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**Solar Energy Education:
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Solar Energy Education: More Important than Ever?

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Abstract

According to recent news, the planet has during the last 12 months exceeded the limit 1.5° C above pre-industrial average temperature. The major reason is the continued increased use of fossil fuels. The IPCC Paris goal is maybe already exceeded. It is therefore most urgent to replace fossils with renewable energy. Presently, solar, wind, and possibly biomass, plus energy efficiency are the most economical alternatives. Unfortunately, the European Union has changed the solution from renewable energy to non-fossil energy, and included nuclear energy in this concept. However, there are good reasons for not building new nuclear reactors, which are given in the paper. It is therefore important that the virtues of renewable energy – and especially solar energy – are taught to all possible target groups in the society: decision makers, media people, industry people, the general public (i.e. voters), school children, to mention just the most obvious target groups. Note that also lobbying is a form of education!

Keywords: Renewable energy, solar energy, education, climate, nuclear energy

1. Climate Change

According to recent news, the planet has during the last 12 months exceeded the limit 1.5°C above pre-industrial average temperature. The major reason is the continued increased use of fossil fuels. This fact was for the first time acknowledged by a Conference of Parties COP in the final document from COP28 in Dubai in December 2023. The IPCC (UN's Intergovernmental Panel on Climate Change) Paris Agreement may already be exceeded.

The agreement is a legally binding international treaty on climate change. It was adopted by all almost 200 Parties at the UN Climate change conference COP21 in Paris in 2015. Its overarching goal was to hold the increase of the global average temperature well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. An excellent summary of recent scientific knowledge is found in Climate Change 2023 Synthesis Report (IPCC 2023).

2. Is Nuclear Energy a Solution?

Unfortunately, the European Union has changed the alternative to fossil fuel from 'renewable energy' to 'non-fossil energy', and included nuclear energy in this concept. Two scientists connected with the Swedish NGO FMKK (Folkkampanjen mot kärnkraft och kärnvapen – the People's Campaign Against Nuclear Power and Atomic Bombs) has (in Swedish) listed 10 major problems with nuclear power in FMKK's Journal Medsols'24, p 5 (FMKK 2024):

1. " Nuclear power is dangerous
2. Nuclear power is unnecessary
3. Nuclear power is expensive
4. Nuclear power cannot save the climate
5. Nuclear power is sensitive to interference
6. Nuclear power has no sustainable fuel supply
7. Secure storage of radioactive waste doesn't exist
8. Many unsolved problems with new kinds of reactors
9. Nuclear reactors may be goals for terrorists and are foundations for nuclear weapons
10. Nuclear power becomes a burden for future generations"

Myself, a nuclear scientist, and also connected with FMKK, has compared the long-lived radioactive waste produced by nuclear reactors with what has been produced by all nuclear bomb test from 1945 up till today. I have written in Medsols'24, p 6 (FMKK 2024):

"Let us compare the annual amount of long-lived radioactive fission products, 2000 kg, with what has been produced by atomic bombs. Between 1945 and today some 2000 atomic bomb tests have been made and of those a bit more than 500 in the atmosphere or under water. If we assume that half of those have used 25 kg uranium-235 and half 6 kg plutonium-239, the total mass of fission products from 500 atomic bombs becomes about 8000 kg. One single average size nuclear reactor produces as much radioactive waste in just 4 years! ... No, nuclear power is no good alternative to coal, oil and fossil gas. Let us invest in sun, wind, water and biofuels instead."

3. Renewable Energy Options

Today, energy is used chiefly in industry, transportation, buildings (heating and cooling), defense/war and data communication. Much energy is in the form of electricity, chiefly produced in plants powered by coal, oil and fossil gas. Fastest growing are solar, wind and hydro electricity, but energy from fossil fuels is also growing. Therefore, the rapid growth of renewable energy has to accelerate. Current technologies work well; for solar energy selective surfaces in heat-producing collectors and crystalline silicon in electricity-producing solar cells, while for wind, energy turbines above 1 MW are common, both on land and off-shore. Since long, hydroelectricity is in extensive use (but very un-evenly spread between countries).

Especially solar and land-based wind are economically much less expensive than the alternatives nuclear and fossil electricity. New technologies are in various stages between research and commercial use; among them perovskite solar cells, marine energy harnessing tidal water, waves and temperature difference between surface and deep water. There are numerous sources of facts on renewable energy; Wikipedia is mostly quite reliable (Wikipedia 2024).

Another important shift is making energy use more efficient. Some technologies have already been successful, like LED light replacing traditional lamps and heat pumps replacing direct electricity for house heating. Much hope regarding transportation deals with electrification of cars and ferries, but more important is probably a change from road to railroad traffic (which is about 10 times more energy efficient!) and from air travel to trains and boats. Much information about energy efficiency is e.g. available from International Energy Agency (IEA 2024).

4. Solar Energy Education is Necessary

There are many lobbyists acting on behalf of nuclear and fossil energy companies as well as oil and fossil gas rich countries. They work hard to make decision-makers slow down the replacement of fossil fuels and journalists counteract individuals' willingness to make their lives less energy consuming. A change from fossil to renewable energy, as well as a decreased energy use, need to take place more or less immediately. If not, there will be little chance of reaching not even the lower Paris goal to keep global warming below 2°C. Solar energy education aimed at many different target groups seems more important than ever.

Public understanding of renewable energy PURE was already in 2011 proposed as an important sub-concept of Public understanding of science PUS (Broman and Kandpal 2011). Today, when all individuals have to be both prepared to as well as change their way of living, PURE is increasingly topical. A well-informed general public is needed to make politicians and civil servants listen to scientists and acting accordingly. Solar panels are not welcome everywhere and even forbidden to put on roofs, especially in old European towns (Henning 2011).

Solar energy is taught in formal settings in schools and universities. School activities are most effective in creating interest and understanding if laboratory experiments are included (Kandpal and Broman 2016). Study visits to places where renewable energy is set at work are also important (Blum 2017). More information on useful pedagogics is found elsewhere (Ott et al. 2018).

In universities, advanced studies at master level is needed to educate students for work in industries as well as in the society. One good example is the European Solar Engineering School ESES at Dalarna University, that since 1999 offers a specialized experience that will broaden the students' professional opportunities in renewable energy. For 25 years, students from nearly 50 countries have come to Borlänge in central Sweden to gain knowledge and skills that are in high demand within the renewable industry. Recruiting for the upcoming program in the fall of 2024 is at the time of writing in progress (ESES 2024).

Furthermore, Universities' tasks include not only research and education, but also informing the society outside. Workshops training young scientists for this task were developed by an EU-financed project (Miller et al. 2009).

Solar energy exhibitions are useful ways to disseminate knowledge and create interest, especially with hands-on exhibits (Broman and Kandpal 2022). International Solar Energy Society ISES has created an online museum that allow visitors to learn about solar energy history and presents solar energy technologies in a number of galleries. A separate gallery will be devoted to Solar Energy Education – presently being constructed. IOMSE opened in March 2024 and is found online (IOMSE 2024).

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