NZE-4 Proposal

SPAM-FLEX

Sustainable Power-to-Ammonia solution to FLEXibilize fossil fuel power plant

ETN – Annual General Meeting
Pau (France) 28th March 2019

Company Overview

RINA operates through a network of companies covering Marine, Energy, Transport & Infrastructures, Business Assurance and Industrial Innovation.

RINA is active across a wide range of industries in:

- Product testing, verification and certification
- Marine Classification
- Vendor Supervision
- Training and Engineering Consultancy

3700
Colleagues

170+
Offices

65+
Countries

Over 150 years of experience

A SPOTLIGHT ON INNOVATION

STRATEGIC RESEARCH & INNOVATION RECORDS

- ✓ **2nd top** industrial participant in FP7*
- ✓ **30% average H2020 success rate:** more than 60 current participations in H2020 projects – 25% coordinated
- ✓ **5000+ partners** in Innovation and Collaborative Research projects **
- ✓ Unique know how in several cross cutting sectors
- ✓ Technology transfer
- ✓ PUMP-HEAT H2020 Project coordination together with UNIGE

10% turnover
Invested in R&D

246,000+ h/y

* Final FP7 Monitoring Report
** www.researchranking.org

H2020 call – LC-SC3-NZE-4-2019

Integrated solutions for flexible operation of fossil fuel power plants through power-to-X-to-power and/or energy storage

Fundings :
EUR 6-10 Million
20 M€ for the call

Coordination and support action:
70% funding

Deadline:
27/08/2019

CHALLENGE

With a **growing share of energy produced from renewable resources** (RES), fossil fuel power plants will have to increasingly shift their role from providing base-load power to providing **fluctuating back-up power** (i.e. ramping up and down) in order to control and stabilise the grid. These **strong fluctuations** result not only in increased wear-and-tear, but (more importantly) also in a lower efficiency and hence higher greenhouse gas emissions per unit of produced electricity. Severe ramping up and down can be limited through **load-levelling i.e. storing power** during periods of light loading on the system and delivering it during periods of high demand.

There is the need to increase flexibility in actual power plant, increasing ramp rate and reducing gas emissions

SCOPE

Validation and **pilot demonstration** of the integration of energy storage and/or use of excess energy (including via power-to-X-to-power) in fossil fuel power plants and showing that EU emission limits for such installations can not only still be met, but that **emissions of air pollutants can even be reduced**. This could include the enabling of the combustion system to deal with **synthetic fuels and/or hydrogen enriched fuels**, as well as a better integration of combined production of heat and power into the overall system.

KEYWORDS : pilot demonstration (at least 1MW), synthetic fuels and/or hydrogen as fuel for power plant combustion
MANDATORY: use of the X produced in by the Power-to-X-to-Power in the same power plant

EXPECTED IMPACTS

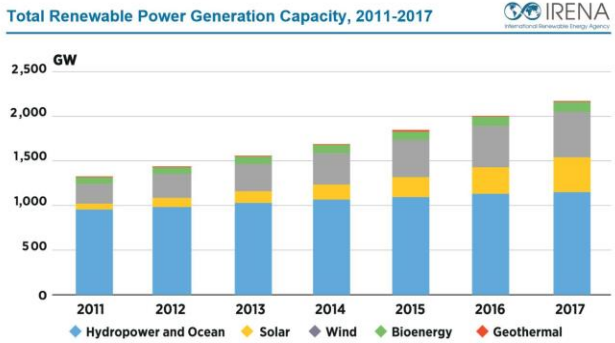
Solutions will contribute to a **smart, secure and more resilient power system** through the integration of **energy storage** for the purpose of **load levelling** in fossil fuel power generation. Results of the project(s) should allow a smoother operation of these plants at **optimal efficiency** and **environmental performance** in order to better adapt to an energy systems that will increasingly be dominated by intermittent renewable energy.

Target objectives:

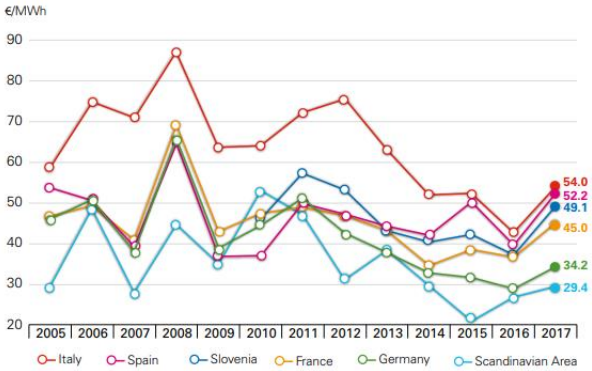
- increase expected ramp-up/down rates
- reduction of GHG, SOx ,NOx
- reduction of Turbine/Compressor ware

BACKGROUND

- Annual renewable shares of electricity production increases dramatically
- Increase of net installed electricity generation from RES which are non-controllable
- Fossil power plant must be operated more and more flexible since RES have feed-in priority
- Electricity market price is decreasing and fossil power generation is pushed out of the market



IRENA, 2018



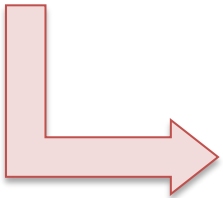
Day-ahead prices on the main European power exchanges
GME Annual Report, 2017

More flexible power plants and energy storage will become crucial for the energy systems with high penetration of RES

BACKGROUND

- Growing expectation for electrical power generation to reduce their CO2 emission
- Needs to store excess electricity at times when pricing becomes very low or even negative.
- Reliable energy storage has fast become the target technology to unlock the vast potential of renewable energy

- The hydrogen gas turbine is a major step towards a carbon-free society
- Hydrogen fired gas turbine is already wide studied by O&M
- The main problems with hydrogen are the safe handling, storage and transport



Using ammonia as a hydrogen source is a potential alternative to the conventional hydrocarbon reforming and makes the on-board hydrogen production free of carbon.

Ammonia already present in CC power plant – easier to store

BACKGROUND

Japan is working very strongly on this topic

Combustion characteristics of ammonia/air flames for a model swirl burner and an actual gas turbine combustor

Posted on August 22, 2016 by NH3 Fuel Associ

Akihiro Hayakawa*[1], K.D. Kunkum[a] C. Okafor[1], Taku Kudo[2], Osamu Kur Kobayashi[1]

[1]Institute of Fluid Science, Tohoku Unive
[2]National Institute of Advanced Industria Japan

NH3 Fuel Conference, Los Angeles, Septe

ABSTRACT

Ammonia is expected not only as hydroge fuel. For an industrial use of ammonia co a swirl combustor should be clarified. Ho fueled combustor, there are some issues t stabilization and reductions of NOx and a stabilization and emission characteristics model swirl burner are investigated. The are 24 mm and 14 mm, respectively, and the burner liner is 150 mm and the inner

Power Generation and Flame Visualization of Micro Gas Turbine Firing Ammonia or Ammonia-Methane Mixture

Posted on August 23, 2016 by NH3 Fue

Norihiko Iki[1*], Osamu Kurata Inoue[1], Taku Tsujimura[1], Hir Akihiro Hayakawa[2]

[1]Fukushima Renewable Energy In
[2]Institute of Fluid Science, Tohok

NH3 Fuel Conference, Los Angele

ABSTRACT

A demonstration test with the aim plant is planned using a micro gas kerosene is selected as a base moc prototype combustor which enabl gas. Diffusion combustion is empl flame stability. 44kW power gener ammonia gas. Although NOx conc combustion exceeded 500ppm, N

Development of ammonia / natural gas dual fuel gas turbine combustor

Posted on August 22, 2016 by NH3 Fuel Association | 3 Comments

Shintaro Ito*[1], Soichiro Kato[1], Tsukasa Saito[1], Toshiro Fujimori[1], Hideaki Kobayashi[2]

[1]IHI Corporation, Japan
[2]Institute of Fluid Science, Tohoku University, Japan

NH3 Fuel Conference, Los Angeles, September 19, 2016

ABSTRACT

NH_3 is a carbon-free fuel, so it has the potential to reduce CO_2 emission from the power plant when used as a fuel. However, NH_3 has combustion characteristics different from conventional hydrocarbon fuels. The N atom in the ammonia molecule causes high NOx emission through combustion reactions. To develop a gas-turbine combustor, which burns a combination of NH_3 and natural gas with controlled emissions, combustion characteristics have been studied experimentally and numerically by using a swirl-burner, which is typically used in gas-turbines. Detailed exhaust gas compositions of the burner have been measured under atmospheric pressure and fuel lean conditions. As

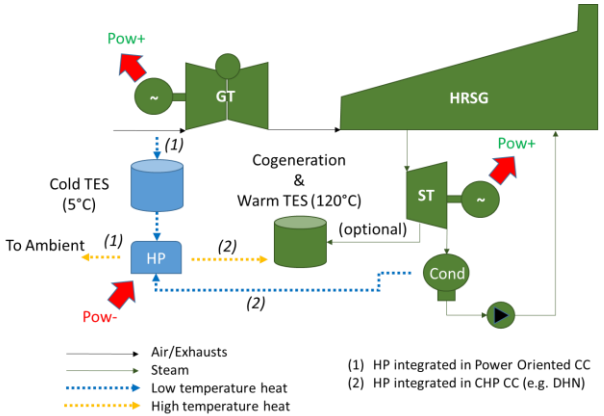
Nikkei Asian Review published two articles outlining plans to build utility-scale demonstrations using ammonia as a fuel for electricity generation. Both projects aim to **reduce the carbon intensity** by **displacing a portion of the fossil fuels with ammonia**. The first project will generate power using an ammonia-coal mix, while the second will combine ammonia with natural gas.

…Europe?!

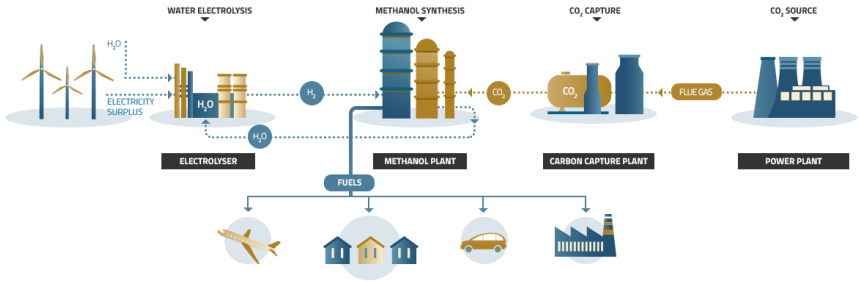
BACKGROUND

PUMP HEAT

- To enhance Combined Cycle power flexibility
- The HP is controlled to modulate power in order to cope with the CC primary reserve market constraints
- The high-T heat can be exploited in district heating network
- HP cooling can be used for gas turbine power boost



MefCO2



- To develop an innovative green chemical production technology
- Produce green methanol as energy vector from captured CO2 and hydrogen produced using surplus renewable energy

CONCEPT

Experience in combined cycle flexibility enhancement

Experience in energy storage by chemicals production and power to fuel

Concept that could be applied to NGCC or IGCC storing <u>ammonia</u> from electricity surplus

- Easily to stored with low related-risks
- Already present in CC plants areas
- Highly cost-effective storage medium
- Mature global energy vector widely used in different sectors

CONCEPT

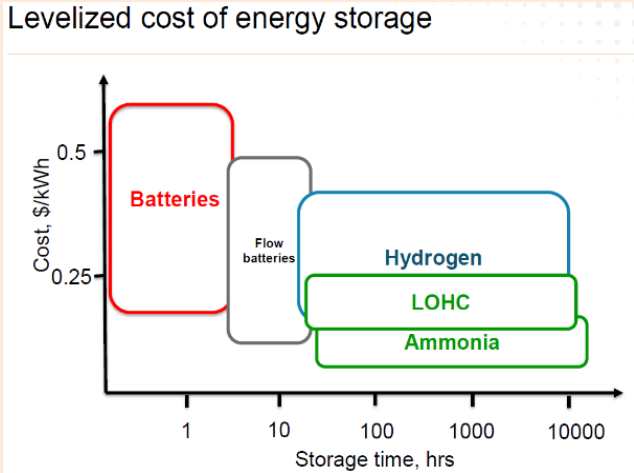
Objective: Demonstrate up to TRL 7 in a real operative plant the integration of power-to-X-to-power able to:

- increase fossil based power plant flexibility
- reduce emissions of the power plant
- use the intermediate product in which power is stored within the power plant itself to produce power again

Ammonia would be more easily stored in power plant premises than any other kind of energy carrier.

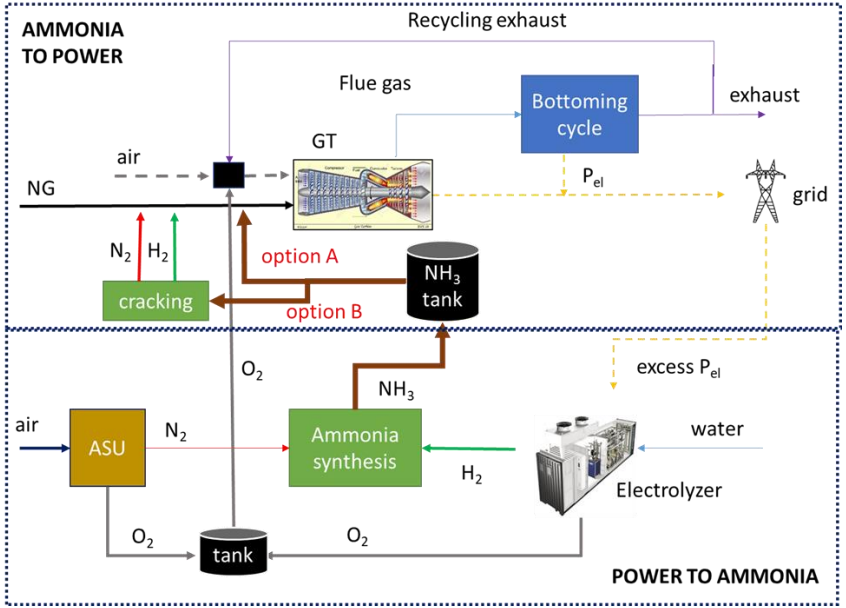
Integration in the plant of a power-to-ammonia system would make possibile to generate both:

- **excess of oxygen**
- **hydrogen**
- **ammonia**

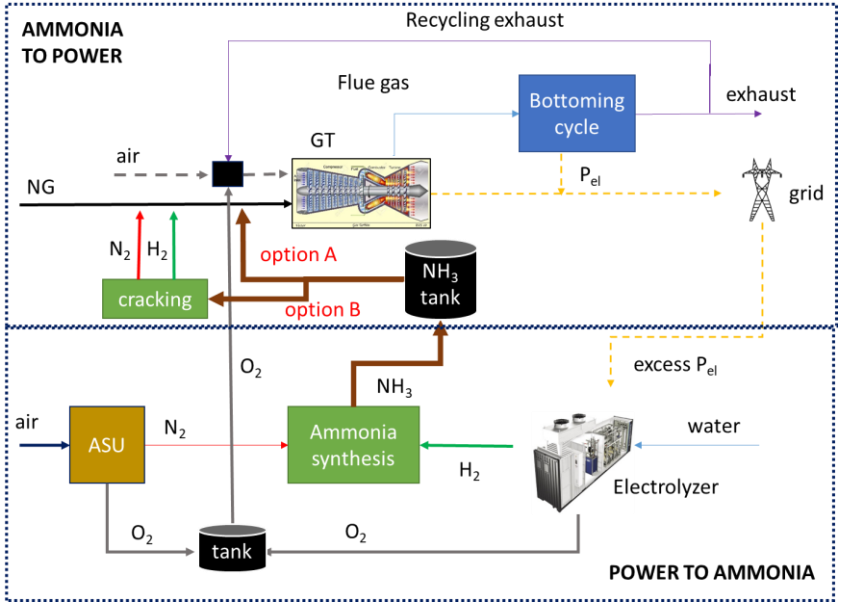


CONCEPT

NGCC



IGCC



CONSORTIUM

We are looking for partners related to:

- Modelling expertise (CFD….)
- Controller development
- GT OEM with specific interest:
  - oxyfuel combustion
  - hydrogen combustion
  - NH_3 combustion (small scale validation)
- Demosite owner (CC plant)

The proposal will be **coordinated by RINA-C** with the support of UNIGE also to create a connection with the ongoing H2020 PUMP-HEAT and MEFCO2 project

Already ETN members interested partners:

CERTH – RTO – Greece
UNIGE – University – Italy
ETN – ASS – Belgium

TIMELINE
close the consortium
within end of April

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