

## Activity 4.2

Title: Developing a Causal Loop Diagram

Learning outcome: to gain an understanding and experience on how to build Causal Loop Diagrams and apply it in the area of Renewable Energy

Applicable: it can be used in the third lecture of the Systems Thinking module

Green skills: discussion, collaborative planning, co-creation, systems thinking

Instructions: Ask the students to develop the CLD of the following description

- Starting with the assumption that the **PV manufacture** increases, the **solar cell manufacture** which is directly linked to it, will start to increase as well. Solar cells are a functional and important part of PV panels, but they contain hazardous materials that are used or being exposed during the process of manufacturing. Therefore, it increases the **toxic chemicals** and as a consequence, *toxic chemicals* impair the **workplace conditions** and burdens the atmosphere.
- *workplace conditions* affect the **health of workers** in the same direction, which means that the *health of workers* is getting damaged.
- Unless the *health of workers* is fine, there will be no employees to manufacture the PVs in the future. So, the variable *health of workers* will reinforce the *PV manufacture*, which means that *PV manufacture* will decrease with a delay.
- *Toxic chemicals* are also connected conversely with *environmental impact* which means that , in our case, as the *toxic chemicals* increase, there will be negative **impact on the environment**.
- *PV manufacture* is connected with both *PV installation* and the *Global PV Market*. Particularly, **Global PV Market** describes the demand and supply for photovoltaic systems, so it directly affects the *PV manufacture* as the more the demand the bigger the *PV manufacture*. As a result, if the *PV manufacture* increases , the **PV installation** will increase as well.
- Generally, as the *Global PV Market* increases the supply of photovoltaic systems there will be more *end-of-life modules*. As a result, the *Global PV Market* positively impacts **end-of-life modules**. However, the *end-of-life modules* consist of many parts that are not recyclable. Therefore, if the *end-of-life modules* increase, the **non-recyclable parts** of these modules will increase too. The increase of these *non-recyclable parts* will have a negative *impact on the environment* because there is no other useful way to handle them yet. As a result, they will end up in the landfills and expose severe toxic chemicals in the soil and in the air.
- Nevertheless, *end-of-life modules* consist of parts that are recyclable too. So if the *end-of-life modules* increase , the **recycling of those PV parts** will increase as they are linked positively.

- Moreover, it is well known that recycling is a good option for the environment so if the *recycling of the PV parts* increase, there will be a *positive impact on the environment*.
- *PV installation* negatively affects **greenhouse emissions** because the use of the photovoltaic systems do not cause greenhouse emissions, so as the *PV installations* increase, *greenhouse emissions* will decrease. *Greenhouse emissions* have an adverse effect on the environment. So the link is negative because, the less *greenhouse emissions* the better the *impact on the environment*.
- *PV installations* need personnel in order to occur, which leads to creation of new jobs. Consequently, *PV installations* are linked positively with **job creation**. These new jobs will create an impact on the socio-economic environment and boost the **economic prosperity**. So there is a positive link between them, as there is between *economic prosperity* and the **investments**, because people are able to see the positive effects of a new idea and if they are economically stable, they invest. A great idea is not the only incentive when it comes to investments.
- The maintenance cost is an important variable to take into account, so when the **maintenance cost** is low, the **investments** are increasing.
- Another factor that increases the investments while it decreases is the **recycling cost**, so the in between link is negative. The performance of the **WEEE Directives** intends to decrease the *recycling costs* and diminish the potential negative effects of improper disposal, while creating economic benefits.
- Since the cost of recycling back to 2003 was high and the *end-of-life photovoltaic modules* were limited, there would not be many industries to invest in the recycling idea. The amount of money that needs to be invested for the machines and the employees of the recycling industry, is higher than the amount of the end-of-life modules. If there is a plentiful number of recyclable parts, the recycling cost is going to be reduced, because there will be ample means to work with and the investment will be worth the final impact. Therefore, if the recycling of PV parts increases, the recycling cost will decrease, having by that a negative connection.
- The *Global PV Market* is affected positively by the investments of the entrepreneurs that choose to invest in the PV technology. Therefore, if the amount of investments is rising, so will the *Global PV Market*.

Correct CLD



