Technology Fact Sheet

Technology Name	**Long term large scale, nuclear units of small capacity**[i]
Subsector GHG emission (megatonnes CO2-eq)	**7,7248 Million t CO2 from energy sector in 2005**
Background/Notes, Short description of the technology option	The HPM small nuclear reactor is a next generation design that uses a liquid metal cooled, uranium nitride fueled, fast-spectrum reactor that employs control rods for reactivity control. The reactor has been designed to deliver 70 MW of heat (25 MW of electricity) for a 10-year lifetime, without refueling. Key advantages of the HPM design are: Advanced reactor design – Use of advanced reactor concepts provides for a safer and simpler reactor, elimination of many potential accident scenarios that affect LWRs, and elimination of complex reactor systems. Small reactor – A smaller reactor is more appropriately sized for smaller generation requirements, can directly replace existing diesel fueled generators, and requires no upgrade to existing small electricity distribution systems. 10-year power module replacement – The HPM provides 25 MW(e) continuously for 10 years on its initial fuel load (compared to an 18 to 24 month cycle for current light water reactors). No on-site refueling is required. After 10 years the entire reactor module is replaced. Underground containment vault – The reactor is sited in an underground containment vault to provide isolation from the environment, prevent intrusion or tampering, and avoid harm from natural disasters. Factory-assembled transportable power modules – Factory assembly allows for standard designs, superior quality control, and faster construction and on-site deployment. A standardized design will offer several advantages: Manufacturing process controls will be uniform and will not vary between units. Nuclear fabrication and assembly will be completed at the factory before the unit is shipped, minimizing the nuclear construction capabilities that are necessary on site. On site construction activities will be limited to the reactor vault, the non-nuclear systems, placement of the HPM in the vault, and connection to the HPM to non-nuclear systems and controls. This will significantly reduce the on-site construction complexity and result in a faster construction schedule. Hyperion will provide standard operating procedures, operator training, licensing support, technical support, in-service engineering, and safety analysis, significantly reducing the nuclear expertise and staffing that is required of the owner/operator. Key material selections include: Lead Bismuth Eutectic (LBE) coolant -The core coolant is LBE, which is non-reactive to air and water, with a mixed mean exit temperature of 500C. A solid phase oxygen control system is used to control the oxygen level in the coolant to maintain a protective coating on structural surfaces, limiting corrosion. Uranium Nitride (UN) fuel- The fuel consists of 19.75% enriched (non weapons grade) UN pellets contained in clad tubes made of HT-9. These high-temperature ceramic material pellets deter the ability to separate plutonium from spent fuel. Stainless Steel structural materials (HT-9 and T-91) Quartz radial reflector B4C control rods for reactivity control -There are three independent reactivity shut-down systems in the core: a shutdown rod system composed of six boron carbide (B4C) rods, a control rod system comprising 12 boron carbide (B4C) rods and a reserve shutdown system consisting of a central cavity into which B4C balls may be inserted. Each of the three systems can independently take the core to long-term cold shutdown. The rod shutdown and the ball shutdown systems perform this safety function automatically and instantaneously when triggered. (www.hyperionpowergeneration.com).
Implementation assumptions Explain if the technology could have some improvements in the country environment.	By 2030, it is envisaged that there will be built at least 4 small nuclear reactors of 25 MW electric capacity.

Implementation barriers	Lack of information regarding benefits, lack of experience in this field and skepticism to implement such a technology.		
Reduction in GHG emissions (MtCO2-eq)	It is assumed that the generation of 750 million kWh of electricity by this technology will result in 420000 tones of CO2 reduction.		
Impact Statements - How this option impacts the country development priorities	Increase country energy security		
Country **social** development priorities	Implementation of this technology will lead to better environment and to higher affordability of electricity, due to the lower cost of produced electricity.		
Country **economic** development priorities – economic benefits	The price of nuclear fuel is significantly lower than the price of natural gas used to produce the same amount of electricity ant this will result in less payment for natural gas and lower tariffs for electricity. Diversification of primary fuel supply will decrease the dependency on one type of fuel as it is now natural gas, as well as will be decreased the dependency on one country from which the natural gas is imported.		
Country **environmental** development priorities	Such a technology will result in no air pollution or CO2 emissions.		
Other considerations and priorities such as market potential	Due to the fact that this is an emerging technology it is assumed that there will be build 4 units of 25 MW up to 2030.		
Costs			
Capital costs	The typical investment costs in the small nuclear units is in the range of 2500 $/kW.		
Operational and Maintenance costs	Operational and maintenance costs excluding fuel costs is typically about 200-220 $/kW per year. The cost of fuel component depends on the nuclear fuel price and will be cheaper in comparison with the same indicator when using natural gas or coal as the nuclear fuel is cheaper.		
Cost of GHG reduction	The cost of electricity produced by these nuclear units is lower than the cost of electricity produced by thermal power plant electricity of which will be replaced. In such a case the GHG reduction does not have any cost.		
Lifetime	Economic lifetime is 25 years. Technical lifetime is 30 years.		
Other	Such technology will result in no air pollution.		
		Old	**New**
Efficiency	%	36	30
Fixed O&M costs	$/kW*month	2	180
Variable O&M costs	$/MWh	3	2.5
Investments	$/kW	0	2500
Fuel price	$/tcc	552	30.45
Time of use of rated capacity	h/an	6000	7500

Fuel consumption	gcc/kWh	341.67	410
Fuel price	$/kgcc	**0.552**	**0.030**
Fuel used	kgcc/kWh	**0.34**	**0.41**
Cost of used fuel	$/kWh	**0.189**	**0.012**
Annual capital costs	$/kW*an		100.000
Per unit fixed O&M costs	$/kWh	**0.004**	**0.013**
Per unit variable O&M costs	$/kWh	**0.003**	**0.024**
Total costs	**$/kWh**	**0.196**	**0.052**

[i] 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/**