In the recent decades it has become evident that fossil fuels are a limited resource, and that the emission of CO_2 could cause global warming with severe changes to the climate. Hydrogen (H_2) is considered as a clean and efficient energy carrier that can play an important role in dealing with the global energy and environmental crisis. With the development of fuel cells, electrical power based on H_2 is increasing around the world. More specifically, hydrogen is also a key fuel for the energy development in Poland. One of the biggest projects of this country is to use hydrogen as a fuel in public transport vehicles.

In order to meet the demand for hydrogen, the economical and environmentally friendly production of H_2 has become an essential part of the hydrogen economy. At this time, one of the best ways to produce H_2 in large quantities, sustainably and with a viable cost is by steam reforming (SR) of bio-oils. Bio-oils are the acidic liquid products from the pyrolysis of biomass. The bio-oils produced from fast pyrolysis can be reformed by pure steam in the presence of catalysts at mild temperatures to generate hydrogen with relatively low required energy. The SR of hydrocarbons occurs through adsorbed species on the catalyst, which react forming CO and H_2 gases.

Despite all the positive aspects of steam reforming of bio-oil, there are still major problems to overcome in this process, being the main the catalyst deactivation, which occurs as a consequence of the carbon deposits and the sulfur-poisoning. The carbon deposits can block the active sides of the catalyst making impossible the catalysis. The deactivation by sulfur poisoning occurs by the strongly binds between sulfur and the catalyst metal. The short lifetime of the catalysts, caused by the deactivation processes, is limiting the applicability of SR of bio-oil in the industry.

The addition of noble metals as co-catalyst has been shown to decrease the deactivation of the catalyst during the SR of bio-oil. This kind of bimetallic catalyst represented a further improvement in the catalytic activity and stability respect to the monometallic catalyst, improving the selectivity towards H_2 and carbon conversion, and leading to more stable gas compositions and higher hydrogen yield. However, the suitability of some noble metals, as rhenium, in the bio-oil SR field still unexplored.

Rhenium is a noble metal which constitute a by-product of the copper production process. Thus, the Polish company KGHM, one of the larger copper producers, is the only European producer of Re from its own resources. At this time, rhenium is mainly used in the aerospace and petrochemical industry. Looking for new applications for this metal can be very interesting for the Polish economy. For that reason and taking into account the suitability of rhenium in other catalytic applications, such as: reforming of heavy naphtha or hydrogen generation by steam reforming of gasoline, we have considered that evaluating the performance of rhenium catalysts in the bio-oil steam reforming processes could be a very pioneering and enriching project, both for science and Polish Industry.

In order to upgrade H_2 production by bio-oil steam reforming the catalytic activity of two rhenium catalysts will be studied in that project, i.e. Re-Ni/Al_2O_3 and Re-Ni/AC. Also, the monometallic counterparts' catalysts, without the Re metal, will be used as a reference. Because of the novelty of using rhenium, the co-catalyst (Nickel) and the support selected (Al_2O_3) are the most widely studied. Thus, will be easy to compare the results obtain with Re, with the ones obtained with Ni/Al_2O_3 combined with other noble metals or additives. Moreover, we will test a less studied support, i.e., Activated Carbon (AC), because it has exhibited a really good performance in previous researchers. A bio-oil obtained by flash pyrolysis, as well as the model compounds phenol and acetic acid will be the raw material for SR process. Testing model compounds, in addition to the raw bio-oil, will let us possible to get a better understanding of the reactions, influence of experimental conditions, deactivation etc. The SR will be performed in a fixed bed tubular flow reactor with N_2 as the carrier gas. In order to evaluate the influence of some key parameters; the experiment will be performed at different temperatures (650-950 ºC) and different ratios of water and carbon compounds. Also, some SR experiments will be carried out in the presence of H_2S, in order to evaluate the ability of Re to avoid sulfur-poisoning. Gas products will be analyzed using a gas chromatography. The catalysts will be characterized before and after the steam reforming experiments for obtaining information about carbon deposits and structural stability of the catalytic materials.

If the results are in line what was expected, could be achieve two catalysts capable of inhibiting to some extent the formation of carbon deposits and sulfur-poisoning. This would allow a further step to be made towards a sustainable industry. Moreover, due to the relevance of H_2 and rhenium to Poland, this would be a direct benefit for the country.