Online course

Co-benefits of renewable energy in climate change mitigation - Overview

Berlin, 2020-03-16

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Learning objectives:

Upon completion of this course, you will be able to

- Understand the theoretical background and origins of the co-benefits concept
- Define co-benefits
- Explain the most widely discussed co-benefits
- Differentiate between co-benefits and co-costs/co-impacts of climate change mitigation measures
- Differentiate between gross and net impacts of renewable energy use
- Argue for the importance of renewable energy use in international climate mitigation activities
- Estimate some quantifications of co-benefits

1 Introduction to the course

Climate change has become one of the greatest challenges of humanity. After decades of intensive research and scientific investigation, the body of evidence on climate change is huge and the key messages are alarming. According to the Intergovernmental Panel on Climate change (IPCC), the lines of evidence point to the following key messages:

- The human influence on the climate system is clear.
- The more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts.
- We have the means to limit climate change and build a more prosperous, sustainable future.

Over the past 200 years following the industrial revolution, humanity (and most notably the highly industrialized countries) has used up two thirds of all available fossil fuels and resources. [1]. There is urgent need for action to limit global warming to 1,5 °C compared to pre-industrial levels. 65% of the global carbon budget compatible with a 2°C goal is already used up. Intense political debates have emerged over the past decades. Often climate change action is seen as a burden or a luxury ambition of industrialized countries or even worse as a means of limiting economic growth of emerging economies [2].

However, recent publications stress the opportunities of climate change action rather than the burdens and establish the link between climate change and other development priorities. The Paris Agreement and the 2030 Agenda for Sustainable Development have led to a renewed interest in the linkages between international climate policy and “win–win solutions” or “no regrets strategies”, termed “co-benefits”.

As vast shares of global greenhouse gas emissions are caused by energy production and use, the energy sector has become a key action area for climate change mitigation measures. The accelerated growth and expansion of renewable technologies alongside rapidly declining costs has created a dynamic shift from conventional sources of energy (coal, oil, gas, nuclear) towards renewable and more climate-friendly energy sources. Apart from the positive contribution of renewable sources of energy (e.g. solar energy, wind power, hydro power, bioenergy, geothermal energy) in reducing greenhouse gas emissions, there are many beneficial side effects of renewable energy use which represent tremendous development opportunities for emerging economies. These so-called **co-benefits** will be explained and explored in this online course in more detail.

1.1 Chapter 1 endnotes

[1]: IPCC (2013)

[2]: IPCC (2017)

2 Co-Benefits of climate change mitigation

2.1 Definition of Co-benefits

Learning objectives:

Upon completion of this course, you will be able to

- Trace the roots of the co-benefit concept
- Define the term co-benefits of climate change mitigation
- Compare and contrast various co-benefits definitions from different international organizations

With the aim to **reconcile climate and development goals,** the concept of "co-benefits for climate change" was formally put forward in 2001 in the Intergovernmental Panel on Climate (IPCC) third Assessment Report [1]. It defines co-benefits as "… benefits of policies that are implemented for various reasons at the same time, including climate change mitigation, acknowledging that most policies designed to address GHG mitigation also have other, often at least equally important, rationales (e.g. related to objectives of development, sustainability, and equity)." These efforts can be traced back more than two decades to the *United Nations Framework on Climate Change* (UNFCCC).

The co-benefits approach has emerged within climate policy since the beginning of the 2000s from public and political debates. It often focuses on the advantages of climate change mitigation measured for controlling air pollution [2]. Over the past two decades, the notion of co-benefits has been continuously moving from the side-lines towards the centre of the debate on climate and energy policy and action.

There is no universally agreed definition of co-benefits but a variety of different approaches published by numerous international bodies and scientific organizations exist. What they all have in common is the idea that multiple positive effects may result from a policy or measure.

Intergovernmental Panel on Climate Change (IPCC) 2007	• "Co-benefits" are the benefit from policy options implemented for various reasons at the same time, acknowledging that most policies resulting in GHG mitigation also have other, often at least equally important rationales.
UNEP – United Nation Environment Programme	• Co-benefits: The positive effects that a policy or measure aimed at one objective might have on other objectives, without yet evaluating the net effect on overall social welfare.
Ministry of Environment, Japan 2009	• Co-benefits refers to multiple benefits in different fields resulting from one policy, strategy or action plan.
World Bank, Background Paper 2010	• Co-benefits are defined as the benefits for the local environment as a result of (mitigation/adaptation) actions that are targeted at addressing global climate change

Definition of co-benefits used by major organizations (Source: LSE Cities, 2016)

2.2 Characteristics of co-benefits:

Learning objectives:

Upon completion of this course, you will be able to

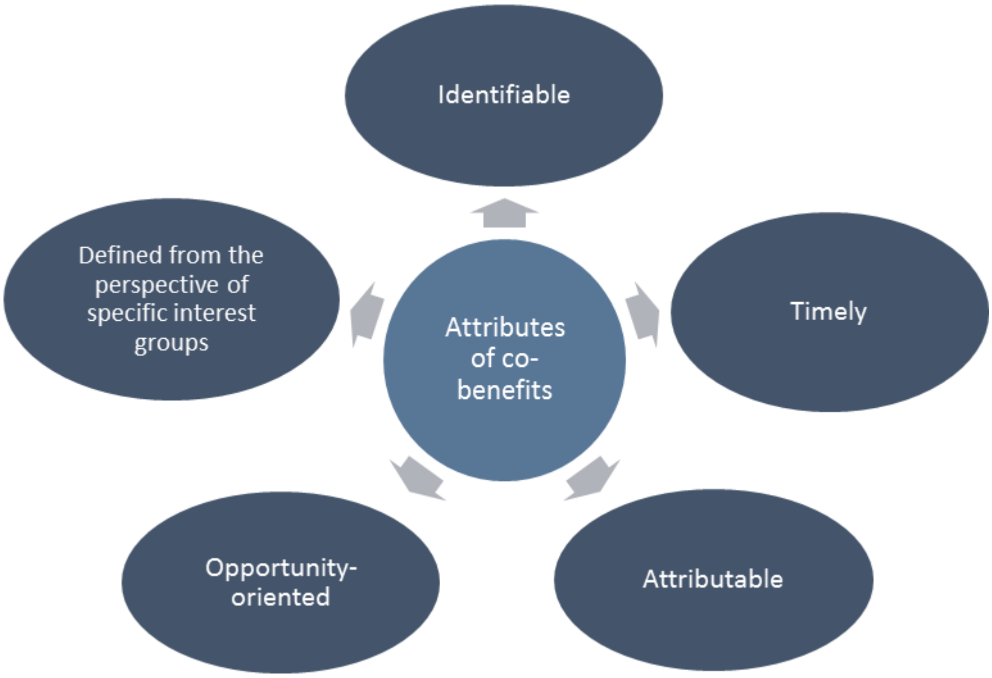
- Identify synonymous concepts to co-benefits
- Distinguish between co-benefits and co-impacts
- Understand the general features of co-benefits

The implementation of mitigation policies and measures can have positive as well as negative effects on economic, social and/or environmental objectives [3]. The side-effects that are positive are deemed as 'co-benefits'. The adverse ones are termed risks, 'negative externalities' and 'co-costs'. The term **co-impacts** is used in a more generic sense to cover both positive and negative side of benefits. As both co-benefits and adverse side-effects occur, the net effect is sometimes difficult to establish.

According to the London School of Economics, a co-benefit has one or more of the following features [4]: Co-benefits …

- can lower the cost of climate change mitigation measures
- can be captured locally
- are available within much shorter time frames than direct effects of climate change mitigation
- may benefit specific stakeholder groups
- can strengthen networks among different partners (locally and globally)
- may mitigate conflicts over scarce resources (e.g. water, land)
- can empower communities and citizens
- are able to reduce energy imports and free government resources
- can improve national economy, local businesses and jobs

IASS has defined **five attributes of co-benefits** that allows for the tracking of processes within the mitigation strategies [5]. First, co-benefits must be **identifiable**, this means that they can be recognized not only by stakeholders or policymakers but by society in general. The second attribute addresses how **timely** co-benefits should be. This means that the effects of mitigatory actions taken should be measurable within a certain time frame. The third attribute is that it must be **attributable**. This means that co-benefits ought to be the consequence of measures taken to mitigate climate change. Another attribute is that co-benefits should be **opportunity-oriented**. This means that co-benefits should be framed to provide the best possible opportunities to people and their environment. Finally, co-benefits must be **defined from the perspective of specific interest groups**, which enables a targeted and focused approach in mitigating problems.



Co-benefits attributes (Source: IASS, 2017)

2.3 Types of co-benefits

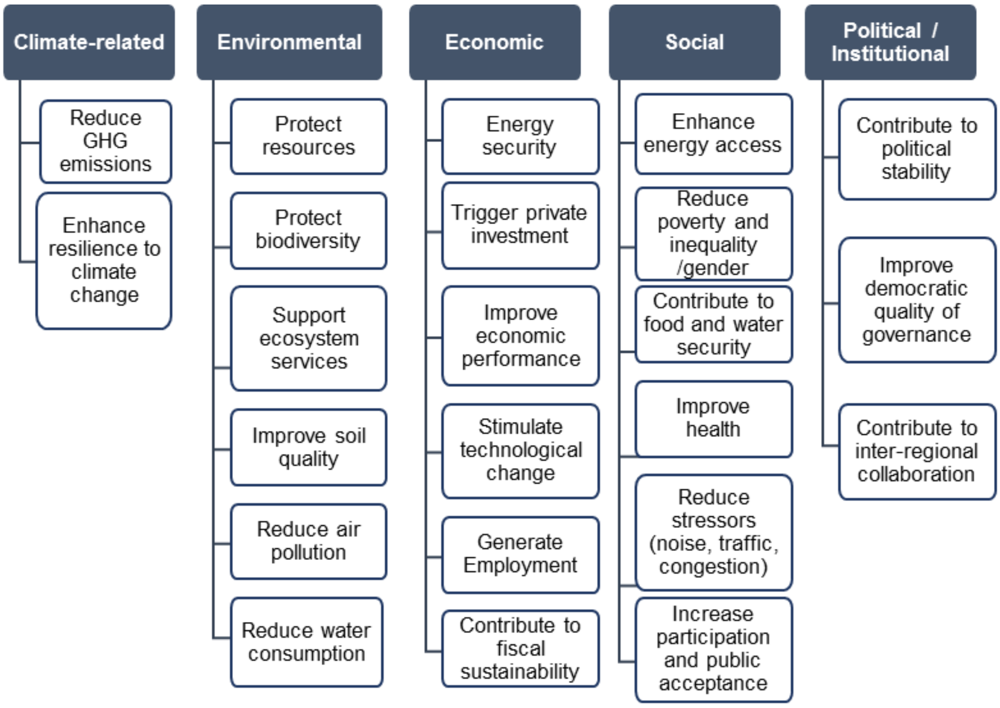
Learning objectives:

Upon completion of this course, you will be able to

- Categorize various types of co-benefits of climate change mitigation
- Summarize the most important social, economic, environmental and political co-benefits of climate change mitigation.

Co-benefits can be grouped into various number of categories. This categorisation may differ based on the responsible institution. On a very general level the Institute for Advanced Sustainability Studies (IASS) has differentiated 5 groups of co-benefits:

- **Climate-related co-benefits** (emission reductions or increased resilience to climate change)
- **Economic co-benefits** (energy security, private investments, job creation)
- **Environmental co-benefits** (biodiversity conservation, resource protection, improved soil quality)
- **Social co-benefits** (improved health, energy access, poverty reduction), and
- **Political / institutional co-benefits** (such as political stability or regional cooperation) [4]



Types of co-benefits according to IASS (Source: IASS, 2017 based on Mayrhofer & Gupta, 2016)

Co-benefits vary in importance in different countries and regions. A potential co-benefit that is quite essential in one country (for example reducing energy imports) may play a much less important role in another that is largely self-sufficient in terms of energy supply, but which attaches great importance to innovation or job creation. A clear definition of country or region-specific co-benefits is the first important step in mobilizing the respective co-benefits.

2.4 Chapter 2 endnotes

[1]: IPCC (2001)

[2]: Hamilton, Kirk; Brahmbhatt, Milan; Liu, Jiemei (2017)

[3]: IASS (2017)

[4]: IASS (2017)

3 Climate and environmental related co-benefits

3.1 Reduce GHG emissions

Learning objectives:

Upon completion of this course, you will be able to

- Identify the importance of reducing GHG emissions
- Associate the social cost-benefit of GHG emission reductions

The global reduction of greenhouse gases has become a great challenge in recent years. Avoiding greenhouse gas emissions does not only have positive implications with respect to climate change, but also improves the quality of the air and consequently the quality of people's lives. An example of this can be observed in the USA, where the co-benefits of different climate policies were studied and projected for the year 2030. It was found that the health benefits derived from the improvement of air quality could compensate between 26% - 1.050% of the cost of carbon policies [1].

Decision-makers need to rediscover the tools that allow for a better analysis of the impacts of greenhouse gas emissions. In this case, it is important to consider the social cost-benefit tools that can be used to analyse the impact of policies or projects. These may not only fall within the economic sphere, but include societal effects such as pollution, environment, security, quality of the space, health, legal aspects etc. [2]. Strictly speaking, reducing emissions is a direct benefit of renewable energy use - not a co-benefit. However, the IPCC and other sources classify emission reduction a climatic co-benefit.

Studies suggest that for every 1 tonne of CO_2 emission removed from the atmosphere through a carbon offset program, a further value of US$664 dollars is delivered in economic, social and environmental benefits for local communities around the world [3].

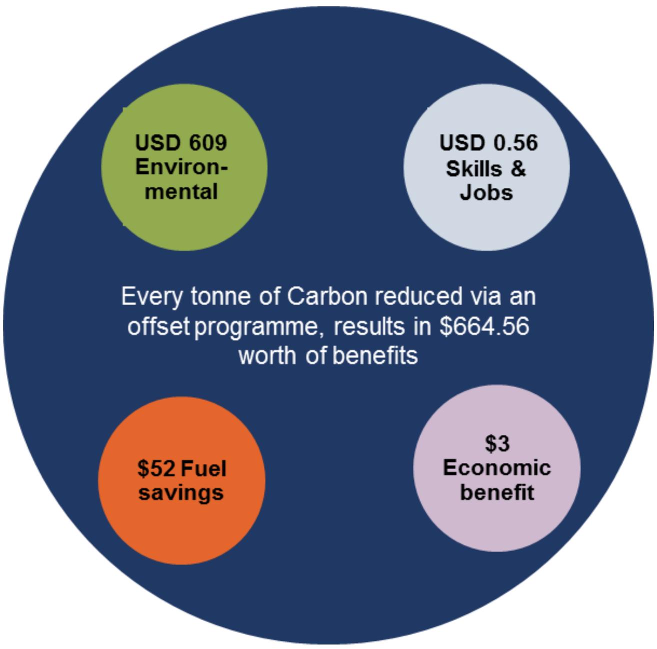


Illustration of the socio-economic benefits of 1 ton of carbon reduction (Source: International Carbon Reduction & Offset Alliance, 2014)

3.2 Enhance resilience to climate change

Learning objectives:

Upon completion of this course, you will be able to

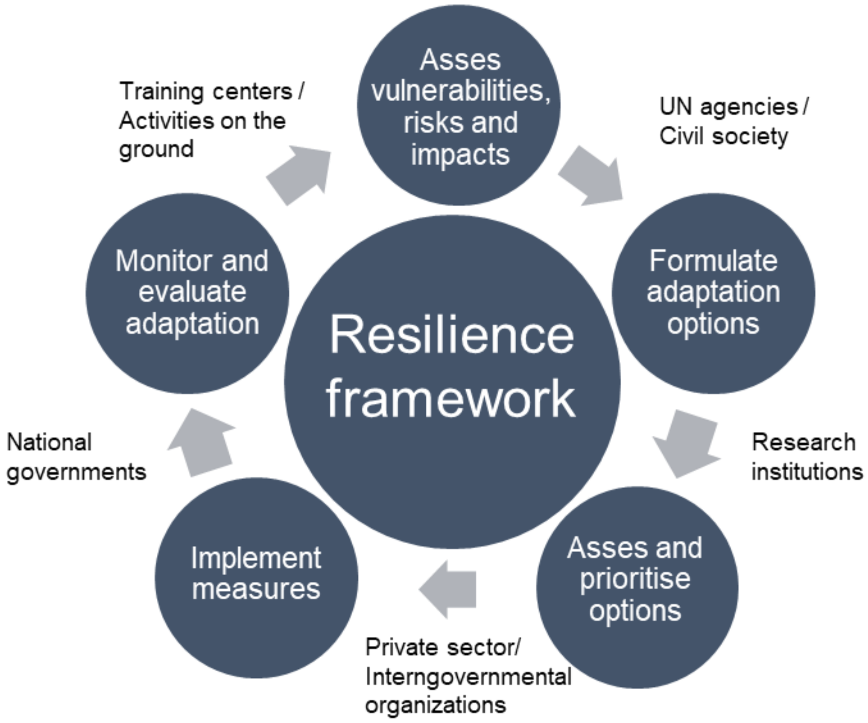
- Define how climate resilience is related to climate change
- Identify the co-benefits that increase resilience to climate change
- Understand the different levels of participation in the process of increasing resilience to climate change

Resilience can be understood as the ability of a system or community to survive an event and to anticipate, adapt and thrive in the face of a change. The importance of this concept is that it incorporates short-term changes as well as long-term trends. Among the key characteristics of resilience to climate change are:

- Flexibility: in the sense that planning and management should adapt and expand to include range of impacts and possibilities.
- Inclusiveness: adaptation strategies within a system or community has to consider vulnerable elements of society as underrepresented minorities in civic processes in order to reduce this disparity.
- Learning: as resilience is an adaptive process, learning must evolve in order to adapt to the circumstances. In this case, it is important to share information and knowledge.
- Prevention and management: resilience must ensure the prevention and worsening/exacerbation of impacts [4].

One of the co-benefits related to resilience highlighted by the World Health Organization (WHO) is the recommendation to governments to inculcate climate change within health programs. This is due to the environmental benefits related to resilience such as avoiding natural disasters and curbing the spread of infectious diseases of non-communicable diseases. Other co-benefits help to reduce the susceptibility to floods and landslides. It also alleviates the increase in temperature that is linked to other negative effects such as droughts, desertification, among others [5].

Resilience is an element that allows actors to work in different moments of climate change adaptation and mitigation strategies. The participation of different institutions ranges from international agencies to training centres.



Resilience framework (Sources: Environmental Information System and UNFCCC, 2014)

3.3 Reduce air pollution / health

Learning objectives:

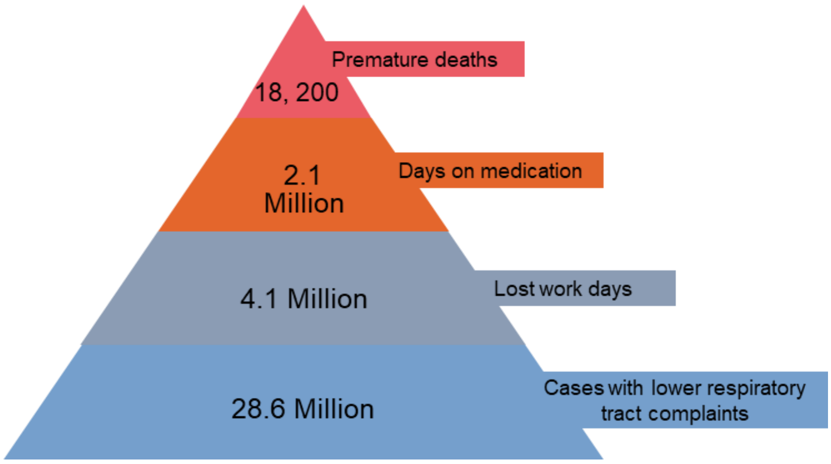
Upon completion of this course, you will be able to

- Understand impacts of air pollution on human health

Air pollution is a major global public health crisis. According to an International Energy Agency (IEA) report, around 6.5 million deaths are attributed each year to poor air quality, making this the world's fourth-largest threat to human health, behind high blood pressure, dietary risks and smoking [6].

In 2016, 92% of the world's population lives in places where pollution levels exceed the limits defined by the World Health Organization (WHO). Air pollution affects people's lives in many ways and is directly linked to asthma, bronchitis and other respiratory infections and diseases. High blood pressure, irregular heartbeat and heart attacks may also result from air pollution. Air pollution is associated with some of the biggest life-threatening illnesses in children (who are especially susceptible to the harmful effects of heavy metals in emissions). These illnesses include pneumonia which is responsible for the deaths of 920,000 children under 5 years of age every year. Children who are exposed to large amounts of lead or mercury risk developing cognitive disorders. They may also suffer irreversible organ damage [7].

Apart from the consequences of air pollution on human health, it also causes massive economic losses worldwide: health costs add up to almost €43 billion a year in Europe alone. In the USA, $225 billion was quantified as lost labour income due to air pollution in 2013 [8]. Other indirect costs are attributed to higher health system costs.



Annual health consequences caused by coal-fired power plants in the EU (27 countries (without Croatia) (Source: Böll, 2015)

A Cobenefits assessment for South Africa found health cost externality of Rand 5 –1 5 cents per kWh of energy generated from coal. As many as 2080 premature deaths annually can be attributed to air pollution from power plants in South Africa. Scaling up renewables in South Africa could cut health costs associated with the power sector by 25% in by 2050 [8].

Fighting air pollution thus leads to immediate beneficial impacts in terms of reduced mortality and lower health costs. Measures like encouraging the use of low-emission vehicles and supporting public transport systems may have particularly strong impacts [9].

3.4 Protect resources: The water-energy-nexus

Learning objectives:

Upon completion of this course, you will be able to

- Identify the links between water and (renewable) energy and its implications for energy security
- Understand the concept of water security and its energy-related risks

The nexus between water and energy is observed in different processes and the secure supply of both are closely interlinked. Huge amounts of energy are needed to maintain the provision of water. The world’s agricultural sector consumes 30% of the world's energy (mainly through energy demand for pumping and irrigation purposes) and 80-90% of the world's fresh water. Agriculture is the world’s largest water consumer [10].

The United Nations defines water security as: *“the capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability” [12].*

It is important to note that the nexus between these two elements has different risks that affect all essential elements of water and energy security. These risks not only confront governments, but any stakeholder engaging in activities related to the water-energy system

- **Water-related risks to energy security**

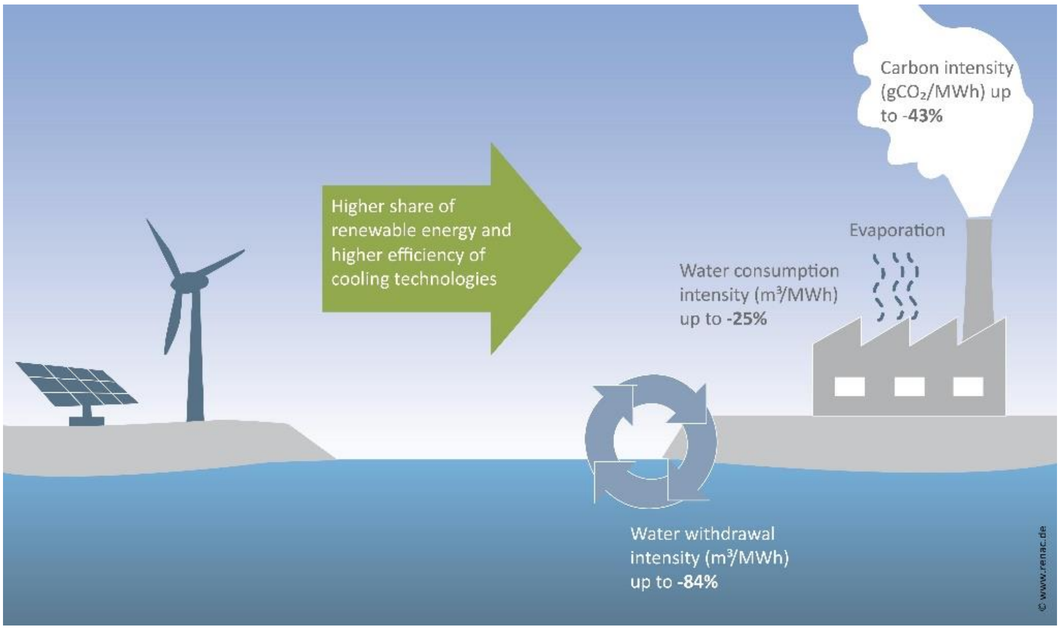
Droughts, heat waves, etc. can lead to the temporary closure of thermal power plants. Global warming may aggravate these risks leading to changes in precipitation levels which might negatively affect energy security in many regions.

- **Energy-related risks to water security**
  An unstable energy supply is also a threat to drinking water provision or to the agricultural sector. Water contamination due to the extraction of fossil fuels or environmental impacts on river habitats due to mixing with hot cooling water are further risks to water security [12].

Likewise, water is vital for energy generation. The most obvious link between water and energy is power generation in hydro power plants or pumped storage systems. But substantial amounts of water resources are also required for the extraction and processing of fossil fuels. Even more water is needed for the operation of thermal fossil or nuclear power plants for cooling. More examples related to the water-energy nexus can be seen in the diagram below.

Water-energy nexus example (Source: IRENA, 2015 and World Bank, 2013)

Across their life cycles, most renewable energy technologies are less water intensive compared to conventional thermoelectric generation. Solar PV or wind withdraw up to 200 times less water than a coal power plant to produce the same amount of electricity [13]. Solar powered water pumping thus not only reduces emissions and costs of diesel-powered pumps, but also contributes to water security.



How renewables can alleviate power sector water stress in India (Source: IRENA, 2018)

3.5 Chapter 3 Endnotes

[1]: Zhang, Yuqiang (2017)

[2]: London School of Economics and Political Science (2017)

[3] ICROA, (2014)

[4]: Second Nature (2018)

[5]: Wang, Y (2017)

[6]: IEA (2016)

[7]: UNICEF (2017)

[8]: WHO (2016)

[9]: IEA (2014)

[10]: IRENA (2015)

[11]: UNU (2013)

[12]: IRENA (2015)

[13]: IRENA (2015)

4 Economic co-benefits

4.1 Increasing energy security

Learning objectives:

Upon completion of this course, you will be able to

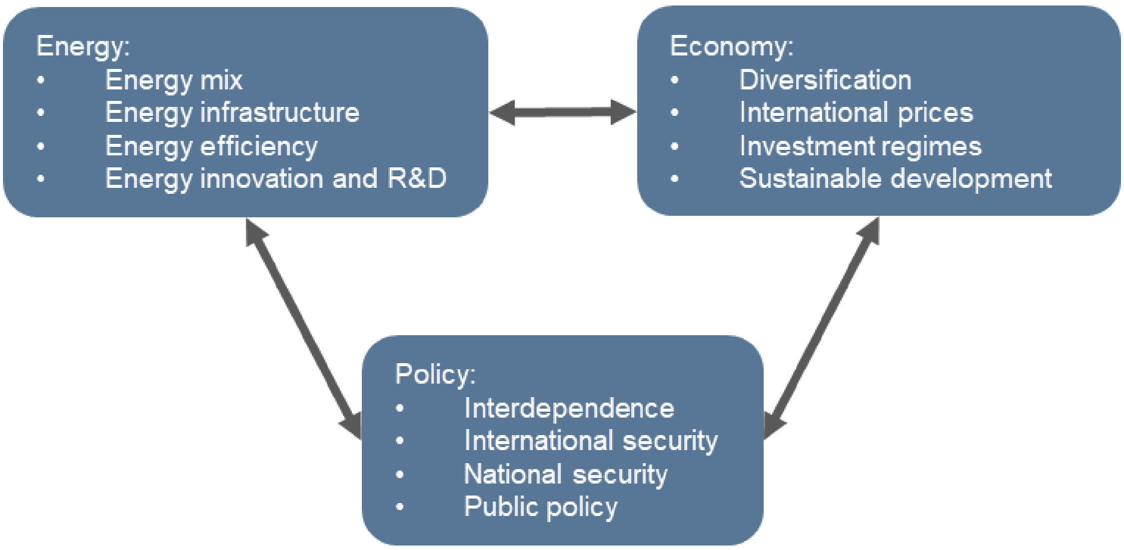
- Define the concept of energy security
- Identify various dimensions of energy security
- Describe the potential opportunity and co-benefits of energy security

The concept of energy security has several dimensions or meanings. Energy security could refer to the uninterrupted supply of energy resources (say imports of (fossil) fuels or electricity into an economy). In this context, energy security is the uninterrupted availability of energy at an affordable price for individuals, companies or an entire economy [1]. Energy security may also refer to the stability of the power supply within a country or region. Regular black outs are an indication of a lack of security of supply. Other definitions of energy security go beyond the physical dimension and include the economic, socio-political aspects of energy security and reliability levels as well;

"Energy security is determined by four factors: first, energy (sources) must be fundamentally present. Second, they must be available or usable. Third, the energy must be affordable, and fourth, the form of energy generation must be socially acceptable" [2].

Energy systems and infrastructure, economies and the political systems are closely linked and interrelated. The interplay between these three sectors are crucial for maintaining energy security.

Fostering usage of renewable energy sources consequently reduces dependency on imported fossil fuels like oil, gas and coal and is one of the energy security actions which have economic co-benefits [3]. Other measures to increase energy security include diversification of the transport sector through electrifying or switching to biofuels, integrating infrastructure, spatial planning, and mass transit policies. These measures will decrease the sector's dependence on oil and diversify the energy supply, thus increasing resilience to external disruptions [4].



Elements of energy security (Source: Cambridge Insight, 2016)

A co-benefits assessment on energy security in India found that Fewer blackouts experienced by consumers supplied by solar mini-grids [5].

4.2 Employment impact / Generate employment

Learning objectives:

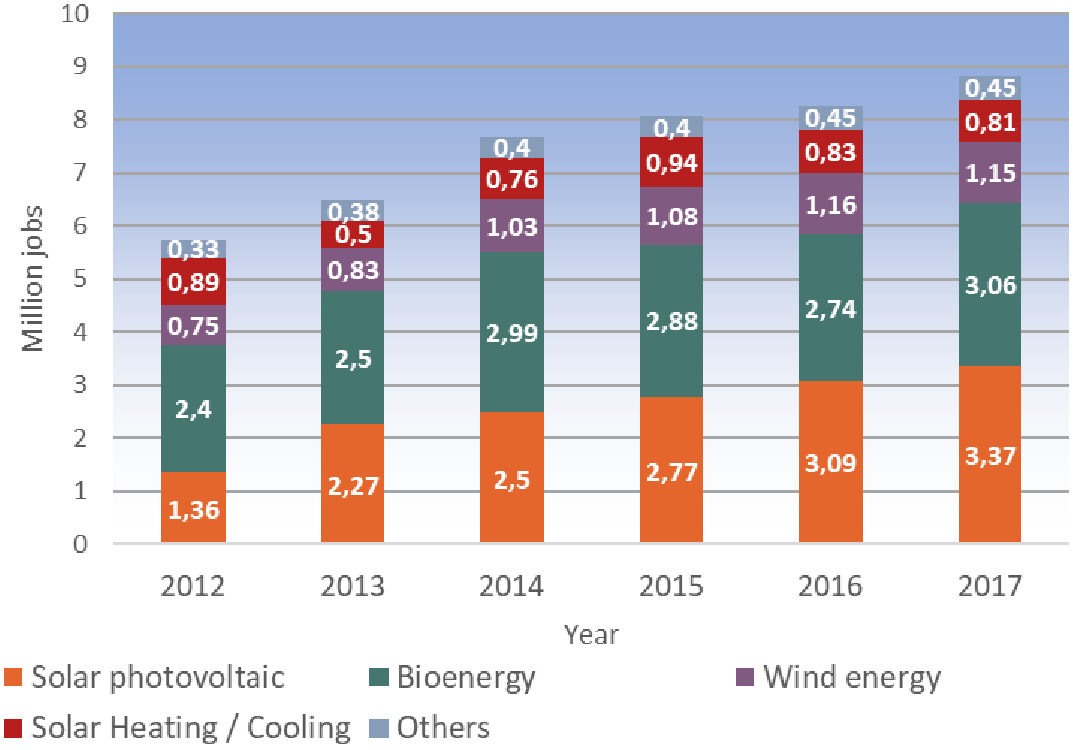
Upon completion of this course, you will be able to

- Identify the importance and impact of renewable energy employment
- Link the concept of green economy to co-benefits
- Know the scale of global employment induced by renewable energy
- Describe the potential opportunity and co-benefit of employment impacts

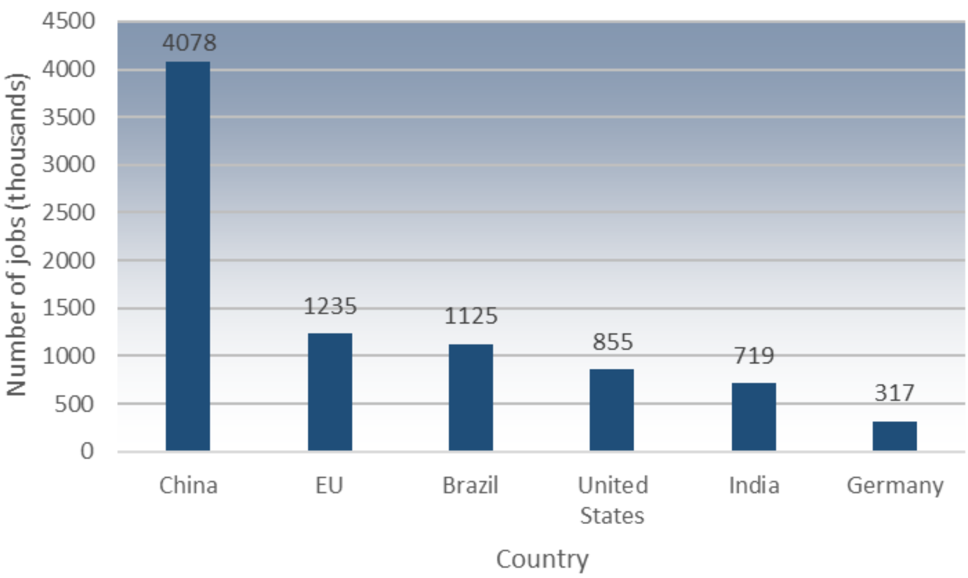
The creation of new jobs is one of the most important drivers of renewable energy deployment. Often renewable employment is connected to the concept of “green economies”. UNEP defined a **green economy** as one that results in “*improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities*” [5]. Renewable energy employment has different layers and dimensions: Renewables may create **direct jobs** through the expansion of renewable energy use (manufacturing of equipment, the installation of RE plants, operation and maintenance…). **Indirect employment** is provided by material or service companies in other sectors providing inputs to direct renewable energy technology manufacturers (for example transport services or component suppliers). Finally, there are **induced employment** effects. These occur along the renewable energy value chain for example in goods and services purchased by those employed directly or indirectly or by effects of changes in electricity tariffs. In sum, induced jobs are those that are created due to economic impact made by the renewable energy sector [6].

The global transition to a low-carbon and sustainable economy can create a large number of jobs in many sectors such as renewable energy, energy efficiency, public transport and organic agriculture among others [7]. REN 21 quantified global renewable energy jobs at 11 million in 2018. A report published in 2017 claims that a global transition to a 100% renewable energy system in 139 countries might create up to 24.3 million net jobs across the world [8]. Increased use of renewable energy not only creates new jobs (which are also more labour intensive compared to traditional energy sector jobs), but also maintain “old ones” as their supply chains are often also based on traditional industries like steel [9]. On the other hand, renewable energy replaces jobs in unsustainable sectors e.g. coal, mining or power generation with fossil fuels.

Co-benefits assessment of employment impacts of renewables have been conducted for South Africa, Turkey, India and Vietnam [10].



Global renewable energy employment by technology 2012-18 (Data source: IRENA 2019)



Renewable energy employment in selected countries (Data source: IRENA 2019)

4.3 Chapter 4 endnotes

[1]: Correljé, Aad and van der Linde, Coby (2005)

[2]: BMUB (2017)

[3]: BMUB (2017)

[4]: Modal, Alam Hossain, Denich, Manfred and L.G. Vlek, Paul (2010)

[5]. COBENEFITS India (2019b)

[5]: UNEP (2016)

[6]: UNU (2013)

[7]: UNEP (2011)

[8]: REN 21. (2019)

[9]: COBENEFITS South Africa (2019c), Turkey COBENEFITS Turkey (2019b), COBENEFITS India (2019c), and COBENEFITS Vietnam (2019b).

5 Social co-benefits

5.1 Reduce inequalities / gender

Learning objectives:

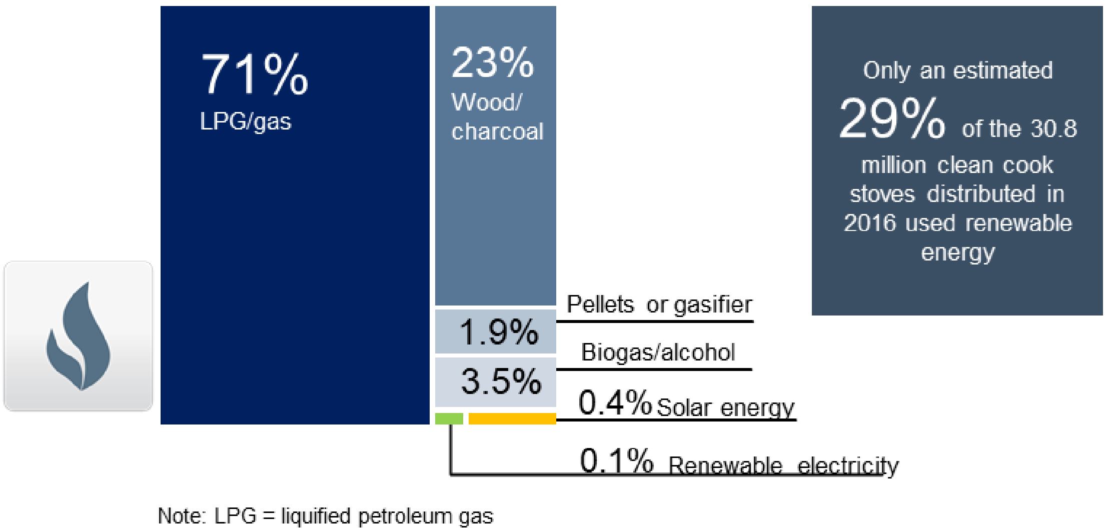
Upon completion of this course, you will be able to

- Recognize the importance of gender in energy supply
- Explain the potential opportunity and co-benefit of gender impacts

In many traditional societies, women are seen as responsible for providing energy and water. Although women are the main users of energy in households, their time and effort taken up in pumping water, agricultural processing and transport are seldom recognized. Consequently, women bear the invisible burden of the human energy crisis. The time invested in collecting biomass-based energy supplies (predominantly by women) is responsible for tremendous poverty and foregone opportunities. So far, women have had limited access to the renewable energy market, leading to unfavorable impacts on participation in decision-making and projects. The participation of women in consultations for the design of projects is still lower than that of men [1].

Using renewable and sustainable energy can catalyze gender equality in that women play an important role in household purchases and energy production, hence making them the main promoters of new technologies applied to the energy sector [2]. Enabling the creation of local renewable energy user groups and co-operatives and empowering women to fully participate at all levels of decision-making, is essential for sustainable energy provision.

The co-benefits that are observed related to this issue focus on reinforcing (especially in developing countries) women's access to renewable energies in homes and communities (small scale), for instance via clean cook stoves and entrepreneurship. For example, in Uganda more efficient stoves and cleaner fuels also are reducing the time people—usually women and girls—need to spend collecting fuel, freeing up time for income generating activities or schoolwork.



Approximate proportion of clean cook stoves by energy source 2016 (Source: REN 21, 2018)

World/region/rountry	Population without access to clean cooking stoves in 2015	
	Share of population	Millions
World	38%	2,792
All developing countries	49%	2,792
Africa	71%	848
Sub-saharian Africa North Africa	84% 1%	846 2.1
Developing Asia	49%	1,874
Central and South America	12%	59
Middle East	5%	12

Population without access to clean cooking, by region and country 2015 (Source: REN 21 2018)

5.2 (Fuel) Poverty alleviation

Learning objectives:

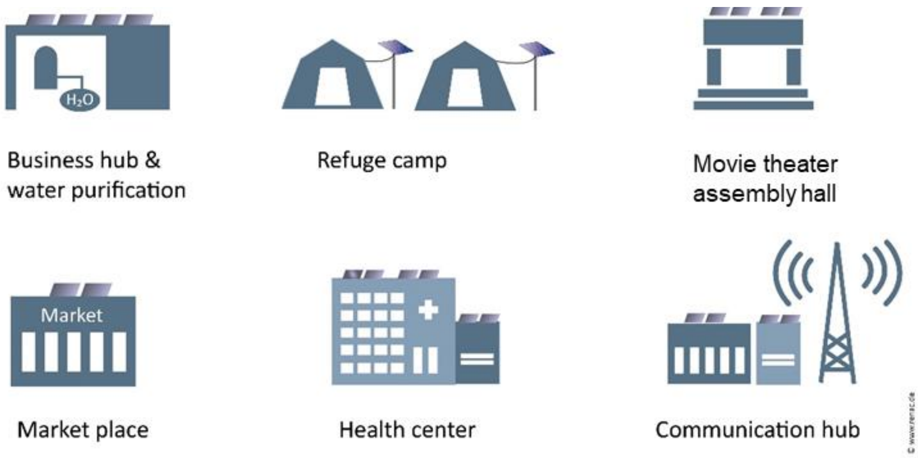
Upon completion of this course, you will be able to

- Determine importance of fuel poverty alleviation
- Recognize the causes and the potential opportunity of co-benefits related to fuel poverty alleviation

Ending poverty is one of the 17 Sustainable Development Goals (SDG). Energy poverty, also known as fuel poverty, is a problem that affects different countries of the world and is understood as the inability to meet the basic levels of energy required for adequate lighting, as well as common activities such as cooking and the use of electrical appliances [3]. Among the causes of fuel poverty are [4]:

- **Low incomes**: a higher percentage of income generated by those with a lower income is used for fuel.
- **Cost of fuels:** the fluctuating price of fuels leads to financial instability that increases vulnerability.
- **Conditions of homes:** the properties where vulnerable people live often find themselves in poor conditions, where there is heat leakage not only making them consume more energy.
- **Access to information regarding energy efficiency:** such information is not always available or distributed to vulnerable groups. Education is a measure by which this can be overcome.

Access to reliable, affordable and environmentally friendly energy empowers individuals and communities to improve livelihoods, gain control over their energy supply and reduce fuel bills to eventually escape from poverty [5]. In some regions, (off-grid) renewables may be the only option of access to energy at all. Solar home systems or village mini-grids supply the basic energy demand for lighting, cooling and other energy services for the energy poor. Beyond meeting the most basic energy needs, some small-scale renewable applications might serve as business models or hubs of employment and local entrepreneurship. An example of this includes PV powered marketplaces for selling everyday goods, water purification, communications, mobile charging, health service centres s, cooling, or printing facilities…)



Possible uses of off-grid renewables (Source: Solarkiosk, 2018)

5.3 Chapter 5 endnotes

[1]: CIF (2017)

[2]: ARE (2017)

[3]: Public policy exchange (2016)

[4]: East Ayrshire Council (2004)

[5]: IRENA (2017)

6 Political / institutional co-benefits

6.1 Improve democratic quality of governance (good governance)

Learning objectives:

Upon completion of this course, you will be able to

- Identify the concept and characteristics of good governance
- Recognize the links between good governance and co-benefits

The concept of good governance can be understood as a decision-making process where decisions are implemented within a sustainable context that meets eight important characteristics: participation, consensus-orientation, accountability, transparency, responsiveness, effectiveness and efficiency, equity and inclusion, and follows the rule of law (compliance). This ensures that corruption is minimized and different people (especially vulnerable groups) have a voice in decision-making [1].

Good governance is also essential for a sustainable energy system. Co-benefits may materialize when regulations, legislation, policies and the administration of electricity generation have a positive impact in other sectors, financially, socially and environmentally, among others. Good governance allows citizens, policy-makers and technicians to get involved in electricity production processes within renewable energy. This not only improves production and lowers the cost of electricity, but also brings about other parallel benefits [2]. Good governance is important in the implementation of sustainable policies in all other fields (social, economic, environmental, cultural, etc.) that allow for a more adequate control of resources by not only by the government but other groups of society as well. This is achieved through active participation in different sectors and at different levels (local, regional, state, among others).

Characteristics of good governance (Source: UNESCAP, 2009)

6.2 Political stability, regional cooperation and mitigation of conflicts

Learning objectives:

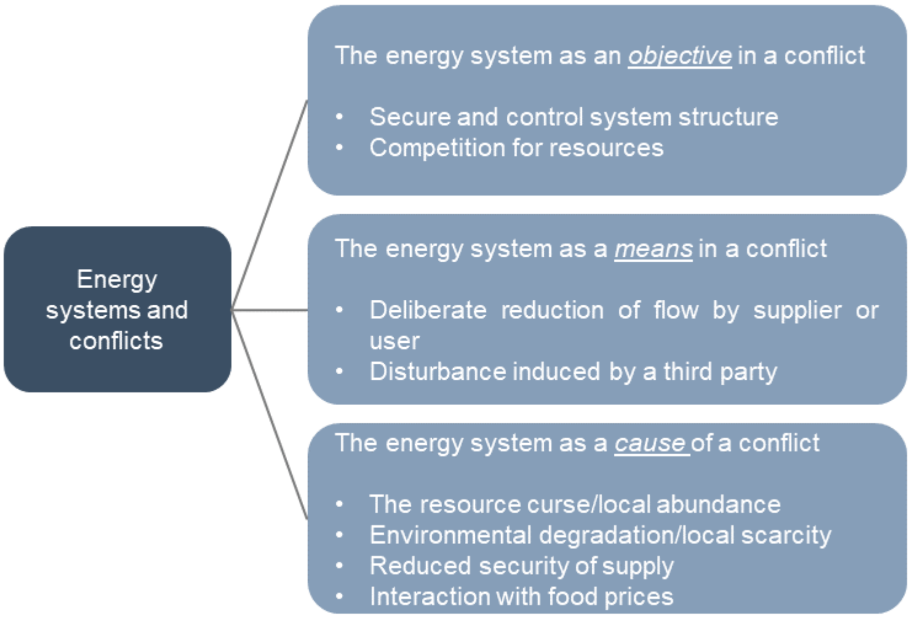
Upon completion of this course, you will be able to

- Associate the importance of impacts on local conflicts with the co-benefits
- Explain the potential opportunity of regional cooperation and political stability

Energy resources and distribution chains have been linked to conflicts in different ways. The unequal distribution of fossil resources (for example power struggles in the Middle East and the strategic ellipse in central Asia) may lead to increasing pressure to gain control of scarce energy or water resources. Apart from the geopolitical conflicts over scarce fossil resources, local conflicts may also be triggered by non-renewable gas, oil and mining activities with potentially violent conflicts over the displacement of local population, land -use rights or environmental pollution. More than 150 mining related conflicts (e.g. over scare water, or land resources) have been reported in Latin America alone since 2000 [3].

In turn, energy matters have also served as a means of increased regional integration, cooperation and coordination. Agreements on coal and nuclear energy formed the nucleus of the European Union since the 1950s. In recent years, the **European Energy Union** has attempted to formulate a consistent EU foreign energy policy, securing energy of supply and a more diversified and clean energy mix. The coordination of cross-border flows of electricity in other world regions has been improved by the creation of cross-boundary power pools (e.g. in Sub-Saharan Africa). The implementation of mitigation policies also promotes the use of renewable energies [4]. Renewable energy policies generally have a better public perception compared to controversial fossil or nuclear energy plans that in principle tend to be less transparent due to the highly sensitive security issues involved.

Energy systems can lead to conflicts based on a variety of stressors, as observed in the following diagram. Understanding these perspectives will allow us to implement mitigation measures that can bring associated benefits to communities.



Different perspectives for the energy systems in conflicts (Source: Månsson 2014)

6.3 Chapter 6 endnotes

[1]: UNESCAP (2009)

[2]: WRI (2010)

[3]: Böll (2015)

[4]: Månsson (2014)

7 Indicators of co-benefits

7.1 Most common indicators of co-benefits

Learning objectives:

Upon completion of this course, you will be able to

- Understand the importance of measuring the co-benefits
- Identify the most common indicators used to measure co-benefits

Although ‘co-benefits’ or ‘multiple benefits’ are often used in discussions on climate change mitigation measures, such terms are rarely measured, quantified or monetized (except in terms of jobs and gross domestic product (GDP) impacts) [1]. In order to make the co-benefits measurable, suitable indicators need to be developed and defined. It should be noted that the co-benefits go beyond the production and distribution of renewable energy, but must be multidimensional and cover other aspects. There is a variety of options on how to quantify the beneficial impacts of renewable energy for climate change mitigation. Some of the most often used indicators for quantifying the co-benefits presented in this course are summed up in the table below.

[1]Air quality index (AQI) is defined as a measure of the condition of air relative to the requirements of one or more biotic species or to any human need.” AQI is divided into ranges, in which they are numbered, and each range is marked with color codes. It provides a number from healthy standard level of zero to a very hazardous level of above 300 to indicate the level of health risk associated with air quality.

[2] The PII measures progress towards IEA World Energy Outlook (WEO) 2010, from the base year 2005. The indicator is expressed as the percentage of the gap between generation 2005 and the WEO 2030.

Chapter	Most commonly used indicators	Units
Climate and environmental	• Greenhouse effect	• C02 equivalents / unit • Change of global temperature (absolute)
	• Stratospheric ozone depletion (keyword: ozone hole)	• Ozone Depletion Potential (ODP in R 11-Äquivalenten) / unit
	• Photochemical oxidant formation (keyword: summer smog)	• Photochemical Ozone Creation Potential (POCP) / unit • Air quality index (absolute)
	• Terrestrial and (non-marine) surface water eutrophication	• Terrestrial eutrophication in nitrate equivalents / unit, (non-marine) surface water in phosphate equivalents / unit
	• Acidification potential in waters and soils	• SO_2-equivalents / unit
	• Use of resources (e.g. Raw materials and fossil energy sources)	• Statistical range of raw materials in years
	• Natural habitat stress	• Number of endangered species / unit, • Area / unit • Hemeroby stages of eco systems
	• Water consumption	• Volume / unit
	• Direct damage to health due to hazardous substances or noise	• Persons concerned / unit
	• Cumulative energy demand (CED)	• Oil-equivalents / unit • Consumed primary energy sources in joule / unit
Economic	• Energy intensity per unit GDP • Electricity consupmtion per capita • Employment factor approach • Investment in renewable power and fuels • Cost of imported fuel	• Megajoules per dollar (MJ/$) • MWh/capita • MW/person • Million $ • Million $
Social	• Jobs created per sector • Share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy • Share of household income spent on fuel and electricity	• Number of jobs created per sector • % of households or population • % of household income
Political / institutional	• Policy Impact (IEA) • Historical record of achieving targets • Existence or creation of institutions required to perform different activities	• Policy Impact Indicator (PII)[2] • % of the gap between generation 205 and the WEO 2030 • Number of achieving targets • Number of institutions created in an given year

Unit= year, energy, GDP or others

Most commonly used indicators to measure co-benefits (Sources: EEA, ACP, IRENA, IEA, EPA, UBA[3] and RENAC)

7.2 Chapter 7 endnotes

[1]: Borbonus (2017)

[3] Untersuchung der Anpassung von Ökobilanzen an spezifische Erfordernisse biotechnischer Prozesse und Produkte, https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/2852.pdf.

8 Summary of the course

The concept of co-benefits of climate change mitigation has attracted increased attention in the international climate scene. Instead of pointing out the perceived high cost of climate action, the focus of co-benefits is based on the potential opportunities and beneficial side effects of climate policies. This course focuses on the co-benefits of renewable sources of energy, although there may be equally strong positive impacts in energy efficiency measures or clean transport policies.

It is important to note that different international organizations (IPCC, UN, World Bank, among others) have their own concepts and definitions of co-benefits. Nevertheless, all of these approaches share the notion that the added benefits of innovative climate policies, clearly outweigh the perceived costs. These gains are valued even more highly when considering the potential catastrophic costs of runaway climate change on the global economy.

We have presented some definitions of co-benefits, a classification of co-benefits and some examples of economic, environmental, social and political co-benefits as well as some potential indicators to measure and quantify these co-benefits. The elaboration of assessment tools and methodologies to more precisely measure co-benefits is subject of another COBENEFITS online course in the RENAC Online Academy.

9 Further reading

Helgenberger, S. and Jänicke, M. (2017). Mobilizing the co-benefits of climate change mitigation. Connecting opportunities with interests in the new energy world; available on:

https://www.iass-potsdam.de/sites/default/files/files/iass_working_paper_co_benefits.pdf

This paper discusses the co-benefits of climate change mitigation and renewable energies, and how these co-benefits could accelerate the global transition towards renewable energies and strong alliances among actors and interest groups to build strong policy and action.

EPA (2018). Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy. A Guide for State and Local Governments; available on:

https://www.epa.gov/sites/production/files/2018-07/documents/epa_slb_multiple_benefits_508.pdf

This document contains the latest information about methods analysts can use and the available tools that support them, also it presents steps to quantify benefits, in addition it also gives examples and case studies where benefits have been quantified.

Asian Co-benefits Partnership White Paper (2016). Putting Co-benefits into Practice: Case Studies from Asia; available on:

https://www.cobenefit.org/publications/images/ACPwhitePaper_2016.pdf

This paper presents an opportunity to demonstrate how cases that put co-benefits into practices in Asia can help to reach the Sustainable Development Goals (SDGs). It shows also how many countries are beginning to integrate multi-benefit considerations into policies.

Cobenefits assessment reports developed during the Cobenefits project 2017 – 2020:

SOUTH AFRICA (ZA)

- COBENEFITS South Africa (2019a): Consumer savings through solar PV self-consumption in South Africa. Assessing the co-benefits of decarbonising the power sector, available on https://www.cobenefits.info/resources/cobenefits-south-africa-consumer-savings.
- COBENEFITS South Africa (2019b): Improving health and reducing costs through renewable energy in South Africa. Assessing the co-benefits of decarbonising the power sector, available on https://www.cobenefits.info/resources/cobenefits-south-africa-health.
- COBENEFITS South Africa (2019c): Future skills and job creation through renewable energy in South Africa, Assessing the co-benefits of decarbonising the power sector, available on https://www.cobenefits.info/resources/cobenefits-south-africa-jobs-skills.

- COBENEFITS South Africa (2019d): Economic prosperity for marginalised communities through renewable energy in South Africa. Assessing the co-benefits of decarbonising the power sector, available on https://www.cobenefits.info/resources/cobenefits-south-africa-prosperity.

TURKEY (TR)

- COBENEFITS Turkey (2019a): Industrial development, trade opportunities and innovation with renewable energy in Turkey. Assessing the co-benefits of decarbonising the power sector available on https://www.cobenefits.info/resources/industrial-development-trade-opportunities-and-innovation-with-renewable-energy-in-turkey/.
- COBENEFITS Turkey (2019b): Future skills and job creation with renewable energy in Turkey. Assessing the co-benefits of decarbonising the power sector available on https://www.cobenefits.info/resources/future-skills-and-job-creation-through-renewable-energy-in-turkey/
- COBENEFITS Turkey (2019c): Improving air quality and reducing health costs through renewable energy in Turkey. Assessing the co-benefits of decarbonising the power sector available on https://www.cobenefits.info/resources/improving-air-quality-and-reducing-health-costs-through-renewable-energy-in-turkey/.
- COBENEFITS Turkey (2020d): Electricity supply security in Turkey *(under construction)*

INDIA (IN)

- COBENEFITS India (2019a): Improving health and reducing costs through renewable energy in India. Assessing the co-benefits of decarbonising the power sector, available on https://www.cobenefits.info/resources/improving-health-and-reducing-costs-through-renewable-energy-in-india.
- COBENEFITS India (2019b): Secure and reliable electricity access with renewable energy mini-grids in rural India. Assessing the co-benefits of decarbonising the power sector available on https://www.cobenefits.info/resources/secure-and-reliable-electricity-access-with-renewable-energy-mini-grids-in-rural-india/.
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VIETNAM (VN)

- COBENEFITS Vietnam (2019a): Electricity access and local value creation for the un-electrified population in Vietnam. Assessing the co-benefits of decarbonising the power sector available on https://www.cobenefits.info/resources/electricity-access-and-local-value-creation-for-the-un-electrified-population-in-vietnam/.
- COBENEFITS Vietnam (2019b): Future skills and job creation through renewable energy in Vietnam. Assessing the co-benefits of decarbonising the power sector available on https://www.cobenefits.info/resources/future-skills-and-job-creation-through-renewable-energy-in-vietnam/

Co-benefits reports developed by the Ambition to Action (A2A) project

KENYA (KE)

- The role of geothermal and coal in Kenya's electricity sector and implications for sustainable development
- The role of renewable energy mini-grids in Kenya's electricity sector

MEXICO (MX)

- Crunching numbers QUANTIFYING THE SUSTAINABLE DEVELOPMENT CO-BENEFITS OF MEXICO'S CLIMATE COMMITMENTS, available at: https://www.gob.mx/cms/uploads/attachment/file/513402/Crunching_Numbers_cobenefits_vf_reduc.pdf.

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