



Report on  
Energy

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Description of the workpackage structure; segmentation into 10 technology sectors

# 1 Energy

## 1.1 Executive Summary

One major challenge of our world will be to provide enough energy for human activities without exhausting the earth resources and without degrading environment. Several possibilities are available to obtain this energy: photovoltaic, thermoelectricity, batteries or supercapacitors, fuel cells, fossil or nuclear fuels, harvesting at a small scale: piezoelectric, magnetic, and electrostatic or at a larger scale: wind turbine, hydroelectricity, geothermal. However, those current solutions used to produce electricity and to provide energy for transport applications as well as to mobile devices should become more efficient, less expensive and environment friendly.

This energy sector involves complex systems including many functions having specific strains and criteria, and interacting with each other. Moreover, these systems are in general applied to supply energy to other devices having their own requirements. Therefore, a novel technology improving a part of the system can not simply be assessed by its intrinsic performances.

Nanotechnology can provide a multitude of improvements and new solutions to this energy sector. The nanometre structuration of materials or of architecture allows indeed multiplying active sites (surfaces, nanoparticles...). It allows also reducing the amount of matter (amount of material displaying specific properties, amount of catalyst material...), which is one of the main challenges for this sector. Another positive consequence of the nanometer scale consists in creating new specific properties: nanowires, quantum dots, nanoporous membranes...

Although all of the sub-sectors are concerned, some applications can expect much more developments, thanks to nanotechnologies, than other ones. Batteries, supercapacitors and low temperature fuel cells can expect positive effects of nanomaterials, for catalysts properties and/or nanoporous membranes for instance. Photovoltaic or thermoelectric devices have huge perspectives of developments thanks to nano-objects like nanowires or quantum dots, as well as from matter nanostructuration. As a consequence, nanotechnologies are assessed as one of the factors to take into account for the future developments of these application sectors.

Other fields will have less impact from nanotechnologies, for two main reasons. On the one hand, many energy sources or conversion means are based on macroscopic effects, such as wind turbines, tidal devices or mechanic energy harvesters. Harvesting or producing energy at the nanoscale will be efficient only if an additional effect of a large amount of such devices can be induced, or if it is possible to manage very low amount of energy to supply low power devices. Size reduction in most of these cases has little interest, and the main use of nanotechnologies is as mechanic reinforcement of structure materials. On the other hand, processes inducing high temperatures, like nuclear energy, fossil fuel or high temperature fuel cells, limit the use of nanotechnologies, mainly because the high temperature generally destroys the nanoscale structure of materials.

Nanotechnology displays a lot of interesting properties regarding energy production or harvesting, but are limited by their usual weakness: integration and process, cost, reproducibility. Nevertheless, the economic and environmental challenges are so vital in

this field that huge research and technological developments are led to find ways to save matter and energy reserves. In this context, nanotechnology remains a promising tool.

The following report is organised by energy sources, which are systems providing electricity at various power levels for multiple applications. These systems are able to convert chemical, thermal, nuclear and so on... energy into electricity. The energy sources are either provided by the user as fuel tank or available in the environment. The principle of conversion or harvesting is described for each device, particularly the parts where nanotechnologies can be used. Then, the most promising nanotechnologies developments are displayed.