DIPARTIMENTO DI INGEGNERIA
CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE -
PHD COURSE IN INDUSTRIAL AND INFORMATION ENGINEERING - 36TH CYCLE

Title of the research activity:	Reducing CO2 emissions through CCU and green hydrogen technologies
State of the Art:	Green hydrogen allows several applications. Power-to-power application provides storage of renewable energy for off grid communities and remote locations, while power-to-gas allows the use of hydrogen from electrolysers directly as an energy carrier to several users enabling different and multiple uses. Some examples are hydrogen-powered turbines, hydrogen-powered vehicles, hydrogen injection into the natural gas grid, hydrogen use, combined with biogas or CO2 to produce clean methane or methanol. Green hydrogen on-site industry applications deserve an increasing attention for reducing CO2 emission, since the gains provided by renewables is expected largely confined to electricity generation, not interesting other carbon-intensive industrial sectors [1]. For steel and other industries using large quantities plants of hydrogen, on-site hydrogen generation using electrolysers coupled to renewable plants can be a greener alternative. Anyway, the OPEX for a Direct Reduction Process of iron ore combined with Electric Arc Furnace (DRP+EAF) based process running on hydrogen is estimated to be about 80% higher than that of the current reference production, that is a Blast Furnace combined with a Basic Oxygen Furnace (BF+BOF), which is based mainly on coal use. On the other hand OPEX for a DRP+EAF based process running on natural gas is expected to be about 30% more than that of a BF+BOF process [2] For this reason also CCU technologies as dry reforming of methane converting fossil CO2 emissions into a hydrogen rich syngas (hydrogen mixed with CO), by exploiting waste heat to sustain the process, could play a relevant role.
Short description and objectives of the research activity:	The aim of the study is the experimental and numerical investigation and optimization of specific CCU and green hydrogen technologies, as well as their implementation in on-site industry application. Specifically, steelmaking and other industry sectors, as ammonia production or oil refining which require large quantities of hydrogen, are considered. In detail, the technology focus of the research activity is: - hydrogen production through electrolysis or also co-electrolysis by means of high temperature electrolyzers - dry reforming of methane using fossil CO2 as reforming agent and waste heat to sustain the process. The activity includes therefore also catalysts investigation to reduce as much as possible the process temperature, avoiding their deactivation for coking.
Bibliography:	[1] International Energy Agency. World Energy Outlook 2016. Int Energy Agency 2016:1–8.

	doi:http://www.iea.org/publications/freepublications/publication/WEB_WorldEnergyOutlook2015ExecutiveSummaryEnglishFinal.pdf [2] F. Dolci, Green hydrogen opportunities in selected industrial processes, Publications Office of the European Union, ISBN 978-92-79-99135-6, 2018
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