ENERGY

A Step-By-Step Guide for
Sustainable Action

Volume I

CREDITS

DIRECTOR

Caitlin Southwick
Amsterdam, The Netherlands
Founder & Executive Director, Ki Culture
LinkedIn

COORDINATOR

Sarah Soltis
New York, USA
Energy Coordinator & Contributor, Ki Culture
LinkedIn

CONTRIBUTORS

Victoria Burrows
Brussels, Belgium
Director, Advancing Net Zero, World Green Buildings Council
LinkedIn

Angela Moore
St. Louis, USA
Facilities & Sustainability Coordinator, Missouri Historical Society
LinkedIn

Jean Damascene Niyonzima
Kigali, Rwanda
Project Engineer, Hydro Operation Great Lakes Ltd
LinkedIn

Matthew Turner
London, UK
Buildings & Places, AECOM

ADVISORS

Sara Kassam
London, UK
Sustainability Lead, Victoria & Albert Museum
LinkedIn

Chiara Manfriani
Florence, Italy
Conservation Scientist, Research Fellow, Universita degli Studi di Firenze
LinkedIn

Jean Hilgersom
Amsterdam, The Netherlands
Museum Consultant, Building Functionality & Sustainability
LinkedIn

Janika McFeely
San Francisco, CA USA
Associate Principal, Integral Group
LinkedIn

DESIGNER

Molly Saunders
Nottingham, UK
Design Lead, Ki Culture
LinkedIn

SUPERVISORS

Lauren Best
Winnipeg, Canada
Collaboration Designer, Ki Culture
LinkedIn

Erika Pontes
New York, USA
Director of Design & Digital Strategy, Ki Culture
LinkedIn

CITATION CONTRIBUTOR

Elisa Carl
Hamburg, Germany
Admin Support, SiC MSc in Conservation, Restoration of Modern Materials & Media, Bern University of the Arts
LinkedIn

ALT TEXT WRITER

Nicole Smith
Washington, USA
Co-Director of Social Sustainability, Ki Culture
Founder, Before Thought
LinkedIn

ADDITIONAL SUPPORT

Eleni Chrstidou
Athens, Greece
Museum Professional
LinkedIn

Morgan Lirette-Prové
London, UK
Book & Paper Conservator, The British Library
LinkedIn

Emma Myers
Toronto, Canada
Exhibit Attendant at Starvox Entertainment, MA Museum Studies, University of Toronto
LinkedIn

Melanie A. Washeim
Newcastle, UK
Paintings Conservation Student, Northumbria University Newcastle Program in Preventive Conservation/ Conservation of Fine Art
LinkedIn

Ki Book Legend

We've created this legend to help you navigate through the information you'll find in the book.

KI TIP

tips & advice

KI FACT

interesting facts

KI VISION

envisioned futures

KI STUDY

case studies

KI TOOL

tools & resources

KI ACTION

actionable items for sustainability

CONTENTS

Click on the headings to jump to different sections!

INTRODUCTION 7

About This Ki Book 8

Ki Principle 1: Follow the Energy Hierarchy 9

Ki Principle 2: Scope 1, 2 & 3 Emissions 10

Journey 1: Understanding Your Energy Uses & Needs 11

WORKING OUT HOW MUCH ENERGY YOU USE 12

Understanding Who's Who in Building Management 14

Where Does Your Energy Come From? Check Your Contracts 15

Review Your Energy Bills 16

Check Your Energy Software 17

Develop an Energy Baseline 18

Benchmarking 19

UNDERSTANDING YOUR BUILDING & ENERGY USE 21

Get to Know Your Building 23

Energy Survey 24

Focus on Lighting 26

Focus on Climate Control 27

Climate Control for Collections 29

LIGHTS, CAMERA, ACTION! 30

Pick Your Battles 32

Show me the money! 33

Before You Buy a Tesla 36

Journey 2: Save Energy! Energy Efficiency & Savings 36

EARLY INTERVENTIONS & QUICK WINS 37

Changing Behaviors 39

Energy-Efficient Equipment 40

REDUCING APPLIANCE ENERGY USE 41

IT (Information Technology) 43

Turn Me Off 44

Phantom Energy 45

Surge Protectors/Wall Socket/Plug Ins 46

Computers 47

Printers, Photocopiers, Fax Machines 48

Refrigeration Equipment 49

LIGHTING SYSTEMS 50

Lights (Indoor & Outdoor) 52

Task Lighting 53

Light Controls 54

Security Lights 55

CONTENTS

Click on the headings to jump to different sections!

IMPROVING THE BUILDING SHELL 56

Draft Proofing 58

CLIMATE CONTROL 59

Climate Control Guideline 61

Climate Control Solutions 63

Microclimates 65

HEATING, VENTILATION & AIR CONDITIONING (HVAC) 66

HVAC & Collections 68

HVAC & Non-Collection Areas 69

Maintenance & Optimization 70

DIGITAL EMISSIONS 71

Data Centers & Digitization 73

Digital Consumption 74

ENERGY TIPS FOR THE LAB 76

Lab Equipment 78

Air Extraction 79

REDUCING HOT WATER USE 80

Finding your Hot Springs 82

Leak Detection 83

Distilled/Deionized/Demineralized Water 84

Journey 3: Carbon & The Road to Net Zero 85

UNDERSTANDING YOUR CARBON EMISSIONS 86

Converting Energy to Carbon 88

Carbon in the Future 89

DEVELOPING A CARBON REDUCTION PLAN 90

Defining a Target 92

Net Zero Energy vs. Net Zero Carbon 93

Action Plan for Net Zero 94

RENEWABLE ENERGY 95

On-Site Renewables 97

Renewable Energy Systems 98

OFFSETTING 99

Calculate Your Emissions 101

Find Your Impact 102

Choose a Project or Charity 103

Invest in Yourself 104

Choose an Existing Offset Provider 105

WHAT'S NEXT? 106

GLOSSARY 107

REFERENCES 111

Energy Ki Book, Volume I

INTRODUCTION

Welcome to the Energy Ki Book! We are thrilled you are interested in saving energy (and money) and are excited you have chosen us to help you along the way. Electricity comprises 25% of global greenhouse gas emissions (GHGs)—the largest emitter! But energy is often the invisible culprit. Since we can't see it, it's easy to forget about—which may result in unnecessary waste of energy and money. Our Energy Ki Book guides you through ways that you can start saving today. From our process-led approach to our quick wins—there are ideas for everyone, no matter where you are in your sustainability journey.

We all want to start saving energy today and we have outlined great ideas for you to jump right in and get started. We also understand that the big-time actions with the big-time savings take a bit more time and might require a few extra steps. The Energy Ki Book outlines all of your options in three journeys. Follow the journeys in order from understanding to implementing to going net zero, or pick and choose your actions based on your needs. Any way you choose to go, we look forward to helping you along the way.

Introduction

Click on the topics to skip ahead!

About This Ki Book

Ki Principle 1:
Follow the Energy Hierarchy

Ki Principle 2:
Scope 1, 2 & 3 Emissions

ABOUT THIS KI BOOK

We understand that museums and cultural institutions have special requirements and specific challenges. The approach presented in this book is a process that follows the **Energy Hierarchy** for the most effective savings and reductions specifically for museums, galleries, studios, and other cultural institutions.

The first journey takes us through **understanding our energy consumption** and forming a plan for our actions. Journey 2 is the action-packed energy-saving tips and tricks and quick wins that can get us started. We will build up and finally arrive at **Journey 3**, which tackles the issue of carbon—what it is in relation to energy, what offsetting means, and how we can go carbon neutral or carbon positive.

Each journey is broken down into a series of actions. Some actions will support other actions, but we will make sure to let you know when actions link to each other.

While this guide is written specifically for cultural institutions, each building and collections/objects have specific needs. We will not be giving specific recommendations for climate conditions, but instead will outline how to best decide for yourself what ranges are appropriate for your institution, collection, and geographic location. And of course, our Ki Coaches are always available to help further!

Photo by Chaitawat Pawapoowadon from Pixabay, 2017

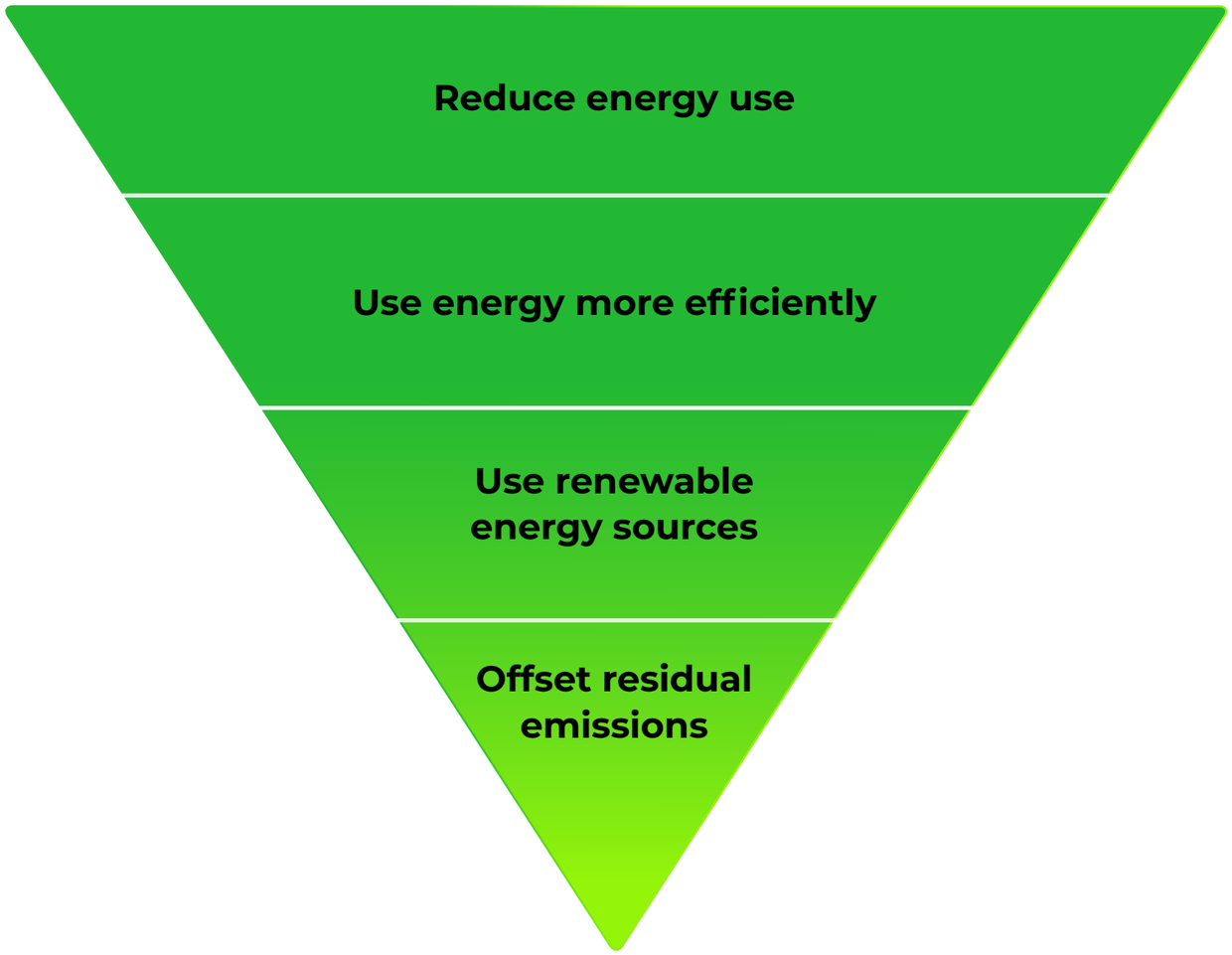
KI PRINCIPLE 1:

Follow the Energy Hierarchy

The general approach to reducing energy consumption and CO^2 emissions for buildings is to follow the energy hierarchy—focusing on each of the steps listed in order:

Why we follow the hierarchy in order:

- The earlier stages are less expensive and easier to implement
- The later stages involve more complex systems that require proper management to work effectively
- Reducing energy usage before installing more efficient upgrades leads to cost savings and more efficient operation



KI PRINCIPLE 2:

Scope 1, 2 & 3 Emissions

Carbon emissions are broken down into three categories. The categories are related to where the carbon comes from and how directly your personal actions affect the emissions. For the purposes of this Ki Book, our focus is on Scope 1 and 2 energy related emissions associated with the operations of the buildings. We will discuss addressing scope three emissions in **“Calculating your Emissions”**.

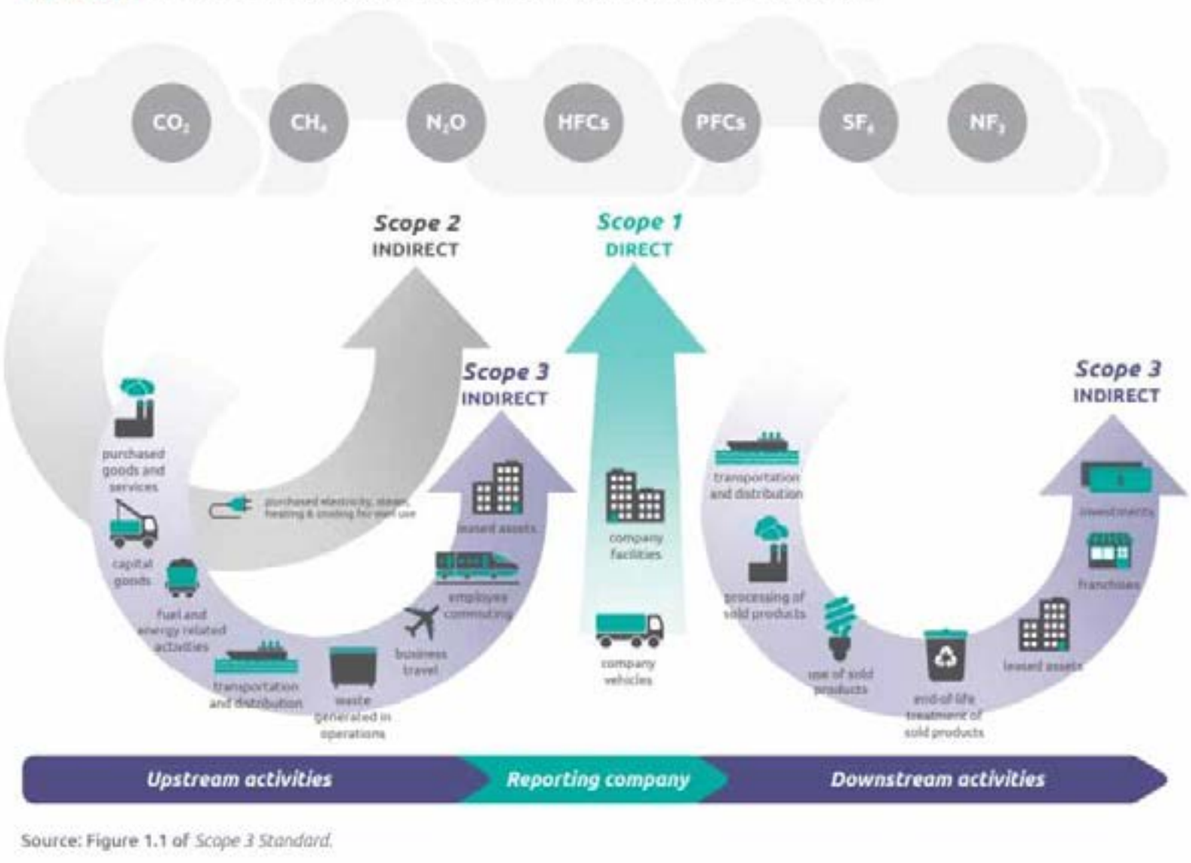
Scope 1: All Direct Emissions from the activities of an organization or under their control, including: fuel combustion on site such as gas boilers, fleet vehicles, and air-conditioning leaks.

Scope 2: Indirect Emissions from electricity purchased and used by the organization. Emissions are created during the production of the energy and eventually used by the organization.

Scope 3: All Other Indirect Emissions from activities of the organization, occurring from sources that they do not own or control. These are usually the greatest share of the carbon footprint, covering emissions associated with business travel, procurement, waste, and water.

What is the Difference Between Scope 1, 2 & 3 Emissions?

Figure [I] Overview of GHG Protocol scopes and emissions across the value chain



Source: Figure 1.1 of *Scope 3 Standard.*

Photo by sustainability and energy management software company Envizi

JOURNEY 1:

Understanding Your Energy Uses & Needs

Welcome to Journey 1! Here we will explore energy—what it is, where we use it, and how we can save it. We all want to reduce our energy use and costs, but sometimes the most impactful savings are not the most obvious. Energy can be complicated, but we hope that this book provides an overview and introduction to get you started.

This Journey is designed to outline the concepts and approach to energy savings and give you options based on your needs and resources. There is a ton that you can already do yourself to start understanding your consumption and tracking your savings, and we will go through these actions here together.

For high-level impact, you will need some help. But we will tell you exactly how to do this—who you need to speak with and what questions to ask. You have the power to make change, and this Ki Book is here to show you how. And don't forget—anytime that you feel confused or need any extra support or help—you can always call your Ki Coach.

So let's take a moment now to get to know energy!

WORKING OUT HOW MUCH ENERGY YOU USE

Every journey starts with a single step and when reducing energy consumption and carbon emissions, the first thing you need to do is understand where you are starting from. This means measuring your energy usage.

Energy consumption has a lot of variables and will require some investigative work. We will be looking at who owns your building, how it's operated, and where your energy comes from. This information will allow us to get a better idea of where we can make savings and how.

Energy is complex. We will be introducing you to a lot of terms here—benchmarking, baselines, EUI, kWh. We will explain these terms as they come up, but we have also included a **glossary** here for you to reference at any time.

Working Out How Much Energy You Use

Click on the topics to skip ahead!

Understanding Who's Who in Building Management

Where Does Your Energy Come From? Check Your Contracts

Review Your Energy Bills

Check Your Energy Software

Develop an Energy Baseline

Benchmarking

UNDERSTANDING WHO'S WHO IN BUILDING MANAGEMENT

Energy can be complicated! And this is why we are not going to tackle it alone. The first and most important step is to identify who is on your team. Often we are not sure who's in charge of our energy bills or who decides what climate conditions we use, who can tell us if we use green energy or what maintenance programs we have for our equipment. All of these people will be key throughout the rest of our journey together, so let's start with getting to know who's who in our organizations.

The answers to the questions in these Ki Actions will help determine what actions we can take moving forward.

KI ACTIONS

First, let's find out who these people are:

- **Your facilities manager**
- **Your operations manager**
- **Your housekeeping teams**
- **Your Head of Security**
- **Your IT technician**
- **Your sustainability director or team (if you have one)**
- **Your conservator/conservation team**
- **Your Chief Operating Officer (COO)**

Then, let's go introduce ourselves and ask them these key questions: (link these questions to later actions)

- **Who owns the building(s)?**
- **What energy contracts are in place?**
- **Who pays the energy bills?**
- **Who operates and maintains the energy systems?**
- **What cleaning procedures are there for equipment? Do we have preventive maintenance contracts (this is where contractors come in and clean and maintain systems and equipment regularly such as changing out filters, etc.)?**
- **What role and responsibilities do our housekeeping teams have?**
- **What equipment replacement programs are in place? For example, when does equipment get replaced, such as boilers? Is there a timeline for this?**
- **Are there any barriers to energy saving actions?**
- **What is our current internal environment and who decides this?**

WHERE DOES YOUR ENERGY COME FROM? CHECK YOUR CONTRACTS

Energy can be sustainable! If it comes from a renewable source. To find out if you are using green energy—or if you can switch to green energy—we need to check our energy contracts. Let's find out where we get our energy from!

Have questions about green energy providers or opportunities in your area? Ask your Ki Coach!

Subscribe to Ki Futures here

KI TIP

What is green energy? Not all energy providers offer the same level of "green". Find out more about different levels of green here:

Renewable Energy Procurement & Carbon Offsetting

Determine Who Manages Building Energy Contracts

INTERNAL

If your contracts are internally managed, whoever told you that is probably the right person to be talking to! Otherwise, they will tell you who has the contracts. Ask to see past and current contracts related to building maintenance.

- What energy provider do you use? Do they supply green energy? If not, is it possible to change?
- Do you use electric utilities? Or gas utilities? Or both?

EXTERNAL

If you're in an institution that is government run or a public-private partnership, reach out to the buildings division (at the city, state, or district offices) and ask for building related contracts (give an example or graphic).

- Are you using green energy? If not, is it possible to change?

REVIEW YOUR ENERGY BILLS

Once you've figured out where your energy comes from, the next step will be to measure how much energy you are using—a.k.a. your energy consumption. For this you will need your energy bills. Don't know who to ask? see —**Understanding Who's Who in Building Management.**

Your energy consumption is the total amount of electricity and gas used. This number will be listed on your bill. Now, bills are different in every part of the world, so the easiest thing to do to figure out how to read your bill is either ask your facilities manager for help or go on the utility company's website, which should have a short tutorial. And of course, if you need more help—ask your Ki Coach!

If your building has a Building Energy Management System (BEMS), then you can skip this step! Ask your facilities manager if you have a BEMS and go to **Check Your Energy Software**.

KI TIPS

For further actions, you will need a year's worth of bills. Make sure to grab at least 12 months worth, but the more data you have, the better! So ask if you can have access for previous years as well.

Photo by Gino Crescoli from Pixabay, 2017

KI ACTIONS

Things to keep in mind

- You may have multiple utilities (gas and electric) or buildings—which means you have multiple bills—so make sure you have them all! (And don't be shy to ask if you're not sure—this is why we made friends with our facilities manager.)
- Make sure you are reading the actual amount used and not estimates. It will say directly on the bill if the amount listed is an estimation or an actual reading
- You may get numbers with different units. To simplify our calculations moving forward, we will be working with kWh (kilowatt hours). If your bill has a different unit, you can convert it **here.**

Things to look out for

While collecting your energy usage, other useful information to look for on your bill includes:

- Meter Number, this will be required for **Benchmarking**
- Demand/Peak Consumption—this helps create your **Baseline** and is required for **Benchmarking**
- Demand Charges/Fee (not required but nice to have)
- Total Charges/Fee (not required but nice to have)

Next, we are going to be working out the total kWh gas and electricity used in your building over a year. This is called a baseline.

CHECK YOUR ENERGY SOFTWARE

If your building has a Building Energy Management Systems (BEMS) or energy monitoring and targeting software, then you are in luck. These tools can make your life much easier.

BEMS are computer systems that monitor your energy consumption. There are a lot of great softwares available to fit all budgets. When choosing a system, you will want to consider various aspects of the systems' functionality, including if the software:

- Provides accurate readings
- Connects to all sensors/monitors
- Reads across multiple buildings/spaces
- Includes benchmarking
- Has a data component
- Has alarms
- Has a preventive maintenance program (speak with your tech team or IT Technician)
- Provides easy-to-read outputs
- Includes built-in training for all staff

Ask your Ki Coach for help finding a system that's right for you!

As well as monitoring your overall energy use, the BEMS can also show you where energy is being used—ie. in different parts of the building or for specific systems such as lighting. You may find that some parts of the building use much more energy than others or some systems are not working as efficiently as they could!

KI TIP

Make sure to check with your facilities manager that the BEMS is up to date and functioning! You can help with checking its accuracy by comparing it to the data in your energy bills.

KI ACTION

To understand how the system is being used and what data you are looking at, talk to your the facilities manager! Some Ki things to find out are:

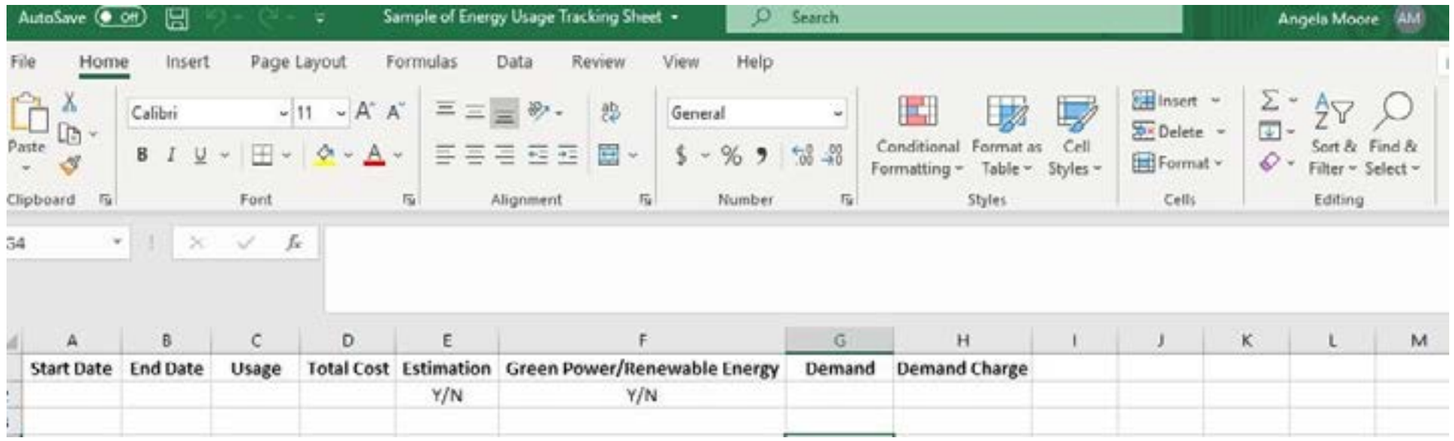
- **What is being measured? (what parts of the building, what systems, etc.)**
- **How often is data collected? (hourly, daily, weekly, monthly)**
- **How is the data collected? (collected manually—people are reading the energy bills and putting the data into the software—or digitally—the BEMS is collecting the data for you)**

DEVELOP AN ENERGY BASELINE

Once we have numbers, it's time to plug them in and find out how much energy we are consuming. In order to track your energy saving progress and compare your institution to others, you will need to create what's called a baseline for your building.

A baseline is your total energy consumption over the year (kWh/year). This will enable you to monitor changes in your energy consumption over
time and will give you a better idea of how much energy you are saving!

This example is super simple and will give you a basic overview of your energy consumption and help track your energy savings over time. However, if you are looking for the next step in energy savings—and also interested in how to save money—then you will need to do what is called **Benchmarking**.



KI ACTIONS

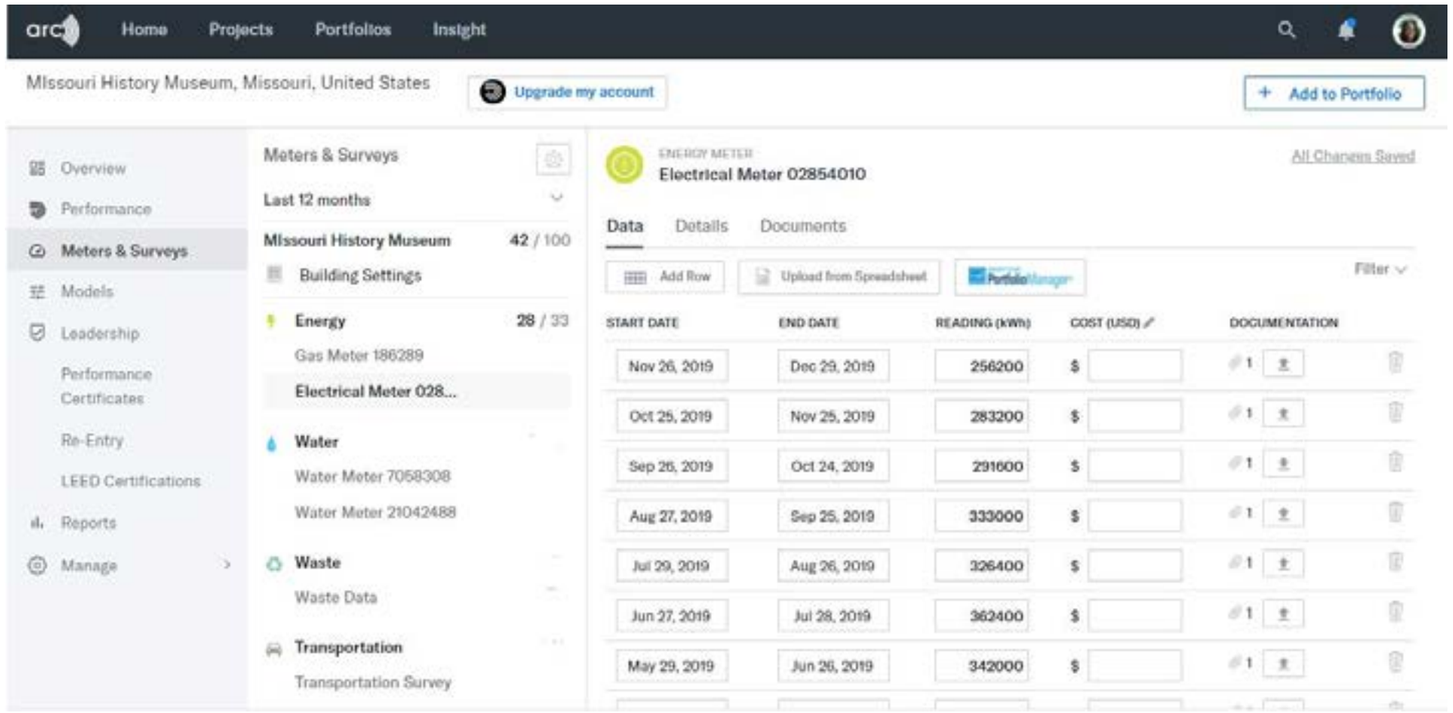
- **To develop a baseline, find out your last 12 months of energy consumption by going over old bills or referring to your BEMS**
- **Then, add up the total usage (in kWh) for the last 12 months. You now have a baseline!**
- **You can easily track your energy consumption on a spreadsheet, such as the one to the left:**
- **Set up a calendar to continue collecting your data and plugging it into the spreadsheet. We recommend doing this monthly for more precise results. Compare your new numbers to old ones as you complete various activities to see how much energy you are saving!**
- **For your next steps it will be helpful to find your consumption per square meter (or square foot). To do this, simply take your baseline (total usage in kWh for the year) and divide by the square meters (or ft²) of your building(s).**
- **Annual usage (kWh) ÷ square meters (feet) = your baseline in kWh/m²/year**
- **Check out the Ki Port to compare your baseline to other Ki Futures institutions! Not signed up yet? Sign up now!**

Subscribe to Ki Futures here

BENCHMARKING

Benchmarking compares your building to other similar buildings. This gives you a better idea of how you are performing compared to your peers and where you can make improvements. It also helps set industry standards.

Benchmarking includes other variables besides just your energy consumption that will enable you to find more areas to save energy—and includes the money thing—so you can start translating your energy savings into $€£¥. This is where all those numbers you collected in **Review your energy bills** will come in handy.



KI VISION

One of the big problems in our sector is that benchmarking is not yet common practice, so it's hard to estimate what our carbon footprint really is.[1] Julie's Bicycle has done some benchmarking for UK organizations, which can be found here.

Julie's Bicycle Benchmarking

SOFTWARE TO THE RESCUE

Benchmarking can feel complicated—there are lots of benchmarks for different building types with different sets of figures and in different countries—so it's easy to feel lost. But benchmarking is something that is done with software—so don't worry, you won't have to deal with a lot of complicated numbers and equations here.

What you will want to do is pick out the software that is right for you—this may be multiple softwares, depending on where you are in your journey. There are many different softwares available and they offer different features. There are also free benchmarking softwares. Ideally, we would all use the same one, so that we can compare globally across the sector. But unfortunately, there is not yet an industry standard for us. While we wait for that, ask your Ki Coach what is available in your country and also if you need help deciding what software to choose.

KI TIP

Benchmarking can be done for the overall energy consumption, or also for individual elements, such as gas or lighting.

Compare your numbers and find flags for savings! Notice higher than average gas usage—maybe focus your improvements on your building shell or heating systems. Higher electricity might point you toward looking at your lighting, equipment, or ventilation systems.

KI TOOL

Some great benchmarking tools we can recommend include; Energy Star Portfolio in the US, CIBSE in the UK, MESSAGE in Rwanda, and RETScreen or Arc Skoru globally.

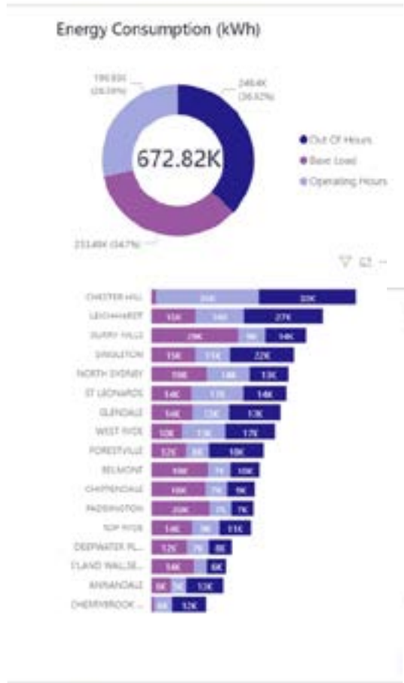
Energy Star Portfolio (USA)

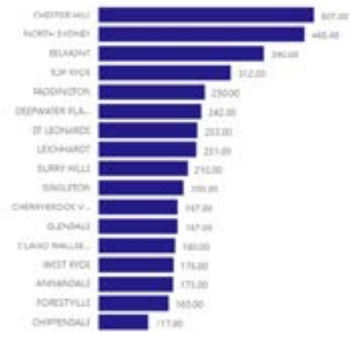
CIBSE (UK)

MESSAGE

RETScreen (Global)

Arc Skoru (Global)





UNDERSTANDING YOUR BUILDING & ENERGY USE

Now that you have a good understanding of your building's energy consumption, the next thing to do is to understand the building itself. This is important, as it will help to identify the limitations and opportunities for making changes.

Understanding your Building & Energy Use

Click on the topics to skip ahead!

Get to Know Your Building

Energy Survey

Focus On Lighting

Focus on Climate Control

Climate Control for Collections

GET TO KNOW YOUR BUILDING

Building on the initial questions and contacts from **Understanding Who's Who in Building Management**, we will now go into greater detail to find out more about our building(s) so that we can work out where we can make changes.

KI TIP

Your finance team might be able to help since they handle all the bills—they might be able to point you in the right direction of who signs off on various contracts including maintenance and renovations.

KI FACT

60-75% of carbon emissions from museums come from their buildings!

KI ACTION

Grab a pen and paper and go visit your team! Questions to ask:

- **Who owns the building (if someone else owns it, what can and can't we do?)**
- **What is the history of the building (When was it built? Has it been used for another purpose before? Write 1-2 sentences)**
- **What is the building made out of? Brick, wood and concrete, stucco?**
- **What are the long-term plans for the building?**
- **What work has been done previously (construction, renovations, upgrades, etc.)?**
- **Who maintains the building?**
- **Does the building have any restrictions on undertaking renovations/additions? (i.e. is it a historical monument and the facade cannot be changed)?**
- **Are there any industry standards that need to be adhered to? Are there any building regulation policies that we need to be aware of, especially for historic buildings?**

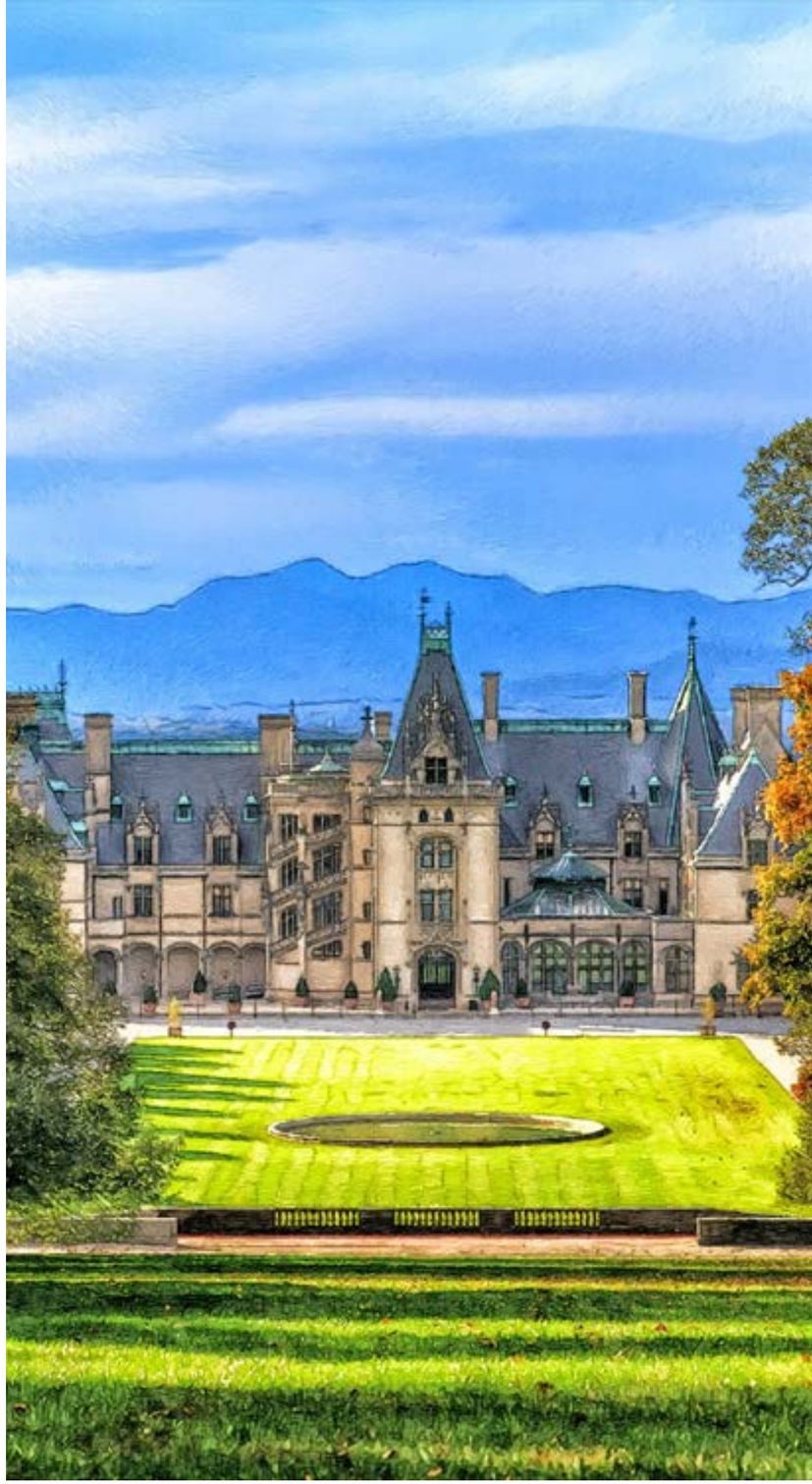


Photo by Donna Kirby

ENERGY SURVEY

Treasure hunt time! To better understand where you use energy, we will start with a basic walkaround survey. It would be good to do this with your facilities manager, who may be able to answer questions as you go and provide access to parts of the building.

The aim of the survey is to identify and document the current status of key energy usage so that you can find areas for improvement. During this walkthrough, you will be looking for areas where operating procedures can be made more energy efficient (i.e. where lights can be turned off when not in use) and seeing if there are any electrical devices or equipment that need to be replaced. (These are all things your facilities manager will be familiar with—so don't worry if you don't know what these mean right now. Also—your Ki Coach is always available to assist you if you need more help!).

KI TIP

Stay safe! See if a health and safety assessment would be needed before starting—especially if you are planning on entering spaces like plant rooms or using equipment like ladders.

Photo by Gerd Altmann from Pixabay, 2018

KI ACTIONS

Grab a pen and paper and your team. Walk around inside your building to each room and note the following:

- What type of room it is—office space, storage, collections display?
- What features are in the room—light fixtures, climate control, windows/doors?
- Who uses the room—visitors, staff, no one?

In each room, we will be looking at the following:

- Heating
- Cooling
- Lighting
- Building Control Systems
- Ventilation Systems
- Electrical Systems
- Building Shell

As you go through each room, run through this checklist. This will help identify where you can start making improvements!

The next step would be a more detailed energy audit. There are many resources available to help with energy audits—including some schemes that offer free on-site energy audits. You can check out **Energy Star's** treasure hunts, **Carbon Trust**, **SEAI**, or STARS for inspiration, or ask your Ki Coach if there are any programs available in your area.

Heating

- Equipment in sound physical condition
- Equipment operating sufficiently with little to no interruptions
- System Operating on Building Automation System
- How often does machinery fall out back into operator mode away from setpoints
- How often is equipment being serviced
- Would the equipment need to be replaced in near future
- Current operating schedule

Cooling

- Equipment in sound physical condition
- Equipment operating sufficiently with little to no interruptions
- System Operating on Building Automation System
- How often does machinery fall out back into operator mode away from setpoints
- How often is equipment being serviced
- Would the equipment need to be replaced in near future
- Current operating schedule

Lighting

- Lighting manually or automatic
- Lighting linked to building automation system
- LED lighting install
- Percentage of LED lighting on site
- Current operating schedule

Building Control Systems

- Percentage of major systems tied into system
- How often is system updated
- Will the system need an update within the near future
- How often are the setpoints operative
- Current maintenance schedule for building operating system

Ventilation Systems

- Operative without interruption majority of the time
- How often are ventilation systems being serviced
- Equipment associated with ventilation within good physical condition
- Current operating schedule

Electrical Systems

- Operating with interruption majority of the time
- Capable of handling site's electrical load
- Metered
- Sub-metered

Building Shell

- Sound
- Insulation
- Date of insulation and method

Make sure to repeat your walkthrough on different days/times throughout the year (morning/lunchtime/evening, winter/summer, weekday/weekend).

FOCUS ON LIGHTING

WHAT DO YOU HAVE & WHAT DO YOU NEED?

Lighting is hugely important in museums—but can also consume a lot of energy unnecessarily. Here, we will look into our current lighting situation and also into where we can make improvements.

KI TIP

Grab your conservation team to help you out for collections and storage areas!

You can then have a conversation with your conservators and operations teams to understand what is actually needed in each area—both for the collections and the people. Compare what is needed to what the current situation is and then jump to Lighting Systems to start making changes and savings!

KI ACTIONS

Your building walkthrough will provide an idea of what is currently in place, but you may want to consider some further details related to the lighting in different parts of the building including:

- **The mix of artificial and natural lighting**
- **The types of lighting systems used (the lumen levels, temperature of light, etc.)**
- **When are the lights on (24/7, occupied times only)?**
- **The choice of lighting controls (motion sensors, timers, etc.)**

Photo by Skye Studios, 2018

FOCUS ON CLIMATE CONTROL

WHAT DO YOU HAVE & WHAT DO YOU NEED?

Preventive Conservation is about preserving our collections through managing the environment they are stored/displayed in. This means that we need to have certain temperatures and relative humidity ranges for our collections. However, the systems we use to manage these can use huge amounts of energy.

The initial **Building Walkthrough** will provide an idea of what is currently in place, but we will need to do a deeper dive into climate conditions to make sure that we are being energy efficient AND taking care of our collections.

KI TIP

Understanding your climate conditions requires the input of a conservator! Make sure to have a conservation specialist on your team to better assess where climate control needs to take collections into account.

Photo by Oliver Peters from Pixabay, 2016

KI ACTION

Grab your colleagues and walk through your building. Take the following survey with you to examine your climate conditions in your institution.

What are the climate conditions inside the building (temperature and relative humidity)? What is it currently maintained at and does this differ for parts of the building? Does it differ at different times (day/night) or different seasons? Tip - ask your facilities manager or conservator for climate control data.

What temperature and relative humidity conditions are needed in different spaces? NOTE: THIS MAY DIFFER FROM WHAT THE CURRENT SITUATION IS! What spaces need relative humidity control and what spaces need temperature control? Do these requirements change for different times (day/night) or in different seasons? Tip—ask your facilities manager for guidelines for office areas and ask your conservation team for storage and display areas.

- Collections have specific requirements. Check out this brief history of **climate control in museums** to better understand why this conversation is so important and where we are at.
- Let's quickly examine where you're at for your collections (make sure your conservation team is with you for this part!)
    - What are the lower and upper limits and fluctuations appropriate for your collections? Do these need to be broken down into different types of collections?
    - Are there any objects that have specific needs in your collection? Do you have microclimates for these objects, or are you relying on general building conditions?
- Where does the heat from direct sunlight need to be managed? Ask your facilities manager if there are any filters on the windows for UV/IR.
- Is your building drafty? Where might your temperature or relative humidity be influenced by outside climate conditions?
- Ask your facilities manager if the doors and windows are thermal insulated
- List the types of heating and (de-)humidifying systems used (including passive ones)
- Do you have an HVAC system? If so, what is it currently set at?
- Do you have a climate monitoring system installed? Where is that data stored?

KI TIP

To assess what climate you need for your collections, it is essential to study the "historical climate" your objects were subjected to in the past. Collect and analyze at least 1 year of temperature and relative humidity data and fluctuations.

CLIMATE CONTROL FOR COLLECTIONS

We all know the debates about climate control, but in order to understand what is best for our collections, let's quickly run through the history and where we are at now:

1960's

First report of the effects of climate on conservation of museum objects[1]

- 50%-65% RH with no "abrupt changes"
- Consider object's history, structure, and past/acclimatized conditions
- Risk assessments introduced

1967

First conference on museum climatology[2]

- How environment affects objects

1978

Garry Thomson - The Museum Environment[3]

- The most influential book on climate control
- RH = 50 ± 5% / 55 ± 5%
- RH for mixed collections = "45 - 60%".
- T = 19°C±1°C (winter) / 24°C±1°C (summer)
- Constant T to minimize RH cycling
- Consider outdoor climate - RH close to local climate

1990

Questioning the status quo

- Smithsonian - materials resiliency higher when historically subjected to wider ranges of RH.

2000's

Sustainability - a factor![4]

- Appropriate over ideal
- No more universal standard
- Local climate, museum building, collection, risks, mission, operational priorities, and available resources
- 2008 - Bizot - rethink specifications - broader environmental parameters

2010

Reducing energy consumption a priority

- Reconsider policies and practices to be more sustainable
- 2012 - New guidelines - AIC, Bizot, British Standards Institution
- 2014 - AICCM
- Industry standard: 40%–60% RH and 15.5°C –25°C[5]
- Avoid extremes and fluctuations, and consider local conditions

TODAY

Houston, we have a problem[6]

- Scientific evidence to back up less rigid, more flexible climate controls
- BUT global standard of 50 +/- 5% RH is not budging
- Many considerations need to be taken into account to make changes
- Change can be made - we just need to work together to do it!

LIGHTS, CAMERA, ACTION!

Often, when we are making changes and want to have big impacts, it is helpful to have a game plan. This section will help you in deciding your next steps and thinking about strategies. For best results, keep these principles and game plan in mind while taking action in **Journey 2.**

Lights, Camera, Action!

Click on the topics to skip ahead!

Pick Your Battles

Show Me the Money!

Before You Buy a Tesla

PICK YOUR BATTLES

The first step is to decide what you want to accomplish. Are you trying to reduce your costs? Would you like to cut your energy consumption? Do you want to start your carbon journey? Let's pick where we want to begin!

KI TOOLS

Need help assembling a team?—Check out Forming Your Team in the Ki Toolkit.

Further help! Do you need assistance getting senior level commitment and support? Check out our Buy-In Guide in the Ki Toolkit.

Subscribe to Ki Futures here

KI STUDY

Your plan can be as detailed or basic as fits your needs. Check out the National Gallery Carbon Management Plan for inspiration!

National Gallery Carbon Management Plan

KI ACTIONS

Some things that you may include in your plan are:

- Types of objectives – carbon, energy, cost
- What partners you may need
  - **Internal! Understanding Who's Who in Building Management** ffor who might be able to help you
  - External—what other services will you need? Do you need an energy specialist? Lighting technician? You may not know this from day one, but keep this in mind. And you can always ask your Ki Coach to help you find these external partners
- **Define a baseline**
- Define goals
- Examples of goals
  - Reduce your energy consumption by 10% yearly
  - Reduce your energy by 20% by 2025
  - Check out what local government or organizations have set for various goals. See **Defining a Target** for more inspiration
  - **Include your goals in your ongoing monitoring for comparing**

SHOW ME THE MONEY!

Sustainability has a marketing problem. Everyone thinks that in order to be sustainable you need to be rich. A big barrier to making big change is upfront costs. Even if this investment will pay for itself in the long-run, cultural institutions are already budget-tight, so we may not think about big projects if they cost a lot. But there are so many amazing programs and options for sustainability projects, so let's see how we can find what we need.

There are four basic types of funding options: tax breaks/incentives, private companies, subsidies/grants, or pay out of pocket.

KI VISION

Circular models such as product-as-a-service are win-win-win for lowering energy, reducing waste, and for your wallet. Check out more about circularity in our Waste & Materials Ki Book and with the experts on the Ellen MacArthur Foundation's website.

Ellen MacArthur Foundation

Photo by Nattanan Kanchanaprat from Pixabay, 2017

TAX BREAKS/ INCENTIVES

Many local or national governments will offer tax incentives for sustainability projects or public sector funding for energy efficiency.

You can get rebates on installing solar panels or lower tax brackets for lower carbon emissions. Look for local utility incentive programs or ask your Ki Coach what is available in your area!

PRIVATE COMPANIES

Many private companies are investing in sustainable projects. There are also companies that will come in and pay for installations or retrofits and then take a percentage of the energy savings resulting from the project. Win - win—no upfront cost to you and instant energy savings!

Additionally, there are companies offering circular models—product as a service (PAAS) - or in these cases, lighting as a service or cooling as a service. PAAS is a model whereby a company offers to pay the upfront cost for their product—they are responsible for the equipment, installation, and maintenance. You just pay to use whatever they are providing. Signify from Philips offers lighting as a service. Check out how the Rijksmuseum Amsterdam saved a ton of money and energy by using the Signify program and these other cool global initiatives.

SUBSIDIES/GRANTS OR PAY OUT OF POCKET

You can also apply for subsidies or grants to cover your sustainability projects. Check out this amazing sustainability project at the **Hermitage Amsterdam** which was funded through a subsidy!

You can also pay out of pocket for your sustainability initiatives—but this can also count toward your carbon offsetting. Check out **Invest in Yourself** to find out more!

KI STUDIES

Some examples of funding initiatives, energy rebate programs, and subsidies:

Public Sector Network from Salix and the Carbon Trust

Spire Energy's Rebate Program

The Rwanda Cooling Initiative (R-COOL)

The Kigali Cooling Efficiency Program (K-CEP)

Signify Lighting as a Service at the Rijksmuseum Amsterdam

BEFORE YOU BUY A TESLA

Many people think that the best way to be sustainable is to buy the latest and greatest new thing. But did you know that it's actually more sustainable to buy a used gas car than a brand new Tesla? But sometimes replacements are necessary, and when that happens, we need to make sure that we are getting what we need. With your facilities manager, we can explore what equipment needs upgrading and **find our best replacement options**. Determine the replacement strategy, asset life spans, and who is contracted to undertake the replacement.

KI STUDY

Many pharmaceutical companies use HPLC machines. But they are only accurate enough to use for a couple of years before they need to be replaced. While these machines may no longer be precise enough to develop the next COVID vaccine, they are perfect for detecting pigments in 18th century textiles! See if your local pharma company may be willing to get a tax write off by donating their old machine to your research lab!

KI TIP

Can you share or borrow equipment instead of buying new? Or save even more money and see if you can get something donated! And remember—you can always ask your Ki Coach for help with getting equipment—new or used!

Photo by Free-Photos 2016

KI ACTIONS

During your energy survey, note any equipment that is in need of replacement (rule of thumb: usually appliances more than 10 years old should be replaced). Then ask the following questions:

- Why does it need to be replaced? Can it be repaired or upgraded first? Sometimes manufacturers or providers offer upgrade or maintenance services for their products - find out if you have any of these options in your contracts.
- If replacement is necessary, then let's first see if we can find a used and workable replacement (better to buy used than new).
- Finally, if we do decide we need something new, then let's make sure that we are getting the latest and greatest—Tesla time! Jump to find out tips on buying **Energy-Efficient Equipment.**

JOURNEY 2:

Save Energy!
Energy Efficiency & Savings

Now that we know where it's hiding—it's time to start saving! In this Journey, we will find those easy targets and also take the work from Journey 1 and apply it to larger actions. If you wanted to get started with instant savings, you may jump straight to this section, but if there is anything you need from Journey 1 to accomplish your goals, we will remind you.

Developing a Baseline can also help you track and measure your energy savings! So be sure to keep up your records so that you can show off your success and savings to your colleagues and upper management.

EARLY INTERVENTIONS & QUICK WINS

Energy savings is a process and a joint effort. It’s always helpful to have your colleagues working with you and to know what you are looking for. Here we will examine how you can influence behavioral changes in your institution and also what to look for for energy efficiency in and around your workplace.

Early Interventions & Quick Wins

Click on the topics to skip ahead!

Changing Behaviors

Energy-Efficient Equipment

Photo by PIRO, 2017

CHANGING BEHAVIORS

Changing your own behavior is the first step to making a big impact—because if you lead by example, it is very likely that your actions will rub off on your colleagues. Also, this is a great chance to make new friends and find out who else is interested in energy.

KI TIP

Assign roles and responsibilities. When people take ownership and feel they have a role to play in any activity, it encourages involvement and investment. This is a great opportunity to recruit additional Ki Champions and get your colleagues involved. Ask them to join you in actions like the energy audit or have an arts and crafts luncheon for people to design their own energy-saving stickers.

Be creative and discover your allies!

Subscribe to Ki Futures

KI STUDY

Check out the incredible savings seen through the Student Ambassador Program from Sustainability in Conservation

Sustainability in Conservation

KI ACTION

Signage and labelling

Putting up signs and reminders around your workplace and museum will draw attention to actions and behavioral change. Energy-saving stickers can remind people to turn off their lights or equipment when not in use, so that you don't always have to nag.

Communications

Another great way to encourage positive behavior is by talking about it! Most people are really interested in saving energy—if they know what to do. Bringing up fun facts and talking about things that you are doing may inspire others to follow suit or be more aware. For more tips on effective communication strategies, see the Sustainability in Conversation Guide on the Ki Port.

Photo by kalhh 2014

ENERGY-EFFICIENT EQUIPMENT

Energy-efficient equipment can save a ton of energy—up to 75% in some appliances![9] Generally speaking, it is more sustainable to use what you have (see Before you buy a Tesla), but when you do purchase new equipment, make sure you are getting the best, energy-efficient equipment on the market! How do you know if it's energy efficient? Fortunately, there are ratings for equipment so you know what you are buying.

LEARN MORE

US, Taiwan, Japan, Canada, and Switzerland have Energy Star Ratings. The EU and Africa use AAA, AA, A, B, C, D, E, F. And Australia uses The Energy Rating Label.

Energy Star Ratings (USA

AAA, AA, A, B, C, D, E, F

Australia's Eenergy Ratings

KI TOOL

Browse selections on EPEAT—definitive global registry for sustainable electronics:

EPEAT

Check out the CEE Energy Efficiency Program Library to find top performers! The Library is also a great tool for finding efficient programs and recycling opportunities in your area!

CEE Energy Efficiency Program Library

REDUCING APPLIANCE ENERGY USE

One of the easiest ways to start saving energy is to start small—with the things you plug in and turn on and off every day. You can save a ton of energy by knowing how to deal with your appliances and equipment as well as making sure they are properly maintained, cleaned, and functioning. Here we will explore energy usage in appliances and find quick ways to save!

Reducing Appliance Energy Use

Click on the topics to skip ahead!

IT (Information Technology)

Turn me off!

Phantom Energy

Surge Protector/Wall Socket/Plug Ins

Computers

Printers, Photocopiers, Fax Machines

Refrigeration Equipment

Photo by RAEng_Publications 2020

IT (INFORMATION TECHNOLOGY)

Looking at electronics, equipment, and appliances, we will need some more help. Your IT Technician will be an ally for finding savings around your office spaces—so if you haven't already, go introduce yourself.

KI ACTIONS

Upgrading IT infrastructure, such as servers, can also be a great way to reduce your electricity. Ask your IT Technician what energy saving protocols are already in place. If there aren't any, does (s)he/they know of any that could be installed? Here are a few that you can suggest:

- Install energy-saving software that turns off computers after hours or install timers
- Company-wide automatic email delete after 1 year
- Set computers company-wide to go into "power save" mode when not in use. Discuss how long computers should be idle before automatically going into sleep mode. The shorter, the more energy saved. Is 5 minutes a good compromise?
    - Bonus—ask if this can be done for other machines, such as printers or copy machines, as well
- Lower the monitor brightness for all screens. A Harvard study found that reducing your computer monitor brightness from 100% to 70% can save up to 20% of the energy the monitor uses[10]

Photo by Julia Wagner, 2018 SiC

TURN ME OFF!

It's quite obvious that a great way to save energy is to turn equipment off when not in use. But did you know that some equipment continues to consume energy even when it's not on?! Let's explore how to use your equipment properly in order to save energy fast.

Did you know that a photocopier left in standby mode overnight consumes enough energy to make 30 cups of tea?![11] It's important to turn equipment off—and not just leave it in standby or power save mode. At the end of the day or when not in use, turn off all equipment.

KI TIP

To ensure that equipment gets turned off at night, set a "last one out" policy whereby whoever leaves the room last makes sure that all equipment is off. This is a great way to set good habits for you and your colleagues. Set out a chart or calendar next to the exit door where the last one out can check off that all equipment was checked and was off.

Federico Beccari, 2016

PHANTOM ENERGY

Did you know that most equipment continues to consume energy, even when it is off? Think of your laptop—even when it's off and fully charged, the little green light stays on. Other appliances have invisible green lights.

Many appliances actually need to be cut off from electricity when not in use. This can be done by physically unplugging the equipment or by using a little add on like a **surge protector or timer**.

KI TIP

Calculate your savings: : measure how much energy the appliance is using with your meter monitor, then ENERGY x 16 = how much energy you save per day by keeping the appliance off outside of working hours! You can easily do this for the weekend as well.

KI ACTION

- **To identify which appliances need to be unplugged or to measure your energy usage/savings, use a meter monitor! These are relatively inexpensive (20 euro) and can save you hundreds!**
- **After you purchase your meter monitor, go around your office or lab and plug in the equipment to the meter monitor. Check and see how much energy it uses while it's on. Then turn the machine off and see if energy is still being used! If so, you have an energy vampire.**
- **Label all of your energy vampires to ensure that they get unplugged when not in use. Design engaging energy saving stickers yourself or download Ki Energy Stickers from the Ki Toolkit.**

Subscribe to Ki Futures

SURGE PROTECTORS, WALL SOCKETS & PLUG INS

Sometimes, we don't remember to turn things off. There are great ways to make sure equipment gets turned off—even automatically! Here are some inexpensive and effective solutions.

KI ACTION

Wall sockets

In some countries, your socket already comes with a built-in energy-saving device. Turn the plug itself off when no equipment is plugged in or when you are not using the equipment.

Surge Protector / Power Strip / Plug In

Sometimes unplugging and replugging in plugs can wear on your sockets and your plugs. Buy a surge protector/power switch to make it easy to turn off the flow of electricity without wearing down the metal in your plugs.

Timers

Another great way to save energy automatically is to add a timer to your outlet. These can be set to automatically cut electricity in non-working hours so you don't have to remember or constantly remind people to do this. These can be purchased cheaply and can be manual, or you can opt for the super fancy versions that can be controlled from your phone!

Photos from top to bottom: by tookapic from Pixabay, 2015. By Thanasis Papazacharias from Pixabay, 2020. By Jürgen Diermaier from Pixabay, 2015

Gerd Altmann, 2016

COMPUTERS

Computers can consume a ton of energy—especially if they are left on. In **IT (Information Technology)** we talk with our IT specialist about ways that we can reduce energy from our computers company wide. Here are a few more tips for lowering your computer energy usage.

KI FACT

Make sure to turn off your computer monitor too! The monitor consumes up to 75% of the energy that powers a whole computer

KI ACTIONS

- **Disable screensavers and put in "sleep mode" when a computer is idle**
- **Set sleep mode to go on sooner**
- **Lower brightness setting for computer screen**
- **Consider flat panel monitors rather than standard monitors—they are more energy and space efficient**
- **Consider using laptops rather than desktops—they are more energy and material efficient than desktop computers**
- **Some computers have settings to turn off automatically at certain times—see if you have this option**

Photo by manuelwagner0 2015

PRINTERS, PHOTOCOPIERS, FAX MACHINES

Printers and photocopy machines are seen around office spaces, although they are used less and less these days. The major problem with printers is that when we want to use them, we just push print and they spring to life and print for us. But most of the time, they sit idle in ready mode. This is a huge energy drain. So how can we be more conscientious about our printing and energy?

KI VISION

Printers are somewhat of a status item in some offices, but the fact is that we don't ALL need one. Can your company make do with one (or a few) shared printers? And actually—fewer printers and printers further away from desks discourages printing! So you save energy, costs of equipment, and trees!

KI ACTION

Things to consider when it comes to your printers, photocopiers & fax machines!

- Consider the location of printers, photocopiers, and fax machines that produce heat; if they are located near a heating or cooling sensor, they can cause overheating or excessive cooling (= energy suck)
- Enable power saving mode on all printers/ copiers/fax machines
- When purchasing new photocopiers/ printers/fax machines, look for the most energy-efficient models that are programmable to automatically shut off after hours
- Consider eliminating individual printers and use all-in-one printers/copiers designed for duplex printing and the use of recycled paper
- Also look for models that have toner/ink saving modes
    - Check out the **Waste & Materials** Ki Book for information on eco-printing strategies!
- Turn off copiers/printers when not in use
- Print in "batches"—make copies all at once rather than multiple times. Each time you start photocopying, the machine consumes extra power to get ready to run

REFRIGERATION EQUIPMENT

We use refrigeration for preservation of artifacts and also for some of our conservation materials. Oh, and probably to keep our lunch in. But inefficient refrigeration or freezing can eat up a lot of energy!

Here are some tips on how to reduce your energy consumption from refrigeration appliances.

KI ACTIONS

- **Make sure your fridge is the appropriate size. It is a waste of energy to use a refrigerator that is a standard kitchen size if you are only storing 5 jars of archaeological glass or one sandwich**
- **Keep your door shut! Opening and closing your fridge door wastes 50 to 120kWh a year. To put that into perspective, 50kWh of energy could run a dishwasher 20 times and 100kWh could run a washing machine 50 times[12]**
- **Make sure it's sealed—any leaks can let out cold air and send your refrigerator into overdrive**
- **If your refrigerator is 10 years or older, replace it**
- **Keep your fridge and freezer stocked—but not overstuffed! Air circulation is key to keeping the system running efficiently - more cold items helps keep the air cold, but if there is no room for air to circulate, then it can also interfere with the efficiency**
- **Don’t put anything hot in your refrigerator. Let items cool before putting them in the fridge**
- **Keep refrigeration equipment away from heat sources such as ovens or radiators. An appliance can consume 20% more energy if there is an increase in temperature**

Photo by OpenClipart-Vectors 2013

LIGHTING SYSTEMS

In **Focus on Lighting**, we investigated your lighting situation. As we know, lighting can be one of the biggest energy consumers in our institutions—which means that it holds one of the biggest potentials for energy savings! Now we will go through and apply the changes we identified to our lighting systems—saving the world one bulb at a time.

LED lights are the most energy-efficient bulbs available, using 90% less energy than traditional Halogen lights!

Switching to LED lights saves at least 50% in energy costs.

LIGHTING SYSTEMS

Click on the topics to skip ahead!

Lights (Indoor & Outdoor)

Task Lighting

Light Controls

Security Lights

Jukka Niittymaa, 2016

LIGHTS (INDOOR & OUTDOOR)

Energy savings can be as simple as switching your light bulbs. LED (light-emitting diode) or CFLs (compact fluorescent light bulbs) are the best and most-energy efficient options. Check out the case study from the Rijksmuseum in **Show Me the Money!** to see how they partnered with Signify to change all of their lighting over to a circular and affordable solution.

KI FACT

Office lights left on overnight use enough energy in a year to heat a home for almost 5 months.[13]

KI TIP

Add lights to your "Last One Out" policy!

KI ACTIONS

Things to consider when it comes to lighting:

- **Turn lights off when not in use and in unused areas**
- **Use natural lighting, minimizing daytime lighting in areas with good sunlight. If you are doing this in gallery spaces, ensure that you install UV filters on your windows to protect your collections. Ask a conservator or your Ki Coach for more help!**
- **Regularly clean lighting fixtures, sensors, and switches**
- **Label switches to indicate the location of lights and to remind people to turn off unnecessary lights**
- **If you are in a historic building, ask a lighting technician to double check that your light sockets (fixtures) will work with LEDs or CFLs. Small retrofits may be required**

Photo by Angelie Mejia 2015

TASK LIGHTING

Task lighting, or spotlights, provide focused light on one area and reduce the need for general light by improving contrast. Task lighting is something we use a lot of in display cases and exhibitions, but let's see how we can save energy using this technique as well as create beautiful experiences.

- Use task lighting (or spotlights) to complement daylight or general lighting
- General lighting can be reduced if task lighting is used—add dimmers to your general lighting or use daylight
- This is a great way to also help preserve your objects! Many museums use motion sensors or buttons to temporarily light objects. This is especially great for light-sensitive objects, but also saves energy!

KI FACT

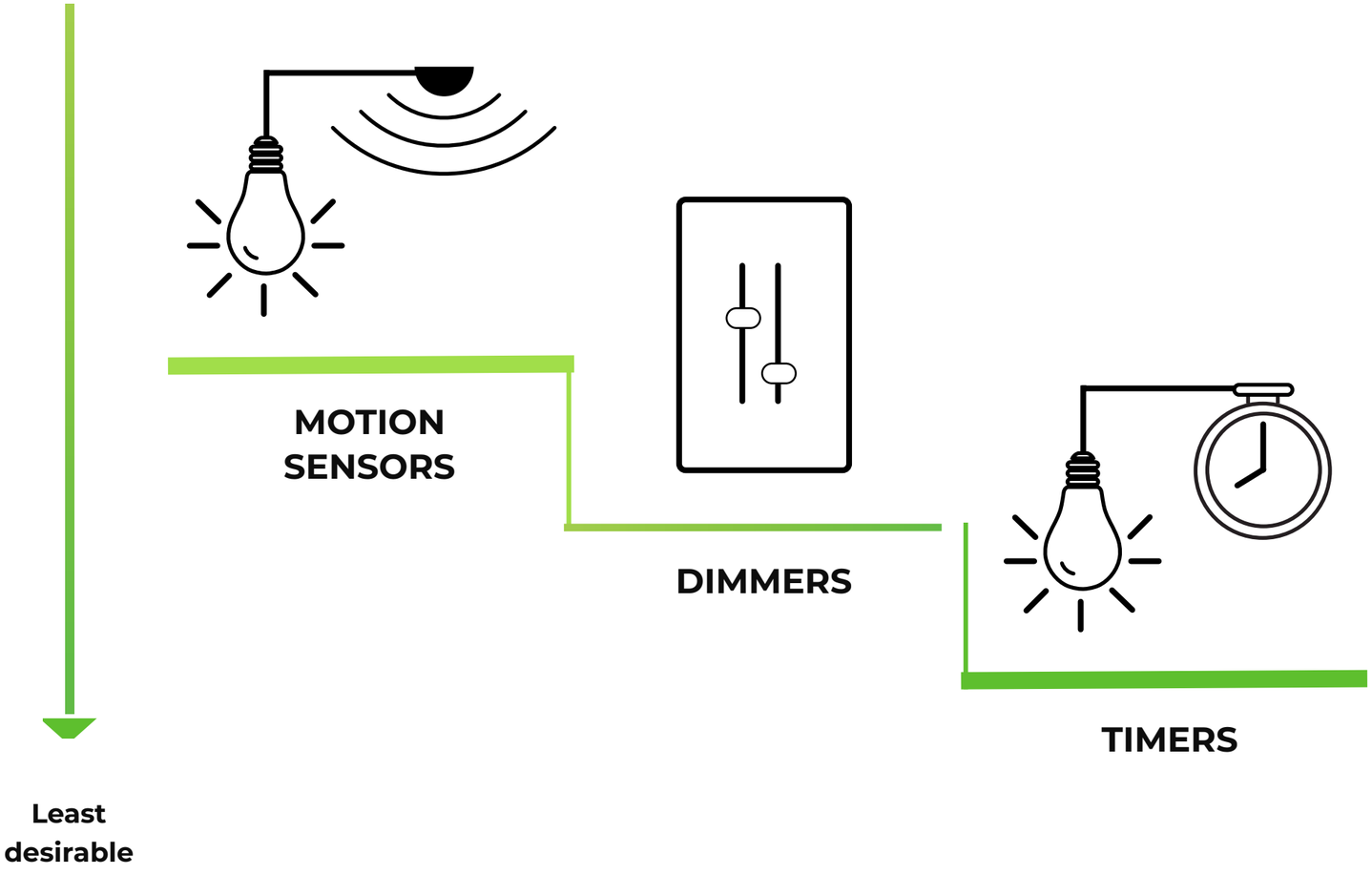
The UK wastes £170 million a year by leaving lights on unnecessarily.[14]

A single light left on overnight over a year accounts for as much greenhouse gas as driving from Cambridge to Paris! If you ensure that just 4 lights around your workspace are switched off every night, each year you could reduce your carbon footprint by the same amount as cutting out 10 flights from London to Paris.[15]

LIGHT CONTROLS

Light controls can have a huge impact on energy. While on your **Energy Survey** walkthrough, you were asked to look at the light controls in your rooms. Some of the solutions will be simple, but will require the help of a lighting technician or electrical person to make the switch. Come up with ideas of what you would like done and then talk with a specialist to see what is possible.

Most desirable



Least desirable

KI ACTIONS

Some ideas for reducing energy consumption at the switch:

- **Avoid having multiple lights activated by a single switch, use separate switches for each light (you don't always need ALL of your lights on—the more switches you have, the more control you have)**
- **Add dimming switches**
- **Install timers for outdoor lighting, update the timer according to the seasons**
- **Install occupancy sensors on the light switch to automatically turn off the lighting when no one is present**

SECURITY LIGHTS

Our institutions house valuable cultural and artistic objects and artefacts, and it is our duty to guard and protect them. Therefore, security measures are often in place in our buildings—which may include security lights. But we need to assess how many lights are really needed, and if they have to be on all the time. Some institutions leave their lights on as security measures 24/7!

KI TIP

Emergency lights do have to be on 24/7 - these are emergency exit signs, etc.

So don't turn those off!

KI ACTION

Grab your Head of Security to evaluate together which lights have to be on. Do lights need to be on continuously or can they be on intermittently? Are there alternatives such as infrared?

Ask if you have a building automation system. Can the security lighting be built into this automation system?

Photo by StockSnap 2017

IMPROVING THE BUILDING SHELL

The building shell—sometimes called the building envelope—is like the skin of the building. Think about just the building itself without anything in it—it is the barrier between the inside and the outside. The building shell is the single most important factor for primary energy use for buildings.[16] Therefore, it is essential that we ensure our shells are working with us to reduce our energy use.

Improving the Building Shell

Click on the topics to skip ahead!

Draft Proofing

Photo by Dan LeFebvre, 2018

DRAFT PROOFING

Having a well-insulated building is hugely important for maintaining a desirable indoor climate. A drafty building can make your HVAC system work overtime and be a huge energy suck! Not to mention, it can cause fluctuating relative humidity or temperatures (which we don't want!). Ensuring that your building is sound and well insulated will save a ton of money and energy—especially for buildings where climate control is of the utmost importance!

The easiest way to improve your insulation is by draft proofing. Use your results from your **building walkthrough** to identify where you might have leaks. There are several easy things to do to fix these or reinforce your building shell.

KI ACTIONS

- **To maintain your indoor climate control, ensure that doors are not propped open and windows are closed.**
- **Revolving doors are a great way to lower air exchange rates and make it easier to maintain indoor conditions.**
- **Use shutters, curtains, and/or awnings to decrease the likelihood of drafts or leaks around windows and doors and reduce impact from wind and harsh weather conditions.**

KI TIP

These are also great measures for regulating your temperature and humidity—add planting trees/bushes to protect from direct sunlight and undesirable microclimates in the museum!

More ideas on draft proofing

KI TOOL

For more detailed information on draft proofing and methodology, check out the IPI's Sustainable Preservation Practices.

Sustainable Preservation Practices

CLIMATE CONTROL

Climate control is at the heart of preventive conservation. Some specialists say that preventive conservation is the most sustainable way to preserve collections, others have denounced the practice as a waste of energy. We are not going to take sides, but we are going to advocate for implementing the latest research and scientific data—which also happens to be energy saving!

We think a lot about our climate conditions inside, but it is important also to take into consideration the outside climate. What kind of climate do you live in? Tropical? Arid? Cold? What kind of temperatures do you experience throughout the seasons? Are there drastic changes from summer to winter? We must think about our natural climates and work with them rather than against them.

Climate Control

Click on the topics to skip ahead!

Climate Control Guidelines

Climate Control Solutions

Microclimates

CLIMATE CONTROL GUIDELINE

In **Climate Control For Collections** we analyzed the history of climate control and preventive conservation. Here, we will take a more detailed look at the current guidelines for climate control.

GUIDELINES

Historically

T: 15.5°C

RH: 60%

Loan Agreements

T: 21°C

RH: 50% (55% or 60%)

Photo by Gerd Altmann from Pixabay, 2018

BIZOT Green Protocol

This protocol has been recognized by numerous institutions and organizations, including the National Museums Directors Council (NMDC), ICOM-CC (The International Council of Museums Conservation Committee), and the International Committee for Museums and Collections of Modern Art (CIMAM):

- T: 16-25°C
- RH: 40%-60%
- no greater fluctuations than 10% in 24 hours

Bizot Green Protocol

Environmental Sustainability

ASHRAE

ASHRAE has developed a system for climate control based on the class of collections with set points at:

- T: 15-25%
- RH: 50%

While ASHRAE is often cited, it requires a subscription to access the handbook. The Canadian Conservation Institute (CCI) gives a great (and simplified) overview of the ASHRAE guidelines here:

ASHRAE

The Canadian Conservation Institute

Getty Conservation Institute (GCI)

The GCI has done extensive research into environmental management and offers excellent case studies for historic houses.

Also check out the article about sustainability considerations in environmental management.

Alternative Climate Controls for Historic Buildings

Collections in Hot & Humid Environments

Climate Control Alternatives for Cultural Institutions— Hot & Humid Climates.

Preserving Collections in the Age of Sustainability

AICCM

The Australian Institute for the Conservation of Cultural Materials has done extensive research on environmental conditions for collections taking into consideration the local climate and offers an array of choices tailored to the geographical location:

- T: 15-25°C (max. 4°C fluctuation in 24 hours)
- RH: 40-60%
- Subtropical climates: 45-65%

AICCM

AIC

The American Institute of Conservation gives a great overview of various guidelines and the history of these recommendations. They also contributed to the interim guidelines adopted by ICOM-CC.

- T: 15-25°C (59-77°F)
- RH: 40%-60%

AIC

ICOM-CC

ICOM-CC endsorses the agreed upon guidelines from AIC, AICCM, the Bizot group et. al. in 2014.

ICOM-CC

Photo by Nuno Lopes 2015

CLIMATE CONTROL SOLUTIONS

With all of these greener, less rigid, scientific-based guidelines, we should be better about our climate control. However, there are many institutions that have not yet adopted these guidelines--usually because of strict conditions for loans or because of insurance companies. But sometimes, it can be as simple as not asking or not knowing

KI VISION

Can we advocate for greener guidelines with our colleagues and peers? Start conversations with various stakeholders—including your Director, insurance provider, art handler/ transportation team, and other museums/ galleries. We need everyone on board to ensure that these protocols are adopted sector-wide globally!

KI ACTION

In **Focus on climate control**--we looked at what our current climate conditions are and what we need. So, the logical next step is to make the change. Take into consideration **which guideline is right for your collection** and ask your facilities manager to apply the new range.

For your specific collection, make sure to consult with your conservation team or ask your Ki Coach. Basic things to keep in mind include:

- **Building shell**—where are your risk areas
- Different areas may have different requirements—not all spaces need to be managed (non-collection areas do not)
- Your requirements may be different during the day and at night—and in different seasons
- Your collections' histories will inform their current requirements
- Take your geographical location and the local climate into account
- Display cases and **microclimates** can be solutions for sensitive objects
- Other techniques for climate control may include passive methods, which are typically localized solutions as opposed to building-wide climate control. These may be great options for historic houses or buildings without HVAC systems:
- Use humidifiers/dehumidifiers where needed
- Use space heaters where possible
- Types of collections have different requirements—is it possible to keep similar materials together?
- **Create microclimates**

KI STUDY

There are numerous publications and studies on climate control for museums. The Image Permanence Institute has done a lot of research on sustainable preservation. Check out their webinars, publications, and research here:

The Image Permanence Institute

The Rijksdienst voor het Cultureel Erfgoed has also published numerous studies and guidelines for risk and climate control:

The Rijksdienst voor het Cultureel Erfgoed

Photo by PommeGrenade, 2017

MICROCLIMATES

Sometimes we have particular objects that are super sensitive to temperature or relative humidity. In these situations, it may be more effective to store/display these objects in microclimates rather than trying to maintain specific conditions throughout a room or building for that one object.

Microclimates can be created and maintained in storage spaces, boxes, or display cases. The temperature and relative humidity can be controlled through simple techniques. Make sure to keep a data logger or other indicator in your microclimate to monitor your temperature and relative humidity.

KI TIP

There are many companies that offer microclimate solutions—ask your Ki Coach for leads and advice!

KI ACTION

- **Ensure your case is airtight**
- **Use absorbents or buffers--salt solutions or silica gels can help control relative humidity, while materials like activated carbon can absorb pollutants**
- **Work with your curatorial team to ensure design and aesthetics are considered for display areas**

HEATING, VENTILATION & AIR CONDITIONING (HVAC)

HVAC systems are heavily relied upon in many parts of the world to help maintain certain climate conditions in our institutions. However, HVAC systems are also one of the most energy-intensive systems in our buildings. If your institution has an HVAC system, there are a lot of things you can do to reduce your energy consumption. We will explore some options here.

This is where the Building Environment Management Systems / building energy optimization, **Check Your Energy Software** and **Energy Survey** can really help! Make sure that you have assessed your current situation and desired situations in **Focus on Climate Control—**before making any changes.

Always consult with your facilities manager and conservators for anything related to climate control!

Heating, Ventilation & Air Conditioning (HVAC)

Click on the topics to skip ahead!

HVAC & Collections

HVAC & Non-Collection Areas

Maintenance & Optimization

Photo by ElasticComputeFarm from Pixabay, 2016

HVAC & COLLECTIONS

The great news is that the IPI has spent years doing all kinds of research on HVAC systems and sustainable preservation management. So we are not going to reinvent the wheel here. To the right, you will find a summary of the IPI's top four tips for HVAC energy savings, but make sure to check their manual for methodology and further details.

Implementing Sustainable Energy Saving Strategies

KI FACTS

- 8-hour nightly shutdown, then yearly savings of 33% may be possible; even a 3-hour shutdown can see 12% savings.

KI ACTIONS

1. System shut down

- Mechanical system shutdowns (turn off fan units)—turn off when not in use or during unoccupied (nighttime) hours
- Decrease HVAC system operation time, especially in storage areas
- Some storage climates are unaffected by short-term system shutdowns and suggest that some systems could be shut off for certain portions of the day (unoccupied hours) and for some portion of the year without reducing preservation quality

2. Nightly setbacks for climate control

- Use different (wider) temp/RH ranges during the nighttime
- This can be trickier to implement in collections areas, especially in summer time, so make sure to consult with your conservation team, Ki Coach, or check the IPI guide

3. Adjust fan speed

- Reduce fan speed
- Prevent systems from sub-cooling and reheating (meaning that you are cooling the space too much and then need to reheat it). Avoid this by checking the control system and setpoint

4. Climate control for the season (and the geographical location!)

- Make sure to always consider the outside temperature and relative humidity

HVAC & NON-COLLECTION AREAS

In our **walkthrough**, we identified different areas of our buildings where collections live and where they don’t. For areas that don't need climate control conditions for collections (such as office areas, restaurants, gift shops, event spaces, and theaters), you can follow different rules.

Here are some additional tips and guidelines for these non-collection spaces:

For Temperature:

- Program the HVAC system to turn off automatically after hours and turn on again during business hours
- Adjust temperature settings to reflect your geographic location and season

For Airflow:

- Make sure doors and windows are airtight
- Keep outside doors and windows closed
- Open windows and turn off the system on sunny days
- If the heating, ventilation, and air conditioning system has zoning capability, program to condition only the zones in use
- If the HVAC system has no zoning capacity, close vents in unused areas
- Make sure that heat-producing equipment is not located near the thermostat sensors
- To ensure free air circulation, make sure that furniture, drapes, and other items are not exposed to vents or air outlets
- Use fans wherever possible. Fans help circulate air, reducing the need for air conditioning, while maintaining a comfortable temperature

Photo by ElasticComputeFarm from Pixabay, 2018

Photo by F. Muhammad from Pixabay, 2017

MAINTENANCE & OPTIMIZATION

HVAC systems are often set incorrectly, not optimally maintained, inefficient, or out of date. Your HVAC system will function much better—and reduce its energy consumption and costs—if it is properly maintained and optimized.

KI TIP

You may have a contract with your HVAC company for maintenance, so find out from your facilities manager what maintenance programs may already be in place.

KI ACTIONS

Maintenance

- Plan regular maintenance checks for HVAC equipment. For companies with large HVAC equipment, it may be worthwhile to have the energy consumption and efficiency of the systems professionally verified
- Perform a pre-season check before winter heating and summer cooling
- Verify that the system is working and is properly programmed, check temperature settings and airflow rate

New systems

- Check if you need to purchase a new system (**don't forget**—when to buy new stuff the most sustainable building is the one that's already built—only buy a new system IF NECESSARY)
- Depending on the age and type of HVAC system, it may be more cost-effective to install new, more efficient equipment before the old one fails
- When purchasing a new HVAC system, make sure it is the most **energy-efficient model**
- When purchasing a new system, make sure it is the right size for your space and usage needs. Systems that are too large or too small will not only waste energy, but will also increase your energy costs

DIGITAL EMISSIONS

Digital emissions? What does that mean? Most people don't realize that all of our digital activities—emails, streaming, loading websites—consumes energy. And a lot of it. All of our digital material has to be stored somewhere—and these are typically in large, very energy-intensive, data centers.

All of our digital content and activities go through these data centers—this is also what “the cloud” is—that data is not living in the sky, but actually being stored somewhere. And at the exponential rate at which we continue to compile email and digitize our collections, data centers are estimated to consume 1/5th of the world's energy by 2025!

Let’s take a look at our digital carbon footprint and see how we can slow the roll on our energy consumption.

Digital Emissions

Click on the topics to skip ahead!

Data Centers & Digitization

Digital Consumption

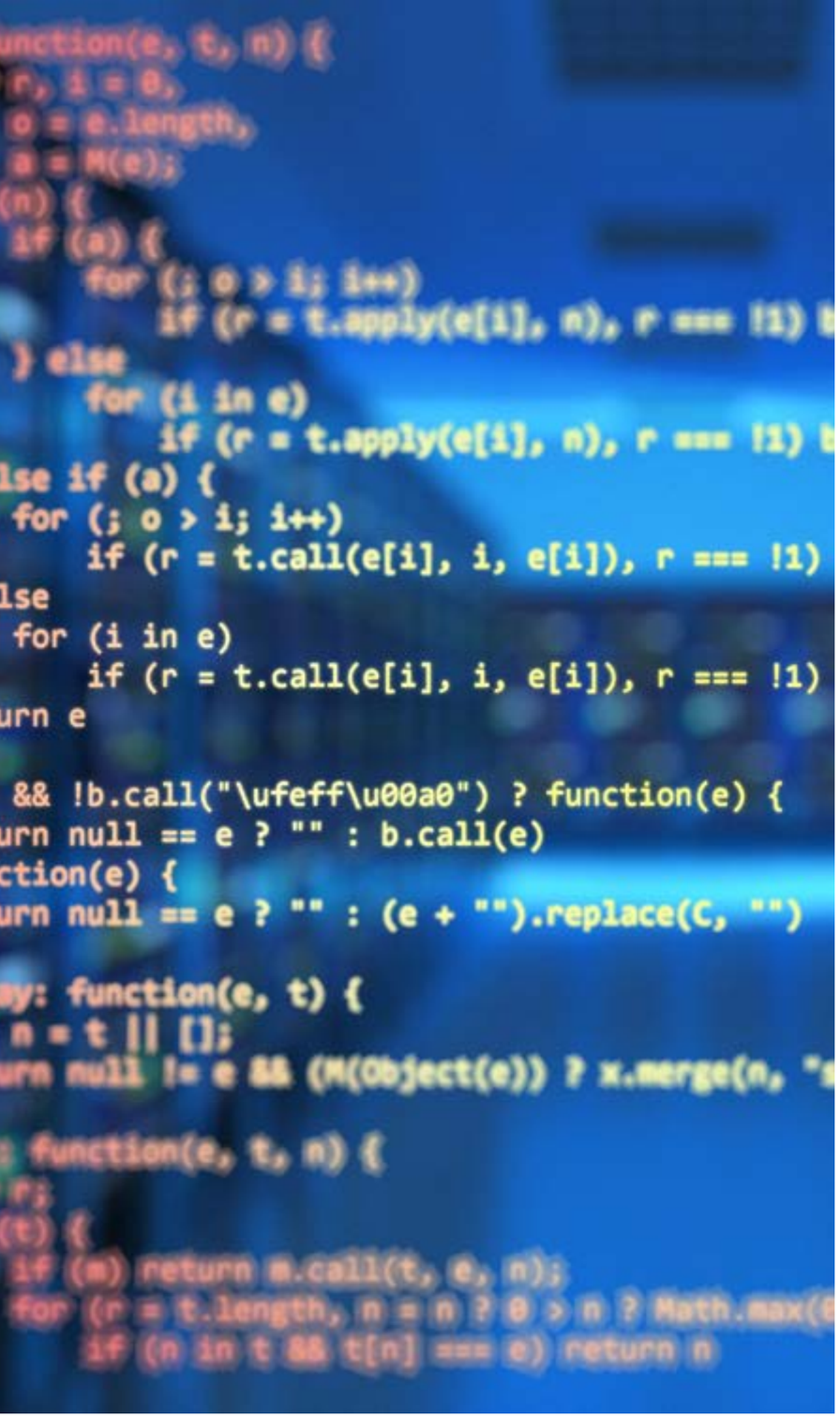


Photo by Elchinator from Pixabay, 2019

DATA CENTERS & DIGITIZATION

There is a trend today (especially during the coronavirus pandemic) to digitize our collections. This is associated with accessibility and also with preservation strategies (see **Social Sustainability Ki Book** for more about digital accessibility). However, these data centers where our collections are stored digitally are consuming extravagant amounts of energy.

So, we need to ask ourselves—what is the price of digitization?

KI TIP

Print this infographic about carbon emissions and the internet and post in your office space to remind colleagues about their digital carbon footprint!

The Carbon Footprint of the Internet

KI ACTIONS

Assess your digitization strategy in your institution:

- Why are you digitizing? What is the impact? Can you prioritize certain objects or collections that will be useful to digitize rather than try to digitize everything? Check out the **Social Sustainability** Ki Book for more about developing a digitization strategy!

Check your storage:

- Where is your data being stored? There are data centers that run on green energy (thank you Iceland.) But keep the **Energy Hierarchy** in mind—reduce then rely on green energy solutions.

- Ask your Ki Coach for help in finding out more about green data centers and what you use!

Photo by Gerd Altmann 2018

DIGITAL CONSUMPTION

Other areas of our digital lives are easier to control—so let's look at what we can do ourselves to lower our digital content and thereby reduce our energy consumption.

KI FACTS

- **2% of global emissions come from the internet—the same as the airline industry.[17]**
- **Loading the average website uses up the equivalent amount of energy as boiling a kettle for a cup of tea.[19]**

KI TOOL

Check to see what the carbon footprint of your website is with websitecarbon or ecograder.

websitecarbon

Ecograder

KI ACTIONS

- Use cloud-based services from companies committed to net zero carbon servers
- Emails consume a ton of energy—all of those old emails sitting in your inbox continue to consume energy as they take up storage space in data centers. Clean up your old emails or ask your IT specialist if your organization can implement automatic delete protocols for emails older than one year
- Shorter emails = less storage space needed. Be concise in your messages and remove unnecessary text or content from emails
    - Many institutions have beautiful banners and signatures at the bottom of their emails—can you remove these from email chains? Ask your IT manager about making that a setting organization-wide
- Use green search engines. At Ki Culture, we use Ecosia!

Ecosia

- Tightening privacy options will decrease tracking and decrease carbon!
- Clear your browsing history (or browse incognito)
- Unsubscribe to mailing lists
- Green your organization's website![18] Talk to your IT technician and web design team about what energy reducing steps you can take:
    - Choose the right web host
    - Use an eco-friendly design—the more complicated the design, the more energy it consumes
    - Make your content printer friendly
    - Improve your site's loading speed—faster = more energy efficient!
    - Educate your visitors! Let them know on your website how much carbon your website uses and what the impact of digital consumption is on the planet

ENERGY TIPS FOR THE LAB

Labs are much more energy intensive than other areas in our buildings. On a square foot basis, labs use four to five times more energy than classrooms and offices.[20] Often, this is due to strict climate controls and energy-intensive equipment.

There are some great initiatives for saving energy in labs, including **Green Lab Associates**, **Labconscious,** and **My Green Lab**. Additionally, many universities have formed programs for greening their research labs.[21, 22, 23, 24, 25, 26, 27, 28]

Let’s take some of the inspiration from chemistry and university labs to find solutions for our research labs.

ENERGY TIPS FOR THE LAB

Click on the topics to skip ahead!

Lab Equipment

Air Extraction

LAB EQUIPMENT

We can use the same approach for finding energy savings in our lab equipment as we did for our **office appliances**, but we need to be aware that lab equipment can be sensitive and might have some special needs.

In addition to evaluating the **machine's energy efficiency** and investigating if it consumes **Phantom Energy**, we need to be aware if the machine will be damaged if we turn it off. So, before we look into energy-saving strategies, first check if the machine CAN be turned off. For example, some FTIR machines need to stay on to preserve the laser. You can contact the manufacturer or ask your facilities manager about what equipment needs to stay on.

KI ACTION

It can be difficult to remember which machines need what, so make a guide or stickers for your equipment to remind users what to turn off, what to unplug, and what to leave on!

Herney Gómez 2017

AIR EXTRACTION

Air extraction requires a lot of energy, and we use a lot of air extraction—especially in conservation. Bench top fume extractors and fume hoods are some of the most energy-intensive equipment in our conservation studios and labs.

KI STUDY

Harvard University did a study that showed that simply keeping fume hoods shut when not in use resulted in a 30% reduction in fume hood exhaust levels and an annual energy savings of over $240,000 at $7/cfm and annual reductions of over 300 metric tons of greenhouse gas emissions.[29]

KI ACTION

- Keep your fume hoods shut if not actively in use! And if you aren't storing anything in them, turn them off!
- Only turn on bench extraction when actively using it
- When possible, try using your bench extraction instead of a fume hood

REDUCING HOT WATER USE

Water is a precious resource in its own right—and we will be diving into 2022 with the release of the **Water Ki Book**. But, did you know that water also relates to energy? It takes a lot of energy to heat up water! In an average home, heating water accounts for 15% of the total household energy use.[30] And did you know that every time you turn on the tap, you are using energy? Pumping water is incredibly energy intensive, and depending on the source of your water, the energy can actually be more expensive than the water itself! In fact, the amount of energy it takes to pump water to Mexico City is more energy than is consumed by the entire city of Puebla (pop. 8.3 million).[31]

So let’s take a quick dip here into how we can save energy by saving water.

Reducing Hot Water Use

Click on the topics to skip ahead!

Finding your Hot Springs

Leak Detection

Distilled/Deionized/ Demineralized Water

FINDING YOUR HOT SPRINGS

First, we can revisit our **Survey** to see where your hot water is being used. An easy way to reduce your energy consumption from hot water use is to use less water! This is easily achieved through some simple measures:

KI ACTIONS

- Install reduced flow taps or shower heads You can purchase some quality, low-flow fixtures for around $10 to $20 a piece and achieve water savings of 25%–60%.[32]
- Run dishwashers only when full or wash dishes by hand
- Only use hot water when necessary—identifying where you are using hot water can help you determine if you actually need to be using it or not
- And check out our **Water Ki Book—coming 2022!**

KI TOOL

Calculate your energy consumption for heating water here:

Water Heating Calculator

KI FACT

In an average home, heating water accounts for 15-18% of the total household energy use.[33]

Photo by Michal Jarmoluk from Pixabay, 2017

LEAK DETECTION

While a leaky faucet may seem like no big deal, it can waste a ton of water—and energy! After all, one drip per second wasts 1661 gallons of water per year![34]

KI TOOL

Drip Calculator

KI ACTION

- Make sure to report and fix all leaks
- While waiting for a leak to be fixed, can you collect the water and store it to be used later?
- Play detective—assign someone to check for leaky faucets periodically to find any undetected leaks

Photo by picturegal 2019

DISTILLED/DEIONIZED/ DEMINERALIZED WATER

Purified water comes in three forms: distilled, deionized or demineralized. We use purified water for various activities in and around a cultural institution—from cleaning to conservation treatments--but production of these waters can be incredibly expensive, not to mention energy intensive!

To reduce your DS/DI/DM water production, first see if you NEED purified water.

- Distilled water removes 99.9% of contaminants, including suspended particles, organic materials, bacteria, viruses, salts, metals, minerals, and physical impuritie
- Demineralized water removes all minerals and salts (including trace elements) from water
- Deionized water is water that has had all of its ions (cations and anions) removed

KI ACTION

See if you can find other sources for purified water—or make it yourself!

- **HVAC systems produce purified water that can be used—talk to your facilities manager about collecting this water or installing plumbing to pump it directly into taps!**
- **Bring in distilled water from your home dehumidifier or dryer[36]**
- **Make purified water yourself! This can easily be done using your stove or—to save more energy—make a solar water still and use the power of the sun!**

KI FACT

Deionized water systems can cost almost $1000 per month![35]

KI TIP

Always use a pH and conductivity meter to check water before using in conservation treatment.

Photo by rony michaud 2014

JOURNEY 3:

Carbon & the Road to Net Zero

Carbon and energy are not the same thing—but are very closely related. It is important to remember that before you start exploring alternative energy sources and going net zero, you first need to reduce your energy consumption as much as possible! So make sure to check out **Journey 1** and **Journey 2** first.

Carbon emissions of museums and the wider cultural sector are not well understood because there has been very little benchmarking to date. Some great work has been done in the USA[37], but we still don't have enough information to really understand what our impact is. However, we know that we can do better[38]. As cultural institutions, it is our responsibility to ensure a sustainable future. And this starts with leading by example.

In Journey 3, we will explore what carbon is and look at how we can reduce our footprint. We will learn about various options for now—and prepare ourselves for a greener future.

Understanding Your Carbon Emissions

We have all heard about the climate crisis—and understand that it is related to carbon dioxide emissions (CO_2). But what exactly does that mean in terms of our impact? And where do these carbon emissions come from?

Energy is related to carbon, but the relationship is not always clear. A unit of energy (in this book we have been working with kilowatt hours—kWh) can produce different amounts of carbon emissions, depending on how that energy is generated and where you are in the world. Here we will take a simplified look at contextualizing carbon and getting an idea of how we can prepare ourselves for greener technologies as they emerge.

Understanding Your Carbon Emissions

Click on the topics to skip ahead!

Converting Energy to Carbon

Carbon in the Future

CONVERTING ENERGY TO CARBON

When we start talking about carbon, it is easy to get lost. What does 12 million metric tonnes of CO^2 actually mean? What kind of an impact is that? Big? Small? To make these numbers mean something, it is helpful to give context. Fortunately, there are some super handy tools to help with this.

To really understand your impact, try these tools to calculate how much carbon is produced by your energy consumption.

KI TOOL

We will look at how to calculate your profesional carbon footprint in Calculate your emissions but if you are curious, you can check out your personal carbon footprint here:

GHG Emissions Calculator

Calculate your personal Carbon Footprint

KI TIP

Providing comparisons of carbon emissions helps people understand what kind of impact you have and what kind of savings you can see! It's much more effective to tell someone that the amount of carbon you can save is equal to 187 pounds of coal burned or the energy it takes to charge 21,680 smartphones rather than saying it will save 171 kg (376 lb) of CO^2 emissions.

Which by the way, is what you can save by turning off your lights around the office.[39]

CARBON IN THE FUTURE

We have seen it first hand—sustainability is the future. Energy companies are already making the shift from fossil fuels to renewable energy. As this trend continues, and more energy companies invest in renewables and efficient technologies, we will continue to see a reduction of emissions from main electricity grids.

While we wait for these changes, there is still plenty we can do.

KI VISION

We can also help this transformation! Asking questions shows interest—ask your local energy companies what their plans are for green energy.

Get involved with local policies to demand greener energy options!

KI ACTIONS

- **We can already start preparing. Emerging green technologies are mostly electric-based, which means that we can start getting ready to receive all of this great green energy by changing our energy systems away from gas and toward all-electric technologies. Talk to your facilities manager to see what is possible for your institution.**
- We can also start planning to go net zero. Check out **Developing a Carbon Reduction Plan** for how to start your journey.

Photo by Ameen Fahmy, 2019

DEVELOPING A CARBON REDUCTION PLAN

The trend today is to set targets for buildings to operate at “net zero,” meaning that there is a balance between the annual emissions from the buildings’ use and compensation for these emissions. Simply put, you reduce your emissions, and then you pay or offset your additional emissions to get to “zero” emissions. But what is net zero? And how can we get there?

We all want to reduce our carbon footprint—but how do we actually do that? Let’s look at what net zero actually means, what our options are, and come up with a gameplan.

Another reminder here that you must first reduce your energy consumption—and therefore emissions—before setting out to reach net zero. Make sure to visit **Journey 1** and **Journey 2** first!

Developing a Carbon Reduction Plan

Click on the topics to skip ahead!

Defining a Target

Net Zero Energy vs. Net Zero Carbon

DEFINING A TARGET

Carbon reduction can feel overwhelming—there is so much to do! But setting goals can help break down the process and make this achievable. Make sure to involve the entire team so that everyone knows what they are working toward!

Net zero goals are determined based on actual consumption data and building operations (see **Journey 1** to help find these numbers and measure your baseline). Appropriate goals will depend on the building features, location, and available technologies. Your own strategy for achieving net zero will be unique to your particular building and situation.

What you may include in your goals:

- The percentage of emissions you will reduce
- The percentage of electricity from renewable sources
- **Offsetting plan**
- Remember to put a time frame as well—are these annual savings or by a set year?
- Also make sure to define what you mean by “net zero” (Net Zero Energy vs. Net Zero Carbon)

KI FACTS

Check out these national and international targets for inspiration and don’t forget to ask your Ki Coach for help along the way!

Paris Agreement[40]—an international treaty on climate change with the goal to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.

New Zealand has committed to net zero emissions by 2050. Targets of 80% of the country’s electricity being sourced from renewables and a phase-out of oil and gas planned for 2035.

Sweden pledged to reach carbon neutrality by 2045— 85% emissions reductions compared to 1990 levels and remaining 15% to be “offset” through investments in projects that contribute to reducing pollution in Sweden and elsewhere across the world.[41]

Subscribe to Ki Futures

Photo by irinakeinanen 2017

NET ZERO ENERGY VS. NET ZERO CARBON

Often the terms “net zero energy” and “net zero carbon” are used interchangeably, but there are important differences that you need to know when setting targets.

NET ZERO ENERGY

For a building to be net zero energy, it must produce all of its energy on-site. The larger the building, or the more energy it uses, the more difficult this target will be.

NET ZERO CARBON

Net zero carbon allows the use of external renewable energy sources. You can be net zero carbon if you buy your energy from providers guaranteeing 100% renewable energy, or through Renewable Energy Certificates (RECs), or other market initiatives. Additionally, net zero carbon allows for compensating unavoidable emissions on-site using carbon offsets. But be careful—this can be tricky to do correctly. See **offsetting** for more information.

WHICH ONE WINS?

Net zero carbon is therefore usually a more appropriate target for the majority of buildings—particularly those with high energy use, poor access to solar energy, or climates or locations that make it difficult to produce enough energy on the building itself.

But remember—no matter what target you are going for—always follow the **energy hierarchy**: reduce your energy consumption first through energy efficiency measures, then use renewable energy for the remaining demand (either on the building or from off-site sources).

KI STUDY

Check out the great work that LETI has done in creating a path to a zero carbon future!

LETI

Photo by Dominique Devroye 2018

KI ACTION PLAN FOR NET ZERO

Now that you have decided to go net zero, there are key questions that you will need to ask yourself. Using these questions, identify key areas of focus, which steps you will take, what you need to do, and what will be done by others.

Is your building energy efficient?

By following the steps outlined in Journey 1 and 2, you will have identified the ways to reduce your energy consumption and optimize the energy performance of your building.

Where does your energy come from?

If you have not yet done so, go back to **Journey 1** to explore where your energy comes from. Do you know how the energy used by your building is generated? Does it come from fossil fuel based electricity grids or do you use fuels on site such as gas, oil, or diesel? Ask your building manager what energy sources are being used and if there are possibilities for renewable sources.

Ask your energy supplier about green energy options!

Many energy suppliers now offer customers green energy options, or switch to a supplier who does.

What alternatives are available?

Achieving carbon reductions will require exploring what's called fuel switching. This may mean changing energy suppliers, replacing equipment, or changing systems to be all-electric.

Explore offsets:[42]

If you are unable to switch your energy provider, account for the carbon emissions associated with your fuel sources by buying high quality carbon offset credits to fund essential projects to sequester carbon or support technology deployment. Note that this is a LAST RESORT and should not be done in place of reducing your energy consumption

Ask your Ki Coach for more help or to discuss an action plan more specific to your field!

Subscribe to Ki Futures

RENEWABLE ENERGY

Let’s face it—we need energy. We cannot live without it. So, renewable energy is the key to a green future. Don’t forget the **Energy Hierarchy—**we must first reduce, but after we have done so, the remaining energy we use should be from renewable sources.

You may feel that this is out of your hands, but there is so much we can do to advocate for green energy in our institutions and in our communities. The first thing is to know a little bit about what we are asking for. Here, we will explore what is available and what is best for us.

There are several renewable energy technologies available in today’s market, with increasingly attractive prices and offers. The most appropriate technology, or combination of technologies, for your building will depend on several factors.

Let’s see what we need to consider when thinking about renewable energy.

Renewable Energy

Click on the topics to skip ahead!

On-Site Renewables

Renewable Energy Systems

ON-SITE RENEWABLES

Having renewable energy systems on your property is ideal for any **net zero target**. To see what might work for your situation, you will need the help of an energy specialist who should conduct a survey. Ask your Ki Coach for help finding a specialist in your area!

Subscribe to Ki Futures

KI VISION

On selecting the best options, ensure the equipment installed is user friendly and consider a real-time display panel in a public area to educate staff and visitors on how much energy is being generated and used at any moment.

KI ACTIONS

Employ a local specialist to visit the building and identify appropriate solutions. The specialist should go through various considerations with you, including:

- **Energy generated from energy source per year (psst... you can help with this)**
- **Return on investment (how long it takes for the system to pay for itself)**
- **Local planning criteria, including land use and noise**
- **Feasibility of exporting heat/electricity from the renewable energy system to the grid**
- **Any available grants or financing models**
- **All technologies appropriate to the site and energy demand of the building (ie. the amount of solar energy a building can access)**
- **Reasons for excluding any technologies (for example, have them explain why wind or geothermal energy would not work—don't be afraid to ask!)**

On completion of this survey, review the recommendations and explore options for funding: some local authorities offer low interest loans or grants for the installation of renewable energy technologies.

RENEWABLE ENERGY SYSTEMS

When you are considering renewable energy, it's helpful to know a bit about what the options are. Here is a handy overview of some of the most common types of renewable energy:

SOLAR

There are two main types of solar energy systems that capture energy from the sun for use in your building: solar PV and solar thermal. Solar PV uses photovoltaic cells to capture and convert sunlight into electricity. Solar thermal uses a collector filled with a fluid that is heated by the sun and then transported to the hot water tank where it heats the water.

Both of these technologies can be applied to a building. Large solar PV farms help supply the electricity grid with renewably generated electricity!

HEAT PUMPS

Air source heat pumps (ASHPs) absorb heat from the outside air to heat the building and provide hot water. They can still extract heat when air temperatures are as low as -15°C. Ground Source Heat pumps extract heat from the ground to do the same thing and can function at equally low temperatures.

WIND

Large turbines capture the kinetic energy of the wind and turn it into electricity. This is most effective when the electricity is generated at large wind farms and then transported to your building via the electricity grid.

Other sources of renewable energy include tidal/hydro (use of waves, dams, or underwater turbines), geothermal (natural heat from the earth), and biomass (the use of natural materials as a heat source).

Zybnek Burival, 2018

OFFSETTING

Like the 5 Rs for **Waste & Materials**, we should think of offsetting like recycling-a last resort. Offsetting is not a solution!

But, when we have done everything else that we can to reduce our emissions, and we still have leftover emissions or emissions that are out of our control (like the flight your visitors took to get to your institution or the food from your cafeteria), then offsets can help.

Carbon offsets involve paying money to sustainability programs/projects to “offset” the carbon that you are producing. Offsetting does not remove the emissions that you produce and should not replace reduction strategies. For more information about carbon offsetting, check out:

Gallery Climate Coalition

Julie’s Bicycle

Climate Active

Offsetting

Click on the topics to skip ahead!

Calculate Your Emissions

Find Your Impact

Choose a Project or Charity

Invest in Yourself!

Choose an Existing Offset Provider

CALCULATE YOUR EMISSIONS

KI TOOL

The first step to offsetting is to decide how much carbon you are offsetting. To do this, you will need to calculate your emissions and then assign a price per tonne of CO_2. There are many different sources that you can use for calculating your emissions, but here are a few of our favorites:

- **Gallery Climate Coalition**
- **Carbon Fund**
- **Climate Neutral Now**
- **Carbon Footprint**
- **Julie's Bicycle**
- **Climate Partner**

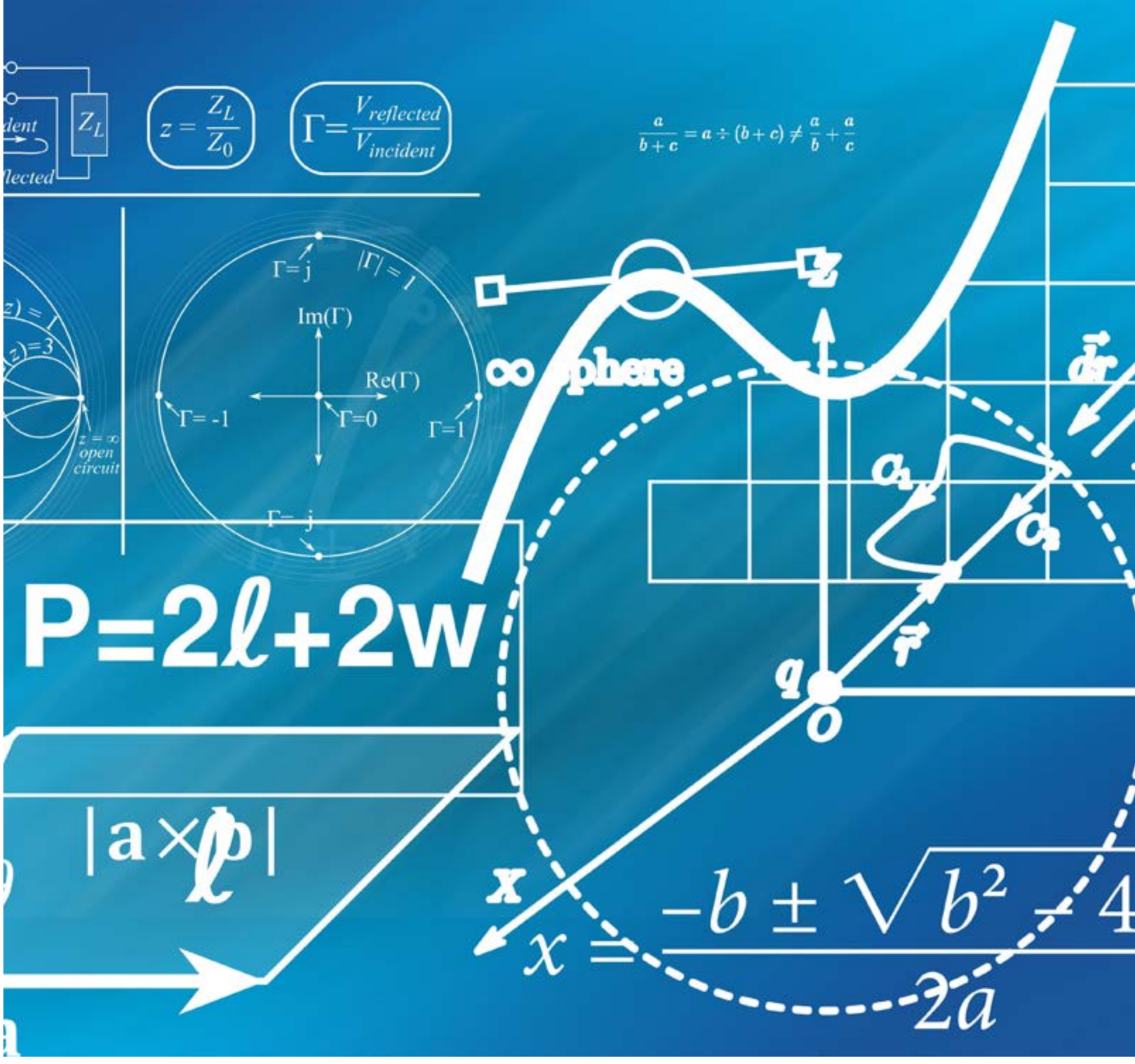


Photo by Gerd Altmann, 2015,

FIND YOUR IMPACT

After you know how much to offset, you need to pick an option for where you want to put your money. You have to be careful though! It can be very confusing to know which programs are effective and which ones are greenwashing. Some offsetting schemes are for-profit and take 20% off the top. Also, prices can vary depending on where you are located globally, so be aware of how much you are paying and what the actual impact is.

You have three options for “offsetting” and investing in a greener future.

- **Donate to a charity** or project that isn’t an offsetting scheme but has great environmental impact
- **Reinvest** the money into your own sustainability projects
- **Offsetting schemes** (vetted and certified)

We like to advocate for investing in projects and in our own futures, which is why we have put offsetting schemes in last.

KI TIP

Check out our PR and Engagement Guide in the Ki Toolkit to see how to effectively publicize your offsetting!

Photo by Gerd Altmann from Pixabay, 2017

CHOOSE A PROJECT OR CHARITY

Offsetting does not have to be done through an offsetting company. And there are many amazing charities and projects that have even greater impact than straight offsetting companies.

CarbonLock is an amazing company deleting CO_2 emission allowances so that large emissions companies (cannot use them and) are forced to become low carbon. The more allowances they delete, the more impact they have. Use your offsetting funds to become their partner and lower CO_2 emissions in Europe!

Art to Acres is an incredible program in the cultural sector that works with artists to purchase and conserve at-risk landscapes acre by acre. And fortunately for us, they have an amazing initiative to help individual actors and institutions participate as well. Visit thier site to select an acre of land and conserve it!

CarbonLock

Art to Acres

Photo by Christo Anestev , 2018

INVEST IN YOURSELF

Invest in yourself! Reuse funds for your own sustainability initiatives.

Looking at the **energy hierarchy**, the first step to going green is to reduce your energy consumption. So, if you can use the money from your offsets to reduce your own emissions, we call that a win-win!

If you do choose to use your offsetting money into something a little closer to home, then reinvest those funds specifically for improving your own carbon footprint. Investing in some of the larger actions here (like upgrades and retrofits) are great ways to have a larger impact in reducing your own carbon footprint and therefore reducing carbon emissions.

Photo by Jeremy Lapak, 2018

CHOOSE AN EXISTING OFFSET PROVIDER

There are a ton of offsetting organizations and companies to choose from, so it can be overwhelming to know who is credible. Always make sure to check if the organization has been certified or rated. If you do decide to go with an offsetting scheme, check out this article; “Offsetting carbon emissions: It has proved a minefield”, to help navigate the world of offsetting and this webinar from Julie’s Bicycle “Putting a price on carbon”.

Offsetting Carbon emissions: It has proved a minefield

Putting a price on Carbon

WHAT OUR COLLEAGUES USE!

Some programs our colleagues support include:

Climate Neutral Now

Carbon Fund

Client Earth

Gold Standard Foundation

Orange Renewable

Aboriginal Carbon Foundation

Greenfleet

Renewable Choice Green-e® Energy RECs

Smithsonian Tropical Research Institute’s Carbon Offsetting Program

WHAT'S NEXT?

Thank you for joining us in making culture sustainable! We hope that you found the first edition of the **Energy Ki Book** helpful! We will continue to update this Ki Book with new ideas, information, and all the latest information so you can always be up to date and discover new actions to take!

If you are interested in finding out more ways you can improve your sustainable practices, check out our **Waste and Material** and **Social Sustainability** Ki Books!

And if you are looking for additional support, tools and resources, as well as a global network, take another step forward in your sustainability journey by joining our **Ki Futures** Program!

GLOSSARY

Baseline: Your baseline is, in simple terms, the amount of energy you are using. Also called your energy use intensity (EUI), this can be calculated by dividing your energy use by the square footage of your building. Your baseline can be used to benchmark—compare the efficiency of your building to that of previous years or to those of similar buildings.[43]

Benchmarking: Benchmarking is comparing one's performance with a standard point of reference for measurement. The resulting benchmark then represented a defined level of performance which can be used as a reference for comparison. Benchmarks can be based on averages – or percentiles – of real performance, and is often based on policy-driven objectives such as 'net zero carbon' (the idea of reducing one's carbon footprint to a cumulative zero).[44]

British thermal unit (Btu): The Btu is the standard unit of measurement for heat. A Btu is defined as the amount of energy needed to raise the temperature of one pound of water one degree Fahrenheit.[45]

Carbon budget: This term refers to three concepts in the literature (1) an assessment of carbon cycle sources and sinks on a global level, through the synthesis of evidence for fossil fuel and cement emissions, land-use change emissions, ocean and land CO2 sinks, and the resulting atmospheric CO2 growth rate. This is referred to as the global carbon budget; (2) the estimated cumulative amount of global carbon dioxide emissions that that is estimated to limit global surface temperature to a given level above a reference period, taking into account global surface temperature contributions of other GHGs and climate forcers; (3) the distribution of the carbon budget defined under (2) to the regional, national, or sub-national level based on considerations of equity, costs or efficiency. See also Remaining carbon budget.[46]

Carbon dioxide (CO2): A naturally occurring gas, CO2 is also a by-product of burning fossil fuels (such as oil, gas and coal), of burning biomass, of land-use changes (LUC) and of industrial processes (e.g., cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the Earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a global warming potential (GWP) of 1. See also Greenhouse gas (GHG).[46]

Carbon Footprint (2): A carbon footprint is the total amount of greenhouse gases produced to support human activities, both directly and indirectly. It can be attributed to an individual, organisation, country, etc. and is usually expressed in equivalent tons of carbon dioxide (CO2). Activities like driving, heating, and food production have associated CO2 emissions. The carbon footprint is then the sum of all of these emissions that were induced by activities within a given timeframe (usually a year).[44]

Carbon intensity: The amount of emissions of carbon dioxide (CO2) released per unit of other variables.[46]

Carbon neutrality: See Net zero CO2 emissions.[46]

Carbon sequestration: The process of storing carbon in a carbon pool. See also Blue carbon, Carbon dioxide capture and storage (CCS), Uptake and Sink.[46]

Carbon Target: A carbon target is a defined value used as a quantitative goal for a company's carbon footprint or net carbon emissions (footprint minus any carbon offset activities) to meet within a given timeframe. These targets can be absolute, or based on a comparison with industry averages.[44]

Climate: Climate In a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. Climate change Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.' The UNFCCC thus makes a distinction between climate change attributable to human

activities altering the atmospheric composition and climate variability attributable to natural causes. See also Climate variability, Global warming, Ocean acidification (OA) and Detection and attribution.[46]

Climate justice: Justice that links development and human rights to achieve a human centred approach to addressing climate change, safeguarding the rights of the most vulnerable people and sharing the burdens and benefits of climate change and its impacts equitably and fairly. This definition builds upon the one used by the Mary Robinson Foundation – Climate Justice (MRFCJ, 2018).[46]

Compact Fluorescent Lamp (CFL): A device that emits light due to electronic excitation of mercury atoms within a lamp. The mercury atoms lose their excitation energy by emitting an ultraviolet photon, which is converted to visible light in the fluorescent coating of the bulb. CFLs are much more efficient in converting electrical energy to light energy than incandescent bulbs.[47]

Decarbonization: The process by which countries, individuals or other entities aim to achieve zero fossil carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry and transport.[46]

Energy: The capacity for doing work; usable power (as heat or electricity); the resources for producing such power.[47]

Energy efficiency: The ratio of output or useful energy or energy services or other useful physical outputs obtained from a system, conversion process, transmission or storage activity to the input of energy (measured as kWh kWh-1, tonnes kWh-1 or any other physical measure of useful output like tonne-km transported). Energy efficiency is often described by energy intensity. In economics, energy intensity describes the ratio of economic output to energy input. Most commonly energy efficiency is measured as input energy over a physical or economic unit, i.e., kWh USD-1 (energy intensity), kWh tonne-1. For buildings, it is often measured as kWh m-2, and for vehicles as km liter-1 or liter km-1. Very often in policy 'energy efficiency' is intended as the measures to reduce energy demand through technological options such as insulating buildings, more efficient appliances, efficient lighting, efficient vehicles, etc.[46]

EUI—Energy use intensity: EUI expresses a building's energy use as a function of its size or other characteristics.[48]

Fossil fuels: Carbon-based fuels from fossil hydrocarbon deposits, including coal, oil, and natural gas.[46]

Global warming: The estimated increase in global mean surface temperature (GMST) averaged over a 30-year period, or the 30-year period centered on a particular year or decade, expressed relative to pre-industrial levels unless otherwise specified. For 30-year periods that span past and future years, the current multi-decadal warming trend is assumed to continue. See also Climate change and Climate variability.[46]

Greenhouse gas (GHG): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and 1 Past IPCC reports, reflecting the literature, have used a variety of approximately equivalent metrics of GMST change. Glossary Annex I AI 551 ozone (O3) are the primary GHGs in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHGs in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Beside CO2, N2O and CH4, the Kyoto Protocol deals with the GHGs sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). See also Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O) and Ozone (O3).[46]

Greenhouse Gas Emissions: Emissions are gases and other particles that are released into the atmosphere as a result of burning fuels and other processes. Generally, these emissions are most likely to come from cars, power generation and industrial processes. A greenhouse gas, then, is a classification of gases that, when released into the atmosphere, are capable of absorbing infra-red radiation. Consequently, this process will trap and hold heat in the Earth's atmosphere. This is called the greenhouse effect, and ultimately is what leads to global warming. Greenhouse gases include carbon dioxide (CO2), Methane (CH4) and Nitrous Oxide (N2O). So a greenhouse gas emission is when a greenhouse gas is released into the atmosphere.

To learn about the different classifications of greenhouse gas emissions, check out our article on classifying emissions here. [44]

Greenhouse Gas Protocol: The Greenhouse Gas (GHG) Protocol is a global standard, developed by the World Resources Institute (WRI), that informs companies and organisations on how to measure, manage and report greenhouse gas emissions. [44]

Grid: The network connecting electricity producers to consumers. The boundaries of the grid can be drawn differently but may include electricity generators, high power transmission wires, lower power distribution wires, and end users such as homes and businesses as well as the regulatory and market structures that impact electricity transactions. The grid is a physical infrastructure transmitting electricity and is also an economic entity that responds to supply and demand communicated through prices. [47]

Heating, ventilation, and air conditioning (HVAC): Heating, ventilation and air conditioning technology is used to control temperature and humidity in an

indoor environment, be it in buildings or in vehicles, providing thermal comfort and healthy air quality to the occupants. HVAC systems can be designed for an isolated space, an individual building or a distributed heating and cooling network within a building structure or a district heating system. The latter provides economies of scale and also scope for integration with solar heat, natural seasonal cooling/ heating etc.[46]

Industrial revolution: A period of rapid industrial growth with far reaching social and economic consequences, beginning in Britain during the second half of the 18th century and spreading to Europe and later to other countries, including the United States. The invention of the steam engine was an important trigger of this development. The industrial revolution marks the beginning of a strong increase in the use of fossil fuels, initially coal, and hence emission of carbon dioxide (CO2). See also Pre-industrial.[47]

Kilowatt Hour (kWh): A unit of measure for energy, typically applied to electricity usage. It is equal to the amount of energy used at a rate of 1000 watts over the course of one hour. One kWh is roughly equal to 3,412 British Thermal Units (Btu).[47]

Life cycle assessment (LCA): Compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product or service throughout its life cycle. This definition builds from ISO (2018). 1Light-Emitting Diode (LED): A device composed of a semiconducting material that emits light upon the application of an electric current. LEDs produce light from electricity more efficiently than either compact fluorescent lights or incandescent lights.[46]

Lumen: A unit of luminous flux represents the amount of light emitted that is visible to the human eye. In the International System of Units, it is the amount of light a one candela source emits over a square radian angle. It is used in measuring and comparing the amount of light visible to the human eye produced by lamps such as light-emitting diodes, compact fluorescent lights, and incandescent bulbs.[47]

Metric Ton: Also referred to as a metric tonne, it is a measurement of mass equal to 1,000 kilograms, or the mass of one cubic meter of water. This is different from the short ton, a unit of measure commonly used in the United States, which is equal to 2,000 lbs.[47]

Mitigation measures: In climate policy, mitigation measures are technologies, processes or practices that contribute to mitigation, for example, renewable energy (RE) technologies, waste minimization processes and public transport commuting practices. See also Mitigation option, and Policies (for climate change mitigation and adaptation).[46]

Monitoring and evaluation (M&E): Monitoring and evaluation refers to mechanisms put in place at national to local scales to respectively monitor and evaluate efforts to reduce greenhouse gas emissions and/ or adapt to the impacts of climate change with the aim of systematically identifying, characterizing and assessing progress over time.[46]

Natural Gas: A gas mixture that occurs naturally in underground deposits. It is composed primarily of methane and may contain other hydrocarbons, carbon dioxide, and hydrogen sulfide. Commonly employed as a fuel for electricity generation, it is also used for space heating, industrial processes, and as a starting material for the manufacture of chemicals and other products.[47]

Net zero CO2 emissions: Net zero carbon dioxide (CO2) emissions are achieved when anthropogenic CO2 emissions are balanced globally by anthropogenic CO2 removals over a specified period. Net zero CO2 emissions are also referred to as carbon neutrality. See also Net zero emissions and Net negative emissions.[46]

Net zero emissions: Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon). See also Net zero CO2 emissions, Negative emissions and Net negative emissions.[46]

Paris Agreement: The Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) was adopted on December 2015 in Paris, France, at the 21st session of the Conference of the Parties (COP) to the UNFCCC. The agreement, adopted by 196 Parties to the UNFCCC, entered into force on 4 November 2016 and as of May 2018 had 195 Signatories and was ratified by 177 Parties. One of the goals of the Paris Agreement is 'Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels', recognising that this would significantly reduce the risks and impacts of climate change. Additionally, the Agreement aims to strengthen the ability of countries to deal with the impacts of climate change. The Paris Agreement is intended to become fully effective in 2020. See also United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Nationally Determined Contributions (NDCs). [46]

Photovoltaic (PV) Cell: Sometimes referred to as a solar cell, a device that utilizes the photoelectric effect to convert incident sunlight directly into electricity. This can be distinguished from solar thermal energy, which is sometimes used to create electricity indirectly. [47]

Public-Private Sector Partnership (PPP): A contractual agreement between a public agency (local, state, or federal) and a private-sector entity to deliver a service or product to the general public. For example, the FutureGen project is a collaboration of the U.S. Department of Energy and members of the coal industry to develop a near-zero emissions coal-fired power plant.[47]

Renewable Energy Resource: An energy source that is naturally replenished. Examples include biomass, wind, geothermal, hydro, and solar energy.[47]

Resilience: The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation. This definition builds from the definition used by Arctic Council (2013). See also Hazard, Risk and Vulnerability.[46]

Risk: The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard, or of adaptation or mitigation responses to such a hazard, on lives, livelihoods, health and well-being, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and the likelihood of its occurrence.[46]

Solar Thermal Generation: Electricity generated from heat produced by solar energy.[47]

Sustainability: A dynamic process that guarantees the persistence of natural and human systems in an equitable manner.[46]

Sustainable development (SD): Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987) and balances social, economic and environmental concerns. See also Sustainable Development Goals (SDGs) and Development pathways (under Pathways).[46]

Sustainable Development Goals (SDGs): The 17 global goals for development for all countries established by the United Nations through a participatory process and elaborated in the 2030 Agenda for Sustainable Development, including ending poverty and hunger; ensuring health and well-being, education, gender equality, clean water and energy, and decent work; building and ensuring resilient and sustainable infrastructure, cities and consumption; reducing inequalities; protecting land and water ecosystems; promoting peace, justice and partnerships; and taking urgent action on climate change. See also Sustainable development (SD).[46]

Wind Farm: A collection of wind turbines used to generate electricity for transmission to and distribution on the electric grid.[47]

REFERENCES

Journey 1

[1] Lee, Joyce (2017). ENERGY STAR Score for Museums: You can manage what you measure. The Green Building Information Gateway; http://insight.gbig.org/energy-star-score-for-museums-you-can-manage-what-you-measure/.

[2] Plenderleith, Harold J., Philippot, Paul (1960). Climatologie et conservation dans les musées (Climatology and conservation in museums). Museum, vol. 13, n. 4, p. 202-289.

[3] Thomson, Garry (ed.) (1967). Contributions to the London Conference on Museum Climatology 18–23 September 1967. London: International Institute for Conservation of Historic and Artistic Works.

[4] Thomson, Garry (1978). The museum environment. London: Butterworths.

[5] Dardes, Kathleen, Staniforth, Sarah (2015). Preventive Conservation—Sustainable Stewardship of Collections. The Getty Conservation Institute; https://www.getty.edu/conservation/publications_resources/newsletters/30_2/preventive_conservation.html.

[6] Boersma, Oekje, Dardes, Kathleen, Druzik, James (2014). Precaution, Proof, and Pragmatism—Evolving Perspectives on the Museum Environment. The Getty Conservation Institute; http://www.getty.edu/conservation/publications_resources/newsletters/29_2/evolving_perspectives.html.

[7] American Institute of Conservation (2020). Environmental Guidelines—Museum climate in a changing world. AIC Wiki; https://www.conservation-wiki.com/wiki/Environmental_Guidelines.

[8] Sharpe, Emily (2020). Getty Conservation Institute helps museums rethink stringent guidelines on conservation. The Art Newspaper; https://www.theartnewspaper.com/news/getty-conservation-environment-museums

Journey 2

[9] U.S. Department of Energy, website. Energy Efficient Computers, Home Office Equipment, and Electronics; https://www.energy.gov/energysaver/appliances-and-electronics/energy-efficient-computers-home-office-equipment-and (accessed 2020).

[10] Harvard University, website. Reduce Monitor Brightness to Reduce Energy; https://green.harvard.edu/tools-resources/green-tip/reduce-monitor-brightness-reduce-energy (accessed 2020).

[11] Carbon Trust, poster. A photocopier left on standby overnight wastes enough energy to make 30 cups of tea; https://emis.nri.org/attachments/article/11/CarbonTrustPosterPhotocopier.pdf (accessed 2020).

[12] Aparicio, Selene (2014). Shut the Fridge Door — You're Wasting Electricity, Good Housekeeping; https://www.goodhousekeeping.com/home/a19095/refrigerator-door-wastes-energy/

[13] University of Cambridge, website. Facts and figures—lightning; https://www.environment.admin.cam.ac.uk/facts-figures#lighting. (accessed 2020).

[14] University of Cambridge, website. Facts and figures—energy; https://www.environment.admin.cam.ac.uk/facts-figures#energy (accessed 2020).

[15] University of Cambridge, website. Facts and figures—energy; https://www.environment.admin.cam.ac.uk/facts-figures#energy (accessed 2020).

[16] Mumme, Sven (n.d.). Building Envelope. U.S. Department of Energy; https://www.energy.gov/eere/buildings/building-envelope (accessed 2020).

[17] Pearce, Fred (2018). Energy Hogs: Can World's Huge Data Centers Be Made More Efficient?. Yale Environment 360; https://e360.yale.edu/features/energy-hogs-can-huge-data-centers-be-made-more-efficient.

[18] Mightybytes, online brochure. Sustainable Web Design—Resources for building a cleaner, greener internet; https://sustainablewebdesign.org/ (accessed 2020).

[19] Scouler, Caoilainn (2019). How to Reduce Your Internet Carbon Footprint. Ethical.net; https://ethical.net/technology/how-to-reduce-your-internet-carbon-footprint/ .

[20] Borchardt, John k. (2009). Achieving Laboratory Energy Efficiency. Lab Manager; https://www.labmanager.com/business-management/achieving-laboratory-energy-efficiency-20515.

[21] Harvard University, website. The Green Labs Program works with researchers, staff, faculty, and building managers to implement sustainable practices and technologies in lab buildings; https://green.harvard.edu/programs/green-labs (accessed 2020)

...No numbering? All nr. 13? More than one references for one sentence or paragraph should not be under one number, rather like this 1, 2, 3, 4, 5, 6

[22] University of Cambridge, website (2019). Green Labs; https://www.environment.admin.cam.ac.uk/green-labs (accessed 2020).

[23] University of Virginia, website. Green Labs; https://sustainability.virginia.edu/programs/green-labs (accessed 2020).

[24] Princeton University, website. Greening Up The Lab: Sustainable Research Practices; https://ehs.princeton.edu/news/greening-the-lab-sustainable-research; https://ehs.mit.edu/lab-research-program/sustainable-labs/ (accessed 2020).

[25]. https://ehs.mit.edu/lab-research-program/sustainable-labs/

[26] University of Bristol, website. Sustainable Science and Green Labs; http://www.bristol.ac.uk/green/get-involved/green-labs/ (accessed 2020).

[27] Howes, Martin, Farley, Martin (2019). Green Labs – Lab Energy 2019 (slides), University of Cambridge; https://www.environment.admin.cam.ac.uk/files/20190222_green_labs_lab_energy_handout_mh.pdf.

[28]. The University of Queensland—The Sustainability Office (n.d.). Green Lab – Best Practice Guide; https://sustainability.uq.edu.au/files/5115/GLBestPracGde.pdf.

[29] Harvard University, website. Fume hoods are one of the most energy intensive types of equipment in a laboratory environment, but significant savings can be achieved by keeping them closed when not in use; https://green.harvard.edu/programs/green-labs/shut-sash-program (accessed 2020).

[30] Alliance for Water Efficiency, home water works – website. Water and Energy Relationship; https://www.home-water-works.org/energy-water (accessed 2020).

[31] Clark, Edwin H. (2007). Plan B Updates. Earth Policy Institute; http://www.earth-policy.org/plan_b_updates/2007/update64.

[32] U.S. Department of Energy, website. Reduce Hot Water Use for Energy Savings; https://www.energy.gov/energysaver/water-heating/reduce-hot-water-use-energy-savings (accessed 2020).

[33] Alliance for Water Efficiency, home water works – website. Water and Energy Relationship; https://www.home-water-works.org/energy-water (accessed 2020).

[34] U.S. Department of Energy, website. Reduce Hot Water Use for Energy Savings; https://www.energy.gov/energysaver/water-heating/reduce-hot-water-use-energy-savings (accessed 2020).

[35] Water Innovations Inc. (n.d.), Operating Cost for WDI Deionized Water System; http://waterinnovations.net/wp-content/uploads/WDI-Ion-Exchange-System_Operating-Cost.pdf (accessed 2020).

[36] The Water Geeks, website. How to Make Distilled Water at Home; https://thewatergeeks.com/how-to-distill-water/ (accessed 2020).

Journey 3

[37] Lee, Joyce (2020). Earth Day during COVID-19: Green Tips for Closed Museums, The American Alliance of Museums; https://www.aam-us.org/2020/04/22/earth-day-during-covid-19-green-tips-for-closed-museums/ .

[38] Richardson, Erin, Worts, Douglas (2018). The True Costs of Collecting – Museums, Climate, and Carbon. Coalition of Museums for Climate Justice; https://coalitionofmuseumsforclimatejustice.wordpress.com/2018/01/31/the-true-costs-of-collecting-museums-climate-and-carbon/ .

[39] University of Cambridge, website. Facts and figures—energy; https://www.environment.admin.cam.ac.uk/facts-figures#energy (accessed 2020).

[40] United Nations (2015). Paris Agreement; https://treaties.un.org/doc/Treaties/2016/02/20160215%2006-03%20PM/Ch_XXVII-7-d.pdf.
United Nations, website. The Paris Agreement; https://www.un.org/en/climatechange/paris-agreement (accessed 2020).

[41] Murray, James (2020). Which countries have legally-binding net zero emissions targets?. NS Energy; https://www.nsenergybusiness.com/news/countries-net-zero-emissions/# .

[42] World Green Building Council (n.d.). Advancing net zero by planning for the removal of offsets; https://www.worldgbc.org/sites/default/files/Advancing%20net%20zero%20by%20planning%20for%20the%20removal%20of%20offsets_FINAL.docx%20%282%29.pdf.

Glossary

[43] California Energy Commission, website. Building Energy Benchmarking Program Frequently Asked Questions; https://www.energy.ca.gov/programs-and-topics/programs/building-energy-benchmarking-program/building-energy-benchmarking (accessed 2020).

[44] Richardson, Will (2017). A Beginner's Glossary to Carbon Benchmarking. Compare your footprint – Blog; https://compareyourfootprint.com/beginners-glossary-carbon-benchmarking/.

[45] California Energy Commission, website. Glossary of LNG-Related Terms & Definitions; https://ww2.energy.ca.gov/lng/glossary.html (accessed 2020).

[46]IPCC (2018). Annex I: Glossary, [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

[47] The National Academy of Sciences, website. Glossary; http://needtoknow.nas.edu/energy/glossary/ (accessed 2020).

[48] Energy Star, website. What is energy use intensity (EUI)? https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/what-energy (accessed 2020).