



# European Metrology Research Programme

## *Sustainable Energy II*

*An overview of the set of projects funded under the Targeted Programme Energy II.*

*The aim of these projects is to establish a sustainable European energy system through measurement research.*

*Focus is placed on technologies that enable greatly reduced greenhouse gas emissions, whilst also ensuring the security of Europe's energy supply.*

## Supporting solar cells

### *Developing tools for the next generation of solar cells*

Energy policies are based on three requirements: security, affordability and sustainability. Photovoltaic (PV) solar cells generate electricity from solar radiation and have grown rapidly as a viable energy source over the past decade. However, the rapid growth, mainly as a result of government subsidies and a reduction in the cost of silicon-based solar cells, is unsustainable both financially and in terms of power requirement.

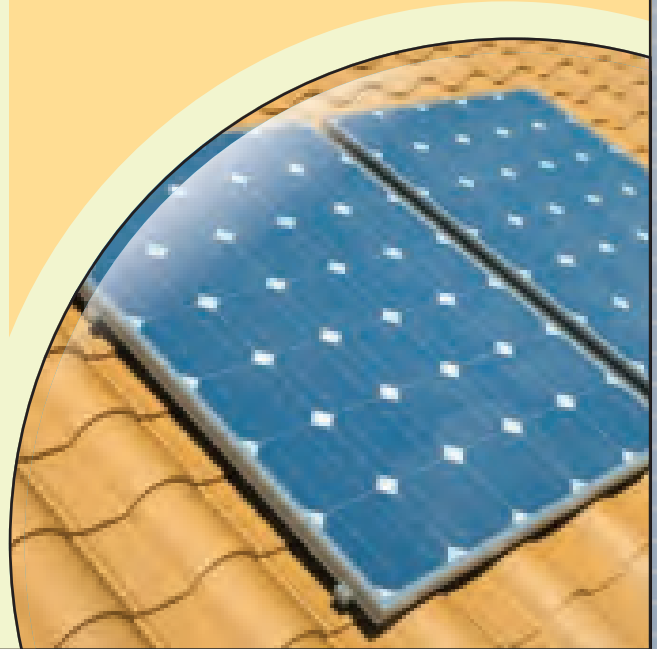
Concentrated photovoltaics (CPV) use relatively cheap optical elements to concentrate sunlight onto efficient multi-junction solar cells (MJSC). The materials that make up these MJSC structures enable solar energy conversion efficiency of 44 %. However, if this technology is to compete with traditional energy sources, the efficiency needs to reach at least 50 %.

This project will reduce the costs of generating electricity from PV by developing the metrological tools required to increase the efficiency of current devices, while improving manufacturing processes and materials. This will enable the production of the next generation of solar cells.

## Project ENG51: Metrology for III-V materials based high efficiency multi-junction solar cells

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[www.projects.npl.co.uk/solcell/](http://www.projects.npl.co.uk/solcell/)



## Stabilising electricity grids

### *Providing measurement tools for Smart Grids*

The increased use of renewable energy is vital to meet emission reduction targets and secure the energy supply in Europe. However, the power provided by renewable energy is intermittent. Unless energy flows can be accurately measured and controlled, this will result in costly power quality degradation, ultimately leading to widespread blackouts.

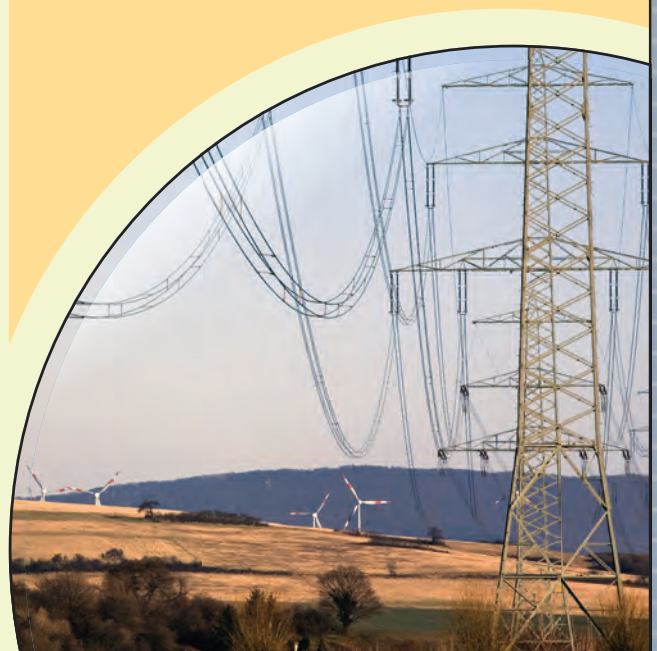
Smart Grids are the mechanisms needed to reliably utilise large amounts of renewable energy; they balance variable renewable supply with changing demand to achieve grid stability and to prevent power quality degradation and power blackouts. New tools are needed by network operators to measure the quality and stability of the electricity supply and enable their steady operation.

This project will build on the work of ENG04, that improved the stability of Smart Grids and accuracy of onsite measurements, by extending the application of developed techniques and addressing identified difficulties. This will lead to new improved grid management methods to help design, control and stabilise Smart Grids facilitating high-quality energy supply from renewable-based generation.

## Project ENG52: Measurement tools for Smart Grid stability and quality

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## Complex thin films for renewable energy

### *Thin film measurements to support low carbon technology*

The global market for low-carbon goods and services is projected to grow from £3.5 trillion in 2008 to just under £4.5 trillion in 2015. Much of this growth is driven by EU targets for the use of renewable energy and energy-efficient devices.

Europe's shift to a low-carbon economy requires a wide range of advanced materials and technologies, including power electronics, solid state lighting, solar energy and energy-efficient windows. These applications are based on complex thin films that possess novel electronic and thermal properties not found in bulk materials.

The complexity of thin films means that there are technical challenges relating to their performance, durability and cost-effective manufacturing. This project will develop the measurements needed to characterise the structure of thin films and their novel properties. Models will also be developed to help interpret the measurements and relate them to product performance. This will accelerate innovation and improve quality control for energy technologies.

## Project ENG53: Traceable characterisation of thin-film materials for energy applications

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## Diversifying the natural gas supply

### *Promoting the use of biogas*

As the EU's natural gas resources continue to decline, it is becoming increasingly dependent on imported natural gas. In response, the European Commission has issued directives and targets to support the use of biogas and encourage the diversification of the European natural gas supply.

These targets specify that by 2020, 20 % of energy consumption should come from renewable sources and biofuels should provide at least 10 % of transport petrol and diesel consumption. There is now an urgent need to significantly increase the amount of biogas injected into natural gas transport and distribution grids, but this cannot happen until robust and reliable measurements are available to assess the quality of the gases.

This project will develop and validate methods so that the gas industry can reliably measure key properties of biogas and biomethane. This will result in the increased use of these renewable fuels throughout the EU and improve the security of the energy supply.

## Project ENG54: Metrology for biogas

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[www.projects.npl.co.uk/metrology-for-biogas/](http://www.projects.npl.co.uk/metrology-for-biogas/)



## Energy output of solar cells

### *Eliminating uncertainty in photovoltaics*

Photovoltaics (PV), a method of generating electricity from solar radiation, has been rapidly growing as a viable energy source over the past decade and the PV world market volume is now approximately 50 billion € per year.

PV devices are currently sold according to their energy output as measured under standard test conditions. These standard test conditions represent climate conditions specific to the USA, which can lead to inaccurate estimates of the energy generated when measured under real operating conditions. Every one per cent uncertainty in energy yield estimation leads to a financial uncertainty of 500 million €. This is particularly relevant in Europe where PV systems are operated in a wide range of climatic conditions.

This project will develop a new classification system of PV devices based on their energy production under different operational conditions. This will provide reliable data, enabling governments and industry to make informed decisions over which PV technologies are most suitable.

## Project ENG55: Towards an energy-based parameter for photovoltaic classification

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## Reliable wind energy

### *Improving the reputation of wind energy*

Renewable energy resources are essential in guaranteeing sustainable energy for the future. Wind energy systems are regarded as one of the most promising technologies but reliability still needs to be improved, as they rarely reach the desired lifetime of 20 years without at least two mechanical failures of major drivetrain components.

These failures can lead to downtimes of several weeks, which mean high operational costs. The problems are compounded for offshore wind farms where access and safety issues increase the costs of maintenance and repairs.

This project will develop new approaches to deliver calibrated measuring standards and procedures for use in drivetrain production. There will be a focus on the accurate measurement of vital components such as shafts, bearings, gears and brakes. The results will prevent unnecessary costs, reduce the number of mechanical failures and extend the lifetime of wind energy systems.

## Project ENG56: Traceable measurement of drive train components for renewable energy systems

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## Better materials for energy

### *Improving detection of defects in new materials*

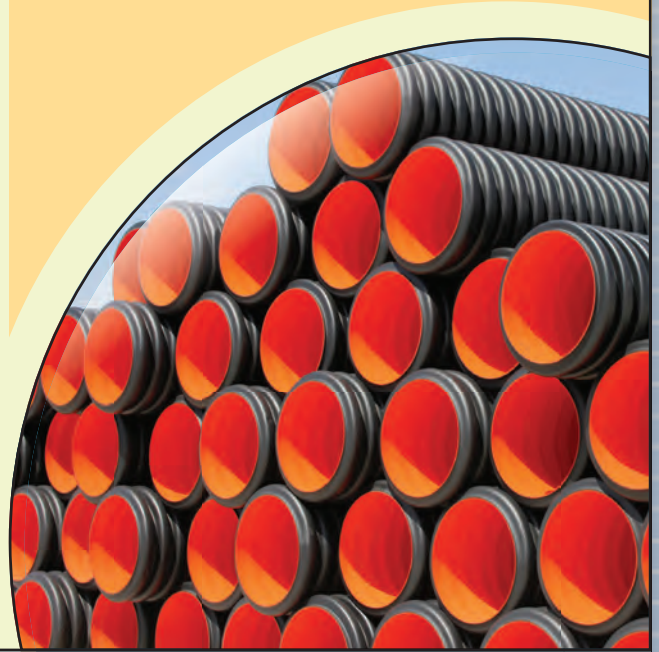
Fibre reinforced plastics offer a combination of properties not available in traditional materials. Their advantages, including excellent mechanical properties, low weight, fatigue and corrosion resistance, make them ideal for use in renewable energy, oil and gas, and transport applications.

However, a diverse range of defects and imperfections can reduce the strength, stiffness and lifetime of the materials, hindering their wider usage. One of the challenges facing accurate and repeatable defect detection is the many different types of defect that can be introduced during processing and fabrication.

This project will develop and validate traceable procedures for novel non-destructive evaluation techniques to detect a range of defect types with a high level of confidence and ensure material quality. This will result in increased safety, life expectancy, energy efficiency and sustainability of fibre reinforced plastics, and increase their acceptance in European industry.

## Project ENG57: Validated inspection techniques for composites in energy applications

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## Multiphase energy flows

### *Measuring combined oil, water and gas flows*

Europe is dependent on energy from oil and gas and will continue to be so for the foreseeable future. Larger reserves are dwindling in number, which has forced suppliers to exploit new reserves that are smaller in size, more remote and situated in deeper water. New wells are increasingly being produced and metered on the seabed, before coming together into shared pipelines that lead to the processing facility.

When oil is extracted from a well, it exists as a multiphase flow of oil, water and gas. Multiphase flow measurement systems currently have high levels of uncertainty of up to 20 %. This is significant given the world economic value of oil and gas is around \$3 500 billion and \$500 billion per annum, respectively.

This project will improve these levels of uncertainty and undertake a comprehensive intercomparison study on multiphase flow to form the basis of a sustainable reference network, reducing financial exposure and risk for industry.

## Project ENG58: Multiphase flow metrology in oil and gas production

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## Non-Newtonian fluids

### *Looking at the uncertainty of viscosity measurement tools*

Non-Newtonian fluids, which include paint, blood, soup, and drilling fluids, contain a large amount of solids and have a viscosity that changes as they are sheared or stretched. For example, the viscosity of non-drip paint reduces as it becomes thinner when being applied to a wall.

The underlying physics of non-Newtonian liquids affects the measurement of viscosity meters, but the resulting uncertainty and inaccuracy have never been systematically evaluated. The highest need for traceable, accurate, non-Newtonian viscosity measurements is in the energy sector.

This project will map out fundamental measurement uncertainties of existing tools and carry out a review of the physics that impacts the viscosity of non-Newtonian liquids to produce a new metrology standard. Ultimately this will improve operational efficiency in the energy sector and enable the construction of more complex oil and gas wells to reach reservoirs in challenging locations.

## Project ENG59: Sensor development and calibration method for inline detection of viscosity and solids content of non-Newtonian fluids

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## Fair trade and transport for Liquefied Natural Gas

### *Improving energy measurements of LNG and its use as a transport fuel*

Liquefied Natural Gas (LNG) is a cost-effective alternative for pipeline gas and its potential use as a transport fuel could also offer a cleaner way to power cars and ships. Energy measurements of LNG have higher uncertainties than other fuels such as gasoline and natural gas. The EU clean fuel strategy requires a reduction in this in order to develop its as a transport fuel.

This project will build on the work of ENG03, which made considerable steps to reduce these uncertainties, by extending primary calibration standards, further reducing uncertainties, improving methods to calculate density and developing methods to validate LNG composition. This will have an economic impact of 150 and 500 million € per year on the total amount of imported LNG in Europe and worldwide respectively. The project will therefore support fair trade due to fewer balancing errors and increased transparency for buyers. The use of LNG as a transport fuel will lead to a reduction in CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>2</sub> and particle emissions.

## Project ENG60: Metrological support for LNG custody transfer and transport fuel applications

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## New electrical measurements for the grid

### *New sensor technologies to support energy trading and security of supply*

National grid companies are investing billions of euros to develop infrastructure and manage their networks, as the increase in distributed energy sources such as wind farms and solar panels is reducing the quality of transmitted electrical power from the grid.

Varying power quality can also make it difficult to trade energy fairly and reliably between countries and across different networks. Modern instruments such as smart meters are installed to monitor power supply between networks, prevent any grid failures from spreading and help pinpoint their origin; however, conventional electrical transformers currently limit their performance.

This project will support the introduction of new, non-conventional technologies for electrical sensing by addressing their current inaccuracy. These new technologies will enable lightweight and accurate measurement systems for voltage and current, enabling more robust and reliable control of the network. This will reduce negative effects associated with renewable energy sources, clearing the way for their further introduction.

## Project ENG61: Non-conventional voltage and current sensors for future power grids

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## Innovative lighting

### *New measurements for solid state lighting*

Innovative solid state lighting (SSL) products based on LED technology could help reduce European energy consumption through the enhancement of electrical efficiency. The first generation of SSL products suffered from variable performance and light quality but, as the technology has matured, considerable improvements have been made. However, consumers still need improved confidence in the performance of new products coming to market.

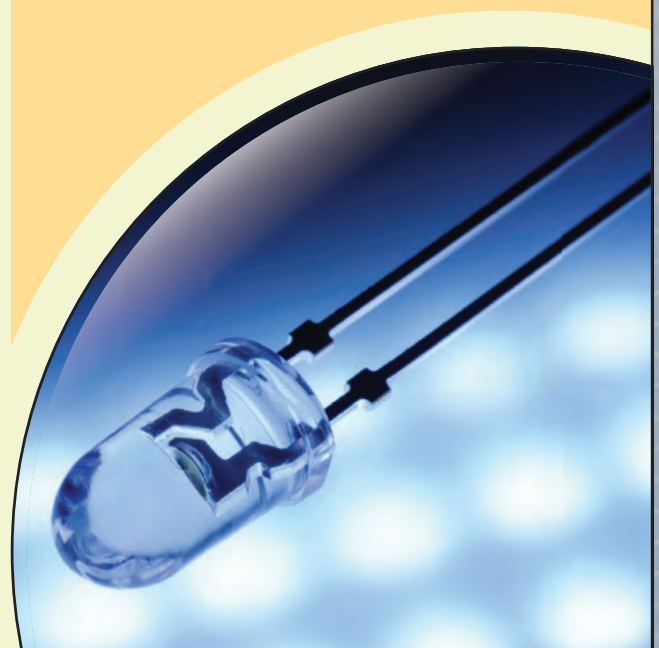
This project will build on the work of ENG05, that developed metrology for first generation SSL products, by developing measurement solutions and an advanced metrological framework for novel second generation SSL products. A new set of metrics will also be developed through physiological studies to investigate safety and comfort aspects of lighting and user perception.

This will enable the reliable measurement of SSL performance, covering light output, efficiency, distribution and quality, as well as safety and lifetime aspects. The results of the project will improve energy efficiency, reduce energy bills and enable consumers to make informed decisions regarding lighting products.

## Project ENG62: Metrology for efficient and safe innovative lighting

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## Sensor network metrology

### *Improving the monitoring of electrical distribution grids*

As electricity networks evolve to accept more distributed renewable generation, it is vital that sufficient information exists for their management and control, enabling grid stability and reducing the possibility of blackouts.

Much of the necessary information is gathered through sensor networks. However, the majority of research into these networks is carried out only in simulation and often assumes that the impedances and structure of the analysed networks are fixed and known. This project aims to develop techniques to enhance the capabilities of sensor networks.

This project will assign reliable uncertainties to real network parameters, make estimates to fill in missing information and validate new algorithms for optimal sensor placement by demonstrating them on model smart grids. The results will improve the monitoring and knowledge of electrical distribution grids and enable more secure and reliable grids with reduced carbon emissions. This will help meet EU targets and stimulate the renewable energy market.

## Project ENG63: Sensor network metrology for the determination of electrical grid characteristics

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## Europe's National Measurement Institutes working together

The majority of European countries have a National Measurement Institute (NMI) that ensures national measurement standards are consistent and comparable to international standards. They also investigate new and improved ways to measure, in response to the changing demands of the world. It makes sense for these NMIs to collaborate with one another, and the European Association of National Metrology Institutes (EURAMET) is the body that coordinates collaborative activities in Europe.

EURAMET has implemented the European Metrology Research Programme (EMRP), a project programme organised by 23 NMIs and supported by the European Union, which will have a value of over 400 M€. The EMRP facilitates the formation of joint research projects between different NMIs and other organisations, including businesses, industry and universities. This accelerates innovation in areas where shared resources and decision-making processes are desirable because of economic factors and the distribution of expertise across countries or industrial sectors.

EURAMET wants to involve European industry and universities at all stages of the programme, from proposing Potential Research Topics to hosting researchers funded by grants to accelerate the adoption of the outputs of the projects.

Full details can be found at: [www.euramet.org](http://www.euramet.org)

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## EMRP

European Metrology Research Programme  
► Programme of EURAMET



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