IAEA
International Atomic Energy Agency

To:	J. Phillips, Acting DIR-NENP	**From:**	I. Khamis, NPTDS
Through:		**Clearance:**	S. Monti, SH-NPTDS
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Subject: Report on the Technical Meeting on Advances in Non-Electric Applications of Nuclear Energy and on Efficiency Improvement at Nuclear Power Plants”

Place of Meeting:	Yildiz Technical University, Istanbul, Turkey
Date of Meeting:	15-17 June 2015
Program code:	1000155/2014.04/RBF-MP1-2015(297898)/613222 NHR-TRV-Non-Staff Other/NENP-NPTDS(337)
Chairperson:	Mr. Sam Suppiah (Canada)
Scientific Secretary:	Mr Ibrahim Khamis

ATTENDING EXPERTS

Name	**Country/Organization**	**Date**
Mr Santiago Labollita	Argentina - CNEA	15-17 June
Mr Sellathurai Suppiah	Canada - CNL	15-17 June
Mr Ibrahim Dincer	Canada - OIT	15-17 June
Mr Gangping Zhang	China - CNNP	15-17 June
Mr Haifei Zhang (as observer)	China - CGNPC	15-17 June
Mr Shengqiang Shen (as observer)	China - DLUT	15-17 June
Mr Mu Xingsen (as observer)	China - DLUT	15-17 June
Mr Karl Verfondern (as observer)	Germany	15-17 June
Mr Attila Talamon	Hungary - AERC	15-17 June
Mr Dipayan Goswami	India - BARC	15-17 June
Mr Nafees Ahmed Vakil	India - BARC	15-17 June

Name	Country/Organization	Date
Mr Nurul Huda	Indonesia – BATAN	15-17 June
Ms Erlan Dewita	Indonesia – BATAN	15-17 June
Mr Bahjat Aulimat	Jordan - JAEC	15-17 June
Mr Muhammad Junaid Anwer	Pakistan - PAEC	15-17 June
Mr Tomasz Jackowski	Poland	15-17 June
Mr Joshua Walter	United States - Terrapower	15-17 June

1. Background

Current thermal efficiencies of nuclear power plants are about 33% i.e. more than 65% of the heat produced in the nuclear power plants (NPP) is discharged into the environment. With increasing energy demands, cost and availability of alternative energy sources, and concern over environment; future nuclear power plants could be made more economical through cogeneration and waste heat recovery. Cogeneration is an important option not only to alleviate impacts of previous issues but also allow nuclear power to penetrate the heat and transportation sectors, and offer flexibility for electrical grids having high intermittent renewable penetration such as wind and solar. Certainly, the obvious advantages of cogeneration may face challenges relating to the inherent characteristics of the heat and transportation market on one hand, business model required for cogeneration plants, and the regulatory frameworks required for nuclear cogeneration on the other hand.

Countries relying on nuclear power could exploit prospects of co-generation and/or the use of heat discharged from a NPP to increase overall efficiency of the plant and make better energy utilization. Major effort has been invested in advanced technologies for the recovery or re-use of waste heat or energy. The International Atomic Energy Agency (IAEA) supports Member States in the demonstration of non-electric applications like seawater desalination, hydrogen production and industrial process heat applications using nuclear energy by providing various forms for information exchange including the publication of various technical and economic documents, coordinated research programs, and technical meetings similar to this technical meeting.

2. Objectives of the meeting

The purpose of this meeting is to exchange information on prospects and challenges relating to non-electric applications of nuclear power, assess the technical and economic merits of cogeneration in nuclear power plants for electricity generation and process heat production, and discuss potential re-use of Low-temperature waste heat and technologies suitable to increase the NPP overall efficiency and make better energy utilization.

3. Agenda

The complete agenda of the meeting is included as ANNEX I of this report.

4. Summary of the work done and results achieved

The **IAEA *Scientific Secretary* (*I. Khamis)*** highlighted the meeting with a background, objectives, and expected outcome of the meeting. A summary of the IAEA activities and worldwide status on non-electrical applications of nuclear energy was presented.

The following contributions were made by the participants:

Argentina (Mr Labollita) Since 2012, the Comisión Nacional de Energía Atómica (CNEA) of Argentina carries on the Project "Industrial uses of Electricity and Steam derived from Nuclear Power Plants" which includes, among other objectives, the study of low temperature heat use on seawater desalination processes. CNEA's project comprises the thermal and electric coupling analysis between a NPP and the desalination plant and the development of a specific thermal desalination technology. The latter consists of the design and construction of a Low Temperature Multi-Effect Evaporation (MEE) system. The basic design of a compact and Modular device, called MP-MEE, is currently in progress. MP-MEE process is under analysis through the development of a full-scope mathematical model. The main characteristics of this process are the inclusion of a preheating chamber on each effect and the implementation of thin film condensation and evaporation phenomena. A specific mathematical model was developed focusing on steady-state mass and energy balances of the whole system to estimate the main performance variables such as GOR (Gained Output Ratio) and Specific Heat Transfer Area. The results showed that it is possible to reach energy efficiencies of about GOR≈20, similar to systems of greater complexity such as MEE-VC (MEE with Vapor Compression) on a smaller and simpler construction device. This is obtained by using 24 evaporation effects operating on a maximum temperature of 78°C.

As a next step towards the development of a full-scope numerical model of the MP-MEE process, the study of thin film heat transfer phenomena and thin film hydrodynamic stability is being carried out. The complete model will be analyzed over a wide range of design and operating conditions. The conceptual mechanical design of the MP-MEE system is based on Plate Heat Exchangers' technology. The device holds some particular constructive characteristics such as serial manufacturing of its components, the ability to change its total capacity after being commissioned and even the possibility of widely modifying the original design operating conditions. In order to validate the mechanical design, the project includes the construction of a pilot-scale unit with a water production capacity of around 10 m3/day coupled to an experimental steam circuit of 30kW of thermal power. Such experimental facility will be previously used for experimental validation of the numerical model.

Canada

1- **(Mr Suppiah)** presented on the recently enhanced capabilities at the Canadian nuclear laboratories for non-electric applications of nuclear energy including:

Capabilities of the labs:

- Noble metal catalyst production for various applications
- Catalyst development and testing for various applications
- Testing of processes (small to large-scale) that apply catalysts
- Process applications development such as heavy water production, hydrogen production, hydrogen recombination, and hydrogen compression
- Computer Modelling: Process Simulation, Energy Storage Analyses, Multi-Physics Simulation (COMSOL), Climate Change Modelling (IPCC), Off-Peak Power Utilization and Base Load Power Integration with Wind
- Electrochemical cell component and catalyst production and testing
- Surface characterization of materials (BET, SEM, XRD etc.)

- Materials development for battery applications including Tritium Batteries for Niche nano- to milli- watt power applications

Infrastructure:

- Dedicated hydrogen and oxygen supply systems
- Industry standard hydrogen/oxygen/nitrogen safety systems
- Controlled access to the hydrogen laboratories
- Gas and liquid analytical services
- Onsite services such as DI water, compressed air, nitrogen, etc.

2- **(Mr Dincer)** delivered his talk on “Improvement of efficiencies for nuclear hydrogen production processes” including several introductory aspects; general issues regarding energy production; potential options (as identifying nuclear as a main option); importance of hydrogen production to achieve carbon free society (as it requires hydrogen production in a more efficient, cost effective, environmentally-benign and sustainable manner); hydrogen production options; copper-chlorine based hydrogen production cycles; design, analysis, assessment and improvement related issues; cogeneration options; system integration for multigeneration (aiming to produce multi products with the same input, such as district heating and cooling, desalination, hydrogen, alternative fuels, chemicals, drying agents, etc.); Clean Energy Research Laboratory (CERL) activities on hydrogen production at UOIT; hydrogen production cycle modeling, design, analysis, simulation and improvement studies; development of exergy-based tools, such as exergoeconomic analysis (including cost accounting), exergoeconoenviromental analysis (including cost and emissions accounting); optimization studies (ranging from single to multi-optimizations); options to integrate copper-chlorine based cycles with renewable energy systems (such as solar); assessment of both energy and exergy efficiencies; assessment of environmental impacts; assessment of economic parameters; and potential methods to improve efficiencies for hydrogen production.

Nuclear-based hydrogen production methods are reported and economic and environmental assessments are performed. Water electrolysis, high temperature electrolysis, thermochemical water splitting cycles and hybrid thermochemical cycles are introduced as nuclear-based hydrogen production methods. The environmental impacts of various hydrogen production processes are evaluated and compared, considering several energy source using an LCA methodology. It is found that hydrogen produced by thermochemical water splitting cycles and wind based electrolysis are more environmentally benign options compared to conventional natural gas steam reforming. Economic assessment shows that nuclear based hydrogen production methods are compatible with conventional hydrogen production via steam-methane reforming. Economic assessment shows that nuclear based hydrogen production methods are compatible with conventional hydrogen production via steam-methane reforming. Hydrogen costs are found to be 2.71, 2.42 and 2.67 $/kg hydrogen for the Cu-Cl thermochemical water splitting, off-peak electrolysis and steam-methane reforming, respectively.

China

1- **(Mr G. Zhang)** presented on the on-going feasibility study for waste heat utilization in the Chinese Qinshan NPP (located in Haiyan County, Zhejiang Province and adjacent to the picturesque Hangzhou Bay. Qinshan Nuclear Power Plant is the birthplace of the nuclear power industry of China’s mainland, with the maximum installed number of units and capacity). There are about 15,300 inhabitants of nuclear power staff and their families living at Haiyan county town, the so-called nuclear power community that is about 15 km distance from Qinshan NPP. The plan is to use the Qinshan NPP to supply heat from the nuclear power plant to the nuclear power community. Considering 1 unit in outage state in winter and the transmission distance of 15 km, the heat power arriving at the nuclear power community will be 40 to 50 MW, and it can meet the heat demand of the nuclear power community in winter.

2- **(Mr H. Zhang)** As a high-safety, flexibility reactor, SMRs can achieve multiple applications such as heat steam freshwater supply. Compared with large NPPs, it may break through the restrictions of population density, site conditions, off-site emergency. From China's current research, SMRs cost of electricity is higher than the large-scale pressurized water reactor, but lower than natural gas. So the SMRs still have a certain competitiveness. And SMRs can be used in the case that large NPPs cannot reach, such as the sea, remote mountainous areas, small power grids. Moreover, through a wide range of applications and mass construction, SMRs are expected to further reduce costs. Within the next ten years, SMRs and large NPPs will co-exist, occupy a certain market share, to provide clean energy for the community together.

Jordan (Mr Aulimat) Presented on the potential for nuclear desalination system in Jordan. He mentioned that Jordan has initiated a Nuclear Project since 2007. The Project aimed at both electricity production and water desalination. Then he showed that in 2010, the siting studies proved that Aqaba site is not suitable to build a nuclear power plant due to the high seismicity of Aqaba area. Jordan has decided to change the NPP site to a new site in the northern part of Jordan and to build the NPP for electricity generation only. Instead of using the co-generation technology for water desalination, the RO technologies to be adopted depends on the cheap electricity produced by the NPP.

Hungary (Mr Talamon) The issues of the energy efficiency and the energy awareness are top priority topics of the European Union. They are also important segments of the Hungarian and the unified EU long-term energy policy. The complex, cascade recycling heat utilization methods as well as investigating the local renewable energy potential by using geospatial tools in the area of Paks town are the topics of the research. The demand side evaluation methodology is based on building typology. The results are synchronized by the National Building Energy Strategy and National Renewable Energy Action Plan. They can be used as an input in decision support systems in Hungary. In the 20 km vicinity the district heating energy potential of the residential building sector is 225 MW and using the existing district heating systems an additional demand of 140 MW could be supplied by cogeneration.

India

3- **(Mr Vakil)** In the ever increasing demand for the fuel (because of the population rise and better standards of living), Hydrogen is considered as an environmentally attractive fuel that could be generated using Nuclear heat. This fuel has the potential to displace fossil fuels, which will exhaust in near future. Hydrogen can be generated by various methods one of which is Iodine Sulfur (IS) process, in which water is split into Hydrogen and Oxygen. IS process involves 3 reactions steps. Bunsen reaction is the key reaction which produces HI and H_2SO_4. As Bunsen reactions is an exothermic and multiphase reaction, it requires better heat and mass transfer coefficients. For that purpose different types have been investigated. One of reactor opted for study here is Oscillatory Baffle Column (OBC).

Oscillatory motion in the column gives uniform mixing within the Baffle cavity which enhances the transfer coefficients. Numerical simulations have been performed to study the hydrodynamics of the column. Studies to evaluate mixing performance are done using residence time distribution analysis. Axial dispersion model is used to quantify the mixing effects through vessel dispersion number. Power dissipation analysis is carried out and compared with a stirred column. From the study, it is seen that OBC is indeed gives better performance which in turn increases transfer coefficients. Hence OBC is considered as a potential option to carry out Bunsen reaction.

4- **(Mr Goswami)** India presented in the IAEA TM meeting on both the aspects of Nuclear Power & Cogeneration and Non-electric Applications of Nuclear Energy. On the cogeneration front a presentation is made on the experience of design considerations installation commissioning and operation of 6300m3 per day Hybrid Nuclear Desalination plant coupled to 220 MWe NPP. Implementation methodology of coupling steam tapping from NPP fabrication and construction of MSF modules safety issues of coupling by intermediate HX loop (IL) through pressure reversals licensing & regulatory issues are also presented. Also discuss are the aspects of thermal coupling losses of power for NPP corroboration wıth DEEP water monitoring for alpha beta & tritium. The basic philosophy of hybridisation is also highlighted. On non-electric applications possible and feasible schemes of waste heat utilisation from various NPP formats like PHWR AHWR research reactors for seawater desalination are presented. A detail case study of a waste heat thermal coupling of a seawater DP with research NPP is presented with the adopted safety features of coupling. Various pressure reversal configurations are presented and discussed. India plays a prominent & decisive role in both cogeneration and waste heat utilisation for non-electric applications of nuclear energy. India has got operating DPs in both the fronts and shared its experiences of design construction and operation of such coupled plants.

Indonesia

1- (Ms Dewita) Electricity demand has increased along with the increasing population. Electricity demand growth in Indonesia is increasing 9.4 percent a year, according to state utility Perusahaan Listrik Negara (PLN). In order to meet its energy demand, Indonesia have several fossil based power plant that it has effect to the environmental. Along with the release of Presidential Decree No. 5 of 2006 (National Energy Policy due to energy mix) indicates that target in 2025 is coal consumption increase to 33% and other new energy and renewable energy, particularly biomass, nuclear, hydropower, solar power, and wind power increase becomes more than 5%. As the first step, Indonesia have planning to construct the experimental power reactor as clean energy with objective is beside as demo reactor for electricity production, it will be also research reactor for nuclear heat application. Therefore, for preliminary study of heat application, it is needed introduction to utilizing nuclear heat for cogeneration purpose, namely for electricity production and coal liquefaction. Coal liquefaction is effort to increasing H to C ratio. Because of coal has H to C ratio is relatively lower compare to the liquid phase hydrocarbon (oil) or natural gas (methane). There are 2 coal liquefaction technology, namely DCL (Direct Coal Liquefaction) and ICL (Indirect Coal Liquefaction). This study used ICL technology because it can produce a product that is cleaner than directly coal liquefaction process, because the sulfur content in coal can be removed before entering the stage of coal liquefaction.

2- (Mr Huda) Hydrogen is an important chemical for fertilizer production. It also will play an important role in the future clean energy systems. The use of hydrogen should overcome the scarcity of fossil fuels, global warming, and fertilizer demand at once. Cheap hydrogen-containing compound with high abundance is water. An energy source is needed for water molecules splitting to produce hydrogen. Potential energy source for this purpose is nuclear. Hydrogen production with nuclear energy is sustainable and renewable. Through a cogeneration system, generation-IV nuclear reactors are potential heat sources for water splitting hydrogen production because of its ability to produce high-temperature heating system with a reliable inherent safety. To that end, the Indonesian National Nuclear Energy Agency has conceptually designed a cogeneration 200 MW high temperature gas cooled reactor named RGTT200K. The presentation consists of a conceptual design of SI (sulphur-iodine) cycle thermochemical hydrogen production process, cogenerated with RGTT200K. For hydrogen production, the indirect splitting of water molecules through SI-cycle is chosen because a direct thermochemical water splitting is difficult and requires a temperature of up to 5,000oC. The 200 MW heat from RGTT200K is distributed as 59.01 MW for hydrogen production, 63.60 MW for electric generation, and 77.39 MW for desalination. This heat power distribution resulted an EUF (energy utilization factor) of 60%. But Bunsen reaction in SI-Cycle is a dilemmatic reaction because it consists of three reactions which will result in a low conversion at any temperature. This presentation concluded that SI-Cycle is too complex for thermochemical hydrogen production and suggests a simplification of SI-Cycle to I-Cycle (fewer steps for water molecules splitting). I-Cycle need no re-reaction of oxygen molecules to form Sulphur trioxide and than to be re-cracked again to form oxygen molecules. This simplification increases EUF up to 80% and makes the cogeneration thermochemical hydrogen production process more feasible.

Pakistan (Mr Anwer) presented on nuclear power generation and cogeneration activities in Pakistan. He discussed current situation at the desalination plant of KANUPP known as Nuclear Desalination Demonstration Plant (NDDP) having the capacity of 1600 m3/day (0.4 Million US Gallons/day) and based on MED. Coupled to KANUPP, the NDDP was commissioned in January, 2010. The plant design was made by M/s Aster, Italy with a total capital cost of 291 Million Pakistani Rs. The ICL loop design, electrical design, fabrication, installation & commissioning completed by PAEC indigenously. He also discussed the cogeneration aspects where plant steam is being used for: hot water production and chilled water production; for showering where plant steam is used to produce 63°C hot water through intermediate loop and the product is used for shower and laundry system; and for ventilation where plant steam used to produce 95~70˚C hot water through intermediate loop and the product is used for ventilation system as per requirements.

Poland (Mr Jackowski) Currently, the heat used in industrial processes in Europe is produced in 100% from burning fossil fuels, mostly imported. In the face of increasingly stringent environmental regulations and limits of greenhouse gas emissions in Europe and the United States, High Temperature Gas cooled Reactors (HTGR) may be the answer to the need for safe, reliable and economical source of heat and electricity for energy-intensive industries. HTGR reactors also can positively affect the competitiveness of the European economy and its energy independence. The presentation contents the results of the study done in the frame of NC2I-R European Research Program selecting potential sites for the location of HTGR in Europe for the majority of industrial end-users in correlation with their requirements for process heat and electrical supply. This report was prepared for Central and Eastern Europe on the basis of many contacts with industrial operators. The conclusion from the study is that the end-users requirements on electrical and thermal power, temperature and pressure of the steam are generally in the frame of parameters of HTGR existing or possible to be built actually.

Turkey (Mr Kam) presented on the development of fast neutron radiography system as useful tool for non-destructive testing for composite materials. The FNR systems in generally consist of three parts: neutron generator (must produce suitable neutron beam), converter or detector and a device to record the radiation intensity. In fast neutron radiography systems neutron generators are usually accelerator based which requires a particle accelerator and a target. Proton or deuteron beam is accelerated to the desired energy and bombards the target material to produce fast neutrons by a nuclear reaction. In our study a sealed DT neutron source is used. Fusion of a deuterium and a tritium atom (D + T) results in the formation of a He-4 ion and a neutron with a kinetic energy of approximately 14.1 MeV. This system mainly consists of a neutron source, a scintillation screen, an optical box, a flat mirror and a CCD camera.

USA (Mr Walter) Medium temperature reactors (~500^{o}C) can be developed with enhanced fuel utilization and proliferation resistance while maintaining economic competitiveness with existing reactor types, like LWRs. The outlet temperature is sufficient to directly drive thermal decomposition reactions of low cost, highly available, carbon-based feedstock and can further support the bulk of the energy needed to reform the decomposition products to synthesis gas. The reformation reaction provides hydrogen needed to create synthesis gas which can support H:C ratios of 2. The synthesis gas, along with char/carbon resulting from the cracking reaction can be utilized in several markets. Economic analysis for using nuclear power in this fashion shows higher rates of return for fuels and chemicals than for making electricity in certain markets. TerraPower is currently developing experimental facilities to analyse thermal decomposition followed by steam reforming optimized to the Travelling Wave Reactor outlet temperature, which is similar to other fast reactor technologies. As with electricity production, waste heat generated from the synthesis process can be used to support desalination. TerraPower is analysing the TWR for use in multiple desalination scenarios.

5. Conclusions

This technical meeting has provided a platform to allow country representatives to make presentations on “Advances in Non-Electric Applications of Nuclear Energy and on Efficiency Improvement at Nuclear Power Plants” and discussed the challenges and opportunities for non-electric applications of nuclear energy. The followings are the main conclusions made by participants to the meeting:

- Interest in non-electric applications has been evident as more countries have participated in this TM.
- Based on the previous experience on non-electric applications of nuclear power and the rising demand for energy, there are many opportunities for MSs in the area of non-electric applications of nuclear energy.
- The IAEA activities in the area of non-electric applications of nuclear energy are consistent with the effort of MSs in sharing information and develop collaboration among them.
- The available tools (DEEP, HEEP, toolkits…etc.) for techno-economic evaluations are useful for a wide range of applications.
- There is lack of understanding of business models to support cogeneration.
- There is a need to better understand the licensing framework for cogeneration.
- There is lack of education and training on nuclear cogeneration applications.
- Cogeneration could benefit from coupling of nuclear and renewables.

- Demonstration and case studies on nuclear cogeneration are necessary for highlighting incentives of non-electric application.

6. Recommendations

Based on the presentations and discussion on the cogeneration issues, participants recommend to IAEA the followings:

- Initiate a CRP on economic assessment and case studies including business models for cogeneration involving non-electric applications of nuclear energy.
- Organize a technical meeting on social and political dimensions of nuclear cogeneration.
- Support MSs in preparing road maps for short-term (5-10 years), midterm (10-20 years) and long-term (over 20 years) for cogeneration applications of nuclear energy for district heating and cooling, desalination, production of hydrogen, fuels, chemicals, etc., and many more. Furthermore, each report may be specific each of these commodities.
- It is necessary to make a white paper on the topic considered after each technical meeting. This will make the meetings more fruitful?
- It is necessary to prepare reports on “Case Studies” for every commodity produced by nuclear cogeneration?
- Organise a technical meeting focusing on operating experience/feasibility projects on process heat applications (Hungary, 2016).

ANNEX I

AGENDA

Technical Meeting on "Advances in Non-Electric Applications of Nuclear Energy and on Efficiency Improvement at Nuclear Power Plants"

15-17 June 2015

Rektorluk Building, Senato Salonu, Besiktas
Yildiz Technical University (YTU), Istanbul, Turkey

Monday, 15 June 2015

09:00	Welcoming and opening remarks	Mr. Khamis (IAEA), Mr Yigit (Turkey)
09:15	Introduction of participants, election of Chairpersons and adoption of Agenda	All participants / Chairperson
09:30	Objectives and overview of the meeting	Mr. Khamis, IAEA
Session 1: Nuclear Power and Cogeneration		
09:45	Investigation of portable neutron radiography systems	Mr Kam (Turkey)
10:15	High efficiency modular multi-effect evaporation system for seawater desalination	Mr Labollita, (Argentina)
10:45	***Coffee Break***	
11:00	Recently enhanced capabilities at the Canadian nuclear laboratories for non-electric applications of nuclear energy	Mr Suppiah (Canada)
11:30	The feasibility study on waste heat utilization for Chinese Qinshan NPP	Mr G. Zhang (China)
12:00	Performance evaluation of oscillatory baffle Bunsen reactor in Iodine Sulfur thermochemical process for hydrogen production from nuclear heat	Mr Vakil (India)
12:30	***Lunch Break***	
14:00	GIS-based evaluation of district heating potential in the area of PAKS NPP	Mr Talamon (Hungary)
14:30	Nuclear power generation & cogeneration activities in Pakistan	Mr Anwer (Pakistan)
15:00	Heat application of the first experimental power reactor for coal liquefaction in Indonesia	Ms DeWita (Indonesia)
15:30	***Coffee Break***	
Session 2: Round table discussion: The future of nuclear power, cogeneration, and efficiency improvement in NPPs		
15:45	Lessons learned and the future of cogeneration	All participants
17:00	***Closing of first day***	

Tuesday, 16 June 2015

Session 3: Non-electric applications of Nuclear Energy		
09:00	An Overview of IAEA activities on non-electric applications of nuclear energy	Mr Khamis, (IAEA)
09:45	Liquid Metal Reactors for Fuels, Chemicals, and Water	Mr Walter (USA)
10:15	Improvement of efficiencies for nuclear hydrogen production processes	Mr Dincer (Canada)
10:45	***Coffee Break***	
11:00	ACPR Small Modular Reactor (SMR) of CGN	Mr H. Zhang (China)
11:30	Low temperature waste heat utilisation of a nuclear reactor for non-electric application – A Case of seawater desalination	Mr Goswami (India)
12:00	HTGR as a source of process heat for the European and U.S. industry	Mr Jackowski (Poland)
12:30	***Lunch Break***	
14:00	Conceptual Design of Water Splitting Process with Sulphur-Iodine Cycle for Hydrogen Production in Cogeneration Nuclear Reactor System	Mr Huda (Indonesia)
14:30	Potential for nuclear-powered desalination systems in Jordan	Mr Aulimat (Jordan)
15:00	***Coffee Break***	
Session 4: Assessment of SMRs vs. Large NPPs for meeting the energy demand of the future		
15:15	Techno-economic assessment of current and future reactors	All participants
17:00	***Closing of second day***	

Wednesday, 17 June 2015

Session 5: Drafting the meeting report		
09:00	Summary of Chairperson	All Participants
10:30	***Coffee Break***	All Participants
10:45	Conclusion & Recommendations	All Participants
12:30	***Closing Remarks***	All Participants
13:00	***End of the meeting***	

Observers to the meeting:

- **Mr H. Zhang (China)**
- **Mr S. Shen (China)**
- **Mr X. Mu (China)**
- **Mr K. Verfondern (Germany)**