EXAMINING THE CONCEPT OF SUSTAINABILITY IN TOURISM

PASSPORT TO SUSTAINABILITY

AN INTRODUCTION TO SUSTAINABILITY

PASSPORT TO SUSTAINABILITY

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PASSPORT TO SUSTAINABILITY

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INTRODUCTION TO SUSTAINABILITY

The GTTP's introductory course, *Passport To The World*, examines the activities involved in planning and completing a trip in order to understand how the Travel & Tourism industry is structured, how and why people travel, and how destinations, cultures, and careers differ.

Typically, all travelers do the following:

Select a Destination;
Use Transportation;
Use Accommodation;
Eat Food;
and Engage in Activities.
Passport to Sustainability **follows that format.**

Passport to Sustainability examines the concept of Sustainability in the following 5 units:

- **Unit 1: For Destinations;**
- **Unit 2: For several forms of Transportation**
- **Unit 3: At small, medium-sized and big companies that provide Accommodation**
- **Unit 4: For various Food sources and also at Sanitation, since you cannot have one without the other**
- **Unit 5: Entertainment and Activities with a Sustainability theme for travellers looking for something out of the ordinary.**

The focus in Units 1 to 5 is on what is working, or could work — plus some question marks.

The 3 Pillars of Sustainability:
A more sustainable planet rests on three "pillars."

- The Ecological Pillar: the world is our home
- The Social Pillar: we are members of communities
- The Economic Pillar: we work to have a good life

Sustainability is activity "that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Source: World Commission on Environment and Development.

Does this sound familiar? Owners of forests should plant, manage and then harvest timber they want "to the greatest possible extent, but still in a way that future generations will have at least as much benefit as the living generation."

—George Hartig, German forestry expert, in the year 1804.

UNIT 1: SELECT DESTINATIONS

OUTCOMES:

You will understand that Sustainability rests on "three pillars:" ecological sustainability, social sustainability, and economic sustainability.

You will understand how and why some destinations that are attracting many visitors are also being destroyed. Managing these destinations in a sustainable way requires choices be made. Those choices are discussed here. Some are successful; some are still a work in progress.

Sustainability as an idea is typically described today as resting on "three pillars:" ecological, social and economic sustainability.

To illustrate the concept of sustainability, this Unit first considers an example that includes all three pillars. It starts with the Ecology pillar: saving a species facing extinction. In this case, Mountain Gorillas.

But the current story of the Mountain Gorillas also includes the Social Pillar, because of all the people, and organizations involved in saving the Mountain Gorillas.

Last, but certainly not least, the story includes the Economic Pillar: these gorillas are now too valuable to kill.

How did that happen?

And what dangers remain?

About Mountain Gorillas:

This video on YouTube is amazing, **youtube.com/watch?v=x2H7zcqjplc%5D**. It is called "Touched By A Wild Mountain Gorilla." In the video John J. King II, a nature photographer and conservationist, is sitting quietly resting in what we learn later is a remote and mountainous jungle setting.

Suddenly a family of wild Mountain Gorillas appears: three babies, a female and a large "silverback" as adult male Mountain Gorillas are called. Two of the kids are curious and start touching King and sniffing him.

King stays very still, head down, avoiding any chance of movement or eye contact that might be interpreted by the silverback as a threat. Instead the silverback lets the kids explore King. The silverback is watchful. After a few minutes he leads the group away. King has a huge smile on his face.

Mountain Gorillas are listed as "critically endangered." The fact that King could interact with these primates reflects the successful efforts of many people and organizations in one area shared by three countries to create conditions so these primates can survive and start to thrive again.

About Mountain Gorillas:

These primates share about 97 percent of our DNA. They are similar to us in many other ways. They catch the same ailments we do: colds, measles, stomach upsets and many others. They see optical illusions the same way we do. They are sociable, get used to human visitors, and live in family groups. They hum and sing.

There are not many Mountain Gorillas, maybe 900 or so in 2015. Most of them live in the Virunga Conservation Area, which is made up of three national parks that share the Virunga Mountains Massif. The area touches Rwanda, Uganda and the Democratic Republic of Congo. Some Mountain Gorilla families are found also in Uganda's Bwindi and Mgahinga parks.

Hard Work:

There is nothing easy about working with Mountain Gorillas. Even counting them is a major project. In 2010 it took six teams of 72 people each from the three countries, who walked walked more than 1,000 kilometers or 600 miles across mountains and through jungle. They counted 786 gorillas.

"This population has made an absolutely remarkable recovery from the approximately 250 individuals that existed only three decades ago," said Dr. Augustin Basabose of the International Gorilla Conservation Program in 2010.

Their numbers had been falling at an unsustainable rate; that is, these gorillas could have become extinct by the end of the 20th century if the death rate had continued.

The causes included war, habitat destruction, disease and deliberate killing. They are still at risk.

Nevertheless the Mountain Gorillas survive, and their numbers are starting to increase.

Why?

How It Is Being Done:

Many national and international conservation groups, researchers and individuals played — and continue to play — a part.

So have governments and dedicated Park Rangers, 200 of whom so far have been killed by poachers.

A researcher, Dian Fossey, focused world-wide attention on the Mountain Gorillas. Her book, "Gorillas In The Mist" was a best-seller and was made into a movie.

But there is another reason, and it is an important one: Mountain Gorillas have become an important source of foreign currency to the countries in which they live. People from around the world want to visit them. The gorillas, financially, are worth protecting.

"Gorilla visits are a high-revenue, low-impact tourism, as small groups paying relatively large sums visit the gorillas," the tourism director at Virunga National Park in the Democratic Republic of the Congo, told the National Geographic Magazine.

Tourist development organizations are not the only ones that think the gorillas are important. An armed militia called M-23 certainly thought so.

Attacks in 2012 by M-23 shut down the Park's two-year old eco-tourism program worth about US$1 million a year in fees. The rebels then started their own moneymaking program, offering treks to visit gorilla families at reduced fees. They wanted the fees to pay for weapons. And the tourists came, paying US$350 each, ignoring the fact that 140,000 refugees had fled the area and its dangers.

The Congolese park is no longer in rebel hands and the former eco-tourism program has resumed.

Visiting the Mountain Gorilla Families of Rwanda:

Rwanda is a country a little smaller than Belgium. Its Parc National des Volcans (Volcanoes National Park) was home in 2015 to 302 gorillas living in 20 families.

Researchers concentrate on studying 13 families. Visits by tourists are restricted to the remaining 7 families.

They live in on the slopes of the mountains of the Parc, the entrance of which is just two hours or so on excellent roads from the international airport in Kigali. There are nice hotels near the park entrance, and less expensive places for backpackers.

If you were foreign tourist in 2017 you paid a US$750 fee to enter the park, where guides will lead your group to where trackers have located one of the families. Your group is limited to eight people, and your permit is good for one person for one day. "Viewing time" is limited to one hour.

In 2018 the fee was doubled to US$1500.

Since the gorillas can catch human diseases, spitting is forbidden; if you cough, cover your mouth and turn away from the gorillas; do not go nearer than 7 meters (about 22 feet); do not litter, and so on. You can use your camera, but don't use flash.

Of that fee, 10% goes to build schools, clinics and other community projects, according to the government.

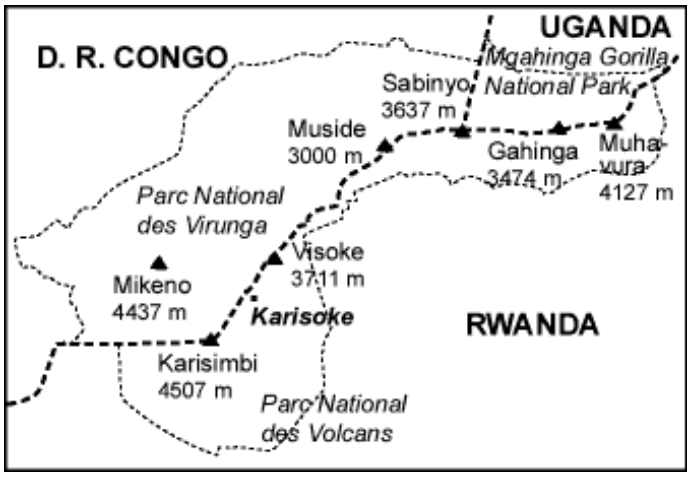


Image courtesy of NASA

An Unlikely Success Story So Far:

In some ways, the Rwanda's Parc des Volcans is an unlikely success story.

In 1990 the country collapsed into civil war for three years, during which the Parc became a battleground. In 1994 the country endured 100 days of massacre during which between 500,000 and 1 million people were killed. But only one gorilla died.

A generation later the Parc is attracting 20,000 visitors a year.

However it does have competitors.

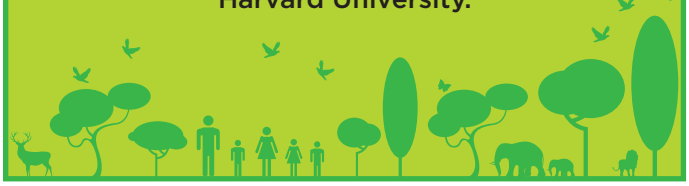
Uganda offers $600 permits and the same level of access to the Mountain Gorillas at Bwindi Impenetrable Park and Mgahinga Gorilla National Park

The Democratic Republic of Congo's Virunga National Park has now reopened. The days when a former director of the park was accused of ordering the killing of all the gorillas — all of them — in the Park are an old but painful memory. He wanted to clear the way for the people who make charcoal, a US$35 million a year business.

And a word here also for ecotourism and profits ...

"Ecotourism is a pipe dream unless it can deliver profits, not massive profits, but profits to small and micro enterprises that need to be connected to either global or regional supply chains."

—Megan Eppler Wood, Director, International Sustainable Tourism Initiative, Harvard University.



A Belgian nobleman, Emmanuel de Mérode, was appointed chief warden to lead the park in 2008. Dr. Mérode's work to protect, stabilize and improve the park nevertheless led to an assassination attempt in 2014 that left him severely wounded. He was not alone. In the previous 10 years 140 wardens were killed, and since his appointment 34 more.

Nevertheless, tourists are returning to Virunga.

"Gorilla ecotourism is and will always be fragile," says Prof. Craig Stanford of the University of Southern California in one of his blogs. He is also Director of the Jane Goodall Research Center at the university.

"Years of careful planning can be ruined by a single criminal act, or by the outbreak of another civil war. For local people, the disruption of tourism means a halt in essential income. But despite all the setbacks and challenges, it has been a savior for at least this one very endangered cousin of our species."

Meanwhile Rwanda's Parc des Volcans prospers.

The doubling of the price of the permit to US$1,500 to visit the gorillas was matched with an increase from 5 percent to 10 percent in the amount going to local communities. The first luxury hotel in the area, Virunga Lodge, has been joined by another, Bisate Lodge, owned by Wilderness Safaris. The company bought the site of the Lodge from 103 people in the local Bisate community for US$500,000. Some 250 people from the area built the Lodge and its six villas. About 50 Rwandans are on the permanent staff, half of them from the village. Cost to stay there, per night, per person, in 2018 is US$1,470 to US$1,555.

"We want to be prosperous," the president told the crowd. " Rwandans were not created to be eternally poor."

But Do Not Forget The Other Gorillas:

This is not such a happy story.

The "Other Gorillas" are the Eastern and Western Lowland Gorillas.

The Western branch is estimated to number about 125,000, according to the Wildlife Conservation Society. Counting them is difficult because they live mostly in dense, isolated tropical forests in western African countries. Now loggers are destroying where they live. Logging roads make it easier for commercial hunters to enter forests to kill them for their meat. The roads also make it easier for farmers to enter, clear land and plant crops to feed their families. The Ebola disease kills them. In 2007 the International Union for Conservation of Nature (IUCN) moved the western lowland gorillas from "endangered" status to "critically endangered" status.

They do have friends.

They need many more

CONCLUSION:

The story of the Mountain Gorillas is essentially one of hope, tenacity, and making the right decisions.

It also demonstrates:

1. Individuals can make a difference. Conservation groups that do not receive taxpayer funding rely on individual contributions from people in many countries.

2. Visitors can make a difference. (A US $1500 fee is a lot of money.)

3. Economics are important: the gorillas are worth more alive than dead.

4. Local communities benefit from the work the 3 park areas do.

5. Telling a good story helps (also known as Marketing).

Rescuing the places you love from their popularity:

Why is this important?

Some destinations are attracting so many visitors that they are being destroyed.

Managing these destinations in a sustainable way requires choices be made. Those choices are discussed here. Some are successful; some are still a work in progress.

Italy's Sistine Chapel:

Why is the Sistine Chapel important?

Consider this image of Italy's Sistine Chapel. Located in the Vatican, the Chapel is home to Michelangelo's frescoes, painted 500 years ago. The frescoes are world-famous art. They are part of our heritage as human beings.

The Chapel is not a museum. Religious services are held here. It is also in this room the leaders of the Roman Catholic Church gather from around the world to elect a pope.

If you visit, you will be sharing a space that measures about 40 meters long by 13 meters wide and 21 meters high (or about 132 feet by 40 feet by 68 feet). Spend the day here in the busy summer season, and you could see some 22,000 visitors passing through in front of you.

In 2014 about 6 million people came from all over the world to admire the frescoes. You can see from the image that it is a very crowded space.

What you do not see are all the invisible things you and everyone else brings in with them.

A lot of warm bodies doing nothing but breathing and sweating in an enclosed space can have a startling impact on temperature and humidity, which are two important

Reminder:
The 3 Pillars of Sustainability:

- The Ecological Pillar
- The Social Pillar
- The Economic Pillar

enemies of the paintings. Typically we exhale 400ml a day of water, or 13.5 ounces, as well as damaging carbon dioxide. Then there is the cloud of about 1 million bacteria we individually expel every hour from our skin, mouth, nose, eyes and ears. Our skin also sheds flakes, creating dust. Our clothes and shoes bring in dust.

The daily impact of as many as 22,000 people was causing damage to Michelangelo's frescoes and other works of art. If not stopped, the ongoing damage was unsustainable: grime and humidity are fresco killers. Tomorrow's visitors would not enjoy what today's visitors see.

One solution is to limit access.

"We all would like the Sistine Chapel miraculously empty … but we live in the democracy of consumption," said Antonio Paolucci, who is in charge of the Vatican Museums, in 2014

Instead in 2010 the Vatican turned — again — to technology to halt the damage

"Nuovo Respiro Nuovo Luce":

Back in 1993 an American air conditioning company installed equipment to deal with temperature and humidity. It was designed to handle 700 visitors at any one time.

Today's 6 million annual visitors is three times more than the annual numbers back then. Not surprisingly, the 1993 equipment was overwhelmed. And the lightning was out of date.

The Vatican calls the rescue project "Nuovo Respiro, Nuovo Luce" or "New Breath, New Light."

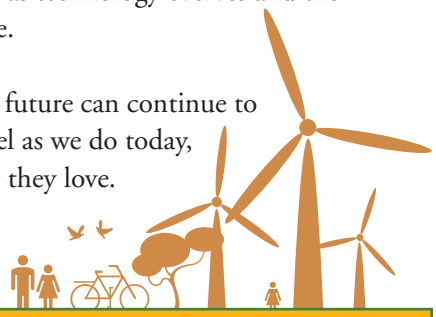
New equipment designed and installed in 2014 relies on computer simulations and modeling of the complex patterns created by the airflow in the Chapel. Computerized controls linked to two video cameras anticipate visitor numbers and adjust system performance intuitively.

The newly designed system adjusts air flow, humidity and temperature and operates improved filtration equipment to deal with the dust brought in by people and the carbon dioxide they breathe out.

The air conditioning company donated its services, as did the company that removed the lighting system and replaced it with more than 7,000 light-emitting diodes to improve the Chapel's lighting, protect the frescoes and use 90 percent less electricity.

The improvements have been made in such a way that they can be improved as technology evolves and the Chapel's needs change.

A lot of people in the future can continue to love the Sistine Chapel as we do today, and not damage what they love.



CONCLUSION:

1. Technology can sometimes come to the rescue.

2. Smart, dedicated people make a difference. Smart people with Vatican Technical Services and the air conditioning company made "Nuovo Respiro" happen. Smart people at the lighting firm, and universities in Hungary and Spain made "Nuovo Luce" happen.

3. It helps to have a back-up plan. In the case of the Sistine Chapel, if the crowds lining up grow too big the authorities can limit how many they allow in

And then there is Bonito in Brazil, which has its own solution, although it may not work for other places

Bonito, a small city in the State of Mato Grosso do Sul:

Why is it important?

This is about an area that has avoided the problems of overcrowding by taking action before the problems arrived. It required economic common sense and positive politics.

Bonito is a small town of about 20,000 people. It is in a remote farming area in Brazil. It is also an area of remarkable geology that has made possible a series of crystal clear rivers, springs, lakes, and natural swimming pools, as well as waterfalls, rapids and caverns. They are beautiful. People come here to swim, snorkel, paddle board, and kayak. Lots of people.

You can easily imagine all these beautiful places swamped with humanity. They are not. How Bonito and the landowners of these beautiful places have avoided this seemingly inevitable fate may have lessons for other places.

What the Bonito area has done is limit access to the "attractions", which are outside the city. Some are many kilometers away.

Land owners and the local government agreed on how many people per hour they will allow to have access without overcrowding, and agreed to coordinate timetables, reservations, and fees.

How it works:

For example, the clear waters of the Rio da Prata make it a popular destination for visitors who want to float down the river on rubber tubes. Groups of 8 people plus a trained guide can enter the river every 20 minutes, for a total of 120 people at any one time.

Visits to the attractions are organized as tours. There are several dozen tour options available, depending on what visitors want to do and where they want to go, and when. Visitors buy tickets called "vouchers" in advance from local travel agencies.

Anybody can visit the town of Bonito. However if you want to explore its attractions located on private land, you need a voucher.

Overtourism

Overcrowding even has its own word now: "overtourism," not to be confused with the concept of "undertourism" which refers to less-visited destinations trying to attract more visitors.

The overwhelming crowds you find in the Sistine Chapel are being replicated around the world in museums, small towns, cities, islands, hiking trails, remote national parks, and even around a lone willow tree growing out of New Zealand's lake Wanaka. The tree is beloved by selfie-takers who climb it and are killing it. A lot of people are not happy about that, as you can find out online.

"Overtourism has grown into a major global issue," said Andrew Sheivachman, an editor at Skift, an online travel and tourism industry publication. (**www.skift.com**)

Earlier in Unit 1 we discussed how technology has been used to protect important art in the Sistine Chapel. We also discussed how the Bonito community manages the number of visitors who visit the area's many springs. Small groups are admitted at timed intervals.

A sample of different approaches being tried and what is missing

Communities around the world are trying many different approaches to managing overtourism.

One way to control the impact of people is to keep them out. Thailand banned all visitors to three popular islands because of the damage caused by visitors.

Less extreme are the restrictions on the number of people who can visit places at any one time, as Bonito does: they include the tiny walled sea-side city of Dubrovnik in Croatia, and the Greek island of Santorini. Some state and national parks in the United States require reservations be made before visiting. Peru now limits the amount of time people can explore the Inca ruins of Machu Picchu.

Greece is crowded in the summer months. It is trying to expand its tourist season into spring and autumn months as a way of reducing the size of the summer crowds, some of who might enjoy the cooler weather.

An important issue for some communities is how overtourism is affecting housing, especially long-term rentals. Many owners or renters who have permission from their landlords, use online services like Airbnb and Bookings.com to offer their spare rooms or entire homes as short-term holiday rentals. Some people have multiple properties they rent to visitors.

And some favorite destinations are trying a little bit of everything.

Amsterdam

Amsterdam and its 165 canals are home to about 900,000 people. Its charms attract about 17 million visitors a year, up from 12 million in 2011.
They range from visitors coming on business to people who want to explore Amsterdam to bachelor parties looking for a cheap and rowdy weekend.

To improve city life for both residents and visitors Amsterdam is using a variety of tools, ranging from applied technology, to the law, and taxes that could add noticeably to the cost of a low-budget holiday.

If you are wondering how long the lines are at the Van Gogh Museum you can watch live-streaming video showing the lines at popular attractions and make your plans accordingly.

Or you can use an app called "Discover the city" which will let you know when an attraction is very busy and then suggest alternatives.

The city has now banned "beer-bicycles" These are four-wheeled vehicles with bicycle seats on each side of a bar table, with each seat equipped with a set of pedals. Customers peddle to propel the bike around the city

center while they drink. Judges agreed with the city that problems caused by the beer bikes included customers shouting, public drunkenness, and urinating in public. Amsterdam wants to encourage a different kind of tourist.

The city now prohibits new shops and businesses in the 17th century Centre district that sell mostly or exclusively to tourists. These range from bike rental companies to souvenir shops. These businesses have grown in number in recent years, converting streets that used to serve the needs of both residents and visitors into "tourist streets."

Following a court ruling, Amsterdam is reducing the supply of short-term vacation rentals. Starting in 2019 Amsterdam will limit to 30 days per year the number of days that people can rent out their homes. In 2018 the number is 60 days. A maximum of 4 people can occupy these holiday rentals. Taxes on accommodation have also been increased. There are licensing requirements. Approvals for new hotels in the city center have been put on hold.

What is missing:

Surprisingly, there is an absence of comprehensive research or analysis about overtourism.

"To date, little has been done to systematically understand and address it," notes "Coping with Success: Managing Overcrowding in Tourism Destinations," a research study by the World Travel & Tourism Council (WTTC), an industry group, and McKinsey & Company, a global management consulting firm.

The reason? "Overcrowding is not exactly alike in any two destinations." Plus, "Not everyone will agree when popularity tips into overcrowding."

"The goal of our work is to bring structure and facts to an issue that has long been characterized by anecdotes and emotion."

You can review the complete study by going to **www.wttc.org** then clicking on "reports." There is also a shorter executive summary. If you want to get a sense of just how complicated this topic is, start with the three paragraphs that make up page 5 of the complete study. Also useful is the six-page list of written sources used in researching the study that comes after page 55.

The WTTC/McKinsey study:

The study examines "five types of problems associated with tourist overcrowding: alienated local residents, a degraded tourist experience, overloaded infrastructure, damage to nature, and threats to culture and heritage."

The study then goes on to create "a diagnostic based on simple, widely available indicators, including tourist arrivals, social media reviews, seasonality and pollution." These are designed to provide a context when discussing the needs of a particular destination.

You can review the diagnostic being applied to four different destinations if you go to page 24 of the full report.

Overtourism is easier to avoid than repair:

"Good tourism management practices and stringent planning are key to the sustainable development of tourism," the study's researchers believe, and they offer the following four suggestions.

1. **Build a comprehensive information base** and update it regularly.
2. **Conduct rigorous, long-term planning** that encourages sustainable growth.
3. **Involve all sections of society –** business, public and social.
4. **Find innovative new sources of money** to pay for any needed local improvements.

A few practical ideas:

Here are actions some communities are taking to manage overcrowding.

1. Smooth visitors over time. Many destinations suffer from imbalances of visitors during certain seasons, days of the week, and times of day, as well as during headline events. Destinations must develop tactics to "smooth" these imbalances so communities and businesses can continue to reap the benefits of tourism

2. Spread visitors across sites. Spreading visitors geographically can help distribute tourists more evenly across residential and under-visited areas and thwart bottlenecks in overcrowded locations.

3. Adjust pricing to balance supply and demand. Pricing can be an effective way to better align demand with supply. But while increasing the costs of visiting a destination or site is likely to limit the number of visitors, it also raises considerations of elitism and the ability of domestic tourists to access their own heritage.

4. Regulate accommodation supply. Some destinations place direct controls on the supply of tourism accommodation—including beds in both hotels and short-term rentals.

5. Limit access and activities. When overcrowding reaches a critical stage, the tactics above may not be enough to mitigate or recover from it. As such, some destinations are limiting or even banning certain tourist activities.

Source: "Coping with Success: Managing Overcrowding in Tourism Destinations," World Travel & Tourism Council (WTTC) and McKinsey & Company.

FAST FACT:

"The top 20 countries account for almost two-thirds of all arrivals. By 2020, the top 20 most popular destinations will add more visitors than the rest of the world combined."

Source: Euromonitor International in "Coping with Success."

UNIT 2:
USE TRANSPORT

OUTCOMES:

You will understand "Carbon Foot Printing" and why it is Important. Harmful gases are released into the atmosphere as part of our daily activities, including transportation. "Carbon Foot Printing" is a way to try and estimate how much has been released.

You will understand how different forms of transportation have different footprints and why it is difficult to make assumptions about which forms of transportation are more sustainable than others.

Welcome To The World Of "Carbon Footprinting":

Why is Carbon Foot Printing Important?

Harmful gases are released into the atmosphere as part of our daily activities. "Carbon Foot Printing" is a way to try and estimate how much. And why is that important? It helps us make more efficient in what we do. Transportation is one of those activities.

Reminder:
The 3 Pillars of Sustainability:

- **The Ecological Pillar**
- **The Social Pillar**
- **The Economic Pillar**

Unit 3 focuses on The Ecological and The Economic Pillars

Here is a counter-intuitive question: does a bicycle always get better mileage than a H2 Hummer, the civilian version of the military Hummvee or Landrover Discovery? Not always. (This is a trick question based on the researches of the U.K.'s Mike Berners-Lee.)

Suppose you are going to snack on a steady diet of new springtime asparagus to fuel your body during your bike ride. It is no contest: bike fueled by asparagus beats Hummer or Discovery fueled by gasoline, and is much kinder to the atmosphere and the air we breathe.

However, maybe it's early winter where you are. But in Peru it is early spring and the new young asparagus are delicious. Many people half a world away where it is winter are willing to pay for out-of-season asparagus. So of course asparagus are shipped in airplanes to those places where people want asparagus

If you are thinking of fueling your bike ride with Peruvian spring asparagus, get that Hummer or Landrover instead: its gets better mileage than the bike powered by asparagus.

Mike Berners-Lee.

Berners-Lee's curiosity touches things as small as the carbon footprint of a text message and as big as the carbon footprint of the 2010 South Africa World Cup. His books include "How Bad Are Bananas? The Carbon Footprint Of Everything."

The trick in the question is how you define "better mileage." Here "better mileage" is measured in terms of a your bike or Hummer's "carbon footprint." There are 3 more trick questions in this section of Unit 3. They are there to encourage you to ask questions when you encounter new concepts and new statistics for the first time.

A 250-gram package of asparagus, according to Berners-Lee, has a 125-gram carbon footprint while it is waiting to be bought by that bicyclist. Those 125 grams come from the carbon-based products used to grow the asparagus.

Fly that package to New York the footprint grows to 1.9 kilograms. Fly it to London, and the footprint is even bigger: 3.5 kg. The reason is obvious: planes use a lot of carbon-derived fuel.

Berners-Lee explores just how many harmful gases — and in what quantities — are released into the atmosphere as part of our daily lives. The gases are mostly derived from carbon. They include carbon dioxide created by burning carbon-based fuels such as coal, oil and wood. There also are other gases, which he includes in his measurements. They are harmful because they help trap heat in our atmosphere and are blamed for changes in our planet's climate. They are known as "greenhouse gases."

"Normal daily lives" includes buying food to eat, using electricity, and using that bike just mentioned. These activities are linked to burning carbon-based fuels, and therefore are responsible for pumping carbon dioxide into the atmosphere. How much carbon dioxide each activity is responsible for is called its "carbon footprint".

A Carbon Footprint Has Many Layers:

But you need to be careful when researching carbon footprints as part of the Passport To Sustainability course. It is not an exact label. Some things are so complicated to measure or even define that a so-called "definitive" number is often just an estimate. It may be an informed estimate, but it is still an estimate.

For example, consider trying to define the carbon footprint of a car that is powered by both a battery and a gasoline engine. It may be manufactured in Japan from steel, aluminum, plastic, rubber, glass and paint, all of which have their own carbon footprints. It is then transported to Brazil in a ship which has its own carbon footprint, powered by fuel which has its own carbon footprint. The car when it arrives is powered by gasoline made from petroleum, as well as ethanol made from sugar cane. It uses electricity made by oil, natural gas, coal and nuclear fuel, all of which have their own individual footprints. The car also produces electricity.

In some ways, looking at an item or activities in terms of their carbon footprint is a little like looking at a photo in color that before you had only seen in black and white. Suddenly a lot more information and meaning is in front of you. You see things differently, and maybe will act differently.

Go By Plane, By Car, By Ship, Bus or Train?

When experts talk about sustainability in transportation, they usually consider both the carbon footprint and fuel efficiency.

There are many, many statistics used to measure fuel efficiency. Here are some of them:

- **p-km** is "passenger-kilometer." If a bicycle/car/train/plane carries one person a distance of 100 km it is said to deliver 100 p-km of transportation. If the vehicle carries 4 people the same distance, it delivers 400 p-km of transportation.
- **kWh per 100 p-km** is "kilowatt hour per 100 passenger kilometers."

Here is another trick question: will you get better mileage if you go by car or go by plane?

Professor Michael Sivak of the University of Michigan's Transportation Research Institute has explored the numbers: you will get better mileage by flying unless your car gets better than 44.7 mpg or 71.9 liters per kilometer, depending on how many people are in your car or in your airplane.

The trick here of course is, once again in how you define "better mileage."

Professor Sivak examines how many BTU's are consumed when driving or flying. He starts with "BTU per person mile," that is how many BTUs are needed to transport one person one mile.

BTU, Calorie, and Joule

BTU, also written "Btu" is the abbreviation for "British Thermal Unit" and is a unit of measurement for measuring energy content. It is defined as the amount of energy needed to raise the temperature of one pound of water at 39.2 degrees Fahrenheit by one degree Fahrenheit.

The metric equivalent uses calories: A calorie is the amount of energy needed to raise 1 gram of water 1 degree Centigrade. To slightly confuse matters, the term "small calories" is used in measuring energy values in food.

In the newer SI-system ("System International d'Unites" agreed to in 1960) 4.184 joule of heat energy raises 1 gram of water from 0C to 1C.

BTU and Btu are used in English-speaking countries that have not adopted the metric system and also in English-speaking countries that have adopted that system, including Britain and Canada. It is used widely as a unit of measurement for natural gas prices, as in "CN$3.00 mm/Btu" or CN$3.00 per million Btu. There are about 1,034 Btu in 1 cubic-foot of natural gas. The unit also remains useful internationally when describing refrigerators, hot water furnaces and air conditioning units.

FAST FACT:

How much is a kilowatt-hour?

Approximately the electricity used if you leave a 40-watt light bulb on for one day.

Source: the late Prof. David MacKay, Cambridge University, UK

The quickest way to improve the statistics for cars is to add passengers and drive farther. Even after allowing for the added weight, BTUs per passenger mile improve. The same applies to aircraft, trains and of course buses.

Some people make the point that it doesn't matter how many people you cram into a car or plane and improve the per person statistics: both dump a lot of carbon gasses into the air. More cars and more planes mean more carbon in the air. Nevertheless using per person or per kilometer statistics make the numbers more manageable. There is an old saying that "if you can count it, you can measure it, and if you can measure it, you can improve it."

And here is another trick question:

If you buy a Hyundai i20 in Europe is it the same Hyundai i20 you get in India?

According to the ICCT (The International Council on Clean Transportation) the answer is no.

The i20 you buy in India emits four-and-half times more particulate matter and over double the amount of nitrogen oxide than the same model made for Europe.

This is not a criticism of the i20 but rather an example that different countries have established different environmental standards for cars and for many other things.

Going By Plane:

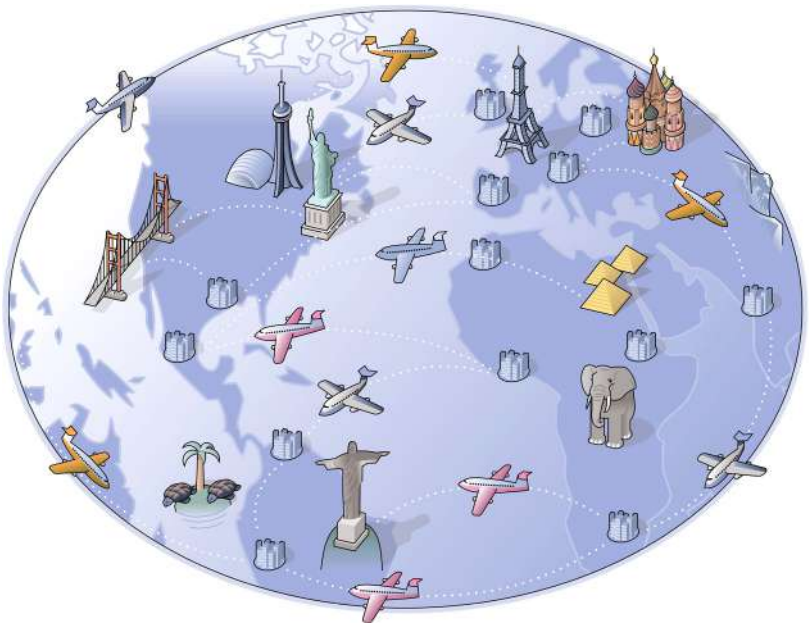
Obviously there are many places you can't drive to or go to by train.

Fly from London to New York City and back again and your flight will add to the atmosphere about 1.5 metric tons of emissions per passenger.

That would be the equivalent, per passenger, of burning not quite 1/3 of a 12-meter tall sycamore with 52 cm diameter trunk, if your jet could burn wood for fuel.

You could also count total emissions on that return London-New York flight. For a typical older 248-seat passenger plane, total emissions from jet fuel would be 372 tons, or the equivalent of burning about 75 sycamores, including their roots. (See how the UK's Ecometrica calculated the carbon content of that sycamore. Go to **ecometrica.com/blog** then enter "Ecometrica Explains the One Tonne Carbon Tree" in the search box.)

The good news (the bad news comes later) is that airplane manufacturers have been steadily improving their aircraft with new engines and bodies made of lighter materials.



The improvements translate into less fuel used, which saves both money and the environment. Fuel is one of the airline industry's biggest expenses. Being able to use less fuel reduces the carbon footprint of individual aircraft.

According to the International Air Transport Association, new aircraft are 70 percent more fuel efficient than 40 years ago, and 20 percent better than 10 years ago. "Each kilogram of fuel saved reduces carbon dioxide (CO2) emissions by 3.16 kilograms," says IATA.

That is good news because there are a lot more aircraft flying today. More people fly today, and the numbers are getting bigger. In 2017 4,100,000,000 are expected to have travelled by air. However there is a big "But" here. The reason there are going to be a lot more planes in the air is because a lot more people want to travel.

If the Boeing Air Craft Company is correct, the number of commercial airplanes in service will more than double in the next 15 years. In 1980, there were just 5,600 western-built commercial jets in service. In 2014 there were about 21,600. Boeing expects that to grow to 43,560, with 4 out 10 planes being bought by airlines in the Asia Pacific region.

The bad news for people who fly is that planes are likely to remain crowded.

Carbon Reporting in Travel and Tourism.

By some estimates the Travel and Tourism industry contributes about 5 percent of the green house gases entering our atmosphere. In August 2016 Researchers at Griffith University and Amadeus IT Group published a 49-page "White Paper" or concise guide to carbon reporting practices by different sectors of the industry. It includes four pages of reference sources, many of them online. It is well-worth reading and can be found at:

www.griffith.edu.au/business-government/griffith-institute-tourism/research/sustainable-tourism-and-climate-change/sustainable-tourism-research-projects

Griffith is a research university in Australia and Amadeus provides Information technology services to all segments of the industry worldwide.

"Greenhouse Gases" and our "Carbon Footprint":

Greenhouses gases are gases, natural and man-made, that help trap heat in our planet's atmosphere. Greenhouse gases are called greenhouse gases because they help trap heat in our atmosphere, in the same way that a greenhouse traps heat so the plants inside can grow when it's cold outside. About three-quarters of greenhouse gases come from fuels that started out as forms of carbon, such as coal, oil and natural gas, and wood. The most common green house gas is carbon dioxide. Its chemical name is CO2.

How To Track Airplanes In The Air

Do you want to know how many planes are flying over your city/country/continent/world right now as you are reading this? Click on www.flightradar24.com

What does "Carbon Dioxide Equivalent" mean?

"Carbon Dioxide Equivalent" or CO2e is a way to compare one "greenhouse gas" to another by using a common unit of measurement.

Carbon dioxide is the "reference gas" against which other greenhouse gases as measured.

Carbon dioxide (CO2) is an abundant naturally occurring gas. It is also created when fuels such as wood and charcoal are burned, and fossil fuels such as coal and oil are burnt.

Other greenhouse gases that trap heat in the atmosphere include:

- Methane (CH4), released by farms if many animals are present. It is about 25 times more effective at trapping heat in the atmosphere than CO2.
- Nitrous oxide (N2O) is about 300 times more effective at trapping heat.
- Fluorinated gases from liquids used for cooling and industrial processes are many thousands of times more effective at trapping heat than than CO2.

To simplify their work researchers describe greenhouse gas quantities in terms of "CO2 equivalents." The objective is to avoid repeating quantities labeled CO2, CH4, N2O, and so on without any context to suggest how significant those quantities are.

Going By Ship:

This is the *Christophe Colomb*. It carries steel containers filled with cargo, the equivalent of 13,300 twenty-foot boxes, stacked high both inside the ship and on top of its decks.

Owned by the French company CMA CGM, the *Christophe Colomb* also carries 10 passengers from China to Europe in 27 days, with brief intermediate stops along the way. Then it makes the return voyage.

Big container ships burn highly polluting heavy oil in their engines. However whether you measure how many tons per mile they carry, or how many kilograms per kilometer, modern giant cargo ship are the most environmentally effective tool for moving around the planet the things the world makes, from shoes to laptops to bananas. Container ships carry about 95 percent of all those things.

Colomb the container ship is more interesting than *Colomb* the passenger boat.

Travelling on a big container ship is a way to experience an important chapter in the history of the world. Container ships and the equivalent of 140 million twenty-foot boxes that they carry are one of the major re-shapers of how and where we make things, according to Marc Levinson, an economist who has studied in detail the impact of that humble metal box.

" The container is at the core of a highly automated system for moving goods from anywhere, to anywhere, with a minimum of cost and complication on the way," writes Levinson, author of the surprise best-seller about containers called, of course, "The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger." The containers are locked, which prevents theft, and carry bar-codes, so they can be tracked

"The container made shipping cheap, and by doing so changed the shape of the world economy," he writes.

How cheap is cheap?

Frederick W. Smith, who started FedEx Corp., a company that delivers parcels around the world, estimates that the price of shipping a pound of product in a container today is now 1/500th of what it was in the early 1960s.

Many of the things we use — clothes or shoes, for example — now can be made anywhere, and then used somewhere else. "The ready availability of inexpensive imported consumer goods has boosted living standards around the world," says Levinson.

Not everyone wins:

"Poor countries, desperate to climb the rungs of the ladder of economic development, could realistically dream of becoming suppliers to wealthy countries far away," says Levinson.

However, new jobs created in some parts of our planet have also resulted in the destruction of jobs in other parts of the planet. Better times for some people, worse times for others.

And then there is the question of the damage to the environment that accompanied the improvement of the living standards of so many millions of people.

It is not easy to make people's lives easier and also manage economic growth.

Containers and Economic Sustainability:

Containers, which helped radically reshape the world economy, have their own sustainability challenges. National economies expand and contract, expand and contract. When they contract, fewer things are made that need to be shipped in containers. That means ship owners have to compete harder for business. One way they do is by lowering the prices they charge to transport goods. When they cannot charge enough to cover their costs their business becomes unsustainable. They then go out of business.

In recent years shipping companies such as TMT Group, Nautilus Holdings Ltd, Genco Shipping & Trading Ltd, Overseas Shipholding Group Inc. and Excel Maritime Carrier Ltd have gone bankrupt.

FAST FACT:

Container ships can carry 20-foot long standard containers or 40-foot long standard containers, and sometimes they carry a mix of the two. In order to describe in a consistent way the cargo capacity of a ship, the industry uses a unit based on the smaller container: the TEU or "Twenty Foot Equivalent Unit." One FEU (Forty-foot-Equivalent Unit) is equivalent to two TEUs.

Going by Train or Bus:

It is should be clear by now that a vehicle carrying a lot of people is more efficient than a vehicle carrying just a few people. Trains and buses are efficient, and in many cases more convenient than airplanes for short trips in crowded countries. Unit 3 leaves the discussion about Transportation with this Fast Fact:

FAST FACT:

A train can move a ton of freight over 480 miles (772.4kilometers) on a single gallon (3.78 liters) of fuel.

Source: CSX Corporation

The Jevons Paradox:

When you think about sustainable transportation, it is wise to keep in mind the "Jevons Paradox". Read the following sentence – how can it be be both right and wrong?

"Improving liters-per-kilometer or miles-per-gallon is a great idea because it means we won't use so much gasoline."

Avoiding or reducing waste is a great idea, because we will save money when we drive to the gasoline station and fill the tank. Improved fuel economy helps reduce our carbon footprint. In Europe and anywhere where gasoline taxes are high, every saving helps.

However is unlikely that total gasoline consumption will decline. Cars that are cheaper to operate because they are more fuel-efficient will attract more people who want the convenience of a car.

The Paradox is named after an English economist, William Stanley Jevons. In his 1865 book "The Coal Question" he showed that how improvements in coal-powered steam engine technology led to steam engines that used less coal. However more coal was used, not less.

Why?

Because better or less expensive steam engines led to many more steam engines being used to power trains, ships, factories, coal mines, which meant more coal was used.

For 19th century steam engines substitute not just 21st century automobiles, but modern refrigeration technology. One example: air conditioners, which not only cool but also remove humidity. They use less energy than they did a generation ago, are more affordable to operate, and cheaper to buy. So people buy them when they can afford to. China and India are big markets for air conditioners, not to mention Africa and the Americas.

But cooling people in hot climates is only part of the story. Refrigeration is used to keep fish, meat and vegetables fresh in trucks, cargo ships, warehouses and stores. Hospitals, research labs, computer facilities and factories depend on refrigeration, and so do offices. Heating accounts for about 20 percent of all power usage. Cooling could soon overtake that number.

In short, there is no simple answer to the question of sustainable travel. Every solution has a potential pitfall. Reduce BTU consumption by cars and more people can afford to drive cars; reduce carbon emissions by planes and more planes get built to accommodate an increasing number of travelers. You get the idea.

FAST FACT:

700 million A/C Window Units Are Coming...

The Lawrence Berkeley National Laboratory in the U.S. estimated in 2016 that 700 million new air conditioners will be installed around the world by 2030. Improvements in energy use and coolant continue to be made. A 30 percent improvement could offset the construction of 1,550 power plants designed to handle peak demand for electricity, according to the Laboratory.

FAST FACT:

Cold Weather Bigger Killer Than Hot Weather

Cold weather kills 20 times more people than hot weather. Researchers at the London School of Hygiene and Tropical Medicine analysed 74 million deaths in 384 locations in 13 countries to arrive at that number in 2015.

UNIT 3:
USE ACCOMMODATION

OUTCOMES:

You will learn the techniques used to achieve sustainability by different sized properties.

You will understand why improving sustainability can be complicated.

Achieving Sustainability and Scale:

Why is this important?
The techniques used to manage small lodges in a sustainable way are not necessarily limited to tiny properties. Bigger properties can use them also, and do, although the overall impacts on their neighborhoods are much larger because of their larger size. And sometimes improving sustainability can be complicated.

Reminder:
The 3 Pillars of Sustainability:

- The Ecological Pillar
- The Social Pillar
- The Economic Pillar

Unit 3 touches on all 3 Pillars

Tales of plastic bottles, the 6:00 a.m. speedboat to Tefé, and 1 million hotel rooms:

At a guess, older hotels have to retrofit their operations to improve their carbon footprint. They range from a small resort in Montana, U.S.A. to giant resort hotels.

It is not always easy, and here is where the tale of the plastic bottles comes in.

Chico Hot Springs Resort and Day Spa, in Pray, Montana, (**chicohotsprings.com**) opened in 1900. It has grown over the past century to the point that today guests can choose to sleep in rooms, chalets, ordinary cabins, or rustic cabins.

General Manager Colin Davis and his staff started a project to see how they could improve the way they managed their recyclable waste plastics, starting with plastic bottles.

That seemed simple enough.

But first it also seemed a good idea to investigate just what happened to those bottles.

Their first discovery? Nothing is simple.

The Chico staff reported that the bottles were transported by truck to a recycling plant 46 miles away (74 km) to be crushed. They were then sent 678 miles (1,091 km) to the port city of Seattle and then shipped about 5,600 nautical miles (10,403 km) to China. There the plastic was processed and sent back to the U.S. in the form of fleece clothing.

The solution? The Resort decided to switch their vending machines from selling drinks in plastic bottles to selling drinks in aluminum cans, which can be recycled without sending them across the Pacific Ocean.

And Now An Example Of Small-Scale Sustainability:

Uakari Lodge in Brazil embraces all the familiar pillars of sustainability, starting with minimal environmental or ecological impact. The water for your shower comes from collected rainwater. Solar power heats the water, and powers the lights (there also is a backup generator).

The social and economic pillars are also in place: area residents are the managers and staff. Education courses for staff include instruction in basic accounting, English, customer service, sustainable agriculture, first aid, and waste management. The food is grown locally.

The Lodge itself consists of five floating cottages, each with two bedrooms and two bathrooms. There is a central floating area with a deck, kitchen, restaurant, bar, video room and library.

The Lodge needs to float because it is in a protected flooded forest, part of the Mamirauá Reserve. Every year between May and October the waters of this part of the Amazon Basin rise and fall between 10 to 12 meters, or 30 and 36 feet. If you want to experience the special world that is the Amazon, this is the place to start from.

To get to the Lodge you can take the 6:00 a.m. speedboat that operates Monday through Saturday, from Manaus in Brazil's Amazonas Province. Between 12 and 14 hours later you arrive in Tefé. Or you can fly in from Manaus in about an hour.

You still have another hour by speedboat to get to the Lodge, which is on a tributary of the River Solimoes.

In addition to its adherence to the three main sustainability concepts, two other things make Uakari Lodge special — its location and its remoteness. In order to survive, the Lodge has to be sustainable.

Although Uakari Lodge is small, far away, and has to be self-contained, its approach to the 3 Pillars of Sustainability will be familiar to many hotel operators of medium or big properties.

A Medium-Sized Resort: Paying Attention To Detail

The Tryall Club on Jamaica's North Coast operates 90 villas spread across 2,200 acres overlooking the Caribbean Sea. These acres over the past 400 years are a monument to human adaptation: they have been the site of a fort; a sugar plantation; a coconut plantation that produced one million coconuts a year. Today it is a resort, complete with a golf course and beach. Tryall did not have a forest like Uakari, but it did, however, establish a forested reserve of 523 acres or (212 hectares).

Tryall's other environmental pillar efforts include:

- **Installation of solar power systems,** a heat recovery system, as well as energy saving technology including LED lighting, energy monitors and control systems. These improvements especially make sense on an island that imports all the fuel used to make electricity.

Social pillar efforts include:

- **Scholarships for local children** to continue their education. The scholarships can take them from elementary school through university to doctoral level studies.
- **The resort and its employees undertake projects** ranging from building housing for the elderly to restoring the local post office to cleanup projects along 20 miles of coast.

Tryall is an important economic pillar of its local community. It employs about 700 people, most of them Jamaican and long service employees.

Courtesy of The Tryall Club

A Big Hotel and Resort Company: The Power Of Big Numbers

Marriott Hotels today have approximately 1 million rooms. (Marriott had approximately 732,000 hotel rooms before acquiring Starwood Hotels and Resorts Worldwide which had 360,000 rooms in 2016.)

That is a lot of rooms, but the hotels themselves range from small boutique establishments to big hotels designed for meetings and conventions.

Marriott and Starwood embrace the same Three Pillars embraced by the Uakari Lodge and Tryall, but on a much bigger scale: the decimal points in its results are in very different places.

Sustainability programs for these big hotels focus on those familiar pillars: Ecological, Social and Economic. The objectives include reducing carbon footprints, reducing energy and water use, education, stopping human trafficking, sustainable seafood, and buying from local suppliers, among others.

Marriott is working to address a set of 17 Sustainable Development Goals (SDGs) set by the UN to end poverty, fight inequality and injustice, and tackle climate change by 2030.

Guests can help. An example is Starwood's "Make a Green Choice" initiative that offers guests the option of declining daily room housekeeping services in return for incentives. It is also a demonstration of the impact a big company can make.

Starwood estimates that in the first three years of the initiative the company conserved 153 million gallons (580,000 cubic meters) of water; 662,000 kilowatts of electricity; 871 therms of natural gas and 190,000 gallons (507 cubic meters) of cleaning supplies.

In 2015 Marriott estimated it reduced energy use by 13.2% vs the 2007 baseline use, water by 10.4% and GHG emissions by 13.2%.

A Product That Disappears Every 24 hours.

A hotel is a tough business to operate. The basic product is a room with a bed and a guest paying money to sleep in that room. The industry calls that money "Revenue Per Available Room." Without a guest in that room every night the hotel has no revenue from it. The room becomes merely an empty space that costs money to maintain.

1 Million Rooms . . . The Hotel Industry Has Its Own Eco-System.

And in many ways it is a delicate system.

The economy can turn bad, guests stay away, and your rooms stay empty. The economy improves, and empty rooms fill up. Weather can have the same impact.

Competitors circle around, trying to fill their own rooms by serenading your potential guests.

Then there are the online reservation services, an important and powerful part of the hotel eco-system, standing between your hotel and your customers.

And now non-hotel people want to re-invent your industry, and they don't even own rooms.

One, Airbnb ("Air Bed and Breakfast") is an online service that offers to link people who need a room with people who have a spare room in their house or apartment and want to make a little money. The owners share the money with Airbnb. The company "has served over 30 million guests since it was founded in 2008," according to Boston University researchers in 2016. The researchers estimate that in one city, Austin, Texas, Airbnb has siphoned off between 8 percent and 10 percent of the money that would otherwise go to the established hotel companies.

But there are defenses. One million Marriott-Starwood rooms create their own eco-system. It may help put competitors, and reservation services, and disruptors like Airbnb at a disadvantage.

Box. U.S. Hotel Green Numbers

A survey of 9,600 U.S. hotels showed:

- **93% had linen and towel reuse programs**
- **29% had energy management sensors**
- **64% had recycling programs**
- **78% used LED lights**
- **77% had water saving program**

However less expensive hotels did poorly in the survey.

Source: The STR research company, quoted in Hotel Management Magazine, November 2015.

CONCLUSION:

Sustainable accommodation is provided by small, medium and very large companies. But many sustainable measure can cost money while others save it.

A big question remains: are customers are willing to pay for sustainability?

For example, an Earth Day 2014 hotels survey by Agoda.com, a big Singapore-based booking site, shows that while most travelers like environmentally friendly hotels, they don't want to pay much more to stay in them. The survey, conducted online in March, 2014, asked 57,000 Agoda.com customers how they felt about environmental efforts by hotels. While 58% of all travelers said they preferred hotels that claimed to be environmentally friendly, only 39% said they would pay an extra $10 or more per night to stay in one that needed to be modified physically to be more environmentally friendly.

Source: **Agoda.com**

It may be that not only do companies have to be willing to aim for sustainability, but travelers must also be willing to be part of the effort.

UNIT 4:
EAT FOOD

OUTCOMES:

You will be aware of a few of the many things that scientists are doing to find replacements for traditional meat supplies. The objective is a meat substitute that causes less damage to the atmosphere, uses less water, and uses less land. Researchers are using animal and plant cells to create new sources of protein they hope people will like to eat.

You will also understand that reducing food loss is another way of increasing food supplies.

You will learn how Ireland encourages sustainable farming as a way of improving agriculture and earning a better living from farms.

AND THERE IS MORE:
Sewage is not a delicate topic but good sanitation is essential to our health.

Assuming that one human being has enough to eat, that human typically produces as body waste 500 liters of urine and 50 liters of feces each year. There are more than 7 billion people on earth and about half have no access or inadequate access to proper sanitation. You will understand some of the things being done to improve that situation.

Sustainable Food Sources: Meat and potatoes and the US $332,000 hamburger

Why is this important?

Of course a US$332,000 hamburger patty is not sustainable. But it is one example of what scientists are doing to find replacements for traditional meat supplies. The objective is a meat substitute that causes less damage to the atmosphere, uses less water, and uses less land. Researchers are using animal and plant cells to create new sources of protein they hope people will like to eat.

The patty was "cultured" — grown — in three months in a lab at Maastricht University in the Netherlands, using muscle cells from two Dutch cows. (See Box: How The Prototype Hamburger Was Made). Cost was US$332,000.

To advertise the technical accomplishment, a celebrity chef cooked the patty in butter and sunflower oil in front of reporters in a BBC TV studio in London.

Reminder:
The 3 Pillars of Sustainability:

- **The Ecological Pillar**
- **The Social Pillar**
- **The Economic Pillar**

Unit 5 focuses on the Ecological Pillar

Inventor Mark Post

"This is meat to me," said a food critic at the event. "The mouthfeel is like meat," said the other food critic there. Neither said it was great. But not bad either, all things considered, was the overall verdict.

That was back in 2013, and the hamburger was a prototype or "proof-of-concept" for tastier meat to come. Since then, its developer, Professor Mark Post has been improving his techniques. He hopes to have it in shops by about 2020. He and his team had the cost per patty down to about $11 in 2015, with more improvements to come.

Post is not alone:

Teams of biochemists, molecular biologists, biophysicists, experts in bioinformatics and other food science specialists around the world are using animal cells to create beef, pork and chicken and other foods. The objective is food that can be produced in huge quantities, at an affordable right price, and tasty enough that people will want to eat them.

Nor are their efforts confined to animal cells.

Researchers are deconstructing plant cells and reassembling them in new combinations to create meat products, with the same texture people want, complete with the blood that people expect in a good hamburger or steak. The "blood," incidentally, is made from plant cells containing the same "heamo" that makes up "haemogloblin" in animal and human blood. Plant-based meats are not plants disguised as meat.

Nor are fish being ignored as a source of manufactured protein.

Cheese and milk products are also on the list.

Driving the investment of time, talent and money in "cultured" meat and other sources of protein is the need to feed more mouths: many, many more mouths.

A bonus in Post's approach is that there are no "genetically modified organisms" (GMOs) involved in his techniques, which are of concern to some people. "The fear about GMOs is that they may potentially produce invasive species through cross-fertilization. This cannot happen with cultured beef," Post told the CNBC television network in the U.S.

Whether people will accept cultured meat is still a question mark.

Dr. Post started a company, MosaMeat BV, to produce his hamburger commercially but it is not in shops yet. It is still a work in progress, and it is not alone.

FAST FACT:

The U.N. estimates that beef, pork and chicken farms use about one-third of the world's grains for feed, and about a quarter of all land for grazing. They are also responsible for about 15 percent of all greenhouse gases created by human activity.

Here are some of the products designed to replace animal-based food that are available or are being developed by startups (newly created companies) with money provided by private investors, governments and large food producers. Investors include some of the biggest meat producers in the world.

- **Complete meals-in-a-bottle** that can be drunk and also dairy substitutes, including milk from a lab rather than a cow.
- **Protein from insects** to make flour. Already found in some shops selling protein bars.
- **Protein created from methane.** Not ready for human consumption yet.
- **Meat created from plants.**
- **Lab-grown meat,** also called "cultured meat" and "clean meat." Dr. Post, mentioned earlier, is a pioneer in this field.
- **Fishless seafood**

The idea of eating a clean meat steak that that requires less water, less cattle feed, a smaller carbon footprint and does not involve inhumane treatment is attractive. But there is an important question to be answered.

How the prototype hamburger was made.

Post's hamburger meat started as stem cells removed from cow muscle tissue. Stem cells are unspecialized cells that are needed to produce specialized cells such as muscles, nerves, skin and all the others that make up our bodies. Then they were placed in nutrients in his lab, where they grew into a million cells which grew into tiny strips of muscles. The strips, each 1-centimeter long and a few millimeters thick, were then laid one on top of eachcother until a patty had been made. Color was added with red beet juice and fat was added for taste.

"Can clean meat scale?" asks CB Insights, a research firm by investors, in a 2017 report titled "Our Meatless Future: How the $90 billion Global Meat Market gets Disrupted."

"Scale" here is another word for "mass-produce something at a price people can afford."

"Though many startups in the (cultured meat) space claim their products will revolutionize meat consumption, the question remains whether clean meat will provide a scalable method to feed the future — or whether it's simply a new wave of molecular gastronomy."

A dissenting voice about cultured beef.

John Vidal, writing in *The Guardian* newspaper in the U.K. after the unveiling of the hamburger manufactured from stem cells in 2013, offers two very different visions of the way ahead for feeding the world. "The laboratory burger served up in London by scientists proposes patented, heavily processed food that has been developed at a phenomenal cost in hi-tech laboratories and is shipped to the world's poorest people to keep them alive. The other proposes that agriculture reconnect itself with small farmers and once again becomes a way for countries to develop and offer better lives for their populations."

Looking for food in all the wrong places south of the Sahara?

- The UN notes that 95% of all research investment over the past 30 has focused on increasing the productivity of farmers south of the Sahara. But only 5% was directed towards reducing food losses.
- However 30 percent of all crops harvested in that region is lost after the harvest. That raises the question: why not invest money in reducing food loss?
- In Uganda, 95% of food losses occur between the time crops are harvested but before they get to people's kitchens.
- By one estimate, food spoiled after it is harvested could feed 48 million people in Africa.
- A big part of the problem? Food storage after the harvest.
- Unsafe storage does not keep out rats, insects, and produces highly poisonous fungi called aflatoxins that can grow in cassava, millet, rice, wheat and many others.
- Other problems include unsustainable pricing: farmers sell their crops as quickly as they can before they go bad, so they do not get the better prices they would have if they had waited.
- Solutions: Better cleaning and drying of crops, then improved storage. Simple heavy-duty storage bags that can be made air-tight so fungi do not grow work well, and are affordable. Bins last longer but cost more. Farmers can hold on to their crops longer until they can get better prices.
- And mobile phones, now common, let them follow crop prices.

Source: Simon J. Costa, UN World Food Program.

Salt Farm Texel:

Meanwhile, some potatoes seem to like salt water…

Why is this important?

Fertile land around the world is going to waste because you cannot grow food on it. Why? It is damaged by salt or salty water. Potatoes that tolerate salt will feed a lot of people.

About a four-hour drive north of Maastricht on the Dutch island of Texel lies Salt Farm Texel. This is where Marc van Rijsselberghe and his colleagues Dr. Arjen de Vos of the Free University of Amsterdam and Robin Konijn have established an outdoor lab.

Their objective is to make more usable about 1.5 billion hectares of land (3.7 billion acres) worldwide that are affected one way or the other by high levels of salt. In addition, about half of the world's water is defined also as "brackish" or salty and not usable to irrigate plants. The lab hopes to change some of that too — and not by removing the salt, which is expensive to do.

Van Rijsselberghe and de Vos are using the open air lab to find out which plants are naturally more salt tolerant, and then develop methods to grow them or increase their yield.

To do so, Salt Farm Texel has 56 plots, each 160 meters square, loaded with pipes and sensors. Fresh water and seawater can be mixed in different strengths and fed to the plant being tested. Levels of salt tolerance can be accurately identified. It is tedious, time consuming work.

After testing thousands of plants, Salt Farm Texel has identified varieties of barley, carrots, onions and cabbage that are more salt-tolerant than previously believed. But the biggest winner so far is a variety of potato that can handle three times more salt than previously thought possible. They don't need fresh water irrigation. Brackish is just fine.

Identifying a hardier potato is just the beginning: next comes adapting local ways of irrigation and drainage to the needs of the salt-resistant plant.

Testing of the potato is underway in Pakistan, where potatoes are popular and there is plenty of salt-damaged land.

But – Salt Farm Texel has a competitor: CRISPR-Cas9

Why is it important?

CRISPR-Cas9 is an acronym for a system that allows you to "edit" the genetic instructions found in the cells that make up humans, animals, insects and plants.

Those instructions determine whether people are born physically strong – or are born with Downs Syndrome. They determine, for example, when wheat sprouts, and whether pigs are susceptible to the virus that causes swine fever.

Unlike what we call GMOs – Genetically Modified Organisms – where new genetic material is inserted into those instructions, CRISPR inserts nothing. It either removes or turns off a part of existing instructions that cause problems in living things. Of course, those instructions also cause wonderful things, like the scent of a rose, or physical beauty in human beings.

Traditional gene modification can take decades. CRISPR eliminates all that. It has been used to create wheat that sprouts early and to breed pigs that are not susceptible to a sub-virus called African swine fever.

Ahead lie efforts to make plants more nutritious or able to tolerate tougher conditions — remember the work being done on Texel to find salt-resistant potatoes. One company has edited the genetic instructions of oilseed rape so that the plant can tolerate herbicides.

The system is simpler than earlier techniques. It is easy, fast, inexpensive, precise, and is radically changing genetic research. The system is still in its early stages of application. The regulations that different countries have written to manage GMOs do not appear to apply to systems likeCrisper-Cas9.

You will be hearing much more about gene editing during your lives.

FAST FACT:

Biggest Beef and Veal Exporters, 2015

- #1 India
- #2 Brazil
- #3 Australia

Green and Sustainable Dairy and Beef Farming: The Irish example:

Why is this important? The Irish example is both about sustainable farming and earning a better living from your farm.

Origin Green, **origingreen.ie**, a 2012 initiative by Bord Bia (the Irish Food Board), is a nation-wide sustainability program that links government, private business and food producers.

This is a voluntary program. It is designed so that Ireland's farmers, food producers — and the businesses that link them to consumers — set and achieve measurable sustainability targets. Results are independently verified.

At the farm level, the Bord Bia has undertaken 137,000 carbon footprint audits across the country. Initial criteria focused first on beef farmers, then on dairy farmers. In 2017 similar criteria will be applied to the lamb, pig, poultry, horticulture and grain sectors of Irish agriculture.

The Origin Green program includes both sustainability and quality assurance segments. Today over 85% of Ireland's 18,000 dairy farmers participate in the quality assurance segment of the program. In addition, 50,000 farmers who account for 90 percent of Ireland's beef exports have been certified that their operations meet quality assurance standards. (**www.bordbia.ie** then click on Origen Green)

Ireland, Sustainability and Patrick Brennan, Farmer.

Here is a glimpse of how an Origin Green dairy farmer, recognized in 2016 by Bord Bia for reducing his farm's carbon foot footprint, operates his farm.

Remember, the technical language and abbreviations used are for readers who are farmers, not students.

Patrick is milking 171 cows on a 73 ha acre grazing block, with a further 24 ha on outside blocks for young stock and silage ground. Over recent years this farm has been converting from tillage as cow numbers have increased, therefore a lot of the ground has been relatively freshly reseeded. An early grass farm, calving starts on January 20th with 79% cows calved within 6 weeks and cows are turned out during the first week of February. Cows are producing 430 kg MS/yr with 500 kg concentrate. At the time of the visit, cows were at 4.45% fat and 3.75% protein. This year Patrick replaced 2 electric water heaters with an external, wall mounted gas water heater which is twice as economical and has hot water available on demand. He also recently installed a GPS system on the tractor and has saved 2 tn fertiliser with more accurate spreading.

Genetically Modified Crops:

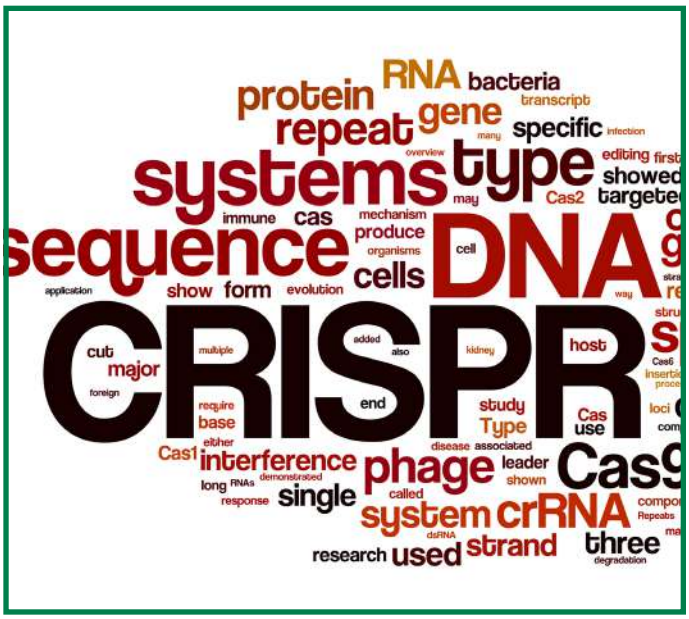
Why are they important?

We modify plants to improve and increase our food supply, and have done so for thousands of years. Modern science has given us new tools to modify in new ways. Whether to use them is the source of many bitter and vocal disagreements. These include whether GM foods are safe to eat, and whether GM crops hurt the environment. Opposing sides both know they are right. Many jurisdictions in Europe ban their use.

Meanwhile one estimate is that 18 million farmers in 28 countries planted GM seeds in 181 million hectares (almost 2 million square kilometers or 700,000 square miles) in 2014. That's more land than all of South Africa and Kenya combined, with a bit left over. It is also more than 100-fold increase since 1996.

Here is how the UN's World Health Organization defines GM foods:
"Genetically modified organisms (GMOs) can be defined as organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination. The technology is often called "modern biotechnology" or "gene technology", sometimes also "recombinant DNA technology" or "genetic engineering". It allows selected individual genes to be transferred from one organism into another, also between nonrelated species. Foods produced from or using GM organisms are often referred to as GM foods."

Are GM foods safe?



This is what the WHO says: "Different GM organisms include different genes inserted in different ways. This means that individual GM foods and their safety should be assessed on a case-by-case basis and that it is not possible to make general statements on the safety of all GM foods."

"GM foods currently available on the international market have passed safety assessments and are not likely to present risks for human health. In addition, no effects on human health have been shown as a result of the consumption of such foods by the general population in the countries where they have been approved."

The WHO has produced a 3,000-word "Frequently Asked Questions" about GM foods. You can find it at:
who.int/foodsafety/areas_work/food-technology/faq-genetically-modified-food/en/

And don't forget your water footprint.

It can take 460 gallons of water to grow the beef needed for a single quarter-pound hamburger (or 1,741 liters of water for 0.113 kilograms of hamburger.)

Why is this important?

It reminds us that farms use water to grow food, factories use water to make things, and of course we use water in our homes.

Water is in short supply in many countries.

"We find that two-thirds of the global population (4.0 billion people) live under conditions of severe water scarcity at least 1 month of the year," two Dutch researchers reported in 2016 in the journal "Science Advances."

They define "severe water scarcity" as periods when areas use double the amount of fresh water usually available from local rivers, lakes, reservoirs, wells and springs.

The researchers, Professor Arjen Y. Hoekstra and Mesfin M. Mekonnen, both of of the University of Twente, reported that earlier studies suggested much lower numbers: 1.7 billion to 3.1 billion people.

Areas affected by water shortages include the Western U.S.A, India, China and countries in Africa.

Reminder:
The 3 Pillars of Sustainability:

- The Ecological Pillar
- The Social Pillar
- The Economic Pillar

This section focuses on the Social Pillar

Humans as food processors:

Why is this important?

Sewage is not a delicate topic. But assuming that one human being has enough to eat, that human typically produces as body waste 500 liters of urine and 50 liters of feces each year. There are more than 7 billion people on earth. Good sanitation is essential to our health.

Here are some important words to know if you are travelling:
WC / water closet / les toilettes / sanitário restroom / gabinetto / conveniences servicios / lavatory / men's room ladies' room.

Sewage systems are important for obvious reasons.

Here is another one: most of us are going to be living in mega-cities like Beijing, China, (21-plus million), São Paulo, Brazil (21-plus million), Lagos, Nigeria (21-plus million), Moscow, Russia (17-plus million).

Our bodies are well-designed machines for receiving and crushing food, then applying chemical digestion to extract the nutrients we need. Stripped of all that is useful, what remains of our nutritional intake continues on its journey, making good sewage treatment oh so very important to our quality of life.

If you had a wonderful, memorable meal while visiting Beijing or Washington D.C. you can relax afterwards and consider one piece of modern technology both cities use: thermal hydrolysis technology developed by a Norwegian company called Cambi AS. The technology is used to process and transform big-city sewage, and it manages to combine good environmental practice and good economics.

Cambi's equipment is used at the ultimate destination of your Beijing meal, the Gaobeiden Wastewater Treatment Plant, Beijing's largest, and the Xiaohongmen WWTP, Beijing's second largest.
It is used in the final resting place of your Washington meal, the Blue Plains Advanced WWTP.

Blue Plains is operated by DC Water, the local water and sewer authority, which is proud of Blue Plains and offers tours of the 64-hectares (157 acres) complex located southwest of the city.

The complex processes the sewage created by 2.2 million residents and 17.8 million annual visitors like you. That is a lot of sewage to process: a daily average of 1.14 million cubic meters (300 million US gallons) of used water and what are delicately termed "biosolids."

Inside the 64-acre site is a 2-hectare (5 acres) area, home of the "thermal hydrolysis," process that enables DC Water to sterilize those solids.

It then uses microbes to digest the solids and create "biogas" — methane gas — to power three turbines the size of jet engines. The turbines generate electricity. DC Water makes enough electricity on-site to supply a third of the electricity needed by the whole plant. The process also reduces smells.

Cambi's thermal hydrolysis process uses heat and pressure to "pressure cook" the biosolids left over after the rest of the Blue Plains plant has treated the sewage delivered to it by DC Water's sewage system.

And here is the clever part:

- The biosolids are pumped into 4 tanks called "pulpers" and heated to 96 degrees Celsius (or 205 degrees Fahrenheit)
- Then the hot biosolids are pumped into four tanks, called "reactors" and heated some more, to 165 degrees Celsius (or 329 degrees Fahrenheit) at a high pressure 5.9 atm (atmospheres) (or 87 psi) for 22 minutes.
- Next is a third set of 4 tanks, called "flash tanks", where the high pressure is suddenly removed, causing the cell walls of the biosolids to explode.
- Waiting for the biosolids and their ruptured cells are 4 airtight "digester tanks," filled with a bacterial mix that will start the natural process called "anaerobic digestion" that creates methane gas. This flammable gas is then piped to the turbines, which continuously generate electricity for use by the entire plant. It is enough electricity to supply about 10,500 Washington-area homes.

Additional benefits of the thermal hydrolysis system:

- Reduces DC Water's electricity bill, which is the biggest in Washington,
- Reduces by half the amount of low-grade sludge that has to be removed by trucks which are expensive to operate,
- Increases the amount of sterilized higher grade sludge that can be used immediately as fertilizer.

DC Water estimates that its overall carbon footprint is now about one-third smaller. Beijing's plants enjoy similar benefits.

But What Happens If You Are Not Near A Sewage System?

If you are very lucky you can, for a small fee, use a "Blue Diversion Toilet," described by its developers as "an attractive grid-free dry diversion toilet, which provides water for flushing, hand washing and personal hygiene."

The goal is to have a system in place so that the toilets are reliable; can be operated in financially sustainable way by many small businesses and families; and are not obnoxious to users.

"We have designed a toilet that works everywhere," says Harold Gründel of EOOS Design GMBH in Vienna, Austria.

Blue Diversion (bluediversiontoilet.com) is a joint project of the Swiss Federal Institute of Aquatic Science and Technology or Eawag in Zurich and EOOS. The toilet functions without being connected to a sewage system, water supply or electrical system.

The toilet recycles and cleans water used for washing, and captures the components of "human byproducts" that are useful and can be sold for fertilizer. The toilet is stocked with 60 liters of water when put in service, and then requires topping up with less than 1 liter a day to replace lost water. Processed waste is removed in sealed "cartridges" and processed at an off-site "Resource Recovery Plant."

The developers say their design offers an opportunity for small businesses to sell and/or operate these toilets.

The developers say their design offers an opportunity for small businesses to sell and/or operate these toilets.

In 2016 small sanitation businesses were projected to be able to "earn back upfront installation fees within one year if they charge 4 cents per toilet visit for each customer," said Blue Diversion. Families would pay US$100 for installation and about US$0.04 per day if 2 families shared a unit.

In 2016 the units were expected to cost U$500 to make and to be sold for US$700 to businesses that would rent them out for US$3.50 per week to small sanitation businesses or to landlords. Payments would be made by mobile phone. Expensive for many people, but the units were designed to be manufactured locally and to cost less than a typical pit latrine to make.

According to the company, "The Blue Diversion toilet exists on prototype level, it is not market-ready yet. We are currently seeking industrial partnersfor manufacturing." (www.bluediversiontoilet.com)

Humans produce by-products, also known as body waste.

One human being produces body by-products that contain proteins, carbohydrates and fats nitrogen, phosphorus, potassium, carbon, and calcium

And one more fact: that same typical human being produces in one year 5.7 kg of biosolids, which includes enough fertilizer to grow 230 kg of cereal, which is enough to feed one human for one year.

Source: Alicia Hope-Herron, "Low-Cost Sanitation: An Overview of Available Methods." 2007, Woodrow Wilson Center For Scholars.

The World's Biggest Museum of Toilets.

Toto Ltd., (wmww.toto.co.jp/company/profile_en/index.htm) the Japanese company that manufactures toilets and other sanitary-ware, opened in 2015 a US$60 million museum in Kitakyushu, Japan, that shows how toilets developed over the centuries. Toto, which celebrates its 100th year in 2017, operates worldwide and employs about 27,000 people. It is the biggest maker of sanitary-ware in the world. The company's website includes instructions on "bathroom etiquette."

Image of Blue Diversion Toilet courtesy of Blue Diversion

CONCLUSION:

1. There are successful Big Projects underway, as the Washington D.C. and Beijing examples show.

2. Not all big population centers can afford Big Projects

3. Small scale efforts are also underway. But the challenge is to develop small-scale facilities that people want to use, and are also affordable.

Too many people without sanitation.

According to the Bill and Melinda Gates Foundation, there 2.5 billion people who have no sanitation facilities at all or very poor ones, and another 2.1 billion who live in urban areas " that use facilities that do not safely dispose of human waste." These include "facilities" that are filled up and then abandoned: a striking example of unsustainability.

8 Billion Reasons To Take Careful Care Of Your Sewer System.

Montreal, Canada, has an old waste treatment system and in late 2015 it could longer defer repairs. But how do you fix something that is in daily use?

The only option, said the city government, was to divert the city's untreated sewage into the St. Lawrence River for a week or so while repairs were made.

Estimated amount of sewage that would flow into the river? About 8 billion liters, or 2.1 billion gallons. Not sustainable!

UNIT 5:
PARTICIPATE IN ENTERTAINMENT & ACTIVITIES

OUTCOMES:

You will see that "entertainment" can take many forms.

Reminder:
The 3 Pillars of Sustainability:

- The Ecological Pillar
- The Social Pillar
- The Economic Pillar

Unit 6 touches on all 3 pillars.

As you know, one focus of Passport To Sustainability is travel. So in this unit we assume that someday you will want to travel to Asia or the Americas, or Africa, Europe or maybe Australia, the Pacific Ocean islands, the South or North Poles.

Depending on where you go, you may have hundreds of choices of entertainments and activities, from A for Abseiling to Z for Zip lines. In most countries you can also find people, companies and governments doing things that touch on The Three Pillars. They offer insights into new ways to improve sustainably how we live and work. They provide glimpses into what the future holds for many people, perhaps including you.

Here are a few suggestions:

1. Affordable Small Solar:
Kenya's M-Kopa Solar: Visiting one version of the future in Kisumu, Kenya.

Which Pillars touched? The Social and the Economic
Why is Affordable Small Solar Important?
Because about 1.2 billion people worldwide do not have electricity. Many can get free or almost-free solar lanterns from various organizations. But how sustainable is free or almost-free?

Now companies like Kenya's M-Kopa are trying another approach.

If you are one of 6 million Kenyans not connected to the national electricity grid and cannot afford a generator then you probably rely on kerosene lamps for light. Kerosene lamps smell, coat your house and your lungs with soot, and cause fires.

They are also expensive to operate, The average daily cost of kerosene, in 2015, was about US$0.75 per day, which is a lot if you are a small-scale farmer living on US$2.00 cash a day plus whatever your farm produces.

Yes, access to the electricity grid — that system of metal cables used to transport and deliver electricity — would be wonderful. However the grid is expensive to build, therefore slow to be built. People need some form of electricity today, not in five, ten or twenty years. M-KOPA, **m-kopa.com** , has bypassed the grid.

What M-Kopa has done is figured out how to replace kerosene lamps in a sustainable way. It sells — not donates or subsidizes — solar kits that can actually do what people need, and to do so for payments of US$0.45 cents a day, which is a lot less than US$0.75 a day for kersosene.

The 2015 kits included two lights complete with cables and switches; a portable and rechargeable flashlight or "torch;" a mobile phone USB charger with five connections, and a rechargeable radio. A 16-inch digital TV was added to the kit in 2016. There is a 2-year warranty on the kit, and a 4-year warranty on the battery. The kits include a battery to store the electricity delivered by the solar panel.

This is how it works.

The customer puts down a deposit of about US$40 for the entire system, then agrees to buy 365 credits for about US$0.45 each. Each daily payment allows the solar kit to deliver electricity for 24 hours. After 365 payments the customer owns the system and pays nothing more for electricity.

Note that mention of "24 hours." The control panel includes a battery to store after the sun goes down the electricity created by the kit's solar panel.

The essential element in M-Kopa's business is Kenya's world-leading ability to transfer cash using their mobile phones. Kenya is a country that entered the telephone age by going straight to mobile phones and bypassing the intermediate step of spending billions on telephone landlines. More than 80 percent of adult Kenyans now have a mobile and a third of the Kenyan economy is managed on mobiles.

M-KOPA uses that mobile phone system to manage its customers' solar kits via "smart meters." Customers pay their US$0.45 using their mobile phones. If cash is tight and they have to miss a daily payment, the electricity is switched off by phone until the payment is resumed. Some 96 per cent of M-Kopa customers complete those 365 payments. M-Kopa sells other equipment as well.

And what about Kisimu?

Kisumu is its port city and home to about 400,000 people. It is a center for business and education. If you visit Lake Victoria, consider spending a little time getting to know the M-KOPA Service Center directly opposite the Kamas Petrol Station in the Kisumu Central district. The service center shares quarters with a farm supplies store and is handy for the Kibuye Bus Station and the Kibuye Market. It is one of four M-KOPA service centers in the city. There are other M-Kopa service all over Kenya.

For a closer look at how Kenya transformed its financial system with mobile phones, go to **gttp.org/students**, click on "Students", then click on "Research Award Winners 2014" and scroll down to "Case Study Winner 2014: Kenya."Click on the pdf to see the excellent study by Derrick Rambeka and John Mark Rajwayi of St. Anthony's Boys High School, Kitale.

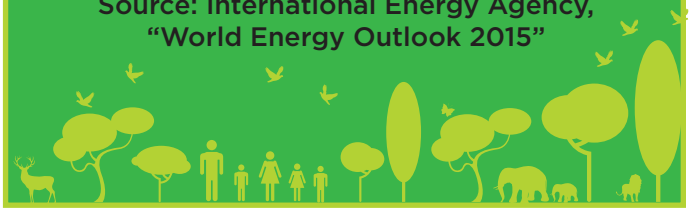
Adding electricity is expensive.

The U.S. Energy Information Agency estimates the following for 2018:

- New natural gas-powered electricity plants will cost US$67.10 per megawatt-hour
- New wind-powered electricity will cost US$86.60 per megawatt hour
- New solar photovoltaic power plants will cost US$144.30 megawatts per hour.

The numbers were calculated to compare power generation projects on the same basis.

Source: International Energy Agency, "World Energy Outlook 2015"



FAST FACT:

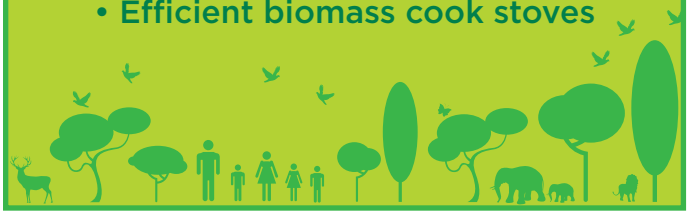
Lighting accounts for about 20% of global electricity consumption
Source: International Energy Agency, "World Energy Outlook 2015

And now come solar micro-grids...

India also is benefitting from companies that develop creative ways to make home solar affordable for people living in remote areas.

As in Kenya, that means finding ways to lend money so people can buy solar equipment and pay back their loan with affordable small payments. For example, Selco Solar Light (selco-india.com) works with banks and sells:

- Home solar systems that can include fans and mobile phone chargers
- Solar-powered outdoor lighting
- Back-up lighting systems for houses "on the grid"
- Efficient biomass cook stoves



Benefits of Small Solar

"When we provide even four more hours of light each night, we give people more time to work, more time to play, more time to be together, more time for conversation. We not only provide four more hours of light: we provide four more hours of life... every day".

Source: Simpa Energy India Ltd. (simpanetworks.com)

2. Big Tech Agriculture 1: Fair Oaks Farms, Fair Oaks, Indiana, USA.

Which Pillars touched? The Ecological and Economic.

Why is Fair Oaks important?

Fair Oaks is one of the biggest dairy farms in the world. It offers a glimpse into one direction dairy farming could take: high tech, massive, sustainable. And unlike many Big Agriculture operations that prefer to avoid public scrutiny, you can visit Fair Oaks, which is about a 90-minute drive south of Chicago on Interstate 65.

Welcome to Fair Oaks, which spreads across 78 square kilometers (30 square miles) divided into 12 operating clusters that are home to 36,000 cows. The cows deliver about 1 million liters, or 280,000 gallons, of milk each day. Artificial hormones are not used to increase milk production.

That is a lot of cows and a lot of milk, but is only part of the story.

Fair Oaks, which is operated by 12 families, grows its own cattle feed and processes its cows' manure in a set of "digesters" to make renewable natural gas to generate the electricity used by Fair Oaks. [See DC Water in Unit 4, Part 2 for discussion of digesters] That electricity is used to power everything from the extensive telemetry used to manage the farms to the systems used to heat the boiling water used for cleaning milking equipment.

The gas also is processed to make compressed natural gas or "CNG" to power its fleet of 42 milk trucks. Manufacturing the gas that is burned to make electricity removes methane that would otherwise be released into the atmosphere. Using CNG instead of diesel to power its trucks reduced Fair Oaks use of diesel by 9 million liters or 2 million gallons.

Mike McCloskey, who started Fair Oaks with his wife Sue in 1999, told Fortune magazine in its February 2016 issue that Fair Oaks has reduced the carbon footprint of a gallon of its milk to about 10 pounds of carbon dioxide equivalent, or 43 percent less than the typical gallon of milk in the U.S.

Fair Oaks squeezes even more use out of that manure by extracting nitrogen and phosphorus used in making fertilizer. The fertilizer of course is used for growing cattle feed.

FAST FACT:

The Fair Oaks Motto:
"Reduce, Revise, Recycle."

Squeezing more value:

More value is also squeezed out of Fair Oaks milk. Some of it is sent through special filters to separate out protein, minerals, sugar and lactose. They are then reassembled in different proportions to create a drink with 30 percent more calcium, which is good for bones, more protein, but no lactose, so people whose bodies are lactose intolerant can drink it. It is marketed in partnership with Coca-Cola, under the name Fairlife and sold by big supermarkets.

In this part of the world, the building where a dairy farmer brings in the cows to be milked is called a "milking parlor." It is possible — but unlikely — that there is another dairy farm in the world that has 500,000 visitors a year who pay money to see cows being milked.

Each parlor is equipped with a slowly rotating turntable containing 72 milking stalls, one for each cow. The cows, who live in 12 barns, each almost 460 meters long (not quite 500 yards), enter their parlor from their barn, and then enter the stalls. They are milked three times a day, and three times a day their manure is vacuumed away.

The milking parlor is one stop on the tour called "The Dairy Adventure" that Fair Oaks offers visitors. Other stops include the "birthing barn" where dozens of calves are born every day and the giant barns where the cows live. There are activities for children, a restaurant, coffee shop, and souvenir shop.

Fair Oaks now raises pigs, so there is a tour of those facilities called of course "The Pig Adventure," with The Winfield Crop Adventure.

3. Big Tech Urban Farm: Tony's Farm, Shanghai, China

Why is it important?
Shanghai has 24 million mouths to feed every day and is trying different ways to put food in front of them.
Tony's Farm's high tech methods are costly today.
But they show us one of the several ways urban farming is going: highly automated, focused on quality control and farm-to-table distribution logistics.

Tony is Tony Zhang Tonggui, who made his money creating a chain of restaurants before turning to farming.

The Chinese government has four grades for sustainably produced food: the top grade is "organic." Next is "green," then "ecological," and finally "non-harmful." Tony's Farm produces certified organic food. Achieving that label meant going through the government's required three-year Soil Improvement Process, a laborious and expensive cleansing of the 288-acre (117 hectares) site clean. A second Tony's Farm is on Chongming Island,and others are on the way.

The farm operates all year long and raises about 100 different kinds of vegetables in its big greenhouses and open-air beds. A US$10 million water filtration plant circulates water to the plants, where sensors monitor temperature, humidity, soil acidity, soil moisture and other indicators of healthy plant growth, and then respond as needed. Too little moisture?
The exact amount of water needed is added.

Meanwhile the farm's software also manages packaging, storage, online sales, deliveries as well as quality control. Fresh vegetables do not improve with age, so 24 hours to 48 hours later, orders are delivered to customers, including families and restaurants as well as supermarkets, in Shanghai and Beijing.

Tony's Farm operates from a cluster of 78 shipping containers that have been rebuilt and assembled into a single, sleek, two-story complex. It combines offices, labs, a packing rooms and a visitor center. Address is 7007 Nanfeng Road, Pudong New District, Datuan Village. The company suggests you bring a translator if you do not speak Chinese.

4. The Triple Water System: Hong Kong International Airport

Why is HKIA's Triple Water System important? The short answer is: it avoids using drinking water wherever it can and instead uses other sources.

If you are traveling in Asia there is a good chance you will change planes at HKIA.

When you do, take a minute to appreciate the air conditioning inside the airport: outside it is humid Hong Kong, which is surrounded by water. Inside the airport, that humidity-generating seawater changes roles: it becomes the cooling medium for HKIA's a/c systems. More than 112 million cubic meters of seawater is used for this purpose each year.

If you use the toilet, you are unlikely to notice that seawater is used for flushing toilets. HKIA uses more than 3 million cubic meters of seawater for this purpose each year. HKIA is a very busy airport.

The water in the washroom sinks is not seawater. It is "grey water," as is all the water used for aircraft cleaning and for cleaning the catering kitchens that supply aircraft. The grey water is piped to a wastewater treatment plant, cleaned, and then re-used to water the airport's landscaped areas. The plant treats about 10 million cubic feet meters of grey water each year, or about 6,000 cubic meters each day. HKIA estimates that is what 11,000 families of four people use each day.

And finally, the third leg of HKIA's Triple Water System: drinking water. It is delivered by a conventional water supply system. It is used for drinking, catering — and fire fighting.

Adopting the TWS has reduced the airport's use of Hong Kong's freshwater supplies by about half. HKIA's methods can be borrowed and used in many other places.

5. Whitelee Windfarm, Scotland.

Why is it important?
We need more diverse and sustainable sources of energy. Windfarms are one of them.

Glasgow is proud of its designation by the European Union as a "European City of Culture." Check on the TripAdvisor.com online site for reviews and you will see why the city is so popular.

Also check the Glasgow area for Whitelee Windfarm, which is about half an hour from the city center, and you will also find enthusiastic reviews. Whitelee is the UK's largest onshore windfarm. It is home to 215 turbines, a nature preserve, 130 kilometers of hiking/biking/riding trails, and a visitor center with a café you can rent for birthday parties. Whitelee will take you around the turbines in buses. Even if you are unlikely to live next to wind turbines, they are interesting to see.

6. And Then There Is Rotterdam, the Netherlands.

Why is Rotterdam important? Rotterdam is a city of 600,000 people and Europe's biggest port. About 80 percent of it is below sea level; the sea is the North Sea, known for its bad weather. The city is using each of The Three Pillars to reach its goal of being "climate-proof" by 2025. Tools range from using modified underground parking lots to store street floodwater temporarily to adding greenery to dilute summer heat waves. Other delta cities from the U.S. to India and Vietnam are learning from Rotterdam's work.

Here is Rotterdam's situation: some 50 kilometers downstream from Rotterdam's city center is the North Sea and tides that reach the city's dock areas.

Between Rotterdam and the North Sea are the country's mighty Delta Works, built to protect the country from the sea.

The system took shape over 40 years after a storm in 1953 broke through the sea defenses, some dating back to the Middle Ages. The storm killed almost 2,000 people. Salt in the seawater damaged almost 200,000 hectares of fertile, productive land (about 500,000 acres).

Inland from Rotterdam the River Meuse can flood, as it did in 1993, causing more than Euros 100 million in damage.

And it rains in Rotterdam, causing regular nuisance flooding, not just in the city center but also in the business areas that lie outside the protection of the dikes.

"We are looking far ahead and have developed a sophisticated climate strategy," Arnoud Molenaar told the U.K.'s The Building Centre News in 2016. Molenaar is Chief Resilience Officer of Rotterdam. The core of the strategy is to work with water, not against it.

Having a strategy is one thing. Executing the strategy is a very different job. "If you want to be a climate-proof city as a whole you want large-scale and small-scale solutions," said Molenaar.

Rotterdam is a typical modern city in that over the past 100 years it has added streets, parking lots, houses, offices and factories. The result is that water has fewer and fewer places to go. However building new sewers or enlarging existing sewers is expensive. "We don't think that is sustainable," said Molenaar.

More than one use for tools:

One approach being used by Rotterdam to manage water is to get more than one use from its water management tools.

For example, when you first look at the recreation area in the Agniese neighborhood of North Rotterdam you see three landscaped and sculpted spaces for people to relax in and enjoy. One seems perfect for football, volleyball and basketball.

A city planner sees something else: an area made up of three basins. Two are shallow, designed to accept water from immediate neighborhood via various sculpted features (one can be used by skateboarders). The third is deep, and will only store water when it rains long and hard. That is the basin designed for football and other sports when the weather is good. When it is rainy, water caught in the shallow basins filters slowly back into the groundwater.

For health reasons, water from the deep basin is released into the city's canal system after no more than 36 hours.

New parking garages also have a duel function. The Museum Park Garage has spaces underground for 1,150 cars. Below them is an empty reservoir that can hold 10 million liters of water (2.2 million imperial gallons). If there is too much rain falling for the sewers to handle, a hatch opens and surface water fills the reservoir in about 30 minutes. When conditions improve the water is then pumped out into the sewers.

Canals are also put to work. The Westersingel is both a pretty canal and reservoir to both capture and store water. When it is full, some of the overflow can be handled by the Kruisplein underground parking lot.

Like many modern cities Rotterdam has miles of paved areas that do not absorb water. A new kind of paving allows water to be absorbed into the ground. Alongside the paving Rotterdam plants "water gardens" – trenches designed to absorb water and grow plants.

Existing levees — raised water barriers — are being improved, terraced and landscaped for use as bike trails and picnic areas to improve the city's quality of life.

Less protected parts of the city require a strategy that relies on "adaptative design." That includes "climate robust" buildings and buildings that "allow flood water to move through a neighborhood without causing casualties or severe damage."

Rotterdam has also identified "heat islands" within the city. These are neighborhoods where the way they were developed over the years has created conditions that trap heat more than other neighborhoods. A partial solution is to encourage — with subsidies — rooftop gardening and more trees. The vegetation lowers roof or street temperatures and helps absorb rain and carbon dioxide (CO_2).

And this being the Netherlands, there is always the option of building houses and offices that float.

One old harbor area, Rijnhaven, is now home to the floating Drijvend Pavilion, a project to show-off technology that floats. Another, the Maashaven, is waiting to be transformed into a mix of businesses and homes, all in structures that float.

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