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Teaching material on Ecological Footprint

LEARNING UNIT 4

HOUSING

AGE GROUP 1 (10 – 13 YEARS)

Version 2.0, jan. 2020

This material is part of a course on the Ecological Footprint for students.

The course consists of the following modules for two age groups:

Age group 1 10-13 years	Age group 2 14-18 years
Calculator	
General Introduction	General Introduction
Mini Hectare Workshop	Mini Hectare Workshop
Nutrition	Nutrition
Housing	A. Housing core B. Housing additional
Mobility	Mobility
Other Consumption	Other Consumption
Background information	

You are here

All the material can be downloaded for free at **www.e-co-foot.eu** in different languages.

calculator.e-co-foot.eu is an online tool that allows students to log their daily activities and trace the Ecological Footprint of their habits. Group functions for teachers make it suitable for a warm-up or later check-up-session.

elearning.e-co-foot.eu is an e-learning package with selected content from the lectures. E-learning can be used for blended learning of this course, as homework or as training and competence check after in-class lectures.

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LEARNING UNIT 4

THE ECOLOGICAL FOOTPRINT OF HOUSING

TEACHING MATERIAL FOR AGE GROUP 1 (10–13 YEARS)

The aim of this Learning Unit is that students understand the importance/the steps to reduce the Ecological Footprint of housing.

Short overview

Duration of Learning Unit: 45 min.

This Unit consist of:

- PDF document with description and input
- Power Point Presentation
- Materials for print

Brief description of this learning unit:

After going through this Learning Unit, students should be able:

+to analyse the components of the housing Ecological Footprint;

+to become active supporters of energy saving and of using it from renewable sources;

+to explain the importance of home insulation to reduce the housing Ecological Footprint;

+to analyse the different house types after their energy index and functionalities;

+to become active in the common efforts to reduce housing Ecological Footprint, by their own solutions;

+to enrich their technical/foreign language knowledge and IT skills.

Overview of content	duration
1. Ice breaker	3 min
2. Introduction to the Ecological Footprint	5 min
3. The type of energy we consume	6 min
4. The way we consume energy	5 min
5. The type of insulation	5 min
6. The living space	3 min
7. Conclusions: Impact of our actions	3 min
8. The most important things YOU can do!	5 min
9. Exercises	8 min
10. Homework (explanation)	2 min

Setting: classroom

Items: empty match boxes (about 16 pieces), flipchart sheets, laptop, beamer.

Connection to subjects: geography, biology, chemistry, physics, mathematics, nature sciences, environmental sciences, national language, English as a foreign language, other foreign languages, project lesson (country specific subjects).

Sequence

The spoken text of the teacher is in blue colour. The explanations of what the teacher does are written in black.

1. Ice breaker

Teacher explains to the students:

The task is A COMPETITION to build a higher tower! Form 2 groups of two-three students (volunteers). You have matchboxes (or any other cubic objects what are the same size):

Group A gets 4 pieces. Group B gets 6 (they must ignore the unfairness...)

Each round the groups can add two pieces to their tower:

- Group A adds two pieces and gets 2 more pieces after each round
- Group B adds two pieces but gets nothing!

The result would be – in 3 rounds, group B remain without pieces, group A has the same number as in the beginning – WHY? BECAUSE GROUP A USED RENEWABLES!!!

Discuss about the results – what are the conclusions?

- Extension: could group A have more than 6 pieces from the beginning? Or, could they receive more than two pieces after each round (more than they spent)? Why/why not?

Renewable is something different than endless!

Renewables: We only have limited pieces of energy per time unit. But we will get these again and again - only the sustainable ones (e.g. amount of energy produced by wind, amount of water in a river, amount of wood that can be cut down in one year).

Fossil: A bigger amount of fossil energy is at hand, but it is not regenerated (on the timescale of mankind), so it will end some day in the future.

Tip: Do not mix up with climate change. This is another important reason, why we should switch to 100% renewable energy as soon as possible.

The key learning of this exercise is that we have to switch anyway, as fossil energy is running out. But it is very important to understand that it would be late for climate change if we wait too long – by the time all fossil fuel are burned, a lot of irreversible changes would have already been happened.

Would the winner have been different, if one or the other group had started with more pieces (more oil, gas, coal, or more renewables?).

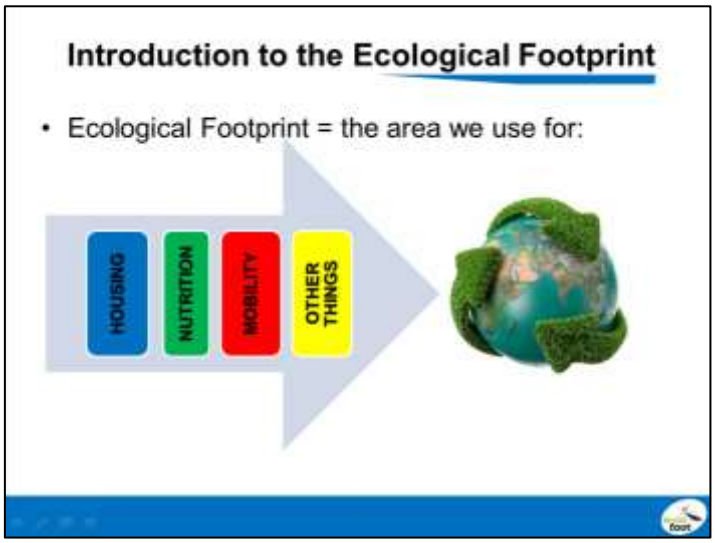
Answer: No, it only would have taken longer. And would cause more climate change!

Could it be possible, that group A had more pieces from the beginning – like equal (6) to group B, or more than them?

Is the renewable energy potential endless in time/space dimensions? Students must think about these questions and give the correct answers – in their own words.

2. (REPETITION) Introduction to the Ecological Footprint

RPT



Human kind needs to consume in order to survive. Everything we consume requires resources. These resources have to be produced by nature and therefore require certain areas of land.

This land is limited because we live on a limited planet. In fact, we can only use 25% of the Earth's surface! The usable area is called bio-productive area.

Teacher launches a challenge to the students to discover examples of how is space used in each way and conducts their answers:

- housing (mostly urban settlements, houses/house yards),

- mobility (e.g. driving and flying – roads, airports, service spaces),

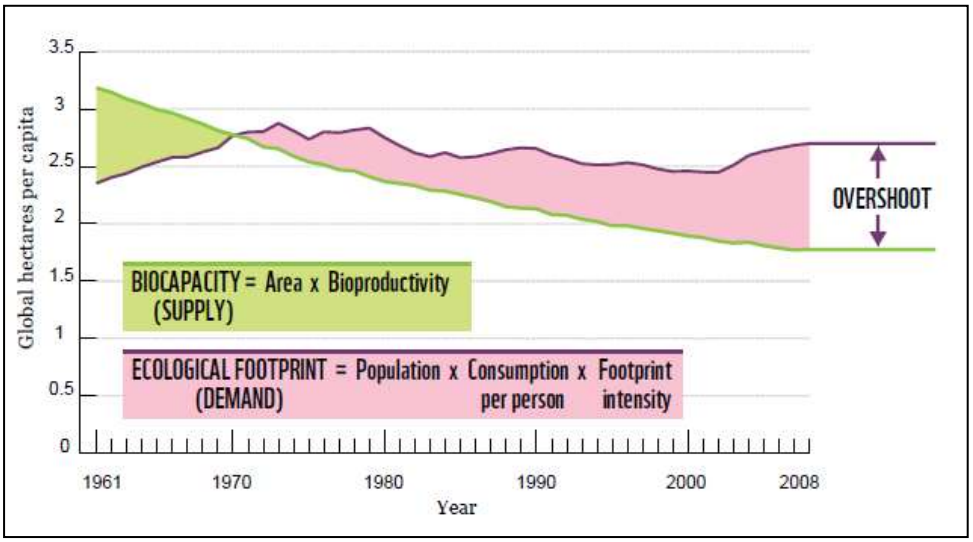
- nutrition (the things we eat and drink – we need area to grow them)

- other many things we use for our daily consumption, apart from food (paper, electronic devices, clothes – we need an area to produce them).

There are different territories we use to produce these things: farmland, pasture, built up areas for industry, houses and roads, forests, oceans and inland bodies of water. Students discover all products these areas are responsible for, by the time animation go on. The Ecological Footprint contains all these territories, but also takes into account the CO_2 emissions we produce.

Additional information for teachers:

- We must drastically reduce the emissions of CO_2, as well as other greenhouse gases very soon; otherwise **global warming** cannot be stopped. The consequences for life on the planet will then be drastic. CO_2 can be stored. This is done by oceans and lakes, but also by plants which absorb, transform and use it for their own growth. To a certain extent, **trees can bind CO_2**, i.e. remove it from the atmosphere, but our planet has not enough bio capacity to bind ALL the CO_2 from fossil fuel combustion.

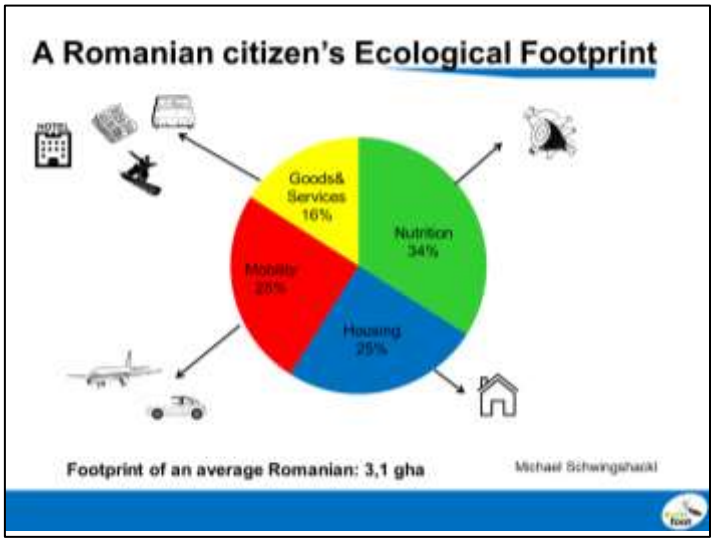


©Global Footprint Network, 2011

- The Ecological Footprint therefore **includes** also **the area of forest that would be needed to bind CO_2 emitted by human activities**. This area can be up to half of the total Ecological Footprint, so it is very significant and leads to overshoot![1]

- In fact, while population number and consumption are both increasing, the forest area is lower each year, due to deforestation (required by the need for firewood or supplies for the paper/furniture production, as well as for agricultural land). That is why, since 1970, the world lives "on credit" because all the available renewable resources for one year are consumed before the end of it. In fact, a "World Overshoot Day" was calculated by the scientists, and every year it is earlier. In 2019, it was on the July, 29th. (See Learning Unit 1, age group 2).

Teacher explains to the students (in case they don't have enough information on the Ecological Footprint and overshot day) the basic concepts.



The Footprint can be divided in four key-areas for the human daily life: nutrition, housing, mobility and non-food consumption.

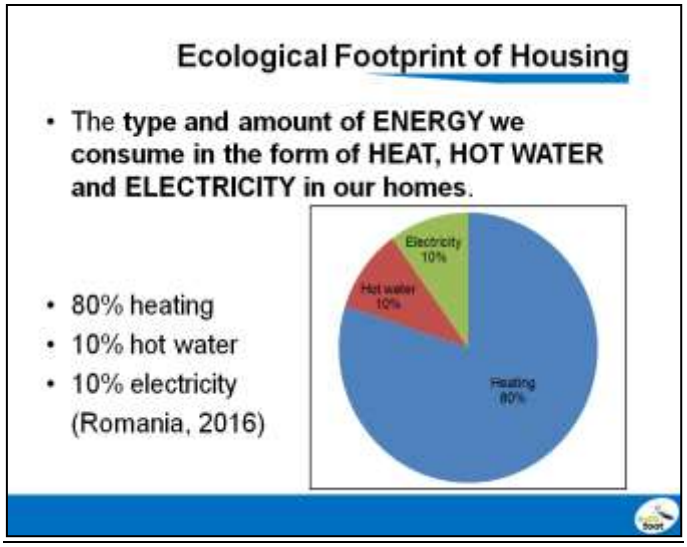
What are the activities that can be included in the nutrition area? (answer: the area needed for all the activities, related to food production, transportation and disposal)

What are the activities that can be included in the housing area? (answer: housing - area for house construction, with comfortable indoor temperatures, water and sanitation, electricity and all devices)

What are the activities that can be included in the mobility area? (answer: mobility - the area for roads, railroads, airports, and the space needed to bind all the substances, resulting from transportation of people, like going to work/school, sport&leisure, or going shopping by car/bus)

[1]What does overshoot mean? People consume more than the planet can re-grow, resulting in a deficit that accumulates over the years. It is like withdrawing money from a bank account, more than the interest rate – while you withdraw from the deposit, it will produce less interest by the time comes, but also will lower the value of the initial deposit.

What are the activities that can be included in the "other consumption" area? (answer: this is everything else people buy except for food, such as: furniture, clothing, electrical devices[2], paper and the other things of everyday life. One of the largest shares of "other consumption" is paper).



What are the energy uses in YOUR HOMES? (Students indicate the forms of consumption, according to their own living conditions)

This part of the Ecological Footprint is caused by the type and amount of ENERGY we consume in the form of HEAT, HOT WATER and ELECTRICITY in our homes.[3]

Heating our homes takes up the most part of the housing Ecological Footprint. Why is heating so important in the Ecological Footprint structure?

Answers (conclusions of the students-teacher dialogue) – to be adjusted for each country.

- Romania is a country with a long cold season (some houses need to be heated for more than half a year).
- The electricity consumption in a house covers a lot of activities, from lighting to computers' use (or electrically operated water pumps, for the houses which are not connected to a centralised water system).
- In Romania, the high price of electricity/natural gas/firewood/water is the main reason to consume less. Saving energy will help to save a lot of money, because the energy bills are the most important expenses in a household[4].

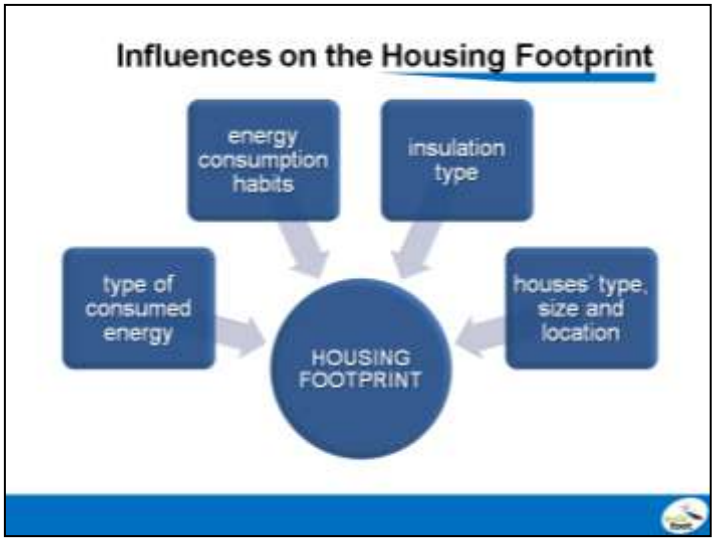
[2]The resources needed to *produce* electronic devices we use in our homes like refrigerators, TVs and so on are part of the "Consumption Footprint" (Learning Unit 6), and the *energy consumption* of these devices is part of the "Housing Footprint".

[3]Of course, there are also resources needed to *build or renovate* houses, which also cause a Footprint. This Footprint is also part of the "Grey Footprint" and not mentioned here separately. See additional information on the "Grey Footprint" in the background material of the Learning Unit 2.

[4]While gas, petrol/diesel or electricity prices are accordingly like in the other EU countries, average population incomes are considerably lower in Romania.

3. Influences on the Housing Footprint

Why is the Housing so important to our personal Footprint? What are its main components?



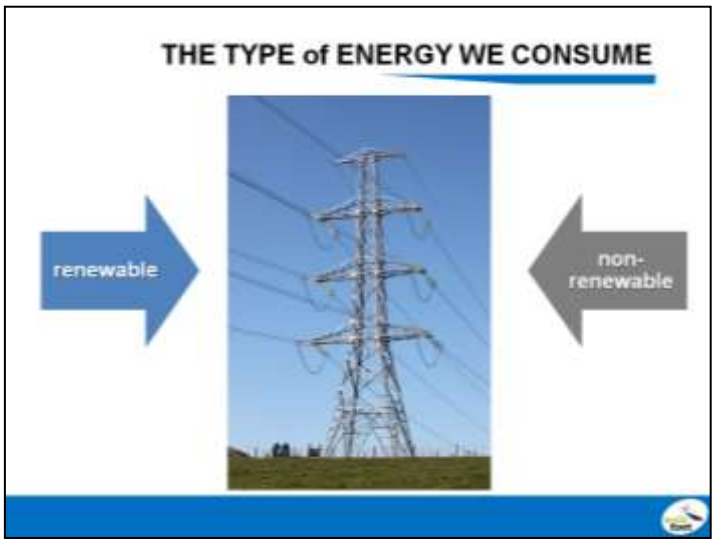
Where do you live? How can you describe your living conditions? Two-three volunteers share with the others the characteristics of their homes: size, type, heating modes, improvements, and so on ... Teacher is looking for examples of different and relevant situations.

There are a lot of differences between the types of houses. What are the key-factors that influence the Footprint?

Students summarize:

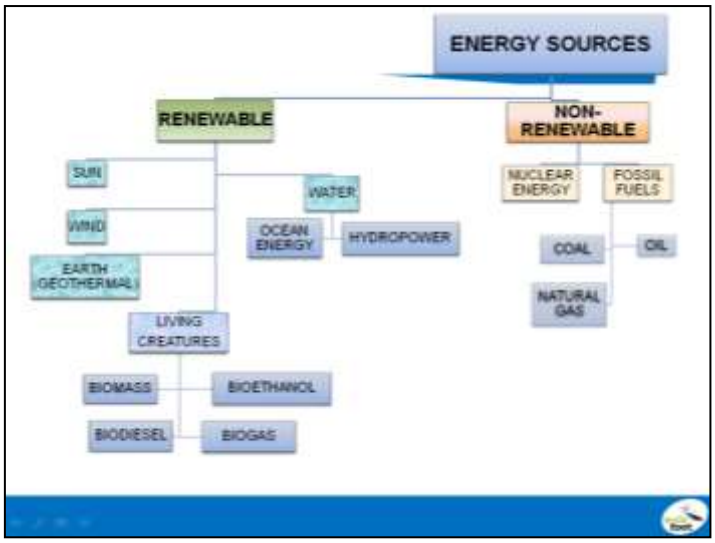
- the **type of energy** we consume for heating or electricity:
- the **way** we consume energy (habits, devices)
- the type of **insulation** and/or **energy production** of our houses
- the **size, type and location** (connection to public transport through the mobility Footprint) of our houses and flats

4. The type of energy we consume



How is our energy produced? Which energy sources for electricity and heat do you know?

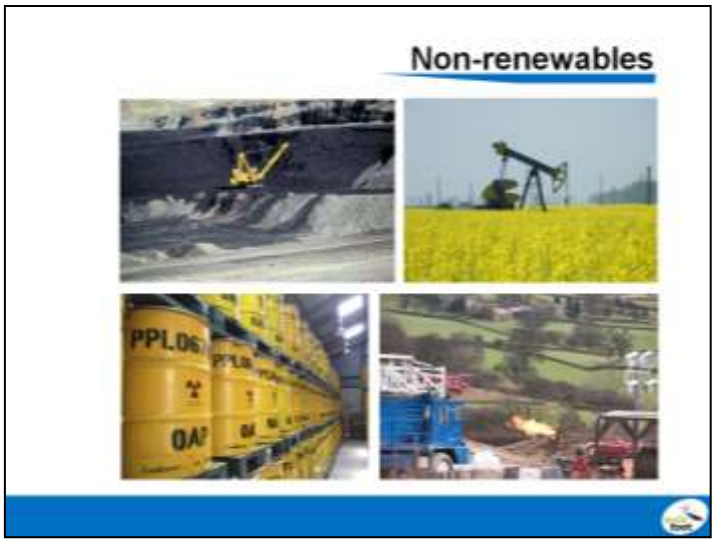
Answers: some of them are renewable, some – non-renewable.



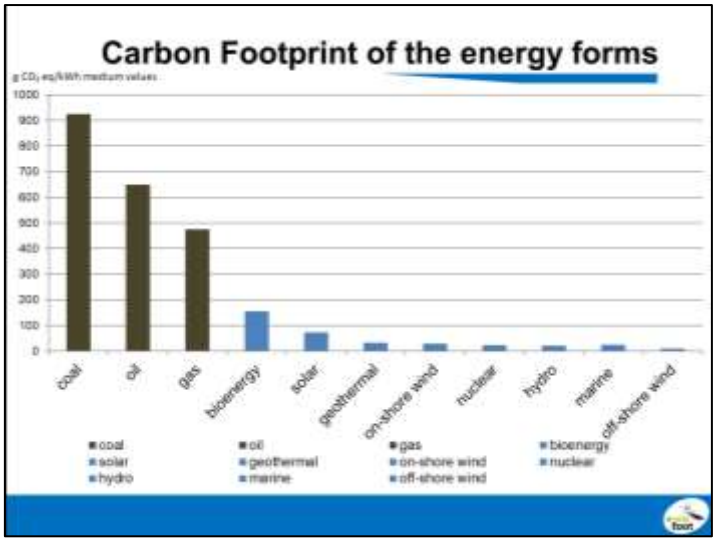
- ➔ **renewable**: wind, sun, geothermal energy, biomass, water
- ➔ **non-renewable**: fossil fuels like coal, oil, natural gas; uranium (nuclear energy)

What are the differences between them? Where do they come from? How can energy be produced by using them?

What are the different impacts of these energy sources on the environment?



Students briefly describe the energy sources and their estimated impact, looking at the pictures from the two slides above – first one, for renewable energy forms, second one – for non-renewables (images appear in the same order as in the scheme).



As we learned before, the Ecological Footprint of fossil fuels is not only calculated using the area of the oil fields and coal deposits, but also using the area that is required to bind the CO_2 emissions – THE CARBON FOOTPRINT (the total amount of greenhouse gases emissions generated by the use of each energy source for heating, hot water heating and electricity production, measured in CO_2 equivalent emissions per unit).

If we compare the Carbon Footprint of all energy forms, using medium values (because the production circumstances are very different from one country to another, even from one year/season to another), we can draw the following conclusions:

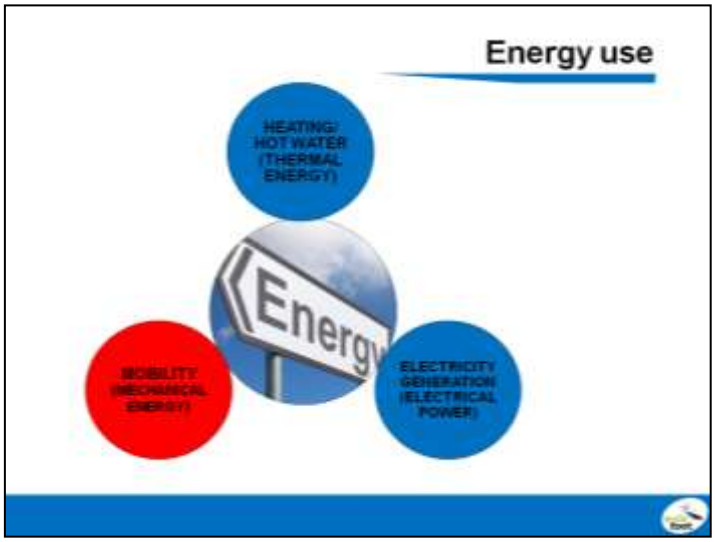
Carbon Footprint of the electricity obtained from different energy forms[5] can be studied in the following table:

	gCO_2 eq/kWh (medium values)
coal	925
oil	650
gas	475[6]
bio-energy	155
solar	72,5
geothermal	32,5
on-shore wind	27,5
marine (wave+tidal)	25
nuclear	22,5
hydro	21
off-shore wind	10

Conclusion->in the situation of responsible actions and good governance, political leaders (or state authorities) should support/encourage the most environmentally free technologies, and, subsequently, issue prohibitive measures against the most Footprint-consuming ones.

[5] data: http://energyforhumanity.org/en/nuclear/fact-file-carbon-footprint/ adjusted by Plattform Footprint

[6] However, it should be noted that methane (CH_4), as the main component of natural gas, is itself a greenhouse gas whose climate impact per quantity is significantly higher than that of its combustion products (CO_2 and H_2O). If leaks occur in the course of extraction, transport or use in a power plant, from which natural gas escapes into the atmosphere, the climate balance is significantly worse than if the gas had been properly and completely burned.



Where does energy come from? How do we use energy in our everyday life? In which forms do we use it? How do we transfer energy from one form to another?

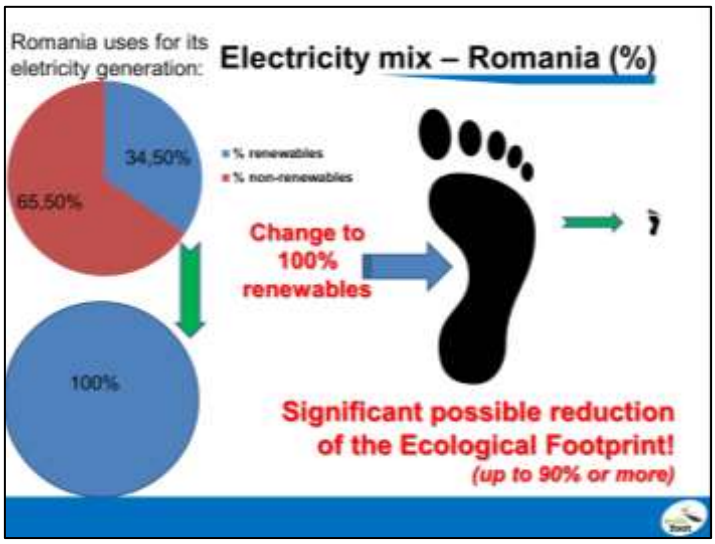
Answers:

- Energy= electricity (ELECTRICAL POWER)

- Energy = heat (CALORIC POWER)

- Energy = mobility (THERMAL AND MECHANICAL POWER)

All of these produce various emissions, which need a significant area to be neutralized. Housing is mostly connected with heating and electricity consumption, although mobility can be influenced by the location and other features of the house (for example, the need for supplies).



The share of non-renewables in the electricity generation of Romania is still too high: 66,5 %!

If electricity would be produced (ALMOST) ONLY from renewable sources – how it could change the Ecological Footprint?

We'll have the possibility to change our electricity mix (the structure of our electricity production) up to 100% renewable energy sources. What are the changes that might happen, in this situation? How would the Ecological Footprint change?

Students should think about reducing pollution, the CO_2 emissions, environmental benefits, modern technologies...

Information for teachers: The truth is that the Ecological Footprint can shrink significantly if the electricity will be generated only from renewable sources (see the reduced footprint on the PowerPoint slide).

Using renewable energy sources is the future of our planet! It can save money, on the long term, reducing the actual pollution and all the harms that result from it.

Imagine a world that used only renewable energy forms. How could you describe it?

Students should answer using terms like these:

- Without operating internal combustion engines!

- With no pollution generated by burning fossil fuels!

- Where thermal power plants will have disappeared!

- Without nuclear power plants – not a threat anymore!

- Where energy problem is completely solved - by using only "clean" technologies!!!

CONCLUSION: Switching to green electricity is therefore by far the most efficient measure in this area which also doesn't have any negative impact on comfort.

Which are the disadvantages or risks of using the renewable firewood for heating?

Pupils give answers like these:

- Air pollution!

- Deforestation!

- Loss of comfort (wood chopping, ash removal etc.).

- Available biomass is limited, even if it is renewable!

5. The way we consume energy

Ways to reduce electricity part of housing Footprint:

Key messages:

- Reduce consumption = reduce the time of use.
- Change consumption habits! Use devices at full load or max. efficiency (ex. washing machines, dishwashers, electric kettles …).
- More efficient devices = Less energy consumption! **(examples ...)**
- Big electrical appliances (oven, fridge, freezer) = about 30-50% of the household electricity. **Constant function → proper use!**
- Stand-by = up to 5% of the electricity demand→**residual heat and unnecessary radiations** *(see the picture of the cat).*

You can see here some examples on how to save heat in our households **–almost for free!**

Students describe, based on what they see/what they know from home, what we need to do:

- **Keep the connecting doors closed**, between spaces with different temperatures and use (bedroom - lobby, living room - kitchen, staircase - corridors, etc.)
- **Frequently ventilate the space in a natural way**, for short intervals, with fully open windows.
- **Use wisely the radiator thermostat** - it can be adjusted to meet the individual heat preferences. It doesn't replace the overall thermostat with electrical programming (for the entire place).
- **Turn down the heating during the night and when you are not at home** – this can be done with a programmable thermostat but also with a switch.

These solutions can be applied at home with no extra costs.

6. The type of insulation

What is the insulation?

It is an extra layer between the house and the surrounding area –a thermal barer between the house and the environment. Like a "winter jacket" for the house in the cold season (combined with a long, white-colour cotton gown, worn in the desert to protect from the huge summer heat)...

INSULATION MATERIALS

How can we insulate a house?

We need a lot of materials to insulate all the house segments that are in connection with the heat transfer. What are the areas, which need insulation? (Examples: exterior walls, windows, roof, others).

Which one of you has his/her house insulated? How did you do it? How much did it cost? Did your parents work by themselves on it, or did they hire specialized people/companies to do it?

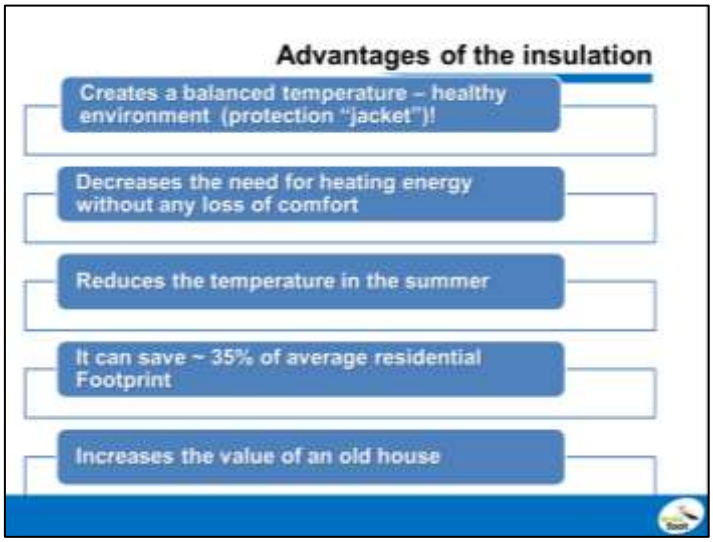
Teacher collects students' answers.

There is a variety of insulation materials, under the form of: rolls, blankets, rigid boards, structural insulation panels, foils and other reflective systems.

Which one is familiar to you?

Some students can indicate some insulation materials they had already heard about or seen – and the circumstances.

There are a lot of insulation materials, from the natural fibbers (wool, cotton, hemp), to the wastes from the textile industry or paper chips (that could be recycled in this way) and a lot of artificial materials, like foam boards, pre-shaped insulated panels or foils and other reflective systems.



What are the reasons for insulating the buildings, residential ones in particular?

The Ecological Footprint can be decreased by thermal insulation. Without any loss of comfort, insulation decreases substantially the need for heating energy: a good insulation can save a lot of the average residential Footprint. Can you estimate how much? Students offer estimations – teacher collects answers and indicates the right percentage, using terms as "one third".

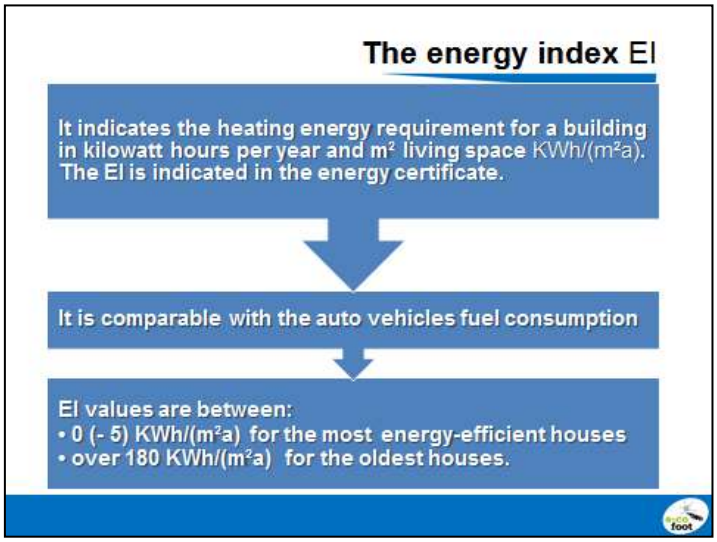
Which one of you lives in a new house? Is it insulated?

Which one lives in a block of flats? Is it insulated on the outside? Have you seen the apartment exterior insulation?

Which one lives in an old building? Have your family thought about insulating it?

Insulation reduces both the expenses for heating during the winter season, and the electricity consumption (air conditioning, ventilation) in the summer. And the indoor temperature is constant, keeping a healthy environment.

Not only new houses can be insulated, but the old ones, as well. This increases the commercial value of a building on the real estate market.

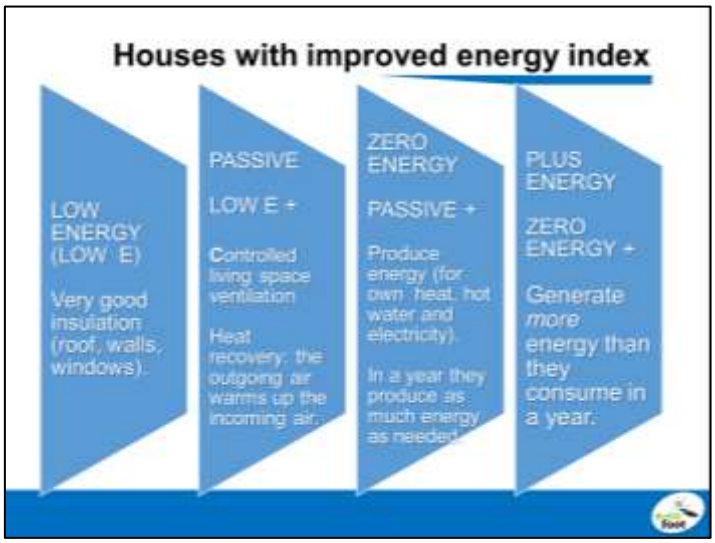


Energy Index indicates the measured specific energy consumption of a building in kilowatt hours per year and sq. meter living space.

If all the possible energy saving and insulation measures are taken, if autonomous heating/electricity systems are installed and all the other possible home improvements are done, then a house should have the lowest possible energy index.

It's like the fuel consumption of a car - it should be a key-factor when buying (or building) a house. Only that, comparing with the consumption, the EI can be improved, through specific measures at any time.

Thus, a normal house can be included in one of the following categories:



If you have an average house (with an EI around 180 kWh/m^{2}a or more) and add to it:

- a very good insulation of all spaces that usually permit heat transfer (roof, walls, windows)

- modern heating systems, pipes and eventually, some solar panels or solar heat water tubes

Then, you obtain a LOW-ENERGY HOUSE (a very efficient one).

If you go further with the transformation, you can include controlled living space ventilation, operated by renewable energy sources (solar, wind, geothermal or hydroelectric energy, supplied by the grid or

autonomously functioning systems). Then, your house has even lower EI and it becomes a PASSIVE HOUSE.

If you add more renewable energy features, so that, for an entire year, the energy produced (in form of electricity, heat or hot water) is equal with the household consumption, then you have a ZERO ENERGY HOUSE.

If you want to invest more, and you can improve it even further, your house will produce MORE energy than consumption – this is the PLUS ENERGY HOUSE (they have an EI up to minus 5 kWh/m^{2}a)

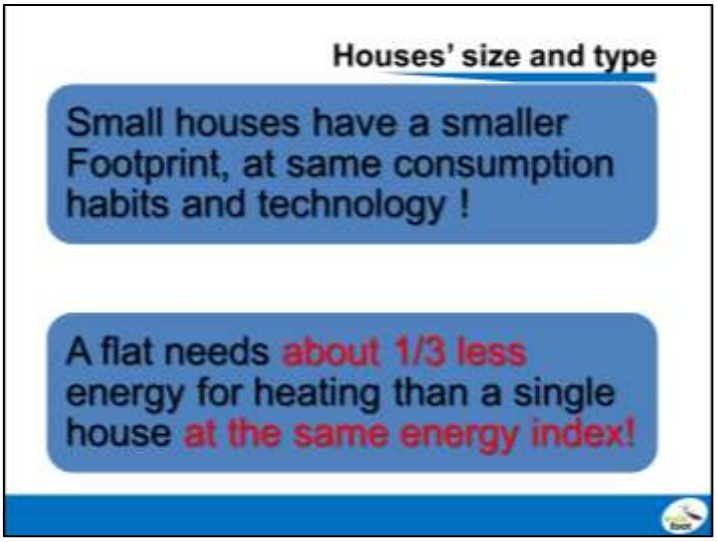
Of course, the process is sometimes impossible in reality (some old houses don't have the technical characteristics that would allow their transformation), but, in time, all the houses should look like these…

Can you imagine living in a house with zero energy bills, or even better, in a house that helps you to get some extra money, instead of paying for the heating/hot water/electricity?

Do you think living in a house like this is uncomfortable for the tenants?

Not at all, it is extremely convenient!

7. The living space

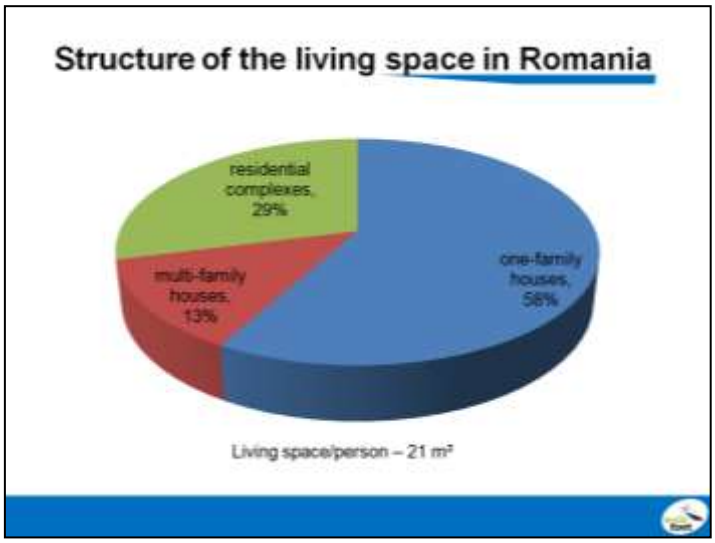


➔ Smaller houses have a smaller Footprint (at the same energy consumption habits and technology)!

Teacher asks students "How big does YOUR FUTURE house have to be, to make you feel comfortable?" Students should realise that a larger house is not only more expensive to maintain, but also "produce" extra Footprint.

➔ If you compare the energy consumption for heating per sq. m of a flat in an apartment block with more than 10 living units to the consumption of a single house (both have the same quality of isolation and its inhabitants the same energy consumption habits), the flat needs up to 1/3 less energy for heating than a single house! Why?

Two students, one living in a block of flats – and the other one, in a single house (if there are any in the class, if not, teacher should be the missing part in the discussion) can talk about their homes, how they are heated. They should compare including how much time during a year is their home heated – usually, a flat needs heating for a smaller period of time.



Teacher asks students to raise their hands if they live in a individual home – counts the answers. Then, explain what a multi-family house is: a single living unit (or the same yard), where more than one family lives (parents and grandparents, siblings, cousins ...). In the end, he/she counts how many students live in a residential complex (a block of flats). If he/she have time to make a simple pie chart, it could be compared with the national values on the slide – if not, it can be estimated:

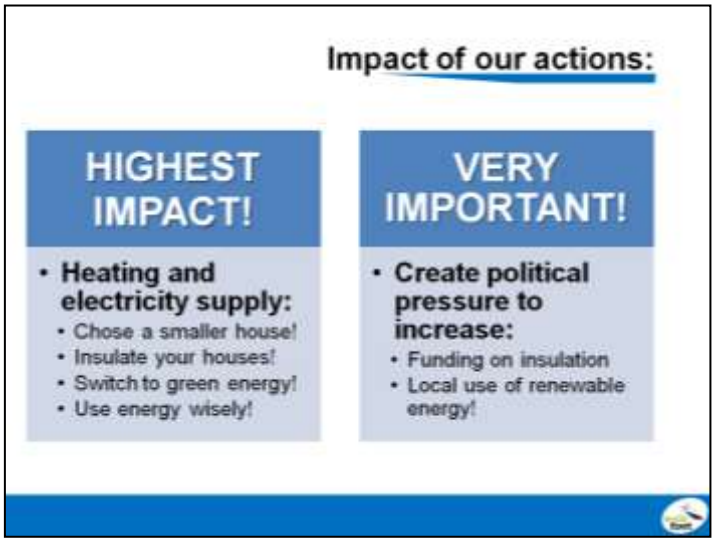
The living space in Romania has the following structure:

- 58 % (more than a half) of the living units are one-family houses
- 13 % - multi-family houses
- 29% are situated in residential complexes.

The bad thing is that the majority of the collective buildings are old blocks of flats built at least 30 years ago, with a very high energy index, old plumbing systems and poorly insulated rooftops.

GOOD News: In the area of housing, with relatively little effort and without loss of comfort, the Ecological Footprint can be massively reduced.

8. Conclusions: impact of our actions



TO SUM UP - There are many things you can do, but not all measures have the same impact. As we learned before, 90% of the Housing Footprint is caused by heating energy and electricity.

The four measures with the HIGHEST impact in these areas are:

A. RESIZING OUR LIVING NEEDS

B. INSULATING OUR HOUSES

C. SWITCHING TO GREEN ENERGY

D. USING ENERGY SO THATAVOID WASTING IT!

Those measures sometimes can be too expensive or, at this moment, **not an available option** in some areas.

Apart from focusing on the other tips to save energy we mentioned above (that have less impact, but are important, too), it is

➔ very important to **create a political pressure to increase funding for insulation and the local use of renewable energy**!

Therefore: **GET ACTIVE FOR AN ENERGY TRANSITION!**

- There are many **groups, campaigns or events** that promote sustainability in our everyday life!
- **Find out if there is such activities in your area**, support them (financially or by participating) and take part in changing the political framework!

9. The most important things YOU can do!

Teacher makes a quiz on the black/white board, with the letters contained in the word "Earth". Each letter corresponds to a different finger (a palm could be drawn on the black/whiteboard, too). It is important to emphasise the importance of each rule, even if they are too small to decide now upon some of them, but as a take-away message for their families. Students can be challenged to fill in the quiz, giving examples from their everyday life.

Exercises&Homework

Teacher has to decide if he/she applies both or only one exercise, in class or use them totally or partially as homework.

Exercise 1: **Housing/ Home Energy SURVEY**

The worksheet is in the zip-file, named as follows:

ecofoot_Housing_Exercise1_agegroup1.pdf

Students must colour some concentric sections around a footprint according to the instructions. Teacher must advise them to start from the interior and not leave blank spaces, so that the students can compare the sizes of their footprints. In the end, they should indicate some ways to reduce it.

Exercise 2: **The type of energy we consume**

The worksheet is in the zip-file, named as follows:

ecofoot_Housing_Exercise2_agegroup1

Students must recognize some of the energy sources/types from their pictures (task A), then to respond to some short questions (tasks B-C). Task D could be solved individually or as group assignment. In the second case, the worksheet can be divided, each group receiving only their task. Discussion of the results can be made in groups or individually, depending on the chosen variant.

Homework

The worksheet is in the zip-file, named as follows:

ecofoot_Housing_Homework_agegroup1.pdf

The teacher hands out worksheets to the pupils listing various measures to reduce the Ecological Footprint of housing in different areas e.g. heating, cooling, hot water and laundry drying, cooking/baking, etc. and explains the three choices:

1. We are already doing this at home!
2. We could do that. Find out how!
3. We can't do that. Why?

For example: Cooling:

Place the refrigerator in a cold position (not directly next to the stove or heater).

Do not choose an unnecessarily cold refrigerator temperature (7°C is sufficient).

Then they put an "X" in the box according to their choice.

They will have to ask their parents about some answers... In the end, they must provide reasons they can't do certain things.

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