ACT CARBON CUTTERS TRAINING PROGRAMME NOTES

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Section 1. Preparatory Reading (taken from the TECs E-Pack):

Carbon Cutters
Action on Climate in Teignbridge

ACT CARBON CUTTERS TRAINING PROGRAMME

SOME USEFUL INFORMATION ON ENERGY AND ASSOCIATED EMISSIONS

- Energy bills are given in kWh (kilo Watt hour) also referred to as a "unit" of Energy.
- 1 kW (or kWh) = 1000 Watt hour (or Wh); 1000 times for each kilo, Mega, Giga, Tera, peta.
- Energy (in kWh) = Power (in kW) x Time (in hours).
- Every 1 Watt on all the time is costing you £2.20 a year (assuming a unit price of 25p).
- 2kg of CO2 is about 1 cubic m of greenhouse gas. This is similar to an 8 mile trip in an average petrol car (based on 2021 UK data) which generates 2 kg of CO2 from the exhaust. Another 2kg for every 8 miles from associated processes like making, maintaining and scrapping the car.
- Emissions for different primary fuels will vary. As a rough guide, 2 kg of CO2e are emitted into the atmosphere from (based on 2021 UK data):
    - ~6.9 kWh of grid **electricity**, excluding device efficiency (~50-350%);
    - ~7.6 kWh of **oil** (or ~0.8 L), excluding boiler/engine efficiency (~25-80%);
    - ~9.3 kWh of natural **gas**, again excluding boiler/cooker efficiency (~30-95%).

  The amount of usable energy will depend on the efficiency of the device used:
  Useable (output) energy = amount of primary (input) energy x device efficiency

Different fuels have different Carbon Intensities (**CI**), some of these will vary from year to year.

Green House Gas (**GHG**) emissions represent a number of different gases which cause atmospheric temperatures to rise by trapping more heat from sunlight. The largest component of these GHGs is Carbon Dioxide (**CO2**), about 80%. Other GHGs, such as Methane (~10%), make a significant contribution as they are more 'potent' despite being shorter lived.

The shorthand for GHG emissions often used are: Carbon; CO2 equivalent (**CO2e**).

Energy can be measured using different scales, most people are familiar with Calories (**Cal**) or more accurately a kilocalorie (**kcal**) where:

1 kWh = 860.421 kcal

How we calculate GHG emissions

The GHG emissions are calculated on a consumption basis. That is, we include all emissions associated with the item or activity, irrespective of where these emissions occurred. Put another way, we include the embodied emissions (also referred to as scope-3 emissions or cradle emissions) associated with manufacturing an item or in providing a service.

Emissions associated with end-of-life (i.e. waste or grave emissions) are also included where available, these tend to represent a small % of the lifetime emissions.

Section 2. Session #1 > Energy, Carbon, Actions:

The purpose is to get a common understanding of how our energy use relates to our Carbon emissions. If we are to talk to others about Carbon emissions, specifically those involved in the Carbon Cutters (**CC**) scheme, we need to have the basic facts. Without this there is a real danger that actions proposed/taken will increase emissions, not something we want to be promoting.

In this session we will not go into the phycology of how this should be used when talking to others (see session #2). The purpose here is to make the maths and physics (i.e. the science) accessible and understood. The session is aimed at anyone who wants to become a CC. As a minimum, they need to have handled money, i.e. receives/spends it in any form.

Depending on what people know and want, the session will include:

- What Energy is and why it is central to life on earth!
- Where does the energy we use come from and what are the consequences of using it?
- How does energy relate to climate change?
- What do we need to do in the activities we have some direct control or influence over, to stay within the 1.5^{O}C increase in atmospheric temperature?
- How to determine effective actions and for what purpose?

Hopefully the session is interactive and takes everyone along to better understand the answers to the above. It should only go to a level of detail, on each of the above, that makes sure no one is left behind. Make sure that before session #1, everyone receives the preparatory text in Section 1 and that they have had an intro session where they are briefed on what a CC is and the training. After session #1, send the notes in section2.1.

Zoom recording of this session is available on the ACT's G-Drive. This may need editing if we are to make it available to CCs.

2.1 Notes for this session

intro: We'll look at what energy is, how it relates to climate change and how this should inform our actions.

Energy

- A couple of things to remember from school
  - Energy can't be created or destroyed (it is cycled from one form into another including matter). Energy can either be potential (stored) or Kinetic (dynamic/moving).
  - Life on earth, and possibly our universe, is carbon based.
- The sources of energy is a result of:
  - Chemical (reaction between elements), e.g. Carbon combining with Oxygen to make CO_2 (i.e. combustion).
  - Nuclear (sub-atomic bonds), fission/fusion processes, this generates much more energy for the same mass of material compared to chemical.
  - Gravity, this is a weaker form of energy for the same mass of material, e.g. hydropower.
  - Thermal (heat), resulting from movement of molecules, present in any material.
  - Electrical and radiant (movement of charged particles), electricity, radiation and light.

  - Others like mechanical, sound and elastic forms of energy, e.g. wind, sound and any object in motion.
- 2 complex lifeforms evolved, plants and animals. Evidence strongly points to life starting as an interaction between matter and energy, but life's origin is not important to this discussion.
- Most energy is used to exist, reproduce, move and do other things.
- Two essential chemical reactions for life to exist:
  - Photosynthesis, CO_2 in the air is combined with water and other elements to produce various hydrocarbons using sunshine as the primary source of energy and releasing O_2 into the air (carbon dioxide + water → glucose + oxygen)
  - Respiration (breathing), oxidises (burns) the hydrocarbons to release energy to live from (glucose + oxygen → carbon dioxide + water)
- All life on earth does respiration, some do both respiration and photosynthesis, e.g. plants.
- Just living needs ~100 Watts (**W**), we are constantly burning carbon through respiration. A human can however produce as much as 2000W for short periods.
  - 100 W x 24 hrs = 2400W per day, ~3kWh to carry out a few other necessities.
  - The bigger and more active we are, the more carbon we need to burn, and vice versa.
- Humans don't just live, we want to create and experience more things. We need extra energy to do this.
- kWh is the universal unit of energy.
  - Eating 3000 Cal worth of food is equivalent to ~2.4 kWh
  - Driving an Electric vehicle ~2-4 miles consumes ~1kWh (depending on what/how/where)
  - 1 Litre (**L**) of oil can generate ~10 kWh if perfectly burnt
  - 1 kg of coal can generate ~8 kWh if perfectly burnt
  - 1 kg of seasoned wood can generate ~ 4 kWh if perfectly burnt
  - Humans consume ~160,000 TWh of energy annually or ~ 23,000 kWh on average per person. Many in the Global South consume less than 1,500 kWh annually with much of that renewable energy (subsistence farming/living).

There are 8,760 hrs in a year, use this to work out annual energy from Power used, and visa versa, e.g. 23,000 kWh = 2,626 W continuous and 1,500 kWh = 171 W continuous.

Carbon

- The reason life can exist is thanks to photosynthesis in plants removing CO_2 from the atmosphere over millions of years. This lowered the CO_2 concentration to ~250 parts per million (**ppm**) which has been relatively stable for 100,000s of years with some fluctuation due to natural events (e.g. large volcanoes and glacial periods).
- Vast amounts of CO_2 circulate the earth in a natural carbon cycle. The natural carbon cycle is ~150 years (the average life-span of living organisms). Some of the carbon captured by photosynthesis or in organisms is released back as these rot in the air, but some is locked into the soil. It remained undisturbed for millions of years, eventually turning into coal, oil and gas (fossil fuels). Shale gas is also a fossil fuel, just locked differently underground.
- The industrial revolution disrupted the natural carbon cycle. It started the extraction of highly efficient fossil fuels and burnt these to produce more and cheaper energy. Our

economic system is now hooked on this for our energy use, some 80% of our energy comes from these fossil fuels with coal representing ~40% of this (~32% of total energy).

- Millions of years' worth of locked carbon was released back into the atmosphere in a short 150–200-year period. Once released, natural systems will require very many years to extract and store it again. About 50-150 kg CO2e/tree/year is sequestered by a mature tree.
- We knew about greenhouse gas concentration and its impacts in 1896, however this was not taken seriously (proven beyond reasonable doubt) until the 1970s.
- There is a linear relationship between temperature and greenhouse gas concentration in the atmosphere.
- Emitted carbon takes 150 years to be absorbed again which means that its impacts last for 150 years, i.e. cumulative impact.
- Humans emits roughly 40 Gigatons of CO_2 a year (40,000,000,000,000 kg), a lot of trees!
- Another 400 Gigatons CO_2 (since 2019) in the atmosphere will cause a temperature increase of 1.5°C. This is the remaining **Carbon Budget** after which we will cause irreversible changes to our climate, making life on earth as we know it impossible. This is the **Climate Tipping Point**, an existential challenge.

Action

- This has to be treated as an emergency, because of the scale of the challenge:
- 400 – 4 x 40 = 240 Gt CO2 budget left to emit before Climate Tipping Point
- At current rate, only 5 years left to get to Net Zero emissions.
- The full impacts are not seen for decades, by which time it is impossible to reverse runaway climate changes and its consequences.
- All actions are necessary, at organisational and individual level.
- The most direct (and only) effective action is to reduce GHG emissions. Several ways this can be done:
  1. Best is to know what your emissions are and how much different actions reduce this by, to stay within your personal/organisational Carbon Budget. Use a representative Carbon Footprint calculator/tracker or bespoke analysis for larger organisations.
  2. Use simple rules of thumb to check what difference major actions could make. These rules will change year on year.
     - Carbon Intensity (**CI**) for electricity/gas ~ 0.25 kg CO2e/kWh ; private car travel ~ 0.5 kg CO2e/kWh or per 1-4 miles; food ~ 0.75 kg CO2e/kWh (~860 Cal, but can vary by 10 fold, 7.5 - 0.075 kg CO2e); goods/services varies a lot so need a lookup list/categories.
     - <5,000 mi p.a. = keep old car until it dies; >10,000 mi p.a. = buy an appropriate EV
     - <50 kWh/m2 p.a. = install a heat pump ; >100 kWh/m2 p.a. = do not install a heat pump
     - You can save 8-12% on annual heating bills for every 1°C reduction on the main heating thermostat.
  3. Follow general actions that, as a minimum, ensure emissions do not increase. Follow the 'safe' actions list which always applies. (see section **Error! Reference source not found.**)
- Indirect actions such a lobbying, organising events to engage your community in direct action are important, especially if tangible reductions in ghg emissions follow in a short period of time.

- Worst of all is to blindly perpetuate other peoples'/organisations' lists without considering their appropriateness to the new situation.
- For those able and willing to do more than follow a general 'safe' list, they will also need to follow a common-sense process to ensure actions remain effective:

1. Know your emissions, the annual total and what causes these.
2. Identify the largest sources of emissions that you have most control over and will cost least money/effort.
3. Plan your actions to achieve maximum return in the shortest time, be realistic, start small and build up. Cutting out unnecessary things (waste) is by far the best action.
4. When action is complete, check if it actually did and will continue to reduce emissions, then start again to identify the next action. Recording these, helps you stay within your 1.5^{O}C limit.