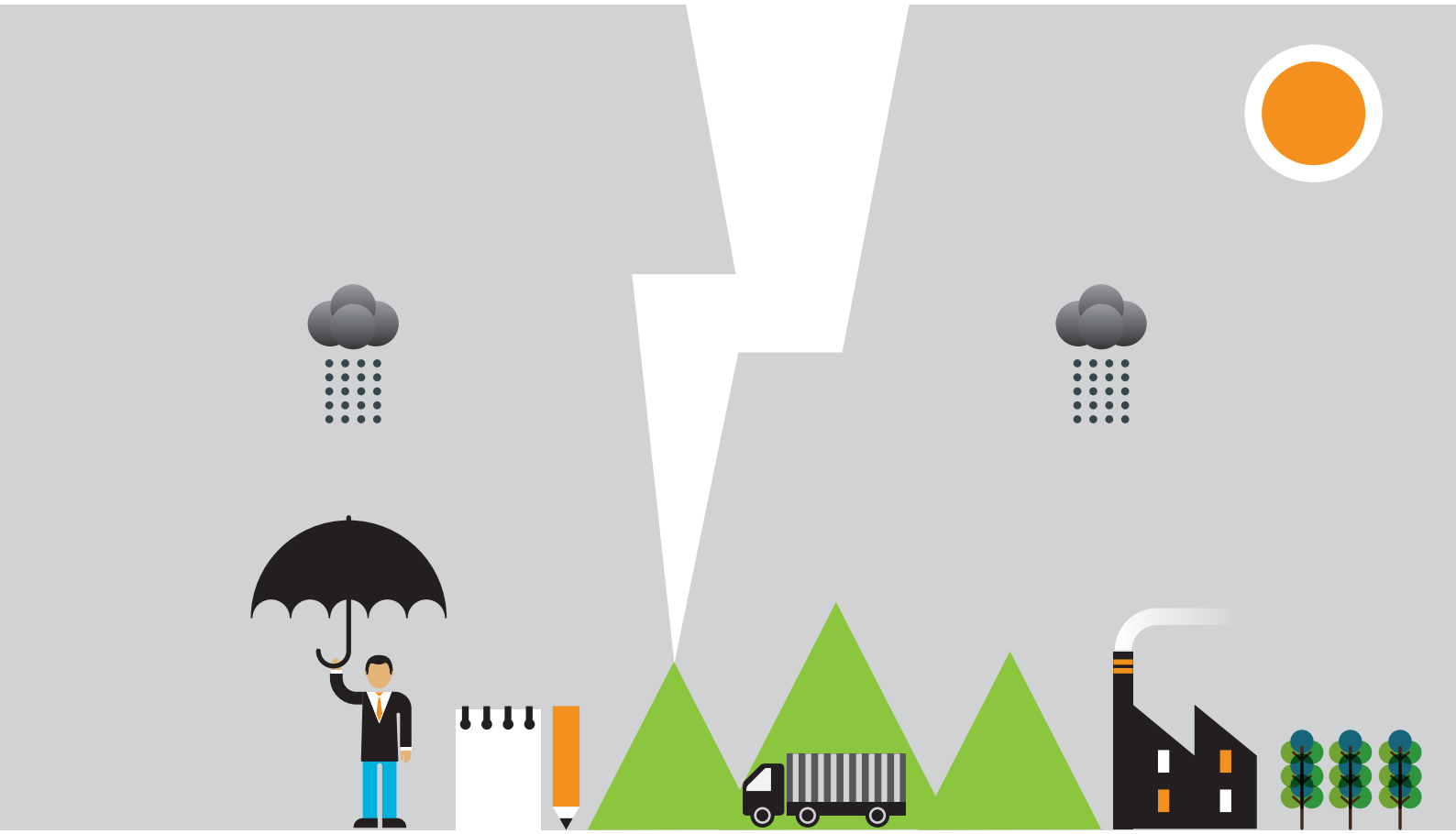

Consultant's Manual

Developing a Climate Change Adaptation Strategy for Companies

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

SIDBI
भारतीय लघु उद्योग विकास बैंक
Small Industries Development Bank of India
We empower Micro, Small and Medium Enterprises

adelphi

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2014

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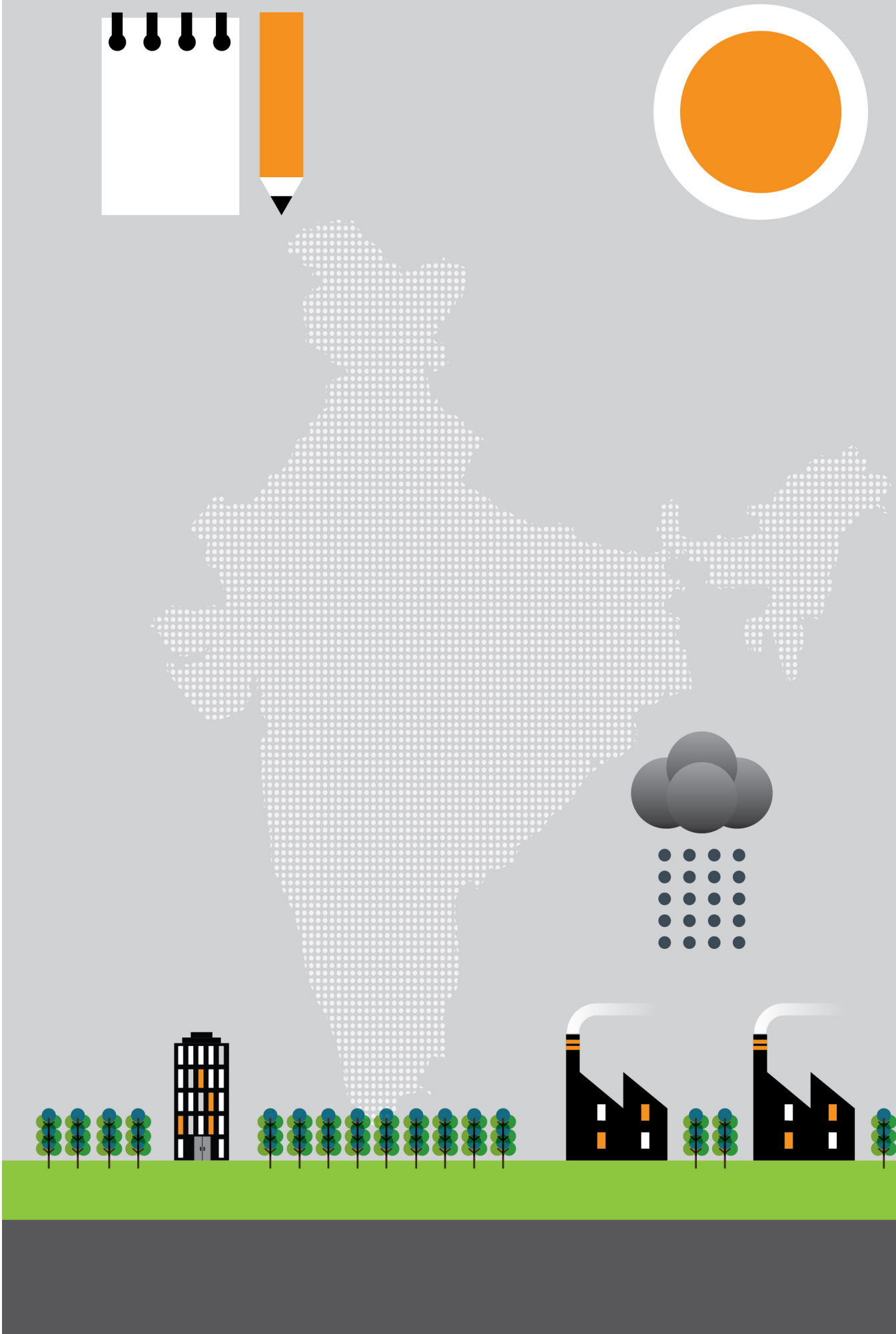


1 Introduction and Overview

1.1 Objective of the Consultant's manual

This Consultant's manual aims to support consultants in the development of a climate change adaptation (CCA) strategy for their client companies.

The methodology and tools build on the **practice-oriented approach to CCA** developed for the Climate Expert e-learning programme and website **(www.climate-expert.in)** in India, but can be applied in any country context. The Climate Expert seeks to raise the awareness of companies on risks and opportunities caused by climate change impacts and assists in developing a CCA strategy. This strategy allows companies to prepare a structured approach to the challenges posed by climate change, thus reducing exposure and managing risks. It also offers an approach to realise potential business opportunities; both can improve the competitiveness of a company, and ensure its long-term survival and growth.

Given the novelty and complexity of the issue it is expected that companies will need additional training and advisory to successfully carry out CCA strategy development and implementation. Consultants and training institutes can therefore address this gap and develop target-group oriented services for companies. Although related to business development services, this is a **new field in business consultancy and capacity building** and promises many new opportunities for those organisations that take up the topic swiftly and comprehensively.

The perspective used to assess climate change impacts also allows for **analyses and activities regarding the competitiveness of companies.** Many aspects considered here, e.g., on resource efficiency and stakeholder relations, are of high relevance for the survival and growth of companies. Thus there is a **strategic overlap** between **getting a company ready to withstand climate change impacts and increasing its overall competitiveness**, which is a great opportunity for the cross-selling of services by consultants.

In order to grasp the new challenges arising from climate change for companies fully, a structured introduction to the topic is necessary. In addition to the approach, **practical experience** is an important prerequisite for consultancy and training purposes. This **Consultant's manual is designed as a guide and source of reference in the course of building these experiences; it is targeted at trainers and consultants that seek to deepen their knowledge on CCA and CCA strategy development on a case basis.** If the methodology is applied thoroughly, it can be used as a step-by-step guidance to develop a company's adaptation strategy.

The CCA methodology, its tools and the Climate Expert website have been developed within a series of projects on climate change adaptation and SME competitiveness implemented by GIZ and supported by its knowledge partner adelphi. Multiple workshops and site visit assessments lay the ground for the CCA methodology and tools that are at the heart of the Climate Expert website, the training and this Consultant's manual. In addition to these outputs, two studies on climate change risks and adaptation opportunities were developed in the Indian context.

1.2 Methodological approach

1.2.1 Steps and tools for CCA strategy development

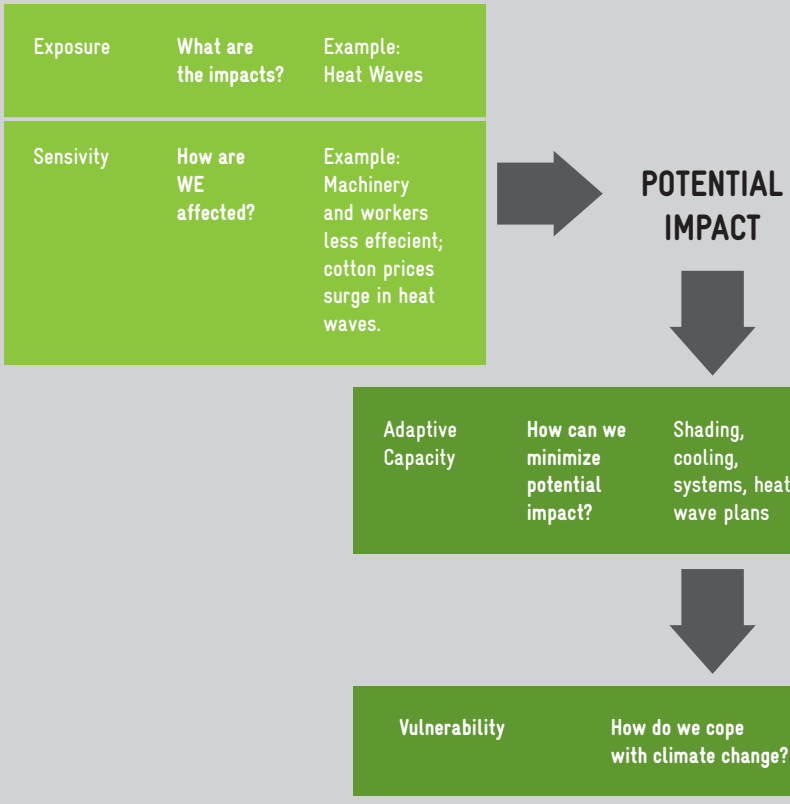
The toolkit for CCA strategy development aims to guide and support the development of a CCA strategy for companies. It is designed to **serve consultancies and trainers as a source for developing their advisory services in the field.** It can also be used by company representatives as a guideline and benchmark on the types of analyses and scope of activities necessary to develop an adaptation strategy. For the purpose of this Consultant's manual, we will assume consultancies (and their clients) as the main target group. In the following, we will thus refer to these as addressees.

This Consultant's manual focuses on the **methodology** of CCA strategy development. Please refer to the Climate Expert website and the Trainer's Manual regarding the **relevance** of CCA to companies in general and to Indian companies in particular.

The methodology presented here helps to assess a company's vulnerability to climate change as well as to identify options for reducing this vulnerability. In addition, it allows for the identification of potential opportunities and measures, and the development of a comprehensive strategy.

The vulnerability of a company is the result of its sensitivity to climate change impacts (determined by the exposure to CC) and its adaptive capacity. These general concepts are illustrated in the following graph:

Figure 1 Key concepts of climate change vulnerability

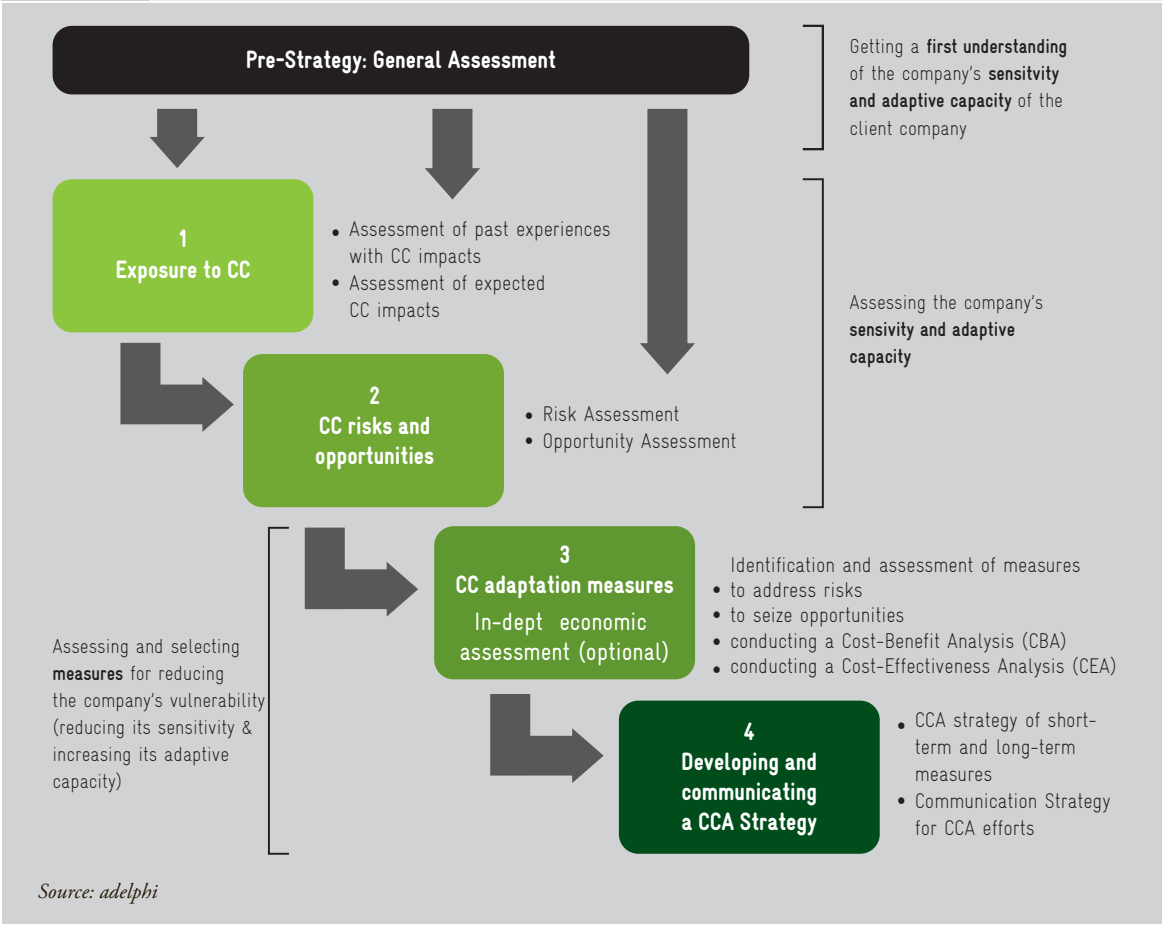


Source: adelphi

The Consultant's manual proposes several distinct steps to assess and reduce vulnerability to climate change. As the target group of the Consultant's manual is mainly consultants, the methodology slightly varies from that of the other tools as proposed by the project, including the Climate Expert website. This is due to the fact that the website facilitates a self-assessment, whereas the Consultant's manual aims to guide consultants in conducting the assessments. The approach is modular, thus the tool from the website could also be used where appropriate.

The approach of this Consultant's manual **breaks down the development of a CCA strategy into four main steps.** These four steps are **preceded by a more general assessment** which is sought to provide you and your client with a first understanding of the company's sensitivity and adaptive capacity. The worksheets that form the basis of discussion for these four steps provide practical pointers for assessing the company´s present sensitivity and adaptive capacity as well as for developing measures to reduce its sensitivity and to increase its adaptive capacity regarding future CC developments:

Figure 2 **Methodology of the workbook**



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1.2.2 Methods for facilitating usage of CCA tools

To effectively support consultants in working with companies on CCA strategy development the guidance provided in this guidebook combines three types of methods:

- An introduction to the **goals and contents of each of the four steps** and the associated worksheets
- **Practical guidance** on how to use the worksheets in consulting assignments with companies´
- A **case study** to illustrate how to use the worksheets

1.2.3 How to use this Consultant's manual

In order to make effective use of this Consultant's manual, we recommend you to first familiarise yourself with the **Climate Expert website (www.climate-expert.in)**. Ideally, you should also attend a training course on the topic, and thoroughly read through the training material. Even though the Climate Expert focuses on the Indian case, future trainers from other countries will find it useful to look at the website; it can also serve as a basis for similar tools in other regional contexts.

Thereafter, you should **study the Consultant's manual**; both its texts and the case study give you important references on how the content and the methodology can be applied in practice.

We then recommend you to **find a first assignment** with a company in one of the most affected sectors; for a detailed list of the most affected sectors in India, please refer to the study on climate change risks that can be found on the website. The study also offers a general assessment approach that can facilitate similar assessments in other countries and regions.

You should **start the assignment by using the assessment grid** – this allows findings by conducting a structured interview on past and expected climate change impacts on a company. In the interview, you can refer to the contents of the Climate Expert as well as the case study presented in the Consultant's manual. The information gathered with this worksheet could then be used for conducting the detailed risk assessment of key impacts and the development of adequate adaptation measures. However, before you proceed you should decide together with the company management whether a detailed assessment of sensitivity and adaptive capacity as well as the development of a CCA strategy makes sense for this particular company.

In case that the company management and you perceive the impacts of climate change on the company to be currently high or expect them to increase, thereby threatening its growth or even survival, you should proceed to **conduct the full CCA strategy development.**

Based on the knowledge of the company as well as your resources available you also need to decide in step 3 whether you will conduct the CCA strategy development with or without the **economic assessment** (chapter 6.3).

After the strategy development is done, it is useful to **keep in close contact** with your first clients both in order to **monitor the implementation of adaptation measures** as well as to **assess the effectiveness and benefits of the CCA strategy** for the company. This will give you strong arguments to engage with new clients and also allow you to review and improve the CCA strategy development process.

1.2.4 Adapting the methodology and worksheets to your consulting assignment

It is important to note that a CC risk and opportunity assessment and the potential development of an adaptation strategy are **specific to each company**. This is due to two factors; first, impacts of climate change are locally specific: while for companies in coastal areas the risk of flooding and saltwater intrusion into groundwater is a key issue, in other areas more severe droughts and resulting challenges for the company might be the key concern. Secondly, climate change impacts vary from company to company; this results from required inputs, the specific value chain of one sector or company, as well as the technology level of each company. Further, the adaptive capacity of companies varies.

Thus, the **CCA strategy must be specific to the geographic location of a company and must consider its value chain, process steps and capacities.** Only then is it possible to accomplish a reduction of the company´s vulnerability to future CC impacts.

For example, a company is more vulnerable to heat waves if labour and electricity inputs are high. Thus, the

company will have to prioritise the implementation of adaptation measures which are effective to address the related risks. The vulnerability of a company´s supply chain to CC impacts can be lower than that of its cluster neighbours of the same sector because it is sourcing from a wider range of suppliers in different locations. Furthermore, a company with existing organisational structures and internal knowledge regarding CC topics as well as access to financial resources has different capacities for implementing a holistic CCA strategy than companies which do not possess these resources.

Other variables of relevance are purchasers' expectations or government regulations regarding CCA topics. Purchaser's expectations vary depending on the products they provide and markets they serve. For example, Western textile brands are highly aware of environmental challenges and work issues, as consumers are known to question their behaviour. Also, lawmakers (including import regulators) can step in to render environmentally harmful or socially questionable activities illegal; in the most extreme form, entire clusters have been shut down. These aspects differ from industry to industry and depend on the location of the final sales market. The respective company needs to be able to adapt to the specific expectations and standards in order to have a license to operate and to keep running the business.

Accordingly, **the methodology and worksheets can be further tailored to the needs and capacities of the particular company:**

- Adjust the worksheets to make them well-suited to the needs of the target company, taking into consideration the industry sector, company characteristics, and its value chain. A company that does not require a significant input of water, for example, does not need to assess this factor. A company which struggles with workers' and community issues should have a closer look at how its stakeholder relationships will be affected by climate change.

- Adjust the depth of the assessment to the interest, capacities as well as financial resources of the client. After each step in the assessment, it is possible to narrow down the points to be addressed in the next step, e.g., selecting only the most relevant climate change phenomena for the risk assessment or focusing only on the most important impact areas. More detailed indications on how to reduce the scope of the assessment is provided in the guidance and case study below.

1.3 Background information on the case study company

The case study used in this Consultant's manual illustrates each step in the process of developing an adaptation strategy for companies. It helps consultants understand the purpose, content and resulting output of each assessment step. The case company called "IndTex" is based on experiences gained during various site visits of textile companies. Its profile, existing and expected CC impacts and adaptation measures outlined below are built on numerous discussions and assessments with Indian textile MSMEs in the NCR. Thus, the case study represents a realistic example of an Indian company confronted with tackling CC risks and realising business opportunities.

The case study focuses on adaptation to one key climate change phenomenon, i.e., the increasing frequency and intensity of heat waves. This selection was done to reduce the complexity of the worksheets; in reality, several other phenomena would have needed to be covered.

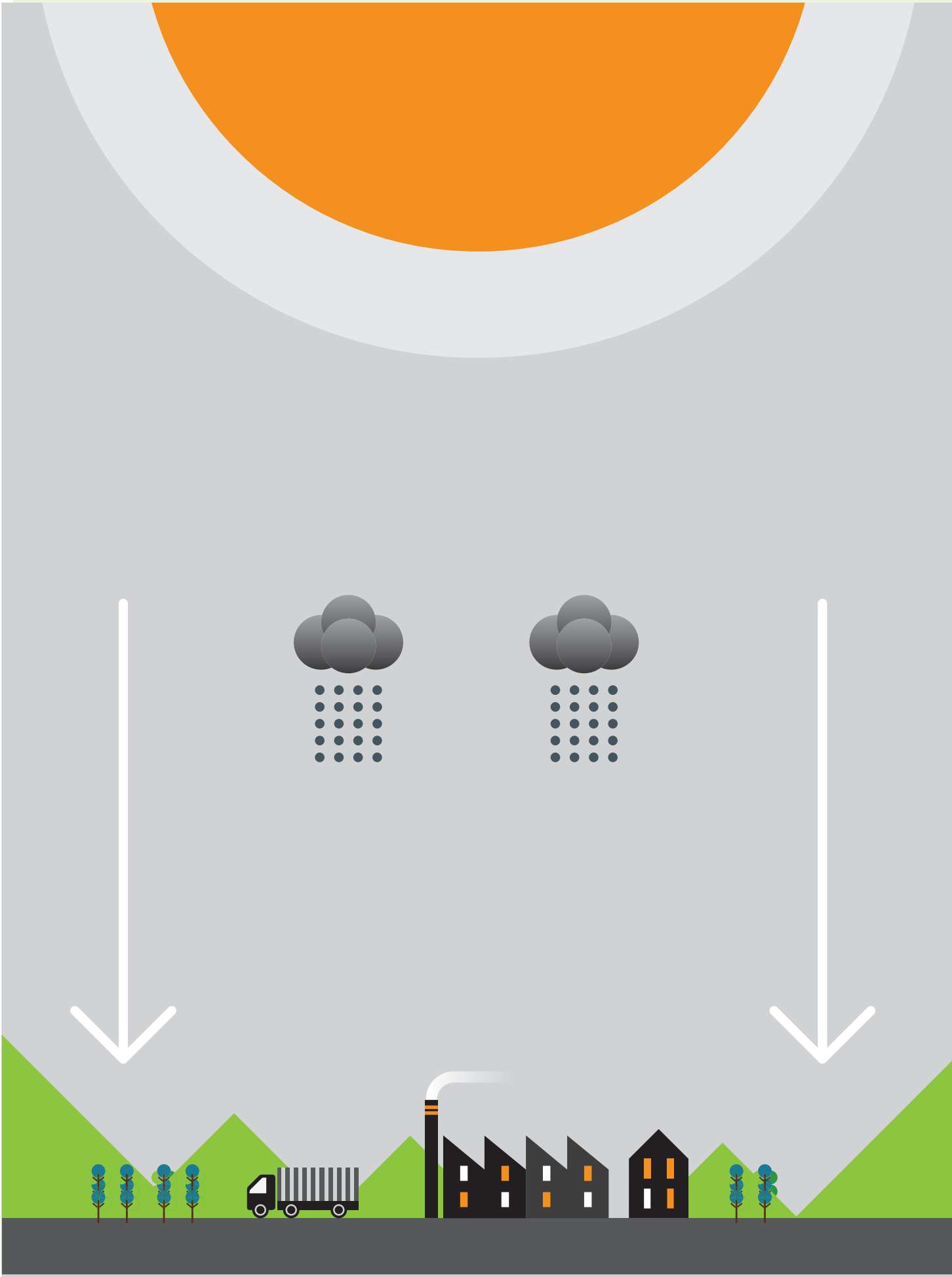
For gaining a more specific understanding of the case company´s features and relating challenges, you can find its basic data below. Detailed information on the economic assessment of the adaptation options for the case study company can be found in Annex 2.

Table 1	Assumptions for calculations of the IndTex case study
Average annual revenue	300,000,000 INR
Average annual profit	15,000,000 INR (5% profit margin)
Work days per year	365
Sewing machines	70
Packaging machine	1
Annual salary per worker	78,000 INR
Product price	33.08 INR/garment – 41.35 INR/garment
Annual electricity consumption	275,910 – 302,730 kWh
Climate risk and adaptation measures analyzed	**Climate Risk A: Quicker overheating of machinery** → 10 days/year 30% machinery breaks down → With a monthly production of 700.000 garments IndTex produces 8.4 million garments per year and 23,014 per day. On each of the days when about 30% of machinery breaks down, IndTex produces 6,904 units of garments less **Adaptation measure:** **1. Improve Building Insulation (Measure 1)** • Reduces days when 30% of machinery breaks down to 4 days/year • No operational costs, additional revenue **2. Purchase of new sewing machines/ packaging machine that are more heat resistant (Measure 2)** • Reduces days when 30% of machinery breaks down to 2 days/year • Higher electricity costs (machines use more electricity: old machines have 500W each, new machines have 550W each), lower labour costs (5 instead of 10 workers operating packaging machine), additional revenue • With a price of 12,000-14,357.14 INR per sewing machine there is an investment cost of 840,000- 1,005,000 INR for all 70 machines; the price for a packaging machine lies at 110,000-120,000 INR **Climate Risk B: Increasing frequency of power-cuts from grid** • Electricity price increases from 8.4 INR/kWh to 10 INR/kWh (under CC Scenario; price change only relevant for CEA) **Adaptation measure:** **3. Installation of solar panels (Measure 4)** • Install capacity to produce 7% of annual power consumption through solar energy

	• Installed capacity: 11.76 – 12.9 kW; solar radiation transformed (efficiency factor integrated) 4.5hours/day * 365 days = 1,642.5h • Annual electricity generation: 19,313.7 – 21,191.1 kWh • Reduces electricity from grid and diesel generator to 254,718.9 – 283,416.3 kWh/year
Location	Industrial cluster near Delhi, Haryana (NCR)
Employees	200
Products and clients	Simple apparel (women's, men's, children's), knitwear, decorated apparel Sold directly to European and Canadian retailers (including Next, FCUK)
Capacity	10 hour shifts, 7days per week Up to 700.000 garments per month 70 days from design to delivery (approx. 15 days transport)
Technology level	Medium: Partially automated production processes Machinery used: 70 sewing machines (various types / functions), 15 ironing boards, 1 steamer, 1 packaging machine
Supply chain	**Upstream supply chain** **Supplied material:** Ready-woven and printed fabric from cotton. **Purchase of yarn:** Cotton yarn is purchased from a range of suppliers in India, Pakistan and China; the transport of the yarn to the dyeing units is conducted by ship and/or truck and is administered by the supplier companies. **Dyeing of woven yarn:** The cotton yarn is dyed in units based in Tirupur, Tamil Nadu; the transport to the fabric processing units is conducted by truck and is administered by the case company (duration: up to 15 days). **Fabric processing:** The processing of the woven yarn into fabric takes place in units in Ahmedabad, Gujarat; transport to the case company in Faridabad, Haryana is conducted by truck and is administered by the case company (duration: up to 8 days). **Management of upstream supply chain:** To ensure timely delivery and competitive pricing, the company has diversified its raw material suppliers in recent years, now sourcing from India, Pakistan and China. To ensure compliance with environmental standards, particularly regarding water use, effluent treatment and level of toxins in dyed apparel, the company has increased its control over the dyeing unit: the dyeing process is directly administered by the company. **Stock** **Storing of fabricated and packed garments:** The company has 1 general storage room and 1 small storage room with air-conditioning for special garments which cannot tolerate inside temperatures above 34°C (problem of stains from handling).

	Downstream supply chain **Transport within India:** The fabricated garments are transported to the warehouse at Delhi airport; transport is by truck and is administered by the case company. The cluster is located directly at the 2-lane asphalt main road leading to Delhi. Traffic jams are extremely frequent as the Faridabad region has been booming as an industrial cluster in recent years, while the transport infrastructure was not extended to match this growth. **Transport to export markets:** The garments are shipped to destinations in Europe and Canada; inter-continental transport is by airplane and is administered by an export trading company.
Location and buildings	**Infrastructure at location** Inside the cluster, road quality is very poor in most parts; while a few asphalt main roads exist most lanes have a very uneven non-asphalt surface. The sewerage system frequently fails to capture the rains during monsoon periods. All units in the cluster are connected to the public electricity and water grid. No independent energy supply is provided at cluster level. **Factory buildings – outside and inside** The factory has two buildings: building A is a two-storey building with one fabrication room on each floor and one drying room for washed clothing. Here, the garment washing, stitching, finishing and packaging take place. Building B is a two-storey building hosting 6 office rooms and the two storage rooms. Facilities and premises are old, but sufficient to withstand common climate irregularities. The condition of buildings is controlled on an annual basis. The company has installed fans and a basic ventilation system to regulate inside temperatures. The smaller storage room reserved for delicate clothing is equipped with air conditioning to avoid handling stains. Two air-conditioned office rooms also exist.
Process chain	The process chain within the manufacturing plant involves five distinct steps: cutting, stitching, finishing (quality control, pre-finalisation), washing and packaging. All process steps are predominantly conducted using manual labour. For stitching, finishing and packaging, workers use sewing machines, ironing machines and packaging machines. Production is organised in process lines with relatively high efficiency.
Inputs	Electricity is used for running of all machinery, for lighting and for ventilation / air-conditioning. Electricity is supplied from a) the grid and b) a company-owned diesel-generator for covering shortages in the grid.

	Water is used for a) the washing of garments at two steps in the process chain: before starting the stitching and after finishing the garment, b) the plating of garments, c) the cleaning of facilities, and d) as drinking water for staff. Water is supplied via the local water pipe system and via ground water. Polluted unusable water is coarsely treated and discharged.

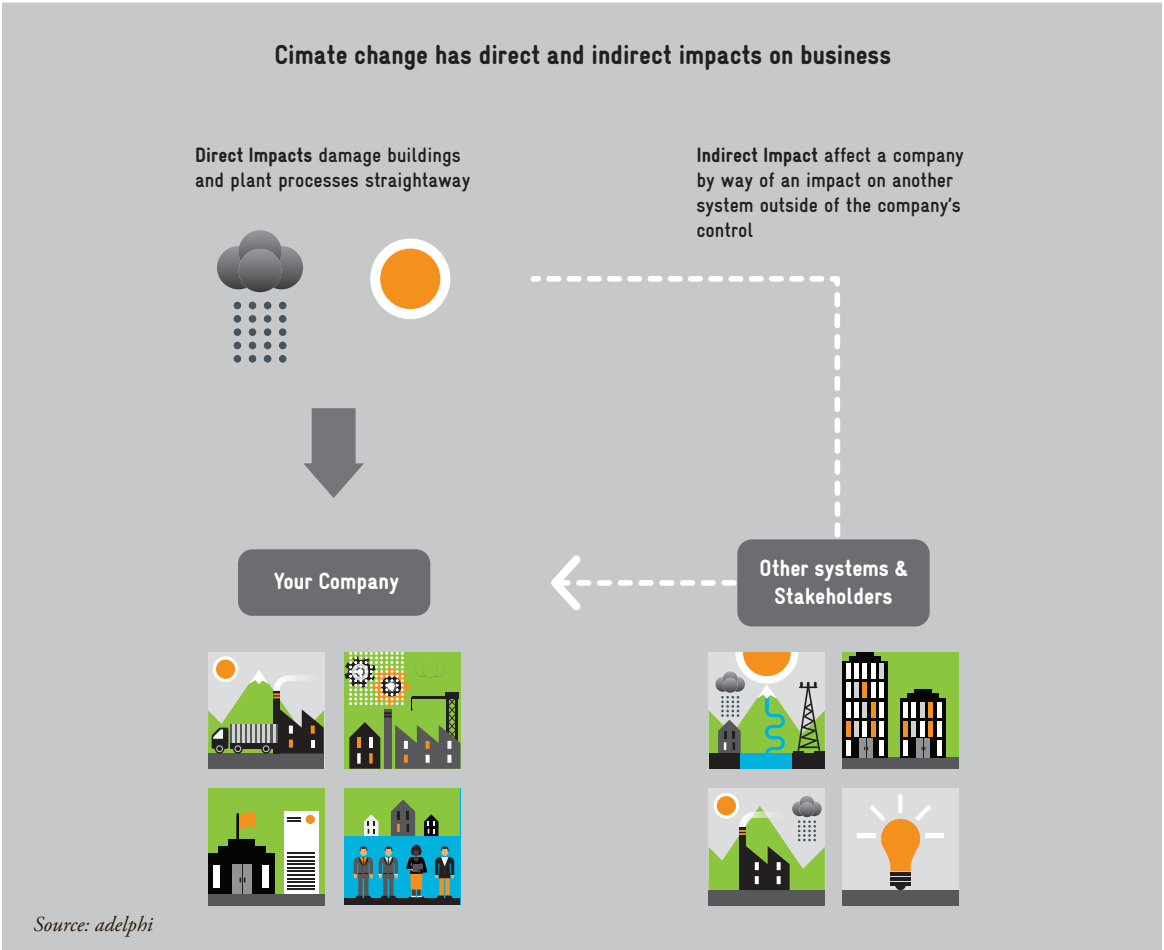


2 Sensitivity and adaptive capacity to climate change: Assessing impacts on the company – STEP 0

Impacts of climate change are different for each company. Impacts depend on the location as well as the production processes of a company.

Impacts can be classified as either direct or indirect: direct impacts damage buildings, and plant processes. Machinery and raw materials may be damaged and workers may be less productive during heat waves. Indirect impacts affect a company through changes in supply and demand, logistics, regulations, impacts on wider stakeholders, such as the surrounding community, and financing. Many impacts result in reduced profitability. For example, prices for materials may rise or delivery of materials may be delayed. Other impacts may not be related to profitability. For example, in response to climate change, regulations may make entire processes illegal. Or banks may only offer credit at a higher premium in particularly affected regions.

Figure 3 Direct and indirect impacts



Source: adelphi

To some people it might come as a surprise that indirect impacts can matter more for a company. This is due to the fact that while a company's own production site(s) may not be greatly affected by climate change, other important stakeholders, such as customers, suppliers or local/national governments, are. Both direct and indirect impacts need to be taken into account to assess the sensitivity of a company to climate change, improve its adaptive capacity and thus reduce its vulnerability (see the explanation of these concepts above).

When assessing a company's vulnerability, there are three broad impact areas of climate change that can be distinguished: "Infrastructure and operations", "Stakeholders" and "Finance and Market". These areas are further divided into the following sub-areas:

Figure 4 **Impact areas and sub-areas**

Source: adelphi

Distinguishing between these areas allows for a structured and comprehensive assessment of climate change impacts on a company. Such an analysis then lays the basis for comprehensively identifying resulting risks and opportunities for a business and addressing these through adequate adaptation measures.

These impact areas will be discussed in detail and illustrated by the case company in step 0 by way of the "assessment grid".

You can find a printable version in the Annex and as an Excel table on the Climate Expert website.

2.1 Assessment grid 0

Purpose and content of the worksheet

The goal of this worksheet is to get a first understanding of the sensitivity and adaptive capacity of the client company to the impacts of climate change. It can be used as a first step to raise the awareness of a potential client on climate change impacts. For this purpose the company is asked several questions for assessing its sensitivity and adaptive capacity regarding the different impact areas of a company.

The questions allow to list and analyse climate change impacts on the company. Subsequently, the company can develop first ideas for countermeasures and also sketch out business opportunities.

Aim and scope of this worksheet are limited to serve as an introduction to the topic and provide an overview over sensitive areas. Used jointly with the other tools presented within the following sections it offers a very comprehensive approach to assess companies' past, existing and future exposure to climate change.

Important categories:
Impact area: This column is divided into the three impact areas and seven sub-areas which have already been described in Figure 4. These areas provide the basis for the assessment.

Critical points: For each impact area, specific questions have been developed that are important to consider when assessing the sensitivity and adaptive capacity of the company.

Assessment: Based on the "critical points" the sensitivity and adaptive capacity of each impact area is assessed. Each question from this column should be answered in a succinct yet comprehensive way. However, this sheet is only the starting point for the more detailed assessments in step 1 and results do not have to be developed to perfection.

In case of risk: This column is based on the assessment you have made within the previous column. It needs to specify to what degree the company is sensitive to a specific climate change impact or does not have the necessary adaptive capacity to tackle it. In the following, it becomes necessary to assess the extent of the risk – this is done by considering how grave losses or damages to the company will be and how likely it is that the impact will occur.

Potential loss or damage can be

- **"Low":** Loss or damage occurs but is limited and does not interrupt production process / value chain or endanger stakeholder relationships.
- **"Medium":** Loss or damage occurs and interrupts production process / value chain or endangers stakeholder relationships; countermeasures can be taken swiftly and easily and the company's survival is not at stake.
- **"High":** Loss or damage occurs, interrupts production process / value chain or endangers stakeholder relationships; countermeasures are difficult to take up or are not effective immediately. After this impact occurs, the company's survival is in question.

The **likelihood** that the climate change impact will occur in the future can be

- **"Not likely":** Impact occurs only in case of specific circumstances, probably not within the next 1-2 years, and has not yet occurred in the past.
- **"Likely":** Impact has occurred in the past and is likely to occur again, but it is not anticipated to be very probable in the next 1-2 years.
- **"Very likely":** The impact is highly likely or even certain and occurs in the next 1-2 years.

Where possible, the answers should be qualified, and any additional information necessary for the accurate assessment of probability and loss and damage stated.

Ideas on measures for addressing risk / opportunity: Following the assessment of risks, first ideas on how these can be minimised are collected. Because climate change not only poses risks to the company but can also open opportunities, this should also be noted in this column. Overall, considerations should include what has been done in the past, and what competitors have done.

How and when to use this worksheet

Time required
Preparation: 0.5 days to familiarise yourself with the company
Assessment: 1.5 h, followed by company visit
Documentation: 3h

You should plan for at least 1.5 h of discussion to cover all areas as described in the assessment grid. After the assessment, it is recommended to take a guided tour through the company, in the best case accompanied by the participants of the meeting. If you have any additional observations concerning the sensitivity and adaptive capacity you should note them as well.

Participants
Top management, representatives of key departments; alternatively, lead engineer.

The information and knowledge needed for the assessment is likely to be found across different departments of the company. Thus, conducting the assessment would ideally take place in a workshop-type meeting with representatives from the top management and the technical, sales and HR department; alternatively, one lead engineer and/or one representative of the top management suffice.

Aim of the consulting session
This worksheet is the first step in your consulting assignment and can help you to get to know the characteristics and challenges of the client company at a glance. You can also use it as a discussion guideline before formally engaging with the company to raise their awareness on the issue of climate change impacts. Answering the worksheet's questions can be an "eye-opener" to the company; often, companies are already planning and/or implementing adaptation measures without identifying them as such.

Your task
The worksheet should be used to guide your conversation with company representatives; thus, you do not need to use every single question if you deem it irrelevant to the company. However, you should definitely cover all impact areas. Sometimes it might be helpful to ask a non-specific, "open" question – e.g., "What are the main concerns for your employees?" – to gather relevant information. As a consultant, it is your job to listen closely and make the connections to potential climate change impacts which might not be apparent to the company. Also, in case that there is an issue within one of the impact areas that you find is not detailed enough on the worksheet, you should add your observations and points of discussion accordingly.

After the assessment, you should summarise your findings in written form and discuss these in case your client has any questions or doubts.

Results from the case study

To illustrate the assessment you can find below the summary and, in the grid, the sample answers to all assessment questions by the case company. While in the later worksheets we focus on the impact of heat waves, here, we have taken a range of climate change phenomena into account.

Summary

Climate impacts regularly **worsen the productivity and profitability of the company.** The frequency of their occurrence will increase. Overall, there are various areas of IndTex which are vulnerable to climate change impacts, particularly regarding impacts on **processes and logistics.** These are in part directly **relevant to its growth and survival.** Few measures have been taken to reduce the sensitivity or increase the adaptive capacity of the company. In terms of opportunities, IndTex could profit from **a structured approach to climate-responsive product development** as well as regarding its **relationship with buyers.**

Table 2 **Assessment grid on sensitivity and adaptive capacity**

Impact Area			Critical Points	Assessment	
Infrastructure and operations	Building/Location	1	Are existing buildings resistant enough to withstand climate change impacts (changing climate, extreme weather events)?	Facilities and premises are 20 years old, but sufficient to withstand common climate irregularities. Outside walls have not shown particular signs of deterioration or instability during or resulting from periods with extremely hot temperatures or flooding. The condition of buildings is controlled by civil engineers annually.	
		2	How sensitive is the company location regarding climate change impacts?	The location and buildings of the company are vulnerable to flooding in times of intense rain, especially because of congested sewerage systems. This situation is aggravated by the trickling of water into the dry soil caused by generally rising temperatures. Flooding did occur in the past with considerable damage on facilities and temporary production stoppages.	
		3	Is infrastructure in direct proximity of the premises resilient regarding changing climate and extreme weather events?	Inside the cluster, road quality is in most parts very poor; few asphalt main roads exist, most lanes have a very uneven non-asphalt surface. The sewerage system frequently fails to capture the rain during monsoon periods. Deteriorating road conditions occur regularly in case of heat waves (cracks in asphalt) and intense rain (flooding and/or erosion of streets) which lead to delays in upstream and downstream supply chains.	
		4	How linked is the company with neighbouring companies? (resources, infrastructure, joint efforts)	The company is part of a typical cluster and depends on a common grid for energy, water supply, and sewerage. In times of high energy demand, blackouts occur; in case of flooding, sewerage system overflows.	
		5	How linked is the company with the community? (resources, infrastructure, joint efforts)	Majority of employees live within surrounding communities. The overflow of the sewers may lead to low water quality in times of flooding; during heat waves, the cluster and the community are in rivalry for water use.	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity
	(not vulnerable; potential change)	Increase frequency of building condition controls to bi-annual checks
	Medium / The occurrence of flooding during monsoon season in the future is likely	Build up dykes on the company property; build water tanks for overflowing water; greening of premises/ground where possible to increase water-absorption
	Low if no extreme case of heat or flooding occurs; otherwise damage can be high due to contract penalties or loss of business	Cluster-level action regarding road improvement; stocking up on raw materials; plan with buffer days for delivery, especially during monsoon season / summer
	Medium / likely	Initiate joint efforts regarding energy supply, e.g., cluster plant; joint building of overflow tanks.
	Medium / happens occasionally (likely)	Initiate community engagement through employee representatives on various issues, including water risk assessment.

Impact Area			Critical Points	Assessment	
Infrastructure and operations	Processes	6	How sensitive are manufacturing processes in terms of uncertain energy and water supply?	All process steps are predominantly conducted using manual labour. For stitching, finishing and packaging, workers use sewing machines, ironing machines and packaging machines. Electricity is used for the running of all machinery, for lighting and for ventilation / air-conditioning. Electricity is supplied from a) the grid and b) a company-owned diesel-generator for covering energy shortages in the grid. Especially in times of heat waves, cuts in energy supply lead to frequent halts in production. Lack of water for washing and ironing is also problematic in times of heat waves; also, water quality is lower and a filtering system needs to be used; otherwise, water trucks have to be ordered, delaying availability of water and making it more costly. Drinking water becomes more costly, which has negative impacts on employees' well-being and productivity. Penalties of purchasers or loss of business are likely to occur in case of delivery delays.	
		7	Is the availability of water supply secure?	No, especially in times of high temperatures/ heat waves, cuts in water supply from grid occur because of increasing demand within the cluster. This leads to production stoppages and causes obstacles for on-time delivery.	
		8	Is the availability of energy supply secure?	No, especially in times of high temperatures/ heat waves, cuts in energy supply from grid occur because of increasing demand within the cluster. This leads to production stoppages and causes obstacles for on-time delivery.	
		9	How sensitive are manufacturing processes to higher temperatures?	In addition to the issues described above, increased inside temperatures during heat waves also cause more frequent failing of machinery due to overheating, especially of older sewing machines and the plating machine. Penalties of purchasers or loss of business are likely in case of production delays.	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity
	High / very likely	Increase number of diesel generators and fuel; build storage facilities for water; diversify water sources. Build in delivery buffers especially in monsoon season / summer.
	See above (6)	See above (6)
	See above (6)	See above (6)
	Medium / very likely	Increasing ventilation and installation of air conditioning to keep inside temperature below extremes.

Impact Area			Critical Points	Assessment	
Infrastructure and operations	Processes	10	How sensitive are manufacturing processes in case of extreme weather events?	Extreme weather events in the region are mainly floods, droughts and heat waves. Impacts are described above (6).	
		11	Is it possible to reduce water and / or energy consumption?	State of the art machinery would require less energy; also, a water recycling system for the pressing / ironing and finishing wash could be installed.	
		12	Are there any measures to provide the processes with energy in case of energy supply outage?	The diesel generator is able to partly fill in these gaps but at considerably higher costs. Also, the amount of electricity which can be provided by the generator is limited. More frequent production stoppages with negative impacts for on-time delivery are likely etc.	
		13	Are there any safety measures to prevent outflow of dangerous or pollutant substances?	The waste water of the pre-processing wash of the fabric contains some toxic residues; it is collected in tanks and then transported to a recycling plant. In case of flooding, the tank could leak. No measures taken so far.	
	Logistics and Stock	14	Is the availability of raw material and auxiliary material affected by climate change impacts?	Cotton prices rise during heat waves. Prices for supplied fabric increase in times of heat waves, droughts or flooding and greater uncertainty in purchasing decisions of customers occurs. Higher input costs have a negative impact on competitiveness. However, the company has a range of suppliers and is therefore somewhat immune to extreme weather events affecting harvests locally. The company seeks to further diversify its sources, thus securing supply by sourcing cotton from different geographic regions in India, Pakistan and China.	
		15	Is there enough flexibility in transport and delivery of goods in case of climate change impacts?	The flexibility is limited since most transport happens overland via trucks. Road quality can deteriorate during heat waves, particularly in case of non-asphalt roads, drivers need more frequent breaks, and alertness might be reduced, thus increasing the risk of accidents. Transport in upstream supply chains might be delayed resulting in production delays, thus endangering on-	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity
	High / likely	See above (6)
	N/A	Modernise equipment.
	See above	See above
	Medium / not very likely	Make tank flood-resistant.
	Medium / likely	Increase of storage volume for input materials. Diversification of suppliers and identification of less vulnerable regions of suppliers.
	Medium/ likely	Build in buffer days for delivery times; increase storage volume for materials; change to alternative ways of transport (train).

Impact Area			Critical Points	Assessment	
				time delivery. Deteriorating road conditions in downstream logistics slightly increase the probability of delivery delays, too.	
Infrastructure and operations	Logistics and Stock	16	Is there any possibility to reduce raw material and product miles and/or reduce complexity of value chain?	Difficult, as some of the most reliable suppliers are located far away.	
		17	Is the storage of goods secure in case of changing conditions (e.g., higher temperature) or other climate change impacts (e.g., flooding)?	Equipment, input and stock is stored inside buildings; thus, there is no risk that intense sunshine directly damages them. Some garments are particularly sensitive to stains from handling, which more frequently occur if employees work in hot temperatures. This is why particularly sensitive garments are processed in a processing storage room with air-conditioning. In times of heat, dust is prevalent and fabric needs to be washed often to avoid dustiness. Further, finished items need to be packaged securely to avoid soiling. If intense rain leads to flooded facilities, the stock materials like fabric materials and garments are endangered of soiling as well. This has negative consequences for the product quality, leads to the need of rewashing and / or causes delivery delays. Equipment is hardly affected if flooding occurs. During monsoon the moisture is very high. This can affect the garments negatively.	
Stakeholders	Employees and community	18	Do working conditions deteriorate due to climate change impacts?	Worker's productivity drops considerably once the outside temperature rises above 35°C.When the temperature is higher than 38°C it drops as low as 30 % of regular productivity. Also, the number of accidents rises during heat waves, as workers have trouble keeping up full alertness. As production is mainly done by hand using automated sewing machines, the productivity drop directly translates into profit losses. The company monitors room temperatures and has a small set of response strategies in periods of extreme heat: staff is informed about how to behave during heat waves and drinking water is provided to the work places directly and frequently.	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity
	N/A	Seek reliable suppliers in closer proximity; integration of some processes in-house.
	Low/ likely	Company has already implemented adequate measures.
	Medium/ likely during monsoon season	Build up dykes on the company property; dehumidifying.
	Medium/ likely	Increase number of ventilators and install air conditioning within production facilities.

Impact Area			Critical Points	Assessment	
Stakeholders	Employees and community	19	Do living conditions of workers deteriorate due to climate change impacts?	Workers mainly live in surrounding communities; there are no living quarters on company premises. Impacts of heat waves on communities are felt indirectly by the company, namely in terms of the number of employees on sick-leave, resulting from deteriorating hygienic conditions in the communities. The same applies in times of flooding. During periods of extreme heat, supply with energy and water is extremely scattered in surrounding communities where the workers live. The cool storing of fresh food becomes difficult and the number of incidences of food-related illness rises. Similarly, water-borne diseases occur more frequently during heat waves as water quality degenerates and water purifiers cannot be sufficiently run due to the gaps in energy supply. Altogether, there is a considerable risk of employees not attending work in times of extreme weather events.	
		20	Are there any impacts on productivity caused by temperature rise or extreme weather?	Employee productivity, see above (18); machinery overheating may occur; productivity is generally lower.	
		21	Has the community been affected by climate change and / or the company's actions in the past?	Water table has sunk and is particularly low in summer. In times of flooding, water quality deteriorates, in part also because of waste water overflow in the cluster. Also, bad road conditions and low harvest rates in times of flood and drought lead to food supply shortages in the community.	
		22	How severely is the community (estate population and surrounding communities) affected by climate change, and by the company's adaptation or maladaptation?	Water has been a contentious issue between the community and the cluster in the past; in case of heat waves, the resulting increase of energy and water usage of the cluster indirectly decreases the availability of those goods for the surrounding communities. There is a risk that this resource conflict could escalate, especially if food supply is also problematic.	
		23	Are there any possibilities to help adapt and / or raise stability of energy/water supply in the community (estate population and surrounding communities) in a joint effort (PPP)?	This would be possible; cluster level action is important regarding this issue, as the company is only one of 50 companies contributing to the problems.	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity
	Medium/ likely	Hire part-time employees when needed; engage with communities of workers to enlist backup workers from their families; installation of houses on the factory premise.
	Medium / likely	Install air conditioning or ventilation system; heat-proof machinery, e.g., through water cooling.
	N/A	N/A
	Medium / likely	Engage with community on various issues on a cluster lever, including water, road conditions, etc.
	N/A	N/A

Impact Area			Critical Points	Assessment	
Stakeholders	Government and regulation	24	Have past direct climate change impacts already affected regulations that your company has to comply with?	In the context of energy efficiency programmes and regulation, companies already face more stringent expectations regarding the insulation of buildings; and these can be expected to become more mandatory in the future. The Energy Conservation Building Code (ECBC) of 2007 details and strengthens requirements of the National Building Code regarding the insulation of buildings, including requirements on insulation materials, fenestration, roofs, ventilation and air conditioning. While the code is currently voluntary, the Department of Renewable Energy, Government of Haryana, started to implement its requirements for buildings and industry; also, the code is planned to become mandatory in the future. Improved insulation, amongst others targeted at reducing heat build-up inside buildings, is a key component of governmental energy efficiency programmes at national and state levels.	
		25	Do projected climate change impacts affect existing regulations?	Currently, no specific requirements exist for companies located in Delhi-NCR or Haryana on how to prepare for or behave during heat waves. Given the expected intensification of the heat wave challenge in the region and increasing governmental action on heat waves in other states and cities, for instance Ahmedabad, governmental programmes and requirements can be expected to intensify in the future. The company is regularly informed about changes in regulatory requirements and upcoming government programmes in areas like energy efficiency by its associations (cluster association, regional textile association). However, the ability to respond to changing expectations is limited, as the costs of acquiring the necessary expertise and technologies are high. Increasing costs because of penalties/ fines in case of non-compliance in the future are possible.	
		26	Are there any regulations that you anticipate or expect to become more stringent in the future?	See above (25)	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity
	High/ likely	Prepare for the requirements to become mandatory.
	Medium/ likely	Top management to join the task force on regulation of the cluster association.
	See above (25)	See above (25)

Impact Area			Critical Points	Assessment	
Stakeholders	Government and regulation	27	Is your company affected by any existing government programmes (e.g., National Missions) or funding streams?	No, but the company is aware of the existence of discounted energy efficiency loans by public banks.	
		28	Are there any government programmes regarding adaptation to be anticipated, or that your company could lobby for?	Most prominently, initiatives of the Bureau of Energy Efficiency (BEE) provide support to SMEs for improving their energy efficiency.	
Finance and Market	Market	29	Is there any falling or rising demand of company's products caused by climate change?	The growing frequency and intensity of heat waves in various parts of the globe increases the demand for very light clothing (through light fabrics and tailored designs) as well as for clothing with cooling properties. Given the design and production capacities of the company, particularly the growing demand for very light clothing, offers market opportunities for the company. Concerning changes in market demand, the company is well positioned to respond to these changes. The company is used to flexibly and quickly responding to changing demands concerning clothing design and fabric properties.	
		30	Are there increasing expectations / standards of purchasers and / or end-consumers in terms of climate change adaptation efforts (and is compliance referring to this aggravated by the vulnerability of the company)?	There is no pressure yet from the company's buyers in Europe and Canada concerning adaptation efforts. However, buyers have started to look into the vulnerability of their supply chains to climate change impacts and the company assumes that expectations concerning the management of risks from climate change impacts will increase in the near future. Already today its buyers require the company to prove compliance with environmental and social standards, including on issues like energy and water efficiency; and health and safety of employees. The company is strongly dependent on keeping up good business relations with existent buyers as competition is extremely high. Thus non-compliance with rising expectations is not an option.	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity
	N/A	Need to seek out ways to be more informed about existing programmes.
	N/A	As member of the task force, the company could become more involved.
	Opportunity, gains: medium/ occurrence is very likely	Further market research
	Medium/ likely	Inform buyers about CCA strategy after its development.

Impact Area			Critical Points	Assessment	
Finance and Market		31	Are there any impacts on product accessibility?	The company uses shipping and air transport to deliver its goods to the buyers; so far, no problems have occurred. Air delivery is also used as a fallback option in case of production lags, but makes the goods unprofitable.	
		32	Is there any opportunity to extend or adapt product portfolio to climate change impacts?	See above (29)	
	Finance	33	Are there any problems regarding short-term cash-flow and financing caused by climate change impacts?	In case of extreme weather events which lead to environmental disasters like flooding, damages on the company's property, buildings and machines will result in high repair costs and thus cuts in cash-flow. As well, higher adaptation standards for buildings and property set by insurance companies are likely and will increase insurance costs in case of non-compliance. The same issue applies for expectations of credit institutes resulting in higher financing costs or non-availability of financial resources in case of non-compliance.	
		34	Are there any problems caused for long-term investments by climate change impacts?	N/A	
		35	Is it likely that your company's liabilities increase due to climate change impacts? (e.g., flooding resulting in toxic discharge)	Yes, this is the case as the surrounding communities are located very closely to the cluster; also, higher liability risks could result from deteriorating work conditions during heat waves and higher likelihood of accidents.	
		36	Are insurance premiums likely to be raised due to climate change impacts and / or are the existing insurances still adequate?	Insurance needs to be obtained for flooding, as risks have increased; all other CCA related risks faced by the company cannot be insured.	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity
	Medium/ very likely	Air delivery is already used in case of problems.
	See above (29)	See above (29)
	Medium/ likely	No ideas offered by the case company.
	N/A	N/A
	High / not very likely	Initiate engagement with the community; heat-proof production facilities and emphasise OHS procedures.
	Being underinsured: High / not very likely	No adequate offer on CC insurance as of yet; keep informed about it.

3 Deciding on the development of a CCA strategy

3.1 Purpose

Following the structured discussion with the company representatives based on the assessment sheet, it is advisable to decide whether to develop a CCA strategy as a next step. It is very important to come to this decision jointly with the company. In case you proceed to do the CCA strategy development, the company needs to invest considerable resources. This will only happen if its top management is convinced of the necessity and urgency to act, as well as the benefits resulting from it.

3.2 Important considerations

In order to do this in a transparent way, we recommend you to explain the assessment and decision process to the company, as well as provide details on the strategy development process before you do the assessment with the company. Even if the company is already convinced that a CCA strategy is advisable we still recommend you to first use the assessment grid interview. This allows your client to get a better understanding of the issues tackled during the CCA strategy development.

After you have done the assessment, you should write up all the information gathered and share this with the company. We recommend you to present the information in the grid as well as to summarise them in a short report. This report should analyse the findings focusing on the most relevant impact areas or sub-areas (see above "Preliminary analysis of the climate change vulnerability of IndTex"). You should also make a recommendation on whether a detailed assessment is necessary or whether the measures identified during the assessment are sufficient for meaningful action towards reducing vulnerability.

In the discussion with the company on whether to develop the CCA strategy you should raise the following issues:

- **Required time**
  Around 1-2 days of at least one top management representative/technical expert is required.

- **Required resources**
  You need to be able to work on the company premises for at least two days; ideally, you are granted full access.

- **Potential benefits by reducing risks / realising opportunities**
  You have already gathered a lot of information on this issue in the assessment grid; it is important to make the company understand that the full strategy development entails a more comprehensive approach to risks and opportunities, also considering impacts that were not discussed during the assessment.

- **Financial abilities**
  Adaptation measures can involve significant investments; before starting out on the CCA strategy development,

you need to discuss the company's ability to finance potential measures; in case it is very low, maybe it makes sense to postpone the CCA strategy development.

- **Your consultancy offer, including implementation support**
  Your offer should include at least 2 days of research before the joint strategy development; you will need this additional amount of time in order to accurately identify the climate change impacts faced by the company. The impacts are locally specific, but once you have data available for one region, you only need to verify it for the specific company. In addition, you should guide the strategy development process as a consultant (2 days of interactive work, 2 days of documentation and analysis, 0,5 days of presentation) and offer implementation support (up to 4 days per year).

- **Any additional services**
  After conducting your first assignments, you will have a good understanding of the types of services that are in demand in this field; use this to develop corresponding services and link up with partners that may bring in additional knowledge, e.g., in the field of energy efficiency.

- **Your consultancy fee**
  Your fee should reflect the experience you have in guiding CCA strategies.

3.3 Results from the case study

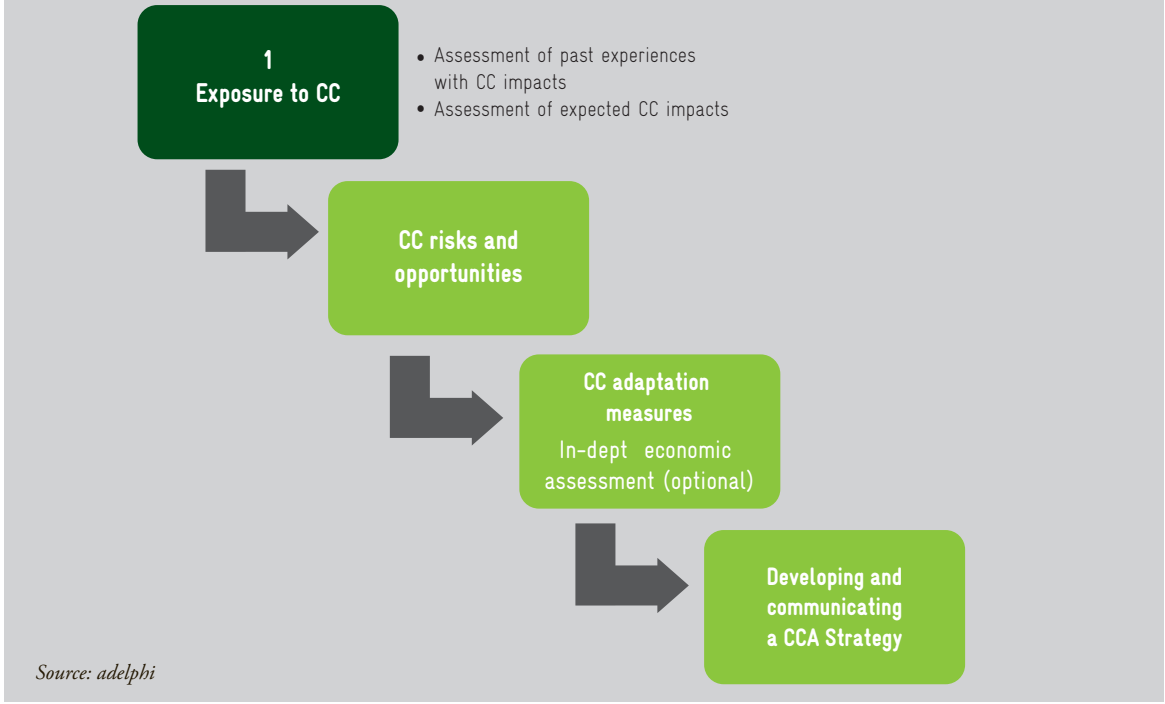
For the case company, the decision was taken considering the following factors:

- Risks and opportunities as stated in the assessment grid
- Discussions with top management regarding resources, benefits, and the financial abilities of the company as well as the services offered by the consultancy.

The following decision was made:
A detailed risk and opportunity assessment as well as a structured development of effective adaptation measures offers **benefits that outweigh the costs of engaging with CCA consultants.** The company is also willing and able to finance potential adaptation measures, especially those that bring additional benefits in terms of resource efficiency. **The development of a CCA strategy is thus recommended.**

4 Exposure to climate change: Assessing past experiences and expected changes – STEP 1

Figure 3 Methodology of the workbook



Source: adelphi

The first step in working with your client on an adaptation strategy is to identify CC challenges to which the company is exposed. This is the ideal occasion to raise awareness about CC impacts on the company and underline the importance of implementing CCA measures or a full-fledged CCA strategy. As a first step in the assessment you ask your client to reflect about past climate change events and impacts on his or her company regarding the above mentioned impact areas. If you have started with the assessment grid, you already have discussed many points. You can prepare the worksheet accordingly. Subsequently to the discussion of this worksheet, you present the expected changes in the areas relevant to the company and encourage reflection about negative and positive consequences for the company. This information you need to gather beforehand.
In case you have discussed the past impacts thoroughly during the assessment grid interview, you can skip this step.

4.1 Past climate change and impacts on the company 1

Purpose and content of the worksheet

This part serves as a first occasion for your client to consciously deal with climate change as a relevant variable for his / her business. The goal is to raise awareness about the relevance of dealing with CCA by means of reflecting on past climate change events which caused a positive / negative impact on your client´s company.

Important categories:

- **Climate phenomenon:** In this column, all climate change phenomena that have been observed in the past are stated. Examples are "gradual increase of average temperature", "increasing frequency and intensity of heat waves", "droughts", "increasing intensity of rainfalls" and "rise in sea levels". These phenomena are then evaluated with the help of the following columns.

- **Point in time:** In order to evaluate the impact of the climate change phenomenon on the company, it is first of all important to specify the time of occurrence or duration of each climate phenomenon. This could be, for example, formulated as "observed over the past four years during May, June and July", "has intensified in the last decade", etc.

- **Impact area:** In this column it is marked which one of the three different impact areas of the client's company is affected by the respective climate phenomenon. At least one needs to be selected for each identified impact. However, each climate change phenomenon can have several impacts on the company, e.g., the climate change phenomenon "Increasing frequency and intensity of heat waves" causes "Decreasing productivity of employees" which is referring to the impact area "Stakeholders" as well as causes "More frequent production stoppages resulting from overheating of machinery" as one example of the impact area "Infrastructure and operations"

- **Description of phenomenon:** This column describes in more detail the climate phenomenon.

- **Resulting disadvantages:** The column refers to "disadvantages" resulting from the respective climate change phenomenon, e.g., "Decreasing productivity of employees" or "More frequent production stops resulting from overheating of machinery"

- **Resulting benefits:** Similar to the last column, this column refers to "benefits" for your client´s company resulting from the respective climate change phenomenon, e.g., "New market opportunities because of changing customer preferences"

- **Subsequent measures taken:** The final column asks for measures which were implemented as a response to identified CC impacts, e.g., "Increasing use of ventilation and AC" as a response to "Decreasing productivity of employees" which was caused by the climate (weather) phenomenon "Increasing frequency and intensity of heat waves"

The outcome of this worksheet is a first overview for you of your client´s perception of climate change, his or her perceived exposure and consequently initiated adaptation measures thus far. Accordingly, it is a first starting point for you to estimate the knowledge and needs of your client as well as to evaluate the sensitivity to climate change and the present adaptive capacity of your client´s company.

How and when to use this worksheet

Time required
Preparation: 2 days of climate data research and analysis
Assessment: 1h (less if assessment grid results have been transferred by you)
Documentation: 2h

Participants
Top management, lead engineer

Aim of the consulting session

The worksheet is of high relevance to familiarise your client with the connections between CC, its impacts on the company and resulting disadvantages and benefits. Reflecting on adaptation measures already undertaken helps the discussion partners understand, that it is very likely that their company is already adapting to the impacts of CC.

Your task is to **guide and support your client in the process of identifying past CC impacts.** You can assist them in completing the worksheet by asking several questions according to your research about past climate change and extreme weather events in the relevant region, e.g., rising average temperatures, increasing frequency and intensity of heat waves, increasing intensity of rainfall, rising sea levels, etc. Thus before this step, **it is your task to inform yourself and search for significant data material about the relevant climate change phenomena** which occurred in the geographical region of your client´s company, its value chain as well at the sales markets. You can use supporting materials such as IPCC reports, state level action plans or the information provided on the Climate Expert website to identify climate change issues relevant for various regions in your country. You can apply your knowledge as well as the case study to explain and illustrate resulting disadvantages and benefits of the identified climate change impacts on those different areas.

However, at this stage of the assessment it is not yet necessary that your client thoroughly identifies all impacts on the company, as this will be done in the next worksheet. Rather, the discussion helps you to better understand which CC impacts have been most important for the company so far.

In concluding the assessment you can point out that the company **has already started to adapt to the impacts of climate change.** However, you need to point out that so far, this adaptation has been reactive. Now you will work jointly on a more **proactive response to CC challenges, allowing the company to address risks before damages** occur, and seize additional **opportunities for the company.**

Results from the case study

The following worksheet states how the case company responded to the assessment of past impacts. The only selected climate change phenomenon is "Increasing frequency and intensity of heat waves" as a common CC phenomenon in India. Obviously, this is not the only relevant past CC phenomenon in India but simply serves as illustration how to apply the worksheet. The case company identified **two impact areas as vulnerable to past heat waves.** Concerning **"Stakeholders"** the case company identified negative effects on the productivity of employees as a disadvantage of heat waves. The applied measure to cope with this impact is to improve ventilation and air conditioning to keep the inside temperature low. Regarding **"Infrastructure and operations"** the case company identified interruptions in production due to cuts in energy and water supply as well as more frequent production stoppages resulting from overheating of machinery as disadvantages. Regarding the first disadvantage the case company did not implement any measure to cope with the negative impacts of heat waves. To prevent the overheating of machinery they applied the same measure as mentioned before: **increasing use of ventilation and air conditioning** to keep the inside temperature low.

Table 3	Past climate change and impacts on the company							
Past Impacts								
			Impact Area					
	Climate Phenomenon	Point in Time	Infrastructure & operations	Stakeholders	Finance & market	Description of Phenomenon	Resulting impacts (Disadvantages /Benefits)	Subsequent measures taken
1	Increasing frequency and intensity of heat waves	Last 10 years		X		On several consecutive days temperatures beyond 30°C have been noted in the city centre; at night it hardly cooled down	Decreasing productivity of employees	Increasing use of ventilation and AC
2			X				Interruptions in production due to cuts in energy supply and water supply	
3			X				More frequent production stoppages resulting from overheating of machinery	Increasing use of ventilation and AC

4.2 Expected climate change and impacts on the company 1

Purpose and content of the worksheet

This worksheet focuses on expected climate change impacts which might affect different areas of a company. The idea is to further complement the list of expected climate change phenomena with further sources and available background information. Thus, the level of uncertainty regarding expected climate change impacts can be decreased as a scientific basis for the sources of CC impacts is given.

The next step within this worksheet is to specify the affected areas, to describe the resulting negative and positive impacts as well as to state its threshold values. Since this section needs to be considered as the preliminary step before conducting an assessment of CC impacts, it is important to familiarise the participating company with causalities in the field of climate change phenomena and resulting impacts.

Important categories:
Variable: In this column, it is stated what climate variable is affected by climate change. For example, this can be temperature or rainfall.

Climate phenomenon: Here, all climate change phenomena that are expected to occur in the future are to be stated. These can be, for example, "gradual increase of average temperature", "increasing frequency and intensity of heat waves", "droughts", "increasing intensity of rainfalls" or "rise in sea levels". It is likely that some of these impacts have already been felt in the past and were therefore identified in the previous worksheet. However, these impacts might change or further impacts could occur. Both worksheets are important for the development of a comprehensive CCA strategy.

Trend direction, expected changes: For each climate phenomenon the direction of the trend is stated (increasing, decreasing) and expected changes are described in more detail than in the previous column.

Period of time (in comparison with): How fast has change occurred in the past? How fast is change expected? In the brackets, it is stated which time period serves as a reference or baseline for the observed changes.

Source: In this step, it is noted where information on climate change trends come from.

Notes on source or scenario: Consequently, it is assessed how reliable the source is and at what point in time an update can be expected. Since adaptation measures will be developed according to the expected climate phenomena it is important that information is as up-to-date and accurate as possible. If sources are not yet fully reliable or are not regularly updated they should be used with caution and further research should be planned and conducted regularly.

Impact area: In this column it is marked which one of the three different impact areas of the client's company is affected by the respective climate phenomenon. While at least one impact area needs to be selected per impact, each climate change phenomenon can also have several impacts on the company.

Description of impact and its critical threshold value: Based on which impact area is affected, it is described what the expected impacts are and evaluated how much these impacts affect the company. It is possible that climate change only starts affecting the company once it crosses a critical threshold. While a general increase in rain intensity might, for example, cause higher humidity and therefore mould infestation, road flooding can only be expected if the water level climbs past a certain amount of centimetres per square metre in a specific time. Both this threshold value and the timing should be quantified where possible.

Notes and comments: Finally, notes and comments are written down in order not to forget critical points that do not necessarily fit into this assessment grid but are important to consider.

How and when to use this worksheet

Time required
Preparation: 2 days of climate data research and analysis (same work as for the past impacts worksheet)
Assessment: 2 h (less if assessment grid results have been transferred and reviewed by you)
Documentation: 1 h

Participants
Top management, lead engineer

Aim of the consulting session
This step is important to further familiarise your client with the connections between CC, its impacts for the company and resulting disadvantages and benefits. If the worksheet is filled in completely, the result is a list of different identified climate phenomena and their potential impacts on the company. Reflecting on adaptation measures already undertaken helps the discussion partners understand that in all likelihood their company is already (reactively) adapting to the impacts of CC. Your client should realise that to face risks and seize opportunities resulting from CC, a proactive instead of a reactive approach to CCA needs to be taken.

Your task as a consultant is to guide your client in identifying relevant CC phenomena which can occur in the future. You are also supposed to provide reliable data and scientific sources (e.g., from IPCC reports, national and regional research institutes etc.) to identify relevant CC phenomena and future projections. Moreover, you need to provide threshold values for CC impacts from reliable sources. If the threshold values are company specific (e.g., increasing inside temperature depending on isolation material; vulnerability for flooding depending on location and type of building), it is your task to identify these threshold values in the discussion with your client.

Altogether, it is of high relevance for companies to base future decisions regarding risk management, implementation of CCA measures and strategy development on reliable data. In this regard, it is your task to support your client in developing sensitivity as well as capabilities to cope with uncertainty regarding CC and its impacts. Ideally you also enable your client to update the information regularly or when new information sources are available.

Results from the case study

The worksheet shown below illustrates the different impacts of one climate change phenomenon which is expected to affect the case company.

The case company is going to face various climate impacts, yet as in subsequent worksheets of the case company the **assessment focuses on the climate phenomenon of "increasing frequency and intensity of heat waves".** Already, such events have occurred more frequently in the past. In the next 3-5 years their occurrence is expected to rise slightly, and after that a more drastic rise is projected (2020-2030). This has various negative and a few positive impacts for the case company. As negative consequences of the mentioned climate phenomenon, the company detects a lower productivity of their employees due to deteriorating work conditions and health reasons. Moreover, the company will be faced with interruptions in their production due to cuts in energy and water supply, and higher costs due to more extensive use of diesel generators to cover gaps in energy supply and to satisfy increased energy demand for air-conditioning and ventilation. Machinery can be affected by heat, as there is little opportunity for cooling down. Furthermore, the company is faced with potentially increasing quality standards for buildings set by insurance companies resulting in higher insurance costs if no adaptation measures are taken by the company.

As a positive impact of the climate phenomenon, the company identifies the opportunity of new demand patterns for light garments in India which opens up business opportunities to enter the Indian market as a first-mover.

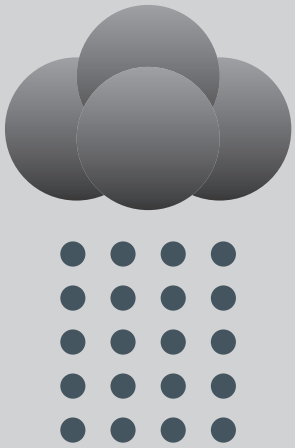
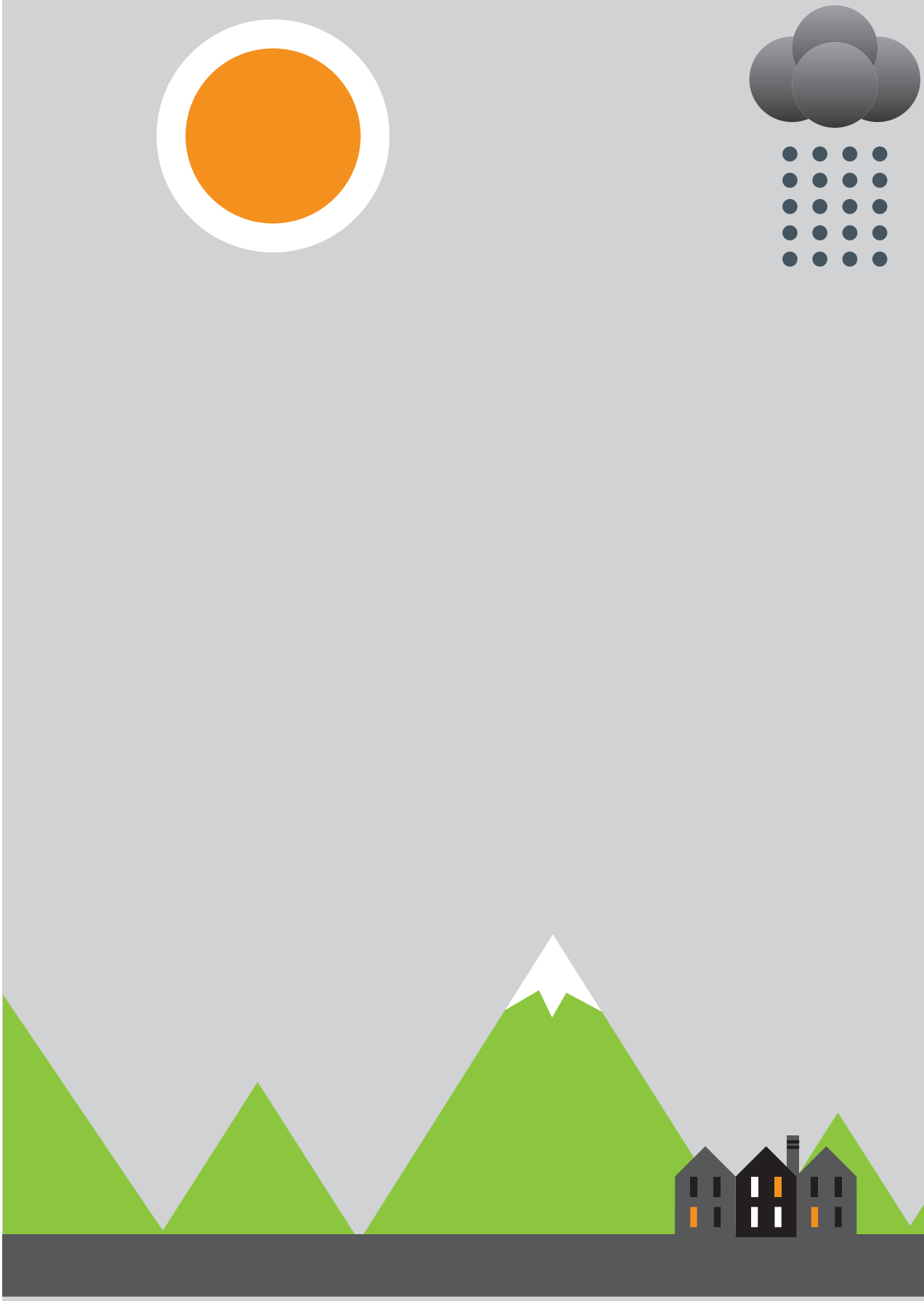


Table 4	Expected climate change and impacts on the company						
	Variable	**Climate Phenom-enon**	**Trend direction, expected changes**	**Period of time (in comparison with)**	**Source**	**Notes on source or scenario**	
1	Temperature	Increasing frequency and intensity of heat waves	Up to 7 heat waves in the short term, higher frequency possible	2012-2017: slight increase; 2020-2030: considerable increase (2001-2011)	Data provided by consultant (e.g., IPCC report)	Need to update assessment according to next report (2013)	
2							
3							
4							
5							

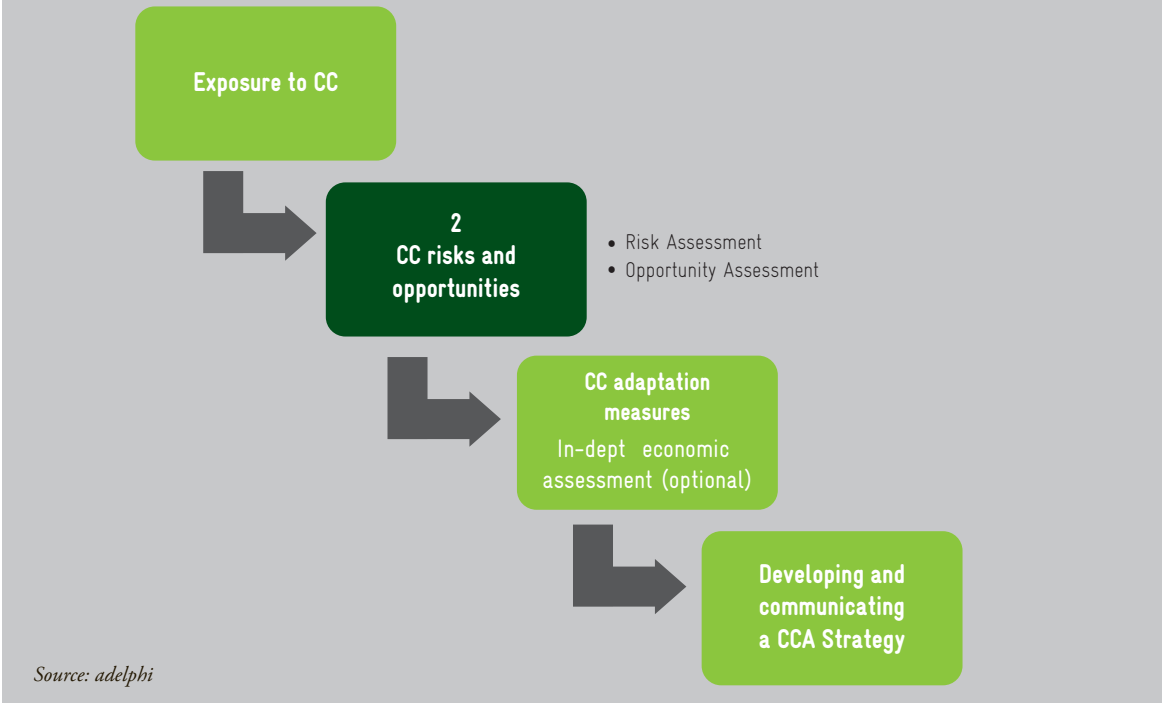
	Impact Area				
	Infrastructure & operations	Stakeholders	Finance and Market	Description of impact and its critical threshold value	Notes and comments
		X		Negative impacts on employees' efficiency and health if workspaces' inside temperature exceeds 34°C.	How high must the outside temperature be and for how long until the inside temperature is higher than 34°C?
	X			An interruption in production due to cuts in energy supply and cuts in water supply if heat waves last for several days.	Try to collect data of past events and observed threshold values.
	X			Higher costs due to more extensive use of diesel generator to cover gaps in energy supply and to satisfy increased energy demand for air-conditioning and ventilation if outside temperature exceeds 35°C.	
			X	Increasing quality standards for buildings etc. set by insurance companies. If no compliance, insurance costs will rise.	
			X	Positive impact: New demand patterns for light garments in India due to rising temperatures open up business opportunities to enter the Indian market.	Market research necessary.



5 Climate change risks and opportunities – STEP 2

5.1 Laying the ground for the risk and opportunity assessment

Figure 4 Methodology of the workbook



Source: adelphi

In the first step, exposure to CC was determined based on the experiences of the company and on an analysis of scientific evidence and projections. In Step 2, risks and opportunities are developed for the most relevant climate phenomena.

A number of climate change phenomena will occur in the regions where the company, its suppliers and markets are located. A comprehensive assessment of climate change impacts, risks and adaptation measures for all relevant climate change phenomena can be quite demanding in terms of staff and financial resources. If resources are limited or organisational buy-in is still low, focusing on one or few challenges could be recommended.

Pre-selection should be done jointly, according to the following criteria:

- Past occurrences of phenomenon and degree of damage
- Likelihood of increase in occurrences / impacts
- Expected timing of increase in occurrences / impacts
- Relevance of expected damages to growth / survival of the company

This allows to focus on the most urgent and relevant phenomena for the company; after the assessment of these issues, it is recommended to also consider – albeit less extensively – the less urgent ones for assessment.

5.2 Risk assessment 2

Purpose and content of the worksheet

This section supports the company to evaluate, rate and prioritise the identified and anticipated CC impacts of the previous section and formulate them as risks. This is the pivotal step to develop suitable adaptive measures and a CCA strategy.

During the consultation, first the various risks are collected for each climate phenomenon. Then, the risk matrix is used as a visual tool to classify risks according to their probability of occurrence and the extent of expected loss or damage to the company. The outcome of this assessment is a clustering of impacts in three different priority categories, namely A, B and C. This prioritisation implies the urgency for initiating adaptation measures. The most urgent risks (priority score level "A") are considered first in the next step which is the development of CCA measures.

Important categories:
Climate phenomenon: All climate change phenomena that are presently experienced and expected to occur in the future are stated. These have been identified with the help of worksheets 4.1 "Past climate change and impacts on the company" and 4.2 "Expected climate change and impacts on the company" and should be used as the basis of the risk assessment.

Impact area: In this column it is marked which one of the three different impact areas of the client's company is affected by the respective climate phenomenon. It is used to structure the assessment process. In order to achieve a comprehensive list it is recommended that you use the list of sub-areas as a guideline for the assessment.

Resulting risk: The resulting risk column seeks to describe which risk the climate phenomenon poses. Risks occur whenever climate change has or threatens to have a negative impact on the company, e.g. by increasing costs, reducing productivity or damaging the company's image. Risks could be, for example, "delays in supply and delivery", "more frequent production stops" or "deteriorating health situation of employees".

Description: In this column it is explained how the climate phenomenon leads to the expected risk. The risk "delay in supply" could, for example, be caused by the deterioration of road conditions which, in turn, can be a consequence of a heat wave.

Expected time frame: Here you state whether the risks are already affecting the respective impact area and, if yes, within which time frame. If no, it should be considered how likely it is that the risk will occur and within which time frame. A risk is very likely to occur if the climate change phenomenon is expected to cross relevant thresholds in the future or if the company is indirectly affected (e.g. when climate change negatively affects the company's stakeholders).

How probable is it that the impact will occur? What is the expected loss or damage? Both this and the next column work with a scoring system that helps assess future events by means of a numerical value (1-5). A simpler version of this scoring system has been used in worksheet 2.1 "Assessment grid on sensitivity and adaptive capacity" that uses terms, such as "likely" or "damage is low" instead of numbers. At this point it is, however, more helpful to assign numerical scores in order to be able to connect several probabilities with each other and to assign overall priorities. Whenever this scoring system is used, the rule applies that high scores express a strong probability or impact in the respective categories.

The column is used for assessing **how probable it is that the risk actually becomes a negative impact for the company.** This probability has three aspects, namely

- The **likelihood of the climate phenomenon:** How likely is it that the climate phenomenon occurs?
- The **timeframe of the climate phenomenon:** What is the timeframe for its occurrence?
- The **likelihood of the impact:** How likely is it that the impact occurs once the climate phenomenon occurs?

Of course, the answers to these questions will be subjective. But by this point, enough information is gathered to base these answers in facts rather than only intuition.

Probability of 1

- The occurrence of the climate phenomenon is not very likely
- It has not occurred in the past and is not expected to occur in the next 1-2 years
- Once the climate phenomenon occurs, the impact does not follow directly and/or other circumstances are important for the impact to follow

Probability of 3

- The occurrence of the climate phenomenon is deemed possible
- It has occurred in the past and /or it is expected to occur but not in the next 1-2 years
- Once the climate phenomenon occurs, the impact follows with only little delay and/or circumstances are not important for it to occur

Probability of 5

- The occurrence of the climate phenomenon is deemed likely
- It has occurred in the past and/or it is expected to occur in the next 1-2 years
- Once the climate phenomenon occurs, the impact follows directly and immediately after

The in-between scores of 2 and 4 should be given if in comparison with other risks the probability is deemed higher or lower or if not all three of the respectively higher probability criteria are fulfilled.

Please note that in this section it is not possible to rate either likelihood of occurrence or damage with 0. This results from the fact that only actual and relevant risks are considered. Any situation that has no likelihood to occur or causes no damage does not qualify as a risk and thus should be dropped from the list.

The next column is used for assessing the **potential loss or damage** of the impact to the company. In contrast to the assessment grid, here we only focus on the loss or damage, not on the feasibility of countermeasures, which will be assessed in more detail later.

Three aspects are of importance:

- Extent of loss or damage
- Affectedness of production processes or value chain
- Affectedness of stakeholder relations

Potential loss or damage of 1:

- Loss or damage occurs but its effect on the bottom line is limited
- Production processes and/or value chain are not interrupted
- Stakeholder relations are not affected

Potential loss or damage of 3:

- Loss or damage occurs and has a significant effect on the bottom line, endangering its growth potential
- Production processes or value chain are interrupted

- Stakeholder relations are affected and necessitate countermeasures

Potential loss or damage of 5:

- Loss or damage occurs and endangers the survival of the company
- Production processes and value chain are interrupted
- Stakeholder relations are endangered and the licence to operate is in question

As damages or losses may exist which are to be avoided by all means, the damage of this particular risk could again be multiplied by a weighting factor.

Risk (probability × extent of damage): Based on the scores of two previous columns, the overall risk score of the phenomenon is calculated by **multiplying** the probability with the degree of loss or damage. As long as no multiplication factor for certain damages is used, each risk will score between 1 and 25 points.

Priority: Based on the risk score, a priority category is given to each risk. Most urgent risks are categorised "A", least urgent "C". Prioritization should follow the general rule "the higher the risk score, the higher the priority". However, specific thresholds between priority areas A, B and C have to be defined by you and the company.

How and when to use this worksheet

Time required
Preparation: 0.5 days of risk accounting
Assessment: 2.5 h (less if assessment grid results have been transferred and reviewed by you)
Documentation: 3 h; plus 2-3h of review of risk prioritisation with other key staff

Participants
Top management, lead engineer

Aim of the consulting session
The consulting session should make clear to the participants that risk assessment is not an accurate science, but that it rather uses existing knowledge and information to project the likelihood and severity of impacts in the future. It is nevertheless an important step towards a CCA strategy, as resources need to be directed to those impact areas that are most likely to affect the company's growth and survival.

Your task as the consultant is to support your client in classifying the climate change phenomena in terms of the affected areas of the company. Likewise, you need to guide your client in figuring out the "probability of impact occurrence" and the "extent of damage" for the company.

We propose to collect the risks per climate change phenomenon first in the table, then assess and calculate their relative score and then use the risk matrix to visualise the risk level of the impacts. The matrix allows for a simple comparison between the different risks in terms of their likelihood of occurrence and impact on the company. You need to find out the relevant information for assessing the probability and impact by drawing on your information and analyses from observing the company´s infrastructure and business operations as well as by asking your client further questions regarding the sensitivity of the company. In combination with your knowledge about the different climate change projections and local CC impacts, it is possible for your client to specify a score for each identified risk in terms of both probability and impact. It is recommended to then test and discuss the prioritisation that you have jointly done with other key staff.

Following our recommendation, you should begin the risk assessment by filling in the assessment table with risks for each single phenomenon.

Results from the case study

Weighting factor used: None

Grading of priority:

Risk A: 14-25 **Risk B:** 8-13 **Risk C:** 1-12

The risk assessment for the case company proceeds by analysing the probability and impact of risks related to the climate change phenomenon "Increasing frequency and intensity of heat waves". The prioritisation seeks to achieve a viable basis for **effectively allocating resources to the most urgent and impact-relevant issues.** This means that for the development and implementation of adaptation measures, the identified risks with a priority score level "A" will be tackled first.

For the case company the most important risks are:

- Quicker overheating of machinery which leads to more frequent production stops
- Increasing frequency of power-cuts from grid which leads to production stops or increasing need of diesel-generators
- Decreasing alertness of employees which leads to more frequent accidents and greater rate of garments with mistakes
- More frequent production delays at suppliers with high water, energy and labour inputs
- Increasing frequency of heat-related health problems of employees

Table 5 Risk table for heat waves

		Impact Area						
	Climate pheno-menon	**Infrastructure & operations**	**Stakeholders**	**Finance and Market**	**Resulting risk**	**Description**	**Expected time frame**	
1	Increasing frequency and intensity of heat waves	X			Deteriorating road conditions on site lead to delays in supply and delivery	Due to high outside temperature several days in a row, streets can crack	Already occurring from April – June	
2	Increasing frequency and intensity of heat wave	X			Quicker overheating of machinery leads to more frequent production stops	Due to increasing inside temperatures, machines can overheat	Already occurring from April - July	
3	Increasing frequency and intensity of heat waves	X			Increasing frequency of power-cuts from grid leads to production stops or an increasing need of diesel-generators (higher costs)	High temperatures lead to an increasing energy demand (AC, ventilation etc.) for the entire cluster resulting in power-cuts	Already occurring from April - July	
4	Increasing frequency and intensity of heat waves	X			Increasing dust occurrence	Increasing dust occurrence leads to the necessity of rewashing clothes more often which in turn increases water consumption	Already occurring year round (except for July-August, monsoon)	
5	Increasing frequency and intensity of heat waves	X			More frequent production delays at suppliers with high water, energy and labour inputs	Due to high temperatures employees sweat more during physical work which leads to handling stains and finally to an increasing necessity of rewashing produced garments (increasing water demand)	Already occurring except in winter months	

	How probable is it that the impact will occur?	**How extensive is the expected loss or damage of the impact, when it occurs?**	**Risk (probability × extent of damage)**	**Prio**
	3	2	6	C
	4	4	16	A
	5	4	20	A
	5	2	10	B
	5	2	10	B

Table 5 Risk table for heat waves

		Impact Area						
	Climate phenomenon	**Infrastructure & operations**	**Stakeholders**	**Finance and Market**	**Resulting risk**	**Description**	**Expected time frame**	
6	Increasing frequency and intensity of heat waves	X			More frequent production delays at suppliers with high water, energy and labour inputs	Heat waves lead to cuts in water and energy supply at suppliers as well as negative impacts on productivity / health of their employees. Delivery delays slow down production at company's facilities with further negative impacts.	Occurs occasionally; no safety net in place if it happens	
7	Increasing frequency and intensity of heat waves	X			Rising costs for energy, water, and labour inputs at suppliers	Rising costs at suppliers can lead to rising prices for supplied fabric	Occurs occasionally, is expected to continue	
8	Increasing frequency and intensity of heat waves	X			Increased heat stress for drivers from suppliers to factory	Heat stress leads to more frequent breaks of drivers and / or can lead to more frequent driving accidents due to lack of alertness	Possible, but has not occurred yet	
9	Increasing frequency and intensity of heat waves		X		Limited productivity of employees leads to less output and can end in delivery delays	Due to high inside temperatures employees feel uncomfortable and are less productive	Already occurring from April - July	
10	Increasing frequency and intensity of heat waves		X		Increasing frequency of heat-related health problems of employees	Health issues (e.g., heat stress) lead to an increasing number of staff on sick-leave, reputational losses among potential employees and in the community and more frequent losses of business due to non-compliance with buyer expectations	Already occurring from April - July	

	How probable is it that the impact will occur?	**How extensive is the expected loss or damage of the impact, when it occurs?**	**Risk (probability × extent of damage)**	**Prio**
	4	4	16	A
	3	3	9	B
	3	2	6	C
	4	3	12	B
	4	4	16	A

Table 5 Risk table for heat waves

		Impact Area						
	Climate phenomenon	**Infrastructure & operations**	**Stakeholders**	**Finance and Market**	**Resulting risk**	**Description**	**Expected time frame**	
11	Increasing frequency and intensity of heat waves		X		Decreasing alertness of employees	Due to high inside temperatures employees´ alertness decreases which leads to more frequent breaks, more frequent accidents and a greater rate of garments with mistakes	Already occurring from April - July	
12	Increasing frequency and intensity of heat waves		X		Increasing need of drinking water for employees	Heat stress increases the need for drinking water which leads to quicker running out of drinking water (with negative health impacts etc.) and / or increasing costs for provision	Already occurring from April - July	
13	Increasing frequency and intensity of heat waves		X		Increasing heat-stress of people in communities leads to an increasing amount of employees on sick-leave	As part of their communities employees are exposed to heat waves all day which has a negative health impact	Already occurring from April - July	
14	Increasing frequency and intensity of heat waves		X		Decreasing availability and quality of water at community level	During heat waves the demand of companies and community members for water increases which leads to lacks in water supply from grid. This causes a growing frequency of dehydration-related health problems of community members, reduced possibilities for personal hygiene	Already occurring from April - July	

	How probable is it that the impact will occur?	**How extensive is the expected loss or damage of the impact, when it occurs?**	**Risk (probability × extent of damage)**	**Prio**
	4	4	16	A
	4	3	12	B
	3	4	12	B
	4	3	12	B

Table 5 Risk table for heat waves

		Impact Area						
	Climate phenomenon	**Infrastructure & operations**	**Stakeholders**	**Finance and Market**	**Resulting risk**	**Description**	**Expected time frame**	
						and leads to a growing frequency of water-borne diseases at community level.		
15	Increasing frequency and intensity of heat waves		X		More stringent standards for insulation of buildings as part of government regulations which can result in penalties or plant closure in case of non-compliance.	As a response to heat waves as a CC phenomenon, governments will increase regulations to secure employees' health and to comply to energy efficiency standards	Not yet occurred; but somewhat likely	
16	Increasing frequency and intensity of heat waves			X	Reduction of capital base due to increasing costs	Several impacts of heat waves such as increasing energy demand, hiring of temporary employees and compliance to new regulations increase the expenditures for companies	Already occurring	
17	Increasing frequency and intensity of heat waves			X	Growing environmental, social and risk management expectations of investors and financial institutions	These expectations require investments to achieve compliance in the respective areas or results in increasing costs for obtaining finance or even a lack of financial resources in case of non-compliance	Not yet occurred, but somewhat likely	

	How probable is it that the impact will occur?	**How extensive is the expected loss or damage of the impact, when it occurs?**	**Risk (probability × extent of damage)**	**Prio**
	3	4	12	B
	4	3	12	B
	3	3	9	B

Table 5 Risk table for heat waves

		Impact Area						
	Climate phenomenon	**Infrastructure & operations**	**Stakeholders**	**Finance and Market**	**Resulting risk**	**Description**	**Expected time frame**	
18	Increasing frequency and intensity of heat waves			X	Increasing insurance costs for buildings and infrastructure	Since extreme weather events such as heat waves can have negative impacts on the conditions of buildings and infrastructure, insurance companies respond with higher rates	Not yet occurred, but somewhat likely	
19	Increasing frequency and intensity of heat waves			X	Increasing expectation of purchasers regarding employees´ health	If purchasers are aware of CC events in their suppliers' countries, they are keen on ensuring a responsible supply chain.	Have been questioned once in the past after late delivery	
20	Increasing frequency and intensity of heat waves			X	Increased expectations of buyers to have very light clothing in product portfolio	This expectation leads to more frequent losses of contracts if the portfolio is not appropriately adapted.	Not yet occurred, but somewhat likely	

	How probable is it that the impact will occur?	**How extensive is the expected loss or damage of the impact, when it occurs?**	**Risk (probability × extent of damage)**	**Prio**
	3	4	12	B
	3	3	9	B
	2	3	6	C

In our example, priorities are given based on the risk matrix depicted in table 6 "Risk matrix for heat waves". In addition to the prioritization of risks this matrix allows summarizing all expected risks at one glance. It is also possible to assign the sub-area of impact to each risk, i.e., 1 = Location & Buildings | 2 = Processes | 3 = Logistics & Stocks | 4 = Employees & Community | 5 = Government & Regulation | 6 = Market | 7 = Finance

Table 6 **Risk matrix for heat waves**

DEGREE OF LOSS OR DAMAGE				
5 - Very high				
4 - High			• Increasing heat-stress for people in communities (4) • More stringent standards for insulation of buildings (5) • Increasing insurance costs for buildings and infrastructure (7)	
3 - Medium		• Increased expectations of buyers to have very light clothing in product portfolio (6)	• Increasing expectation of purchasers regarding employees´ health (6) • Growing environmental, social and risk management expectations of investors and financial institutions (7) • Rising costs for energy, water, and labour inputs at suppliers (3)	
2 - low			• Deteriorating road conditions on site lead to delays in supply and delivery (1) • Increased heat stress for drivers from suppliers to factory (3)	
1 – Very low				
	1 – Very low	2 - Low	3 - Medium	
	PROBABILITY			

5.3 Assessment of new opportunities 2

This worksheet seeks to identify business opportunities with regards to the impacts identified before. Climate change can reinforce existing needs of customers but also create new ones. Accordingly, it is the goal to identify market opportunities resulting from climate change impacts on purchasers and / or end consumers which in turn is going to affect the strategic focus of the assessed company.

Purpose and content of the worksheet

The worksheet helps your client to systematically assess new market opportunities resulting from various climate change phenomena which have been identified within step 1 of the methodology. Whereas previous

	• Quicker overheating of machinery (2) • Decreasing alertness of employees (4) • More frequent production delays at suppliers with high water, energy and labour inputs (3) • Increasing frequency of heat-related health problems of employees (4)	• Increasing frequency of power-cuts from grid (2)
	• Limited productivity of employees (4) • Reduction of capital base due to increasing costs (7) • Decreasing availability and quality of water at community level (4) • Increasing need of drinking water for employees (4)	
		• Increasing dust occurrence (2) • More frequent handling stains on sensitive garments (3)
	4 - High	**5 - Very High**

PROBABILITY

steps focussed on risks and how to avoid negative impacts of climate change on the company, in the following worksheet the opportunities arising from a changing climate are analysed.

Therefore, each opportunity is first listed both by the triggering climate change phenomenon and regarding the geographical region of the arising market and then assessed by several criteria.

Important categories:
Climate phenomenon: All climate phenomena that are presently experienced and expected to occur in the future within the respective regions of the company's markets / customers are stated. They might be similar to those phenomena identified for the client's company during the risk assessment. However, depending on

the company's target market, the climate phenomena could also be completely different and therefore could make a whole new identification process necessary. If this is the case, you should first list out the target markets (next column) and then focus on the most likely climate phenomena in these regions. If necessary, a more comprehensive analysis of target regions can be conducted.

Target market /customers: The company's most important target markets and/or customers are stated. In order to make the next step – defining the impacts of climate change on these actors – possible, they can be grouped roughly into regions that belong to the same climate zone and/or the main type of products they purchase in order to avoid duplication.

Expected market changes: Which impacts is climate change expected to have on the company's markets and/or customers? Changes could include the demand for new or specialised products or the increase / decrease of purchasing power.

Timing / urgency: How soon could expected changes occur? With the help of this aspect the company's decision-makers understand how fast adaptation processes have to be initiated in order to maximise positive results.

Potential product / service / innovation: Based on expected market changes and their timing, it is assessed which potential products, service or innovation the company can offer its customers.

Type of service / product / innovation: It is marked whether the company's new or adapted products, service or innovation help the customers lower their climate vulnerability or adapt to climate change (CCA). Other types could have, for example, a climate change mitigation function.

Challenges / Solutions: In this column, challenges that are connected to the development or adaptation of products and services are described. Consequently, solutions to these challenges are outlined. For example, while it could be a challenge to include new products into the production line without sufficient technical capacity, the solution could be to hire additional staff with the required skills.

Benefits: Benefits from the development or adaptation of products and services are described. These could, for example, relate to the company's reputation or revenues.

Timing of the measure / comments: The last column is used to set the time frame for the company's reaction to market changes and to note comments.

How and when to use this worksheet

Time required
Preparation: 2 h desk research on broad and climate-relevant trends in the client's market
Assessment: 2.5 h
Documentation: 2 h

Participants
Top management; marketing department; customer relations/sales department

Aim of the consulting session
Expected market changes can occur very quickly. Thus it is important to anticipate the timing or urgency of a potential demand change and adapt or develop a product / service as a response to the changing market

conditions. Challenges and solutions as well as benefits are to be documented and the timing of the opportunity and strategic implications discussed.

Your task as the consultant is to support your client in completing this opportunity assessment as accurately as possible. Depending on the knowledge and capacity of your client your tasks may comprise the specific identification of market opportunities due to changing demand patterns and the advancement of suitable products / services based on your knowledge and research about the respective industry, your observations of the capabilities and capacities of your client's company and former answers. Further tasks range from evaluating characteristics of the identified products / services / innovations, to supporting your client to assess the challenges and benefits for each opportunity.

Results from the case study

The case company has identified market opportunities in terms of new garment products. Instead of "Increasing frequency and intensity of heat waves" it was decided to assess the situation of "Increasing number of hot days" as an accompanying effect; this could be an opportunity for the case company to take advantage of already recognisable **changes in customer preferences.** One of them would be the preference of light, loose clothing. Another opportunity can be identified in changed **purchasing behaviour**; seasonal purchases, including spring or autumn wear, are less frequent as hot days become more prevalent. Retailers try to counter this behaviour by adding more sales cycles to the usual seasonal ones; thus the company identified the option to add **more inter-seasonal sales cycles** with retailers. Both opportunities cannot be realised by the current company staff only but would likely require the support of a marketing agency. Another opportunity is arising in terms of an increasing demand for apparel made from fabrics with cooling effects. This trend is especially significant for markets in Europe and Canada but requires more in-depth market research in those regions before investing in research and development activities.

Table 7 Assessment of new opportunities

	Climate pheno-menon	Target market / customers	Expected market changes	Timing / urgency	Potential product / service /innovation	
1	Increasing number of hot days	India, retailers	Increased demand for light clothing	Already noticeable, continuous growth expected	Apparel designs with high ventilation properties (loose cuts, thin fabrics, room for air circulation); advertise them to retailers as responsive to CC trend	
2		India, retailers	Shorter winter season and increase in hot days leading to less necessity to vary items of clothing, thus less purchases	Already noticeable	Connect with retailers on CC driven consumer trends; Innovation: increase of variety of items per season (pre-season, 2 seasonal collections, after-season)	
3		Europe, Canada, brands	Increased demand for apparel made from fabrics with cooling effects	Notable today particularly in the sports apparel market; expected to take up momentum in general apparel market in next 5 years	Build up apparel line with cooling fabrics	

5.4 Preselecting risks for the development of measures 2

This summarising step serves as an explicit pre-selection for identified risks based on the former assessment. This pre-selection is valuable for your client as the overall goal for efficient and effective resource management necessitates a prioritised course of action. This is particularly relevant in the case of limited resources and capacities. Accordingly, the pre-selection enables your client to pursue and address the most vulnerable areas of their company in terms of developing appropriate measures for the most urgent risks.

Most important are the "A" prioritised risks from the Risk Matrix. It is your task to ensure the appropriate selection and to examine whether an impact area of the company is especially vulnerable and requires specific attention.

In case of sufficient resources and capacities, your client is encouraged to select and address risks with a lower priority level as well in order to develop a holistic CCA strategy within the following steps of this assessment process. In this regard, it is suggested to select risks of lower priority within highly vulnerable impact areas, thereby decreasing the company´s overall vulnerability.

	Type of service / product /innovation					
	Lower climate vulne-rability	CCA	Other	Challenges / Solutions	Benefits	Timing of the measure / comments
		X		New role for company, shaping demand of retailers; potentially cooperate with marketing agency	First-mover advantage; potential to turn into a brand-name manufacturer of functional clothing	Long-term strategic orientation
			X	Convincing retailers that higher number of variety is necessary for boost in purchases; potentially cooperate with marketing agency	Lessens the market risk of decreased purchases	Possible in short-term
		X		New role for company, shaping demand of retailers; product development and technical capacity not present in the company; necessary to hire the required staff	First-mover advantage; potential to turn into a brand-name manufacturer of functional clothing	More information needed on market developments and technical state of the art

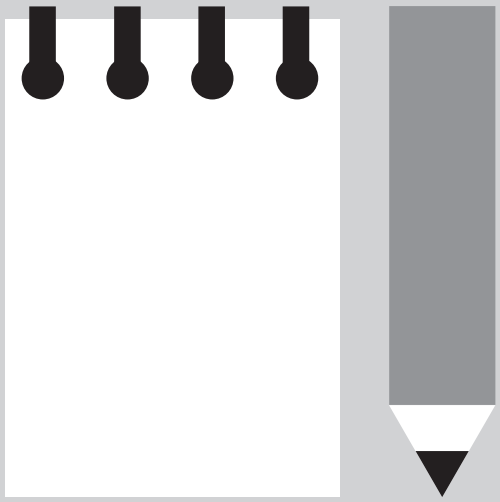
The same approach could be done to assess the most promising opportunities; however, as the identification of opportunities will likely lead to a much smaller number of items, this step is normally unnecessary. The methodology would be completely transferrable from the risk pre-selection methodology.

Results from the case study:
You can find an overview chart for the case company´s risks resulting from an "Increasing frequency and intensity of heat waves" below which results in **"Processes", "Logistic & Stocks" and "Employees & Community" being the most vulnerable impact areas.** Risks with a "Priority Level A" are identified in these impact areas and will be addressed within the following steps of developing a CCA strategy for the case company.

Still, in case of sufficient resources and capacities risks with a "Priority Level B" can be selected as well for the measures step. In this respect, the impact area "Finance" occurs to be of relevance for the case company as well.

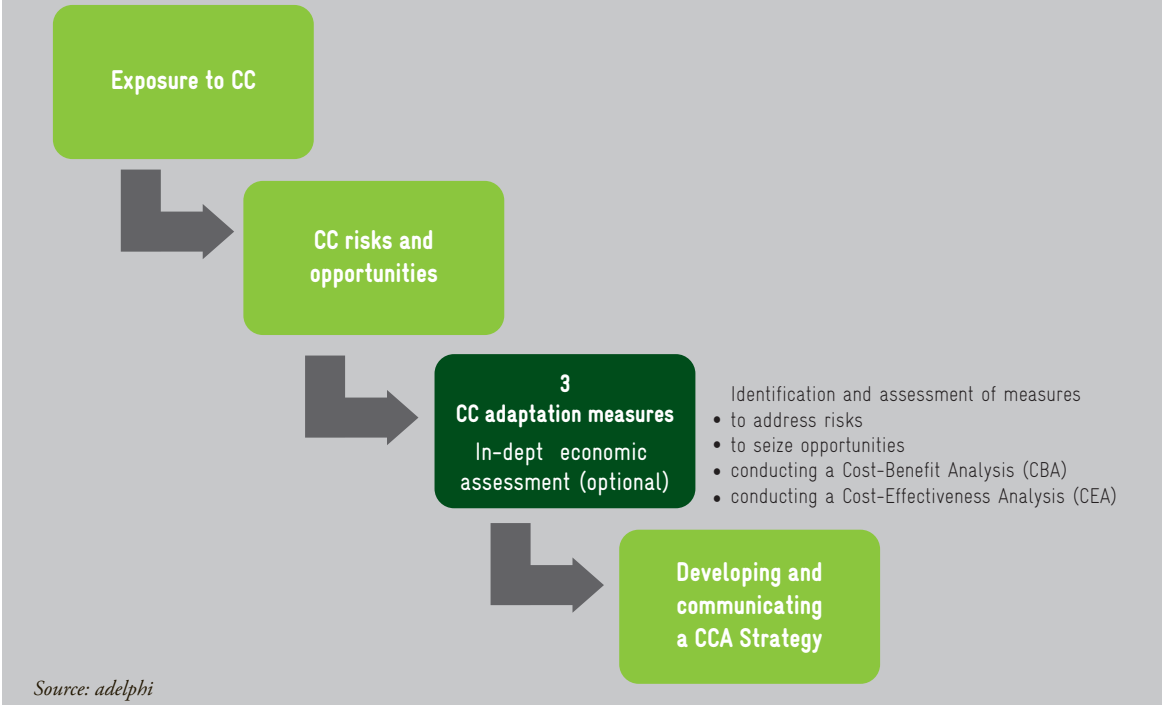
Table 8	Prioritised risks for the CC phenomenon "Heat Waves"
Priority Level A	• Quicker overheating of machinery (2) • Increasing frequency of power-cuts from grid (2) • More frequent production delays at suppliers with high water, energy and labour inputs (3) • Decreasing alertness of employees (4) • Increasing frequency of heat-related health problems of employees (4)
Priority Level B	• Increasing dust occurrence (2) • Rising costs for energy, water, and labour inputs at suppliers (3) • Increased heat stress for drivers from suppliers to factory (3) More frequent handling stains on sensitive garments (3) • Increasing heat-stress of people in communities (4) • Limited productivity of employees (4) • Decreasing availability and quality of water at community level (4) • Increasing need of drinking water for employees (4) • More stringent standards for insulation of buildings (5) • Increasing expectation of purchasers regarding employees´ health (6) • Increasing insurance costs for buildings and infrastructure (7) • Growing environmental, social and risk management expectations of investors and financial institutions (7) • Reduction of capital base due to increasing costs (7)
Priority Level C	• Deteriorating road conditions on site (1) • Increased expectations of buyers to have very light clothing in product portfolio (6)

(1 = Location & Buildings | 2 = Processes | 3 = Logistics & Stocks | 4 = Employees & Community | 5 = Government & Regulation | 6 = Market | 7 = Finance)



6 Climate Change Adaptation Measures – STEP 3

Figure 5 Methodology of the workbook



Source: adelphi

6.1 Measures for addressing risks 3

This section builds upon the risk assessment and pre-selection of risks and develops CCA measures for the prioritised risks in order to reduce the company´s vulnerability of affected impact areas by climate change phenomena. Your client is asked to first define and then to rate CCA measures in different categories in order to specify a priority level and formulate next steps.

Purpose and content of the worksheet

The purpose of this worksheet is to provide assistance for your client in choosing appropriate CCA measures to be implemented as part of designing a CCA strategy. Hence, the worksheet is designed to enable your client in assessing identified CCA measures in terms of their effectiveness, feasibility and concerning their side effects. As a result, your client has a comprehensive base for prioritising CCA measures and to conclude which next steps should be taken.

Important categories

Risk: The risk which was identified in Step 2 "Risk assessment" is stated.

Priority: The priority of addressing the risk is noted. Again, the priority can be filled in directly using the results from Step 2.

Adaptation measure: In this column all possible adaptation measures that can lower the respective risk are noted. This is an important step and should include adaptation measures of various types and time frames. As these adaptation measures will be assessed afterwards, you should not hesitate to also write down measures which do not have a clearly positive impact on first sight. During the assessment phase it could turn out that certain measures are more appropriate for other risks or that they offer more opportunities than was expected before.

Technology level: After stating the CC risk, its priority level and the addressing CCA measure, the first assessment step is to rate the technology level of the CCA measure. For example, a ventilation system can be low-tech (improving the ventilation through wind shafts) as well as high tech (installing automatic ventilators and air conditioners).

Effectiveness: How effectively does the measure reduce the risk? (×2 in case study): The next steps of the assessment include rating the measure's effectiveness for risk reduction, feasibility and positive and negative side effects. In order to do so, we once again make use of a scoring system similar to the one used in the worksheet "Risk assessment". Again the rule applies that the higher the score the stronger the agreement with the respective category ("5" would represent, for example, "high effectiveness", "high feasibility", "many positive side effects" or "many negative side effects"). In this case, it is important to rate the respective categories relative to each other; thus, it may be necessary to adjust all assessments in a final step. For example, if you assessed the effectiveness of a measure as "5/very high" but it turns out that several other measures will be more effective, this particular measures' effectiveness could be downgraded to a "4".

With the help of this particular column it is decided how effectively the measure reduces the risk. **Since effectiveness of risk reduction is the main objective of the measure and accordingly of high relevance for its priority level we propose to multiply the score by 2.** As mentioned before, it is up to your and the company's discretion to adapt the relative weighting of each criterion.

Feasibility: The next stage is to assess the feasibility of the CCA measure which determines the level of difficulty of its implementation.

- Technical feasibility: assesses the company´s knowledge and ability to implement the measure using own technical means.
- Organisational feasibility: examines the company´s internal capacities and resources to implement and maintain the measure independently and to integrate its realisation into existing processes without the necessity of acquiring or building up new capacities.
- Financial feasibility: the three categories of financial feasibility refer to financial figures in order to consider the investments and running costs of the implementation as well as its expected amortisation period. The amortisation period is mainly relevant for those measures that have positive side effects, e.g., increase of energy efficiency. If production stops can be reduced considerably, then it is the avoided costs resulting from this measure that should be figured in.

Positive side effects: The next two categories assess the degree of positive and negative side effects of the respective CCA measure. "Potential for reducing costs" refers to cost reductions for the company (e.g., reduced energy costs due to better insulation or more energy efficient machines). "Synergies with other CCA measures" refers to the realization of synergy effects from the implementation of more than one measure leading to lower investment and running costs than implementation of a single measure only. "Contributing to climate protection" evaluates the positive side effect of CCA measures regarding mitigation (e.g., reduction of GHG). "Contributing to other sustainability goals" considers positive side effects for topics like biodiversity conservation, the assurance of decent working conditions, contributions to increasing living standards within

communities and improvement of ecological and social standards within the whole supply chain. The category "reversibility / flexibility" refers to the required expenses for reversing or changing a CCA measure once it has been implemented.

As above, your client has the opportunity to add additional categories to supplement the assessment by adding additional positive side effects. For example, you could add the categories "contribution to reputation management" and "skill development" (as we will assess in the opportunities sections).In this respect, it is important to decide on a scaling and determine the relevance of the additional category for the ultimate priority level.

Negative side effects: Negative side effects of implementing a CCA measure relate to "negative social / community impacts" which can result in difficulties for implementation (e.g. by limiting the community's access to resources). Further categories are "Negative environmental impacts" (e.g., increasing GHG emissions due to increasing use of air conditioning) and "Negative impacts on existing approaches" (e.g., increasing use of ventilation and air conditioning during heat waves increases the probability of power cuts from grid) caused by the implementation of the respective CCA measure. Additional categories can be added by your client (for considerations in this respect see above at additional measures for positive side effects).

Conclusion:

- **Sum:** the points assigned for "effectiveness", "feasibility" and "positive side effects" are added up. The points for "negative side effects" are subtracted.
- **Priority:** Each adaptation measure is prioritised according to the sum of points it has reached. While "A" indicates the highest priority, "C" is the lowest. You need to decide the exact scaling of this prioritisation as it would vary if you added further assessment criteria. This would also need to be adjusted if you changed the weighting of each criterion for the final score.

Notes and comments: Finally, notes and comments are written down in order not to forget critical points that do not necessarily fit into this assessment grid but are important to consider.

Additionally, it is possible to multiply those categories that are of special importance for the company by a weighting factor (e.g. 1.5 or 2). It is up to your and the company's discretion to adapt the relative weighting of each criterion. It is important to realise that the table that you are developing jointly should not be treated as a final result but as a result for a structured discussion that needs to be verified and repeated regularly.

How and when to use this worksheet

The worksheet below supports your client to assess all the above mentioned characteristics and side effects of identified adaptation measures.

Time required

Preparation: 2 days of climate data research and analysis (same work as for the past impacts worksheet)
Assessment: 2 h (less if assessment grid results have been transferred and reviewed by you)
Documentation: 3 h

Participants

Top management, lead engineer

Aim of the consulting session

The consulting session aims to identify the most appropriate measures according to a set of criteria; the criteria suggested here can be used for a general assessment, but also adapted to each company. Furthermore, the criteria can be weighed differently if they vary strongly in importance or relevance for the company.

Your task: The first step and a task of high importance for you is to support your client in identifying adaptation measures. In order to receive a comprehensive set of adaptation measures you need to build upon your experience and knowledge regarding generic and / or industry-specific CCA measures. In addition, you need to consider the client-specific conditions regarding the exposure to CC as well as its sensitivity and adaptive capacity. Therefore, it is valuable to make use of the former assessment steps and develop CCA measures in close collaboration with your client.

After stating the CC risk, its priority level and the addressing CCA measure, the first assessment step is to rate the technology level of the CCA measure; this is done to characterise the measure's technological complexity. For example, a ventilation system can be low-tech (improving the ventilation through wind shafts) as well as high tech (installing automatic ventilators and air conditioners). The next step is to rate the measure´s "effectiveness for risk reduction" which is supposed to be the main objective of the measure and accordingly of high relevance for its priority level.

In the end, the prioritisation is conducted by adding the different assessment results while subtracting negative impacts. In the end, this comprehensive assessment enables your client to define a priority level for the considered CCA measure as well as to decide on a starting point for implementation.

Results from the case study

Weighting factor used: Effectiveness is doubled

Priority grading:
Risk A: 35-60 **Risk B:** 26-34 **Risk C:** 0-26

The CCA measures addressing the "A" prioritised risks resulting from the CC phenomena "Increasing frequency and intensity of heat waves" are stated below.

After assessing all potential CCA measures, the following were evaluated with the **priority level "A"** and accordingly are: "Improve building **insulation**" in response to the overheating of machinery, "Installation of **solar panels**" as effective in responding to power cuts and, "**Diversify suppliers** / identify less vulnerable regions" with regard to problems in the supply chain due to heat wave occurrence.

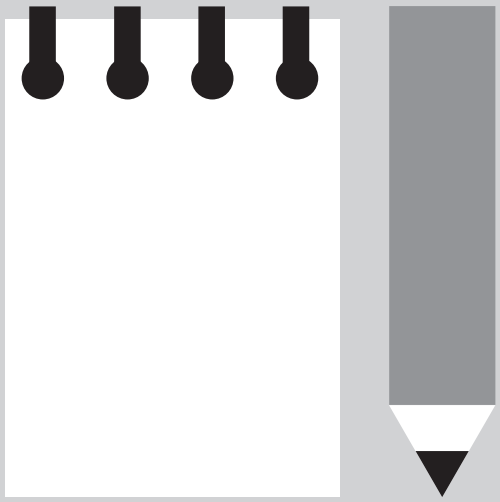


Table 9 List of measures for addressing risks

			Technology Level				Feasibility*					
Risk	**Prio**	**Adaptation measure**	**Low-tech**	**Mid-tech**	**High-tech**	**Effectiveness (x2)**	**Technical feasibility**	**Organisational feasibility**	**Financial feasibility: investment**	**Financial feasibility: Running costs**	**Financial feasibility: amortisation period**	
Quicker overheating of machinery	A	Improve building insulation	X			5	5	5	3	5	2	
		Ventilation during night times	X			3	5	5	2	1	4	
		Facade and roof greening	X			1	3	3	2	2	1	
		Purchase of new sewing machines/ packaging machine which are more heat-resistant		X		4	4	1	1	3	3	
		Install air conditioning system		X		5	4	1	2	1	2	
Increasing frequency of power-cuts from grid	A	Increase number of diesel generators		X		3	5	4	1	1	2	
		Installation of solar panels			X	3	1	3	1	3	4	
More frequent production delays at suppliers with high water, energy and labour inputs	A	Increase the storage volume for input materials	X			3	4	4	3	3	3	
		Diversify suppliers/ identify less vulnerable regions	X			3	5	3	5	5	0	

	Positive side effects*					Negative side effects*					Notes and Comments
	Potential for reducing costs	Synergies with other CCA measures	Contributing to climate protection	Contributing to other sustainability goals	Reversibility/ flexibility	Negative social / community impacts	Negative environ-mental impacts	Negative impacts on existing measures	Sum	Prio	
	3	0	2	1	0	0	0	0	36	A	Make full cost-benefit calculation before deciding
	0	1	2	0	2	0	0	0	28	B	Effective but costly
	0	0	1	2	1	0	0	0	17	C	Effectiveness not clear
	4	4	1	0	0	0	0	0	29	B	Relatively effective but organisational challenge, as employees need to train on new machines; additional energy consumption likely
	0	2	0	0	2	0	0	0	24	C	Very costly investment and running costs
	0	0	0	0	3	0	-2	0	20	C	Easy to implement and relatively effective but negative environmental impacts
	4	4	4	4	2	0	0	0	36	A	Effective; decreasing grid energy consumption. High investment costs; need to assure technical feasibility
	4	2	0	0	1	0	0	0	30	B	Easy to implement and relatively effective; potential for cost cutting through hedging and bulk purchases
	4	2	0	0	5	0	0	0	35	A	Easy to implement and relatively effective; potential for additional cost cutting through stronger negotiation standpoint

6.2 Measures for seizing opportunities / new markets 3

Purpose and content of the worksheet

The worksheet is helping your client to systematically assess new opportunities resulting from various climate change phenomena which have been identified within the assessment grid of step 0.

Important categories:
Climate phenomenon: All climate change phenomena that are presently experienced and expected to occur in the future within the respective regions of the company's markets / customers are stated. The information for this and the following 4 columns can be derived from worksheet "Assessment of new opportunities".

Target market: Most important target markets and/or customers are stated. They should be grouped roughly into regions that belong to the same climate zone and/or the main type of products that they purchase.

Expected market changes: Which impacts is climate change expected to have on the company's markets / customers? Changes could include the demand for new or specialised products or the increase / decrease of purchasing power.

Timing / urgency: How soon could expected changes occur?

Potential product / service / innovation: Based on expected market changes and their timing, it is assessed which potential products, service or innovation the company can offer its customers.

The next steps of the assessment include rating the measure's effectiveness, feasibility and positive and negative side effects. In order to do so, once again a scoring system similar to the one used in the worksheets of Step 2 is used. Again the rule applies that the higher the score the higher the agreement in the respective category. As mentioned before, it is up to your and the company's discretion to adapt the relative weighting of each criterion.

Expected revenue generation / Current market demand (×2 in case study): Within this first step the effectiveness of a product, service or innovation is rated. This assessment has two aspects

- Additional revenue that can be generated by realising the opportunity
- Likely demand for the product, service or innovation

Revenue / Market demand of 1
- The revenue would only be of marginal interest to the company
- The market demand for the product, service or innovation does not yet exist

Revenue / Market demand of 3
- The revenue generated would be relevant for the company
- The market demand for the product, service or innovation already exists

Revenue / Market demand of 5
- The revenue generated would be important and could shift the core business of the company
- The market demand for the product, service or innovation is already strong

The in-between scores of 2 and 4 should be given if in comparison with other opportunities revenue or market demand is deemed higher or lower or if only one criterion of the higher score is fulfilled.

Please note that in this section it is not possible to rate with 0. This results from the fact that only actual and

relevant opportunities are considered. Any situation that has no revenue relevance or no market demand does not qualify as an opportunity and thus should be dropped from the list.

In the next three columns the technical, organisational and financial feasibility of the innovation are assessed.

Technical feasibility: Technical feasibility examines the company´s knowledge and ability to realise the innovation using its own technical means.

Organisational feasibility: This aspect assesses the company´s capacities and resources to realise and further develop the innovation independently and to integrate it into existing processes without the necessity of new capacities.

Financial feasibility: This column considers the investments and running costs of the implementation as well as its expected amortisation period and whether the company can finance the product development, production and marketing.

Sum: Here, the results from the previous columns are added up.

Prio: Each adaptation measure is prioritised according to the sum of points it has received. This would need to be adapted according to the number of assessment criteria and in view of weighting factors.

Conclusion: The outcome of this assessment can be summarised in a conclusion. According to whether priority and feasibility are high, the adaptation measure should be adopted, further developed or delayed in favour of other, more important adaptation measures.

Again, it is possible to multiply those categories that are of special importance for the company by a weighting factor (e.g. 1.5 or 2). It is up to your and the company's discretion to adapt the relative weighting of each criterion. It is important to realise that the table that you are developing jointly should not be treated as a final result but as a result for a structured discussion that needs to be verified and repeated regularly.

How and when to use this worksheet

In addition to the measures that can lower the identified risks, your client should also be enabled to identify and realise opportunities. Therefore, each opportunity identified before is assessed by several categories, starting from the geographical region regarding the arising market opportunity as well as referring to the triggering climate change phenomenon.

Time required

Preparation: Documentation of the opportunities assessment; research on the various opportunities – app. 3 h
Assessment: 2 h
Documentation: 2 h

Participants

Top management, lead engineer, marketing department, customer relations/sales department

Aim of the consulting session

It is asked to specify the expected market change, the urgency and the potential product / service as a response to the changing market conditions. Also, the technical feasibility is assessed as well as a rough financial feasibility and the internal / organisational feasibility. These assessments combined with the outlook of the potential product / service / innovation assist in making a sound decision on opportunities and help comparing the costs and benefits of the different options.

Your task as the consultant is to support your client in completing this opportunity assessment as accurately as possible. As a result, the approximate probability of realising benefits when seizing the market opportunities should be stated by your client. In the end, each opportunity is to be prioritised in one of three categories (A, B, C) regarding the analysis, resulting from all the categories assessed before. This prioritisation is followed by a discussion on how to implement measures to achieve the identified market opportunity. It is likely that further market research is necessary to verify the assessment. Your task may be to assist your client in doing further market research and obtaining data.

Results from the case study

Weighting factor used: Effectiveness/ likelihood of business is doubled.

Priority grading: A 20 - 25 B 13-20 C 3-12

The case company being situated in the textile industry has identified market opportunities in the development of new garments. "Increasing frequency and intensity of heat waves" as an accompanying effect of overall rising temperatures in India provides an opportunity for the case company to take advantage of already recognisable changes in customer preferences for lighter clothing. Another opportunity is arising in terms of an increasing demand for apparel made from fabrics with cooling effects. This trend is especially significant for markets in Europe and Canada but requires more in-depth market research in those regions before investing in research and development activities.

Table 10 Measures for seizing opportunities / new markets

Climate phenomenon	Target market	Expected market changes	Timing /urgency	Potential product / service / innovation	Revenue /Market (x2)	TF*	OF*	FF*	Sum	Prio	Notes and comments
Increasing number of hot days	India, retailers	Increased demand for light clothing	Already noticeable, continuous growth expected	Apparel designs with high ventilation properties (loose cuts, thin fabrics); advertise them to retailers as responsive to CC trend	5	5	4	3	22	A	Develop product; identify innovative ways to market, e.g., clusters
	India, retailers	Shorter winter season and increase in hot days decrease necessity to vary items of clothing, thus less purchases; trend to increase variety of items and sales circles per season	Already noticeable	Connect with retailers on CC driven consumer trends; join already existing trend to increase the variety of items per season (pre-season, 2 seasonal collections, after-season); production peak in winter	2	5	4	5	15	B	Identify retailers that have already serviced the trend; market products to them.
	Europe, Canada, brands	Increased demand for apparel made from fabrics with cooling effects	Notable today particularly in the sports apparel market; next 5 years	Build up apparel line with cooling fabrics	5	2	3	2	17	B	Explore cost of new material, machinery, etc.

TF: Technical Feasibility, OF: Organisational Feasibility, FF: Financial Feasibility

* 0= non-existent // 1 = very low // 2 = low // 3 = medium // 4 = high, // 5 = very high

6.3 In-depth economic assessment of adaptation measures: Cost-Benefit Analysis (CBA) & Cost-Efficiency-Analysis (CEA)

In Step 3, adaptation measures for the most pressing risks have been identified and prioritised based on a qualitative assessment, i.e. a multi-criteria analysis (MCA). Sub-step "In depth: economic assessment" allows to also conduct a quantitative economic assessment of the measures using CBA and CEA which can further help to prioritise the measures according to the greatest economic benefits to the company,

Climate change impacts can lead to costs (as well as benefits) for your client's company. Damages through flooding, disrupted supply changes or spoiled products as result of a climate change event may reduce a company's profits.

This economic view on climate change is probably the most convincing argument you can offer enterprises for developing an adaptation strategy. Adaptation to climate change allows reducing the potential damages and thus costs. With the economic assessment approach introduced in this section of the manual, you can estimate together with your client which savings can be achieved by implementing a certain adaptation measure compared to others.

For the economic assessment of adaptation measures, two different approaches are applied: Cost-Benefit Analysis (CBA) and Cost-Effectiveness Analysis (CEA). In the approach chosen for the CBA only those measures are selected for an assessment that have a positive effect for the company even in the absence of climate change impacts. Yet, measures assessed under the CBA always target an area which may potentially be affected by climate change. For example, measures that generate water, energy or other resource input savings can most likely always be considered in a CBA. By conducting the CBA five result figures are calculated: the **Net Present Value (NPV)** indicating the difference between discounted costs and discounted benefits of a measure over its entire lifetime, the **Cost-Benefit Ratio (CBR)** providing the ratio of discounted costs of the measure over the discounted benefits of the measure for its entire lifetime, the **Return-on-Investment (RoI)** showing the money saved with the investment measured in percentage of the total invested sum, the **Internal Rate of Return (IRR)** being the discount rate which will cause the NPV of the investment to equal zero and the **payback period** giving the time it will take for the undiscounted annual benefits to equal the initial investment costs. By comparing the figures of different measures with each other the enterprise can decide which of the measures is most cost-efficient.

If the CBA result figures are positive for a measure it means that the measure is a 'no-regret' measure. Given that all values chosen in the calculation are correct the company will not make any losses through the measure. Moreover, if climate change impacts occur the company will most likely make additional benefits.

The CEA does take into account climate change impacts. Different from the CBA, the CEA, however, does not calculate with absolute savings but rather in reduced profit loss. The CEA result figures are the **"avoided profit loss" in percent of total profit** achieved by implementing the measures as well as the **Cost-Effectiveness Ratio (CER)** which is an adjusted cost per unit of reduced profit loss.

Combining the results of both economic assessments allows the evaluation of measures with and without climate change. On this basis and be considering the results of the previous assessment steps, the enterprise can decide which adaptation measures are most relevant for implementation.

Before starting with the assessment approach two important terms need to be introduced that will be used throughout the following sections: **cost-efficiency and cost-effectiveness**. Following a popular definition, efficiency means "doing things right". It refers to the relation between input and output. Cost-efficiency

thus refers to the relation of costs required for producing a certain unit of benefit. The optimal efficiency is therefore the maximization of the benefit-cost ratio (or the minimisation of the cost-benefit ratio respectively). Effectiveness, on the other hand, is about "doing the right things". Usually, and as shown in the section on CEA, effectiveness refers to a qualitative goal rather than a quantitative goal (or benefit). One could ask whether a certain measure is effective in achieving a predefined goal. Two measures could be effective in fully meeting the requirements to achieve the goal, yet one of the two would require less inputs than the other – thus one would be more (cost-) efficient than the other. Speaking of cost-effectiveness brings quantification back into the game. Cost-effectiveness asks for the measure that is most cost-efficient, the two could be used as synonyms. Therefore we will only be using the term cost-efficient in the part on CBA. In the CEA, we speak of cost-effectiveness as the objective to be achieved is not (directly) monetary. Whereas in the CBA monetary cost and benefits are compared, the CEA considers costs required for achieving a non-monetary objective [1].

6.3.1 Cost-Benefit Analysis

Economic assessment of adaptation measures: Cost-Benefit Analysis (Worksheet Step 3.3a)

Purpose and content of the worksheet

Quantification of costs and benefits in monetary terms/economic figures is a general task particularly relevant for business operations. It helps the enterprise to compare and prioritise measures and hence identify the most suitable, effective and cost-efficient adaptation measures. This enables the company to make informed decisions for resource allocation.

The goal of this worksheet is to gain an **overview over adaptation measures for which a Cost-Benefit Analysis (CBA)** is relevant. Even though, usually, the benefit of an adaptation measure is its potential to reduce climate-induced damages and losses, we focus here on adaptation measures that achieve additional cost-savings and/or additional revenues **independently from any change in climate**, i.e. in the absence of any future climatic changes (so called 'no-regret measures'). By doing so, we avoid having to determine the exact monetary costs and benefits of uncertain, future climate impacts. Instead we identify benefits, which can be **realized instantly after the measure is implemented** and which are therefore much easier to grasp and verify. Although we do not factor in uncertain future changes in climate, these measures do address impacts of climatic changes and climate variability that are already recognisable [Note: If you aim to quantify the costs and benefits of climate change under uncertainty you can conduct a Cost-Effectiveness Analysis (CEA), which is explained in the next chapter and conducted in the worksheets 3.4a to 3.4e]. Even further, it is likely that **most companies are already familiar** with terms such as energy or resource efficiency and productivity gains. All of this makes monetisation of costs and benefits a lot easier.

Important categories:
Risk addressed (column B): Here, the risks which are tackled by the identified adaptation measures are noted. This is to help you remember exactly what the purpose of each adaptation measure is and, thus, what its implementation will target.

Adaptation measure (column C): In this column, all adaptation measures identified in worksheet "3.1 Measures-Risks" that can realistically be implemented and have a high priority for the company (A or B) should be listed.

Footnotes

1 See Carl von Ossietzky Universität Oldenburg - Center für lebenslanges Lernen (C3L). Online at: http://www.c3l.uni-oldenburg.de/cde/COLproject/web-col/concept.htm

Cost reductions and revenue generation (column D): This step serves to identify whether and to which extent the adaptation measure will achieve cost reductions and/or revenue generation irrespective of climate change. The identification of these measures can be guided by the considerations undertaken in worksheet "3.1 Measures-Risks" – all adaptation measures which achieve additional positive side effects by reducing costs (column Q "Potential for reducing costs") or generate additional revenues are relevant. In a next step, it should be considered whether these additional benefits can be quantified easily or not. Writing this down already gives a first orientation on whether a CBA is relevant for this measure. In order to avoid complex quantifications under uncertainty it is recommended to only conduct a CBA for those measures that have the potential to generate cost-savings or additional revenues even in the absence of any climatic changes.

Conduct CBA or not (columns F&G): At this point, it will be decided which adaptation measures will be assessed using the CBA. It is recommended that only those measures are selected for conducting a CBA, which have clear cost-savings or the potential for additional revenue generation. Also, economic figures for costs and benefits need to be easily quantifiable and available.

How and when to use this worksheet

Your task is to support your clients in selecting/identifying those measures out of all the previously identified adaptation measures for which a Cost-Benefit Analysis (CBA) should be conducted. You should have some examples ready.

Time required
Preparation: 15 min
Assessment: 30 min

Participants
Top management, lead engineer, lead controller

Aim of the consulting session
The consulting session should make clear to the participants under which conditions, i.e. for which types of adaptation measures, the CBA makes sense and can generate useful results for informed decision-making for resource allocation. A crucial criterion is that adaptation benefits need to be quantifiable in monetary terms. The CBA should be applied to evaluate adaptation measures when cost-efficiency is the most important criterion and decision-makers are not sure which adaptation measure achieves the greatest monetary benefits or which one is the least costly [Note that cost-efficiency refers to the relationship of costs and benefits: the lower the costs compared to the economic benefits, the more cost-efficient the measure]. It should also be communicated that other criteria such as feasibility are disregarded and that this method requires extensive information in monetary terms on the various costs, savings and additional benefits of the measure. Quantification in monetary terms is not always easy or possible and the participants need to understand that an inappropriate discount rate will lead to distorted results.

Your task as the consultant is

- to support your client with identifying measures for which a Cost-Benefit Analysis should be conducted and
- to communicate the necessary criteria for and use of a successful CBA.

We suggest to look at the list of identified and qualitatively prioritised CC risks and their respective potential adaptation measures (see worksheet "3.1 – Measures-Risks" and Chapter 6 in this manual) and **discuss the availability of the necessary quantitative information on their costs and benefits with your client**. In this context, you should also draw on your analyses from observing the company's operations and documentation of financial information. For each of the identified adaptation measures relevant for conducting a CBA, list the CC risk the measure responds to, the measure itself as well as an indication whether the measure will directly reduce

costs or generate additional revenue in the table. In the column "Conduct CBA", please mark those measures you and the client decide to apply a CBA to.

Results from the case study

The CCA measures (1) "Improve building insulation" and (2) "Purchase of new sewing machines/ packaging machine that are more heat-resistant" in response to the CC risk "Quicker overheating of machinery", as well as (4) "Installation of solar panels" in response to the risk "Increasing frequency of power cuts" were selected to conduct a CBA for. For the following worksheets, the components of the CBA will be illustrated using the adaptation measure (1) "Purchase of new sewing machines/ packaging machine that are more heat-resistant" as an example since it is assumed to have the greatest cost reduction potential among the measures addressing the risk of overheating machinery. Results will be briefly discussed for all three relevant adaptation measures.

Table 11 Overview of adaptation measures (worksheet "3.3a – Economic assessment CBA") A Cost-Benefit Analysis is relevant for the following measures:

#	Risk addressed	Adaptation measure	Does the measure directly reduce costs or generate revenues in an easily quantifiable way? (without consideration of CC impact)	Priority of adaptation measure	Conduct CBA?	
					Yes	No
1	Quicker overheating of machinery	Improve building insulation	**Yes** (generates additional revenue by reducing the days when about 30% of machinery breaks down from 10 to 4 days p.a.)	A	X	
2	Quicker overheating of machinery	Purchase of new sewing machines/ packaging machine that are more heat resistant	**Yes** (generates additional revenue by reducing the days when about 30% of machinery breaks down from 10 to 2 days p.a.)	B	X	
3	Quicker overheating of machinery	Install air conditioning system	**No**	C		X
4	Increasing frequency of power-cuts from grid	Installation of solar panels	**Yes** (reduces annual electricity costs of grid-electricity and diesel by producing about 7% of power consumed)	A	X	
5	Increasing frequency of power-cuts from grid	Increase number of diesel generators	**No**	C		X

CBA - COSTS of adaptation measures (Worksheet Step 3.3b)

Purpose and content of the worksheet

This worksheet serves to determine the total undiscounted costs, which will be necessary to implement the adaptation measures. These costs consist of I. investment costs and II. operating costs.

Important categories:
Currency: Here, it is clarified which currency the monetary costs (and later on also the monetary benefits) will be expressed in.

Risk & Adaptation measure: In these two boxes, the risk and the corresponding adaptation measure to be assessed are filled in (you can copy risks and corresponding measures from sheet 3.3a - Economic assessment CBA). Each adaptation measure which is to be assessed with a CBA according to the previous sheet (3.3a - Economic assessment CBA) gets a separate cost table, so that eventually there are as many tables as adaptation measures for which a CBA is conducted.

Cost categories: In this row, all costs that will be incurred to implement the identified adaptation measure are summarised in two categories, namely the I. one-time/initial investment costs during the first year (e.g. for purchase of new equipment) and II. the on-going operating costs (e.g. resource inputs such as raw material, energy, water, labour etc. as well as maintenance) for a certain timescale/period of time which has to be selected/defined.

Cost components of cost categories: In this row, it is possible to further specify the expected cost categories into cost components. For both investment costs and operating costs it is possible to collect up to three cost components. For investment costs, these could be purchasing costs, delivery costs and installation costs or the costs for hiring a company to hold energy efficiency seminars. Regarding operating costs, it might be relevant to think of overhead costs, incremental costs and maintenance costs. Cost components can be different for each adaptation measure. However, it is not always necessary to identify particular cost components. It is also possible to proceed using only the two overall cost categories I. investment costs and II. operating costs, if these cannot be split into different cost components.

From/To cost ranges: In these columns, the lowest and highest possible costs to implement the adaptation measure are filled in. Using cost ranges helps to express estimations of costs when factoring in different future cost developments or general uncertainty about costs. However, the worksheet will also automatically calculate the average costs in order to make the results of the CBA better comparable and representable. Note that while investment costs arise only in year one, operation costs will occur in all years during which the measure is used. Costs ranging up to ten years into the future can be included.

Undiscounted total costs per year (columns R, S, T): In these columns, the lowest, highest and average total costs per year are displayed. They are calculated automatically by adding up the cost components under "investment costs" and "operating costs".

Sum of undiscounted total costs over all years: Finally, this row presents the sum of undiscounted total costs over all years. This worksheet discounts the costs over a time period of ten years, as this is assumed to be the average life time of adaptation measures [Note that if you wish to extend the total number of years for your calculations the worksheet and its formulas need to be adapted accordingly].

Box 1 **Differentiating total and net costs and benefits**

Please note that you have to decide between **two different methods for calculating costs and benefits for measures** which require some kind of operating costs that also occur without the measure being implemented. Adaptation measures that have no operating costs (e.g. for maintenance) but only investment costs do not require a choice between the two calculation methods.

The main difference between the two methods is that one does consider operating costs of measures which already have operating costs today in the 'cost' category (method 1.), the other one doesn't (method 2.). An example can outline this difference: think of the measure of investing in a more efficient diesel generator to replace the old (inefficient) one. The new diesel generator of course has operating costs as it requires diesel for generating electricity, let us assume 20 litres of diesel per day. The old diesel generator consumed 30 litres per day producing the same amount of electricity. There are **two options to calculate costs and benefits:**

1 Method 1: Costs for this measure are the one-time **investment costs** for purchasing the new generator **as well as the operating costs** of 20 litres per day; this means that **benefits are the saved costs** of 30 litres per day (for the old generator not in use anymore) which are entirely saved **(total benefits).**

2 Method 2: Costs for the measure are **only the investment costs**; benefits are the costs of 10 litres of diesel saved per day **(net benefits)**.

As an example you will find a table below that shows both methods for calculating the benefits of purchasing a new diesel generator that reduces the amount of diesel required for producing electricity. Cells marked in green show the benefits for method 1, cells marked in blue show the benefits for method 2.

This decision will determine whether you can compare some of the results of the CBA, i.e. Cost-Benefit Ratio (CBR), Internal Rate of Return (IRR) and Return on Investment (RoI), with those measures that are calculated by using the other method [Please consult the results section "3.3d - RESULTS of the Cost-Benefit Analysis" below for an explanation of the CBA results figures].

Costs and savings	Annual operating costs of				= Additional cost savings/year	
	1 old diesel generator		1 new diesel generator			
	From	To	From	To	From	To
Diesel	283,500.00	311,850.00	212,625.00	233,887.50	70,875.00	77,962.50

Both options will result in the same NPV, but RoI, IRR and CBR will be higher for option 1. The advantage of using method 1 is, however, that it is made transparent in the calculation which operating costs are expected. Which method to choose depends on the other measures that the adaptation measure in question is supposed to be compared with.

It is always to be discussed between the company representatives and the consultant and decided on a case-by-case basis which method should be chosen. For ensuring that the client understands that a measure does not eliminate operating costs entirely, method 1 is to be preferred. For comparing all five result figures (NPV, CBR, RoI, IRR and payback period) of measures directly with each other, method 2 is to be preferred.

How and when to use this worksheet

Time required
Preparation: 1 day for the collection of information on the costs associated with the adaptation options. The time can of course vary with the number of assessed adaption options.
Assessment: 2 h for filling in the information and discussing the costs estimates with your client.
Documentation: 1 h

Participants
Top management, lead engineer, lead controller

Aim of the consulting session
The consulting session should serve to assist your client in quantifying the costs of the selected adaptation measures and understanding the necessary cost components that have to be considered in order to determine overall costs. For each measure, all associated costs need to be stated in monetary terms.

Your task as the consultant is to support your client in **identifying all underlying cost components of the adaptation measure** as well as in acquiring additional cost information, if necessary. We suggest starting by compiling an overview of the information needed in a table and gathering the values together with your client. How such a table could look like is shown for the example of electricity costs in box 2 below. The necessary cost data depends on the type of business and varies by sector. You have to draw upon your experience and your assessment of the client company. For measures such as installing new machinery, various operating costs of existing machinery need to be accounted for (ideally for each unit of machinery; otherwise derived from total numbers) in order to assess how these differ from investment and operating costs of new machinery. Operating cost components include costs for inputs such as water, electricity / energy, chemicals, raw materials, maintenance / repair or labour. Some of these costs may be derived from costs of fuel such as diesel or fuel wood, if electricity for production processes or energy for a (water) heating process is generated on site. Make sure to explain any cost components or units of measurement that may be unclear to your client. You will have to **make sure that all necessary cost information is available and recorded**. It may, of course, be the case that a measure only requires an initial investment and no further operating/maintenance or opportunity costs. Together with the client it is also your task to identify the required investment costs for the measures. There may be different machine types, ventilation systems etc. and you have to decide with the client on a **realistic price range** for the investment costs.

Results from the case study

The case study company IndTex currently experiences the break-down of about 30 percent of its machinery on ten days per year on average due to heat waves. The CCA measure (2) "Purchase of new sewing machines/ packaging machine that are more heat-resistant" in response to the CC risk "Quicker overheating of machinery" aims to reduce this figure to about two days per annum by replacing sewing machines and the packaging machine, which are subject to break-downs on extremely hot days. There are initial investment costs in year one as well as different types of operating costs in each year of the machinery's operation. This measure replaces all 70 existing sewing machines as well as the one packaging machine (see "I. Investment Costs" in table 12). The operating costs are split into the components "Electricity", and "Labour" (see "II. Operating Costs" in table 12). The worksheet then calculates the undiscounted lowest, highest and average total costs (aggregated) for all **new machines for each year** as well as for the total ten years of operation considered for this CBA.

Electricity costs for the operation of new machinery are calculated by multiplying the annual electricity consumption of the respective machines in kilowatt hours (kWh) by the current local electricity price. This electricity price is calculated using a function that considers the grid electricity price as well as the diesel price for

generator-produced electricity, depending on each of their consumption shares. A lower and a higher figure are given for electricity consumption to account for the uncertainty regarding the actual electricity consumption of the new machinery (see box 2 below for details). Labour costs are derived by multiplying the number of workers (one per sewing machine and five for the packaging machine) by their annual salaries (see comment below table 12). It is crucial to use consistent units of measurement regarding time and quantity, i.e. to distinguish between costs per machine or for all machines, per day or per year. Please note that the calculation so far assumed that labour and electricity costs will stay the same for the next ten years in this case study. If larger changes in costs for labour or energy are expected then you can alter the undiscounted costs per year accordingly.

Table 12 Cost categories of purchasing more heat resistant machines

Cost Categories	I. Investment Costs (in INR)		II. Operating Costs (in INR)			
Cost Components	Purchase of machines		Electricity*		Labour**	
Year	From	To	From	To	From	To
1	950,000.00	1,125,000.00	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
2	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
3	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
4	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
5	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
6	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
7	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
8	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
9	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
10	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00

*) Electricity price: 8.4 INR/kWh (assumed to be stable over the next ten years)

**) Annual salary of one worker: 78,000.00 INR; one worker per sewing machine, five for the packaging machine

Box 2 **Illustration of electricity costs calculation**

These costs represent the electricity costs that the company incurs annually through the operation of 70 sewing machines and one packaging machine.

Days of operation per year	365
Hours of operation per day	9 -10
Watt per sewing machine	550
Electricity price per kWh	8.4 INR

Annual electricity consumption of sewing machines		
	One sewing machine	**All 70 sewing machines**
From	9 hrs/day * 365 days * 550 W = 1,806,750 Wh = 1,806.75 KWh	* 70 = 126,472.5 kWh
To	10 hrs/day * 365 days * 550 W = 2,007,500 Wh = 2,007.50 KWh	* 70 = 140,525 kWh

Electricity consumption of the one packaging machine	
From	12,420 kWh
To	14,110 kWh

Total annual electricity consumption (adding consumption of sewing machines and packaging machine)	
From	126,472.5 kWh + 12,420 kWh = **138,892.5 kWh**
To	140,525 kWh + 14,110 kWh = **154,635 kWh**

Total annual electricity costs (multiplying total annual electricity consumption with the electricity price)	
From	138,892.5 kWh * 8.4 INR/kWh = **1,166,697 INR**
To	154,635 kWh * 8.4 INR/kWh = **1,298,934 INR**

Table 13	Total Costs		
	Undiscounted total costs per year (in INR)		
Year	From	To	Average
1	7,966,697.00	8,273,934.00	8,120,315.50
2	7,016,697.00	7,148,934.00	7,082,815.50
3	7,016,697.00	7,148,934.00	7,082,815.50
4	7,016,697.00	7,148,934.00	7,082,815.50
5	7,016,697.00	7,148,934.00	7,082,815.50
6	7,016,697.00	7,148,934.00	7,082,815.50
7	7,016,697.00	7,148,934.00	7,082,815.50
8	7,016,697.00	7,148,934.00	7,082,815.50
9	7,016,697.00	7,148,934.00	7,082,815.50
10	7,016,697.00	7,148,934.00	7,082,815.50
Total costs over all years (in INR)	**71,116,970.00**	**72,614,340.00**	**71,865,655.00**

CBA – BENEFITS of adaptation measures (Worksheet Step 3.3c)

Purpose and content of the worksheet

This worksheet serves to determine the total undiscounted benefits, which the adaptation measures will create. These benefits consist of additional cost-savings and additional revenues that can be derived by implementing the measure.

Important categories:
Benefit categories: In this row, all benefits that the adaptation measure can generate are summarised in **two categories**, namely **I. additional cost-savings** and **II. additional revenues.**

Benefit components: In this row, it is possible to further specify the expected benefits. For both additional cost-savings and additional revenues it is possible to specify up to three benefit components. Additional cost-savings could be achieved e.g. by increasing resource efficiency for inputs such as energy and water or by reducing production steps. Installing new machinery with greater output per hour (besides efficiency increases) would be an option to increase productivity and hence increase revenues. For each measure, different benefit components can be identified. However, as in the previous worksheet, you could also proceed without specifying the expected benefits. When specifying the benefits you should again consider the box found in the previous section (box 1) on costs that explains the difference between total benefits and net benefits.

From/To: In these columns, the lowest and highest possible benefits are filled in.

Undiscounted total benefits per year: In these columns, the lowest, highest and average total benefits per year are displayed. They are calculated automatically by adding up the benefit components under "additional cost-savings" and "additional revenues".

Sum of undiscounted total benefits over all years: This row presents the sum of undiscounted total costs over all years.

How and when to use this worksheet

Time required
Preparation: 0.5 days for the collection of benefits from implementing the measure in the company. Benefits of a measure can already be collected when identifying its associated costs.
Assessment: 2 h for filling in the information and discussing the benefit estimates with your client.
Documentation: 1 h

Participants
Top management, lead engineer, lead controller

Aim of the consulting session
The consulting session should serve to assist your client in quantifying the benefits of adaptation measures and understanding the necessary benefit components. Benefits can be quantified simply by comparing costs and revenue of old procedures and/or machinery (depending on the type of measure) with the new ones after implementing the adaptation measure.

Your task is to help your client quantifying the benefits of the individual adaptation measures. As the CBA focuses on measures that generate cost-savings and/or additional revenue independently from future impacts due to climatic changes (unless otherwise specified), you have to make clear to the participants that the total benefits equal the total costs that the company saves through the adaptation measure, e.g. the operating costs of an old (inefficient) diesel generator that would be replaced through the adaptation measure. If your client would like to quantify and separately display the annual net benefits of the adaptation measure, you need to subtract the annual undiscounted costs of the adaptation measure from the costs without adaptation. This calculation determines how much cost-savings and/or additional revenue the adaptation measure generates (see box 1 above for more details).

Results from the case study

For the CCA measure (2) "Purchase of new sewing machines/ packaging machine that are more heat-resistant" in response to the CC risk "Quicker overheating of machinery", the benefits of the measure equal the (previous) operating costs that were saved by replacing the old machinery. Alternatively, the benefits could be illustrated by immediately calculating the net benefits (subtracting the new costs from the old costs and adding additional revenue). In the case study, method 1 is chosen (total benefits) and hence the operating costs for the new machinery have been included on the cost side. This method is chosen for reasons of illustration as it is more complex than method 2 and you should be familiarised with it. Method 2 is automatically applied for measures without operating costs.

On the cost savings side, the costs for running the old machinery are inserted as it is these entire (previous) costs that will be saved once the new machinery is installed [Note that the investment and operating costs of the new machinery were entered in the previous worksheet "3.3b – CBA – Costs"]. Compared to the new machinery, the old machines consume(d) less electricity as each old sewing machine has 500W, while the new and more

heat-resistant sewing machines have 550W. Labour costs of the old machinery, on the other hand, are higher because the new packaging machine increases labour productivity and only requires the labour equivalent of five full-time workers instead of ten. Both old and new sewing machines are operated by one worker at a time and hence labour costs for sewing machines do not differ in this case. The most significant benefit though, is the additional revenue the company can achieve from additional production by reducing the number of days when about 30 percent of machinery break-down from ten to two per year (see "II. Additional revenues" in table 14). Box 3 below demonstrates how the calculations were performed.

Table 14 Benefit categories of adaptation measure

Benefit Categories	I. Cost-savings (in INR)				II. Additional revenues (in INR)	
Benefit Components	Electricity*		Labour**		Reduced break-downs of machinery***	
Year	From	To	From	From	From	To
1	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
2	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
3	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
4	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
5	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
6	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
7	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
8	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
9	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20
10	1,059,954	1,176,840	6,240,000	6,240,000	1,827,074.56	2,283,843.20

*) Electricity price: 8.4 INR/kWh (assumed to be stable for the next ten years)

**) Annual salary of one worker: 78,000.00 INR; one worker per sewing machine, ten for the packaging machine

***) Days of approximately 30% of machinery breaking down reduced from ten to two days

Box 3 **Input figures for calculation of benefit components**

Electricity		
	From	**To**
Electricity consumption per year per sewing machine (assumptions)	1,642.5 kWh	1,825 kWh
Electricity consumption per year per packaging machine	11,210 kWh	12,350 kWh
Electricity consumption per year for all 70 sewing machines	114,975 kWh/year	127,750 kWh/year
(a) Cost of electricity for sewing machines at price of 8.4 INR/kWh	965,790 INR/year	1,073,100 INR/year
(b) Cost of electricity for packaging machine at price of 8.4 INR/kWh	94,164 INR/year	103,740 INR/year
Total electricity costs per year = (a)+(b)	**1,059,954 INR**	**1,176,840 INR**

Labour	
Annual salary of workers	78,000.00 INR
Workers required for operating the packaging machine	10
Workers required for operating all 70 sewing machines	70
Total annual costs for workers	**6,240,000 INR**

Additional revenue		
	From	**To**
Daily garment production affected by breakdown of machinery (30 % of total daily production)	6,940 units	
Price per garment	33.08 INR	41.35 INR
Reduction of breakdowns by 6 days (building insulation)	1,370,305.92 INR	1,712,882.40 INR
Reduction of breakdowns by 8 days (new machinery)	1,827,074.56 INR	2,283,843.20 INR

Table 15	Total Benefits		
	Undiscounted total benefits per year (in INR)		
Year	From	To	Average
1	9,127,028.56	9,700,683.20	9,413,855.88
2	9,127,028.56	9,700,683.20	9.413.855,88
3	9,127,028.56	9,700,683.20	9.413.855,88
4	9,127,028.56	9,700,683.20	9.413.855,88
5	9,127,028.56	9,700,683.20	9.413.855,88
6	9,127,028.56	9,700,683.20	9.413.855,88
7	9,127,028.56	9,700,683.20	9.413.855,88
8	9,127,028.56	9,700,683.20	9.413.855,88
9	9,127,028.56	9,700,683.20	9.413.855,88
10	9,127,028.56	9,700,683.20	9.413.855,88
Total benefits over all years (in INR)	**91,270,285.60**	**97,006,832.00**	**94,138,558.80**

RESULTS of the Cost-Benefit Analysis (Worksheet Step 3.3d)

Purpose and content of the worksheet

This final sheet of the Cost-Benefit Analysis serves two purposes: 1) it determines the discounted costs and benefits per year as well as across all years/the timescale; 2) it calculates the five key results of a CBA: Net Present Value, Cost-Benefit Ratio, Internal Rate of Return, Return on Investment and Payback Time.

Important categories:

Discount rate: Here, it is inserted which rate the costs and benefits will be discounted with. The discount rate is determined based on the market interest rate of the respective sector.

Discount Factor: The discount factor expresses how much future costs and benefits are worth today based on today's discount rate. It is automatically determined by using the formula [1/(1+r)^t], with r = discount rate and t = year.

Discounted total costs per year & Discounted total benefits per year: In these columns, the lowest, highest and average discounted costs and benefits per year are listed. The worksheet automatically calculates these figures by multiplying the discount factor by the costs and benefits which were determined on the two previous sheets.

Sum over all years: This row presents the sum of total discounted costs and benefits over all years.

Net Present Value (NPV): The Net Present Value (NPV) is the difference between discounted costs and discounted benefits of a measure over its entire lifetime. It is calculated by subtracting the discounted costs from the discounted benefits. By using discounted costs and benefits the NPV accounts for the fact that costs and benefits accruing in the future are worth less today. If the result of the NPV is positive, the adaptation measure is economically feasible in absolute terms. Through the NPV, different adaptation measures can be ranked – the higher the NPV, the higher the net benefits of this measure. The NPV of the adaptation measure is shown based on the ranges which were used to determine costs and benefits.

Cost-Benefit Ratio (CBR): The Cost-Benefit Ratio (CBR) is the ratio of discounted costs of the measure over the discounted benefits of the measure for its entire lifetime. It expresses how much money has to be spent in order to create one unit of benefit. The adaptation measure is cost-effective if the CBR < 1, meaning that costs are smaller than benefits.

Internal Rate of Return (IRR): The Internal Rate of Return (IRR) is another figure to measure and compare the profitability of investments. It is the discount rate which will cause the NPV of the risk mitigation measure to equal zero (if NPV=benefits - costs=0, then r=IRR), i.e. where the present value of total (discounted) costs equals the present value of total (discounted) benefits. This means that with the IRR used as the discount rate, costs equal benefits. Calculating the IRR follows the same logic as calculating the NPV. The main difference is that, rather than deciding on a discount rate depending upon the risk of the measure, calculating the IRR relies on an iterative solution to determine what discount rate will cause the NPV of the project to equal zero. The IRR can be calculated by trial and error by varying the discount rate in the NPV formula until the NPV is equal to 0. If this is the case the discount rate used is the IRR. Please note that also Excel uses an iterative process to derive the IRR. The IRR can be used to compare different adaptation options with each other. The higher the IRR, the greater the returns of the investment. Please note that due to the Excel calculation process a supporting calculations table is used which is found in the columns T-X. This table does not need to be altered. Please also note that Excel discounts the first year of costs and benefits whereas we have chosen to start discounting from year 2. Therefore, the NPV will not equal zero if you insert the IRR as a discount rate.

Return on Investment (RoI): The Return on Investment (RoI) is the money saved with the investment measured in percentage of the total invested sum (investment costs and operating costs). A 60% RoI means that the cost of the project and another 60 percent of these costs have been recovered. The RoI thereby puts the gains of an investment (the NPV) in relation to the costs of the investment. It is calculated by dividing the NPV by the discounted costs over the entire lifetime of the investment. The higher the RoI, the higher the returns of the project in relation to the invested sum. You should note that the RoI is therefore always dependent on the invested sum. A higher RoI does not necessarily mean that a measure generates more absolute savings than another measure with a lower RoI. For the absolute amount of savings the NPV is to be consulted.

Payback time (in years): The payback time is the time it will take for the undiscounted annual benefits to equal the initial investment costs. In other words, after how many years the company will realise net benefits. When assessing a measure for which total benefits were considered (see box 1 in section "COSTS of adaptation measures") make sure you divide the investment costs by net benefits. Also note that you should subtract low benefits from high costs and vice versa to get the respective minimum and maximum figures.

How and when to use this worksheet

In this worksheet, your client only needs to choose an appropriate discount rate. However, this might be a difficult task. As the UNFCCC recommends, a quick way to estimate the discount rate is to take the prevailing

Footnotes

2 UNFCCC (2002): Annotated guidelines for the preparation of national adaptation programmes of action. Online at: http://unfccc.int/resource/docs/publications/annguid_e.pdf

interest rate for capital in the sector and to correct it for inflation (UNFCCC 2002)[2] .
The worksheet will then automatically calculate the key CBA results based on the information you entered regarding costs and benefits in the worksheets "3.3b – CBA – Costs" and "3.3c – CBA – Benefits".

Time required
Preparation: 1 h for interpreting the results before you present them to the client.
Assessment: 30 min for presenting the results to the client and discuss them with him/her.
Documentation: 10 min

Participants
Top management, lead engineer, lead controller

Aim of the consulting session
This consulting session should make clear to the participants what the key results of the CBA mean and how these translate into decisions regarding the selection of adaptation measures to be implemented. It is crucial to assist the client in choosing an appropriate discount rate. The client needs to understand that an inaccurate discount rate will lead to distorted results.

Your task is to make sure that the information was entered correctly and that the values for total discounted costs and benefits make sense. Use your experience with adaptation measures and insights from observing company processes and management. Furthermore, you need to explain the key CBA results to the client to allow for informed decision-making regarding the selection of preferred CCA measures based on their cost-efficiency. Once you have analysed the key CBA results, we recommend that you try out different discount rates (and possibly other key input figures such as investment costs) in order to find out whether the results are reliable across different scenarios of discount rates and other variables. You should be especially careful when a slightly altered value makes the NPV become negative. This is an indicator that the positive economic effect of the measure may not be realisable if one of the parameters changes.

Make sure to explain that in order to calculate the ranges of costs and benefits in the previous worksheets ("3.3b - CBA - Costs" and "3.3c - CBA - Benefits"), the minimum values of each cost/benefit component were added (i.e. "From+From") to derive the minimum total costs/benefits and the maximum values of each cost/benefit component were added (i.e. "To+To") to determine maximum total costs/benefits. For the key CBA results, we are comparing costs with benefits. In order to show the full possible ranges, for the NPV, for example, the maximum costs are subtracted from the minimum benefits and the minimum costs are subtracted from the maximum benefits. This gives us the absolute lowest and highest values possible. Please note that the average values stay the same with either method.

Results from the case study

As the first step of this final worksheet of the CBA, the discounted total costs as well as the discounted total benefits are calculated and illustrated per year and as a sum for all years (discount rate=8%). The values for the sum of discounted total costs and the sum of discounted total benefits for all years are needed for the calculation of the NPV, CBR, and RoI. The IRR is calculated using the undiscounted total costs and benefits for each year between year one and year ten.

For the assessed CCA measure (2) "Purchase of new sewing machines/ packaging machine that are more "heat-resistant" in response to the CC risk "Quicker overheating of machinery", we can conclude that the measure is cost-effective. The NPV is positive and both the minimum and maximum CBR are smaller than one (average: 0,77). Hence, the discounted total benefits exceed the discounted total costs (also see tables 16 and 17). There is also a significant RoI of 30 percent on average and the company is able to achieve monetary benefits equal to the

initial investment within less than a year (the average payback time of 0.46 years corresponds to about 5 months; see table 18). The value for the IRR is 5 percent. The CBA results are sufficient to determine that this measure generates greater benefits than costs, even in the absence of climatic changes in terms of increased break-downs due to more expected hot days per year.

For illustration purposes, please see table 19, which displays the key CBA results for the CCA measure (1) "Improve building insulation" in response to the same CC risk of machinery break-downs due to heat. Although the NPV is substantially smaller and it takes longer for the initial investment to pay off, this measure shows a high IRR (61 percent on average) and the RoI is much greater than for purchasing new machinery. The higher IRR and RoI results from the circumstance that no operating or maintenance costs accrue and thus an overall lower cost figure is used (compared to the measure new machinery). As specified in the section on "COSTS of adaptation measures" above (box 1), values for CBR, IRR and RoI of measures should only be compared if the calculation method is the same for both measures (either both using total or net benefits).

The CBA results for the CCA measure (4) "Installation of solar panels" (table 20) show that the total costs exceed the total benefits. The NPV is negative and the CBR is greater than one, hence, you can infer that the purchasing and installation costs (as running or maintenance costs are small) exceed the electricity cost-savings the company can generate by producing seven percent of their electricity consumed on site (assuming an average electricity price of 8.4 INR/kWh without changes in climate). The initial investment would only pay off after about 10 years.

Table 16 Discounted total costs of implementing adaptation measure

Year	Discount Factor	Discounted total costs per year (in INR)		
		From	To	Average
1	1.00	7,966,697.00	8,273,934.00	8,120,315.50
2	0.93	6,496,941.67	6,619,383.33	6,558,162.50
3	0.86	6,015,686.73	6,129,058.64	6,072,372.69
4	0.79	5,570,080.30	5,675,054.30	5,622,567.30
5	0.74	5,157,481.76	5,254,679.91	5,206,080.83
6	0.68	4,775,446.08	4,865,444.36	4,820,445.22
7	0.63	4,421,709.33	4,505,041.07	4,463,375.20
8	0.58	4,094,175.31	4,171,334.33	4,132,754.82
9	0.54	3,790,903.06	3,862,346.60	3,826,624.83
10	0.50	3,510,095.43	3,576,246.85	3,543,171.14
Sum over all years		**51,799,216.66**	**52,932,523.38**	**52,365,870.02**

Table 17	Discounted total benefits of implementing adaptation measure			
Year	Discount Factor	Discounted total costs per year (in INR)		
		From	To	Average
1	1.00	9,127,028.56	9,700,683.20	9,413,855.88
2	0.93	8,450,952.37	8,982,114.07	8,716,533.22
3	0.86	7,824,955.90	8,316,772.29	8,070,864.09
4	0.79	7,245,329.54	7,700,715.08	7,473,022,31
5	0.74	6,708,638.46	7,130,291.74	6,919,465.10
6	0.68	6,211,702.28	6,602,121.99	6,406,912.13
7	0.63	5,751,576.18	6,113,075.91	5,932,326.05
8	0.58	5,325,533.50	5,660,255.47	5,492,894.49
9	0.54	4,931,049.54	5,240,977.29	5,086,013.42
10	0.50	4,565,786.61	4,852,756.75	4,709,271.68
Sum over all years		**66,142,552.93**	**70,299,763.81**	**68,221,158.37**

Table 18	CBA results for measure (2) "Purchasing new sewing machines / packaging machine that are more heat resistant"		
Key CBA Results:	**From**	**To**	**Average**
Net Present Value (NPV)*:	13,210,029.55	18,500,547.15	15,855,288.35
Cost-Benefit-Ratio (CBR)	0.80	0.74	0.77
Internal Rate of Return (IRR):	5%	6%	5%
Return on Investment (RoI):	25%	36%	30%
Payback Time (in years)	0.57	0.35	0.46

Table 19	CBA results for measure (1) "Improving building insulation"		
Key CBA Results:	**From**	**To**	**Average**
Net Present Value (NPV)*:	6,930,453.41	10,413,066.76	8,671,760.08
Cost-Benefit-Ratio (CBR)	0.30	0.16	0.22
Internal Rate of Return (IRR):	68%	56%	61%
Return on Investment (RoI):	231%	521%	347%
Payback Time (in years)	2.19	1.17	1.68

Table 20	CBA results for measure (4) "Installation of solar panels"		
Key CBA Results:	**From**	**To**	**Average**
Net Present Value (NPV)*:	- 591,707.05	- 254,953.74	- 423,330.39
Cost-Benefit-Ratio (CBR)	1.50	1.20	1.34
Internal Rate of Return (IRR):	0%	1%	0%
Return on Investment (RoI):	-33%	- 17%	- 26%
Payback Time (in years)	11.72	8.86	10.29

6.3.2 Cost-Effectiveness Analysis

Economic assessment of adaptation measures: Cost-Effectiveness Analysis (Worksheet Step 3.4a)

Purpose and content of the worksheet

This (qualitative) sheet serves to gain an overview over adaptation measures for which a CEA is relevant. For conducting the CEA it is important to understand the concept of CEA. You should explain the CEA approach to your client in this step as it is the outset of the CEA.

Cost-Effectiveness Analysis (CEA) enables the client to **factor in potential climatic or regulatory changes that may occur and/or worsen in the future.** While the CBA is used to assess the costs and benefits of an adaptation measure independent from any future changes in climate, the **CEA specifically looks at the damages the company may face from climate change impacts.** For the CEA you need to estimate to what extent climatic (or regulatory) changes may affect operations and make assumptions on the severity of impact and the likelihood of occurrence for each impact scenario. As you can construct three scenarios with varying severities and corresponding likelihoods, you can calculate the outcomes of different climate or regulatory change scenarios. This is the first distinction between the CBA and CEA in the Climate Expert approach.

The second distinction concerns the unit of benefit used. While the CBA requires direct monetary benefits of implementing a measure, benefits for the CEA do not need to be quantifiable in monetary terms. Traditionally, a CEA does not consider economic benefits but looks at non-monetary benefits such as "degrees of temperature reduced indoors" or "litres of water recycled", which in turn can be related to economic/monetary values of course. It allows comparing measures with each other that have the same type of effect and compare their cost for achieving one unit of this effect. The CEA is used to **identify the most inexpensive out of different adaptation measures** aiming to accomplish a **specific objective**. For the Climate Expert approach this specific objective is the **reduction of profit loss** from climate change impacts. This benefit has an "economic touch" as we use "percentage of reduced profit loss" as indicator for the objective. This unit of measurement has the advantage that the percentage values of reduced profit loss do not give the client seemingly objective monetary values but only indicative figures for profit development. This is important to understand because the results of the CEA will be less reliable than the CBA as you will need to factor in climate change impacts, which may be difficult to predict. With the relative value of percentage of (reduced) profit loss, measures' benefits do not have to be converted into absolute monetary terms. For reasons of plausibility and consistency you should nonetheless cross-check the percentage values of (reduced) profit loss in calculations with absolute figures on the side in the course of conducting the CEA.

Based on the selection of adaptation measures made in this worksheet, the next three worksheets will serve to calculate their cost-effectiveness, i.e. how large their costs are in order to accomplish the specific objective of reducing profit losses.

Important categories:
Risk addressed (column B): Here, the risks corresponding to the selected adaptation measures are noted. This is to help you remember exactly what the purpose of each adaptation measure is and, thus, how its implementation will roughly look like.

Adaptation measure (column C): In this column, all adaptation measures that were given priority A or B in worksheet "3.1 – Measures-Risks"are listed.

Prevent loss of profit (column D): In this column, it should be briefly outlined qualitatively how and to which extent the adaptation measure will be able to prevent the loss of profit due to climate change. Writing this down already gives a first orientation on how to evaluate the benefits later on.

Priority of adaptation measure (column E): Here, the priority of the respective adaptation measure noted in Column AG in the worksheet "3.1 – Measures-Risks" is entered.

Conduct CEA (columns F&G): At this point, it should be clear for which adaptation measures a CEA will be conducted. It is recommended that all identified measures are selected as they provide an additional criterion for the final selection of the most appropriate adaptation measures. However, if time is short, it is possible to pick the most important risk and to assess only those measures which tackle this risk.

How and when to use this worksheet

This worksheet should list the potential adaptation measures and help to create an overview, for which measures a Cost-Effectiveness Analysis should be conducted. You should have some examples ready.

Time required
Preparation: 15 min
Assessment: 30 min

Participants
Top management, lead engineer

Aim of the consulting session
The consulting session should make clear to the participants under which conditions, i.e. for which types of adaptation measures, and for which key questions the CEA makes sense and can generate useful results. The application of a CEA is appropriate when cost-effectiveness is the most important criterion and decision-makers do not know which adaptation measure is the least costly to achieve a specific objective, i.e. to reduce profit loss from CC. The Cost-Effectiveness Ratio indicates the cost per unit of benefit and is the key result of the CEA. For decision-makers this information is essential as the adaptation option with the lowest cost per unit of benefit is often preferred.

Your task as the consultant is to support your clients with the identification of measures for which a Cost-Effectiveness Analysis should be conducted and communicate the necessary criteria (climate / regulatory risk must have an effect on profits which can be estimated, different severities of climate / regulatory change and their likelihoods can be estimated) for and the use of a successful CEA. Make sure that **all the adaptation measures that were given priority A or B in worksheet "3.1 – Measures-Risks" are listed here** with their corresponding climate risks. You should also assist your clients to determine how and to which extent the individual adaptation measures will prevent profit losses due to CC impacts. Only those adaptation measures should be selected which show a realistic potential for reducing the profit loss expected from climate / regulatory change. You can also go back to the worksheet "3.1 - Measures-Risks" to assess how certain measures score in the relevant categories (especially effectiveness). If time is short, help your client make a selection of adaptation measures to conduct the CEA for and mark these in the respective column for clarity.

Results from the case study

The three CCA measures (1) "Improve building insulation" and (2) "Purchase of new sewing machines/ packaging machine that are more heat-resistant" in response to the CC risk "Quicker overheating of machinery", as well as (4) "Installation of solar panels" in response to the risk "Increasing frequency of power cuts" were selected to conduct a CEA for (see table 21) as they had been rated with priority A or B in Step 3 (see worksheet "3.1 – Measures-Risks"). For the remaining worksheets of this CEA, we will calculate and illustrate the costs, benefits and analysis results of the measures (1) "Improve building insulation" and (2) "Purchase of new sewing machines/ packaging machine that are more heat-resistant" of the IndTex case study in order to compare their cost-effectiveness. Although the overall specific objective of the CEA is the reduction of profit loss, we can even directly compare the effectiveness of these two measures aiming at the reduction of machinery break-downs from heat in this example. This is possible, because both measures address the same climate risk. Since the specific objective "profit loss reduced" is expressed in percent, the results from the CEA will also inform the client on which option is better able to reduce machinery break-downs and with which effect on profits.

Table 21 Overview of adaptation measures

#	Risk addressed	Adaptation measure	How and to what extent is the measure able to prevent loss of profit due to climate change?	Priority of adaptation measure	Conduct CEA?	
					Yes	No
1	Quicker overheating of machinery	Improve building insulation	**Yes** (improved building insulation can reduce the number of CC related days when non-heat-resistant machinery breaks down)	A	X	
2	Quicker overheating of machinery	Purchase of new sewing machines/ packaging machine that are more heat resistant	**Yes** (more heat-resistant machinery could better withstand heat waves exacerbated by CC)	B	X	
3	Quicker overheating of machinery	Install air conditioning system	**Yes** (air conditioning reduces the number of days when about 30% of machinery break down because of CC induced heat waves, but would require large amounts of electricity at high prices and also cause extra costs)	C		X
4	Increasing frequency of power-cuts from grid	Installation of solar panels	**Yes** (electricity generation through solar panels reduces the quantity of electricity consumed from the grid and hence reduces the additional costs from higher grid-electricity and diesel prices through CC)	A	X	
5	Increasing frequency of power-cuts from grid	Increase number of diesel generators	**No** (CC will likely increase both grid and diesel prices)	C		X

CEA - COSTS of adaptation measures (Worksheet Step 3.4b)

Purpose and content of the worksheet

This worksheet serves to determine the total undiscounted and discounted costs which will arise when implementing the adaptation measures. These costs consist of investment and operation costs.

In order to increase comparability of results later on, the costs of adaptation will be calculated for two time horizons, namely for five and ten years. It is possible to work with both or just one time horizon. In the latter case, costs will have to be determined only for years one to five. It should be noted that the Cost-Effectiveness Ratio (CER) is calculated by only considering the investment costs. The total costs including operating costs are, however, considered again in this worksheet for reasons of consistency and transparency.

Important categories:
The following categories are equal to those in the worksheet "3.3b - COSTS of adaptation measures" for the Cost-Benefit Analysis: Currency, Risk, Adaptation measure, Cost categories, Cost components, From/To, Undiscounted total costs per year have to be transferred accordingly

The following categories are added:
Discount rate: Here, it is inserted which rate the costs and benefits will be discounted with. The discount rate is determined based on the market interest rate of the respective sector.

Sum of undiscounted total costs over 5 years & Sum of undiscounted total costs over 10 years: In these two rows, the sums of total undiscounted costs over five and ten years are displayed. Please note that for reasons of consistency the total costs are noted down here. For calculations, however, only the initial investment costs are considered.

Sum of discounted total costs over 5 years & Sum of discounted total costs over 10 years: In these two rows, the sums of total discounted costs over five and ten years are displayed. They are calculated automatically by using the stated discount rate. Again, these figures are not being used in further calculations but only used for reasons of consistency and transparency.

How and when to use this worksheet

Time required
Preparation: 0.5 days (less if the costs have already been collected for the CBA)
Assessment: 2 h to discuss the different cost components and estimates with the client
Documentation: 1 h

Participants
Top management, lead engineer

Aim of the consulting session
The consulting session should serve to assist your client in quantifying the costs of the selected adaptation measures and understanding the necessary components. For each measure, all associated costs need to be stated in monetary terms.

Your task as the consultant is to support your client in identifying all underlying cost components of the adaptation measure as well as in acquiring additional cost information, if necessary, in order to determine total costs. We suggest to start by making an overview of the information needed in a table and gather the values together with your client. The necessary cost data depends on the type of business and varies by sector. You have to draw

upon your experience and your assessment of the client company. For measures such as installing new machinery, various operating costs, and potentially maintenance and opportunity costs need to be accounted for (ideally for each unit of machinery). Please see the section "CBA Costs of adaptation measures" of the Chapter "Cost-Benefit Analysis" as the calculation of adaptation costs in the CEA follows the same principle.

In addition to the calculation of costs like for the CBA, this worksheet of the CEA also aggregates the total costs over the time periods of five and ten years and discounts these costs over the same time horizons. These figures have only an informative purpose and are not relevant for further calculations.

Results from the case study

The costs of the CCA measure (2) "Purchase of new sewing machines / packaging machine that are more heat-resistant" in response to the CC risk "Quicker overheating of machinery" are calculated the same way as for the CBA. There are initial investment costs in year one as well as different types of operating costs in each year of the machinery's operation. This measure replaces all 70 existing sewing machines as well as the one packaging machine (see "Investment Costs" in table 23). The operating costs are split into the components "Electricity", and "Labour". There are only initial investment costs for the CCA measure (1) "Improve building insulation" and the company would not face any annual operating costs (see table 22). This worksheet then calculates the undiscounted lowest, highest and average total costs for both CCA measures for the time horizons of five and ten years. For details on the calculations please consult box 2 and table 12 above)

Same as for the CBA, electricity costs for the operation of new machinery are calculated by multiplying the annual electricity consumption of the respective machines in kilowatt hours (kWh) and the current local electricity price. This electricity price is calculated using a function that considers the grid electricity price as well as the diesel price for generator-produced electricity, depending on each of their consumption shares. Labour costs are derived by multiplying the number of workers (one per sewing machine and five for the packaging machine) with their annual salaries. It is crucial to use consistent units of measurement regarding time and quantity, i.e. distinguish between costs per machine or for all machines, per day or per year.

Based on the undiscounted costs for each year and a discount rate of eight percent, this worksheet then calculates the discounted total costs of adaptation for two time horizons (five and ten years) in order to increase comparability of results later on.

Risk	Quicker overheating of machinery
Adaptation measure	Improve building insulation
Discount rate	8%

Table 22 Cost categories for improving building insulation

	I. Investment Costs (in INR)		II. Operating Costs (in INR)		Undiscounted total costs per year (in INR)		
Year	From	To	From	To	From	To	Average
1	2,000,000	3,000,000	-	-	2,000,000.00	3,000,000.00	2,500,000.00
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-
Sum of undiscounted total costs over 5 years (in INR)					**2,000,000.00**	**3,000,000.00**	**2,500,000.00**
Sum of discounted total costs over 5 years (in INR)					**2,000,000.00**	**3,000,000.00**	**2,500,000.00**
Sum of undiscounted total costs over 10 years (in INR)					**2,000,000.00**	**3,000,000.00**	**2,500,000.00**
Sum of discounted total costs over 10 years (in INR)					**2,000,000.00**	**3,000,000.00**	**2,500,000.00**

Risk	Quicker overheating of machinery
Adaptation measure	Install new and more heat resistant machinery
Discount rate	8%

Table 23 Cost categories for purchasing more heat resistant machinery

Cost Categories	I. Investment Costs (in INR)		II. Operating Costs (in INR)			
Cost Components	Purchase of machines		Electricity*		Labour**	
Year	From	To	From	To	From	To
1	950,000.00	1,125,000.00	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
2	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
3	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
4	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
5	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
6	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
7	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
8	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
9	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00
10	-	-	1,166,697.00	1,298,934.00	5,850,000.00	5,850,000.00

*) Electricity price: 8.4 INR/kWh (assumed to be stable over the next ten years)

**) Annual salary of one worker: 78,000.00 INR; one worker per sewing machine, five for the packaging machine

Table 24	Total Costs		
	Undiscounted total costs per year (in INR)		
Year	From	To	Average
1	7,966,697.00	8,273,934.00	8,120,315.50
2	7,016,697.00	7,148,934.00	7,082,815.50
3	7,016,697.00	7,148,934.00	7,082,815.50
4	7,016,697.00	7,148,934.00	7,082,815.50
5	7,016,697.00	7,148,934.00	7,082,815.50
6	7,016,697.00	7,148,934.00	7,082,815.50
7	7,016,697.00	7,148,934.00	7,082,815.50
8	7,016,697.00	7,148,934.00	7,082,815.50
9	7,016,697.00	7,148,934.00	7,082,815.50
10	7,016,697.00	7,148,934.00	7,082,815.50
Sum of undiscounted total costs over 5 years (in INR)	**36,033,485.00**	**36,869,670.00**	**36,451,577.50**
Sum of discounted total costs over 5 years (in INR)	**31,206,887.46**	**29,585,287.20**	**29,240,276.69**
Sum of undiscounted total costs over 10 years (in INR)	**71,116,970.00**	**72,614,340.00**	**71,865,655.00**
Sum of discounted total costs over 10 years (in INR)	**51,799,216.66**	**52,932,523.38**	**52,365,870.02**

CEA - BENEFITS of adaptation (Worksheet Step 3.4c and 3.4d)

The following two worksheets "3.4c - CEA Benefits Part I" and "3.4d - CEA Benefits Part II", determine (in a two-step process) the **benefits of adaptation over non-adaptation**. In our case, the **objective of adaptation will be to reduce profit losses caused by climate change.** Calculating with reduced profit loss in percent (rather than reduced absolute profits) is often easier as no exact monetary figures for losses from climate change are required. Additionally, the profit loss figure in percent is particularly meaningful in a business context. The benefit will therefore be measured as "avoided profit losses" in percent of overall profits.

The worksheet "3.4c - CEA Benefits Part I" determines the potential profit loss if no adaptation takes place while the worksheet "3.4d - CEA Benefits Part II" assesses which profit loss might still remain after a measure has been implemented. [Note that only through the subtraction of the profit loss with adaptation ("3.4d - CEA Benefits Part II") from the profit loss without adaptation ("3.4c - CEA Benefits Part I") the reduced profit loss through adaptation can be calculated].

CEA - BENEFITS of adaptation Part I: Potential profit losses due to non-adaptation (Worksheet Step 3.4c)

Purpose and content of the worksheet

The first step on the way to determining the avoided profit losses is to identify the actual profit losses that climate change is expected to cause. The aim of this worksheet is thus to determine the potential profit losses due to non-adaptation. Such reduced profit can be the effect of additional production costs, lost revenues and repair costs.

When conducting a CEA it is crucial to understand, both concerning this and the following worksheet, is the approach to uncertainty. **Since we are dealing with uncertain future impacts of climate change, it is necessary to consider different possible developments.** We do this by calculating the benefits of adaptation for three different impact scenarios. In scenario A, impacts of CC on the company will be minor, in scenario B medium (e.g. 1.5 times as strong as in scenario A) and in scenario C drastic (e.g. 3 times stronger than in scenario A). Note that all monetary values for CC impacts, i.e. profit losses, are inserted only once for the "minor" impact scenario, which serves as the "base" scenario. The medium and drastic scenarios are calculated automatically based on the figures inserted into the excel sheet and the impact factors. An annual loss figure will be calculated assuming the "minor" impact scenario (Scenario A). Using the impact factor, higher loss figures are automatically calculated for Scenario B and C. Taking into account the different likelihoods of the scenarios over the timeframe of five and ten years, an annual average figure is additionally calculated for the distribution of a five- as well as a ten year time-horizons.

Important categories:

Unit of measurement: In this box, the unit of measurement is stated. Since the overall benefit will be measured in "avoided profit losses", the costs of non-adaptation are identified as "Loss of profit".

Impact Scenarios - Scenario A "Minor impacts", Scenario B "Medium impacts", Scenario C "Drastic impacts": These boxes are used to pay respect to the uncertainty surrounding the benefits of adaptation. While in scenario A, impacts on the company will only be minor, scenarios B and C will be more severely felt.

Impact factor: The impact factor is used to determine how much more severe scenarios B and C will be compared in relation to scenario A. While the impact factor for A is fixed at 1, the other two factors can be chosen according to the expected relative impact severity.

Likelihood 5 years, Likelihood 10 years: In these boxes, the different likelihoods for each of the three scenarios to occur in the next five and/or ten years are stated. Once the likelihoods for scenarios A and B have been determined, the likelihood for scenario C will be calculated automatically so as to come up with a sum of 100 percent. It is possible to work with both or just one of the time horizons.

Loss Categories: In this row, all types of losses that climate change can cause are summarized in three categories, namely additional production costs, lost revenue and repair costs.

Loss Components: In this row, it is possible to further specify the expected losses. For all three categories it is possible to specify up to three components.

Profit loss/year & From/To: In these boxes, the lowest and highest possible profit losses are filled in. As we are assuming a ceteris paribus scenario, common in economic calculations, we assume that only CC impacts have an effect on profits and all other potential effects on profits are neglected. This approach is justified as we aim at identifying explicitly and only the effect of CC on the company. Figuring in other potential impacts on profits would distort the result for our key interest CC impact and bring more uncertainty into the results. Therefore, as it is assumed that only climate change will have an influence on the company's profits over the next five or ten years, it is possible to determine the profit loss for only one year. Changes in profit loss will be included later on by multiplying the profit loss/year with the impact factors and likelihoods.

Total profit loss/year if no change is expected: In these boxes, the total profit loss per year is calculated for each scenario. These values for each of the scenarios indicate the profit loss if only one of the three scenarios occurs over the next ten years. Either there will be minor, medium or drastic impacts, but conditions will not change over this time period.

Total profit loss/year if change is expected (5 year horizon), Total profit loss/year if change is expected (10 year horizon): These boxes now present the aggregated results for the expected profit losses per year in case of changing scenarios over these time periods. Results are calculated by multiplying the average profit losses of the scenarios A, B and C by their respective likelihoods. Results are given for the five and ten year time horizon. Stating benefits and results in percentages makes these values more comparable across measures and sectors.

How and when to use this worksheet

Time required
Preparation: 1 day for calculating the expected profit losses resulting from climate change. Although the figures are given in percentage values you should cross-check these values in supporting calculations estimating actual losses (in monetary terms) from CC and state them in percentage of profit loss. You will also need to derive meaningful impact factors and likelihoods of occurrence. These should be based on your prior research on climate change impacts in the region. For reasons of transparency you should state all the assumptions that you have taken in a separate sheet. The calculation of the profit loss resulting from climate change can be conducted in the 'supporting calculations' worksheet. Note that the template for the supporting calculation is rather general and should be adjusted by you to the needs of the enterprise.
Assessment: 3 h for going through the supporting calculation with your client and discussing the assumptions for impact factors, likelihood and profit loss values.
Documentation: 1 h

Participants
Top management, lead engineer

Aim of the consulting session
This consulting session should serve to assist your client in understanding and measuring the costs of non-adaptation. Measuring the costs of non-adaptation builds on the projection of expected climate change and resulting climate phenomena (e.g. the "Increase in the frequency and intensity of heat waves" or "Reduction of average rainfall") as well as the identification of the specific impacts these phenomena have on the company (i.e. in impact areas such as 'Processes' and 'Employees and neighbouring communities', to name a few). This has already happened in the earlier stages of this process to develop a CCA strategy. In this step it is important to communicate to the client how this information needs to feed into the CEA to determine the potential costs of non-adaptation in terms of avoided profit losses.
Your task is to guide your client in determining
the cost components of non-adaptation (e.g. costs of resource use, reduced productivity, repair costs or lost revenue),

the variable impact factors for Scenario B and C according to the expected impact severity as well as
- the likelihoods for each of the scenarios.
-
- By entering these in the required fields of this worksheet, it calculates the total costs of non-adaptation in terms of avoided profit loss per year. You need to make clear that the values for the three scenarios are calculated based on the assumption that conditions and CC impact assumptions do not change (ceteris paribus principle). Only the values over the five- and ten-year horizons assume that CC impact predictions will change according to the previously assigned likelihoods. Make sure that the matrix with the impact factors and likelihoods for the three different scenarios is filled in. You can use the worksheet 'supporting calculations' to calculate the expected profit losses from climate change.

Results from the case study

As a first step in the process of quantifying the cost-effectiveness of the two measures (1) "Improving of building insulation" and (2) "Purchase of new sewing machines/ packaging machine that are more heat-resistant" and "Improve building insulation" in response to the CC risk "Quicker overheating of machinery" and comparing their cost-effectiveness, this worksheet calculates the estimated lost profits due to non-adaptation. For the measure (1) "Improving of building insulation", profit loss only consists of the lost revenue. For the CCA measure (2) "purchase of new machinery", the costs consist of a) lost revenue due to the increased breakdown of machinery and b) increased cost of electricity due to higher electricity prices (resulting from power cuts). All figures are expressed in terms of annual profit loss in percent of total profit.

In the case of climate change, the average number of days when about 30 percent of current machinery breaks down from overheating increases from 10 to 15 per year (Scenario A). For this case study company, the impact factors of 1.5 and 3 were assigned to Scenario B and C respectively. This means that the impacts of Scenario B will be 50% more severe than Scenario A and Scenario C is expected to be three times as severe as Scenario A. The likelihoods for each of these scenarios to occur in five years are set at 70%, 20%, and 10% for A, B, and C respectively. For the occurrence of these scenarios in ten years, these likelihoods are changed to 40% for Scenario A, 40% for Scenario B, and 20% for Scenario C. This means, that although it is expected with a 70% likelihood that there will be only minor impacts in five years, in ten years minor impacts will be less likely while medium and severe impacts on the company become more likely.

Projections for total profit loss without adaptation show that not replacing the packaging machine and sewing machines will result in much greater profit losses (Total profit loss/year if change is expected, 10 year horizon: 2.96%; see table 29) than not improving the building insulation (Total profit loss/year if change is expected, 10 year horizon: 0.69%; see tables 27). This can simply be attributed to the annual operating costs for the old machinery, while there are no operating costs with or without the improved building insulation.
Supporting calculation for the profit losses can be found in Annex 2.

Table 25 Climate change scenarios

	Impact factor	Likelihood (5 years)	Likelihood (10 years)
Scenario A "Minor impacts"	1	70.0%	40.0%
Scenario B "Medium impacts"	1.5	20.0%	40.0%
Scenario C "Drastic impacts"	3	10.0%	20.0%

Risk	Quicker overheating of machinery
Adaptation measure	Improve building insulation
Unit of measurement	Loss of profit

Table 26 Profit losses without adaptation (insulation)

Profit losses due to non-adaptation						
Loss Categories	**I. Additional production costs**		**II. Lost revenue**		**III. Repair costs**	
Loss Components	-		**Break-down of machinery**		-	
	From	**To**	**From**	**To**	**From**	**To**
Profit Loss/Year	-	-	0.38%	0.48%	-	-

Table 27 Total profit losses without adaptation across scenarios and time horizons

Profit losses due to non-adaptation								
Scenario A			**Scenario B**			**Scenario C**		
From	**To**	**Average**	**From**	**To**	**Average**	**From**	**To**	**Average**
0.38%	0.48%	0.43%	0.57%	0.72%	0.65%	1.14%	1.44%	1.29%
Total profit loss/year if change is expected (5 year horizon)								
0.56%								
Total profit loss/year if change is expected (10 year horizon)								
0.69%								

Risk	Quicker overheating of machinery
Adaptation measure	Install new and more heat resistant machinery
Unit of measurement	Loss of profit

Table 28 Profit losses without adaptation (machinery)

Profit losses due to non-adaptation						
Loss Categories	**I. Additional production costs**		**II. Lost revenue**		**III. Repair costs**	
Loss Components	**Electricity Costs**		**Break-down of machinery**		**-**	
	From	**To**	**From**	**To**	**From**	**To**
Profit Loss/Year	1.35%	1.49%	0.38%	0.48%	-	-

Table 29 Total profit losses without adaptation across scenarios and time horizons

Total profit loss/year if no change is expected								
Scenario A			**Scenario B**			**Scenario C**		
From	**To**	**Average**	**From**	**To**	**Average**	**From**	**To**	**Average**
1.73%	1.97%	1.85%	2.60%	2.96%	2.78%	5.19%	5.91%	5.55%
Total profit loss/year if change is expected (5 year horizon)								
2.41%								
Total profit loss/year if change is expected (10 year horizon)								
2.96%								

CEA - BENEFITS of adaptation Part II: Remaining profit losses due to adaptation (Worksheet Step 3.4d)

Purpose and content of the worksheet

This sheet serves to determine the remaining profit losses incurred by the company with adaptation.These losses are calculated based on the remaining costs resulting from climate change for the company. The figure of remaining profit loss is required to calculate the CER result of avoided profit loss which is the difference between profit loss from climate change without adaptation and the remaining profit loss (in worksheet "3.4e - CEA - Results"). For calculating the remaining profit loss the same methodology is used as in the previous worksheet. More details on how to calculate remaining profit loss is found in the box below (box 4)

Important categories:

Unit of measurement: In this box, the unit of measurement is stated. Since the "Loss of profit" due to climate change in case of non-adaptation was already identified in the previous worksheet, the complementary task now is to measure the "Remaining loss of profit" that can be expected in case of adaptation.

Regarding their set-up, all other categories are equal to those of the previous worksheet. Jus remember to fill in the remaining profit losses. In case the remaining profit loss is negative, only cell BC6 for Scenario A should be filled in for the first measure (please consult box 4 below for more details).

How and when to use this worksheet

Time required

Preparation: 0.5 days for calculating the profit loss reduction of the measures.
Assessment: 2 h for presenting and discussing the results with the client.
Documentation: 1 h

Participants

Top management, lead engineer

Aim of the consulting session

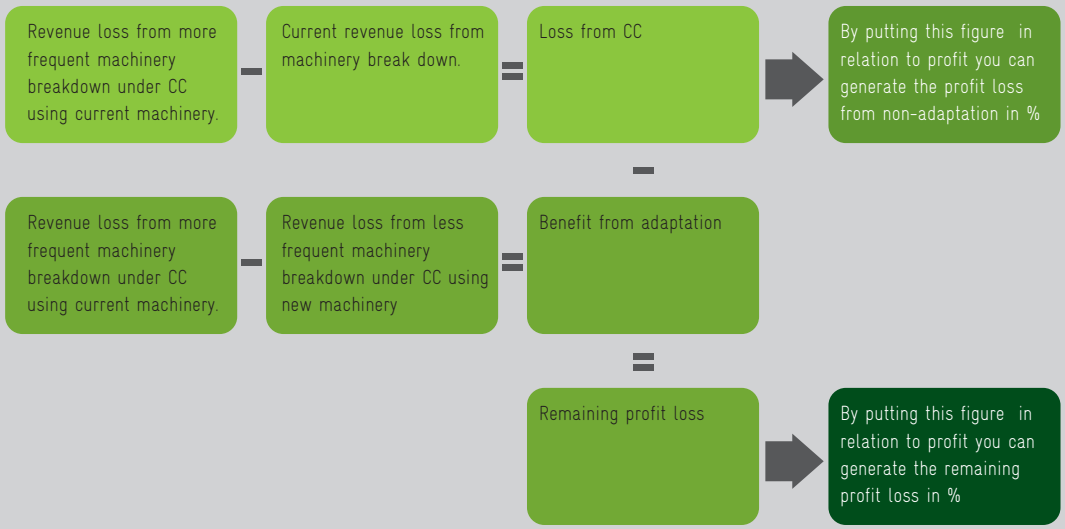
The consulting session should make clear to the participants that CC impacts – despite implementation of adaptation measures – may still cause profit losses as adaptation measures can often only partly compensate impacts In order to calculate avoided profit losses, the remaining profit losses have to be determined based on the remaining costs the company incurs despite the adaptation measure. Note that this could under certain circumstances mean that the company incurs negative profit losses. This would be the case if the cost-savings or additional revenues exceeded the potential losses from climate change. In this case the company would generate more profit than today, even in the case of climate change. As in the previous worksheet (3.4c) on expected profit losses, you can also use the 'supporting calculations' worksheet. Additionally, you should state your assumption on how the reduction of profit loss is achieved through the measure on an extra-sheet.

Your task is to make sure that your clients understand the difference between the costs of nonadaptation and the remaining costs with adaptation and why these are needed to calculate the avoided profit losses. For this worksheet, you should estimate what the remaining profit loss is after the measure has been implemented. You can use estimations to derive this figure or use the 'supporting calculations" worksheet to calculate what the remaining profit loss is. As the aim of the CEA is to determine by which percentage of total profit a measure reduces the profit loss from climate change, this step of explicitly assessing the remaining profit loss for each measure is highly important. How the supporting calculation of the remaining profit loss can be conducted (for the example of machinery break down) is shown in the diagram (Figure 5):

The logic of this calculation approach is also found in the 'supporting calculations' worksheet where the remain-

ing profit is automatically calculated when the required values (for example input costs for a certain process with or without climate change) are filled in.

Figure 6 **Calculation method for CEA**



Box 4 **Calculating the remaining profit loss**

For calculating the remaining profit loss several things have to be kept in mind:

The idea behind the figure of remaining profit loss is the following: climate change has negative effects on the company, thus the company's profit decreases; with the implementation of adaptation measures this profit loss can be reduced – for example the company doesn't lose ten percent of its current profits but only five percent. However, there may be cases when a measure generates savings that extend the profit loss expected due to climate change. The results are 'negative remaining profit losses' which actually mean that the company would make more profits than today when implementing the measure even under the conditions of climate change.

This is where the impact factor (regarding the relative severity of the three possible scenarios) comes into play. The impact factor is multiplied in the worksheet with the expected profit loss to show that with climate change, higher losses are expected. Also, remaining profit losses are usually multiplied with the impact factor to show that under more severe climate change scenarios the remaining profit losses are also higher because the measure is not as effective as under the baseline scenario. If, however, we have 'negative (indicated with a minus) remaining profit losses' (i.e. not a reduction of profit, but an even greater profit than today due to the adaptation measure) using the impact factor would distort the results. Instead of a worsening of impacts in terms of less profit for the company we would receive more profits. The impact factors are therefore not used in cases when you operate with a 'negative remaining profit loss'. In such a case results are only provided for Scenario A. The worksheet will automatically fill the cells for Scenario B and C as well as the aggregated values for the five- and ten-year time horizon with the term "no value".

If you would like to calculate results for heavier climate change you would have to calculate with other figures for the baseline case (Scenario A). This means you would have to enter higher expected profit loss and more remaining profit loss. You could use another table of the worksheet to compute results for the same measure but assuming other values for expected profit losses and remaining profit losses.

Results from the case study

As the second step in the process of determining the implementation benefits of "Purchase of new sewing machines/ packaging machine that are more heat-resistant" and "Improve building insulation" in response to the CC risk "Quicker overheating of machinery" and comparing their cost-effectiveness, this worksheet calculates for each of these measures the remaining profit losses with adaptation. For the CCA measure "purchase of new machinery", these consist of the remaining lost revenues (because this measure only reduces the average annual days of about 30 percent of machinery breaking down from ten to two days) as well as remaining electricity costs. For the measure to improve the building insulation, the remaining profit loss only consists of the lost revenue of the remaining four average annual days when about 30 percent of machinery break-down. All figures are expressed in terms of annual profit loss in percent of total profit.

The impact factors and likelihood values have to remain the same as in the previous sheet. They must not be changed.

Projections for total remaining profit loss per year with adaptation show that replacing the packaging machine and sewing machines will result in much greater remaining profit losses (Total remaining profit loss/year if change is expected, 10 year horizon: 3.99%) than not improving the building insulation (Total remaining profit loss/year if change is expected, 10 year horizon: 0.54%; see tables 31 and 33).This can simply be attributed to the annual operating costs for the new machinery, while there are no operating costs without the improved building insulation.

Risk	Quicker overheating of machinery
Adaptation measure	Improve building insulation
Unit of measurement	Remaining loss of profit

Table 30 Remaining profit losses with adaptation (insulation)

Remaining profit losses despite adaptation						
Loss Categories	**I. Remaining additional production costs**		**II. Remaining lost profit**		**III. Remaining repair costs**	
Loss Components	-		**Break-down of machinery**		-	
	From	**To**	**From**	**To**	**From**	**To**
Reduced profit/year	-	-	0.30%	0.38%	-	-

Table 31	Total remaining profit losses with adaptation across scenarios and time horizons								
Total remaining profit loss/year if no change is expected									
Scenario A			Scenario B			Scenario C			
From	To	Average	From	To	Average	From	To	Average	
0.30%	0.38%	0.34%	0.45%	0.57%	0.51%	0.90%	1.14%	1.02%	
Total remaining profit loss/year if change is expected (5 year horizon)									
0.44%									
Total remaining profit loss/year if change is expected (10 year horizon)									
0.54%									

Risk	Quicker overheating of machinery
Adaptation measure	Install new and more heat resistant machinery
Unit of measurement	Remaining loss of profit

Table 32	Remaining profit losses with adaptation (machinery)					
Remaining profit losses despite adaptation						
Loss Categories	I. Remaining additional production costs		II. Remaining lost profit		III. Remaining repair costs	
Loss Components	Remaining electricity costs		Break-down of machinery		-	
	From	To	From	To	From	To
Reduced profit /year	2.19%	2.46%	0.15%	0.19%	-	-

Table 33	Total remaining profit losses with adaptation across scenarios and time horizons								
Total remaining profit loss/year if no change is expected									
Scenario A			Scenario B			Scenario C			
From	To	Average	From	To	Average	From	To	Average	
2.34%	2.65%	2.50%	3.51%	3.98%	3.74%	7.02%	7.95%	7.49%	
Total remaining profit loss/year if change is expected (5 year horizon)									
3.24%									
Total remaining profit loss/year if change is expected (10 year horizon)									
3.99%									

RESULTS of the Cost-Effectiveness Analysis (Worksheet Step 3.4e)

Purpose and content of the worksheet

This final worksheet of the Cost-Effectiveness Analysis serves two purposes: 1) it determines the benefits of adaptation over non-adaptation. This result is calculated as the difference between "Profit loss due to climate change" and "Remaining profit loss with adaptation"; 2) it calculates the cost-effectiveness ratio of each measure for the different scenarios assuming that the severity of impacts changes over five and ten years, and for each scenario assuming no change of impacts.

Important categories:

Average initial investment costs: Here, the average initial investment costs are presented. They are transferred automatically from the worksheet "3.4b - COSTS of adaptation measures". Please note that only investment costs are considered here as all operating costs are already included in the remaining profit loss value.

Profit loss due to climate change: In these boxes, the profit losses which can be expected to be caused by future climate change are shown. They were transferred unchanged from the worksheet "BENEFITS of adaptation Part I".

Remaining profit loss with adaptation: Similarly to the two previous categories, these boxes display the profit losses which climate change will cause even if adaptation is practiced. The results were transferred unchanged from the worksheet "3.4d - BENEFITS of adaptation Part II".

Benefit of adaptation over non-adaptation: In these boxes, the benefit of adaptation over non-adaptation is calculated. This is done automatically by the worksheet by subtracting the remaining profit losses from the total profit losses. If remaining profit loss is negative, only the cell for Scenario A should be filled in (please consult box 3 above for more details).

Cost-Effectiveness Ratio (CER): The Cost-Effectiveness Ratio (CER) is an adjusted cost per unit of benefit, i.e. percent of reduced profit loss. The CER is calculated by dividing the value/variable of the average initial investment costs by the value/variable of reduced profit loss in percent multiplied by a factor of 10,000. The lower the ratio, the more cost-effective the measure! Please note that the measure does not make sense in economic terms if a negative value is obtained for CER. The aggregated cost-effectiveness ratio is calculated as the average of the five- and the ten-year ratio. In case that only Scenario A is considered the ratio for this scenario should be used for comparisons with other measures.

Average Aggregated CER: The Aggregated CER gives you one single figure that you can use to compare the measures with each other. Usually, it is calculated by taking the average of the CER values for the five- and ten-year time horizon. If there are no values for Scenario B and C, the Average Aggregated CER is that of Scenario A.

How and when to use this worksheet

Time required

Preparation: 1 h for familiarising yourself with the results and interpreting them. You can also change some key variables to test whether any significant changes occur in the results.
Assessment: 1 h to discuss results and implications with the client
Documentation: 1 h

Participants

Top management, lead engineer

Aim of the consulting session

This final consulting session of the CEA should support the participants in understanding how the values of the previous worksheets have been used to calculate the CEA key figures "Benefit of adaptation over non-adaptation" as well as the "Cost-Effectiveness Ratio" of each measure for the different scenarios assuming change of impacts and no change of impacts.

Your task is to make sure that the importance of the different input values as well as the message and meaning of the CEA results are understood by the participants. The "Cost-Effectiveness Ratio" illustrates an adjusted cost per unit of benefit, i.e. percent of reduced profit loss, and the client is consequently able to choose the adaptation measure with the lowest ratio (provided the ratio is greater than one; negative Cost-Effectiveness Ratios indicate that investment costs are greater than the reduction of profit loss from CC). The client can choose among measures addressing different risks to implement those that generate the largest profit loss reduction at the lowest price. If he/she wants to tackle a specific risk, also the measure that most cost-effectively reduces the profit loss from the negative impacts of this risk can be identified.

Results from the case study

The results of this final worksheet of the Cost-Effectiveness Analysis of the adaptation measures (1) "Improve building insulation" (average aggregated CER of 193,643.16) and (2) "Purchase of new sewing machines/ packaging machine that are more heat-resistant" (average aggregated CER of -11,213.29) show that the measure (1) improving building insulation is more cost-effective in reducing profit loss (due to machinery breakdowns caused by rising temperatures) than measure(2) purchasing new and more heat-resistant sewing machines and a new packaging machine. In fact, measure (2) is not cost-effective at all when assuming future climate change impacts on machinery (indicated by the negative value of the CER).

While improving the building insulation reduces the number of days when machinery breaks down less (from ten to four days) than purchasing new machines (from ten to two days), it does not involve annual operating costs. Consequently, despite the higher initial investment costs, the improved building insulation reduces the profit loss due to the climate change impact on machinery by 21 percent while the more heat-resistant machinery increases the profit loss by 35 percent across all scenarios and time horizons. This means, that when assuming a higher electricity price in the case of climate change (10 INR/kWh vs. 8.4 INR/kWh without CC), the increased electricity consumption of the more heat-resistant machinery leads to higher electricity costs than the measure is able achieve in increased profits from machinery breaking down less frequently. These higher electricity costs even lead to a negative Cost-Effectiveness Ratio that indicates a higher profit loss through this measure in the case of climate change (see table 37).

Risk	Quicker overheating of machinery
Adaptation measure	Improve building insulation

Table 34 Benefits from improved insulation

Benefit of adaptation over non-adaptation				
Scenario A	**Scenario B**	**Scenario C**	**Aggregated 5 years**	**Aggregated 10 years**
0.09%	0.14%	0.27%	0.12%	0.14%
Reduced profit loss from adaptation (in percent)				
-21%	-21%	-21%	-21%	-21%

Table 35 Cost-Effectiveness Ratios for improved building insulation

Cost-Effectiveness Ratio					Average Aggregated CER
Scenario A	**Scenario B**	**Scenario C**	**Aggregated 5 years**	**Aggregated 10 years**	
277,777.78	185,185.19	92,592.59	213,675.21	173,611.11	193,643.16

Risk	Quicker overheating of machinery
Adaptation measure	Install new and more heat resistant machinery

Table 36 Benefits from more heat-resistant machinery

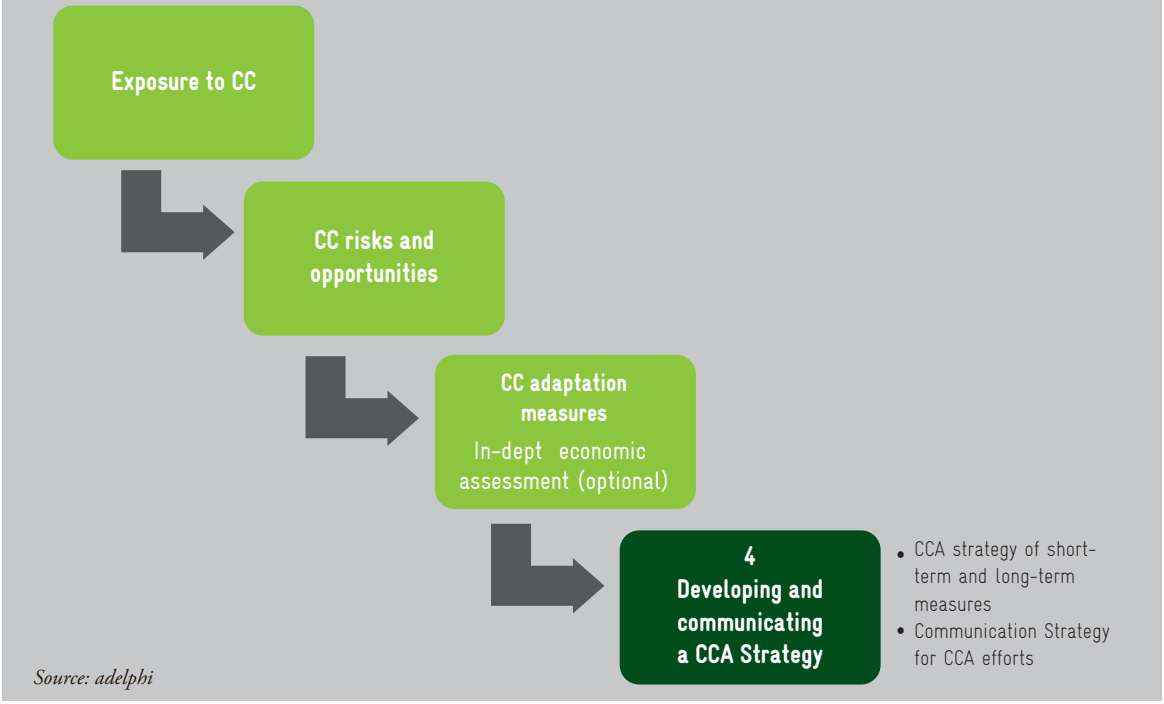
Benefit of adaptation over non-adaptation				
Scenario A	**Scenario B**	**Scenario C**	**Aggregated 5 years**	**Aggregated 10 years**
-0.65%	-0.97%	-1.94%	-0.84%	-1.03%
Reduced profit loss from adaptation (in percent)				
+35%	+35%	+35%	+35%	+35%

Table 37 Cost-Effectiveness Ratios for more heat-resistant machinery

Cost-Effectiveness Ratio					Average Aggregated CER
Scenario A	**Scenario B**	**Scenario C**	**Aggregated 5 years**	**Aggregated 10 years**	
-16,085.27	-10,723.51	-5,361.76	-12,373.29	-10,053.29	-11,213.29

7 Developing and communicating an adaptation strategy – STEP 4

Figure 7 Methodology of the workbook



This final section is designed to assist your client in developing and communicating a full-fledged CCA strategy. It builds on the identified and assessed adaptation measures as well as the preselected opportunities from the last section.

7.1 Developing an adaptation strategy 4

Purpose and content of the worksheet

The worksheet below supports the company in developing and communicating the CCA strategy. It aims to guide the company in comprehensively managing risks as well as seizing opportunities from climate change.

Important categories:

#: State whether the measure is a Risk (R) or Opportunity (Op) and enumerate them per short-, medium- or long-term.

Adaptation measure: First of all, the adaptation measures that have been identified with the help of the two previous worksheets on "Measures for addressing risks" and "Measures for seizing opportunities / new markets" are filled into this column.

Risk addressed: Subsequently, it is described which risk the specific measure tackles. Even though this relationship has already been identified in the worksheet "Measures for addressing risks" it is important to repeat it and make it as clear as possible in order for all stakeholders to understand the logic behind the CCA strategy. If it is understood why certain measures are implemented they will receive greater support.

Additional advantages: Following the addressed risks, the advantages that can be derived from a certain adaptation measure are described. The resulting additional advantages are likely to be "reducing costs", "securing production flow", "improving the company's image", etc.

Type of measure: In this column it is stated what type the measure is; among the options to choose from are the following: grey (technological or infrastructure measures), green (ecosystem-based measures) and soft (organisational and stakeholder-focussed measures). This allows you and your client to assure that a variety of types is used to create synergetic effects throughout the organisation.

Affected area: Here it is stated which of the 7 impact areas is addressed by the adaptation measure. Just to remind you: these can "Building & Location", "Processes", "Logistics & Stock", "Employees & Community", "Finance" and "Market". One adaptation measure can of course be applicable to more than one impact area. Again, this creates an overview of the variety of methods chosen which is important to achieve a multi-pronged approach to adaptation.

Synergies and conflicts: While in the previous column only the main impact area which is addressed by the adaptation measure was noted, this column can be used to highlight the positive and negative impacts the adaptation measure can have on the other 6 impact areas. "Synergies" have (unintended) positive effects for two or more impact areas. "Conflicts", on the other hand, point out that improvements within one impact area lead to a deterioration of the situation within one or more of the other areas.

Integration possibility: This column is meant for reflecting on existing possibilities to integrate the various measures into the objectives, projects and activities of the company. Thus, questions like "Which projects exist into which individual measures could be integrated?" and "How can the topic of adaptation be put on the agenda of existing planning processes?" need to be answered.

Potential barriers: Several issues are raised in the column "potential barriers". Usually, there are numerous potential barriers for integrating and implementing adaptation measures. These include financial, technological, political, social and institutional aspects. One of the major impediments to the timely implementation of adaptation measures is related to the short-term planning horizon of companies. Other barriers exist due to a lack of problem awareness, uncertainty, lack of information and temporal misjudgement. Accordingly, the company is asked to reflect on potential problems in the process of implementing measures for an adaptation strategy and document them into the worksheet.

Ideas for overcoming barriers: Subsequently, in this column appropriate solutions for overcoming the identified barriers are noted.

Success indicators / Monitoring activities: Success indicators or other means to assess each measure are identified or developed. This enables the company to measure the performance and progress of implementing adaptation measures.

Notes and comments: Finally, notes and comments are written down in order not to forget critical points that do not necessarily fit into this assessment grid but are important to consider.

How and when to use this worksheet

After both CCA measures and opportunities are identified and assessed, it is time to consider the development of a CCA strategy. This strategy is designed to assure that measures are implemented in a coordinated and effective way and are long-term oriented. Before this final step, it is recommended to share all the documentation with your client and instruct them to already develop first thoughts on the strategic approach.

Time required

Preparation: Documentation and analysis of all assessments – app.4h
Assessment: 2h
Documentation: 2 h

Participants

Top management, lead engineer

Aim of the consulting session

The aim of the session is to raise the awareness of the company regarding the importance of a coordinated and structured approach towards CCA and define first steps as well as a review procedure. Furthermore, the aim is to sort the measures according to the time horizon of their implementation (short-, medium- or long-term).

Your task is to **guide the company** in selecting the measures which address the risks of highest priority and have scored well in the assessments of the last section. It is suggested to consider measures of medium or low priority as well if they can be implemented easily and cost-effectively. These "quick-wins" need not have scored very highly on effectiveness, for example, if they can be easily implemented and have additional benefits.

For assessing which measure to implement in the **short-, medium- and long-term,** you need to discuss in depth with the top management and engineers. Here a scoring system would be too simplistic, as a **multitude of factors needs to be taken into account.** Generally speaking, two criteria should be used to assess the appropriateness of measures in a given time, namely the urgency to tackle the risk and the **costs of the measure in question.** Like for other investment decisions of the company, a return of investment calculation should be made and the amortisation period should be assessed.

Results from the case study

The different columns of the worksheet are illustrated by selected adaptation measures of the case company below.

In addition to the adaptation measures mentioned above for illustrative purposes, there are some more comprehensive measures listed here. The following measures have been identified as suitable for implementation **immediately** in response to the higher frequency and longer duration of heat waves: to increase the **storage volume** for input materials, to **diversify suppliers/** identify less vulnerable regions, and to produce and market apparel designs and materials with **high ventilation** properties. As measures that require some more planning and financing, the following have been identified as suitable for **medium-term implementation:** the **insulation of the administrative building, facade and roof greening** and the **installation of solar panels.** Lastly, the following measures have been identified as **long-term adaptation options:** the **construction of a climate-proof plant** in non-affected area and the **build-up of an apparel line with cooling fabrics.** Both require a long-term view and planning process and need to be integrated into the strategic decision-making of the company.

Table 38 **Developing an adaptation strategy**

Short-term adaptation measures to be implemented (implementation period: immediately)

	Adaptation measure	Risk / market opportunity addressed	Additional advantages	Type of measure	Impact area	Synergies and conflicts	
R1	Increase the storage volume for input materials	More frequent production delays at suppliers with high water, energy and labour inputs	Hedging against rise in market price of input material	Grey	Building	None	
R2	Diversify suppliers/ identify less vulnerable regions	(Same as above)	Better negotiation position	Soft	Logistics	None	
O1	Apparel designs and materials with high ventilation properties	Change in demand due higher number of hot days	Increased revenue generation and higher market share	Soft	Market	None	

Medium-term adaptation measures to be implemented (implementation period: years 2-3)

	Adaptation measure	Risk / market opportunity addressed	Additional advantages	Type of measure	Impact area	Synergies and conflicts	
R1	Insulation of the administrative building	Reduced productivity during heat waves	Cost-reduction through reduced requirements for cooling	Grey	Employees	Synergies with energy-saving concept and positive impacts on processes (risk of overheating of machinery reduced); conflicts: disturbs work for substantial period of time (constructions, noise etc.); construction	

	Integration possibility	Potential barriers	Ideas for overcoming barriers	Success indicators / Monitoring activities	Notes & comments
	Heat-proof the additional storage space	Land acquisition / building permit	Refurbish existing underused buildings / rent or share storage space	Amount of storage space used for supplies Frequency of production stops or delays because of supply lack of input material	
	Make suppliers aware of CC risks and thus strengthen relationship	High identification costs; trust building with new suppliers	Approach business chambers; build new relationships slowly	Number of suppliers / input material Frequency of production stops or delays because of supply lack of input material	
	Make buyers aware of CC risks and thus strengthen relationship	Lack of design capacities; difficulty to get buyers to pay attention	Cooperate with local buyers first to create strong relationship; use the thusly developed products as showcase	Number of products that take heat into account Number of requests for cooperation	

	Integration possibility	Potential barriers	Ideas for overcoming barriers	Success indicators / Monitoring activities	Notes & comments
	Integration of measure into energy-saving concept	High costs	Insulation in three phases: • Most heat prone rooms with workplaces for staff; • Other office rooms with workplaces for staff; • Other rooms without workplaces for staff (e.g. storage rooms)	Severity of heat stress in administrative buildings • Definition: number of days per year on which maximum inside temperature exceeds 26°C • Measurement: monthly data compilation and	

Medium-term adaptation measures to be implemented (implementation period: years 2-3)							
	Adaptation measure	**Risk / market opportunity addressed**	**Additional advantages**	**Type of measure**	**Impact area**	**Synergies and conflicts**	
						workers need to be hired because of limited know-how within the company.	
R2	Facade and roof greening	Quicker overheating of machinery and production stop during heat waves	Reduction of energy costs through reduced requirements for cooling. Fewer break-downs of machines.	Green	Building	Positive effects on working conditions (lower inside temperatures); positive environmental impacts. Conflicts: no internal know-how + time-consuming implementation if no experiences	
R3	Install solar panels	Frequent power cuts during heat waves and production stops	Reduction of energy costs; less strain on machinery due to frequent power cuts	Grey	Processes	Climate change mitigation through renewable energy generation	

Long-term adaptation measures to be implemented (implementation period: years 4-8)							
	Adaptation measure	**Risk / market opportunity addressed**	**Additional advantages**	**Type of measure**	**Impact area**	**Synergies and conflicts**	
R1	Construct climate-proof plant in non-affected area	Loss of productivity due to heat waves (and other risks)	Construct plant according to energy efficiency standards for cost saving effect	Grey	Building, Logistics, Processes, Market	Climate change mitigation through energy efficiency; integrate solar panels	
O1	Build up apparel line with cooling fabrics	Change in demand due to higher number of hot days	Increased revenue generation and higher market share	Soft	Market	None	

	Integration possibility	Potential barriers	Ideas for overcoming barriers	Success indicators / Monitoring activities	Notes & comments
				annual reporting by Head of operations • Target: zero days of heat stress per year	
	Could be integrated in marketing material or sustainability strategy	Technical issues, i.e., sun exposure and watering of plants	Cooperate with gardening firm on plant selection and train employees; use recycled water	Severity of heat stress in administrative buildings	
	Could be integrated in marketing material or sustainability strategy	Financing; maintenance	Seek renewable energy credit line; consider feed-in-tariff as option; build internal expertise for maintenance	kWh generated by solar panels Number of disruptive power cuts	

	Integration possibility	Potential barriers	Ideas for overcoming barriers	Success indicators / Monitoring activities	Notes & comments
	To be integrated into marketing strategy towards buyers	Financing	Seek energy efficiency and renewable credit line	Plant built; plant profitability in comparison to others	
	To be integrated into marketing strategy towards buyers	Expertise in material design and use lacking	Cooperate with innovative companies	Number of products that use innovative materials	

7.2 Communicating the adaptation strategy 4

Purpose and content of the worksheet

An implemented CCA strategy has additional value for your client when it is communicated to internal and external stakeholders adequately. The worksheet within this section supports your client systematically in achieving this potential.

The internal communication (target audience: employees) aims at achieving the following aspects:

- Increases the internal knowledge about CCA measures/ strategy (awareness raising)
- Builds capacity and ownership for implementation (support, commitment and participation)
- Improves internal reputation
- Generates ideas for developing and improving the CCA strategy

The latter potential can be enhanced by advertising internal contests for new and innovative CCA measures as well as awards for exemplary performance. In order to generate internal acceptance for CCA and to ensure organisation-wide CCA efforts, a strategic CCA team can be implemented.

External communication addresses diverse stakeholders such as (end-) customers, purchasers, communities, investors, political authorities and non-governmental organisations. It is important for your client to recognise that external communication needs to be stakeholder-specific since different stakeholders do have different levels of knowledge, expectations and interests towards the company and its performance regarding climate change topics.

For instance, if your client communicates its efforts to the wider public, part of the audience might not yet know a lot about climate change and its impacts. In order to successfully communicate climate change impacts and the company´s efforts to this audience, it is helpful to start out with examples from everyday life such as droughts or water cuts.

On a general basis, external communication aims at achieving the following aspects:

- Opportunity to promote the success of implementation efforts and acquire a pioneer status
- Improvement of external reputation towards diverse external stakeholders
- Potential to trigger collaboration in adaptation efforts, e.g., on cluster level, in cooperation with communities, supporting programmes by governments, Public Private Partnerships, etc.

Important categories:

Issue/message: In this category you list which issue(s) to communicate and what the message would be. These could be related to the CCA strategy in general or to specific measures or clusters of measures.

Target group: This category necessitates defining a target group to whom to deliver the message to. Also, several target groups can be targeted with the communication of one issue, but usually, the aims and means of communication would vary for each group.

Aim: In this section, it is stated what the aim of communicating a particular issue would be, and why delivering this message is relevant to the company. Aims could be related to relationship or reputation building, or to actively deflect perceived communication risks, e.g., in the area of water risk.

Means of communication: Here, different media are listed that can be used for communicating a certain issue.

Timing and frequency: In this category, timing and frequency of the message communication are determined.

Point department: Various departments can be responsible for communicating a message; often, this would need to be assisted and coordinated by the PR or marketing department.

How and when to use this worksheet

A suitable and transparent communication of implemented CCA measures/ the fully-fledged CCA strategy is a valuable undertaking for enhancing the internal acceptance of the company´s CCA strategy and to increase the employees´ commitment for and identification with their employer. Furthermore, a holistic communication strategy including external stakeholders can improve external relations and the reputation of your client's company.

Time required
Preparation: 1h
Assessment: 2h
Documentation: 1 h

Participants
Top management, HR department, marketing department

Aim of the consulting session
The aim of the session is to raise the awareness of the company that communication is an important factor for the success of the CCA strategy; both internal and external communication are of relevance. Internal communication can happen via internal training programmes, quarterly meetings, company magazine, newsletters or the intranet. External communication can be accomplished by means of different communication channels such as company website, newsletters or social media as well as direct communication with purchasers.

In this regard, **your task** is to support your client in selecting which issues to communicate and to whom this communication should be directed at, setting specific goals of communication, choosing suitable communication tools and channels, drafting a time schedule and allocating responsibilities.This procedure applies for internal and external communication. Altogether, it is important for your client to integrate communication activities regarding CCA into existing processes / strategies in order to achieve a transparent, consistent and credible communication strategy. In this regard, it can be recommended to integrate CCA efforts into strategy documents (Sustainability and/or Climate Change strategy), handbooks, guidelines, software tools, security plans and process manuals as well as to determine specific responsibilities. One key strategy in CCA communication is to not only focus on climate risks but also on arising opportunities. In this context, it might be useful to propose a long-term vision, for instance a vision of a climate resilient region to which your client company could proactively contribute by means of its own adaptation strategy and its support to affected communities. Your client could also relate their company's adaptation efforts to its wider commitments in climate protection and environmental sustainability.

Your client should not hesitate to communicate uncertainties and limits of his / her current strategy. This enhances transparency and credibility of CCA efforts and enables an open debate about potential improvements.

Results from the case study

The **internal communication** priorities of the case company include the **promotion of workforce-related CCA measures** in general in order to improve the standing of the company among its employees. Other internal issues aim at sharpening the profile of the company as an innovator and thus seek to improve reputation, and generate additional adaptation ideas. **External communication** focuses on strengthening the company's image as a sustainable and long-term oriented player and trigger **collaboration** in adaptation efforts with other companies or organisations; therefore, an important way of communicating is the participation in conferences regarding risk and climate change.

Table 39 **Communication plan**

Internal communication						
	Issue / Message	**Target group**	**Aim**	**Means of communication?**	**Timing / frequency**	**Point department**
1	CCA measures (new building insulation, energy-efficient air conditioning, Installation of health supervisors) will be implemented in order to secure acceptable working conditions	Employees	Increase the standing of the company among its employees. Prove that employees are a valuable resource (internal reputation).	Assembly, word of mouth, newsletter	One time, for each additional measure	HR department
2	Implementation of emergency plan/ warning system for heat-related health problems of employees	Employees	Awareness raising for heat wave related health risks. Process optimisation and increasing alertness for risks in case of heat wave occurrence. Proof of the company´s awareness and ability to act.	Newsletter, Security Plan, documentation for behaviour in case of emergencies	Updating, especially in times of risk	HR department
3	CCA measures (new building insulation, increasing storage volume, diversification of suppliers) to ensure smooth and efficient processes are implemented	Employees	Employees served by optimal process conditions. Increases the internal knowledge about CCA measures/ strategy.	Assembly, word of mouth, newsletter	One time, for each additional measure	HR department
4	Investments in product development (for seizing market opportunities)	Employees	Improve identification with the company and CCA topics. Proof for investments into future topics (job security).	Assembly, word of mouth, newsletter	Updates about efforts and success	HR department

Table 39 Communication plan

	External communication					
	Issue / Message	**Target group**	**Aim**	**Means of communication?**	**Timing / frequency**	**Point department**
5	CCA strategy is implemented in order to assure customer satisfaction, punctuality of delivery, acceptable work conditions	Purchasers/ customers, local government	Prove compliance to purchaser´s expectation (and beyond). Improve company reputation.	Newsletters, Company homepage, conference (as case study), print media (as op-ed?)	When decision is made, again when measure is completed; use in company material	PR/ Marketing manager
6	Solar panel installation is planned	All stakeholders, including community, business associations etc.	Improves company reputation regarding sustainability efforts.			
7	Facade/ Roof greening is planned	All stakeholders, including community, business associations etc.	Improves company reputation regarding sustainability efforts.			

8 Annex 1 - Worksheets

Table 40	Assessment grid on sensitivity and adaptive capacity			
Impact Area			**Critical Points**	**Assessment**
Infrastructure and operations	Building/Location	1	Are existing buildings resistant enough to withstand climate change impacts (changing climate, extreme weather events)?	
		2	How sensitive is the company location regarding climate change impacts?	
		3	Is infrastructure in direct proximity of the premises resilient regarding changing climate and extreme weather events?	
		4	How linked is the company with neighbouring companies? (resources, infrastructure, joint efforts)	
		5	How linked is the company with the community? (resources, infrastructure, joint efforts)	
	Processes	6	How sensitive are manufacturing processes in terms of uncertain energy and water supply?	
		7	Is the availability of water supply secure?	
		8	Is the availability of energy supply secure?	
		9	How sensitive are manufacturing processes to higher temperatures?	
		10	How sensitive are manufacturing processes in case of extreme weather events?	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity

Table 40 **Assessment grid on sensitivity and adaptive capacity**

Impact Area			Critical Points	Assessment	
Infrastructure and operations	Processes	11	Is it possible to reduce water and / or energy consumption?		
		12	Are there any measures to provide the processes with energy in case of energy supply outage?		
		13	Are there any safety measures to prevent outflow of dangerous or pollutant substances?		
	Logistics and stock	14	Is the availability of raw material and auxiliary material affected by climate change impacts?		
		15	Is there enough flexibility in transport and delivery of goods in case of climate change impacts?		
		16	Is there any possibility to reduce raw material and product miles and/or reduce complexity of value chain?		
		17	Is the storage of goods secure in case of changing conditions (e.g., higher temperature) or other climate change impacts (e.g., flooding)?		
Stakeholders	Employees and community	18	Do working conditions deteriorate due to climate change impacts?		
		19	Do living conditions of workers deteriorate due to climate change impacts?		
		20	Are there any impacts on productivity caused by temperature rise or extreme weather?		
		21	Has the community been affected by climate change and / or the company's actions in the past?		
		22	How severely is the community (estate population and surrounding communities) affected by climate change, and by the company's adaptation or maladaptation?		

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity

Table 40			Assessment grid on sensitivity and adaptive capacity		
Impact Area			**Critical Points**	**Assessment**	
Infrastructure and operations		23	Are there any possibilities to help adapt and / or raise stability of energy/water supply in the community (estate population and surrounding communities) in a joint effort (PPP)?		
	Government and Regulation	24	Have past direct climate change impacts already affected regulations that your company has to comply with?		
		25	Do projected climate change impacts affect existing regulations?		
		26	Are there any regulations that you anticipate or expect to become more stringent in the future?		
		27	Is your company affected by any existing government programmes (e.g., National Missions) or funding streams?		
		28	Are there any government programmes regarding adaptation to be anticipated, or that your company could lobby for?		
Finance and market	Market	29	Is there any falling or rising demand of company's products caused by climate change?		
		30	Are there increasing expectations / standards of purchasers and / or end-consumers in terms of climate change adaptation efforts (and is compliance referring to this aggravated by the vulnerability of the company)?		
		31	Are there any impacts on product accessibility?		
		32	Is there any opportunity to extend or adapt product portfolio to climate change impacts?		
		33	Are there any problems regarding short-term cash-flow and financing caused by climate change impacts?		

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity

Table 40 Assessment grid on sensitivity and adaptive capacity

Impact Area			Critical Points	Assessment	
Finance and market	Finance	34	Are there any problems caused for long-term investments by climate change impacts?		
		35	Is it likely that your company's liabilities increase due to climate change impacts? (e.g., flooding resulting in toxic discharge)		
		36	Are insurance premiums likely to be raised due to climate change impacts and / or are the existing insurances still adequate?		

Table 41 Past climate change and impacts on the company

			Impact Area			
	Climate Phenomenon	Point in Time	Infrastructure & operations	Stakeholders	Finance & market	

	In case of risk: Potential loss or damage (low, medium, high) / Likelihood of occurrence (not likely, likely, very likely)	Ideas on measures for addressing risk / opportunity

	Description of Phenomenon	Resulting impacts (Disadvantages /Benefits)	Subsequent measures taken

Table 41 Past climate change and impacts on the company

			Impact Area			
	Climate Phenomenon	Point in Time	Infrastructure & operations	Stakeholders	Finance & market	

	Description of Phenomenon	Resulting impacts (Disadvantages /Benefits)	Subsequent measures taken

Table 42	Expected climate change and impacts on the company						
	Variable	**Climate Phenonmenon**	**Trend direction, expected changes**	**Period of time (in comparison with)**	**Source**	**Notes on source or scenario**	

	Impact Area				
	Infrastructure & operations	Stakeholders	Finance and Market	Description of impact and its critical threshold value	Notes and comments

Table 43 Risk table for climate phenomena

		Impact Area						
	Climate phenomenon	Infrastructure & operations	Stakeholders	Finance and Market	Resulting risk	Description	Expected time frame	

	How probable is it that the impact will occur?	How extensive is the expected loss or damage of the impact, when it occurs?	Risk (probability × extent of damage)	Prio

Table 44 Risk matrix

DEGREE OF LOSS OR DAMAGE			
	5 - Very High		
	4 - High		
	3 - Medium		
	2 - Low		C
	1 – Very low		
		1 – Very low	2 - Low
		PROBABILITY	

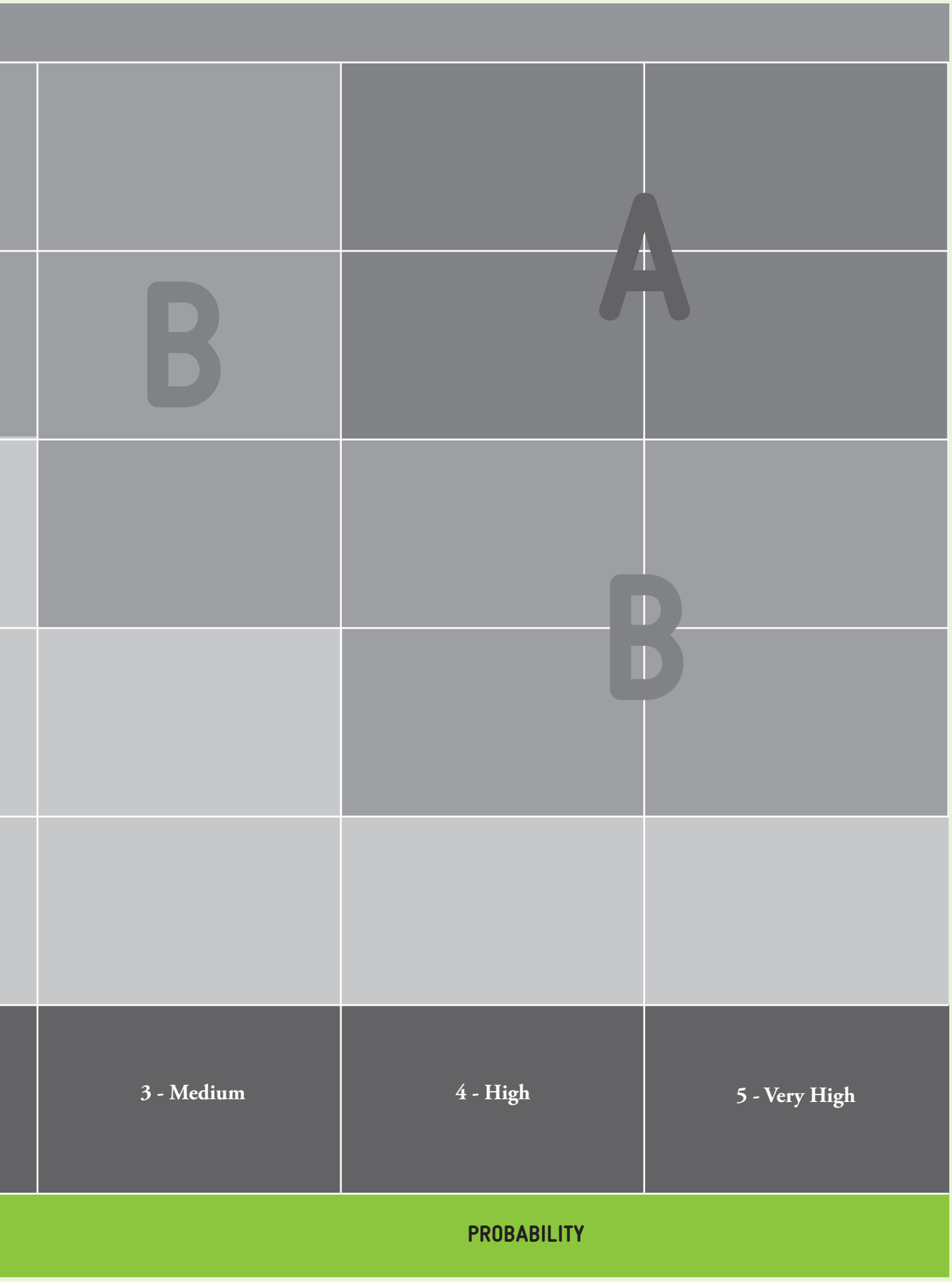

A
B
B
3 - Medium
4 - High
5 - Very High
PROBABILITY

Table 45	Assessment of new opportunities					
	Climate pheno-menon	**Target market / customers**	**Expected market changes**	**Timing / urgency**	**Potential product / service /innovation**	

	Type of service / product /innovation					
	Lower climate vulne-rability	CCA	Other	Challenges / Solutions	Benefits	Timing of the measure / comments

Table 46	Prioritised risks for the CC phenomenon "Heat Waves"
Priority Level A	
Priority Level B	
Priority Level C	

(1 = Location & Buildings | 2 = Processes | 3 = Logistics & Stocks | 4 = Employees & Community | 5 = Government & Regulation | 6 = Market | 7 = Finance)

Table 47 List of measures for addressing risks

			Technology Level				Feasibility*					
Risk	Prio	Adaptation measure	Low-tech	Mid-tech	High-tech	Effectiveness (×2)	Technical feasibility	Organisational feasibility	Financial feasibility: investment	Financial feasibility: Running costs	Financial feasibility: amortisation period	

	Positive side effects*					Negative side effects*					
	Potential for reducing costs	Synergies with other CCA measures	Contributing to climate protection	Contributing to other sustainability goals	Reversibility/ flexibility	Negative social / community impacts	Negative environmental impacts	Negative impacts on existing measures	Sum	Prio	Notes and Comments

Table 48	Measures for seizing opportunities / new markets				
Climate phenomenon	Target market	Expected market changes	Timing /urgency	Potential product / service / innovation	

TF: Technical Feasibility, OF: Organisational Feasibility, FF: Financial Feasibility

* 0= non-existent // 1 = very low // 2 = low // 3 = medium // 4 = high, // 5 = very high

							Revenue /Market (×2)
							TF*
							OF*
							FF*
							Sum
							Prio
							Notes and comments

In-depth economic assessment

The in-depth economic assessment consists of several worksheets which require the performance of calculations. These calculations are automatically conducted in the Excel worksheets. The following worksheets are included in the Excel sheet:

- 3.3a – Economic assessment CBA (template included below – no calculation performed)
- 3.3b – CBA – Costs (template included only in Excel sheet – calculation performed)
- 3.3c – CBA – Benefits (template included only in Excel sheet – calculation performed)
- 3.3d – CBA - Results (template included only in Excel sheet – calculation performed)
- 3.4a – Economic assessment CEA (template included below – no calculation performed)
- 3.4b – CEA – Costs (template included only in Excel sheet – calculation performed)
- 3.4c – CEA - Benefits Part I (template included only in Excel sheet – calculation performed)
- 3.4d – CEA - Benefits Part II (template included only in Excel sheet – calculation performed)
- 3.4e – CEA – Results (template included only in Excel sheet – calculation performed)

Economic assessment of adaptation measures: Cost-Benefit Analysis

A Cost-Benefit Analysis is relevant for the following measures:

Table 49 Economic assessment of adaptation measures: Cost-Benefit Analysis

#	Risk addressed	Adaptation measure	Does the measure directly reduce costs or generate revenues in an easily quantifiable way? (without consideration of cc impact)	Conduct CBA?	
				Yes	No
0					
1					
2					
3					
4					
5					
6					

Economic assessment of adaptation measures: Cost-Effectiveness Analysis

A Cost-Effectiveness Analysis is relevant for the following measures:

Table 50	Economic assessment of adaptation measures: Cost-Effectiveness Analysis				
#	Risk addressed	Adaptation measure	How and to what extent is the measure able to prevent loss of profit due to climate change?	Conduct CEA?	
				Yes	No
0					
1					
2					
3					
4					
5					
6					

Table 51	Developing an adaptation strategy						
	Short-term adaptation measures to be implemented (implementation period: immediately)						
	Adaptation measure	**Risk / market opportunity addressed**	**Additional advantages**	**Type of measure**	**Impact area**	**Synergies and conflicts**	

	Integration possibility	Potential barriers	Ideas for overcoming barriers	Success indicators / Monitoring activities	Notes & comments

Medium-term adaptation measures to be implemented (implementation period: years 2-3)							
	Adaptation measure	**Risk / market opportunity addressed**	**Additional advantages**	**Type of measure**	**Impact area**	**Synergies and conflicts**	

	Integration possibility	Potential barriers	Ideas for overcoming barriers	Success indicators / Monitoring activities	Notes & comments

Long-term adaptation measures to be implemented (implementation period: years 4-8)							
	Adaptation measure	**Risk / market opportunity addressed**	**Additional advantages**	**Type of measure**	**Impact area**	**Synergies and conflicts**	

	Integration possibility	Potential barriers	Ideas for overcoming barriers	Success indicators / Monitoring activities	Notes & comments

Table 52	Communication plan					
Internal communication						
	Issue / Message	**Target group**	**Aim**	**Means of communication?**	**Timing / frequency**	**Point department**

Table 52	Communication plan					
External communication						
	Issue / Message	Target group	Aim	Means of communication?	Timing / frequency	Point department

Annex 2 - Supporting Calculations

How to come up with figures for profit loss and conduct supporting calculations

Measure 2: Purchase of new sewing machines/packaging machine that are more heat resistant

For this Cost-Effectiveness Analysis (CEA), it is assessed whether an adaptation measure that achieves greater benefits than it requires costs under business as usual conditions (i.e. without the assumption of any climatic changes, (see CBA) also proves cost effective under the assumption that a certain climate phenomenon will have an impact on the company's operations.

The supporting calculations are used on the example of purchasing more heat-resistant machinery. This machinery reduces the average number of days when about 30 percent of machinery breaks down due to overheating from ten to two per year under current climatic conditions. However, in this CEA it is assumed that climate change would cause an increase in days when 30 percent of old machinery breaks down up to 15 days per year. New machinery would not be affected by hotter days. Hence, this new machinery would reduce the profit losses from lower production output on these days.

The following values serve as inputs for the calculations, in addition to the initial assumptions for the CBA and CEA:

Variables			
	Total	**From**	**To**
Average annual profit (INR)	15,000,000		
Garments per day	23,014		
Price/garment item (INR)		33.08	41.35
Profit margin (%)	5		
INR/KWh (no CC)	8.4		
INR/KWh (with CC)	10		
Electricity consumption OLD machinery (kWh/year)		126,185	140,100
Electricity consumption NEW machinery (kWh/year)		138,892.5	154,635

In order to quantify the overall profit loss with and without adaptation, all cost and revenue components that are subject to climate change impacts need to be considered. As climate change also has an impact on the electricity price, e.g. through emissions regulation, scarcity of energy inputs, or power-cuts through extreme weather events, assessing the cost-effectiveness of an adaptation measure needs to factor in the anticipated changes in electricity costs. It is assumed that the average electricity price, as a function of grid-electricity and diesel price for electricity produced by a generator, increases under climate change from 8.4 INR/kWh to 10 INR/kWh.

In this case study, the new and more heat-resistant machinery actually consumes more electricity than the old machinery.

Electricity Costs				
Electricity costs (per year, INR)	Old Machinery		New Machinery	
	From	To	From	To
Climate Change Scenario	126,185 kWh * 10 INR / KWh =1,261,850	140,100 kWh * 10 INR / KWh =1,401,000	138,892.5 kWh * 10 INR / KWh =1,388,925	154,635 kWh * 10 INR / KWh =1,546,350
No Climate Change Scenario	126,185 kWh * 8.4 INR/KWh =1,059,954	140,100 kWh * 8.4 INR/KWh =1,176,840	138,892.5 kWh * 8.4 INR/KWh =1,166,697	154,635 kWh * 8.4 INR/KWh =1,298,934

First, this CEA approach calculates the minimum and maximum annual electricity costs for the **old (non-adaptation)** and the **new (adaptation)** machinery (see previous table). In order to determine the profit loss from additional electricity costs without adaptation (i.e. keeping the old machinery) in the case of climate change (CC), the electricity costs without CC are subtracted from the electricity costs with climate change. The result (see the first row in the following table) is the additional electricity cost caused through climate change (minimum and maximum). The percentage of total profit "that is lost from climate change impacts" is then derived by dividing these costs (= absolute profit loss from electricity costs) by the annual profit and multiplying by 100.

Profit loss (non-adaptation) = Benefits I = Electricity costs OLD machinery with CC - Electricity costs OLD machinery without CC		
	From	To
INR	1,261,850 – 1,059,954 = 201,896	1,401,000 – 1,176,840 = 224,160
Percent* (of total annual profit)	201,896/ 15,000,000 * 100 = 1.35	224,160/ 15,000,000 * 100 = 1.49
*) These percentages are then entered in the electricity cost category in the worksheet 'CEA – Benefits Part I'		

Similarly, the minimum and maximum remaining profit loss from electricity costs is calculated by subtracting the electricity costs from old machinery in the absence of climate change impacts from the electricity costs of the new machinery when facing impacts from climatic changes. This remaining profit loss represents **the differ-**

ence in electricity costs between the **adaptation measure with climate change impacts** and **non-adaptation without climate change.** In this case, this remaining profit loss from electricity is positive as the new machines consume more energy in the production process and the electricity price increases as a result of climate change impacts. A negative remaining profit loss would indicate that the adaptation measure in the case of climate change has lower electricity costs than the old machinery even without climate change.

Remaining Profit loss = Benefits II = Electricity costs NEW machines CC - Electricity costs OLD machines no CC		
	From	**To**
INR	1,388,925 – 1,059.954 = 328,971	1,546,350 – 1,176,840 = 369,510
Percent* (of total annual profit)	328,971/ 15,000,000 * 100 = 2.19	369,510/ 15,000,000 * 100 = 2.46
*) These percentages are then entered in the electricity cost category in the worksheet 'CEA – Benefits Part II'		

Profit loss from machinery breaking down

Besides the electricity price, climate change impacts are also expected to increase the days when about 30 percent of old machinery breaks down from ten to 15 per year. The new machinery, on the other hand, will not be affected by climate change impacts. With an annual production of 8.4 million garments, IndTex produces about 23,014 garments per day. When machinery breaks down, the company faces revenue losses due to reduced output (about 23,014 * 30% = 6,904 garments less on these days). One item of garment is sold at a price between 33.08 INR and 41.35 INR. The following table calculates how much annual revenue loss the company will face with and without climate change impacts for old and new machinery.

Revenue loss from machinery breaking down (per year, INR)	Old Machinery		New Machinery	
	From	**To**	**From**	**To**
Calculation	garments/day * price * **days of break-downs** * % machinery breaking down			
Climate Change Scenario (15 days)	23,014 * 33.08 *15 * 0.3 **=3,425,819.18**	23,014 * 41.35 *15 * 0.3 **=4,282,273.97**	23,014 * 33.08 *2 * 0.3 **=456,775.89**	23,014 * 41.35 * 2 * 0.3 **=570,969.86**
No Climate Change Scenario (10 days)	23,014 * 33.08 *10 * 0.3 **=2,283,879.45**	23,014 * 41.35 *10 * 0.3 **=2,854,849.32**	23,014 * 33.08 *2 * 0.3 **=456,775.89**	23,014 * 41.35 * 2 * 0.3 **=570,969.86**

In order to determine the **additional revenue loss** from climate change without adaptation, i.e. keeping the old machinery, the revenue loss without climate change is subtracted from the revenue loss that would occur with climate change impacts increasing the annual number of days when about 30 percent of machinery breaks down from ten to 15. As this CEA uses 'profit loss' as the unit of measurement,[3] this difference in revenue loss is then

Footnotes 3 Note that it is important to distinguish between revenue and profit!

Profit Loss = Benefits I = Lost Profit with CC (OLD machines) - Lost profit without CC (OLD machines)		
	From	To
Calculation	(Costs OLD CC – costs OLD no CC) * profit margin	
INR	(3,425,819.18 – 2,283,879.45) * 0.05 = 57,096.99	(4,282,273.97– 2,854,849.32) * 0.05 = 71,371.23
Percent* (of total annualprofit)	57,096.99/ 15,000,000 * 100 = 0.38	71,371.23/ 15,000,000 * 100 = 0.48
*) These percentages are then entered in the loss category 'Lost revenue' in the worksheet 'CEA – Benefits Part I'		

multiplied by the profit margin of five percent in this case. The first row of the following table hence states the **absolute profit loss from lost revenue.** In order to be able to aggregate the profit losses from different cost categories, this absolute profit loss is then converted into 'percent of total profit' (second row of the following table).
The remaining profit loss from lost revenue equals the lost revenue from about 30 percent of machinery breaking

Remaining Profit loss Benefits II = Remaining lost profit = Lost profit adaptation CC (NEW machines)		
	From	To
Calculation	Profit loss from NEW machinery breaking down * profit margin	
INR	456,775.89 * 0.05 =568,973.5	570,969.86 * 0.05 = 612,118
Percent* (of total annualprofit)	568,973.5 / 15,000,000 * 100 = 0.15	612,118 / 15,000,000 * 100 = 0.19
*) These percentages are then entered in the loss category 'Remaining lost revenue' in the worksheet 'CEA – Benefits Part II'		

down on two days per year (unchanged with or without climate change impacts), as new machinery is not affected) multiplied by the profit margin. The second row of the following table converts the absolute remaining lost profit to the unit of percentage of total annual profit.
The worksheet 'CEA – Benefits Part I' then aggregates the percentages of profit losses in each cost category ('electricity costs' and 'lost revenue from machinery break-downs' in this case) to calculate total profit losses from climate change without adaptation. The worksheet 'CEA – Benefits Part II' aggregates the percentages of remaining profit losses in each cost category ('remaining electricity costs' and 'remaining lost revenue from machinery break-downs' in this case) to calculate remaining total profit losses from climate change with adaptation.

The 'CEA Results' worksheet then calculates the benefits from adaptation over non-adaptation by subtracting the average total remaining profit loss (adaptation) from the average total profit loss (non-adaptation) and consequently the Cost-Effectiveness Ratio for each of the scenarios and time horizons.

Annex 3 - Case Study

Economic assessment of climate change adaptation measures in micro small and medium-sized enterprises

Application of Cost-Benefit Analysis (CBA) and Cost-Effectiveness Analysis (CEA) as part of private sector risk-management and for investment decision prioritisation

DyeingCo Industries Pvt. Ltd., Ludhiana, India

This case study has been developed by adelphi commissioned by GIZ sector project on private sector development on behalf of BMZ.

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Part A: Introduction and Background

This case study has been developed as part of a project for developing and testing an economic assessment approach of climate change adaptation options in India. The economic assessment method comprising a Cost-Benefit Analysis (CBA) and a Cost-Effectiveness Analysis (CEA) which is applied in this case study is now part of the Climate Expert approach. The assessment approach allows companies to **prioritise between different adaptation measures** and choosing the one with the greatest economic benefits for the company.

Information on materials on the **Climate Expert approach** can be obtained free-of-charge from www.climate-expert.in.

The assessment on which this case study is based was conducted in March and April 2014. A team of international experts as well as an Indian consultant who had been trained in the Climate Expert approach visited the company, called DyeingCo Industries Pvt. Ltd[4] in Ludhiana, India. During two half-day visits information was collected and results were calculated and discussed with the company. During the same time, **another company visit was conducted in a pharmaceutical company in Hyderabad**, India.

Before the site-visits were undertaken, the Climate Expert **worksheets** were shared with the contact person. Additionally, a **list of relevant data** to be gathered was communicated. This list included such items as turnover, water consumption, electricity consumption, labour costs, raw materials consumed, and a flow chart of company processes. Also, the company contact was asked to **inform relevant staff members** such as the lead engineer, plant supervisor, and accountant to be available during the site visit. The consultant team collected information

Footnotes 4 Company name changed for reasons of anonymity.

on past climate change impacts and likely future development of the local climate to discuss these impacts with the company during the visit.

At the first visit, the Climate Expert approach was again introduced to the company representatives present. After going through the **assessment grid of the Climate Expert** (worksheet '0 - Assessment grid') and also presenting the findings on expected climate change, the team took a **tour of the company premises**. Based on the impressions of the company tour, the assessment grid and the discussed climate change impacts the team jointly with the company representatives identified **key risks** for the company and ranked them. Subsequently, several **adaptation options** for the risks most relevant for the company were identified. For each of the measures the **relevant costs and benefits** were discussed with the company representatives. Based on this collection of data the consultant team then performed the **calculations for the economic assessment** using the Climate Expert calculation worksheets for CBA and CEA (worksheet sets 3.3 and 3.4) on the following day. The results of this assessment were presented to the company during the second visit. Based on these discussions some adjustments of the assumptions taken were made in the following days. Finally, the completed worksheets with the calculated results were shared with the company.

The case study starts off with a short description of the company and a description of how the company is affected by climate change **(Part B: Climate Change Impacts)**. This is followed by the description of the adaptation measures that have been identified **(Part C: Climate Change Adaptation)**. In the next steps results of the CBA **(Part D: Cost-Benefits Analysis)** and the CEA **(Part E: Cost-Effectiveness Analysis)** are presented for the measures which had been selected for an economic assessment. In the last section **(Part F: Conclusions)**, the implications of the economic assessment for the selection of adaptation measures for implementation are summed up.

Part B: Climate Change Impacts

Company profile

DyeingCo Industries Ltd. is an Indian dyeing company located in Ludhiana, Punjab (see red area on the map below). With an **annual turnover of INR 80 - 100 million** (ca. EUR 950,000 - 1,190,000[5]), **annual profits of INR 4 million** (EUR 47,600) and **120 employees** (20 skilled, 80 unskilled, 20 office staff; of the unskilled workers ca. 25 are contracted from an outside service provider), the company can be considered small- to medium-sized.

DyeingCo Industries has a **short and local supply chain**. The company receives fabric directly from the clients who required dyeing for their products. These clients come exclusively from the Ludhiana textile cluster. Inputs to the dyeing process, mainly fuel (pet coke and rice husk) and chemicals for dyeing are supplied by companies from Ludhiana. Even though the end-user markets for DyeingCo Industries' dyed fabrics spread across India and even into Africa, changes in these markets do not directly influence the company. With its short and local value chain, DyeingCo Industries is hedged against price fluctuations and even some climate change impacts. This means that the company does not have to worry about long disruptions of the supply chain, for example due to deteriorating road conditions during heat waves.

Annually, the company dyes approx. 4,050 tonnes of polyester and 900 tonnes of cotton. The **production processes are based to a large extent on machinery**, including jigger and soft flow dyeing machines as well as dryers. A boiler generates steam by using pet coke and rice husk as fuel for heating up water. Overall, the **process of dyeing is very energy and water intensive**. With several of the company's 20 dyeing machines out-of-date, energy and water requirements are rather high. This means that resources like water and energy which are expected to become scarcer and thus more expensive in the future are used inefficiently.

Footnotes 5 With an exchange rate of EUR 1 = INR 84 (as of April 2014)

DyeingCo Industries has its premises in the **Ludhiana textile cluster**. The company owns one large building which was built in 2001. Several smaller storage shacks are also found on the company premises. **Electricity is supplied mainly form the grid** and, in cases of power cuts, from the company's own **diesel generator. Water is supplied free of charge via a groundwater pump** (except for electricity costs for operating the pump) but the necessary infrastructure to feed in water from public water suppliers is in place. Waste water is treated in the company's **own effluent treatment plant** before it is discharged into the cluster's sewage system.

The region in which the company is located is **usually hot during summer**, with mean temperatures around 35°C and maximum temperatures of up to 45°C on rare occasions. Over the last few years, however, the area has experienced **heat waves** with temperatures rising beyond the average several times. The precipitation patterns have also changed: **rain events have not only become more intense during monsoon season, but they also arrive more unexpectedly throughout the year.** Also, monsoon patterns (first occurrence/duration) have become more erratic.

It can be expected that climate change will become more severe in Ludhiana in the future. **Until the mid- century** (2021 - 2050) the Government of Punjab [6] projects **an increase of annual maximum temperatures of up to 1,8°C.** Particularly in the pre-monsoon and winter seasons this temperature increase could even be higher (up to 2,3°C). Similarly, **minimum temperatures are expected to rise by around 2°C** over the year. With regard to rainfall, possible changes point in different directions: while the **post-monsoon season is projected to see an increase of rainfall by 30 - 64 percent, winter could possibly become drier (-22 - 0 percent).**

Company Facts:	
Location	Ludhiana, Punjab
Products	Dyeing of fabric (4,050 tonnes of polyester and 900 tonnes of cotton per year)
Annual turnover	INR 80 - 100 million (ca. EUR 950,000 - 1,190,000)
Annual profit	INR 4 million (EUR 47,600)
Employees	120 (20 skilled, 80 unskilled, 20 office staff)
Supply chain	Up- and downstream supply chain: Ludhiana End-user markets: India (and Africa)
Technology level	Medium: machine-supported processes, out-dated machinery
Inputs	Chemicals: 2 - 15 t chemical mix for cotton per year; 27 - 164 t chemical mix for polyester per year Water: 1,00,000 - 6,00,000 litres per day Electricity: 5,000 - 5,500 kWh per day Fuel for steam production: 6 t of pet coke OR 15 t of rice husk per day
Past climate change	Increased number of heat waves, more intense rain events during monsoon season, unexpected rain events throughout the year, more erratic monsoon patterns
Future climate change	Increasing minimum and maximum temperatures during all seasons (possible exception: post-monsoon), wetter climate during most seasons (except for winter and, possibly, pre-monsoon)

Footnotes

6 Government of Punjab (2012). Punjab State Action Plan on Climate Change. Department of Science, Technology, Environment and Non-Conventional Energy.

How the company is affected by climate change

As mentioned in the introduction, the consultant team assessed the expected impacts of climate change on the company through a multi-step process. Before engaging personally with the company, information on past and future climate change trends were obtained through desk research. For this task it is advisable to collect several sources and compare the projections to obtain a higher accuracy. If no information for a specific city is available one should look for data on the state level.

In the next step, the Climate Expert worksheets '0 - Assessment grid', '1.1 - Past impact', '1.2 - Expected changes', and '2.1a Risk assessment' were used to evaluate which climate change impacts will affect the company most severely. Conducting a tour through the company's premises can be very useful to get an overview on the general condition of the company's processes and operations.

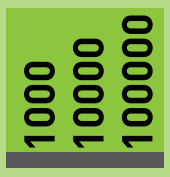
Buildings and location	During heavy rain events water enters the premises of the company and leads to water logging. This happens in cases when the sewage system is not able to cope with the water especially during heavy rain events. Due to water logging on the premises operations have to be shut down for several hours. Such production gaps are expected to increase with climate change.
Processes	Dyeing is a highly energy intensive process. Energy is required in form of fuel for generating steam as well as in form of electricity for running the machinery. Heat is generated from pet coke and rice husk, but the company also depends on electricity from the grid. During summer, the company experiences **frequent power cuts.** These have consequences for the company's financial bottom-line, as it needs to run the diesel generator which reduces the profit margin. This risk even multiplies during heat waves. Another key input for the dyeing process is water which the company pumps directly from the groundwater. In the last 10 - 15 years the **groundwater level has decreased drastically** (approx. ten metres) due to rising demand and extended periods of drought. It is expected that climate change will further intensify the problem and might **endanger the company's water supplies.** For the moment, however, another challenge looms larger: the expectation that the government will forbid the excessive use of groundwater, as is already the case in other Indian states. For the moment, water is free (albeit it needs to be pumped from underground).
Logistics and stock	As the company dyes fabric for clients that continue processing the fabric, it does not have to keep the finished products in storage for long. Therefore, storage of products has not been affected by climate change impacts. However, the outside storage area of **rice husk and pet coke** which the company uses for its boiler is inadequate and the **material often gets moist or wet, prolonging the firing time.** Not only is the storage affected by changing weather and climatic conditions, the **availability and prices of supply** are, too. Usually, the price for rice husk and pet coke rises significantly during monsoon season.
Employees/ community	Already in spring, temperatures in the manufacturing space were 5 - 6°C higher than outside temperatures due to the heat necessary for the processes and the machinery. Ventilation is not optimal. Thus, hot summers and heat waves strongly affect the **well-being and productivity of the employees.** In addition, the ash from the burning process was noticeable in the air and would probably also impact health of employees.

Government/regulation

The company is keenly aware that new regulation could severely affect its business case. As seen in the section "processes", climate change makes the already tense ground water situation in the region even worse. It is therefore only a question of time until the government introduces a **mandated price on water consumption or a regulation that forbids the use of ground water**, which would directly impact the bottom line of the company. Currently, there is a regulation in place that forbids companies to install additional ground water pumps. Only those already in operation may be used for extracting ground water. So far, no measures to increase water efficiency have been taken by the company. If even stricter regulation is implemented, the new pricing could probably only be offset by a major investment in new water-efficient machinery. Another important issue is waste water treatment – while the company uses its own treatment plant, there are plans on a state level to mandate common effluent treatment plants. In other regions of India, even a "Zero-Effluent" Policy has been implemented.

Market

The company has **not yet noticed any changes** in customer preferences or buyer demands which could be related to the impacts of climate change. However, generally the order rate for dyeing declines in summer, as its clients also face problems related to the temperature increase in summer months.



Finance

The company has experienced noticeable, although not drastic, f**inancial damages due to climate and weather related impacts.** In particular production stops due to electricity cuts or water intrusion have affected the bottom-line. Apart from this, the company has not yet felt impacts from a changing climate on its financing environment.

Part C: Climate Change Adaptation

How the company plans to adapt to climate change impacts

Buildings and location

The company considers building a **shed for the pet coke / rice husk storage area**. With this measure the fuel material is supposed to be kept almost completely dry so that its **heating value can be increased by around 5 percent.**

Storage area today (Source : adelphi)

Processes

Increasing the efficiency of today's water intensive processes should be the main element of an adaptation strategy. Potential measures to achieve such savings are therefore in the focus of an economic assessment. One possible solution for decreasing water demand would be the **investment into more water (and energy) efficient dyeing machinery.** As another option, the company could consider putting into place a **water recovery system** that would **recycle up to 30 percent** of the waste water from the dyeing process and make it available for reuse.

Both adaptation options do not just reduce water intensity in the face of rising water prices but also proactively address potential changes in regulation (see "Government and regulation").

Waste water treatment plant (Source: adelphi)

Machinery (Source: GIZ)

Logistics and stock

Apart from the shed construction (see "Buildings and Location"), no additional investment is planned.

Employees/ community

Apart from the new machinery, no investment is planned with regards to worker health and productivity.

Government /regulation

The company owner **closely monitors regulatory developments and other government initiatives.** This will allow the company to prepare for regulatory change or governmental programmes that enforce or support climate change adaptation early on (see "Processes").

Markets

Due to its very local market, and its specific position as a service provider rather than an end-product manufacturer, there are **no implications** for its product or market strategy.

Finance

The adaptation measures presented in the other impact areas all contribute to reducing climate-related risks for the company – and thus help avoid costs. Besides this, the company has not yet undertaken particular measures to reduce financial risks or seize new financing opportunities opening up in response to the changing climate. However, there is interest in potential financing of new energy-efficient machinery from specific credit lines, if applicable.

Part D: Cost-Benefit Analysis (CBA)

Which costs and benefits can be expected from adaptation

In the process of the climate change adaptation assessment, the company jointly with the consultant team identified several adaptation options that can mitigate or even eliminate the risks resulting from climate change. In the case study three adaptation measures were identified. For all of them a Cost-Benefit Analysis (CBA) as well as a Cost-Effectiveness Analysis (CEA, see part E) were conducted. If more adaptation measures are identified during an assessment, a Multi-Criteria Analysis is conducted (worksheet '3.1 - Measures-Risks'), which allows for a first prioritisation of measures. Those measures that have a high priority (A) and could realistically be implemented should be selected for economic analysis. A CBA should only be conducted for measures which have the potential to generate savings or additional revenues even in the absence of climate change. A CEA can be conducted for all measures that have been selected for an economic assessment.

With the CBA, the company can determine **which of the relevant adaptation measures are economically feasible even without the impacts of climate change** (in contrast to CBA a CEA is applied when uncertainty, e.g. about possible future impacts of climate change, is considered). The CBA serves to compare measures in order to prioritise them according to monetary values. As almost all measures require some investment and potentially also maintenance or operating costs, a company should identify which measure generates the largest savings over a certain time span.

Conducting the CBA allows calculating five result figures: **Net Present Value (NPV), Cost-Benefit Ratio (CBR), Internal Rate of Return (IRR), Return on Investment (RoI)** and **payback time.** These five CBA result figures can be used to compare investment options, i.e. adaptation measures, with each other. The NPV indicates how many benefits can be generated over the lifetime of the investment taking into account the discounted costs and benefits of the measures. The CBR expresses how much money has to be spent in order to create one unit of benefit. The IRR considers the time value of money and calculates the discount rate at which the NPV of the investment equals 0. Generally, the IRR should not be below the market interest rate for capital. The RoI indicates how much additional money (in percent of the invested money) is earned over the lifetime of the investment. The higher the RoI, the more financially viable the adaptation measure. Finally, the payback time in years illustrates over what time span the measure can be expected to recoup its investment costs.

When using the CBR, the RoI and the IRR to compare different adaptation options one should be careful whether the measures were calculated using the same method for cost and benefit estimation. If for one measure, for example, operating costs are considered under the total cost figure and hence total benefits consist of the previous (and now entirely saved) operating costs (see table 53 and the method marked with (*)), its CBR, RoI and IRR should not be compared with a measure whose only costs are the investment costs and benefits are considered as net benefits (see table 53 and the method marked with (**)). More information on this limitation can be found in Box 1 above.

A brief explanation of how the **five CBA result figures** are calculated can be found in the **Case Study Annex**. For more detailed information, the **respective sections in this Manual** can be helpful as they explain in detail the calculation approach for each of the CBA result figures.

The three adaptation options for DyeingCo Industries are: **1) purchasing more efficient dyeing machines, 2) installing a roof for the fuel storage area and 3) installing a water recovery/recycling system.** The CBA must be seen in the context of the entire climate change adaptation assessment. Before looking for the specific costs and benefits of the measure, the team searched for more general information, for example on the number of work days, the number of machinery, etc. This allowed drawing conclusions from statements such as "We use X amount of water per day per machine" for calculating annualised costs (and benefits) for the company.

Before conducting the CBA, some basic data was collected in a discussion with the company staff while going through the prior steps of the assessment (using the worksheet '0 - Assessment Grid') on the following items:

Item	Quantification	Notes
Operating days/year	300	/
Workers	20 skilled (annual salary/worker: INR 108,000) 80 unskilled (annual salary/worker: INR 78,000) = Overall labour costs: INR 8,4 million	Office staff costs are not considered
Machinery	20 dyeing machines	Assumption: all machines use same amount of input and create same amount of output

Annual inputs per dyeing machine	From	To	= Minimum and maximum estimated inputs
Electricity use (kWh): Electricity cost (INR):	33,750.00 283,500.00	37,125.00 311,850.00	= 8.4 INR / kWh (average costs from grid & generator)
Water use (litres): Water cost (INR):	1,500,000.00 4,950.00	90,00,000.00 29,700.00	= 0.0033 INR / litre (energy cost for water pump)
Chemicals use (tonnes): Chemicals cost (INR):	30 332,181.82	178 1,993,090.91	= (chemical mix for cotton and polyester combined)
Fuel use (tonnes): Fuel cost (INR):	72 720,000.00		= 10,000 INR / tonne (only pet coke is considered as it is the main fuel input)
Labour cost (INR):	420,000.00		= 1/20 of the overall labour costs

1 Purchasing more efficient dyeing machines

The company expects that purchasing and installing more efficient dyeing machines will cost between INR 5 - 7 million per machine. Once a machine has been successfully installed, it needs electricity, water, chemicals and steam (produced from pet coke) for the dyeing process. Additionally, workers have to be around to handle the machine. All of these inputs and activities cause considerable operating costs which are summarized in table 53 "Costs and savings".

What is more important in determining the economic benefit of the machine is whether and how fast the benefits of installing this new machinery exceed its costs. Compared to the old machinery, the new equipment will require less inputs (fuel, labour, water chemicals), so that large cost savings in all areas can be achieved (see table 53 "Costs and savings"). Savings in labour costs mean a productivity increase of labour. As less labour is required for machines, the labour can be used at other stages of the process improving the overall productivity of the company. As shown in table 53 "Costs and savings" below, particularly the reduced need for chemicals can lead to substantial cost reductions.

In the Climate expert approach measures lowering the requirement for inputs such as water, energy or labour are considered as climate change adaptation measures. As they lower the dependency on inputs which may potentially be negatively affected by climate change, they are adaptation measures. While being labelled adaptation measures in this approach, they can also be climate change mitigation measures as they might reduce greenhouse gas emissions of a process due to lower fuel or electricity requirements. They could also be considered as resource efficiency measures as they generally lower the dependency on resource inputs, sometimes even on resources that are not affected by climate change at all.

Table 53 Costs and savings – dyeing machinery

Costs and savings	Annual operating costs of				= Additional cost savings/ year	
	...1 old machine		...1 new machine			
	From	To	From	From	From	To
Electricity	283,500.00	311,850.00	212,625.00	233,887.50	70,875.00	77,962.50
Water	4,950.00	29,700.00	2,475.00	14,850.00	2,475.00	14,850.00
Chemicals	332,181.82	1,993,090.91	166,090.91	996,545.45	166,090.91	996,545.45
Energy	720,000.00	720,000.00	468,000.00	468,000.00	252,000.00	252,000.00
Labour	420,000.00	420,000.00	315,000.00	315,000.00	105,000.00	105,000.00
Sum	**1,760,631.82***	**3,474,640.91***	**948,190.91**	**1,812,282.95**	**812,440.91****	**1,662,357.96****

On the cost side, the company has to pay initial investment costs in year one and yearly operating costs for the years one to ten (the company calculates with a time horizon of 10 years). In the calculation used, regular operating costs are attributed to the cost side[7] .

Footnotes

7 Please note that another approach of conducting the CBA would be to only consider the investment costs for the cost side and substract „operating of the new machine" from „operating costs of the old machine" to achieve the savings counted in the benefit sheet.

On the benefit side, the company saves the operating costs of the old machine (which are higher than those of the new machinery). In table 53 "Costs and savings" above they are marked with an (*). Another way of calculating benefits would be to subtract the new, lower operating costs from the old operating costs to achieve the net savings (the results of this method of calculation is marked with an (**) in table 53). For calculations, the company could have chosen to compare 1) investment costs & new operating costs with the old operating costs; or 2) investment costs with the net benefits resulting from lower operating costs. Aiming to make the calculation process clearer, it works with option 1)[8] .

In order to reflect that future costs and benefits are worth less today, they need to be discounted at a rate appropriate to the market interest rate. Using a discount rate of 8 percent and a timeframe for the investment of ten years, the results displayed in table 54 "Key CBA Result Figures" below **seem rather ambiguous**. At the lower end of the range the measure does not make sense in economic terms at the higher end it does – the **NPV on the lower end of the range is negative, the one at the higher end of the range is positive** (see table 54 "Key CBA Result Figures"). The **CBR varies between 1,58 and 0,47.** For the measure to generate more benefits per unit of cost the ratio would have to be smaller than 1. **IRR and RoI are negative for the lower end of the range and positive for the higher end.** Finally, the **payback time** indicates that the measure can be expected to **recoup its investment costs in less than two years for the best case, but would not be able to do so in the worst case.** If all factors actually took the lower values the measure would not pay-off and the company would make a bad investment decision. Yet, if we consider the average values of the ranges provided here, the results of the CBA are positive.

Table 54 Key CBA Result Figures – dyeing machinery

Key CBA Figures	From	To
Sum of discounted total costs (A)	11,871,433.24 INR	20,133,411.43 INR
Sum of discounted total benefits (B)	12,759,101.44 INR	25,180,333.20 INR
Net Present Value (B-A)	-7,374,310.00 INR	13,308,899.96 INR
Cost-Benefit-Ratio (A/B)	1.58	0.47
Internal Rate of Return (B-A=0)	- 6 %	20%
Return on Investment ((B-A)/A)	- 37%	112%
Payback time in years	- 135.52	1.98

2 Installing a roof for the fuel storage area

Installing a roof for the fuel storage area will cost the company between INR 100,000 - 200,000 for material, transportation and installation. As the new roof does not need any noteworthy maintenance, no further costs are expected. On the benefits side, clear efficiency gains in terms of lower fuel requirements should be the result of this adaptation measure. The purpose of the roof is to keep the fuel material dry and, thus, to increase its heating value by 5 percent. Based on cost estimations for pet coke and rice husk, the following annual cost savings can be expected:

Footnotes

8 Please also note that the decision which calculation method to choose has an effect on the RoI, IRR, and CBR.

Table 55	Fuel consumption – fuel storage		
Annual fuel costs (in INR) (1.800 t pet coke or 4.500 t rice husk)		Additional cost savings/year (in INR) (= 5% of old costs)	
From	To	From	To
18,000,000.00	20,250,000.00	900,000.00	1,012,500.00

While the measure has relatively low costs, benefits are substantial. Consequently, all key figures show positive results, implying that this measure is highly desirable from a financial viewpoint.

Table 56	Key CBA Result Figures – fuel storage	
Key CBA Figures	From	To
Sum of discounted total costs	100,000.00 INR	200,000.00 INR
Sum of discounted total benefits	6,522,199.12 INR	7,337,474.01 INR
Net Present Value	6,322,199.12 INR	7,237,474.01 INR
Cost-Benefit-Ratio	0.03	0.01
Internal Rate of Return	450%	1012%
Return on Investment	3161%	7237%
Payback time in years	0.22	0.1

3 Installing a water recovery/recycling system

Finally, the company calculates that installing a water recovery/recycling system will require an initial investment of INR 30 - 40 million. Operating this water recovery system will result in electricity costs (INR 150,000 - 300,000 per year), but no other significant operating costs are expected.

Table 57	Water consumption – water recovery system		
Total annual water costs of all 20 machines (in INR)		Additional cost savings/year (in INR) (= 30% of old costs)	
From	To	From	To
99,000.00	594,000.00 [9]	29,700.00	178,200.00

Footnotes

9 The broad range of water consumption reflects some of the uncertainty about actual water consumption. As water is one of the areas with the highest risks for the company a broad range is chosen to take into account different water consumption scenarios and their effect on the company.

With the water recovery system installed, 30 percent less water has to be pumped from groundwater. Despite these water savings and substantial discounted total benefits, the key CBA result figures show that installing a water recovery system is not economically feasible for the company. This measure has a negative NPV and shows a very high Cost-Benefit Ratio. Hence, in the absence of climate change impacts on water availability and price, costs are much larger than the returns of this investment.

Table 58 Key CBA Result Figures – water recovery system

Key CBA Figures	From	To
Sum of discounted total costs	31,087,033.19 INR	42,174,066.37
Sum of discounted total benefits	215,232.57 INR	1,291,395.43 INR
Net Present Value (NPV)	-41,958,833.80 INR	-29,795,637.76 INR
Cost-Benefit-Ratio (CBR)	195.95	24.07
Internal Rate of Return	-	-34%
Return on Investment	-99 %	-96 %
Payback time in years	-147.98	1063.83

Part E: Cost-Effectiveness Analysis (CEA)

Which adaptation measure is the most cost-effective

Using the same data as for the CBA, the company has conducted Cost-Effectiveness Analyses (CEA) in order to determine which of the adaptation measures can reduce profit losses in case of climate change in the least costly way. For this calculation the worksheets labelled with '3.4' are used. Effectiveness refers to the benefit one unit of invested money achieves. For comparing adaptation measures targeted at different areas (water, electricity, fuel, etc.), the unit chosen is avoided profit loss as climate change (to be relevant for the considerations of enterprises besides CSR) affects its profit. And that's what climate change actually does: higher water or electricity cost, flooding, worker sickness decreases company's profits. Adaptation measures allow reducing this profit loss. For example, it is expected that higher water costs will reduce the company's profit by 5 % annually but with the adaptation measure, losses are only 2 %. It is also expected that higher electricity prices reduce profit by 7 %. With a measure targeting electricity consumption, the losses are reduced to 4 %. This means that both measures reduce profit loss by 3 %. However, the measure affecting water consumption costs EUR 10,000 whereas the one affecting electricity only costs EUR 7,000. This means that the latter is more effective in reducing profit loss and should be preferred.

For the future, DyeingCo Industries expects **changes both in the local climate and in relevant regulation by the government with negative effects on the company's profit.**

One of the most important climate change impacts will be on water availability – rainfall will become more erratic and intense, meaning that there will be very little water during drought periods and more rain than today during wet seasons. Together with a high water demand, this will lead to a decline of the groundwater table, thus endangering the company's water supplies. At the same time, wetter climate during monsoon and post-monsoon

seasons will lead to additional fuel requirements of 10 percent as the fuel currently stored outside will become wetter or wet more frequently. For the moment, however, another challenge looms larger: as already described earlier, the company assumes that in the near future, the government will mandate a water price of 100 INR per 1,000 litres and that 50 percent of the water used for the dyeing process will have to be purchased in order to protect groundwater tables. Currently, water is nearly free as only electricity costs occur for pumping ground water. In addition to impacts on water availability, climate change is also likely to affect the company's electricity supply. It is expected that extreme temperatures will more often lead to power cuts[10]. During heat waves in India the increasing usage of air-conditioning systems leads to shortages of electricity supply and thus power cuts. Once there is no more electricity from the grid, it becomes necessary to run the costly diesel generator. This increases the average electricity price for the company. If no adaptation measures are taken, all of these changes will be reflected in the company's profits. Based on an annual profit of INR 4 million, the following table 59 "Additional costs due to climate change/regulatory impacts"" illustrates expected profit losses:

Table 59 **Additional costs due to climate change/regulatory impacts**

Annual additional costs and resulting profit losses in INR	Additional costs		Profit loss	
	From	To	From	To
A) Purchasing of water (50% of 30-180 million litres at 0.1 INR/litre and 50% at 0.0033 INR/litre)	+ 1,549,500	+ 9,297,000	- 38.6%	- 231.7%
B) Higher electricity costs (675.000-742.500 kWh for 9.67 INR/kWh instead of 8.4 INR/kWh)	+ 855,802	+ 941,382	- 21.4%	- 24%
C) Increased fuel use because of wetter weather (+10% = +144 t pet coke (10,000 INR/t) or + 360 t rice husk (4500 INR/t))	+ 1,800,000	+ 2,025,000	- 45 %	- 50.36%

Purchasing more efficient dyeing machines will allow the company to reduce some of the profit losses from water, diesel and pet coke/rice husk use (A+B+C). The more new machines, the more inputs can be saved. Installing a storage shed will prevent the entire profit loss from increased fuel use (C) and installing a water recovery system will reduce the necessity to purchase expensive water (A) by 30 percent. As mentioned above, these measures could also be classified as resource efficiency measures or, for the more efficient machinery and the storage rack, as climate change mitigation measures.

For conducting the CEA, three different impact scenarios (Scenario A "Minor impacts", Scenario B "Medium impacts" and Scenario C "Drastic Impacts") are used to reflect uncertainty regarding the severity and timing of CC impacts on the company's operations. DyeingCo Industries expects that within the next five years, scenarios A, B and C will occur with likelihoods of 70, 20 and 10 percent. Over the next ten years, this distribution will change to a likelihood of 40, 40 and 20 percent respectively. Scenario A is the base scenario for which the expected damages are stated in this document. Impacts for Scenarios B and C are automatically calculated by using an "impact factor". For calculating the higher expected damages from these scenarios, the Scenario A dam-

Footnotes 10 An example is the blackout which occurred in India in July 2012 and affected nearly 600 million people.

ages are multiplied with the impact factor of Scenario B and C. For DyeingCo Industries, impact factors of 1,5 are used for Scenario B and 3 for Scenario C. This means that under a drastic scenario the damages of climate change would be three times as high as under the "minor impacts" scenario. The discount rate chosen for all measures is again 8 percent.

Please note that it may be the case that implementing an adaptation measure leads to savings for the company that entirely compensate the profit loss the company expects due to climate change. The company would actually make more profit by implementing the measure even under the profit-threating conditions of climate change. In this case, we do not calculate values for Scenario C and B.

1 Purchasing more efficient dyeing machines

On the cost side, the same costs can be expected for purchasing new machinery as for the CBA: initial investment costs and operating costs. On the benefit side, benefits are calculated as the difference between profit losses from using old machinery and remaining profit losses that the company incurs even if it installs new machinery. Additionally, the savings generated from using less chemicals and labour are counted as 'negative profit loss' and are thus figured in as additional profit. The following table 60 "Adaptation benefit for dyeing machines" shows

Table 60 Adaptation benefit for dyeing machines

Average annual profit loss	Profit loss per old machine	Remaining profit loss per new machine	Benefit from adaptation over non-adaptation
Scenario A	7.51%	-14.91% [11]	22.42% [12]

how much profit loss can be expected if one old or one new machine is used under a climate change scenario. As the remaining loss is negative and thus an actual benefit for the company, we cannot use the impact factors for Scenarios B and C. Therefore, only the figures calculated for Scenario A are provided.

The results show that more efficient machinery for dyeing reduces the profit loss incurred without adaptation by 298[13] percent. This means that the potential profit loss is reduced entirely and almost twice the amount of potential loss becomes an additional saving. Considering the Cost-Effectiveness Ratio will help to determine if this percentage of profit loss reduced justifies the high costs of the adaptation measure (see table 63 "Cost-Effectiveness Ratio").

Footnotes

11 Negative remaining profit loss means that the company will actually make more profit with the measure under climate change conditions than without the measure today

12 In case of negative profit loss, the benefit from adaption over non-adaption is the sum of the entire reduction of profit loss and the additional profit generation resulting from cost savings

13 A remaining profit loss of 0 % (meaning that the company would generate the same profit as today) would mean a reduction of profit loss by 100 %. If we have a value of profit loss production greater than 100 % it means that implementing the measure actually leads to a profit that it is higher than today. Reducing the profit loss by 200 % would mean that by implementing the measure the company has an additional profit that amounts to the sum that the company would have lost in absence of the measure.

2 Installing a roof for the fuel storage area

Already today, storage of fuel materials in the open leads to the effect that due to the humidity of the material five percent more fuel is used than would be required. Climate change will further increase today's fuel use by another ten percent as some parts of the year will be wetter. Constructing a roof to keep stored fuel material dry will not only allow the company to avoid increasing fuel requirements but will even lower them compared to today. This measure allows reducing profit losses by 162 percent, thus generating additional profit through cost savings. As mentioned above, only the values for Scenario A are provided because applying the climate change impact factors to profit savings achieved from the measure would distort the results.

Table 61 Adaptation benefit for fuel storage area

Average annual profit loss	Profit loss per old machine	Remaining profit loss per new machine	Benefit from adaptation over non-adaptation
Scenario A	38.25%	-23.91%	62.16%

3 Installing a water recovery/recycling system

Under current circumstances, DyeingCo Industries is expected to face substantial profit losses within the next five and ten years due to regulation putting a price tag on water and restricting the usage of groundwater. By installing a water recovery system, the company reduces the quantity of water that needs to be purchased by 30 percent. As the following table 62 "Adaptation benefit for water recovery system" shows, this adaptation measure lowers the profit loss incurred by climate change impacts by 95 - 117 percent. Since profit loss is still rather high under these circumstances, the company should consider systems with even higher recovery rates or identify other measures to reduce water consumption generally.

Table 62 Adaptation benefit for water recovery system

Average annual profit loss	Profit loss without water recovery	Remaining profit loss with water recovery	Benefit from adaptation over non-adaptation
5 years horizon	175.69%	80.63%	95.06%
10 years horizon	216.24%	99.24%	117.00%

The Cost-Effectiveness Ratio

The Cost-Effectiveness Ratio (CER) depicts how much money has to be spent in order to create one unit of benefit. In the approach chosen for the CEA, benefit is defined as "reduction of profit loss by 1 percent". The lower the ratio of investment and the "benefit of adaption over non-adaption in percent", the more effective the investment in terms of lowering profit loss.

As the results in the following table 63 "Cost-Effectiveness Ratio" show, installing a roof above the fuel storage area is the least costly option to achieve the objective. This option is followed by purchasing more efficient dyeing machine. Finally, constructing a water recovery system requires the highest costs per unit of profit loss reduction.

Table 63 Cost-Effectiveness Ratio for the three adaptation options

Cost-Effectiveness Ratio		
More efficient machine	Roof for storage	Water recovery
2,676	24	3,337

Part F: Conclusions from CBA and CEA

Analysing results for informed decision-making

With the CBA, the company can determine which of the relevant adaptation measures are economically feasible even without the impacts of climate change. For the CBA, companies select adaptation measures which generate savings or create additional revenues. As almost all measures require some investment and potentially additional maintenance or operating costs, a company should identify which measure generates the largest savings over a certain time span. By conducting a CBA the company can use the NPV, CBR, RoI, IRR and payback period to assess which of the measures generates the largest absolute benefits (NPV), the highest returns on the investment (RoI and IRR), the most benefits per unit of money invested (CBR), or has the shortest payback period. However, the CBA does not give information on which adaptation option is the least expensive in achieving a certain objective. The CBA does also not consider the expected impacts of climate change and/or regulation.

While the measure "new machinery" shows the highest NPV (Table 54) there is much uncertainty about whether it currently yields economic benefits. Using values at the lower end of the range (i.e. low benefits and high costs), all relevant result figures become negative. Before implementing this measure, more research is required to calculate with more reliable figures and smaller cost and benefit ranges. Installing a roof shows clear benefits in terms of the NPV and all other relevant figures (Table 56). However, one should be careful when comparing RoI, IRR and CBR of this measure with the measure new machinery as the two are calculated differently. While for the latter no operating costs exist, operating costs are added to total costs for the former. This has an effect on the values for RoI, IRR and CBR making them become less favourable for the measure "new machinery". The measure water recovery system shows no positive values for the CBA (Table 58) which means that this measure does not provide economic benefits under current circumstances.

Looking at the Cost-Effectiveness Ratio (CER) (Table 63) shows that building a roof is more cost-effective under the assumptions taken for climate change and regulation. This measure reduces profit losses from climate change at a cheaper price than purchasing more efficient production machinery or setting up a water recovery system.

It can be concluded that **installing a roof is certainly a no-regret option as it yields benefits both with and without a change in climatic and regulatory conditions. New machinery makes sense economically under climate and regulatory change, and also today, if benefits and costs take an average value.** If, however, costs of the measure become a bit higher and benefits slightly lower than average, DyeingCo Industries would lose money. For this measure, it could be reconsidered whether the range of values assumed is correct or if maybe the lifetime of the investment could be extended.

Installing a water recovery system is only feasible if water does become more expensive. As both new machines and water recovery reduce water requirements, a CBA should again be conducted for both measures assuming that there will be a mandated water price in the near future. As a result, water recovery might not only become economically feasible but could also potentially have a greater NPV than installing new machinery.

Case Study Annex

Result figures of the CBA/CEA

Net Present Value (NPV): The Net Present Value (NPV) is the difference between discounted costs and discounted benefits of a measure over its entire lifetime. It is calculated by subtracting the discounted costs from the discounted benefits. By using discounted costs and benefits the NPV accounts for the fact that costs and benefits accruing in the future are worth less today. If the result of the NPV is positive, the adaptation measure is economically feasible in absolute terms. Through the NPV, different adaptation measures can be ranked – the higher the NPV, the higher the net benefits of this measure. The NPV of the adaptation measure is shown based on the ranges which were used to determine costs and benefits.

Cost-Benefit Ratio (CBR): The Cost-Benefit Ratio (CBR) is the ratio of discounted costs of the measure over the discounted benefits of the measure for its entire lifetime. It expresses how much money has to be spent in order to create one unit of benefit. The adaptation measure is cost-effective if the CBR < 1, meaning that costs are smaller than benefits.

Internal Rate of Return (IRR): The Internal Rate of Return (IRR) is another figure to measure and compare the profitability of investments. It is the discount rate which will cause the NPV of the risk mitigation measure to equal zero (if NPV=benefits - costs=0, then r=IRR), i.e. where the present value of total (discounted) costs equals the present value of total (discounted) benefits. This means that with the IRR used as the discount rate, costs equal benefits. Calculating the IRR follows the same logic as calculating the NPV. The main difference is that, rather than deciding on a discount rate depending upon the risk of the measure, calculating the IRR relies on an iterative solution to determine what discount rate will cause the NPV of the project to equal zero. The IRR can be calculated by trial and error by varying the discount rate in the NPV formula until the NPV is equal to 0. If this is the case the discount rate used is the IRR. Please note that also Excel uses an iterative process to derive the IRR. The IRR can be used to compare different adaptation options with each other. The higher the IRR, the greater the returns of the investment. Please note that due to the Excel calculation process a supporting calculations table is used which is found in the columns T-X. This table does not need to be altered. Please also note that Excel discounts the first year of costs and benefits whereas we have chosen to start discounting from year 2. Therefore, the NPV will not equal zero if you insert the IRR as a discount rate.

Return on Investment (RoI): The Return on Investment (RoI) is the money saved with the investment measured in percentage of the total invested sum (investment costs and operating costs). A 60% RoI means that the cost of the project and another 60 percent of these costs have been recovered. The RoI thereby puts the gains of an investment (the NPV) in relation to the costs of the investment. It is calculated by dividing the NPV by the discounted costs over the entire lifetime of the investment. The higher the RoI, the higher the returns of the

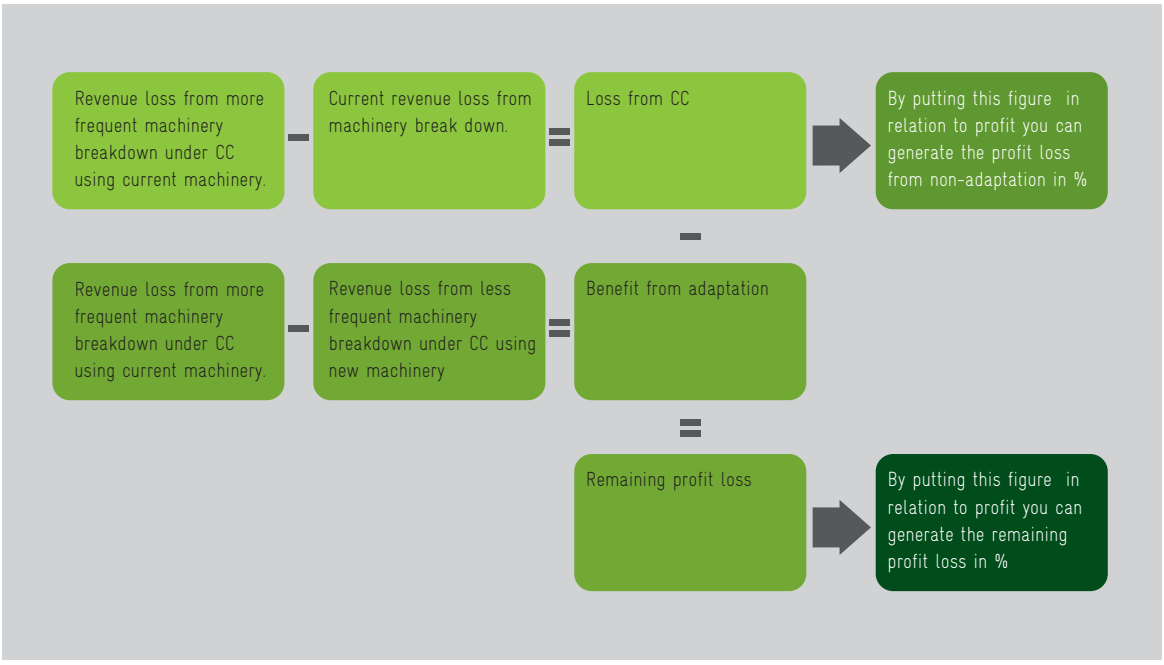
project in relation to the invested sum. You should note that the RoI is therefore always dependent on the invested sum. A higher RoI does not necessarily mean that a measure generates more absolute savings than another measure with a lower RoI. For the absolute amount of savings the NPV is to be consulted.

Payback time (in years): The payback time is the time it will take for the undiscounted annual benefits to equal the initial investment costs. In other words, after how many years the company will realise net benefits. When assessing a measure for which total benefits were considered (see box 1 in section "COSTS of adaptation measures") make sure you divide the investment costs by net benefits. Also note that you should subtract low benefits from high costs and vice versa to get the respective minimum and maximum figures.

Cost-Effectiveness Ratio (CER): The Cost-Effectiveness Ratio (CER) is an adjusted cost per unit of benefit, i.e. percent of reduced profit loss. The CER is calculated by dividing the value/variable of the average initial investment costs by the value/variable of reduced profit loss in percent multiplied by a factor of 10,000. The lower the ratio, the more cost-effective the measure! Please note that the measure does not make sense in economic terms if a negative value is obtained for CER. The aggregated cost-effectiveness ratio is calculated as the average of the five- and the ten-year ratio. In case that only Scenario A is considered the ratio for this scenario should be used for comparisons with other measures.

Average Aggregated CER: The Aggregated CER gives you one single figure that you can use to compare the measures with each other. Usually, it is calculated by taking the average of the CER values for the five- and ten-year time horizon. If there are no values for Scenario B and C, the Average Aggregated CER is that of Scenario A.

Calculation approach for CEA



More information on how the figures required for conducting the CEA can be calculated is found in the respective sections above.

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- Natural Resource Management
- Private Sector Development
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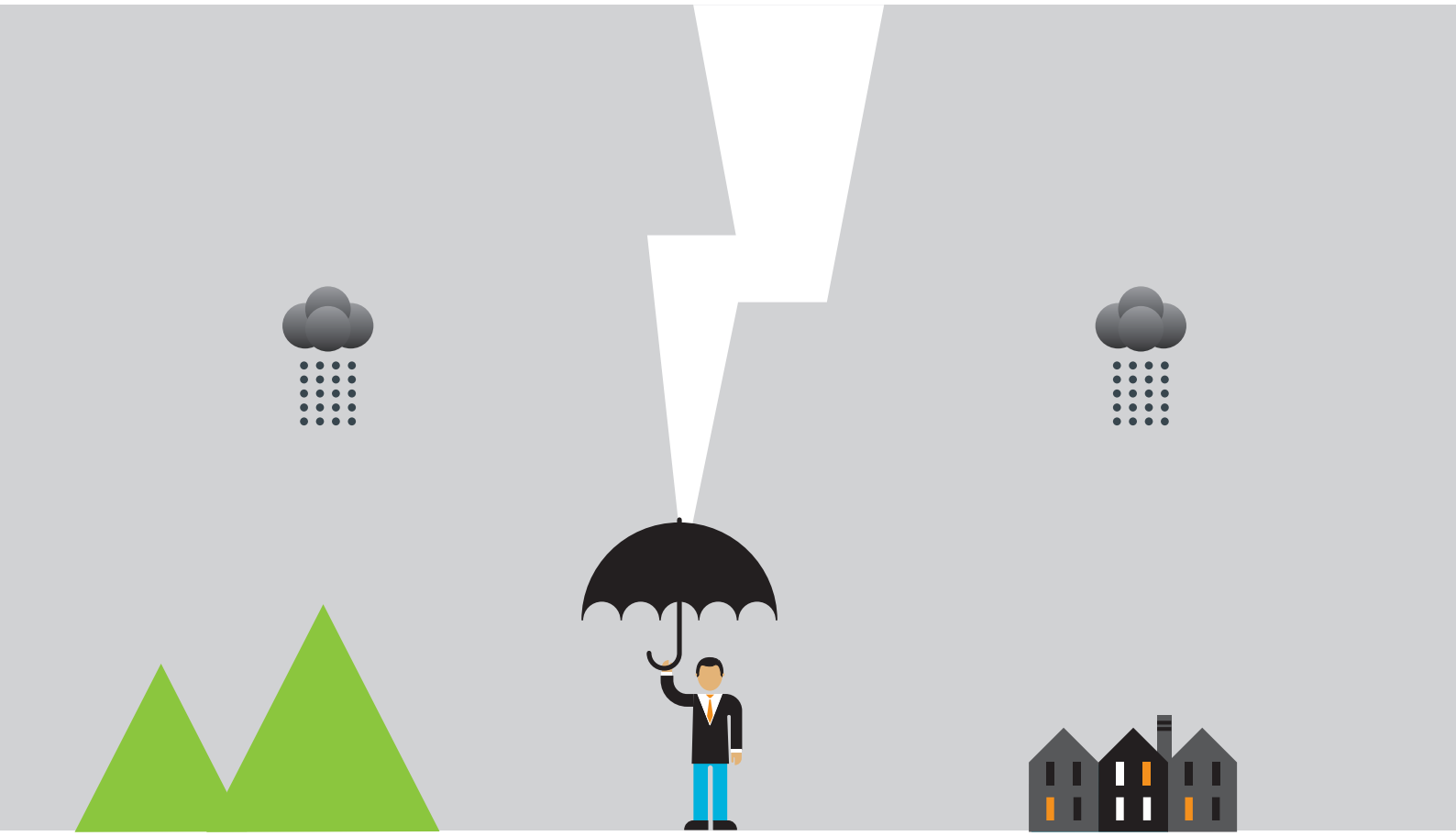

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