Draft Project Title	NoGas : Monitoring and remediation of Noxious Gas in urban water systems for better health and wellness in the city
Short Description of the project idea and expected outcomes	To address the problem of urban noxious gas, NoGas brings together, in a multidisciplinary collaborative project, researchers and industrials from multi-disciplinary fields ranging from fluid mechanics and metrology, environmental chemistry and electrochemistry, electro-microbiology and biogeochemistry, genomics and neuroscience, social geography, urban management and economics and ICT, to municipal utility and urban water management. NoGas solutions will be managed in an integrated manner based on short-term and long-term remediation strategies.
Main Objectives	deploying nature-base solutions (NBS) to monitor noxious gases released from sewers that are regarded as increasingly unacceptable in the urban space. NoGas aims at impacting on the reduction of the health risks associated with sewer dysfunctions, and the corrosive damages on infrastructure, in turn innovating in urban water governance using citizen expertise and finally, developing innovative and exportable technologies. NoGas will improve urban resilience to Climate Change, enhance water resources management sustainability and contribute to the creation of healthier and greener European cities by 2020.
Specific Objectives	NoGas' specific objectives will be as follows: • Objective 1: To implement nature-based sensor network and monitoring systems in two large "front-runner" cities accounting around 10 000 individual sensors to be deployed and scaled up to 6 European follower cities (estimated 100 000 sensors to be deployed by 2020); • Objective 2: To implement nature-based remediation solutions to stop N2O emission and reduce CH4 and H2S gas emission from urban water system by 50 % by year 2020; • Objective 3: develop across whole city a mapping system based on olfaction of voluntary citizens, validated by an e-nose network installed in situ, and processed thanks to the use of ICT and social media; • Objective 4: To engage citizens and stakeholders (city managers, SMEs, decision-makers) to concretely provide feedback (odour perception) and give their opinion on the improvement of their local environment via a social media & Internet of Things platform to be developed. We expect to reach 500 000 citizens during the 4 year project increasing by 20% per annum; • Objective 5: To deploy and replicate in "follower" cities through a well-structured communication and dissemination activities including knowledge sharing and training. We expect to reach 2.7 million citizens by 2020 in all the five follower cities, which total together 7.53 million; • Objective 6: To assess in 'front-runner' cities the life cycle and economic feasibility of the developed solutions that will be deployed in multiple 'follower' cities. This will also include the analysis of potential barriers in large scale deployment of the monitoring solutions; • Objective 7: To ensure future exploitation and replication including export of the developed solutions by developing a robust business plan, including the analyses of socio-economical and regulatory framework in the targeted megacities around the world.
List of potential activities	Citizen involvement: Because odour problems are often measured subjectively by the public complaints, it is necessary to include the social sciences approaches in the tools of management, identification and remediation of noxious odours in the city. Odour perception of citizens is a major indicator to rate the remediation technology efficiency and in this standpoint. So, one of the NoGas issues is to monitor the noxious odours through the perceptions of people living close to smelly zones before, during and after the implementation of the remediation public works. NoGas aims at enhancing citizen participation by connecting sensors and people. We will build on existing approaches from both social engineering and Web of things to build and keep up-to-date city maps of noxious gas. To do so, NoGas will provide an exchange platform dedicated to gas monitoring and advertising remediation actions. NoGas platform will both automatically gather sensor data and allow citizen to signal an odour and its characteristics (place, intensity, type…), either online from their homes or through connected, mobile and geo-localised tools (smartphone apps). NoGas will exploit the concept of avatar to bring together all these agents in a common virtual space, so that they can all collaborate and mesh the whole city area. All data gathered through this platform will be analysed using statistical and cartographic methodologies to dynamically set up adequate and optimized responses to noxious

odours detection. Lastly, we will apply semantic and learning techniques in order to discriminate specific city descriptors from generic ones and therefore, allow adaptation of the platform from front-runner to follower cities.
In addition to reporting of odour problems, NoGas platform will provide extra services to citizens, such as: accessing to data on own neighbourhood; newsletter to inform on remediation programmes, and provide feedback; question to operation staff; and events as a feast of scents and wellness; NoGas will used to boost citizen participation to the platform. Hence, sensor data, as well as citizen-provided information will be used for design new indicators and stimulate a city co-construction for (and by) its own dwellers.
The web-based application will be provided to citizens, operational experts and utility managers. They will be “ground-truthed” by the front-runner cities before being offered to the follower cities and any other cities eager to apply the NoGas nature-based solutions. The underlying data model will be designed using advanced adaptation techniques, to allow re-parametrisation according to the follower cities’ environments. This approach ensures that the application tool can be easily updated and can address any odour or corrosion-related issue at practical level.
Continuous monitoring: Use of new e-nose sensors able to shelter up to 12 electrochemical sensors (as CO, CO2, H2S, CH4, NO, NO2, O3, SO2, Cl2, C2H4O, H2, HCl, HCN, PH3, NH3), a PID (for VOCs) and 6 MOS sensors (in Odour Units). Noxious gas amounts (H2S, CH4, N2O, NH3, CO2, CO, H2, O2, PH3) by micro GC, and VOC.
Monitoring based on quantification of microbial activity based on microbial fuel cell system: biodegradation process of organic matters by microbial activity will be measured by a new generation of microbial sensors using naturally occurring bacteria to measure the quantity of electrons donors in situ.
Remediation based on biological end-of-pipe stimulation: The treatment is based on biological and chemical oxidation of the volatile and odorous compounds using oxygen supplied by aeration as electron acceptors . The NBS will serve as an alternate to traditional methods based on chemical additions in the pump sump.
Remediation based on controlled-use of water retained in catchment: The controlled water retention in the catchment (e.g. through hydraulic retention tanks or storm water treatment ponds, wetlands) in the sewer, will be done by means of controlled-release of the retained storm water, hydraulic retention time in sewers. This would also present some secondary benefits, such as the opportunity to use the retained water in recreational areas, increased urban biodiversity, evaporative cooling.
Remediation based on physical action on air and water fluxes: Gas production, transfer and monitoring strongly depend on air-water flow conditions, particularly air-water flow velocity . The management of water velocity and air sweeper without energy costs (using only hydraulic head to control the operation of the gate) is relevant to increase velocity and air sweep and to reduce deposits. The optimization of their locations at the district scale will be done thanks to simplified multiphase flow modelling using original multi-outlet modelling approach .
Remediation based on physical action on river hydro-geomorphology urban rivers: In urban or suburban contexts, natural self-purification capacity is insufficient to preserve water resources and must be stimulated. In NoGas, this will be done based on the use of natural self-purifying capabilities specific to some geomorphological facies.
Remediation based on electrochemical microbial control: This will be based on the use of an anode acting as inexhaustible electron acceptors at high ORP to guide metabolisms toward less toxic or harmful products. This technology was resulted from a project funded by the French Research Agency, ANR OH Risk El Hamico, and the theme is supported by the Auvergne-Rhône-Alpes Region thanks to a doctoral grant.

Expected impact on European level

According to Eurostat data, water supply and remediation activities involve 58 000 enterprises suppling 1 269 000 jobs, and generating a turnover amount of € 190 249 Million a year in Europe.
It is expected that NoGas will compete in this market generating at least a turnover of hundreds of millions of Euros (based on 100 000 sensors to be deployed by 2020) and at least thousands of jobs (related to monitoring, remediation, installation, maintenance, training, dissemination as well as management in all cities involved).
New green jobs will be created for group animation and supporting citizen communities, as essential actors in an integrated water management in the city. When a same platform is deployed across cities, there will be less technological barriers (data standards and communication protocols) as well as regulatory and administrative hurdles.
Sewer systems suffering from H2S corrosion generally require costly and premature replacements or renewals of pipes, manholes, pump stations. Restoration of damaged sewage due to H2S corrosion represents roughly 10% of the total cost of wastewater collection and treatment.
NoGas will allow increased awareness of citizens to the benefits of a re-natured city, the

ability to breathe clean air, no injurious to health. For city managers and stakeholders, there will be better quantification and tracking of cost centres for making informed decision. Policy-making will be also more customised to local needs thus enhancing citizens' participation in governance. This in turn will create a more cohesive community around sharing of information and ideas, festive events, thanks to new communication and information tools.
NoGas will increase links and cooperation between partner cities, the efficiency and environmental performance of urban water sector inside and between the partner cities, in particular through synergies between public water authorities, citizens, services water, various economic actors and industry, SMEs and research organizations.
NoGas will lead to the emergence of new easily replicable city management practices, more community and associative thanks to innovating ICT tools and IoT uses, validated by full-scale experimental approaches in various urban contexts.
Sanitation is at the heart of development issues. Global market is growing very rapidly and estimated to reach $ 650 Billion in 2020, with an annual global growth rate of 4%, with strong disparities + 2-3% for developed countries (Europe/North America) and + 10% for China and the Middle East. Europe already plays a leader role in developing the Green Growth concept, and must keep a constant flow of innovation, including eco-engineering of monitoring and bio-remediation to stay ahead in a highly competitive sector.
NoGas platforms will involve the various urban water users in a transferable comprehensive and coherent interaction system with the possibility to migrate between cities the virtual representations (avatars) of sensor and users, as well as to share data and adaptable environment models, this will open the European economy to growing export markets, because of global urbanisation trend and the weight of sanitation systems in the priority societal challenges. The wide and fast deployment of innovative sustainable NoGas solutions into the urban water management sector will create new opportunities both inside and outside Europe for emerging countries, like countries of Near and Middle East and the Maghreb through the always close relationships between institutions.
NoGas will contribute to and comply with the following policies and European directives:
• EU environmental policies, in particular Directives 2000/60/EC for the 'good status' of water bodies; 2006/7/ EC on bathing waters; Directive 2009/29/EC, particularly for N2O
NoGas addresses three major European societal challenges, such as "health, demographic change and well-being", "Climate action, environment, resource efficiency and raw materials" and "Europe in a changing world - inclusive, innovative and reflective societies".
Improved urban health and wellness of citizens and workers: For the 1990-1999 decade, Bureau of Labor Statistics lists 87 poisoning deaths of US sewer workers, attributable to toxic inhalations. H2S is a chemical hormone belonging to the new family of gaso-transmitters (CO, NO & H2S), playing a major role in human physiological balance. H2S presents such pleiotropic effects on the physiology that may explain many of the pathologies encountered among sewer worker . Moreover, because of its sub-toxic pleiotropic effects, H2S can cause chronic contamination of people without any clinical signs, except perhaps a life expectancy reduced due to increased morbidity .
Impact on the security and health for sewer workers and all citizens will evaluated by the rate of complaints and follow-up of the sewermen's health status. Citizens' satisfaction level can be measured during the project time frame. However, serwermen's health improvement will require longer follow-up period. At least, we can measure the amount

of incidences or work related accidents among the selected groups to be followed.
NoGas will increase the social cohesion and involvement of citizens through its Citizen Empowerment Programme, these actions of motivation and involvement, and creation of a web platform for exchange and information. Citizen science to assess the satisfaction rate by analyzing data on social media. NoGas will impact the everyday life of tens of millions with hundreds of thousands of empowered citizens in a global city network connecting together the various city stakeholders.
Climate warming: The contribution of GHG from urban water systems to climate warming is far from negligible. Wastewater treatment is considered the 7th highest GHG contributor to the atmosphere. For instance, USEPA reported in 2010 that U.S. wastewater treatment released 24.3 Tg CO2eq (i.e. CO2 GHG equivalents) via CH4 and 4.9 Tg CO2eq via N2O during 2008. Unfortunately, empirical validation of models using field data is lacking.
NoGas will propose a methodology to properly evaluate sewer the GHG contribution (CO2, N2O & CH4), and aims at reducing at least by 50% the warming effect due to urban water systems. Any NBS preserving the water quality contributes to the climatic challenge.
NoGas will improve city water planning and management, in shifting current paradigm

	towards smarter, user-driven management of city infrastructures and services. It want guide the city towards a more inclusive urban regeneration, and a better socially accepted city planning and the collaboration stimulation between all stakeholders (including scientists) around WoT platforms dedicated to citizen exchange and consultation. emissions; and 2010/75/EU on integrated prevention and pollution control. • EU policy to reduce greenhouse gases in accordance with the roadmaps 'to a resource efficient Europe' COM (2011)571 and ‘for moving to a competitive low-carbon economy in 2050' (EC, 2011) reduction of domestic emissions. • Paris Agreement to limit global temperature rise to less than 2°C, by supress N2O released from sewer, and reduce CH4 .emissions by 50%. • EU water policy enforcement and probably extend it worldwide implementation potential, in Middle East, in China, a promising market despite the current downturn NoGas will pave the way for a new type of Cleantech designed from knowledge about the functioning of water environment accumulated by researchers, as NBS for monitoring (e-nose, microbial-based sensor and toxic gas sensor based on human cells), remediation (electrochemical biofilm luring, water management), and social science (expert olfactory sense of citizens). The concept of "smart city" is rapidly changing along with technological advances in mobile technologies. As citizen can issue geolocated data when travelling in the city, it goes beyond sensor data analysis.
Call identifier	SCC-02-2017
Full topic	Demonstrating innovative nature-based solutions in cities
	I will be the project leader/coordinator
Which kind of partner are you searching for?	Research Institute/University SME cities
Expertise or specific role of partners sought	gas monitoring, sensoring, humanities, urban mangement, neuroscience, IoT,
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Description of the organisation	

Centred on scientific research that aims to produce concrete solutions to aid government decisions and that leads to action (or “finished research”), the Irstea model rests on four fundamental parameters:

Partner research with a strong technological and methodological component, based on the collaborative construction of scientific questions with various economic participants.
Research that supports public policy through strong cooperative links between Irstea and the Ministries for the Environment and Agriculture, regional authorities and devolved government services.
Scientific cooperation with research bodies and universities
A European and international setting, particularly with regard to involvement in European environmental research networks