., Mandle, L., Merriman, J.C., Mulligan, M., Peh, K.S.-H., Raudsepp-Hearne, C., Semmens, D.J., Stolton, S., Willcock, S., 2018: Tools for measuring, modelling and valuing ecosystem services: Guidance for Key Biodiversity Areas, natural World Heritage Sites, and protected areas.

World Resources Institute, 2018: A Guide Tt Selecting Ecosystem Service Models for Decision-Making. Lessons from Sub-Saharan Africa.

5 Facilitating the Final Assignment

5.1 Preparing the assignment

As part of the final exercise, students work in small groups of two to four people on an actual model, applying what they have learned about integrating relevant social, economic and environmental indicators into traditional sectoral models.

The students will identify one or more **(i) issues** to analyse; **(ii) targets** for selected indicators of performance; **(iii)** estimate the **investment** required to reach such targets and then propose and analyse **(iv) policies** that would allow, as enabling conditions, to implement the investment required.

Since some models cannot estimate investment, it will be possible for the students to decide whether to use a target or investment approach, or a policy approach. In the former case, typical of optimization models, the student would introduce the target as an assumption and the model would estimate the investment required[2]; in the investment approach; the model input is the investment simulated, such as 1% of GDP or a specific monetary value; in the latter case the student would simulate a policy, such as an incentive or subsidy, as an assumption and the model would estimate the outcomes of such an intervention.

The starting point is the identification of an issue related to the IGE and the SDGs. Existing issues could be proposed, such as already existing commitments for emission reduction, as found in the Nationally Determined Contribution – NDC. For subnational and sectoral models, where national targets are not available, best practice, such as technology, could be used. You can provide a list of issues, as a starting point for the discussion in the class. The choice of the issue for the final exercise should be discussed with the students in the previous modules, for example, Module 3. Each student will tend to work with problems and opportunities they are familiar with, such as the growth of GHG emissions could be countered by the introduction of a tax for those that have followed economics courses, or through the use of a direct investment in renewable energy capacity in the electricity generation mix for those that have worked with systems engineering models for the energy sector.

The second item to consider is the use of simulation models. For this final assignment, each student will have to be equipped with a laptop or workstation, have access to a simulation model, such as from previous courses, models they are already familiar with or having been offered the possibility of working with a new model, and be able to use such a model. This implies having knowledge of

[2] An alternative way to do the target approach is to do an iterative process of investment approach several times until the target is reached.

the software with which the model has been developed and of how to make changes to the model, concerning both data and equations.

Thirdly, each student will have to carry out research on the areas that have to be added to their model, and then implement the changes required. Once the issue is identified, the next task is the identification of relevant indicators that represent the causes and effect of such issues. These indicators will have to be included in the modelling assessment and added to the model, if not already available. All relevant indicators should be added to the model to assess the role of investments in addressing the issue, such as achieving specific targets. Practically, this means: estimating the investment required; identifying policies to support the required investments; and estimating the system-wide implications of reaching a stated target. As indicated above, the sequence of tasks and the approach used would change depending on the modelling approach and model used. For example, optimization models use targets as key scenario assumptions, while econometrics and simulation could use both investment and policy.

It is important that each modification to the model is documented in detail, so that it is possible for all other students and the lecturer to understand what changes are made and why. With the goal of stimulating learning across disciplines, it is suggested that students share information on the problem or opportunity they have chosen, the model they will work with, the indicators they will add to the model and the scenarios they will simulate. This will allow for the sharing of information among groups and disciplines, and facilitate learning.

Finally, the lecturer should present one or two examples of the full process: identification of the issue; review of indicators, both required and included in the model;, required model modifications, both conceptualized and implemented;, simulation and analysis of results; writing of model documentation and results, where a template of the report in MS Word could be shared; and presentation to the class, where a template of the PowerPoint presentation could be shared.

5.2 Presenting the assignment to students

The students need to perform the following tasks in small groups:

1. Identify a relevant issue at sectoral or national level:
    - Select the issue to analyse, such as growing air and water pollution.
    - Identify relevant indicators for the analysis of this problem.
    - Create a list of indicators that cause the issue as well as a list of the indicators that are impacted by the issue, considering social, economic and environmental indicators.
    - Identify the variables that should be included in a modelling assessment of the issue.

2. Search for existing targets, such as from the NDC for emission reduction, or use best practice:

- Select the target to analyse, such as emission reduction.
- Identify relevant indicators for the analysis of this target.
- Create a list of indicators that may influence the implementation of the target, as well as a list of the indicators that are impacted by the target, considering social, economic and environmental indicators.
- Identify the variables that should be included in a modelling assessment of the target.

3. Modify model structure and inputs based on whether the model chosen uses investment or policy as an input:
   - Select the model to use for the analysis of the issue and target.
   - Identify and describe the strengths and weaknesses of the model chosen.
   - Identify the variables that should be added to the model for a proper IGE assessment of the opportunity or problem.
   - Carry out research on how the new indicators are calculated in their field. For example, look for best practices, such as on how emissions are calculated in models for power generation.
   - Integrate these indicators in the model. Different approaches could be used, including adding multipliers or changing the structure of the model by including new endogenous variables.

4. Simulate the model and analyse results:
   - Depending on the model used, set up the model for simulation by adding assumptions on investment or policy, using a target or policy-driven approach.
   - Simulate the baseline scenario and alternative ones by including selected targets, policy interventions or investments.
   - Assess whether the results of the model change when the new indicators are added.
   - Document the changes made and the results of the model.

5. Presentation of the work completed to the class and deliverance of the final report. The presentation includes:
   - 20-minute overview of the work performed.
   - 10-minute discussion of the main challenging tasks.
   - Reaction of the class, with any potential questions for clarification and suggestions for the improvement of the analysis.

   Role playing could be used, with various groups of students representing the interests of selected ministries and asking targeted questions in relation to their specific policy priorities.

Examples can be provided for each of the steps, and the first six can be discussed in class. For instance:

1. Select the issue, such as the growth of GHG emissions:
    - Relevant indicators for the analysis of the causes of the issue include energy consumption by energy source, forest cover and carbon sequestration.

2. Select relevant targets, such as 29% of emissions relative to 2005, or as a baseline, as per the NCD:
    - Relevant indicators for the analysis of the impacts of reaching the target include construction of renewable energy power generation capacity, improvement of energy efficiency, employment creation, energy use, emissions and air quality, and health impacts.

3. Select the model and modify the model structure:
    - Select the model to use for the analysis of the issue. For example, a systems engineering model of the energy sector or a CGE model for macroeconomic performance.
    - Identify and describe the strengths and weaknesses of the model chosen. CGE models are strong in assessing economic performance, but often miss biophysical indicators or make high level assumptions, such as for energy consumption and emissions.
    - Identify the variables that should be added to the model for a proper IGE assessment. Add a more disaggregated energy demand module to the GCE, by sector and energy source, or consider adding a land component that allows you to forecast land use and forestland for carbon sequestration.
    - Carry out research on how these required indicators are calculated in their field. Was any CGE model coupled with a systems engineering energy demand and supply model?

4. Simulate the model and analyse results:
    - Set up the model to analyse either investments, such as $10 million invested in solar PV, or policy, such as the introduction of a 30% incentive to reduce the capital cost of solar PV, or targets, such as assume that a 10% penetration rate of solar PV is achieved by 2030.
    - If investment is not the scenario input, estimate the investment required to reach the target, with and without a policy incentive.

It is important to note that it is not necessary to ask students to develop new modules. It may be sufficient to add a few selected variables, such as the economic impact of air pollution, for the analysis to be more relevant and aligned with the IGE definition.

5.3 Evaluating the work of the students

The assignment will be evaluated according to the following criteria:

- Was the group able to explain strengths and weaknesses of the chosen modelling approach in the context of an IGE assessment?
- Did the group include social, economic and environmental indicators in their modelling assessment?
- Did the group make actual changes to the model to include more indicators? How were these changes made, such as adding multipliers or changing the structure of the model?
- Were required investments, potential avoided costs and added benefits of IGE interventions identified and quantified with the new model?
- Were impacts assessed for different economic actors, over time and for specific locations?
- Are the students able to explain how their improved model can support decision making for sustainable development?

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PAGE PARTNERSHIP FOR ACTION ON GREEN ECONOMY

This document is a Facilitator Guide for the implementation of a Higher Education Course on Inclusive Green Economy (IGE) Modelling. It provides an overview of the course and offers guidance for each of the three modules and the final exercise of the course. Facilitators will find information on learning objectives, essential content to be covered, how to prepare and deliver lectures, and how to facilitate group exercises.

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For further information:

PAGE Secretariat
UNEP
Resources and Markets Branch
11–13 Chemin des Anémones
CH-1219 Chatelaine-Geneva
Switzerland
page@un.org

www.un-page.org

@PAGEExchange

@GreenEconomyUNEP

un-page.org/newsletter

www.un-page.org

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