

## Technology Fact Sheet

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| Technology Name                                                                                               | <b>Long term large scale, IGCC units<sup>i</sup></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Subsector GHG emission (Mt CO <sub>2</sub> -eq)                                                               | <b>7,7248 Million t CO<sub>2</sub> from energy sector in 2005</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Background/Notes, Short description of the technology option                                                  | <p>Coal gasification technology, often referred to as Integrated Gasification Combined Cycle (IGCC), is the process of gasifying coal to produce electricity. The coal is gasified by burning finely-crushed coal in an environment with less than half the amount of oxygen needed to fully burn the coal. Essentially, the coal is not burned directly but undergoes a reaction with oxygen and steam. This produces what is known as synthetic gas or “syngas.” This gas is then combusted in a combined cycle generator to produce electricity. The technology integrates the production of purified gas and the production of electricity. In terms of environmental benefits, the technology reduces emissions of sulphur dioxide, particulates and mercury, as well as of carbon dioxide, in particular when combined with carbon capture and storage. Integrated Gasification Combined Cycle (IGCC) technology can reach a higher efficiency rate than typical coal combustion technologies, such as sub-, super- and even ultra-supercritical combustion. Where the latter can reach efficiencies of between 30 to 45%, IGCC plants could achieve an efficiency rate of higher than 45%. The latter is achieved by combining the two cycles of firing the coal gas and using the residual heat to produce electricity. The technology contains the following steps. First, coal is gasified by creating a ‘shortage’ of air/oxygen in a closed pressurised reactor. The creates a chemical reaction of the coal with the oxygen. The product from this process is a mixture of carbon and hydrogen (CO + H<sub>2</sub>), which is also called synthesis gas or syngas or fuel gas. The syngas is subsequently cleaned and burned with either pure oxygen or air. This creates a superheated steam with which electricity is generated. The residual heat from this process is cooled down which creates another stream of steam to produce electricity. Efficiency of IGCC could be further increased if the process of purifying the syngas (removing of particulates and sulphur) could be done at higher temperatures. Currently, purification takes place at relatively low temperatures (around 50 °C), but techniques to clean at temperatures of around 500-600°C are tested. This could increase the overall efficiency of IGCC to over 60%. IGCC plants can also be configured to facilitate CO<sub>2</sub> capture before the combustion of the syngas. In this process, the syngas is ‘shifted’ using steam to convert CO to CO<sub>2</sub>, which is then separated for possible long-term sequestration. This means that an IGCC power plant combined with carbon storage technologies can be completely carbon emission free. An example of a zero emission power and chemical plants which combines gasification with CO<sub>2</sub> capture and storage can be found in Kedzierzyn in Poland. (source: climatetechwiki.org)</p> |
| Implementation assumptions Explain if the technology could have some improvements in the country environment. | <p><a href="#"><u>It is assumed that there will be built at least one unit of IGCC of 200 MW output, due to the fact that the price of coal will not increase at the same rate at the price of natural gas.</u></a></p> <p>It is envisaged that this technology will use coal as fuel.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Implementation barriers                                                                                       | Lack of information regarding benefits, lack of experience in this field and of course lack of financial resources for investment due to the fact that the specific investment in such power plant is very high - 3000 \$/kW.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Reduction in GHG emissions (Mt CO <sub>2</sub> -eq)                                                           | If implemented the technology will result in annual reduction of 390000 tones of CO <sub>2</sub> for 2030.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Impact Statements</b>                                                                                      | Increase country energy security                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Country <b>social</b>                                                                                         | <p>Increased efficiency of energy conversion and use;</p> <ul style="list-style-type: none"> <li>• Lower emissions to the environment, in particular of CO<sub>2</sub>, the main greenhouse</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

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|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|
| development priorities                                              | <p>gas;</p> <ul style="list-style-type: none"> <li>• Large cost savings, providing additional competitiveness for industrial and commercial users, and offering affordable heat for domestic users;</li> <li>• An opportunity to increase the diversity of generation plant, and provide competition in generation and promotion of liberalization in energy markets;</li> <li>• Increased employment – construction of such units is a generator of jobs.</li> </ul> <p>Using this technology there will result in more than 10 % less fuel used to use the same quantity of electricity.</p> <p>Affordability of electricity: As electricity produced by such unit will be cheaper in comparison with electricity produced by other generation units using natural gas.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |            |
| Country <b>economic</b> development priorities – economic benefits  | Lower costs for coal used as fuel means less natural gas imported and less paid for it as well as the decrease of energy dependency and diversification of fuel import sources.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |            |
| Country <b>environmental</b> development priorities                 | <p>IGCC plants have the lowest CO<sub>2</sub> emissions among coal power plants (Ordorica-Garcia, 2006). An IGCC plant emits around a quarter less CO<sub>2</sub> than a pulverizing coal power plant (appr. 750 g CO<sub>2</sub>/kWh vs appr. 1 kg). To compare: A natural gas combined cycle plant emits approximately 400 g CO<sub>2</sub>/kWh. Coal gasification offers the possibility, when using oxygen in the gasifier, of preparing CO<sub>2</sub> as a concentrated gas stream. In this form, it can be captured relatively easily. In a conventional (pulverised) coal or gas fired power plant, CO<sub>2</sub> can only be removed after combustion which with current technologies is economically less attractive. In the case of IGCC, CO<sub>2</sub> can be removed before the syngas is fed into the gas turbines. According to Ordorica-Garcia (2006), capturing 80% of the CO<sub>2</sub> would reduce emission to less than 200 g/kWh, which would involve an energy penalty due to CO<sub>2</sub> capture of around 25% of the total auxiliary power output.</p> <p>Reduced air pollution: By replacing of 1.4 billion kWh of electricity to be produced in conventional thermal power plant it will result in reduction of about 390000 tons of CO<sub>2</sub> per year.</p> |            |            |
| <b>Other</b> considerations and priorities such as market potential | It is envisaged that there will be implemented at least one unit of 200 MW output.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |            |
| <b>Costs</b>                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |            |
| <b>Capital costs</b>                                                | The typical investment costs in IGCC will be about 3000 \$/kW, taking into account that it is necessary to comply with CO <sub>2</sub> reduction requirements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |            |
| <b>Operational and Maintenance costs</b>                            | <p>Operational and maintenance costs excluding fuel for IGCC units is typically about 120 \$/kW per year.</p> <p>The cost of fuel component depends on the coal price.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |            |
| <b>Cost of GHG reduction</b>                                        | <p>The cost of electricity produced by these coal units is lower than the cost of electricity produced by thermal power plant electricity of which will be replaced.</p> <p>In such a case the GHG reduction does not have any cost.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |            |
| <b>Lifetime</b>                                                     | Economic lifetime is 30 years. Technical lifetime is more than 30 years.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |            |
| <b>Other</b>                                                        | Total energy efficiency is approximately 50 %.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |            |
|                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>Old</b> | <b>New</b> |
| Efficiency                                                          | %                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 36         | 50         |
| Fixed O&M costs                                                     | \$/kW*month                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 2          | 120        |
| Variable O&M costs                                                  | \$/MWh                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 3          | 0          |
| Investments                                                         | \$/kW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0          | 3000       |
| Fuel price                                                          | \$/tcc                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 552        | 160        |
| Time of use of rated capacity                                       | h/an                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 6000       | 7000       |
| Fuel consumption                                                    | gcc/kWh                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 341.67     | 246        |

|                             |               |              |              |
|-----------------------------|---------------|--------------|--------------|
| Fuel price                  | \$/kgcc       | <b>0.552</b> | <b>0.16</b>  |
| Fuel used                   | kgcc/kWh      | <b>0.34</b>  | <b>0.246</b> |
| Cost of used fuel           | \$/kWh        | <b>0.189</b> | <b>0.039</b> |
| Annual capital costs        | \$/kW*an      |              | 120.000      |
| Per unit fixed O&M costs    | \$/kWh        | <b>0.004</b> | <b>0.017</b> |
| Per unit variable O&M costs | \$/kWh        | <b>0.003</b> | <b>0.017</b> |
| Total costs                 | <b>\$/kWh</b> | <b>0.196</b> | <b>0.074</b> |

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<sup>i</sup> This fact sheet has been extracted from TNA Report - Technology Needs Assessment for climate change mitigation - Republic of Moldova. You can access the complete report from the TNA project website <http://tech-action.org/>