Fly ash is a solid waste residue produced throughout coal combustion to generate electrical power. The global revenue of this waste amounts to approximately 800 Mt per year, of which 500 Mt are produced in China, 140 Mt in India and 115 Mt combined in the United States and the European Union. Half of this global revenue finds an economical purpose (in metallurgical and construction industry, agriculture etc.). The other half is subject to long-term storage in the form of industrial piling or landfills. One of the reasons why fly ash ends up in landfill instead of being recycled in building or construction industry is the presence of a residual (unburned) carbon in the form of polyaromatic hydrocarbons (PAH), such as naphthalene, fluorene, anthracene, phenanthrene etc. PAHs presence greatly contributes to CFA toxicity as they have been evidenced to have carcinogenic and otherwise toxic effects on living organisms. Apart from organic pollutants, landfilled fly ash also contains heavy metals (Pb, As, Hg, Cd, Se, Cu, Cr, Ni) and some amounts of valuable rare earth elements (REE) such as Nd, Y, La or Gd. High concentrations of HM and REE within CFA motivated researchers to find ways to leach those compounds from CFA to allow for their recovery mainly due to their market value. In turn, the organic pollutants like PAHs are not so attractive to the industry, so they are not the main subject to removal from fly ash. However, this approach would be useful for eliminating or diminishing the toxic characteristics of CFA which then could be used in a broader range of applications (soil amelioration, road and train embankments etc.) or even it could improve the efficiency of HM and REE recovery. Therefore, within the BioFlyAsh project we would like to answer the two basic questions: (**1**) if and to what extent the microorganisms can utilize the residual carbon adsorbed to the fly ash? **(2)** whether the properties of fly ash will improve after the biodegradation of unburned coal and could be used in building or construction industry? Given that high carbon fly ash contains a broad range of hazardous compounds, and in untreated form cannot be used in practical applications, these questions should be addressed to develop suitable management strategies to maximize recycling of fly ash, which is stored in a landfill

To answer the questions, we will deploy an interdisciplinary research strategy. We will analyze fly ash from landfill of 4 different locations of coal-fired power plants with high residual carbon content. At the first stage we will identify organic components of unburnt fly ash, and based on these results we will select the most representative substrates for the isolation of the bacteria and fungi to study the biodegradation of residual carbon and verify the effect of this transformation. Isolated pure cultures and consortia of bacteria and fungi will be subjected for functional characterization, including the test for fly ash colonization abilities; tolerance to PAHs and other components of residual carbon, and mineralization of selected PAHs. For the detail study of microbial mineralization of unburnt carbon we will use natural consortium as well as we will construct synthetic consortium of the most active and metabolically versatile microorganisms (we assume no more than 3-5 strains). Both type of the consortia will be testes within RSM (Response Surface Methodology) and ANN (Artificial Neural Networks) focused on the biostimulation with nutrients and co-metabolic substrates as well as basic process conditions such as pH, temperature or salinity. The most optimal process conditions will be used in the last work package of the project which aimed at verification of functionality of the treated (by biodegradation) fly ash as a material in construction industry.

Our research will advance the basic understanding on how individual microbes and microbial consortia interact with high carbon fly ash. In particular, biodegradation of unburnt carbon, as well as aliphatic and aromatic hydrocarbon tolerance will be investigated. From the mineralogical and geochemical studies we will learn how microbial degradation of residual carbon influence the fly ash properties in the context of the application in construction industry. At the same time, our research output will guide fly ash industries to optimize their process technology and product yield.