Seminario " ESP & CLIL: friends, false friend or foes?"
"Time-Esperia Industrial Museum« ITIS Paleocapa, BG -18/10/2017

LIGHT from LIGHT

Photovoltaic power system

understanding basic concepts and design elements

CLIL subject

overview

CLIL … one more definition

- is the CLIL just a method to make the learning process of a student more attractive ?
- is it a way of teaching from backstage?
- is it a way to please students with some fun?

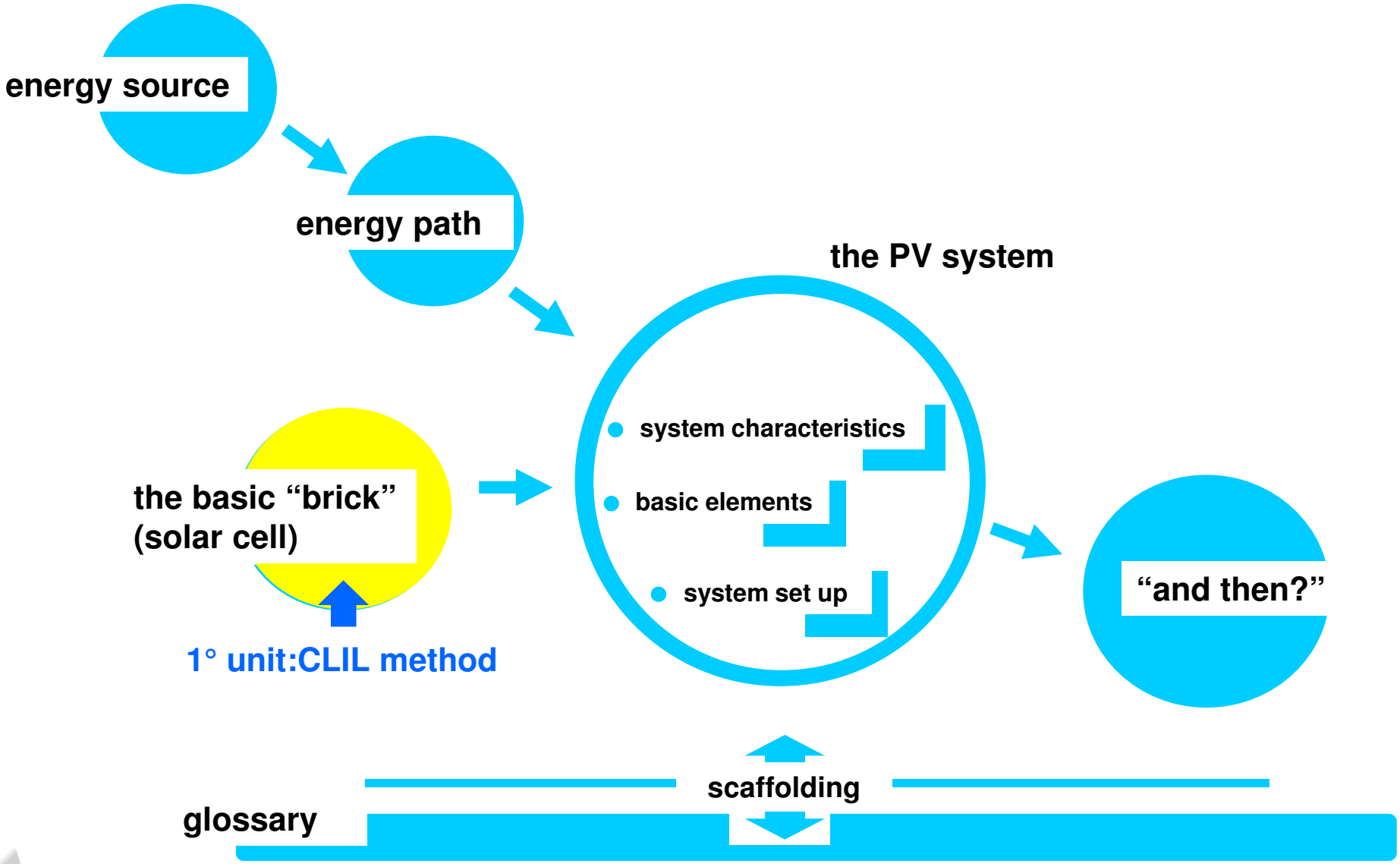
these are true but we know for sure

- the CLIL could be a perfect method of eliciting knowledge
- and also a real novel maieutic method

CLIL subject

overview

the concept map



CLIL subject

planning

TEACHING PLAN

TITLE: LIGHT FROM LIGHT

SCHOOL: Upper secondary CLASS: 5

STUDENTS' LEVEL: B2 N. OF STUDENTS: 20

SCHOOL TERM: First term TIME TAKEN: 3 units

AIMs: to understand the photovoltaic system and to be able to design a basic one

OBJECTIVES:
to allow students

1. to understand the basic photovoltaic process
2. to acquire the basic physical knowledge
3. to learn the basic rules for a simple system design
4. to evaluate the environmental impact of the energy production based on a PV system
5. to compare different energy production system in terms of their environmental compatibility

TECHNOLOGICAL TOOLS EMPLOYED: projector, multimeter, light sources

JOINT TEACHING WITH COLLEAGUES: the laboratory teacher

PRE-REQUISITES:

language skill:

- Students know the basic rules of speaking interaction (ex. turn-taking)
- Students can work in pairs and can interact in whole-class discussion
- Students can infer information from examples in context

basic knowledge related to the subject

- light physics
- materials behavior versus electricity (conductor, semiconductor, dielectric) and energy bands model
- use of some basic electric instruments like a multimeter
- light emitting diodes (LED)

MATERIALS:

- Coursebook
- Handouts
- Photocopies
- Slides

CLIL subject

activities

glossary

the «glowing» energy

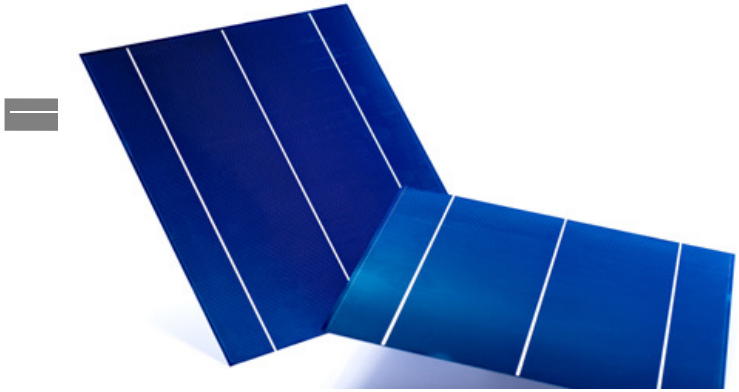
CLIL subject

PROCEDURE, ACTIVITIES AND CLASSROOM MANAGEMENT: 1st UNIT

PHASE + timing	ACTIVITIES	HOW	WHY
LESSON 1 WARM-UP 20 minutes	Guessing game; team work	The teacher asks the student to set up groups of maximum five students and supplies students with a sheet with a random list of technical words and their definitions; students must link each word with the proper definition	To test the basic knowledge of the students
PRESENTATION 10 minutes	Introduce to the subject	The teacher shows a concept map of the subject, the aim and the expected outcome of the lesson	The students need to clear understand what they are going to do
TEAM WORK 30 minutes	Set up the experiment and take measurements	The teacher supplies each group with a kit composed by a multimeter, a LED and a light-variable flashlight. The students have to light the LED with the flashlight and measure the different level of the voltage across the LED terminals vs the different levels of light coming from the flashlight and report the measurements on paper	The students have to be able to set up an experiment and to do the right measurement
ANALYSIS 40 minutes	Analyse the result of the measurements	The teacher collects the reports and examines them with the students comparing, analysing and discussing the results	The students have to try to understand the physical phenomenon by their own
SYNTHESIS 20 minutes	Guess the phenomenon behind the behaviour	Students are again in groups and each group is asked to shortly prepare a presentation on slides describing the phenomenon they observed and their guess behind the behaviour	The students become able to properly understand the twofold behaviour of a LED

- glossary

CLIL subject



glossary

- basic PV system glossary

glossary

- **Air Mass**: the path length which light takes through the atmosphere normalized to the shortest possible path length (that is, when the sun is directly overhead). The Air Mass quantifies the reduction in the power of light as it passes through the atmosphere and is absorbed by hair and dust
- **angle of incidence** - angle between the normal to a surface and the direction of incident radiation; applies to the aperture plane of a solar collector. Most modern solar panels have only minor reductions in power output within plus/minus 15 degrees. The loss is a function of the cosine, so at 45 degree angle, output drops off by about 30%
- **array** - any number of photovoltaic modules connected together to provide a single electrical output. Arrays are often designed to produce significant amounts of electricity
- **azimuth** - angle between the north direction and the projection of the surface normal into the horizontal plane; measured clockwise from north. As applied to the PV array, 180 degree azimuth means the array faces due south

B

- **balance of system** (BOS) - represents all components and costs other than the PV modules. It includes design costs, land, site preparation, system installation, support structures, power conditioning, operation and maintenance costs, batteries, indirect storage, and related costs

CLIL subject

glossary

- **boron (B)** - the chemical element commonly used as the dopant in photovoltaic device or cell material

C

- **cell** - the basic unit of a photovoltaic panel or battery
- **conversion efficiency** (cell or module)--The ratio of the electric energy produced by a photovoltaic device (under one-sun conditions) to the energy from sunlight incident upon the cell
- **CO2** - carbon dioxide
- **D**
- **donor** - in a photovoltaic device, an n-type dopant, such as phosphorus, that puts an additional electron into an energy level very near the conduction band; this electron is easily exited into the conduction band where it increases the electrical conductivity over than of an undoped semiconductor
- **dopant** - a chemical element (impurity) added in small amounts to an otherwise pure semiconductor material to modify the electrical properties of the material. An n-dopant introduces more electrons. A p-dopant creates electron vacancies (holes)

CLIL subject

glossary

CLIL subject

E

- **EVA** - (ETHYLENE VINYL ACETATE) an encapsulant used between the glass cover and the solar cells in PV modules. It is durable, transparent, resistant to corrosion, and flame retardant

G

- **grid-connected (PV system)** - a PV system in which the PV array acts like a central generating plant, supplying power to the grid

I

- **incident light** - light that shines onto the face of a solar cell or module
- **inverters -** devices that convert dc electricity into ac electricity (single or multiphase), either for a graphical presentation of the current versus the voltage from a photovoltaic device as the load is increased from the short circuit (no load) condition to the open circuit (maximum voltage) condition. The shape of the curve characterized cell performance
- **ion** - an electrically charged atom or group of atoms that has lost or gained electrons; a loss makes the resulting particle positively charged; a gain makes the particle negatively charged
- **irradiance** - the direct, diffuse, and reflected solar radiation that strikes a surface. Usually expressed in kilowatts per square meter. Irradiance multiplied by time equals insolation

glossary

- **I-V curve** - a graphical presentation of the current versus the voltage from a photovoltaic device as the load is increased from the short circuit (no load) condition to the open circuit (maximum voltage) condition. The shape of the curve characterizes cell performance

K

- **kilowatt (kW)** -1000 watts (unit of measurement of the power)
- **kilowatt-hour (kWh)** - one thousand watts acting over a period of 1 hour. The kWh is a unit of energy. 1 kWh=3600 kJ

L

- **load -** anything in an electrical circuit that, when the circuit is turned on, draws power from that circuit

M

- **maximum power point** (MPP) - the point on the current-voltage (I-V) curve of a module under illumination, where the product of current and voltage is maximum. [UL 1703] For a typical silicon cell panel, this is about 17 volts for a 36 cell configuration

CLIL subject

glossary

- **module** - a number of PV cells connected together, sealed with an encapsulant, and having a standard size and output power; the smallest building block of the power generating part of a PV array. Also called panel

N

- **n-type semiconductor** – a semiconductor produced by doping an intrinsic semiconductor with an electron-donor impurity (e.g., phosphorous in silicon)

O

- **open-circuit voltage** (Voc) - the maximum possible voltage across a photovoltaic cell or module; the voltage across the cell in sunlight when no current is flowing

P

- **peak watt** - a unit used to rate the performance of solar cells, modules, or arrays; the maximum nominal output of a photovoltaic device, in watts (Wp) under standardized test conditions, usually 1,000 watts per square meter of sunlight with other conditions, such as temperature specified
- **photovoltaics** (PV): the name of a method of converting solar energy into direct current electricity using semiconductor materials that exhibit the photovoltaic effect

CLIL subject

glossary

- **photovoltaic (PV) effect**: the creation of voltage or electric current in a material upon exposure to light
- **photovoltaic (PV) array** - an interconnected system of PV modules that function as a single electricity-producing unit. The modules are assembled as a discrete structure, with common support or mounting. In smaller systems, an array can consist of a single module
- **photovoltaic (PV) cell** - the smallest semiconductor element within a PV module to perform the immediate conversion of light into electrical energy (dc voltage and current)
- **photovoltaic (PV) conversion efficiency** - the ratio of electric power produced by a photovoltaic device to the power of the sunlight incident on the device
- **photovoltaic (PV) efficiency** - the ratio of electric power produced by a cell at any instant to the power of the sunlight striking the cell. This is typically about 9% to 14% for commercially available cells
- **photovoltaic (PV) generator** - the total of all PV strings of a PV power supply system, which are electrically interconnected
- **photovoltaic (PV) module** - the smallest environmentally protected, essentially planar assembly of solar cells and ancillary parts, such as interconnections, terminals, [and protective devices such as diodes] intended to generate DC power under unconcentrated sunlight

CLIL subject

glossary

- **photovoltaic (PV) panel** - often used interchangeably with PV module (especially in one-module systems), but more accurately used to refer to a physically connected collection of modules (i.e., a laminate string of modules used to achieve a required voltage and current)
- **photovoltaic (PV) system** - a complete set of components for converting sunlight into electricity by the photovoltaic process, including the array and balance of system components
- **p–n junction** - a boundary or interface between two types of semiconductor material, p-type and n-type, inside a single crystal of semiconductor. The "p" (positive) side contains an excess of holes, while the "n" (negative) side contains an excess of electrons
- **p-type semiconductor** - a semiconductor in which holes carry the current; produced by doping an intrinsic semiconductor with an electron acceptor impurity (e.g., boron in silicon)
- **S**
- **semiconductor** - any material that has a limited capacity for conducting an electric current. Generally falls between a metal and an insulator in conductivity
- **short-circuit current** (Isc) - the current flowing freely from a photovoltaic cell through an external circuit that has no load or resistance; the maximum current possible

CLIL subject

glossary

- **silicon** (Si) – a chemical element, atomic number 14, semi-metallic in nature, dark gray, an excellent semiconductor material. A common constituent of sand and quartz (as the oxide). Crystallizes in face-centered cubic lattice like a diamond. The most common semiconductor material used in making photovoltaic devices

- **solar spectrum** - the total distribution of electromagnetic radiation emanating from the sun
- **substrate** - the physical material upon which a photovoltaic cell is made

T

- **tilt angle** – the angle at which a photovoltaic array is set to face the sun relative to a horizontal position. The tilt angle can be set or adjusted to maximize the seasonal or annual energy collection

W

- **wafer** - a thin sheet of semiconductor material made by mechanically sawing it from a single-crystal or multicrystal ingot or casting

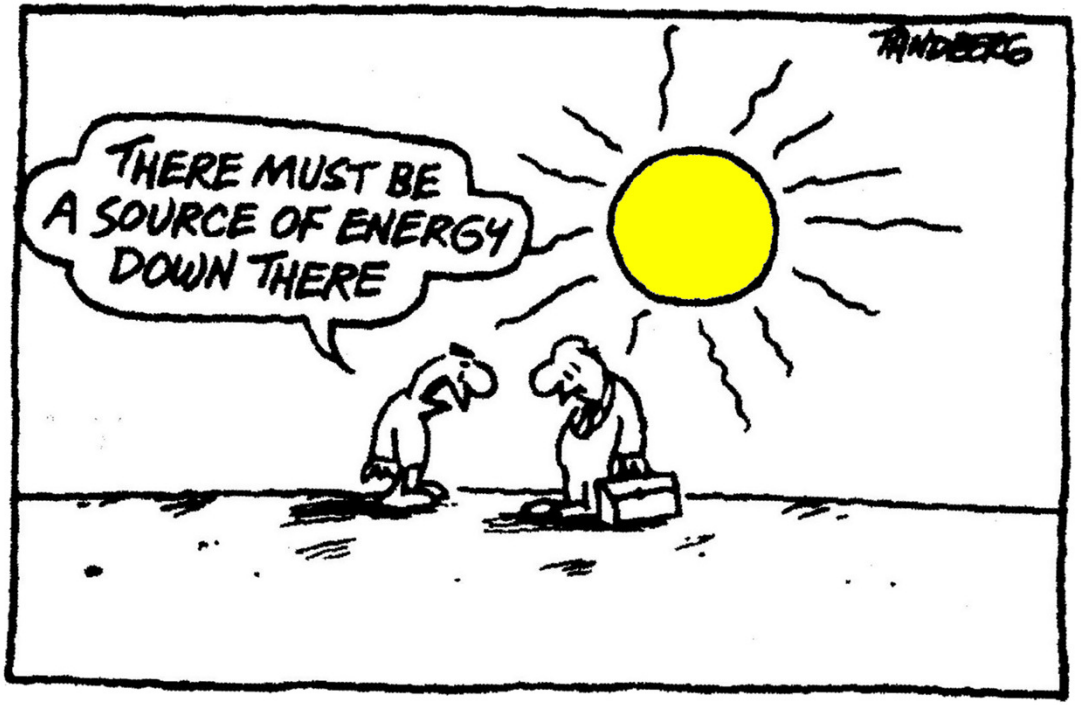
CLIL subject

PV system

CLIL subject

"and then ?"

the evidence



- *Solar is by far the largest energy resource available on Earth.*

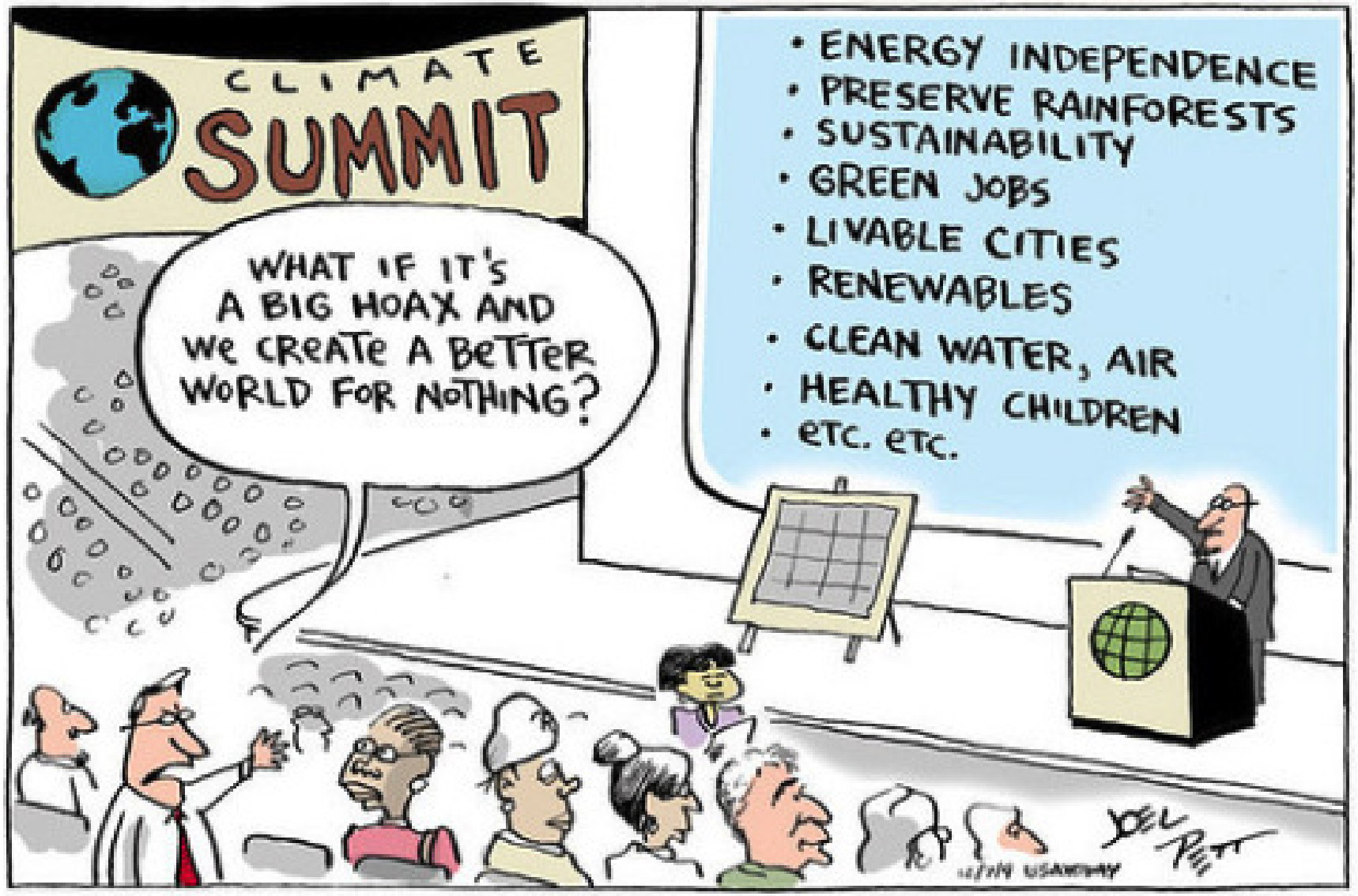
All other energy sources—aside from nuclear, geothermal, and tidal—come from sunlight. Fossil fuels are just solar power integrated over millions of years using dinosaurs (and other carbon-based life forms) as batteries. Wind and wave power is merely solar power absorbed unevenly across the Earth's surface, leading to thermal gradients and mass flow.

- ***Solar photovoltaics is growing fast—faster than any other energy technology***. Cumulative installed PV capacity worldwide has doubled every two years since the year 2000, reaching ~200 gigawatts-peak (GWp) in 2014.

CLIL subject

- "and then ?"

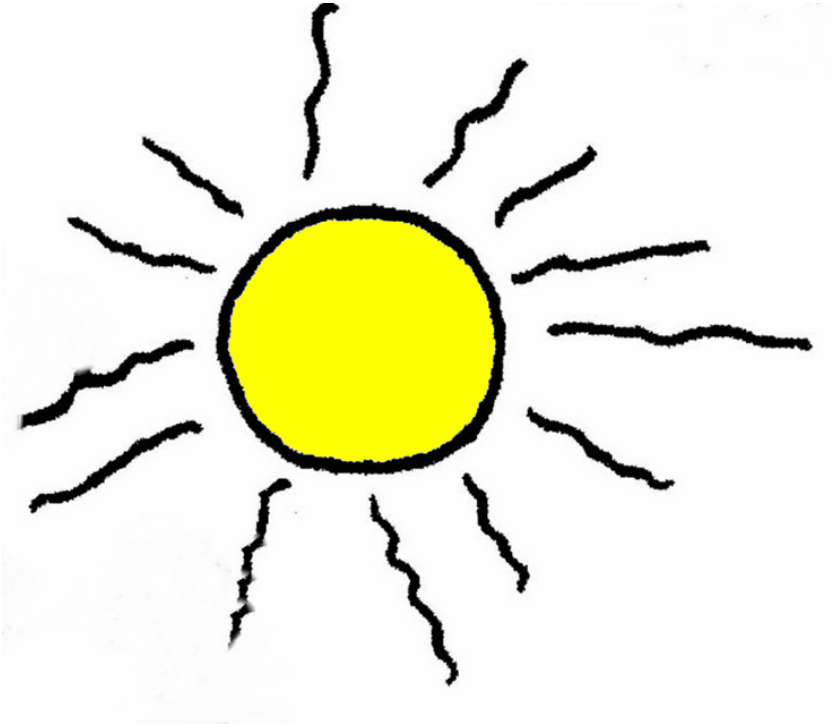
the big question



CLIL subject

"and then?"

… but there is not such a risk



- climate change is a real and present threat to the future of human life and all other life on Earth

- the solar energy holds the best potential for meeting humanity's future long-term energy needs

- *but to realize this potential it is required an increased emphasis on developing lower-cost technologies and more effective deployment policy, says a comprehensive new study on the future of solar energy* (MIT Energy Initiative)

CLIL subject

LIGHT from LIGHT

Photovoltaic power system

understanding basic concepts and design elements

Thanks !...