Water-Food-Energy Nexus:
The Interconnected Approach to Water Sustainability

Dr Hani Sewilam

Director,
UNESCO Chair in Water Resources & Hydrological Changes
Academic Director,
Engineering Hydrology Department
RWTH Aachen University
Germany

Professor of Water Resources and Sustainable Development
Founding Director,
Center for Applied Research and Environmental Sustainability
The American University in Cairo
Egypt

Main Focus:

1. Water Scarcity and Sustainability
2. Water-Energy-Food Nexus
3. Nexus and Next Generation
4. Regional Conflict on WEF Resources
5. Nexus Research and Development

1. Water Scarcity & Sustainability

Water shortages affect **88 developing countries** that are home to half of the world's population.

Source 1

Water Scarcity

Over the next **25 years**, the number of people affected by severe water shortages is expected to increase **fourfold.**

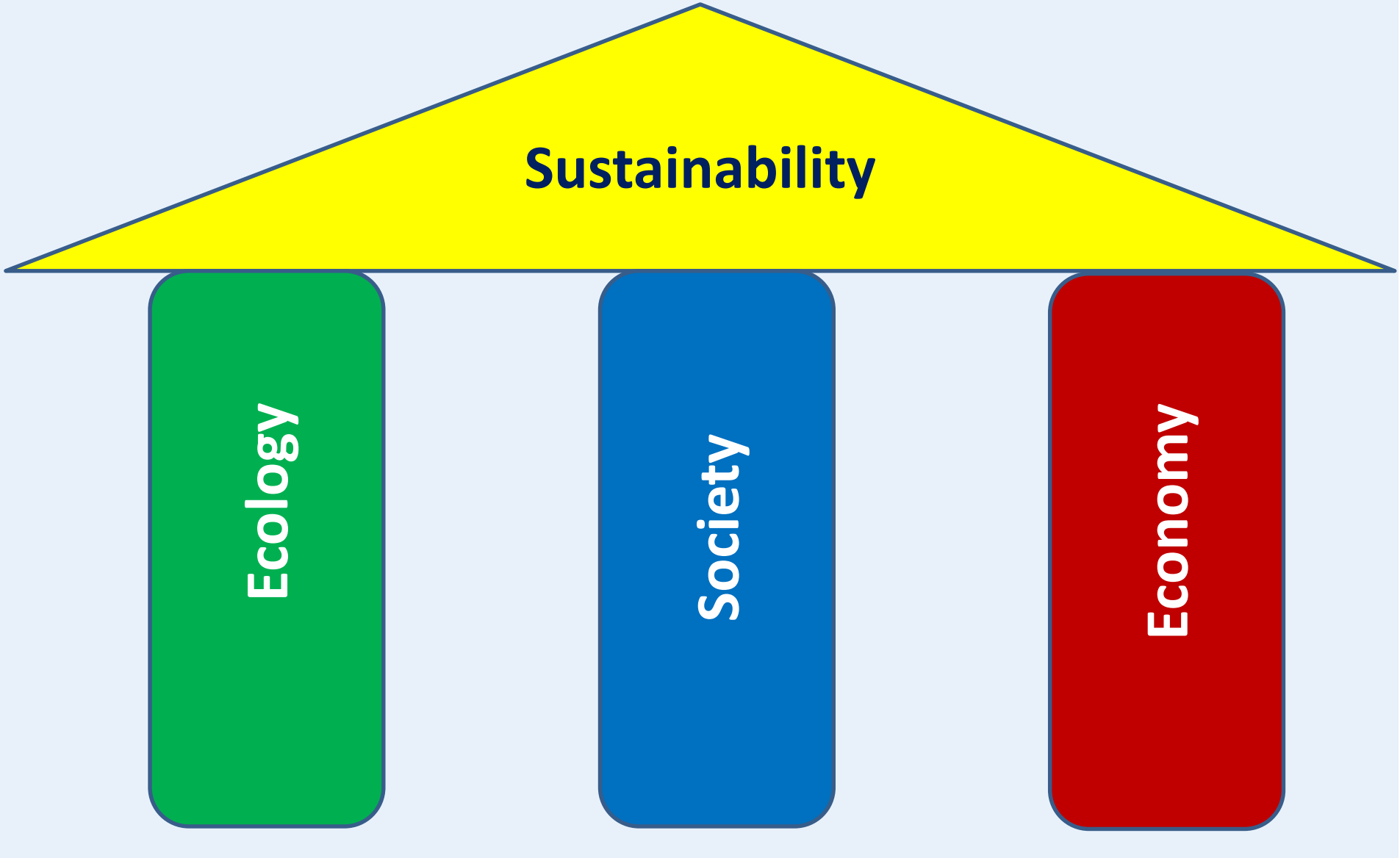
Source 2

Water Scarcity

Water shortage is affecting education, health, poverty, conflict, etc.

Source 3

Sustainable Development



The Global Agenda 2030 –
The Sustainable Development Goals: SDGs

Water Footprint

Source 3

Water Footprint

Source 4

Water Footprint

Source 5

Water Footprint

Source 6

THE AMERICAN UNIVERSITY IN CAIRO
100 YEARS

UNESCO
United Nations Educational, Scientific and Cultural Organization

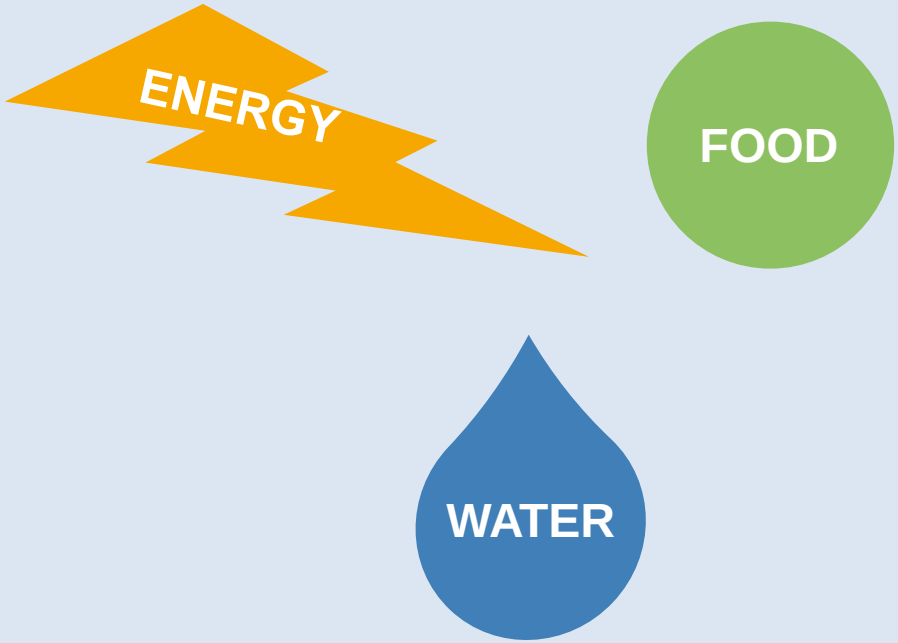
HYDROLOGY @ RWTH AACHEN

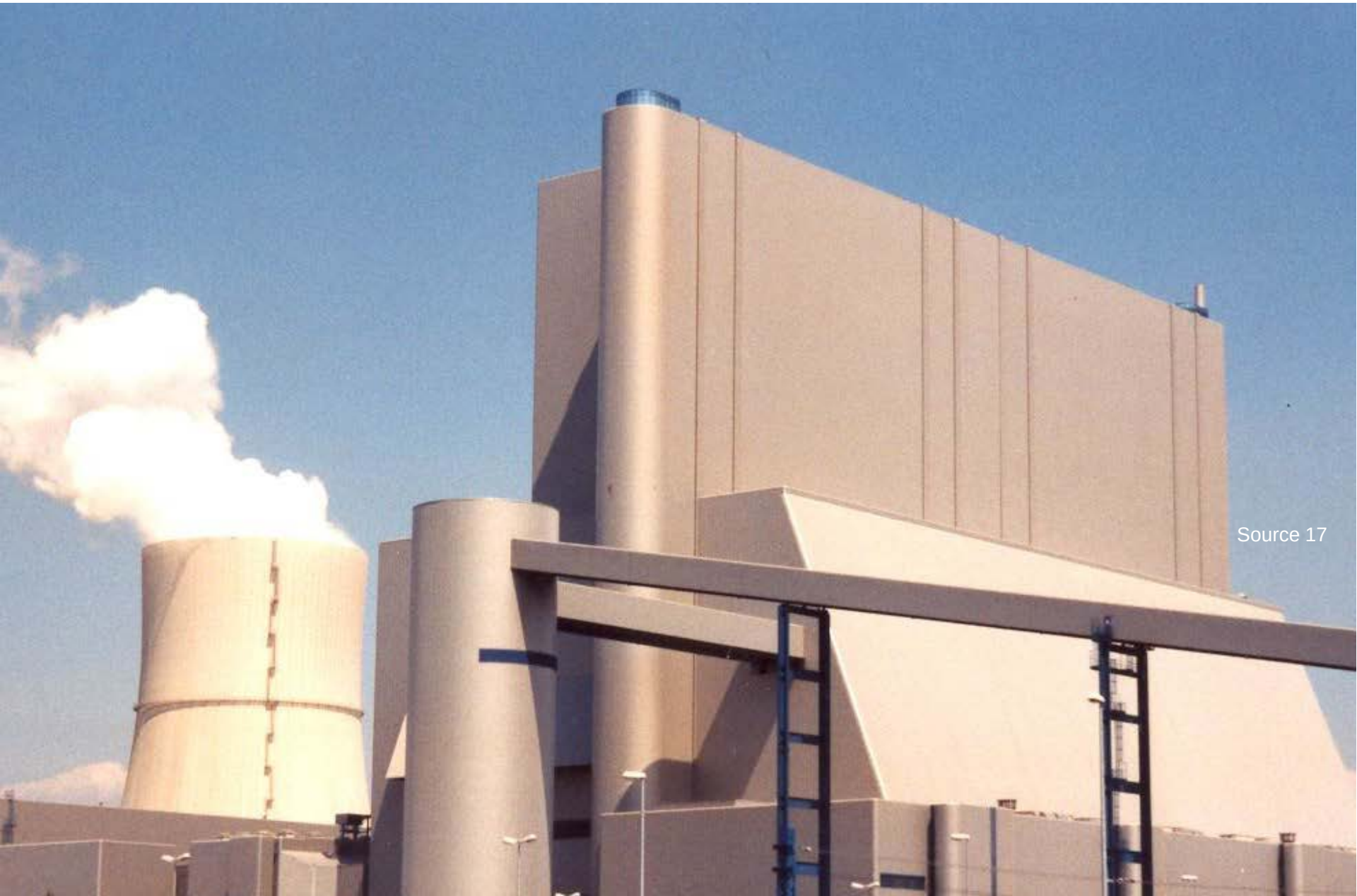
JC-WISE
Water Initiative on Sustainability and Engagement
賽馬會惜水・識河計劃

Message 1

Solving the water problem is the key to achieve the SDGs

2. Water, Energy and Food Nexus




WATER
ENERGY
THE AMERICAN UNIVERSITY IN CAIRO
100 YEARS
United Nations Educational, Scientific and Cultural Organization
HYDROLOGY @ RWTH AACHEN
Source 17


Source 18

Source 19


Source 20

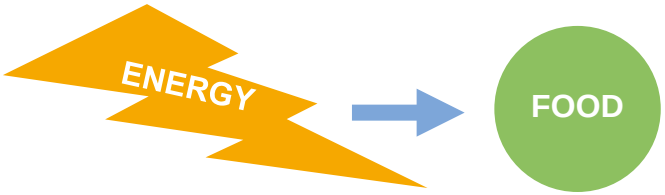
We need water to irrigate crops

Source 21

Maize is used to produce biofuel

Source 23

Energy for food supply chain



Source 22

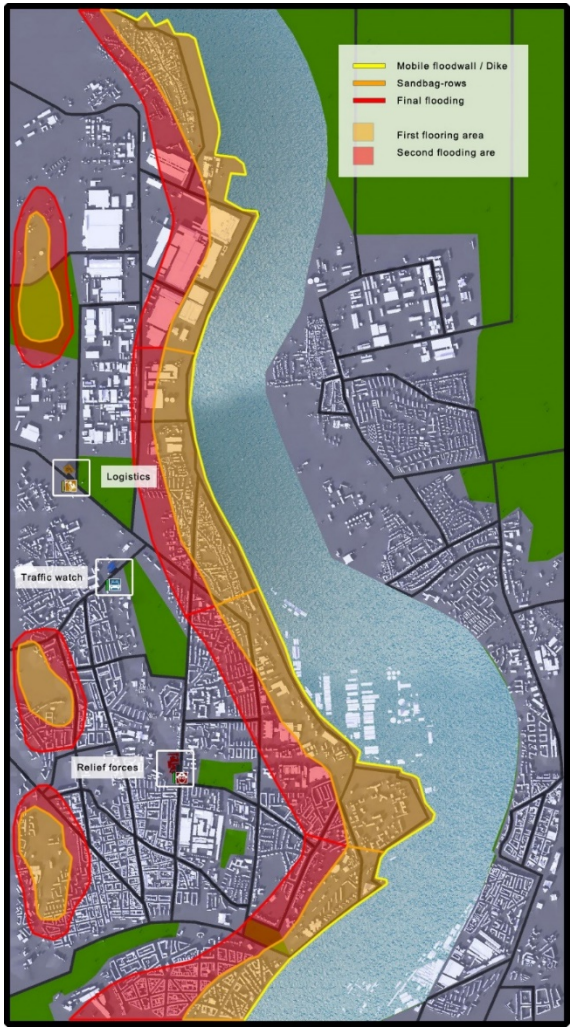
Message 2

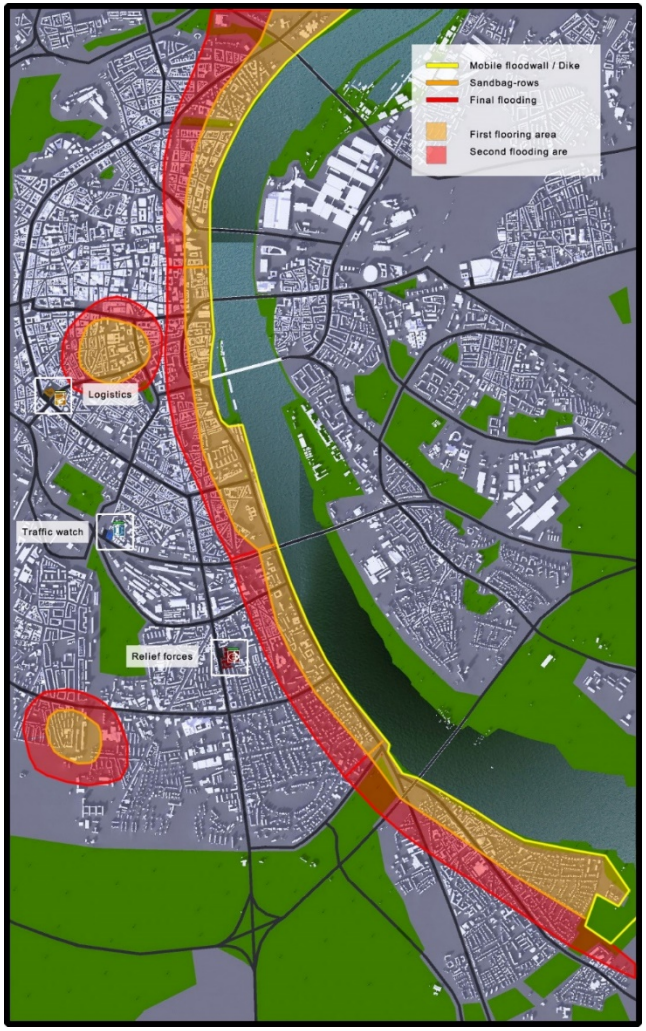
Saving food = Saving (water + Energy)

3. Next Generations

Serious Gaming

GIS


Mobile floodwall / Dike
Sandbag-rows
Final flooding
First flooring area
Second flooding are
Logistics
Traffic watch
Relief forces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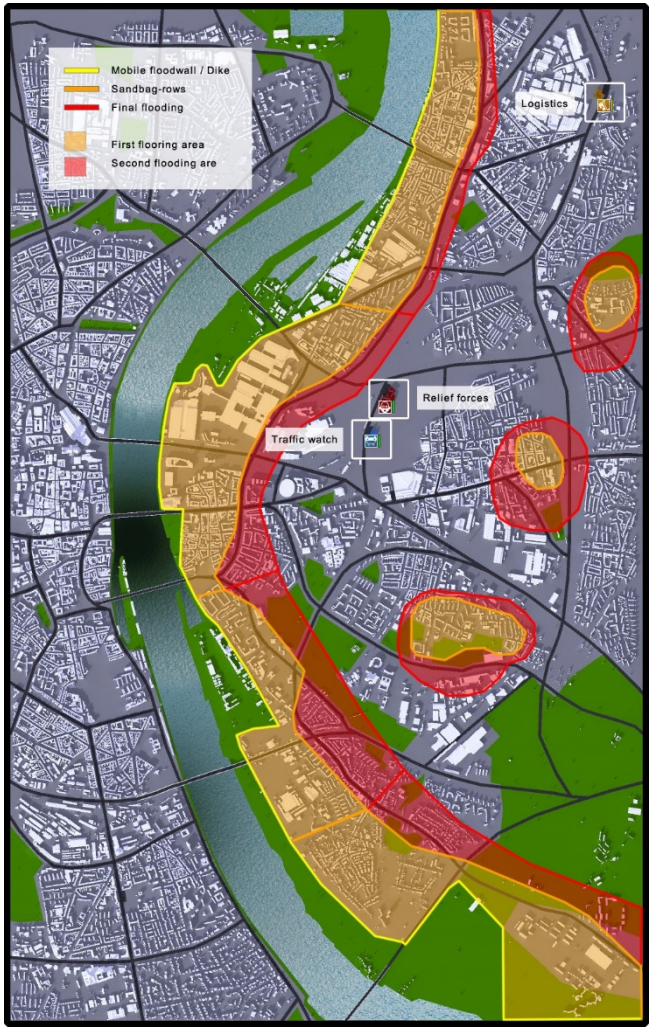

Mobile floodwall / Dike
Sandbag-rows
Final flooding
First flooring area
Second flooding are
Logistics
Relief forces
Traffic watch

Education for Sustainable Development

School of 2030

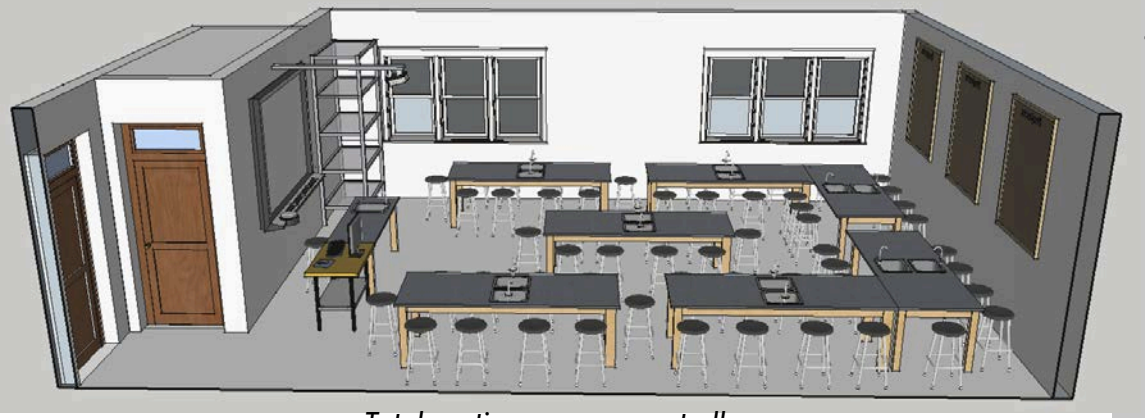
Infrastructure

Infrastructure

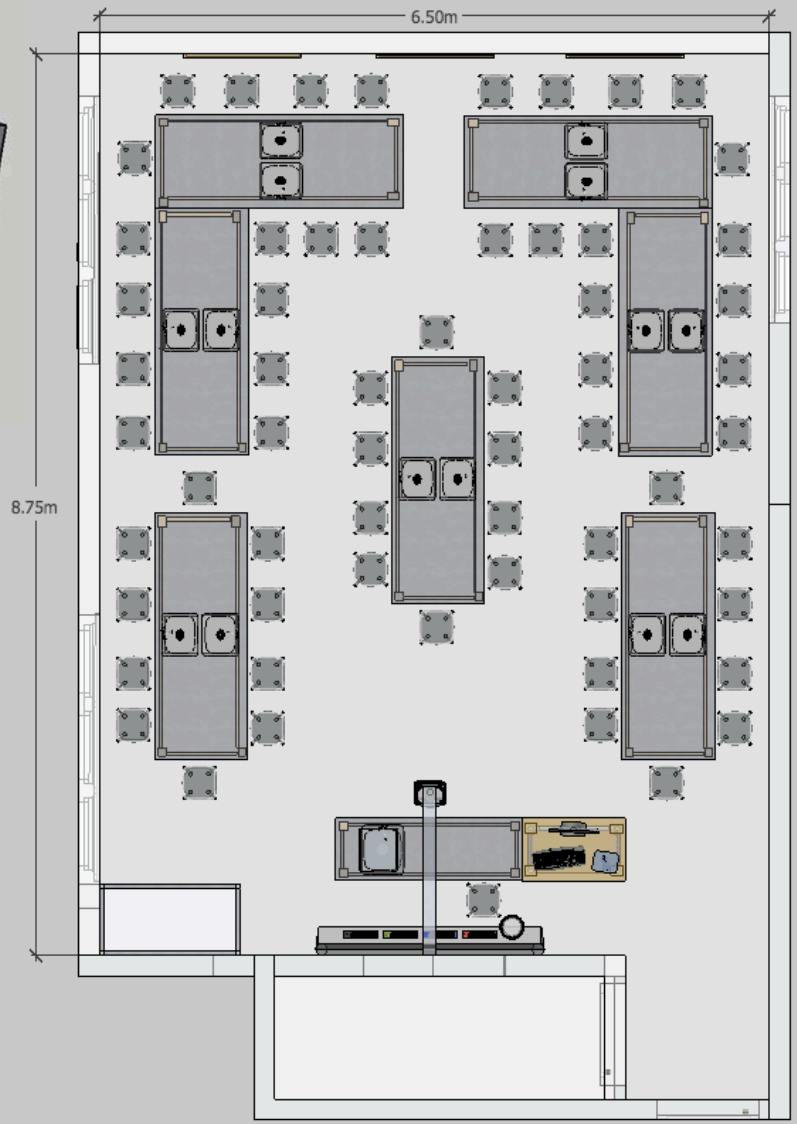
Infrastructure

MOH. FAROUK WAHDAN SCHOOL

Science Lab



Total seating arrangement allows for the allocation of 60 students



School Renovations

Teaching Methods

Teaching Methods

Education for Sustainable Development Kits

Our Planet \ Environment

The Perfect Meal

F.G01.02

Location	Type	Duration
Home economics classroom	Story, followed by interactive game and mini project	60 minutes

Optimum student number/ student grouping	Groups of 5 students each
Prerequisites	———
Short description	A story about the importance of balanced healthy food, followed by creating balanced healthy meal using food cards or by drawing, and finally preparing a simple balanced healthy meal
Learning objectives	- To understand the meaning of balanced healthy meal - To appreciate the importance of healthy meals to our body - To practice preparing balanced healthy meal
Skills	- Analytical skills - Cooperation - Motor skills - Drawing
Keywords	Healthy meals, balanced meals
Necessary Materials	- Food cards - Coloring pens - Fruit, vegetable, grain product and dairy product per student
Assessment method	Being able to create healthy meal through the cards or drawing activity
Background information	———
Link to MOE's curriculum:	Home economics, Grade 1, Lesson 2
subject, unit, and possible lesson(s)	———
References (if applicable)	Picture source: http://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Healthy/%20Eating/A3_Healthy_Ireland_Food_Pyramid_Poster_Consumer_Version.pdf Story source: http://magicfrogtales.com/5-free-short-stories-eat-healthy-be-healthy-and-smile/#1

Implementation procedures:

STEP 01

Motivation "3 minutes"

- Ask the students can food be harmful and listen to their interpretations

STEP 02

Tell the story: "10 minutes"

- Reggie Mouse loved cheese.
- He ate cheese for breakfast, cheese for lunch, and cheese for dinner.
- Reggie Mouse ate cheese and nothing else.
- Reggie's mom, Rita Mouse, always said to him, "Reggie, it is fine to eat cheese, but you should also eat healthy foods like fruits, vegetables, cereal, breads, chicken, and fish, too."
- Reggie Mouse would smile and say, "No way, Mom, I only eat cheese and nothing else."
- One day as Reggie Mouse got dressed, all the buttons on his shirt went, "Pop, Pop, Pop."
- "Oh, no, my shirt has 'SHRUNK!'" cried Reggie Mouse.
- And as Reggie Mouse put on a pair of his pants,"Rip, Rip, Rip,"went the pants.
- "Oh, no, my pants have 'SHRUNK!'" too, cried Reggie Mouse.
- Reggie Mouse then ran to his closet and tried on all of his clothes.
- "Pop, Pop, Pop" went all the buttons on all of his shirts.
- "Rip, Rip, Rip," went all of his pants.
- Reggie Mouse cried and cried and said, "Oh, no, all of my clothes have 'SHRUNK! What can I do?"
- Rita Mouse heard her mouse-son crying. She quickly walked into his bedroom and asked in a gentle voice, "Reggie, why are you crying and why are your clothes all on floor?"
- "Oh, Mom, it's awful, my clothes have all "SHRUNK," cried Reggie Mouse in his saddest mouse-voice.
- "Hmmmm, all your clothes have 'SHRUNK'? I think I know what we can do to 'Un-Shrink' them," she said.
- "Reggie, if you want to 'Un-Shrink' your clothes you must stop eating only cheese and begin eating healthy foods like fruits, vegetables, cereal, breads, fish, and chicken," said his mom.
- That night Reggie Mouse ate chicken, carrots, spinach, and grapes for dinner.
- And in a very short time by eating healthy foods, Reggie's clothes "UN-SHRUNK!"

STEP 03

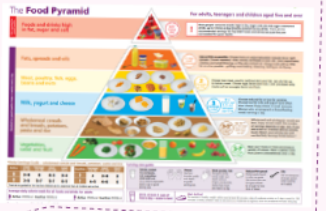
Conclusion "5 minutes"

- Ask the students why Reggie was crying.
- Ask the students why didn't Reggie's clothes fit him "let them discuss in groups"

STEP 04

Start explaining how our bodies need different types of food using food pyramid banner "hang it on the board": "10 minutes"

- plenty of vegetables, salad and fruit
- a serving of wholemeal cereals and breads, potatoes, pasta and rice at every meal - go for whole grain varieties wherever possible
- some milk, yoghurt and cheese
- some meat, poultry, fish, eggs, beans and nuts
- a very small amount of fats, spreads and oils
- and a very small amount or no foods and drinks high in fat, sugar and salt



STEP 05

give each group of the students food cards set and ask them to work in groups of 6 to choose some of them to form healthy balanced meal or to draw healthy balanced meal

"20 minutes"

STEP 06

let each group explain their drawing and selections to the other groups

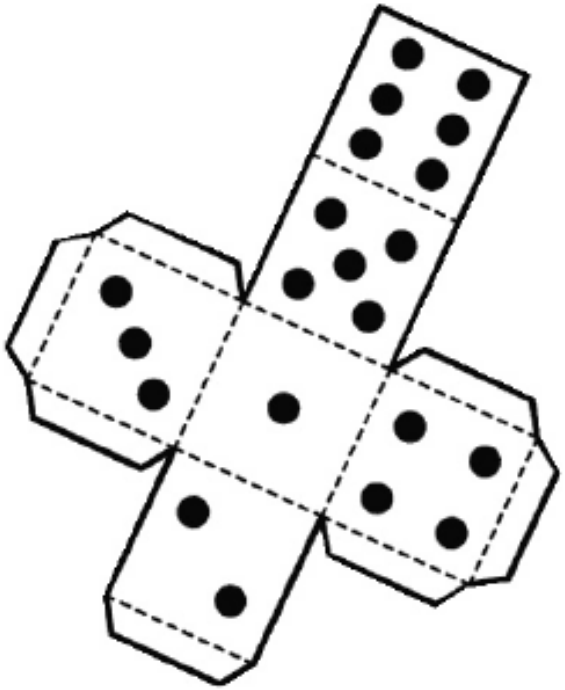
Assessment * Student's contribution in the drawing activity to form healthy meal

Suggestions for extended activities at home:

Possible adaptation/extension:

-Prepare with the class simple healthy balanced meals and sell them for other students

-Use sorting food cards instead of the drawing activity, where each group is asked to use the food cards to form a healthy balanced meal



Copy the image three times.

Color the die shape red in one copy, another one in green and another one in blue. Cut the shapes out and glue them on the edges to make your own dice.

Linking Different Worlds

Activity Sheet



Society	Environment/ Agriculture	Economy
1. Conservation	1. Water	1. Food
2. Housing	2. Air	2. Business/ Industry
3. Medical care	3. Land use/ Soil	3. Local economy
4. Poverty	4. Waste	4. Global economy
5. Education	5. Pollution	5. Jobs/ Livelihoods
6. Politics	6. Habitat	6. Markets

Summary Table

Code	**A3.K0.06**
Title of Activity	**Blessing or Curse? Taking Positions**
Type of Activity	Internet research and debate
Location of Activity	Classroom, computer lab
Duration	Two lessons
Optimum Student Number	Whole class divided into groups – ideally six groups, each further divided in two subgroups.
Purpose and Short Description	This activity aims at raising students' awareness about genetically modified crops and foods by conducting a series of debates. Students work in groups to prepare a position either in support of or against the development and use of transgenic crops. The teacher assigns each group a particular crop and what position the group should take.
Learning Objectives	1. Students learn to examine and analyze scientific information. 2. Students are able to evaluate the quality of information and scientific evidence. 3. Students apply logic to reach decisions with regard to environmental issues.
Skills	Scientific thinking skills, logic, structuring arguments, interpersonal skills
Necessary Materials	Access to a computer lab and Internet access
Vocabulary	GMO, genetic engineering, transgenic crops
Assessment Method	Peer review of group presentations.
Materials for Assessment	Evaluation sheet
Information Sources	http://www.envtliteracy.org/nstmod/GM-Crops.pdf Opposing Transgenic Crops Ag BioTech InfoNet (www.biotech-info.net) Alliance for Bio-Integrity (www.biointegrity.org) Center for Ethics and Toxics (www.cetos.org) Center for Food Safety (www.foodsafetynow.org) Greenpeace Genetic Engineering (www.greenpeace.org/usa/campaigns/genetic-engineering) Union of Concerned Scientists: Genetic Engineering (www.ucsusa.org/food_and_environment/genetic_engineering) Supporting Transgenic Crops Agbioworld (www.agbioworld.org) AgCare (www.agcare.org) Biotechnology Industry Organization (www.bio.org) CheckBiotech (www.checkbiotech.org) Council for Biotechnology Information (www.whybiotech.com/main.html) CropGen (www.cropgen.org)

Links to EG School Curriculum: Recommendation	
Class / Discipline	Class 9 / Arabic
Semester / Unit	Term 1: Unit 3, Lesson 1, Benefit of Science

Implementation Procedure

Lesson 1:

1. Begin the lesson with a brainstorming on what students know about genetic engineering and Genetically Modified Organisms (GMOs). During the discussion observe and identify which students are pro and which are contra genetic engineering.

2. Divide the class into groups, preferably six groups - one per crop, each group is further divided in two subgroups. (Each subgroup should have a minimum of three students.) Explain the task: each group is assigned a certain crop and its position (pro or contra genetic engineering of this crop). It is recommended to put students in a group that actually opposes their opinion, e.g. a student that is pro genetic engineering is placed in a group that carries out the research on the contra arguments. This forces them to reflect on their opinion and evaluate the arguments carefully.

Crops that are often genetically modified are for example:

- Soy
- Cotton
- Corn
- Canola
- Tomato
- Potato

3. For the rest of the lesson, students are asked to carry out Internet research about their assigned crop in regards to their position. While doing the research, they should work on structuring the arguments and putting them into a consistent position. Remind the students that their arguments should be backed up with scientific evidence and defensible logic as much as possible.

Lesson 2:

1. In the next lesson, each team is given ten minutes to structure their arguments again and to prepare to face their opponents.

2. Each of the groups is given five minutes to present their arguments. The pro-group should present first, then the contra group.

Note: The Internet is a rich resource for finding data on the impact of transgenic crops. Web pages that both support and oppose GM crops are readily available; you should, however, try to determine how credible a site is by virtue of the logic and evidence it offers to back up its position. The University of California, Berkeley (www.lib.berkeley.edu/TeachingLib/Guides/Internet/Evaluate.html) gives excellent guidance in evaluating the credibility of web resources.

Assessment

During the presentation of each group, the other students are asked to fill in the Evaluation sheets. After each presentation, the sheets are given to the teacher who collects them and calculates the overall result of the respective group. In the end the group with the most convincing argumentation can be announced and every group is given their assessment sheets so they can see the evaluation by their peers.

EduCamp


EDU CAMP.EU
المستوى الثالث
أنشطة التعليم من أجل التنمية المستدامة
مجموعة
الطاقة
هذا الجزء مقسم إلى ٩ أنشطة، تركز على «الطاقة"، وهو موجه للمدرسين والطلبة في الصف الثالث الإعدادي من نظام التعليم المصري.


EDU CAMP.EU
المستوى الثاني
أنشطة التعليم من أجل التنمية المستدامة
مجموعة
عالمنا
هذا الجزء مقسم إلى ١٢ نشاطاً، تركز على "عالمنا"، وهو موجه للمدرسين والطلبة في الصفين الأول والثاني الإعداديان من نظام التعليم المصري.

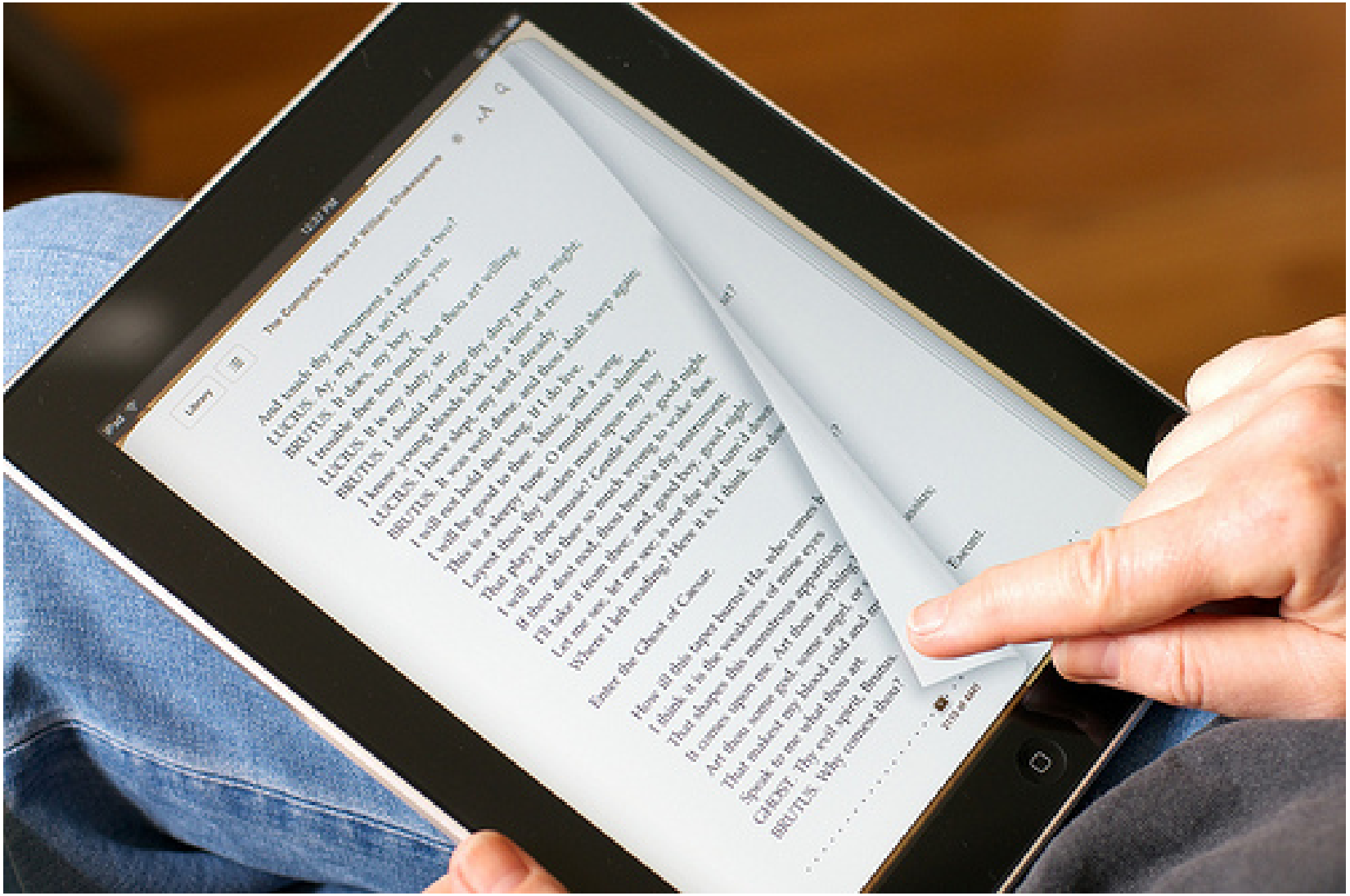

EDU CAMP.EU
المستوى الأول
أنشطة التعليم من أجل التنمية المستدامة
دليل
المستخدم


EDU CAMP.EU
أنشطة التعليم من أجل التنمية المستدامة
دليل المعلم

Education for Sustainable Development Kits

iBooks

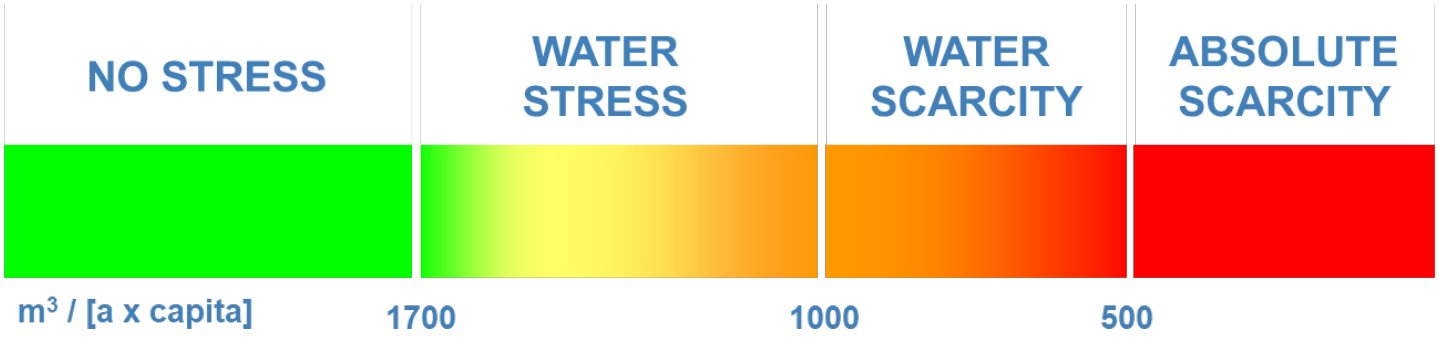
ESD-Kits Level 1, Level 2 and Level 3



Message 3

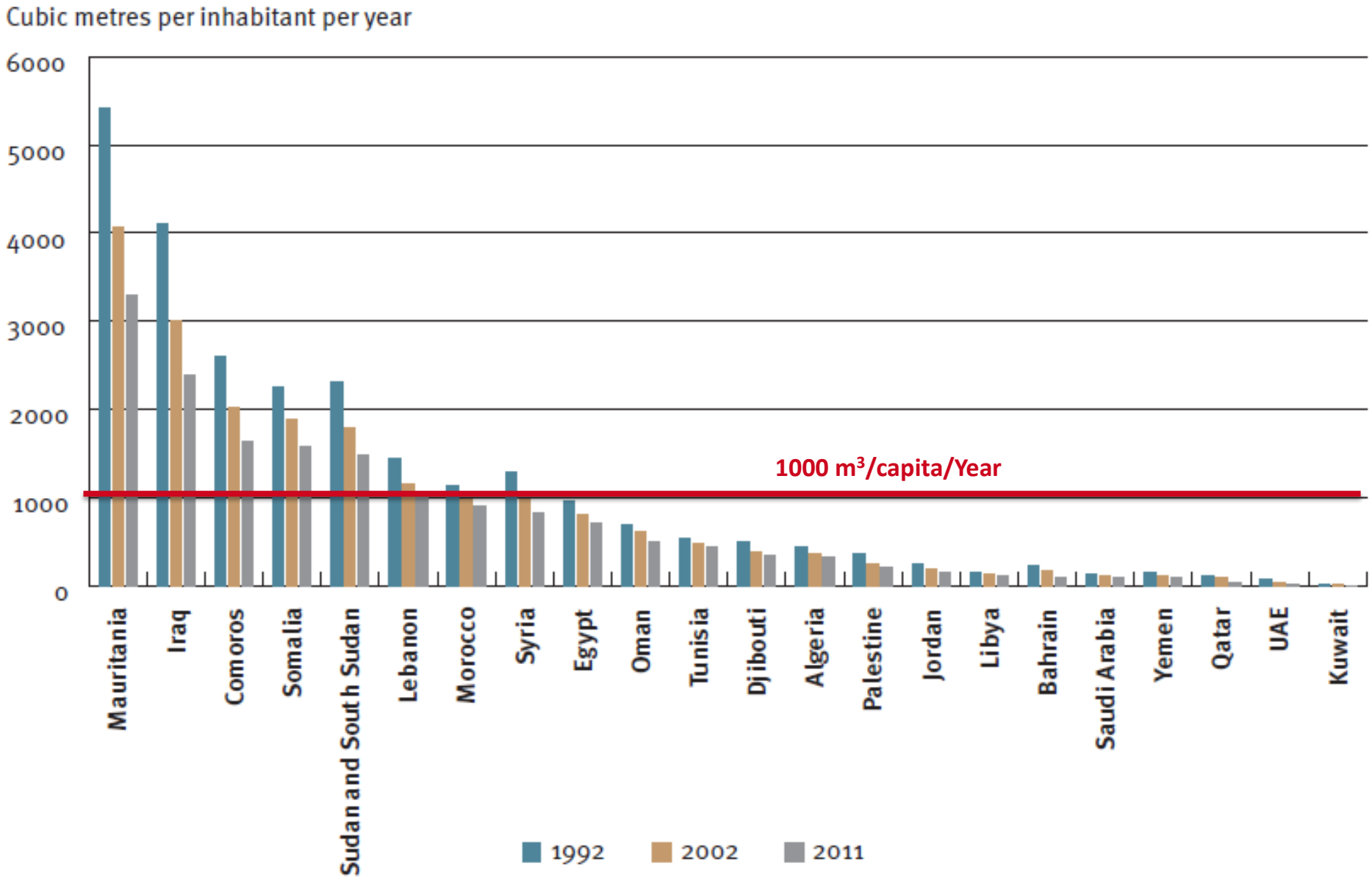
Start as early as possible with Education for Sustainable Development (ESD)

4. WEF Regional Conflict



Source 4

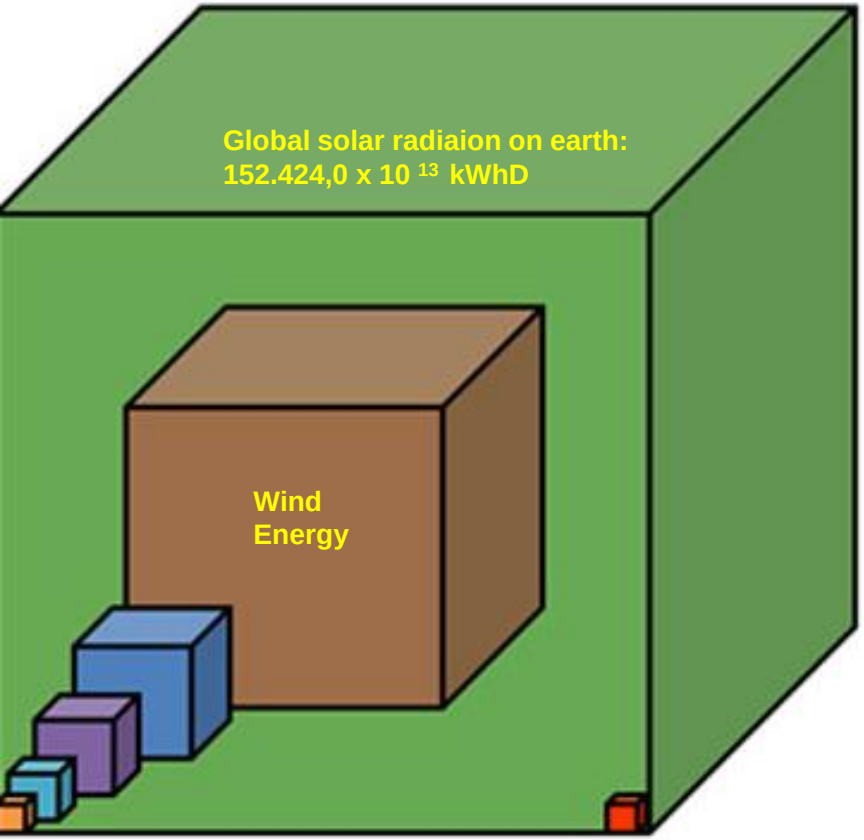
Falkenmark Indicator



Source 5

Energy Sources

Current Global Primary Energy Consumption is 15 TW

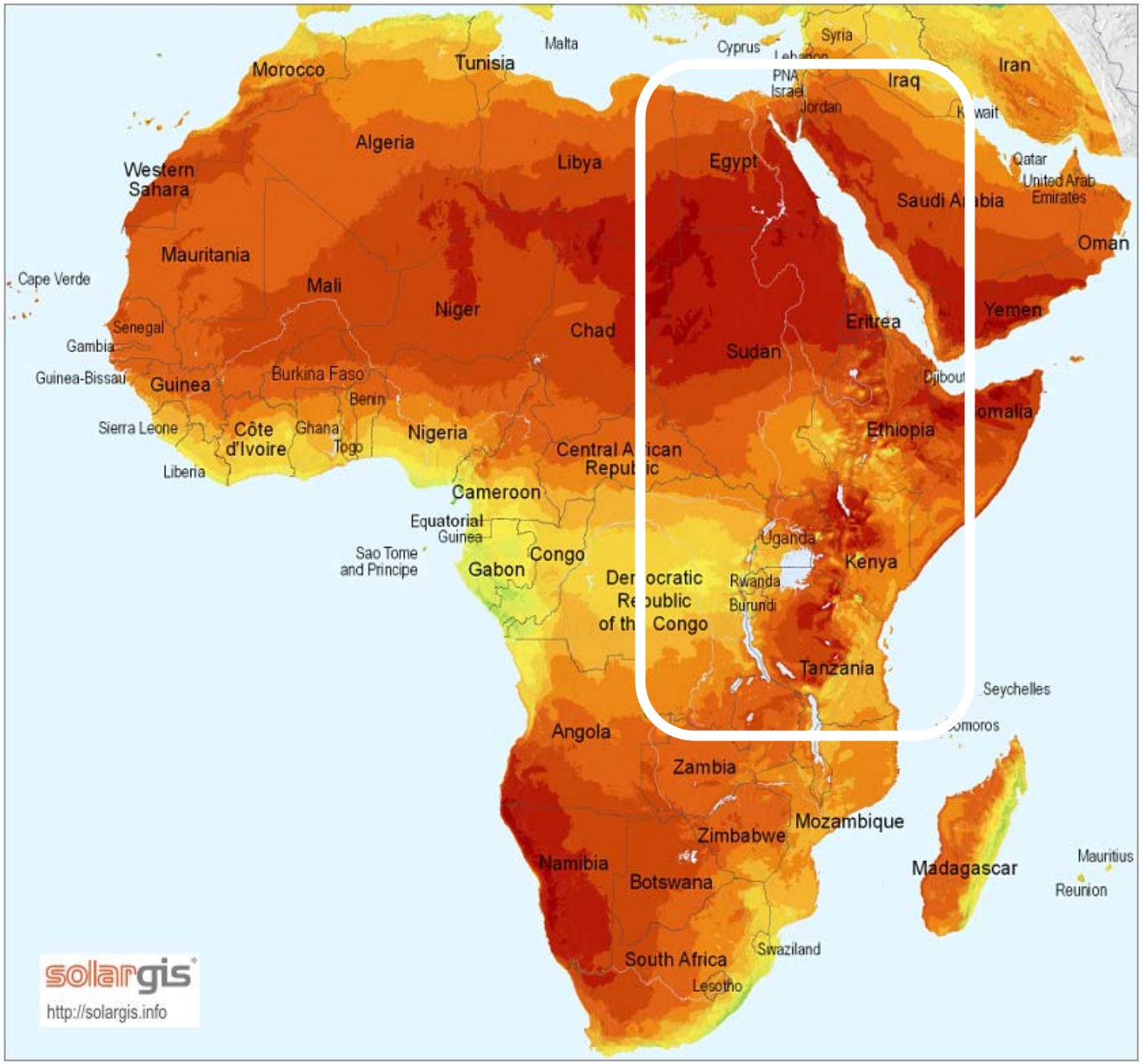


- Global Primary Energy Consumption (GPEC)
- Hydro Energy(1 x GPEC)
- Tidal Energy(2 x GPEC)
- Geothermal Energy(10 x GPEC)
- Biomass Energy(20 x GPEC)
- Wind Energy(200 x GPEC)
- Solar Energy(1800 x GPEC)

[Source: Set for 2020, Executive Summary, EPIA, http://www.setfor2020.eu/]

Global horizontal irradiation

Africa and Middle East



Average annual sum (4/2004 - 3/2010)

< 1600 1800 2000 2200 2400 > kWh/m²

0 500 1000 km

The Grand Ethiopian Renaissance Dam
(Millennium Dam)

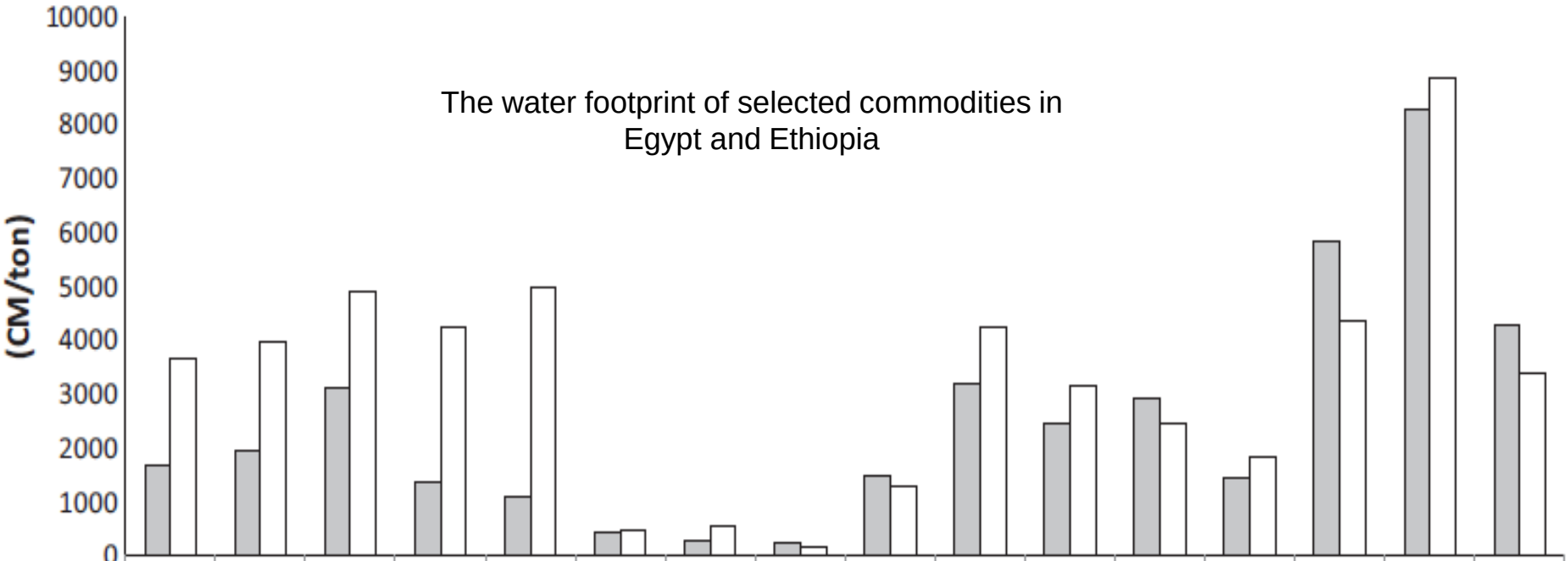
Source 8

A dam to generate 6,000 MW of electricity.

To store 74 billion cubic metres,
costs have been estimated at nearly $5bn.

Efficiency of Water Use

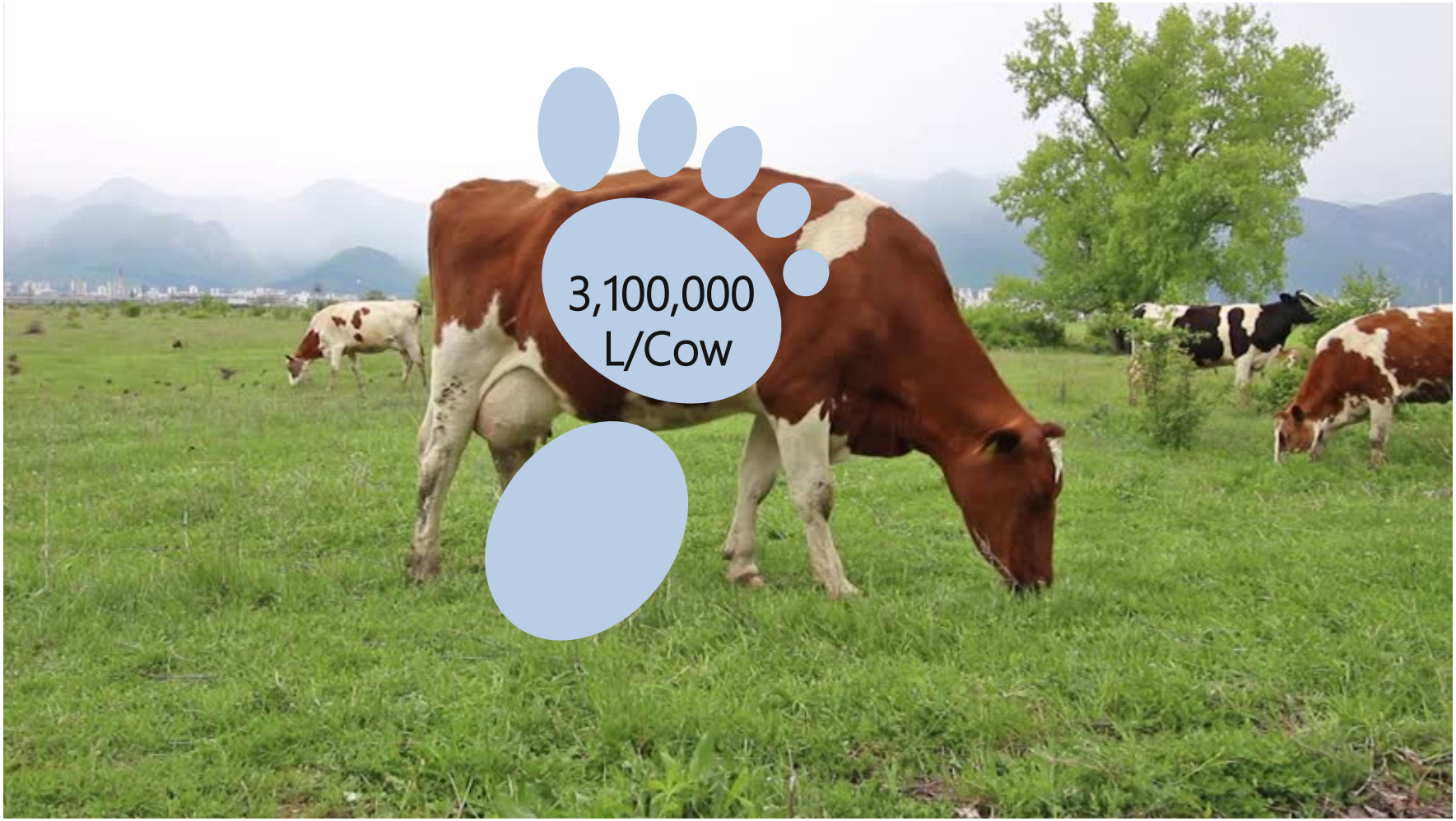
The water footprint of selected commodities in Egypt and Ethiopia



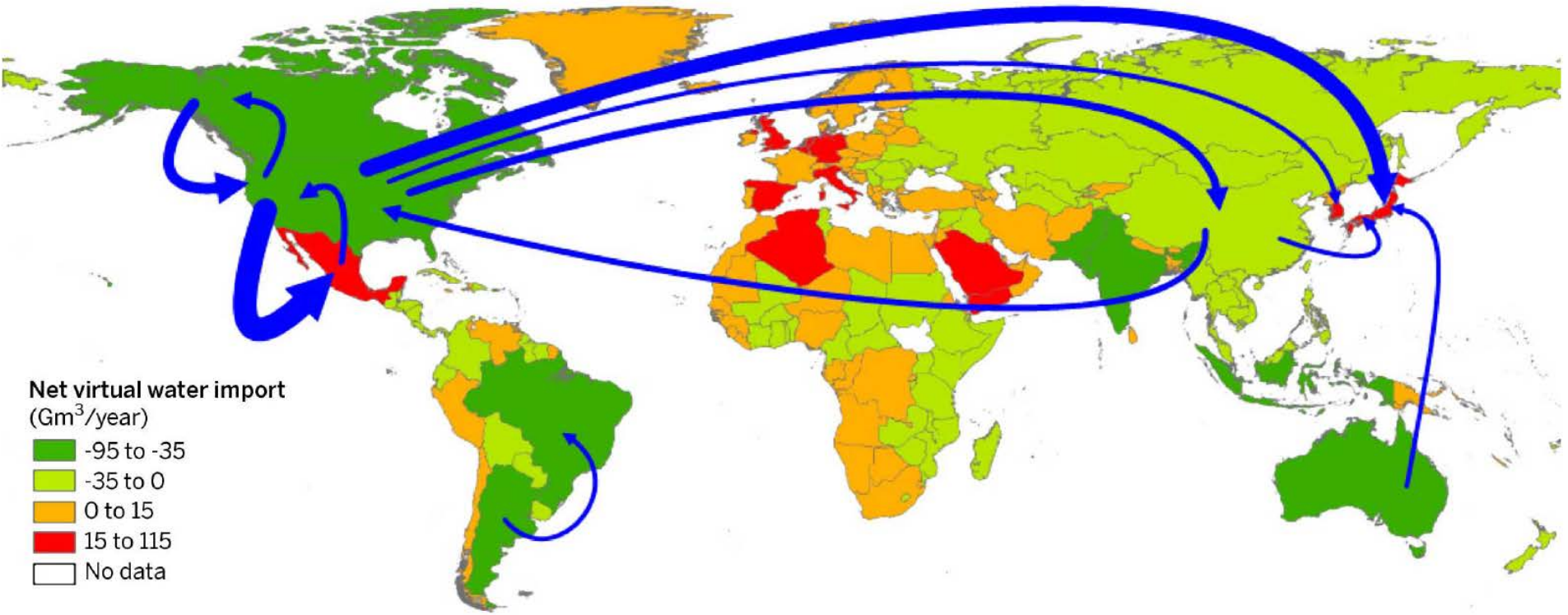
	Wheat	Rice	Barley	Maize	Sorghum	Potatoes	Sweet Potatoes	Sugar Beet	Sugar Raw	Beans	Pulses, Other	Sunflowerseed	Cotton seed	Poultry Meat	Fats, Animals, Raw	Eggs + (Total)
Egypt	1692	1948	3118	1390	1107	421	297	232	1487	3199	2482	2922	1453	5839	8308	4291
Ethiopia	3679	3970	4908	4237	5007	467	563	150	1304	4239	3171	2453	1841	4361	8891	3381

Source 9

Importing Virtual Water



Virtual Water

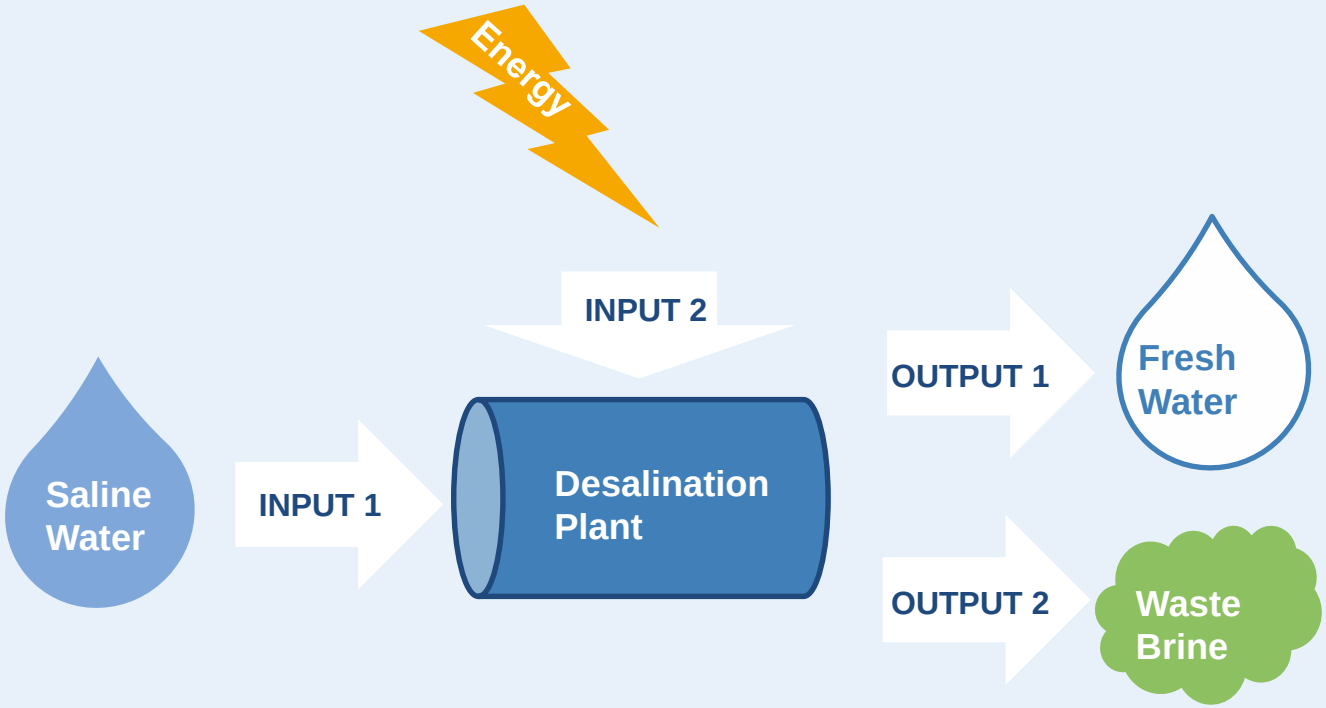


Source 3

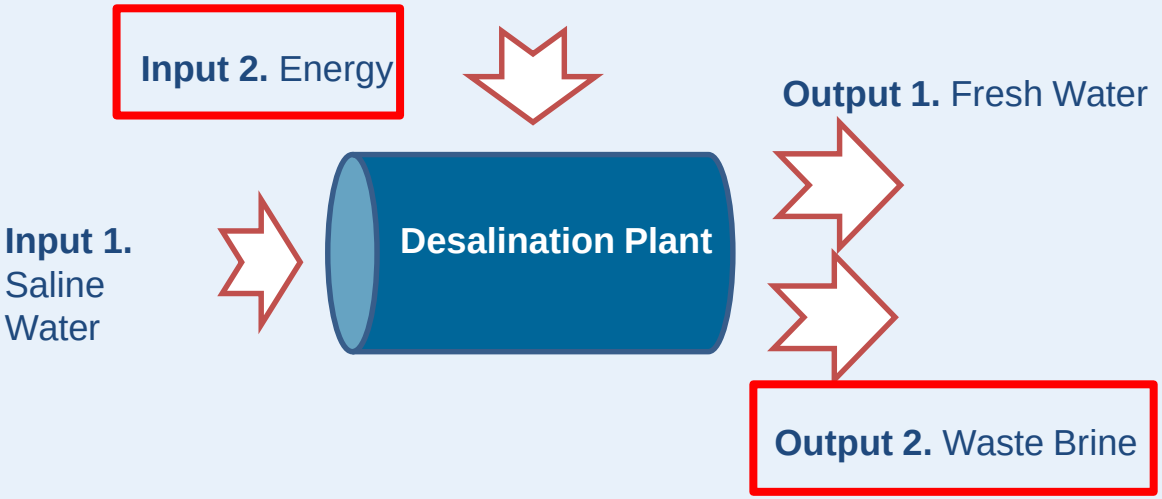
Message 4

Collaboration without Boarders

5. Research & Development

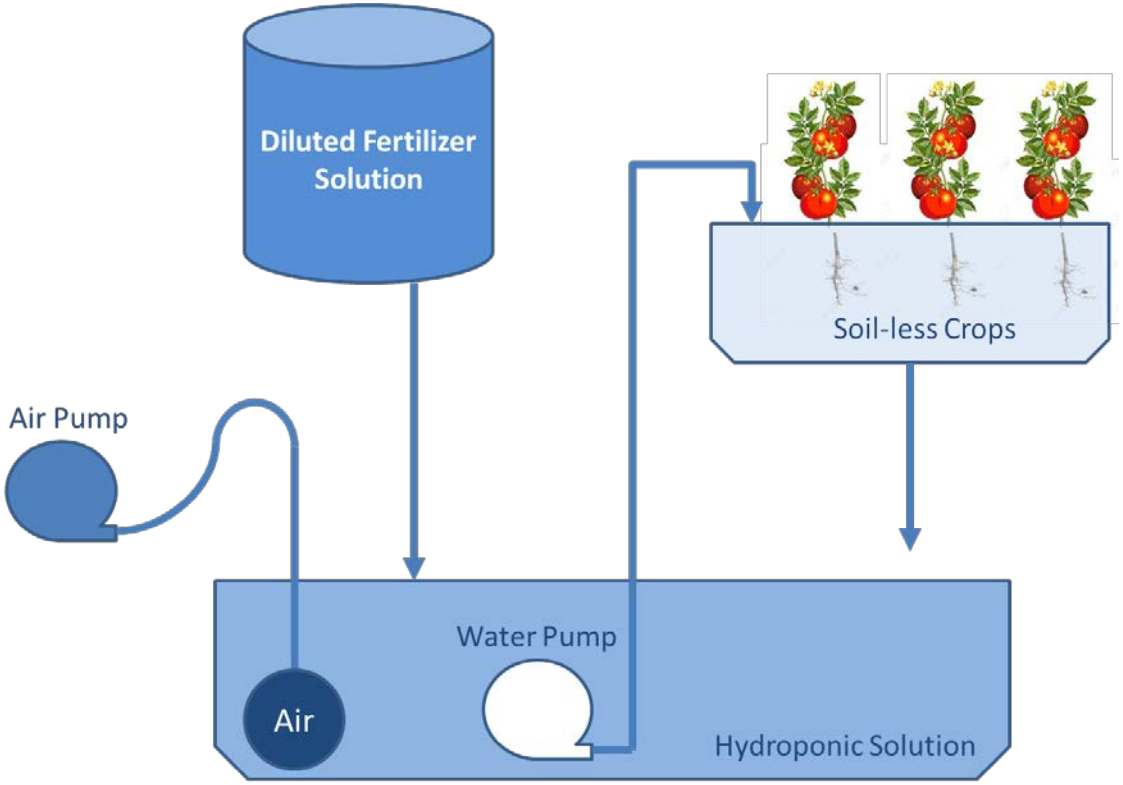


Desalination Problems



Surface Irrigation

Hydroponics



New Agriculture Generation

SunDrop

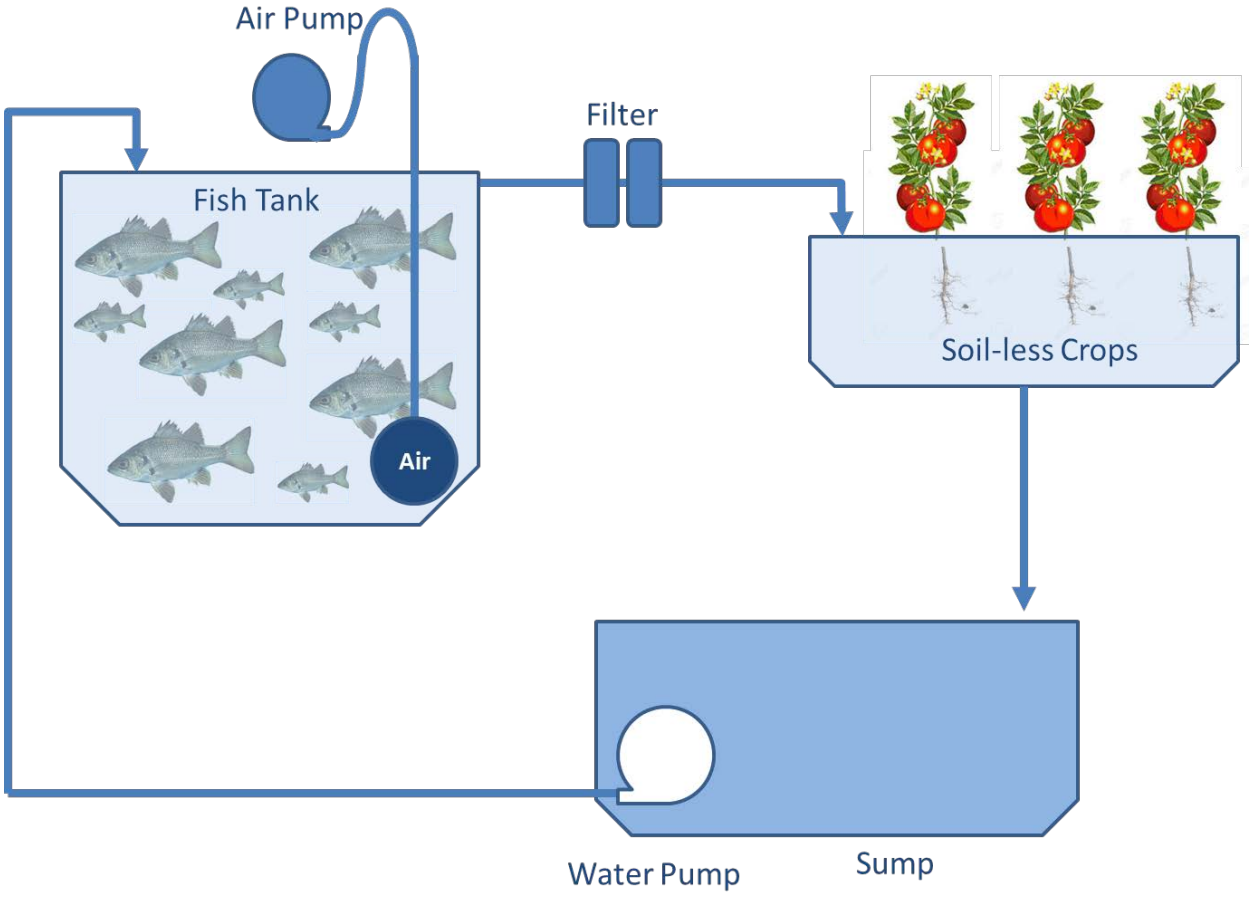
Deep Water Culture - DWC

Source 7

Nutrient Film Technique - NFT

- **Plants grow in tube or closed gutter that provides a small, continous water flow**

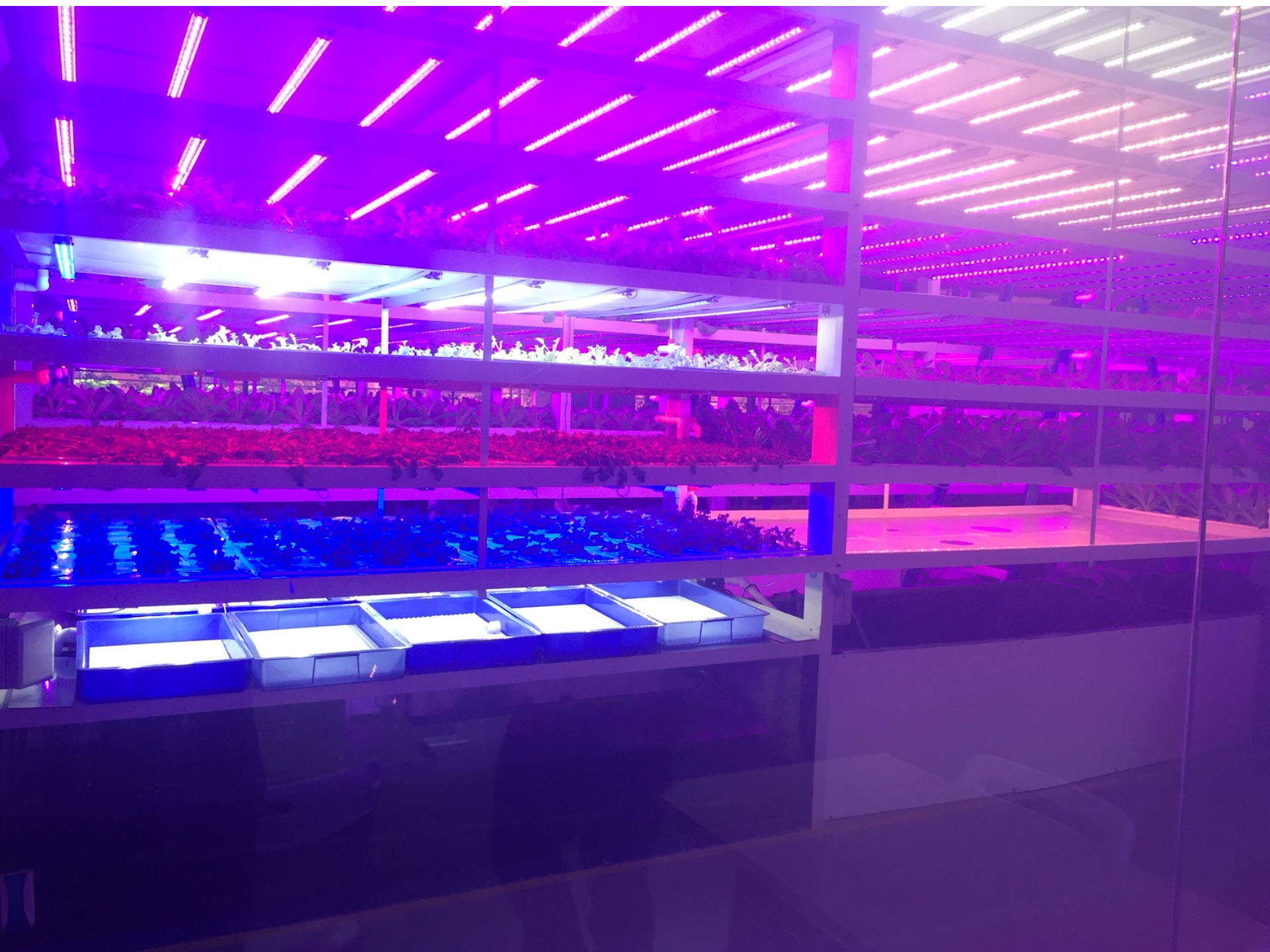
Aquaponics

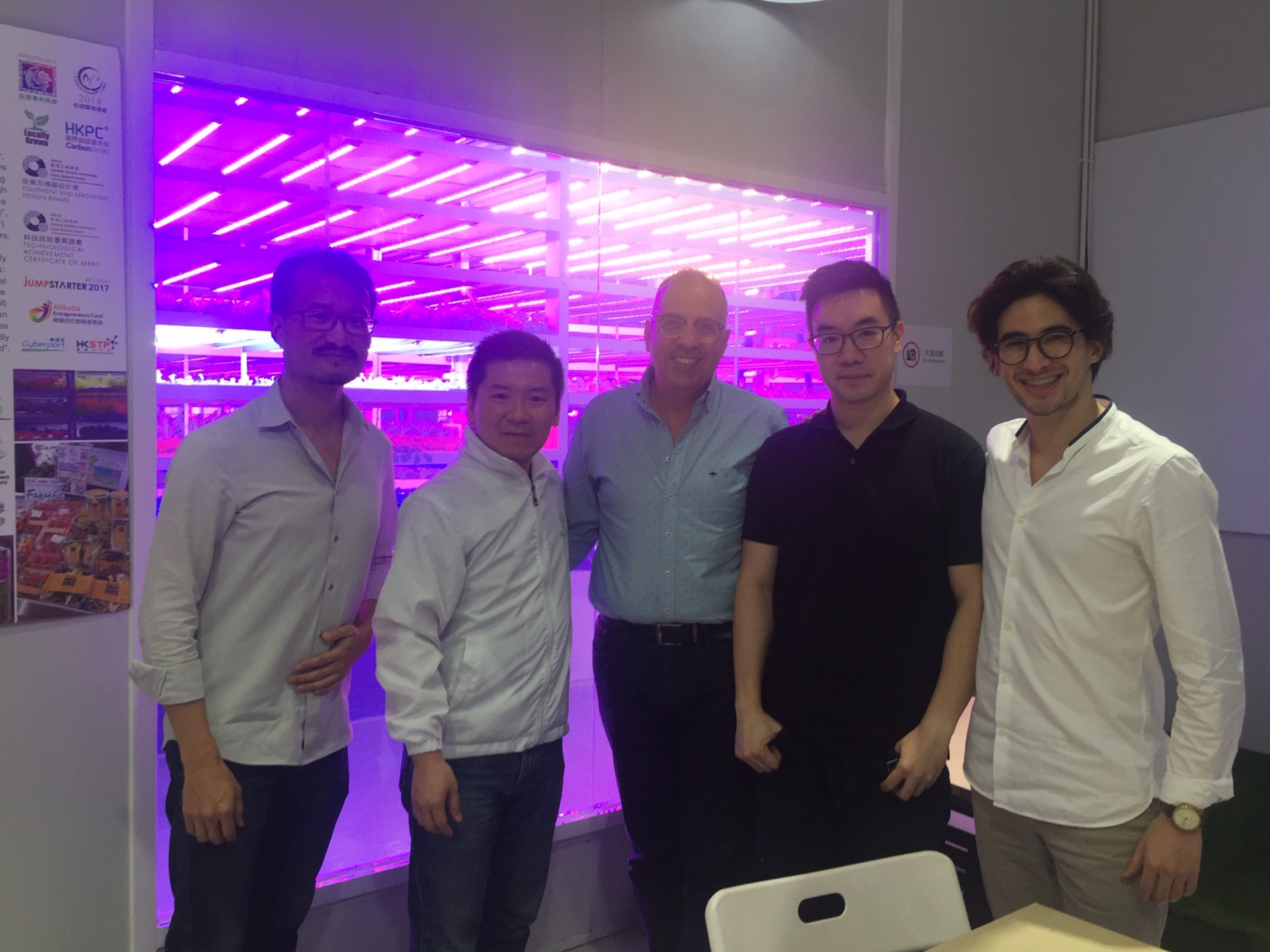

Air Pump
Filter
Fish Tank
Air
Soil-less Crops
Water Pump
Sump

Indoor Agriculture or Vertical Farming

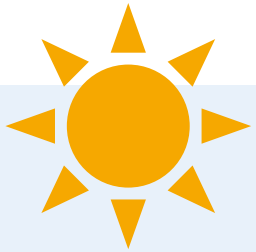
https://foodtechconnect.com

Indoor Agriculture or Vertical Farming

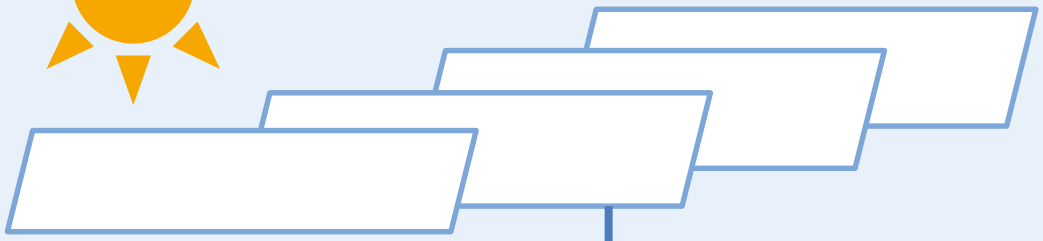



Locally Grown
HKPC
Carbonsmart
2014
JUMPSTARTER 2017
Alibaba Entrepreneurs Fund
Cyberport
HKSTP

WEF Nexus Model



Renewable Energy



Energy

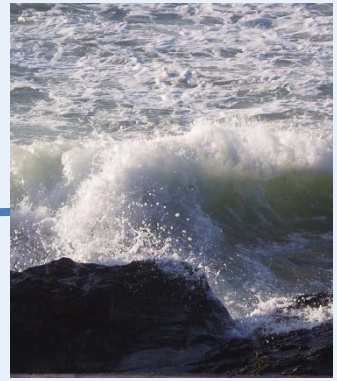
Crops

Source 25

Irrigation Water

Desalination

Salty Water



Brine

Alge

Shrimps

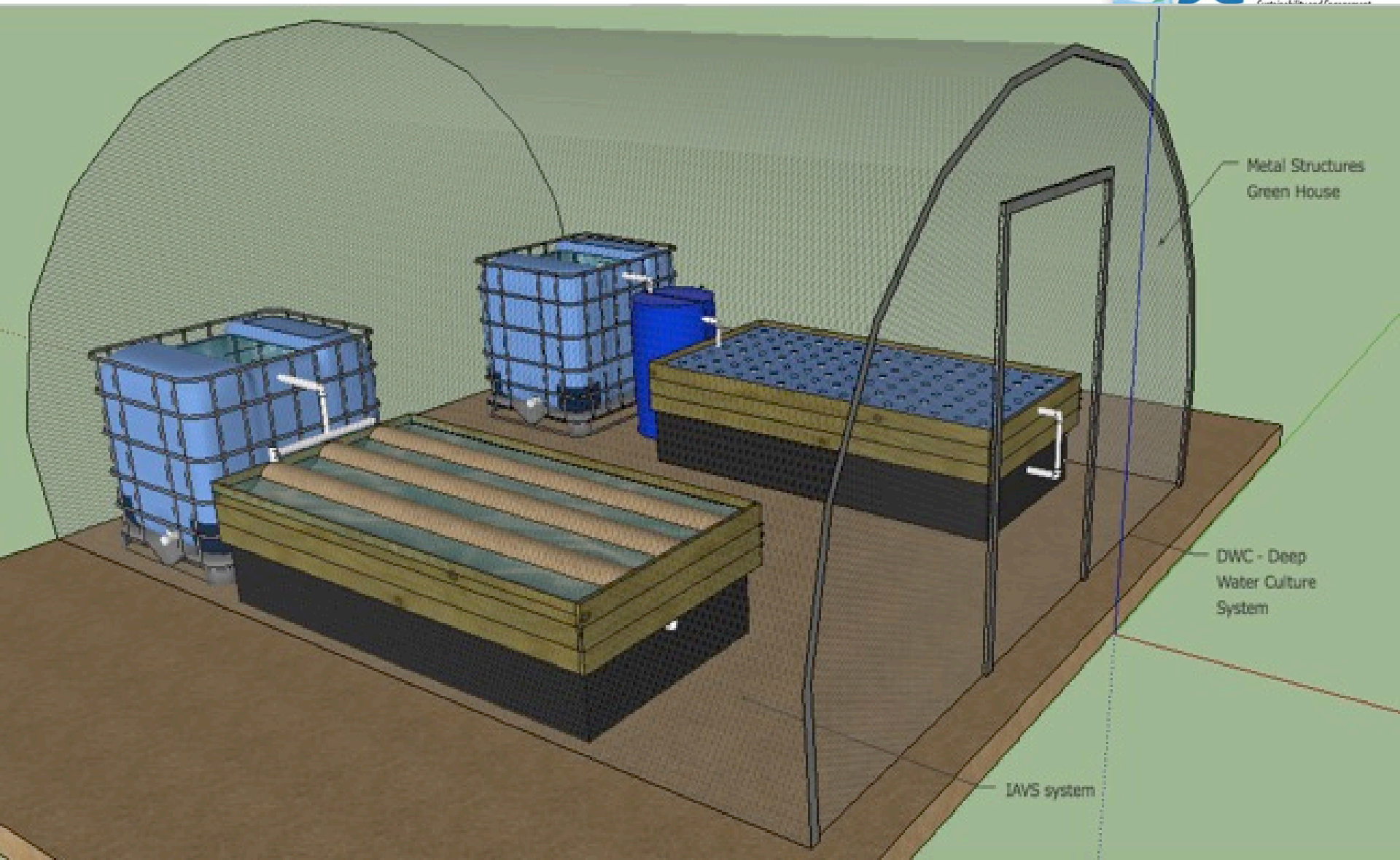
Salt

The Nexus Model

PV System

Desalination

Aquaponics


Metal Structures
Green House
DWC - Deep
Water Culture
System
IAVS system


RAFT BASED AQUAPONICS

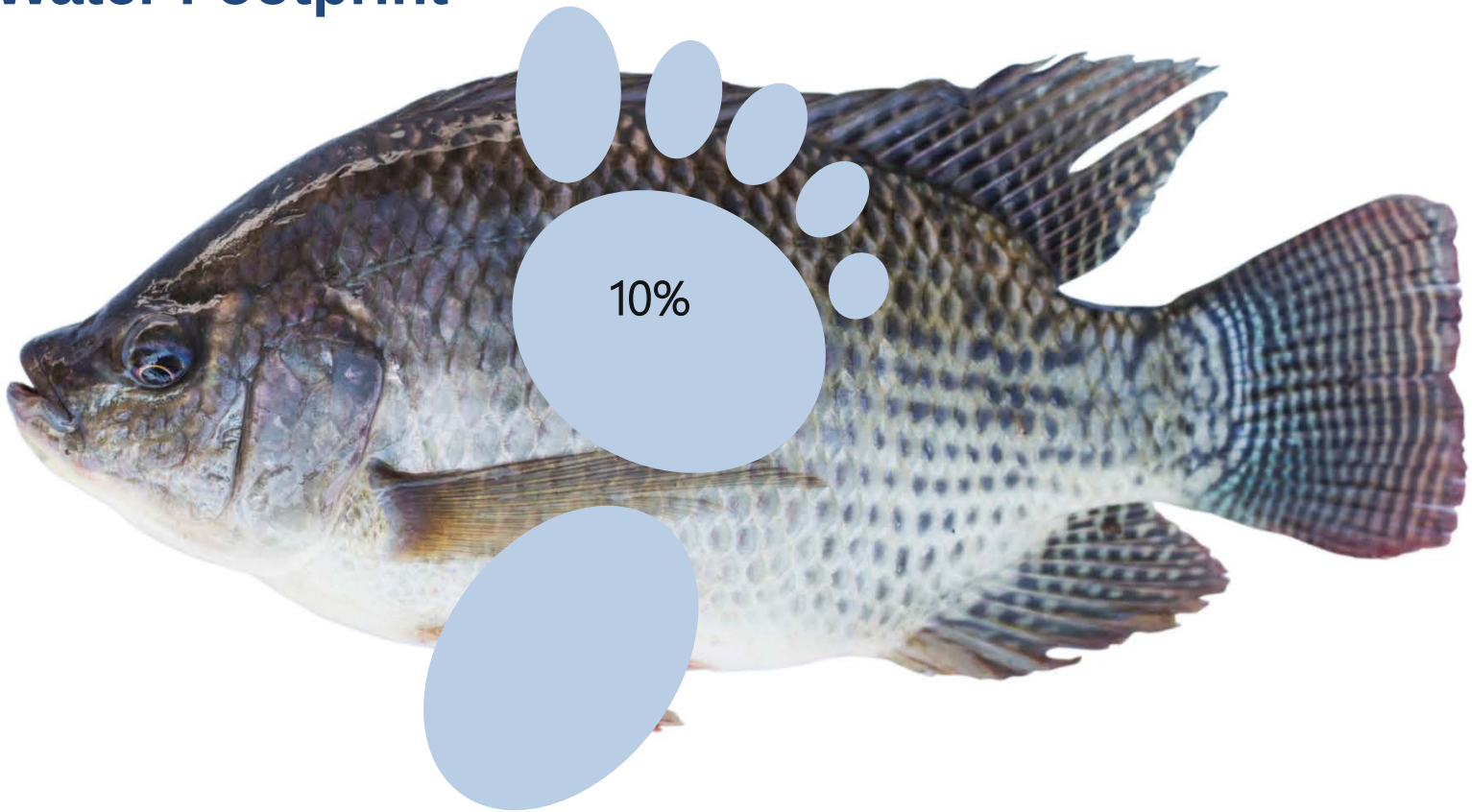
Aquaponics/Hydroponics

Fish

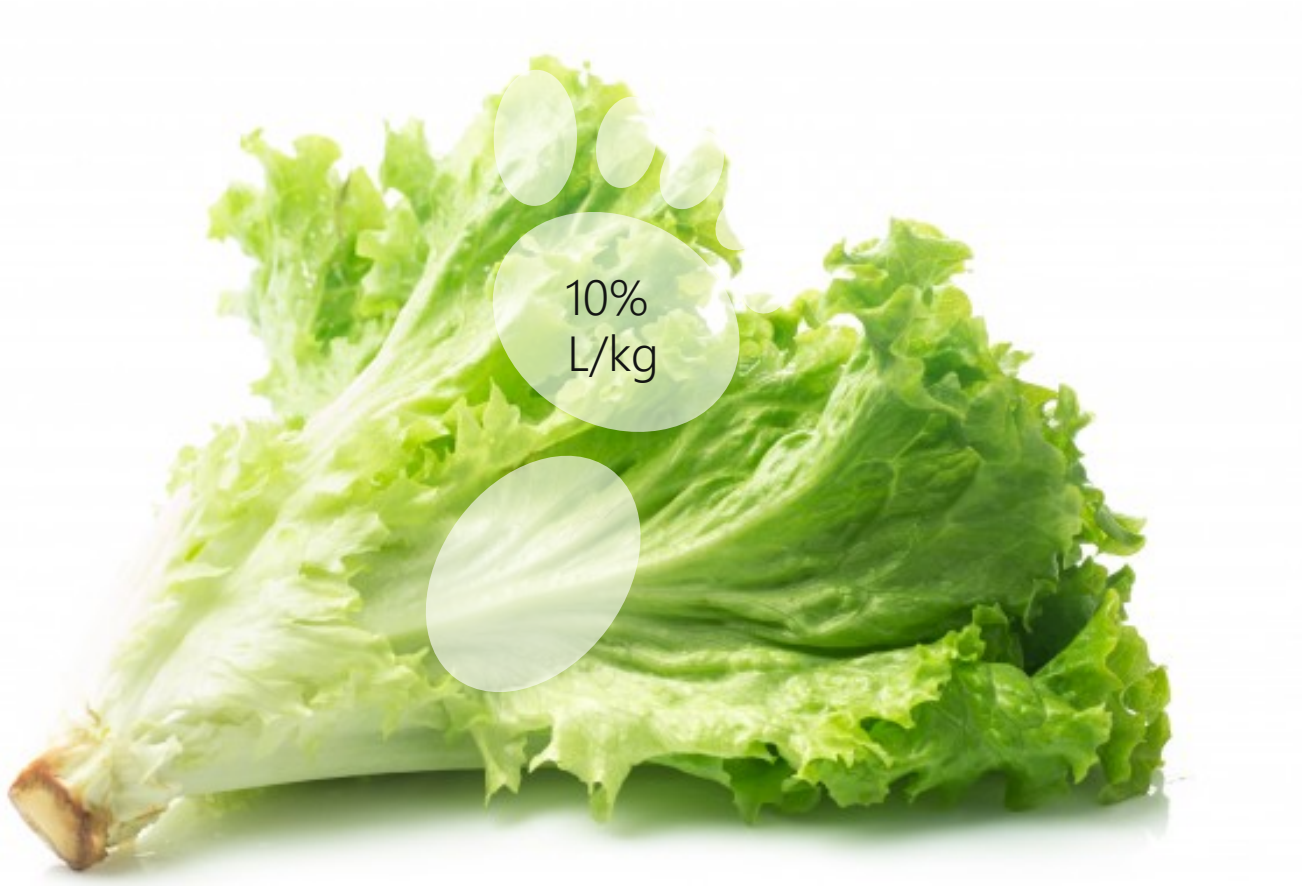




10% Water Footprint



10% Water Footprint



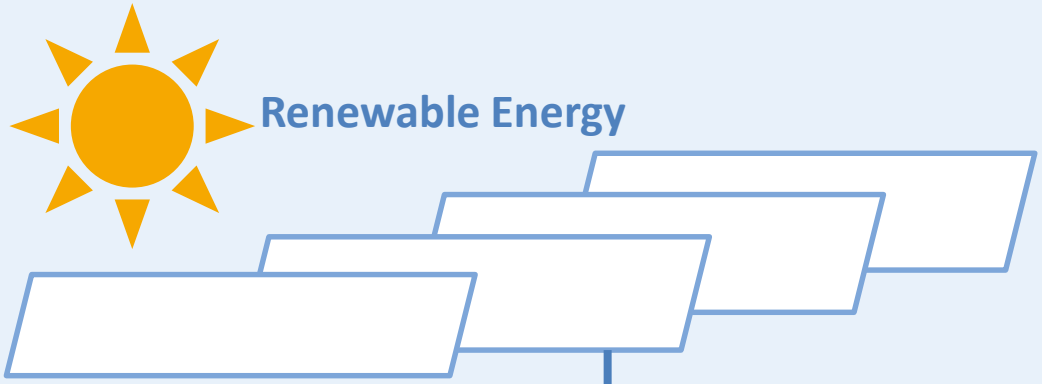
Productivity of Unit Water

M3/Water






WEF Nexus Model



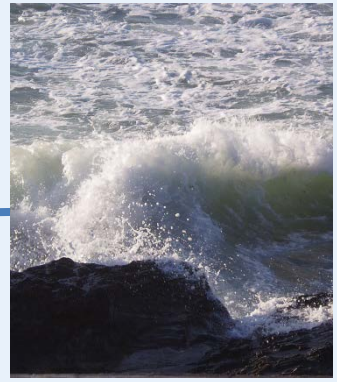
Crops

Source 25

Irrigation Water

Desalination

Salty Water



Brine

Alge

Salt

Shrimps

Message 5

Producing more with less

www.edx.org

Water-Energy-Food Nexus and Sustainability

Sustainability Ambassadors


















Sustainability Ambassadors

sewilam@lfi.rwth-aachen.de