SPANDA JOURNAL

QUARTERLY OF THE SPANDA FOUNDATION

ONLINE EDITION | WWW.SPANDA.ORG/ARCHIVE.HTML

SPANDA.ORG

I,1/2010

Energy & Development

THE SOFT APPROACH

SPANDA

SPANDA JOURNAL

SPANDA.ORG

I,1/2010

EDITORIAL

TURYA:

A SUBTLE ENERGY?

EVEN THOUGH CONSCIOUSNESS AND SOUL ARE separate entities, a soul can be deep-seated in the consciousness and eternally dwell there in a state akin to peace. When we are able to freely share our time, passion, enthusiasm, determination, insight and love with no refrain and expectation of any return, then we are softly paving the path to growth. Which prosperity does not increase in value? It is not *you* or *I* that matters, we are both mere polarities, in unity, you and I are *one*. Never bargain for a 'thank you' for what you do or have done, as you did it for me not for you. Discovery takes place deep within our selfhood where inner and outer are no longer two, but one, solely one. The deeper we sink into ourselves, the furthers we reach out into the world.

The essence of the cognition of unity, by which creator, creation and creature are one, is the initial impulse unfolding itself into the space-time dimension. The time is ripe, but there is no time, actually.

DE MESOTERICA HUMILTADE

The sword is for the one whose proud neck is held high;
no blow falls on the shadow thrown flat
upon the ground.

RUMI, *Mathnawi*, IV: 2759

→ | IN THIS ISSUE

Per i tuoi bei occhi ho perso il senno, non quello di poi ma quello di adesso.

If everything is one, who are we? An emanation reaching back to its origin? Engaged in attaining the origin, more than in knowing its inconceivable nature, we swiftly move forward: backwards to the source, to the beginning of time and before. *Anábasis* and *katabasis*, contraction and expansion, the synchronic pulsation of reality is gaining pace, when time is no longer the frame of reference neither of the two actions comes before the other, they really are simultaneous, both inhalation (inspiration?) and exhalation: a suspension of breath. Reaching back to the origin always implies an *inner* journey, a change of direction, an energy conversion. At a given point of this process, the inner transmutes into the outer and all polarities relinquish. Now there is only one, not two or three, even God, Allah, YHWH, Kṛṣṇa, Maria, Giovanna e Giuseppe are all one – only the methodologies and techniques leading back to the origin differentiate them. There is no exclusive way to the origin, no copyright holders; *relige* them all together and you will have again just one. No further recognition or personification is in need: the inner human collective plane takes hold

– the final reality for which this universe wa[i]s conceived. *Poeti, vati e cantori, santi e intronauti.* The cosmic dance, its energy and power, neither ends nor dies: it rebounds in itself, in its stillness resilience. Beware, the aboriginal wave is anew, no one could ever stem its tide, this plane of the manifestation has already transmuted onto the next one where one and one makes zero, where only undifferentiated unity holds true.

At re-birth there is light, light upon light: *enérgeia, érgon*, physical, not meta-physical, the active and expressive power of an entity, of an organism, of an *órganon* coming into existence. Before you and dimension we are bound to death. Expand, develop yourself and give back to the world what you received so far. Released from *lila*'s joyful play, consciously take part in the virtuous cycle: from above to below, from below to the world, from the world to above, back and forth. Once united within, the border in-between gradually fades, 'giving' is a result of growth. *Philanthropos*, don't stop the flow! Build on what unites, not on what divides. Further to history lay meta-history with its hierohistory where everything is in the present – past and future are declinations of time. The past is past: learn, forget and forgive, and move on. Action springs from

me were differentiated by birth, before the big-bang of this current universe, or the *fiat lux* of this manifestation *(non ho sentito un grazie, ma non ve n'era bisogno)* there was *turya,* the still undifferentiated subtle energetic plan preceding creation: timeless, nameless, without attributions, in stillness, acting at rest. All of a sudden light into darkness (love?) with a longing to give. The restless *entelécheia* is at work again: a *rûh*, a *pneuma*, a soul, a *jiwa* takes off from the first manifestation. Then, subtle energies flourishing all over and round, consciousness shifts towards its own primacy, development, inner and outer, in-out: the creative energy sets its play. Keep quite, "go placidly among the winds." Neither fear nor hesitate, just follow it, recall it, remember it, and act.

The world of reality is a world of acts, not of stillness, nirvana is a gateway to reality not the final destination. If we only abode in this time-space the encounter of spirit and matter in the soul, from quality and quantity, supported by a sincere, pure and unconditioned impulse to give, freed from self-interest, egoism or profit: the time of secrets is over: spirit and matter are one. When spirit has spiritualised matter and matter has materialized the spirit (*anábasis katabasis)* then a pure act is possible, an act that doesn't generate karma but concurs to its own purification, to laundry the actor's individual history and, in more general terms, to lessen human pain. In other words, actions performed in purity alleviate poverty – and not merely the material poverty of goods and monies.

Energy & Development is an overview of certain physical aspects of some renewable energies and their use in our 'times', and an invitation to constantly re-new ourselves, and our views. ▣

THE MANY FUTURES OF ENERGY

ALESSANDRO COLOMBO | GUEST EDITOR

Alessandro Colombo (Milan, Italy, 1967) is an electrical engineer specialized in electrical power systems. He has been project manager at the Italian Electric Test Center (CESI) and Head of the R&D electronics at ABB Power Technology in Dalmine (Italy). Since 2003 he is Patent Examiner at the European Patent Office in The Hague (Netherlands). Strongly involved in technology innovation and patent matters, he holds the EQE qualification for patent attorneys and a Master in Intellectual Property Law and Management at the CEIPI (Strasbourg, France, 2009). To foster awareness on energy issues, he contributes with articles to several online magazines and organizes open working groups.

→ | OVERVIEW

“Happiness is not an ideal of reason but of imagination.”

IMMANUEL KANT

ACCESS TO ENERGY IS considered a necessity for the survival and the development of individuals and societies.

The rich OECD countries are so addicted to energy availability in the daily life that even a temporary shortage of electricity or gas supply leads to a wave of panic and irrational behaviors, as recently seen during the Ukrainian crises. No energy today means no food tomorrow. Since the largest quota of the energy sources derive from oil, gas and coal, the control of those fuels is often considered a matter of national security.

In several developing countries, on the other hand, the chronic lack of energy services or their low affordability prevents any social and economic progress. Energy poverty can be dramatic even in regions with abundant resources, when they lack the infrastructures and the technology necessary for the distribution and use.

Access to energy is therefore a multi-dimensional issue involving social, financial and geo-political aspects beside the technical and geographical factors.

Nevertheless, the energy market has traditionally been a low-transparency business, based on a centralized control of the sources and the processes, with very little influence from the customers and low public attention. The less people know, the smoother it works.

Fortunately, the wheel is now moving. After the ineffective world summit in Copenhagen in December 2009, the energy debate has spread beyond the circle of the technical-scientific community and involves more actively the political level, the mass media and the civil society. The disequilibria of the present fuel-based system are more clearly perceived, especially the environmental damages created by carbon emissions and the perspective exhaustion of the fuels reserves.

The recent Energy Report from the International Energy Agency (IEA) suggests indeed that we are at the doorstep of a radical change in the way of producing and consuming energy and foresees different scenarios, each featuring specific advantages and supported by different groups of interest.

The following intends to offer an overview of the most promising opportunities for the future energy sector. For a better understanding of the discussion, the main energy-related concepts are summarized in the box.

THE «CLEAN» FUELS

Since the known reserves of coal and natural gas appear sufficient to cover the world's demand for another 150 years, utilities and big industries are investing in a technology called Carbon Capture and Storage (CCS), whose aim is to extract the carbon dioxide form the exhaustion gases and to store it underground as a liquid or solid waste.

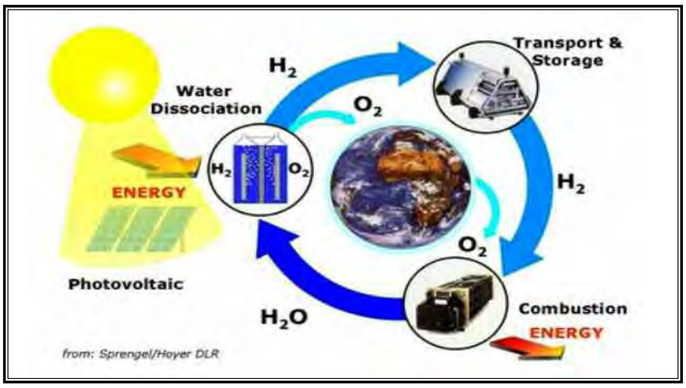
Even if achieving a carbon-free combustion, those techniques present other environmental inconveniences, such as the absorption of a disproportioned amount of fresh water and energy (every third power station needs another one for the CCS only), resources that will be indeed more rare and valuable in the future.

In its 2008 Energy Report, for example, Greenpeace defines the CCS a “false hope”, since it will not be operative anyway before year 2030, it cannot eliminate the risk of gas leakages from the storage location and, most importantly, subtracts today crucial funds to the research on sustainable forms of energy.

RENEWABLE ENERGIES 'AT POWER 20'

Renewable energy sources include sunlight – collected either with photovoltaic or solar thermal techniques - wind power, hydropower, tides and waves, geothermal, biomasses (e.g. wood, plants, biofuels, micro-algae) and fermentation biogases. They represent altogether a niche segment, with an 8% production share in Europe and 2% worldwide, but showed a remarkable growth in the recent years. Europe differs from all other regions in its clear policy of subsidies and in the ambitious goal of achieving the quota of 20% by the year 2020 (the so called Directive "20-20-20").

The advantages of those sources are their quantitative abundance (usable wind power worldwide amounts at 200 times the global energy demand, solar irradiation 3,000 times), and their distributed availability which may guarantee independence from geo-political agreements (think of the benefit for the developing countries...) Moreover they are easily scalable to different sizes, from big power generation plants to micro domestic installations.



A strong limiting factor for renewable sources is the high cost of the installation in relation to the potential production: natural sources, dispersed and discontinuous, must be captured over a relatively large area and accumulated in some storage device (batteries, heat tanks, pressurized air).

The market potential however is really huge, and sufficient to attract research centers, manufacturers and energy suppliers into a "technological run" which is expected to achieve a decisive cost reduction of the renewable technologies, and their subsequent large-scale adoption. In particular, the segment of off-shore wind generators is living a golden season, with rate of growth of 15-20 % per year, and unit cost decreasing at 0.04-0.08 cent/kWh, thus competitive with the traditional fuel generators.

Also the civil and residential segment presents various innovations, such as the "solar tile" or the vertical-axis wind turbines, which tend to simplify their installation and the structural integration within the buildings.

The Energy Social Forum held in Stuttgart in January 2009 presented examples of energy sharing among small communities or multi-family groups. It was noted that a direct participation in the production cycle stimulates a more critical approach in the use and consumption of energy.

THE HYDROGEN ECONOMY

A different possible scenario is based on the use of hydrogen (H2), a totally clean fuel releasing only water steam and easily convertible into heat, electricity, or motion of vehicles.

Several research projects and information groups are now active on that technology. The European Commission launched in 2006 the project "HyFleet" by sponsoring a fleet of 47 public buses, now circulating in ten EU cities with excellent results. BMW has manufactured a pre-series of 100 units of its 'Hydrogen-7', with satisfactory performances and driving range.

The Hydrogen technology, however, requires the development of complementary systems, such as storage devices or distribution networks, which still show poor efficiency and limited diffusion. The advent of the Hydrogen Economy – so baptized by Jeremy Rifkin in his best-seller dated 2002 – is therefore possible but highly uncertain.

NUCLEAR EXPENSES

The CO2 alarm is pushing big investors and several governments like US, China, France and Italy towards a return to the nuclear power, a technology appreciated for the high energy productivity at low cost (0.02-0.04 Eur/kWh) and the virtual zero-footprint on the atmosphere.

Against new nuclear programs, however, both environmentalists and scientists like Nobel laureate Carlo Rubbia keep warning about two unsolved problems: the unsafe storage of the radioactive wastes (refer to the aborted "Yucca Mountain project" in USA, the biggest attempt ever to create a long-term storage facility) and the uncertain evolution of the costs, which are expected to ramp up in the next decades.

The nuclear energy represents a rigid model, highly centralized and requiring decade-term plans of inflexible operation. In a context of open market, growing flexibility, and diffusing alternative technologies, the nuclear choices appear strategically shortsighted.

WHAT A SMART GRID

The traditional power network is designed on a unidirectional model of energy distribution (from

PROPRIETIES OF ENERGY

ENERGY = the physical quantity associated to the dynamic processes and responsible for any activity or movement.

FORMS OF ENERGY = Gravitational (potential of an elevated mass), kinetic (mass in movement), Electrical, Magnetic, Chemical, Electromagnetic (light or radiation), Thermal, Nuclear.

SOURCES OF ENERGY = sunlight, wind speed, tides and waves, water jumps, biomasses, fossil fuels, nuclear fuels

CHANGE OF ENERGY FORM = transformation or conversion.

Example of a vehicle: chemical energy (fuel) -> kinetic energy (motion) -> heat (brakes).

Energy can be stored and transported, but the various forms are not equivalent in this respect. Optimal for storage are potential energy (e.g. pumping stations), chemical (in fossil fuel or batteries) and nuclear. On the contrary, electrical energy is very flexible to use and to be transmitted over long distances, but cannot be stored.

THE MAGNITUDES OF ENERGY

The international unit to measure energy is the Joule (J), a very tiny amount for the practical applications. One joule is the work of lifting by one meter a potato of 100 grams.

3,6 million joules equate 1 kilowatt-hour (kWh), the unit used by electricity suppliers.

8 million joules (2,000 calories) is the average daily energy intake for a working man.

The range of billion joules (gigajoules [GJ]) expresses the energy consumption per person in one year; Fig. I represents the differences between the average consumption in India (6 GJ), Europe (95 GJ) and USA (200 GJ).

In Industry, energy is often measured in equivalent tons of oil [toe], corresponding to 42 GJ circa. The world population in 2007 consumed 12,000 Mtoes (million toes), 80 percent coming from the combustion of oil, gas and coal (Fig. II).

DISTINCTION BETWEEN ENERGY AND POWER

While energy is a cumulated quantity, power is *the rate* at which energy is exchanged or consumed. If energy is thought as the water content in a recipient, power is the water flow through the tap, thus energy per unit of time, and is measured in watt (W) (joule per second).

The distinction between Power and Energy is important for intermittent energy sources, e.g. for wind generators. The installed power, expressed in kilowatt (kW) or megawatt (MW), indicates the peak generating capacity under full wind speed, and is related to the initial investment. The produced energy, instead, is the cumulated amount of kilowatt-hours produced in a day or in a year, and depends also on the wind behavior in the specific location.

Typical sizes for wind turbines are 200-500 kW up to 3 MW for very large units.

In comparison, the power of nuclear or fuel stations ranges from 600 to 2500 MW, equivalent to a park of hundreds large wind turbines.

EFFICENCY

In any conversion a quota of the incoming energy is not converted into the desired form, due to dispersion into heat, noise or other un-useful effects. The ratio between the desired output and the input is the efficiency, very important when comparing different solutions or different technologies (e.g. tungsten lamps vs LED lighting).

The higher the efficiency, the lower is the energy consumed to achieve the same result.

For practical and economical reasons, the efficiency tends to increase with the size of an apparatus. A 1000 kW generator is normally more efficient than 10 generators of 100 kW. This factor is key when choosing the optimal scale of a power installation or network.

the power station to final users) and cannot sustain more than 25-30% of renewable sources without risks for its operative stability. To overcome such limitations new power grids equipped with intelligent and inter-communicating devices are being developed. The "smart grids" will allow real time transits of energy among users and a high number of distributed generators, similarly to how Internet works out the exchanges of information among single computers.

The smart grid technology represents a focus of the US Energy program promoted by the Obama's administration, and is being implemented as first step through the installation of intelligent energy controllers and meters in several US cities.

Also the European Commission has included the smart grids in its strategic research agenda, promoting a dedicated funding within the current Framework Program 7 running until year 2013.

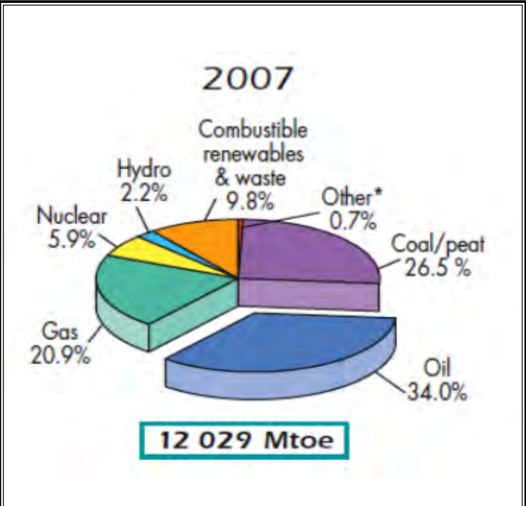


FIGURE I

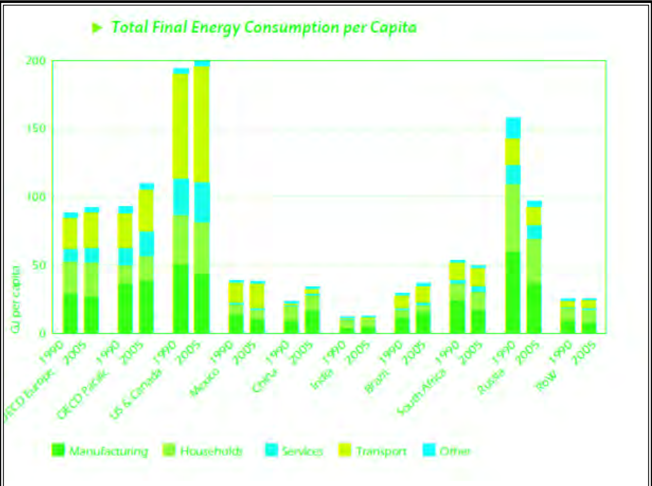


FIGURE II

FUTURISTIC ENERGIES

Beside the technologies described above, other futuristic lines of research have now been launched, normally sponsored by public funding, in the hope of achieving a prototype and perhaps practical applications in a few decades.

An important project concerns the nuclear *fusion,* the reaction between hydrogen isotopes occurring inside the stars, which can provide a virtually unlimited amount of energy with minimal environmental impact. Through one of the biggest technological cooperation of our era, the governments of US, Europe, Japan, Russia, China, Korea and India have started in 2006 the project ITER, with the scope of realizing a prototype of large fusion reactor, now under construction in the site of Cadarache (South France). Skeptical voices object that the intrinsic difficulty of dealing with a core material at a temperature of some-million degrees makes the whole project extremely uncertain and practically unrealizable before 30-40 years.

Another interesting direction relates to the greenest dreams of the mankind: replicating the natural photo-synthesis processes of plants and leaves, to capture sunlight energy and atmospheric carbon at the same time. The Massachusetts Institute of Technology (MIT) with its program 'MIT Energy Initiatives' is now at the forefront of that line of research, expecting operative results within the current decade.

Last but not least, the project SERT of the NASA is exploring the futuristic technology of the "space solar". It consists of a park of solar panels installed on satellites, able to transmit power to a receiving station on Earth through a microwave or a laser beam. The critical factor is the long distance between transmitter and receiver, but the possibility to exploit permanent irradiation, independent from meteorological circumstances, represents the attractive advantage.

REFERENCES

AEI (Italian Electrotechnical Association), Issue on *Energie rinnovabili*, 2008 - *Energie rinnovabili emergenti*, 2010.

EUROPEAN COMMISSION – EUROPEAN TECHNOLOGY PLATFORM SMART GRIDS, *Strategic research agenda for Europe's electricity network of the Future*, 2007.

GREENPEACE INTERNATIONAL, *Energy revolution, a sustainable pathway to a clean energy future for Europe*, 2005.

IEA (International Energy Agency), *World Energy Outlook*, 2007, 2008, 2009.

NATIONAL GEOGRAPHIC, *The future of Energy*, Special Ed., April 2009.

SCIENTIFIC AMERICAN, *A big plan for the Solar Energy*, (1) 2008.

MEETING OUR 21ST CENTURY CHALLENGES

PAUL ALLEN

Paul holds an Honours degree in Electronic and Electrical Engineering from Liverpool University. Following the successful design, development and operation of a community access recording studio in Liverpool, Paul joined the Centre for Alternative Technology in 1988, responsible for design, development, production of a wide range of renewable energy systems including solar powered medical systems for use in Bosnia, Eritrea and many other parts of the world. Paul worked to develop CAT's spin-out engineering company Dulas Ltd in 1990, which has now gone on to become a successful independent business.

In 1995 Paul took up the newly created position as CAT's Media and Communications Officer, this involved pro-active and re-active work with radio, television and the press, acting as principal spokesperson for the centre. 1997 Paul was a founding director of EcoDyfi, the local regeneration organisation for the Dyfi Valley, in Mid Wales. Winner of the 2002 EU Campaign for Take-Off Award, Ecodyfi has established a number of community-based water, wind, solar and wood-fuel schemes.

In 1997 Paul became the Development Director heading the strategic development of the organisation for the next decade. Recent projects include the Autonomous Environmental Information Centre, development of the 'Carbon Gym' calculator and most recently the 'Wales Institute for Sustainable Education'.

Paul is currently CAT's External Relations Director, heading the ground-breaking Zero Carbon Britain strategy programme, liaising directly with key policy makers in Government, business, public sector and the devolved assemblies to disseminate the findings of their evidence-based scenario development work.

He held key positions as UK Millennium Fellow (1996); Director 'EcoDyfi' (1998); Fellow Royal Society of the Arts (2005) Board Member Cynnal Cymru (2006); Climate Change Commissioner for Wales (2007); Presented to All-Party Parliamentary Climate Change Group (2007), Environmental Audit Committee (2008) & European Parliament (2009); Board member of the International Forum for Sustainable Energy (2008).

→ I CHALLENGES

"If a man hasent' discovered something he will die for, he isn't fit to live."

MARTIN LUTHER KING

THE WORLD IS IN CRISIS, IN THE 21ST CENTURY WE face enormous challenges brought about by changes in the earths climate. In Europe and the industrialised west, the well being of individuals and communities is underpinned by:

1. Climate Security – Our hospitable, reliable climate;
2. Energy Security – Access to abundant, cheap fossil fuels;
3. Economic Security – Stable economic and monetary systems.

All three of these aspects are now in crisis, and left unchecked they will compound and synergise. As we feel these impacts they bring wider issues to the forefront such as climate change and migration. A climate refugee is a person displaced by climatically induced environmental disasters. Such disasters result from incremental and rapid ecological change, resulting in increased droughts, desertification, sea level rise, and the more frequent occurrence of extreme weather events such as hurricanes, cyclones, fires, mass flooding and tornadoes. All this is causing mass global migration and border conflicts. Furthermore displacements of peoples and reduced resources impacts on the areas where people are migrating too and consequentially social pressures.

In our report Zero Carbon Britain 2030, we took a look at the science behind our most recent understanding of these key challenges and argue that we need to rapidly decarbonise Britain now in order to do so equitably and humanely. In doing so the industrialised west and in this case Britain can accept responsibility for its carbon emissions. The full report is available free to download at www.zerocarbonbritain.com, but here below is an overview of our analysis.

CLIMATE SECURITY

Since the industrial revolution, global atmospheric concentration of carbon dioxide has increased from 260 parts per million to around 380ppm. So far, by the greenhouse effect, we have raised the average global temperature by 0.8°°C. Even if we were able to stick at 380ppm, we are locked into another 2 or 3 decades of warming which will take us up to around 1.5°C.

Below a 2°C rise on average global temperature we know the earths natural 'carbon sinks' work to buffer us from the worst effects of our fossil fuel emissions, slowing climate change by helping sink around half of the carbon dioxide we release back into the earth.

Over recent years, clear and robust evidence has emerged, a global temperature rise above 2°°C trigger has a high likelihood of triggering an array of much larger climate feedbacks which will runaway beyond control and unleash climate chaos. Allowing this to happen on an Earth supporting six to nine billion inhabitants would unleash widespread economic collapse, massive agricultural losses, international water shortages, dangerous rises in sea levels, food famines, widespread ecological degradation and create tens of millions of environmental refugees – basically a global catastrophe that would dwarf recent hurricanes or floods and last for tens of thousands of years.

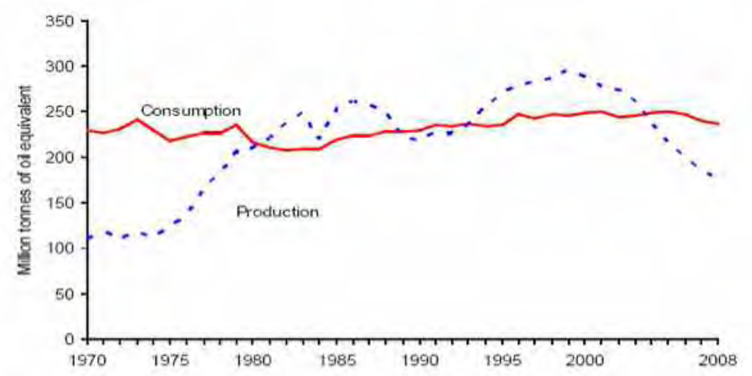


FIGURE 1

Long industrialised countries are responsible for the majority of the problem and possess infrastructure and wealth achieved through burning fossil fuel over the past 150 years. Historical responsibility for climate change rests overwhelmingly on the long-industrialised world, but it is the majority world that will be hit hardest by the consequences. We, who have already spent so much of the global carbon budget should therefore set the pace to help foster a global agreement. All of these facts suggest that a programme to avoid a 2°C rise must aim for zero emissions as quickly as is possible.

However, even a 2°C rise cannot be considered 'safe'. It would still mean we have made the Earth warmer than it has been for millions of years. An alliance of the most vulnerable (Small Island States and Least Developed Countries) has called for the maximum to be 1.5°C. So 2°C must be considered as the very maximum absolute upper limit for an acceptable level of risk, and it is imperative that this target at least is not exceeded.

There is no time to delay. In light of the most recent evidence, the UK must aim for as close to a 100% cut as possible, as fast as possible. The Zero Carbon Britain 2030 scenario explores how this could be achieved in just two decades.

ENERGY SECURITY

Climate security is not the only reason we should embark on a transition away from fossil fuels. Our unstoppable oil economies are now being halted by the immovable facts of geology. For the first time in our history, just as demand is exploding across the globe, humanity will soon no longer be able to increase fossil fuel production year on year. No one is talking about oil "running out," but rather the realisation that despite accelerating demand, global rates of production must inevitably plateau and go into decline. What remains being dirtier, considerably more expensive and harder to extract.

Of the 98 oil producing nations in the world, 64 are thought to have passed their geologically imposed production peak, and of those, 60 are now in terminal production decline. Britain has now joined those in decline.

In 2005 the UK again became a net energy importer, as shown in FIGURE 1. The principal reason for this is the decline in North Sea oil and gas production. Britain has been producing gas from the North Sea since 1967 and oil since 1975. The basin is now 'mature' (UK Oil & Gas 2009).

Our North Sea oil production reached its peak in 1999; UK gas production peaked in 2000, and is now declining at 2% per annum. If the UK continues to rely on gas, it will increasingly have to import it from Norway, the Netherlands, the former Soviet Union and Algeria.

If we can find or borrow the money, importing energy from overseas can for now substitute for our failing domestic production. But, due to global geological constraints they cannot offer a reliable long-term solution. There are other short-term energy security options such as a return to coal, which would of course accelerate climate change. Coal, therefore is not an environmentally sustainable option and may quickly become uneconomic if carbon pricing is deployed.

Our longer-term energy security is dependant on our development of alternative sustainable sources.

These sources can be powered up to meet the drivers of both climate and energy security.

ECONOMIC SECURITY

The rules that determine the next two decades will be very different from those that determined the previous two. Since the late 1970s the North Sea oil and gas reserves have enabled the UK to be a net energy exporter, making a significant contribution to the UK's balance of payments. It has been estimated that replacing North Sea extraction with imports would add £ 45 billion to the trade deficit, based on a rough estimate of 100 billion cubic metres of gas at 2p/kWh, 680 million barrels of oil at $ 60 per barrel and an exchange rate of $ 1.75 to the pound. In addition, the Exchequer raised nearly £ 13 billion in tax from the offshore oil and gas industry in 2008.

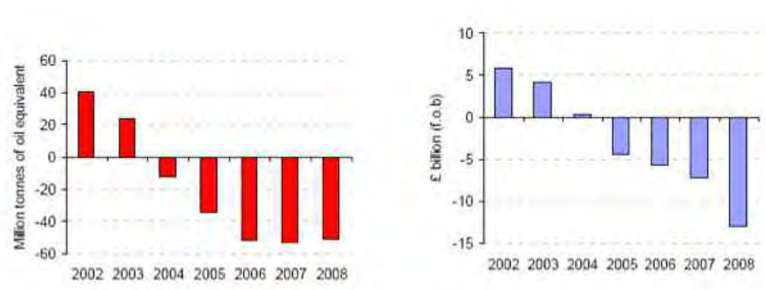


FIGURE II

JOINING THE DOTS ON ENERGY

So what does this all tell us? Well, on numerous fronts, the consequences of the past 150 years of rapid industrialisation are all simultaneously coming home to roost. Many of us still haven't really grasped the serious nature of our predicament. Even senior experts, scientists, NGO's and political leaders fail to appreciate that the most recent evidence on both climate and energy security reveals a situation more urgent than had been expected, even by those who have been following it closely for decades.

There is a huge gulf between what the most recent climate science tells us we urgently need, present CO2 reduction targets (80% by 2050) and the speed of which we are moving away from fossil fuel dependency.

The urgent challenges of the 21st Century cannot be solved with a 20th century mind-set; they require a smart, conscious and integrated approach.

Once we join the dots and look for the bigger picture, we find a great many solutions to climate security are the same as solutions to energy and economic security. This requires an immediate and fundamental overhaul of the way we use energy to deliver our well being, and a massive new programme to harvest our indigenous renewable energy sources.

Never has in our history has a closing window of opportunity been so vitally important to grasp. The credit crunch has shown us the consequences of not reacting ahead of events. If we ignore the warnings and wait until the climate / energy / economic crunch is really upon us before becoming serious about scaling-up the solutions, in the ensuing chaos and dislocation we may struggle to muster the resources required.

A ZERO CARBON BRITAIN

If the problems are left un-checked they will compound and synergise, but if we act in time, the solutions will also synergise, but in a positive way. To foster debate around such a transition, CAT has developed the 'Zero Carbon Britain 2030' strategy to show how we can integrate our detailed knowledge and experience from the built environment, transport, energy industry and agriculture into a national framework offering a common, coherent vision linking government and industry and citizens – endorsing, supporting and connecting actions across all sectors of society.

By taking the right actions now, we stay ahead of events – through re-thinking our attitudes and taking an uncompromising new approach to energy we find we can deliver well being on with a lot less energy, and we can extract the energy we do need from our indigenous renewable energy sources.

The built environment, for example, can play a significant role in reducing the UK's greenhouse gas emissions through measuring and reducing emissions in construction and maintenance as well as regulation to enforce the reduction of emissions from both new buildings and the existing stock. Putting a price signal on carbon will further encourage businesses and individuals to upgrade their buildings, and creative business models such as 'energy service companies' plus improved design and refurbishment standards can play a vital role. Through careful selection of building materials a national campaign can enable the building stock to lock away carbon helping to reduce atmospheric levels of CO2.

Rather than residing at the leaky end of a peaking pipeline of polluting fossil fuel imports, Britain can head its own indigenous energy-lean renewable supply chain. Every field, forest, island, river, coastline, barn or building holds the potential to be a power station, with different technologies appropriate to every scale or region.

By their very nature these renewable reserves will not peak, in fact as the technology matures and becomes economic in a wider range of applications, the available reserve actually increases.

This transition is the cornerstone of a new economic approach that will move society on from doing the things that got us into so much trouble in the first place. By learning the hard economic lessons of the past few decades we can re-focus the ingenuity of the finance sector on the actual challenges at hand.

and acted ahead of events and a future where we have let events overtake us.

Britain can stay ahead of events through creating a new kind of economy; stable in the long term, locally resilient but still active in a global context, rich in quality jobs, with a strong sense of purpose and reliant on indigenous, in-exhaustible energy. But the window of opportunity is closing, - now is the time to act. Such a rapid de-carbonisation will be the biggest undertaking we have made in generations, so it will require a great many to commit to

Investment in such an economic stimulus would not only create a vast carbon army of re-skilled workers, and inject money into the economy at ground level, it would also deliver very tangible returns to repay the taxpayer, or pension fund from the price of the energy saved or generated. Through this approach, we not only tackle climate and energy security, but also get the nation back to work, within a stable economy by our indigenous renewable energy sources, and heading off an escalating balance of payments crisis as North Sea exports tail off and the we pay price of imported energy goes through the roof.

A zero carbon transition will, of course, entail a challenging period in our history, requiring bold decision making and an urgent sense of common purpose, more akin to that which pertained during World War II than in any period since. There is little to be gained however by they way we live today with those of a zero carbon future, because life as we know it now must inevitably change whether we prepare for it or not. A more useful comparison is between a future where we have been proactive

the challenge, but in doing so we will find a sense of collective purpose that we have been craving for a very long time.

The full report is available free to download at www.zerocarbonbritain.com. ▣

THE SUPER-GRID

A CONVERSATION WITH GREGOR CZISCH BY ALESSANDRO COLOMBO

Dr Gregor Czisch, a fully qualified agriculturist, studied physics at Munich Technical University, specializing in energy supply. He wrote his PhD in electrical engineering on scenarios for a future electricity supply with renewable energies. He has worked on various topics in the energy-related field at Munich TU, the DLR Stuttgart, the Fraunhofer ISE in Freiburg, and the Max Planck Institute for Plasma Physics (IPP) in Garching. Among his key areas of scientific focus were solar building engineering, utilization of biomass, wind energy and hydropower, primary energy analyses, emission analyses, high temperature heat storage and solar thermal power plants. During his work in the R&D division Information and Energy Economy at the Institute for Solar Energy Supply Techniques (ISET) and at the Institute for Electrical Energy Technology/Rational Energy Conversion (IEE-RE) at the University of Kassel, he worked on potential-analyses for renewable energies and on simulating their production behavior, on conceptualizing energy transport systems and on developing scenarios for a CO_2-neutral electricity supply. This work resulted, among other things, in a PhD with the title Scenarios for a Future Electricity Supply – Cost-Optimized Approaches to Supplying Europe and its Neighbors with Electricity from Renewable Energies, *for which he was awarded the distinction summa cum laude. Since completing his doctorate, parallel to his research at the University of Kassel, Dr Czisch has worked as a consultant to the Scientific Advisory Council on Environmental Change of the German Federal Government (WBGU) and was, among other things, invited as an expert to hearings in various ministries, parliaments and utilities.*

→I ON FOCUS

> *"It is a good morning exercise for a research scientist to discard a pet hypothesis every day before breakfast."*
>
> KONRAD LORENZ

YOUR STUDIES DEMONSTRATE THE FEASIBILITY OF A European electrical system supplied only by renewable sources. What are the main points of your proposal?

My proposal – derived from the results of my research – is to develop a large scale grid throughout Europe and Sahara – called *super-grid* – to interconnect wide spread different sites with electrical generators supplied by renewable sources, namely wind, solar, hydropower, and biomass.

In contrast with the *smart grids*, which represent a futuristic approach made of highly intelligent applications, the super-grid is already feasible with the technology available today, and serves to exploit in an optimal way the enormous potential of the renewable sources. [FIGURE 1].

To demonstrate this possibility, I carried out from 1997 till 2004 a technical and economical systemic study. The first preliminary publication was in 2001. I analyzed the potential and the temporal behavior of the renewable sources in all different locations worldwide and the corresponding unitary cost of the equipment for production and transmission of renewable electricity including all costs for operation and maintenance. The data for Europe and its neighborhood were then fed in a huge mathematical optimization to calculate the optimal distribution and dispatch of all generators and transmission systems.

The main result for the base case scenario – only allowing to use existing technologies at current market prices (around 2001) – is that the most efficient arrangement is a system where *two thirds of the electrical supply are provided by wind power*, which is available in all areas but with different daily and seasonal behaviors (e.g. in Northern Europe the strongest winds are in winter, while in Sahara in summer). The super-grid indeed compensates the fluctuations of electricity produced in different countries and therefore is foreseen – as a result of the optimization – to strongly interconnect the sites of production and consumption.

The other sources selected to provide a mayor contribution are biomass (17%) and already existing hydropower plants (15%). Biomass and existing storage hydropower (not pump storage which only provides a minor contribution as backup) are mainly used as energy storage (the most important storage hydropower is existing in Scandinavian countries) and as backup when the production from wind power is not sufficient to meet the demand.

The role of the solar power from solar thermal power plants would be instead only marginal (1,6%), because the present technology to exploit the sun is very expensive compared to the other ones. In fact the cost figures for the solar thermal power plants in the scenarios might have been a bit optimistic. They have not been based on current market data since there was no new plant built for more than a decade. The first new commercial one was built in 2008 and the costs were twice as high as estimated for the base case scenario. Therefore it is unlikely that the optimization would have chosen solar thermal power plants if it would have "known" the real today's costs.

Photovoltaic (PV) production is not selected by the optimization. To give a significant contribution, the cost of the PV installations should be reduced by 8 times compared to the costs figures of around 2001 or about 5 to 6 times compared to the today's costs. Then the optimization finds a best solution that includes 4% of the electricity produced by PV applications only sited in the sunniest Sahara states. But this cost decline might be unrealistic. So even this small contribution might eventually never become part of a cost optimal solution.

The overall cost of electricity calculated for the base case scenario is 4.6 Euro cent/kWh. This can be compared to the 6-10 cents/kWh we are paying at the electricity market (EEX) for consumption shaped electricity today. This outcome is very encouraging: with a proper mix of renewable energies and a super-grid infrastructure embracing Europe, North Africa and smaller parts of Siberia, we can provide electricity to all countries at a lower cost than today, freeing the system from fossil or nuclear fuels and with no more substantial impact on the environment.

Isn't the sun power more available than wind in Sahara?

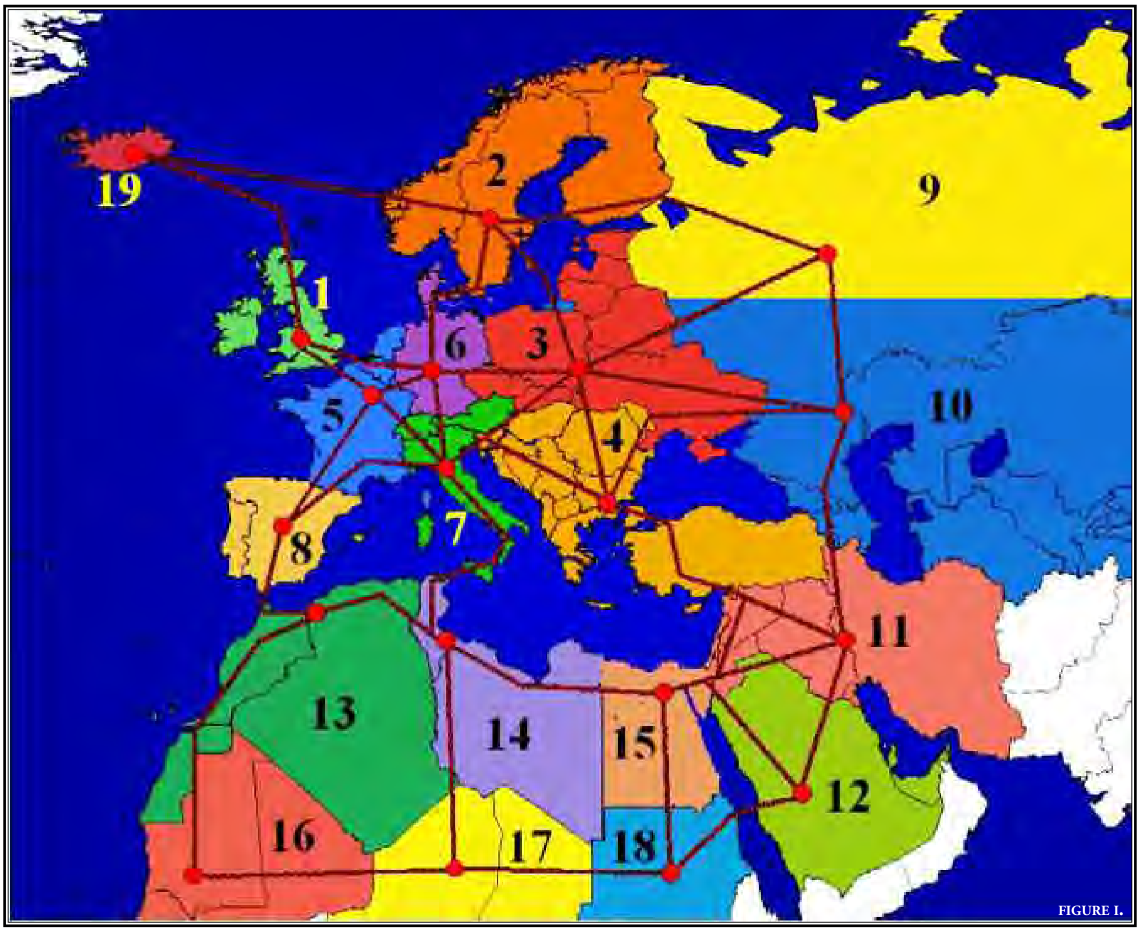


FIGURE I.

Yes and no, the wind resources are tremendous in North Africa. I agree that in the common perception the Saharan region is normally associated with the sun resource, but at a closer look also the potential of wind energy is enormous. According to a recent study from the Harvard University, and confirmed by several others also my some years older studies, eight countries in the Sahara could individually generate the whole electricity need of Europe or some times more from wind power. Hereby no site is selected where the average load of the windmill was less than 20% of the rated power. Many sites are much better. So the potentials could serve with more than enough amount cheap electricity.

On the other side, the nuclear energy seems to be even cheaper, at 2 cents per kWh, according to its supporters. Is that realistic?

The figures for the nuclear energy are under serious debate. The nuclear power stations need a huge investment for their construction and a long working time for their amortization. This creates the need to run the plants continuously at full power, "until it breaks into pieces", and only then the average cost of the generated electricity can decrease more or less to the variable costs of 1.5-2 c/kWh if we neglect the debate about the costs of insurance and the long term cost of nuclear waste disposal.

Nuclear plants are therefore used to mainly cover the steady base of the demand of electricity. But if the use of alternative sources like wind power expands also a growing part of the base load band will be provided by them, the nuclear plants would no longer be run continuously, the initial investment is recovered more slowly, and the average production cost increases.

In other words, nuclear plants are more or less incompatible with an increasing quota of renewable generation. An intelligent strategy of investment should privilege instead other flexible and adjustable types of generation, which can perfectly work with the variability of alternative sources. The existing nuclear stations should be gradually phased out and no new ones should be built.

How was the reaction from the scientific community and the political level to your proposal?

After almost nine years from the first publication of the results and a large number of presentations in conferences and papers, I consider the reaction too cold and too slow.

This has to do with the political positions, and the interests involved. In Germany for example we have three main strategic directions with regard to the energy issues.

First, the coal lobby, which is strong both in the right and the left-wing parties like the SPD, and promotes the construction of new coal power plants more or less ignoring the climate impact.

Secondly, we have the supporters of nuclear power, equally strong and well connected to the utilities and also with some background in different parties.

At last, there are the opponents of both of them, which can be identified in the "green groups" across the several parties. They often promote a vision of "beautiful" small-scale installations, a sort of decentralized autarchic model, and are supported by manufacturers and installers as the ones of solar panels.

Such an approach, even if perceived as alternative to the traditional system, can never really compete with or hardly replace the big nuclear or coal industry, and therefore allows for their long-term permanence.

Decentralists oppose even the construction of new power lines, which are also needed to transport energy from wind power within the national borders.

They think of an ideal like every house supplied by its own solar cells and independent from the network, but that in the best case leads to very expensive supply with poor energetic efficiency.

Who are the parties supporting your scenario?

My proposal received strong support throughout most political parties, either officially or indirectly. I have been invited to many hearings, like at the German ministry of Economy, to discuss the law for the acceleration of the construction of transmission lines *[Energieleitungs-ausbaugesetz]*, as well as in the EU parliament, where I presented my results firstly in 2004, or in conjunction with the Baltic sea parliamentarian conference, leading to a resolution for the construction of HVDC lines (High Voltage Direct Current, an old and modern technology used to transmit electricity to very long distances, above 800 km). In 2009 a new EU directive was issued, to allow the import of electricity generated from renewable sources from non-EU countries, in order to arrive at the aimed quota of 20% of the EU energy consumption provided from renewables by 2020.

These regulations are consistent with the Supergrid idea.

Also the industry is now drawing attention to the super-grid thanks to the Desertec Industrial Initiative, joined by major energy groups like RWE and EON. I initiated this idea since I contacted the main driver the Munich RE in 2005. Now the result is – a bit different than I tried to communicate – based on large solar thermal installations in the Sahara Desert, with the electricity transported to Europe by HVDC lines. So again we see parts of the super-grid.

Unfortunately the solar thermal technology is not mature enough, it is still expensive in comparison to wind power (15-20 c/kWh against 3-5 c/kWh for wind energy) and would take too long time to develop to a major source able to help to avoid the worst effects of the climate change in time.

In 2008 we have had only 100 MW of new solar thermal plants, while the new wind generators amounted at 27.000 MW in the same period, almost 300 times more, and growing constantly by 30-40% per year.

I don't know why Desertec Initiative focues on solar plants, but a guess is that they don't really foster a quick transition to alternative sources, since they represent the industrial groups and utilities that also run the existing traditional plants.

Do you see geopolitical issues that might render instable such realization?

I answer with a question. Why don't we raise a geopolitical concern to the fact that Europe currently imports about 25% of its natural gas imports from a single country, Algeria, and another 40% from one other single country, Russia? The gas pipelines currently in use act exactly like a supergrid, transporting gas from Sahara and from Siberia to Europe. There is no conceptual difference from transmitting electricity instead of gas.

The only difference is that the gas is stored in big storages to guarantee about 2 month of autonomy (The storage hydropower storages with a capacity roughly equal one month of the electricity consumption are somewhat smaller), but if Algeria would stop the supply we would soon have big problems. And we experienced a crisis when Ukraine stopped the transit of gas from Russia through its territory.

The scenario with renewable electricity would be instead much more secure, because the sources can be diversified, with less dependency from single countries.

Think about the enormous rise of the oil price, which increased ten times in a decade, jumping from roughly 10$/barrel in the 90s to the 150$/barrel we saw recently… this cannot happen with renewable sources, which instead become cheaper with time, thanks to the advancement of technology, and are available more or less everywhere, with a relatively low variation of cost.

What conditions would facilitate the implementation of a new grid? How are you involved in fostering that idea?

One approach is to apply the EU directive and the German law mentioned before, which facilitates the erection of new transmission lines, but we lack a similar legislation all over Europe. We further need a harmonized regulation to support the financing of these projects, for example a common European feed-in tariff able to cover the cost for production and transmission of the electricity.

This would be a powerful instrument to attract investors and to guarantee a certain security of the financial returns, which in turn would give access to cheaper credits. I'm lobbying for that idea since several years, lately in the "Mitigation Country Study for Germany" for the UN Human Development Report 2007/2008 *Fighting climate change: Human solidarity in a divided world.*

What consequences may this large grid system have on the Saharan countries?

The benefits for the concerned countries in Africa could be tremendous.

I give one simple example. To import 10% of its electricity demand from wind energy in Morocco, Europe would have to invest about 3% of its GDP in wind generators in Morocco. This corresponds to roughly 200% of the Moroccan GDP. Such a decision would boost the local economy, creating jobs, local competences and industries. In addition it would help Morocco to produce its electricity from its own wind resources since the resources can more cost efficiently be used in large scale than for the small national demand. The tremendous potential can hardly be exploited to a considerable extend if there is not a powerful connection with an interregional grid with the big consumer Europe.

Such a large-scale cooperation based on renewable energies would constitute a win-win situation, and the same is valid for several other Saharan countries.

It would be a clear sign towards a systematical change in the way we live together, because it would not be a fragmented intervention or a temporary help for a developing country, but a sustainable investment in order to serve for a mutual interest in the long term.

Before we go on with a more divided world, more tensions throughout the Mediterranean, more immigration phenomena, we have to think of cooperation and catch such an opportunity for a global human development. It reflects an important decision we have to take, to find a standpoint cooperation or separation.

Is there any feedback from the Saharan countries?

Yes and very positive. Since the beginning of my work I've been cooperating with politicians and scientist from Morocco and from other North African countries, like the former Minister of Mining in Algeria who published the results of my study in his journal, or Egyptian authorities, or Sahara-wind a company lobbying for exports of wind energy from Morocco for roughly one decade now. Many Africans have well understood the benefits of such a system.

Are there similar projects outside Europe and Sahara?

Nobody has developed so far a systemic study like mine for another world region.

A study with some similarities but much simpler was published in Scientific American. I had exchanged ideas with the authors in some conference in 2004, but they followed a more simplified approach and did not optimize the whole system.

I have discussed the results of my research also in China and India – here in connection with the Observer Research Foundation – and I saw some further developments.

An interesting development in Africa is driven by the enormous hydropower potential located close to Inga at the river Congo. Here could be built one single hydropower station that could deliver about two thirds of the whole African electricity demand at very low cost, around 1 c/kWh. This opportunity is known since decades. And there are other very good sites at the river Congo and at other African rivers.

Several African countries are joining together to build up so called power pools. The Idea is to erect a kind of pan African Super-grid to make use of this potential source of electricity at Inga all over Africa. There is some involvement of The World Bank, the African Development Bank, and industries like ABB. This development could be combined with the development of the European/North African Super-grid.

In 1989 Karl-Werner Kanngießer, an expert at HVDC, proposed that a part of the electricity from

Inga could be delivered to Europe by means of an HVDC connection.

I knew this proposal and therefore I also elaborated one scenario making use of the energy from Inga, with the interesting result that the overall cost of electricity would be reduced considerably, both because the hydropower is cheaper in itself and because it helps to restrict the remaining use of wind power to better sites with higher efficiency, an advantageous systemic effect.

I am discussing this scenario and the combination of the two Super-grids with African experts. We also consider potential problems of security when a huge proportion of electricity comes from one single site. Or we look at the situation where at once a huge part of the production comes from a new plant and would force existing plants to be switch off, a situation which is not very welcome by the owners of the existing plants. But combining the African Super-grid with the European/North African Super-grid both problems could be solved since the relative contribution of the Inga power plant would be much smaller in the common system and the backup capacities for emergency situations would be much bigger.

So the combined Super-grid system expanding from Inga over the whole African continent and to Europe matches very well with the European and African demand and the need of African development. If we imagine the routes connecting Inga with Europe, we could feed electricity along the way in many grids of African countries, supporting industrialization and development at very low cost. When the African demand grows further African renewable sources like wind, hydropower or biomass could be used to feed into the Super-grid while the more expensive electricity could be used and paid by the rich European countries.

How is public awareness about the energy debate? Is it still considered a merely technical issue?

My feeling is that the public awareness is growing quickly. I am asked to give presentations in many different contexts, technical, political, or groups of interested citizens, and all of them are very open minded – as long as they do not belong to a certain lobby or a company's shareholders or belief in a very decentralistic approach.

However, the opportunities represented by the super-grid are not yet fully arrived at the political level. If we look at the recent Copenhagen debates: instead of developing new ideas, they are still discussing about the trading of CO2 emissions, carbon limits, carbon-taxes and other old-style proposals which hardly are effective because they are too much based on the unrealistic believe in the positive market forces and neglect the inelastic behavior of the consumers in the case of energy consumption.

The carbon tax for example cannot achieve any significant CO2 reduction, because Energy is a good with low *price elasticity*: when the price increases, the consumption remains the same (like the mentioned 10-time increase of oil price which had hardly any effect on the consumption). Another tax on the fossil fuels will not really help to reach any goal of reduction, but will only make the energy more expensive, resulting in harmful social effects like reduced accessibility for poor people. In the rich state Germany, as many as about 800.000 households are disconnected from electricity and/or gas supply annually because they simply cannot pay the bill. This has serious consequences not only for the lifestyle but also for health.

A tax intervention on energy reflects an old political mentality based on the believe that the marked will be the best regulation.

If governments want to change something they have to think in completely other ways. E.g. they should directly change the electricity system, which is responsible for roughly half of the global CO2 emissions from fossil fuels. Our society has the possibility to establish a cheaper electrical supply without CO2 emissions. Why aren't these solutions taken into account in the climate debate? There is not enough political awareness about the known possibilities.

ENERGY FOR THE POOR

THE MISSING LINK FOR ACHIEVING THE MDGS

BAHAREH SEYEDI ~ MINORU TAKADA

Bahareh Seyedi is affiliated to the Environment and Energy Group of the United Nations Development Programme. Prior to her engagements at UNDP Headquarters in New York, she took part in multiple development initiatives as programme officer and project manager in West Africa, Central America, and South East Asia.

Minoru Takada is Head of the Sustainable Energy Programme at the Environment and Energy Group of the Bureau for Development Policy at United Nations Development Programme (UNDP) in New York. Before joining UNDP's Policy Bureau, he was posted at UNDP in Angola and also served in Ghana as a community development officer.

→| MDGs

"*All moanday, tearsday, wailsday, thumpsday, frightday shatterday, till the fear of the law.*"

JAMES JOYCE

I ~ ENERGY IS THE MISSING MDG

Energy is a prerequisite for improving the livelihoods of billions of people living in unimaginable conditions of poverty. It is the missing link that can no longer be ignored if the development community is serious about achieving the Millennium Development Goals (MDGs). Meeting the MDGs is an extraordinary endeavor that enables the poor to break out of poverty by unleashing socio-economic development and environmental sustainability. Adopted by 189 world leaders during the Millennium Summit in September 2000, the MDGs provide a number of benchmarks to overcome major hurdles towards sustainable human development. The eight goals range from eradicating extreme poverty and hunger, achieving universal primary education, and promoting gender equality, to reducing child mortality, improving maternal health, combating diseases, ensuring environmental sustainability, and a global partnership for development. Missing from the list of eight goals, however, is energy. None of the MDGs can be met without access to adequate, affordable, and reliable energy services that provide essential input to tackle poverty in its multiple dimensions including deprivation from economic opportunities, poor health, gender inequality, and lack of education (BOX 1). Promisingly, the global community has come a long way since 2000 in recognizing the intrinsic linkages between energy and the MDGs as they are becoming ever more visible and can no longer go unrecognized. Indeed, this is evident from the United Nations Secretary-General Advisory Group on Energy and Climate Change (AGECC) who calls for expanding energy access to more than 2-3 billion people by 2030 to overcome energy poverty, climate challenges, and meet the Millennium Development Goals in its recent report "Energy for a Sustainable Future" launched in April 2010.

II ~ THE ENERGY HAVES AND THE HAVE-NOTS

In light of growing consensus on energy's multiplier effect for poverty reduction and achieving the MDGs, efforts have been on the rise to meet the energy needs of the poor by expanding access to modern forms of energy services. Yet, in spite of the efforts made over the past two decades - whether its improving access to electricity, clean fuels for cooking and heating, or motive power – there remains an enormous energy gap between the haves and the have-nots.

In the developed world, energy is often taken for granted- light turns on at a flick of a switch, water flows with slight force on the tab, space is heated with pressing of a button and cooking is possible with turning of a knob. This picture of availability and accessibility of energy and the services that it provides is not homogeneous across the globe. Two glaring statistics attest to the scale of the current energy inequality: about 3 billion people – half of humanity- still rely on solid fuels for their most basic energy need, cooking, while 1.5 billion people lack access to electricity.

Energy poverty is particularly acute in the most vulnerable parts of the world including the Least

ENERGY AND MDGs LINKAGES

GOAL 1 ~ ERADICATE EXTREME POVERTY AND HUNGER

✓ Access to affordable energy services from gaseous and liquid fuels and electricity enables enterprise development, job creation, and increased agriculture production. In Bangladesh, villages with electricity generate 11 times more jobs than those without. The annual income in poor electrified households was 65% higher than that in non-electrified ones.

✓ The majority (95 percent) of staple foods need cooking before they can be eaten and need water for cooking.

GOALS 2 AND 3 ~ ACHIEVE UNIVERSAL PRIMARY EDUCATION AND PROMOTE GENDER EQUALITY

✓ Lighting in schools and homes helps retain teachers and provides illumination required for after dusk study.

✓ Many children, specially girls, do not attend primary schools in order to carry wood and water to meet family needs.

✓ In Mali, access to mechanical power for water pumping has almost doubled the girl-to-boy ratio in primary school.

GOALS 4, 5 AND 6 ~ REDUCE CHILD MORTALITY, IMPROVE MATERNAL HEALTH, COMBAT DISEASE

✓ Indoor air pollution and gathering and preparing traditional fuels exposes young children to health risks and reduces time spent on child care. Occurrence of child pneumonia (up to 5 years of age) in children exposed to use of solid fuels increases by 2.3 times. Use of modern fuels can therefore help reverse this trend and enhance child mortality. Kitchen smoke contributes to about 2 million premature deaths annually.

✓ Women are disproportionally affected by indoor air pollution, water, and food-born diseases, all of which contribute to poor maternal health conditions, especially in rural areas.

✓ Health care facilities, their staff and equipment all require electricity (illumination, sterilization, refrigeration, etc.).

GOALS 7 AND 8 ~ ENSURE ENVIRONMENTAL SUSTAINABILITY, DEVELOP GLOBAL PARTNERSHIP FOR DEVELOPMENT

✓ Energy production, distribution, and consumption has adverse affects on the local, regional, and global environment including local indoor air pollution, land degradation, acidification of land and water and climate change.

✓ The World Summit for Sustainable Development (WSSD) called for partnerships to support sustainable development, including the delivery of affordable, reliable, and environmentally sustainable energy services.

BOX 1

Developed Countries (LDCs) and Sub-Saharan Africa (SSA) where more than 80 percent of people primarily rely on solid fuels for cooking, compared to 56 percent of people in developing countries as a whole. In other words, the consequences of use of solid fuels in developing countries illustrates the reality of billions of poor, particularly women and children, who bear the burden of spending much of their time searching for and collecting wood, animal dung, and other polluted fuels that they use for cooking in smoke-filled kitchen environments or for heating their living spaces. Not only they face arduous workloads and limit their free time that could otherwise be invested in productive activities (ea.g. education, healthcare, etc.), they are also exposed to major, if not deadly, health hazards (BOX 2).

For the haves in the regions of the world where people have enjoyed the benefits of electricity most of their lives, even one day without it is hard to imagine. Yet, for over 80 percent of people living in South Asia or Sub-Saharan Africa, lack of access to electricity is a daily reality, where physicians cannot provide quality health services because they do not operate within quality facilities, where children's time on educational activities is limited by darkness after dusk, and where entrepreneurs' economic output is restricted by insufficient power that is necessary to enhance the productivity of their businesses. This is a significant opportunity cost debilitating some of the poorest communities in the world in meeting their development objectives.

III ~ SURMOUNTING THE ENERGY CHALLENGES OF THE POOR: A 5-POINT AGENDA

Ending energy poverty is no doubt a daunting challenge. But the stakes are high and the consequences of inaction are almost certain to be exacerbated. According to International Energy Agency (IEA) analysts, under the business-as-usual scenario, 1.3 billion people will still lack access to electricity and 2.4 billion will continue to use traditional biomass for cooking and heating in 2030. Nevertheless, in the face of these mounting challenges, cause for optimism remains and meeting the energy needs of

HEALTH RISKS SSOCCIATED WITH USE OF SOLID FUELS

- ✓ About two million premature deaths occur each year that are associated with the indoor burning of solid fuels in unventilated kitchens.
- ✓ Inhaling indoor smoke doubles the risk of pneumonia and other acute respiratory infections among children under five years of age.
- ✓ Women exposed to indoor smoke are two times more likely to suffer from lung cancer than women who cook with cleaner fuels.

BOX 2. ~ SOURCE: UNDP ~ WHO, 2009.

the poor is far from impossible. Indeed, experience in the last two decades has convincingly demonstrated a variety of successful technological, financing, and delivery mechanisms that have led to significant results in many developing countries. Based on such experiences, the United Nations Development Programme (UNDP) firmly believes that surmounting the energy challenges of the poor is attainable. UNDP proposes five priority actions to pave the way towards universal access to energy for 3 billion energy poor by 2030.

1 ~ PRIORITIZING ENERGY NEEDS OF THE POOR: SETTING TIME-BOUND ENERGY ACCESS TARGETS

In developing countries, governments must make the energy needs of the poor a national development priority. The logic is not far fetching: national budgets are allocated based on the priorities set out in a country's development and poverty reduction strategy. Budgetary allocations are needed to roll out policies and programmes that address the energy needs of the poor. Accordingly, if a country is to tackle the energy challenges of the poor, it has to reflect energy access as a priority in its poverty reduction strategy. This, however, is not always the case in many developing countries, where national poverty reduction strategies are typically focused on the business-as-usual development planning processes aimed to extend infrastructure and power generation capacity while the needs of the poor who are mostly "beyond-the-grid" are too often ignored. A recent UNDP analysis found that about half of developing countries have established targets for electricity access, for example. In contrast, only few countries have set targets for access to modern fuels (17 countries), access to improved cooking stoves (11 countries), or access to mechanical power (5 countries). To successfully improve energy access and scale up energy services for achieving the MDGs, goals, policies, and budgets need to be aligned according to the needs of the poor. Setting time-bound targets is paramount to better articulation of such needs and to monitoring of progress towards achieving the end goal. Fortunately, there are some countries that have done so successfully (BOX 3).

ECOWOS WHITE PAPER ON ENERGY ACCESS

The title *White Paper for a Regional Policy Geared towards increasing access to energy services for rural and periurban populations in order to achieve the Millennium Development Goals* indicates the underlying concern of the 15 West African Heads of State who adopted this policy on 12 January 2006. The White Paper contains an analysis of the existing situation with respect to access to energy in the region, and fixes ambitious objectives:

- ✓ Access to improved cooking services for 100% of the population in 2015;
- ✓ Access to motive power for at least 60% of the rural population;
- ✓ Access to individual electricity service for all urban and 36% of rural dwellers.

The *White Paper* has already succeeded in mobilising political and financial efforts in favour of access to energy in the region.

BOX 3. ~ SOURCE: ECOWAS, 2005.

2 ~ DELIVERING BASIC HOUSEHOLD AND PRODUCTIVE NEEDS: GOING BEYOND ELECTRICITY TO ADDRESS COOKING FUELS AND MECHANICAL POWER

Access to three energy services of electricity, clean fuels, and mechanical power is needed to address the basic needs of the poor at the household level. Despite the traditional energy sector view of energy as electricity generation, poles, and transmission lines, electricity alone is not the solution to all the needs of the energy poor. Access to cleaner fuels and improved devices for cooking and heating have proved to be crucial in reducing health risks associated with use of solid fuels and inefficient stoves in unventilated environments. Mechanical power for agro-processing machinery or water pumping can drastically reduce the time spent on drudgery chores and increases opportunities for productive and income-generating activities. A variety of technological innovations based on locally driven business models are already in existence that have significantly improved the socio-economic conditions of the poor and have set foot in the road towards achieving the MDGs (BOX 4).

the capital investment required for achieving universal levels of access by 2030 is about $30-40 billion per year. This is relatively insignificant (only about 5 percent) in comparison with the total global energy investment expected during this period. Aligning national poverty reduction strategies to energy access goals and targets will allow public sector funding to be channeled accordingly. In addition, innovative funding mechanisms such as public-private partnerships are needed to leverage public

IMPACT OF MECHANICAL POWER FOR AGRO-PROCESSING MACHINERY IN BURKINA FASO

The Multi-functional Platform (MFP) programme promotes economic development and poverty reduction, particularly for women who are amongst the most vulnerable groups. It does so by providing a low-cost, simple and robust energy service for agro-processing enterprise managed by women that can also be used to pump water and generate electricity. To date, 400 platforms have been installed in 8 regions of the country benefiting 600,000 people in total. The programme's contribution to accelerating the achievement of the MDGs, particularly reducing poverty and hunger, gender equality, and education are impressive:

✓ Time-use surveys show that the platforms reduce by 2 to 4 hours per day the time women devote to domestic chores. This time is invested in income generating activities.

✓ Among the 24,000 women who benefit directly from the platforms, each woman saves an average of $55 per month compared to $11 per year without use of the platform.

✓ An evaluation, conducted in 14 villages in the Eastern region of Burkina Faso, shows that the literacy rate has raised from an average of 29% to 39 % after the installation of a MFP.

✓ Women's position in rural communities is extremely weak due to social and cultural practices. Beneficiary women who have involved themselves in a MFP enterprise have become more active community citizens. The women are not only engaged in the improvement of their own enterprise but participate more actively in community meetings.

Between 2010 and 2015, 1,400 new platforms will be installed to the benefit 2,5 million people (i.e. 23% of the population). In this phase, UNDP will focus especially on the reinforcement of economic activities around the Platforms and on the development of female, rural entrepreneurships. The programme has already spread to other countries in West Africa with support from UNDP.

BOX 4. ~ SOURCE: UNDP, 2010a.

3 ~ MOBILIZING FINANCING AND SEEKING INNOVATIVE INVESTMENT OPPORTUNITIES

While technologically feasible, providing about 3 billion people with access to modern energy services may at first seem financially unbearable and out of reach. Recent studies, however, suggest otherwise. According to United Nations Secretary General Advisory Group of Energy and Climate Change,

sector financing. Furthermore, creating enabling environments to increase the poor's access to small scale financing – loans, credits, and other financing mechanisms targeting low-income households – is essential in enhancing the purchasing power of the poor to benefit from the energy services available to them (BOX 5).

SMALL SCALE FINANCE FOR MODERN COOKING FUELS IN KENYA

Substituting use of Liquid Petroleum Gas (LPG) for wood is one means for providing sustainable cooking fuel. Families that wish to switch from wood to LPG must buy an LPG stove and pay a deposit to obtain an LPG cylinder.

In Kenya, the number of household LPG cylinders grew from 50,000 in 1995 to over 700,000 in 2002. Some 4900 SACCOs (Savings & Credit Co-operatives), provided micro finance for LPG cylinders, at an interest rate of 12 to 15% per annum. The loans were packaged and refinanced by the Kenya Union of Savings & Credit Co-operatives.

While micro finance played an important role, the success of the programme is also due to accompanying measures: liberalisation of the fuels market; government mandated standardisation of cylinder valves; removal of VAT and import duties on LPG sales.

BOX 5. ~ SOURCE: UNDP, 2009.

4 ~ DEVELOPING CAPACITY OF INSTITUTIONS AT THE LOCAL, NATIONAL, AND REGIONAL LEVELS

Capacity development lies at the heart of successful delivery of energy access to the poor. It is central in every step of the delivery process, from creating enabling conditions and integrating energy needs of the poor in poverty reduction framework and strategies, to identifying investment opportunities and mobilizing financing, to building the institutional capacities of local authorities, community organizations and beneficiaries, and to successfully deliver, manage, and maintain the energy service systems. Capacity development also plays an essential role in bringing down the cost of interventions by enhancing local markets and attracting further investments for replication and scale-up. Evidence from decentralized energy programmes demonstrates that upfront investment in capacity development is initially 2 to 3 times higher than the level of investment required for hardware. In later stages of the programme, however, when capacity has developed and with economies of scale, the costs are reduced dramatically. Experience from Nepal's Rural Energy Development Programme provides a perfect example of the role of capacity development in successful delivery of energy access programmes (BOX 6).

DEVELOPMENT OF INSTITUTIONAL CAPACITY OF LOCAL ACTORS IN SCALING-UP AND REPLICATION OF DECENTRALIZED ENERGY SYSTEMS IN NEPAL

Nepal has made a significant progress in developing local institutional capacity to expand access to modern energy services for rural populations. The Rural Energy Development Programme (REDP), implemented under the execution of the Alternative Energy Promotion Center (AEPC), has directly impacted over 230,000 beneficiaries with a total of 267 micro-hydro schemes installed and owned by the local communities. Its aim is to enhance rural livelihoods through promoting rural energy technologies, primarily community-managed micro hydro systems. It does so in part by developing the capacity of rural people to effectively utilize locally available energy resources and manage rural energy systems, thus reducing energy production costs.

With support from UNDP, the programme was initiated in 1996 to cover 5 districts only. Recent field surveys indicate development impacts such as increase in income by almost 30% per year in households, improved rate of enrolment in secondary education by 50%, and twice as much time-saving for women for activities such as reading, participating in educational programmes, and healthcare in communities with electricity. The programme has now evolved to cover 40 districts in its current third phase in partnership with the World Bank.

By 2012, the programme is planning to be present in Nepal's 75 districts with anticipated capacity to grow by a further 6000 kW, supplying electricity and mechanical power to roughly 1.5 million rural households that will accrue cumulative quantifiable benefits of over US$ 285 million per year. The programme is also working towards seizing the opportunity through Clean. Development Mechanism (CDM) with an aim to install a total of 15 MW of new MHS capacity, of which REDP would contribute 6.5 MW.

BOX 6. ~ SOURCE: UNDP, 2010b.

5 ~ FORGING STRATEGIC PARTNERSHIPS

Surmounting the challenge cannot be addressed by one sector alone. Meeting the energy needs of the poor requires concerted efforts to leverage the necessary knowledge, skills, and resources from a broad coalition of public entities, development agencies, civil society, and the private sector. Forming synergies and partnerships allows risks and responsibilities to be shared while it enables combining, complementing, and capitalizing on strengths and capacities to meet the needs of the poor most effectively in a way that it can induce fundamental impacts on their socio-economic development and achievement of the MDGs. To this end, the United Nations has formed UN-Energy, the UN -wide partnership to coordinate and strengthen joint efforts to advocate for and take action on energy issues. Given the important role it can play for the UN system, it is envisaged that UN -Energy's activities will be significantly scaled-up in the years to come.

IV ~ ENERGIZING THE MDGS: TOWARDS UNIVERSAL ENERGY ACCESS

Energy is inseparable from socio-economic development and environmental sustainability. Achieving universal access to adequate, reliable, and affordable energy services for the 3 billion energy poor must be put at the forefront of the development discourse if MDGs are to be met. It is ambitious and challenging, but the goal of universal access to energy is also an achievable one, as demonstrated through many successful examples of technically and financially viable and innovative experiences that have induced development impacts with significant scale to some of the most vulnerable communities. Strong political commitment is essential at all levels. Energy needs of the poor must become a priority in poverty reduction strategies where time-bound targets to deliver three essential services of electricity, clean fuels, and mechanical power must be reflected. The role of capacity development cannot be ignored and it has to be an integral part of all the processes associated with delivering energy services to the poor. There is an urgent need for concerted action among the public, the private, and civil society organizations to build awareness, catalyze financing, and capitalize on knowledge, skills, and best practices that have demonstrated successful scale-up and replication of development impacts for the energy poor.

KJØRVEN, OLAV, "Energizing the MDGs: going beyond business-as-usual to address energy access, sustainability and security", in *Annual Report of The Commonwealth Finance Ministers Meeting*, 2006.

UNDP (United Nations Development Programme), "Women Entrepreneurs in Burkina Faso", *UNDP newsroom item*, 2010a.

——, "Assessment of the development benefits from expanding access to micro-hydro electricity in rural Nepal", *upcoming publication*, 2010b.

The 2010 MDG Summit – to be held in September – presents an immense opportunity to make the case for the criticality of achieving universal access to energy by 2030, and to pave the way in this direction. It is time for world leaders to commit to liberating 3 billion energy poor from poverty by setting time-bound targets on providing access to energy services, by identifying innovative financing mechanisms to be challenged in this direction, and by building a strong coalition in all sectors to work together in making universal access to energy a reality.

BIBLIOGRAPHY

UN-SG AGECC (United Nations Secretary General Advisory Group on Energy and Climate Change), "Energy for a Sustainable Future", 2010.

BARKAT A., S.H. KHAN, ET AL., "Economic and Social Impact Evaluation Study of the Rural Electrification Program in Bangladesh". Arlington, VA: Human Development Research Centre and NRECA International, Ltd., USAID, 2002.

ECOWAS (Economic Community of West African States), "White Paper for a Regional Policy Geared towards increasing access to energy services for rural and peri-urban populations in order to achieve the Millennium Development Goals", 2005.

IEA (International Energy Agency), "World Energy Outlook", 2009.

——, "Bringing Small Scale Finance to the Poor for Modern Energy Services: What is the role of government? Experiences from Burkina Faso, Kenya, Nepal, and Tanzania", 2009.

——, "Energizing Poverty Reduction: A Review of the Energy-Poverty Nexus in Poverty Reduction Strategy Papers", 2007.

——, "Achieving The Millennium Development Goals : The Role of Energy Services, CaseStudies from Brazil, Mali and the Philippines", 2005.

—— and WHO (United Nations Development Programme and World Health Organization), "The Energy Access Situation in Developing Countries: A review focusing on least developing countries and SSA", 2009.

UNITED NATIONS MILLENNIUM PROJECT, UNDP AND WORLD BANK, "Energy Services for the Millennium Development Goals", 2005.

Certum est quia impossibile est.
[It is certain because it is impossible]

TERTULLIAN, *De Carne Christi*.

THE ENERGY WE ARE EATING

CARLO GUBITOSA

Carlo Gubitosa is a telecommunication engineer working since 1996 as freelance journalist for many major Italian newspapers and websites, writing about social issues and no-profits activities. He collaborates since 2003 with the faculty of communication sciences in Bologna as lecturer, and is currently following the development of a Content Management System (CMS) realized to fit the need of non-profit organization. He wrote nine books about social communication, forgotten wars and other issues, and strongly believes in the power of non-violent social change that communication technologies can reveal. In 2009 he founded the magazine Mamma!*, the first Italian magazine who melts journalism and comics.*

→| **ALTERNATIVES**

> ***"If we want things to stay as they are, things will have to change."***
>
> GIUSEPPE DI LAMPEDUSA

WHEN I EXPLAIN TO MY omnivore friends that the cattle's farts can damage the ozone layer more than the vehicle traffic, and that the main scope of the oil wars is to feed our stomach before filling our tanks, they think I am getting crazy and stare at me with astonishment and disbelief. I really can't blame them.

That diffidence has indeed encouraged my study, from a scientific point of view, of the energetic and the environmental impacts of the consumption of animal proteins. After a deep study of the scientific literature, I find crazy those people who struggle to minimize their ecological imprint with small actions only – short showers, flow-splitting taps, high-efficiency lamps – and forget the most simple and effective solution to save water, oil and land: reducing the intake of meat and animal proteins in general.

Scientific documents show clear evidence (TABLE 1): by replacing 1 kg of ovine meat with the equivalent 1 kg of soya, it is possible to save as many as 49 thousand liters of fresh water, more than the amount we individually consume for bath and showers in one year. To make up one food calorie of beef meat, it is necessary to burn 40 calories of fossil fuels. While a hectare of land used for the farming of bovine meat can feed one person only, the same hectare would feed more than 20 people, if converted to the production of potatoes. Moreover, as the FAO Report "Livestock's long shadow environmental issues and options" demonstrated in 2006, the methane expelled by livestock in intensive farming is far more dangerous, in terms of greenhouse effects, than the exhaustion gases emitted by the global vehicles fleet worldwide.

Despite being publicly known, these data are commonly ignored and kept out of the flashlights. The limitation of meat consumption is never mentioned as an effective tool for the reduction of our ecological imprint. Why?

The reasons are related to a series of concurrent factors.

Animalists and vegetarians tend to have a radical approach towards their choices, which are then perceived as "difficult" even by those sensible people who would be willing to lower their consumption of animal ingredients, even if not eliminating them from their diet. Furthermore, strong economic interests are connected to the meat industry, encouraging our ministries, for example, to eat meat in public by any minimal sign of consumers' hesitation. Besides, a large disinformation campaign anachronistically describes vegetarianism as an unsustainable and unhealthy option; on the contrary, it is demonstrated, with the highest medical-scientific reliability, that a lacto-ovo-vegetarian diet is perfectly compatible with an healthy alimentation, and that the risks of cardiovascular diseases, in comparison with an omnivore diet, are strongly reduced.

In such a context, people hardly realize how much land, water and energy could be potentially "liberated" by means of a simple improvement of their diet habits.

Science indicates that peace is built also at the table, starting from the food choices, and that we can contribute everyday to rebalance the exploding needs of the mankind with the possibilities of our Earth, which could give to everybody all what is necessary for a sober life.

There is no need to embrace a particular "food religion", but to learn how eating "with our brain" before using our mouth and stomach. We will discover that animal proteins are neither indispensable for a balanced alimentation nor for the pleasure of the taste, and that their production requires an enormous amount of resources which could be more usefully employed. That concept is indeed at everyone's reach.

We may therefore follow a more balanced diet standard in order to reduce our ecological imprint at the minimum. What we need is only a deeper awareness and a broader view over our interconnections with the world, to get the link between the move of the butterfly in our garden and the hurricane in the other part of the world. Small actions in our daily life may have big consequences on the whole planet.

A diet able to conjugate vegetarianism and a responsible use of resources leads to a different vision of the world, free from violence and cholesterol, the latter being even potentially dangerous for our body, as well known by those invited to suspend meat intake for medical reasons.

The excessive consumption of animal proteins in our society jeopardizes the food sovereignty and the survival of populations living on other countries far away.

Water, cereal, prime materials and oil consumed just for our tables are both limited and exhaustible resources. The basic idea of an energetically and ecologically sustainable approach to the alimentation requires just some respect for our mother Earth. By reducing the meat consumption we can achieve a better and tastier eating, and restore the hope to populations who have turned poor due to our greed and unaware lifestyle.

Our willingness to understand the world and to search what is better for us will become an active instrument of peace and justice for all.

TABLE 1 – MEAT CONSUMES MUCH MORE WATER

TO PRODUCE 1 KG OF ...	... THE NEEDED AMOUNT OF WATER IS
Millet	272 liters
Potatoes	630 liters
Corn	650 liters
Grain	900 liters
Rice	1,600 liters
Soya	2,000 liters
Chicken	3,500 liters
Pork	6,000 liters
Beef	43,000 liters
Ovine	51,000 liters

SOURCE: David Pimentel et al., "Water Resources: Agricultural and Environmental Issues" [Food production vs. water consumption] - http://dspace.library.cornell.edu/bitstream/1813/352/1/pimentel_report_04-1.pdf .

TABLE 2 – MEAT CONSUMES CEREALS

TO PRODUCE 1 KG OF…	… THE NEEDED AMOUNT OF CEREALS IS …	… THE NEEDED AMOUNT OF FORAGE IS…
Milk	0.7 kg	1 kg
Chicken	2.3 kg	--
Turkey	3.8 kg	--
Pork	5,9 kg	--
Eggs	11 kg	--
Beef	13 kg	30 kg
Lamb	21 kg	30 kg

SOURCE: David e Marcia Pimentel, "Sustainability of meat-based and plant-based diets and the environment" [Amount of cereal needed to the production of animal food] - http://www.ajcn.org/cgi/content/abstract/78/3/660S.

TABLE 3 – MEAT OCCUPIES LAND

1 HECTARE OF LAND EMPLOYED TO PRODUCE…	… CAN FEED FOR ONE YEAR
Cabbage	23 people
Potatoes	22 people
Rice	19 people
Grain	15 people
Beans	9 people
Peas	9 people
Pork	3 people
Lamb	2 people
Chicken	2 people
Beef	1 person

SOURCE: Colin Spedding, "The effect of dietary changes on agriculture" [Efficiency of land by different uses].

TABLE 1 – MEAT CONSUMES OIL

TO PRODUCE 1 CALORIE OF…	… THE NEEDED AMOUNT OF FOSSIL ENERGY IS
Turkey	10 calories
Pork	14 calories
Beef	40 calories
Lamb	57 calories

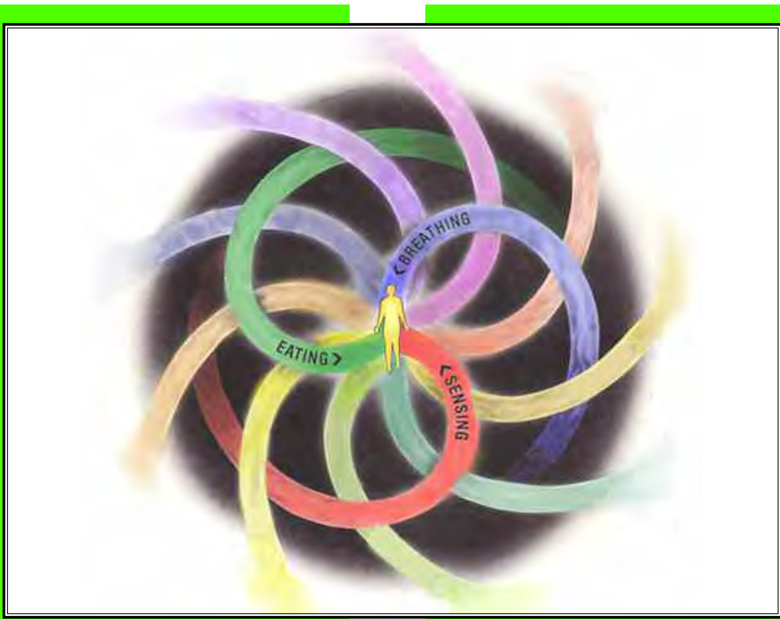
BIBLIOGRAHY

IPPOLITO, A. - GUBITOSA, C., *Ricettario della pace. Consigli e ricette per mangiar bene senza appesantire il mondo*, Meravigli, 2009.

PIMENTEL, D. ET AL., "Water Resources: Agricultural and Environmental Issues", in *BioScience* 10 (2004).

—— - PIMENTEL, M., "Sustainability of meat-based and plant-based diets and the environment", in *American Journal of Clinical Nutrition,* 78 (2003).

SPEDDING, C., "The effect of dietary changes on agriculture", cited in "The Social and Economic Contexts of Coronary Prevention", in *Current Medical Literature*, 1990.



DECALOGUE FOR EATING PROPERLY WITHOUT BURDENING THE WORLD

1 ~ Eat seasonal fruit and vegetables, locally produced: it required less energy to reach your table.

2 ~ Be aware that all proteins you need can be provided by vegetal food, with an environmental and social impact much lower with respect to the animal proteins.

3 ~ Independently from the specific diet, ingredients like soja, seitan and tofu can perfectly replace the meat and give to your alimentation a higher variety and a lower ecological imprint.

4 ~ To avoid contributing to the environmental damages related to the intensive farming, use eggs produced in biological farms only, where huns live outdoors and not in cages, fed by biological food. In Europe there is a numeric code pressed on each egg. The last digit of biological egg is "0" (zero).

5 ~ Balance your diet with at least 20% of raw food, such as fruit, salads, vegetables, ready to be consumed without any energy for the cooking.

6 ~ Cultivate at home or on your terrace what you can produce autonomously, like parsley, basil, small onions.

7 ~ For imported products like spices, tea, coffee and cocoa, use preferably the circuits of the fair trade.

8 ~ Use the tap water for your daily drinking. In 99% of the cases it is good enough to drink or can be easily depurated.

9 ~ Avoid products packaged in plastics. In contrast with supermarkets, open markets in your neighborhood allow you to use recyclable paper bags.

10 ~ As a general rule, avoid eating or consuming beyond your real needs.

AN ECO-LOGIC MOVE

A RENEWED LEGAL FRAMEWORK FOR RENEWABLE ENERGY SOURCES

SIMONA SAPIENZA

Simona Sapienza was educated at the Sawyer Business School (Pittsburgh, US), at the University of Rome «La Sapienza» where she received her MA in Law and PhD.

Ms Sapienza has held various academic positions in Italy and has been legal counsel for the Italian Institute of Research for the international protection of human and civil rights. She has been actively engaged in supporting NGOs projects associated with the Department of Public Information of the UN and in inter-cultural projects promoted by the EU Commission.

Ms Sapienza is currently Senior Associate in the International Capital Markets department of Allen & Overy (Rome), which she joined in 2000.

Ms Simona Sapienza is a Board member of the Spanda Foundation.

→| NEW DIRECTIONS

> ***“The end of law is, not to abolish or restrain, but to preserve and enlarge freedom.”***
>
> JOHN LOCKE

For many years renewable energies were seen as an energy option that, while environmentally and socially attractive, occupied niche markets at best, due to barriers of cost and available infrastructure. In the last decade, however, the case for renewable energy has become economically compelling as well.

There has been a true revolution in technological innovation, cost improvements and in our understanding and analysis of appropriate applications of renewable energy resources (RES), notably solar, wind, small-scale hydro and biomass-based energy, as well as advanced energy conversion devices such as fuel cells.

There are now a number of energy sources, conversion technologies and applications that make renewable energy options either equal or better in price and services provided than the prevailing fossil-fuel technologies. In a growing number of settings in industrialised nations, wind energy is now the least expensive option among all energy technologies, with the added benefit of being modular and quick to install and bring on-line. Also, photovoltaic panels and solar hot water heaters placed on buildings can help reduce energy costs, produce a healthier living environment and increase the overall energy supply.

Conventional energy sources based on oil, coal and natural gas have proven to be highly effective drivers of economic progress, but at the same time, they are highly damaging to the environment and human health. These traditional energy sources are facing increasing pressure on a multitude of environmental fronts, with perhaps the most serious one being the looming threat of climate change and a needed reduction in greenhouse gas emissions. It is now clear that efforts to maintain atmospheric CO_2 concentrations below even double the pre-industrial level cannot be accomplished in an oil- and coal-dominated global economy.

In principle, RES can meet many times the world's energy demand. More important, renewable energy technologies can now be considered major components of local and regional energy systems. As an alternative to centralized power plants, renewable energy systems are ideally suited to provide a decentralised power supply that could help to lower capital infrastructure costs. Renewable systems based on photovoltaic arrays, windmills, biomass, or small hydropower can serve as mass-produced energy appliances that can be manufactured at low cost and tailored to meet specific energy loads and service conditions.

These systems have less of an impact on the environment, and the impact they do have is more widely dispersed than that of centralised power plants, which in some cases contribute significantly to ambient air pollution and acid rain.

Renewable energy systems are now poised to play a major role in the energy economy and in improving the environmental quality of many countries.

A sound vision for a sustainable energy policy has been laid at the European Union level.

In January 2007 the European Commission set out an integrated energy/climate change proposal that addressed the issues of energy supply and climate change. Two months later, European Heads of

State welcome the plan and agreed upon an Energy Policy for Europe. The plan called for a:

— 20% increase in energy efficiency;
— 20% reduction in greenhouse gas emissions;
— 20% share of renewable energies in overall EU energy consumption by 2020;
— 10% biofuel component in vehicle fuel by 2020.

In January 2008, the European Commission put forward an integrated proposal for Climate Action, referred to as the *Energy-Climate Legislative Package*. After nearly a year of intensive negotiations, the *Energy-Climate Legislative Package* was adopted by the 27 EU member states on 12 December 2008, by the European Parliament on 17 December 2008, and finally by the Council of the European Union on 6 April 2009.

In order to achieve the European renewable energy targets, the Council adopted Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market and Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport.

The directive aims at achieving by 2020 a 20% share of energy from renewable sources in the EU's final consumption of energy and a 10% share of energy from renewable sources in each member state's transport energy consumption.

To achieve these objectives, the directive for the first time sets for each member state a mandatory national target for the overall share of energy from renewable sources in gross final consumption of energy, taking into account countries' different starting points.

The share of renewable consumption comprises the direct use of renewables like biofuels plus the part of electricity and heat that is produced from RES like wind and hydro, while final energy consumption is the energy of households, industry, services, agriculture and the transport use. The denominator for the RES share includes distribution losses for electricity and heat and the consumption of these fuels in the process of producing electricity and heat.

The main purpose of the mandatory national targets set out by the directive is to provide certainty for investors and to encourage technological development allowing for energy production from all types of RES. To ensure that the mandatory national targets are achieved, member states have to follow an indicative path towards the achievement of their target.

Each EU member state will have to adopt a national renewable energy action plan setting out its national targets for the share of energy from RES consumed in transport, electricity, heating and cooling in 2020 and will have to notify it to the Commission by June 2010.

To reach the mandatory targets, member states will apply national mechanisms of support or measures of cooperation between different member states and with third countries. They will also be able to import physical renewable energy from countries outside the EU and this would provide the possibility of a physical connection with large-scale solar installations in North Africa for example.

The creation of a tradable guarantee of origin regime allows member states to reach their targets in the most cost-effective way: instead of only developing local RES, member states will also be able to buy guarantees of origin, thus certificates proving the renewable origin of energy, from other member states where the development of renewable energy is cheaper to produce.

This table gives national overall targets for the share of energy from renewable sources in gross final consumption of energy in 2020 set under Directive 2009/28/EC.

MEMBER STATE	SHARE OF ENERGY FROM RENEWABLE SOURCES IN GROSS FINAL CONSUMPTION OF ENERGY, 2005	TARGET REQUIRED BY 2020
Austria	23,3%	34%
Belgium	2,2%	13%
Bulgaria	9,4%	16%
Cyprus	2,9%	13%
Czech R.	6,1%	13%
Denmark	17,0%	30%
Estonia	18,0%	25%
Finland	28,5%	38%
France	10,3%	23%
Germany	5,8%	18%
Greece	6,9%	18%
Hungary	4,3%	13%
Ireland	3,1%	16%
Italy	5,2%	17%
Latvia	32,6%	40%
Lithuania	15,0%	23%
Luxembourg	0,9%	11%
Malta	0,0%	10%
Netherlands	2,4%	14%
Poland	7,2%	15%
Portugal	20,5%	31%
Rumania	17,8%	24%
Slovak Republic	6,7%	14%
Slovenia	16,0%	25%
Spain	8,7%	20%
Sweden	39,8%	49%
United Kingdom	1,3%	15%
EU-27	**8,5%**	**20,0%**

The directive sets out the following interim targets in order to ensure progress towards the 2020 target:

— 25% of target between 2011 and 2012;
— 35% of target between 2013 and 2014;
— 45% of target between 2015 and 2016;
— 65% of target between 2017 and 2018.

Individual member states are free to decide the most suitable mix of RES to be used to meet their respective targets. They will also be required to report their progress towards the interim and 2020 target every two years, from 2010.

There will be non-financial penalties if a member state fails to meet its interim targets. Said that, the Commission has reserved the right to take legal action against member states if they fail to demonstrate sufficient progress towards the interim targets.

Each member state is also permitted to trade any excess renewable energy credits it may have after meeting its respective interim targets.

The directive does not recognize virtual renewable energy from investments in renewable energy projects in other countries nor allows for the creation of a European-wide market in renewable energies certificates. The directive requests that member states encourage the use of small-scale renewable energy in buildings and provide priority grid access to renewable energy sources.

It is worth noting that the directive does not provide for a single EU-wide harmonised support scheme. This is to be appreciated as at present the range of mechanisms of support for the promotion of energy from renewable sources in operation around Europe are too different and it would have been too risky to attempt any form of harmonisation.

So far member states have maintained or established their preferred support mechanism, be that premium systems/feed-in tariffs or certificate systems. In premium/feed-in systems the support levels are often differentiated for different technologies. Certificate systems are often technology neutral. All this has led to different results.

The circumstance that the Commission did not attempt to create a harmonised EU-wide payment mechanism for electricity production from RES (RES-E) must also be welcome. At this stage in fact it would have put European leadership in renewable energies at risk.

Harmonisation of a payment system for RES-E will make sense after a single EU truly competitive electricity market is established. At present, we have 27 different electricity markets with different electricity prices and it would have been highly risky to set only one support mechanism for renewable electricity.

Were the Commission to pursue a harmonised EU system, the optimal way to do so would be through the application of the polluter pays principle[1] and by imposing a tax on electricity production.

A part from the targets imposed by the directive, a successful framework for the development and deployment of RES-E at EU level will require political effort in four fields:

— Well designed payment mechanism;
— Grid access and strategic development of the grids;
— Good governance and appropriate administrative and planning procedures;
— Public acceptance and support.

If one or more of these key components are missing, little progress will happen. Looking at payment mechanisms in isolation may lead to wrong conclusions about the effectiveness of a specific mechanism of support for the promotion of RES-E. It is therefore important that any analysis of the success or failure of national support mechanisms seeks to identify whether a positive or negative development can be attributed to the design of the payment mechanism, or whether other factors in the form of administrative, grid access and, or public acceptance barriers affected the development.

It should also be noted that no country has ever managed to develop a market for renewable electricity through the application of just one policy. Historically, success has been the result of combinations of policies as stated by the International Energy Agency[2]: *"Significant market growth has always resulted from combinations of policies, rather than single policies. (…) In no case is there evidence of strong market growth with only one policy in place. Those countries that have experienced strong growth in 'new' renewables, such as wind and solar, including Germany, Spain, the United States and Denmark, have done so through a combination of financial incentives and guaranteed prices, underpinned by strong R&D."*

The Commission's efforts to identify successful and unsuccessful approaches to support mechanisms in the member states will have to take a more holistic approach, and will have to include identification of the sources leading to success or to failure. In addition, prior to a decision on harmonisation, the Commission should conduct an analysis of the various market distortions that exist, such as the varying grid connection costs throughout the EU and the differing administrative barriers, for example planning procedures, as well as specify the steps to be taken to remove the various market distortions prior to the harmonisation of the support mechanisms.

There are requirements that any future EU-wide mechanism must meet in order to create a sound investment climate for renewable energies such as compatibility with the polluter pays principle, high long-term investor confidence, simple and transparent implementation, high effectiveness in deployment of renewables, encouraging technology diversity, innovation, manufacturing, R&D, technology development and lower costs, compatibility with the liberalised electricity market and with other policy instruments, facilitating a smooth transition, encouraging local and regional benefits, public acceptance, transparency and integrity, protecting consumers, avoiding fraud and free riding.

With regard to biofuels, the directive sets the 10% target for renewable energy in the transportation sector at the same level for each member state in order to ensure consistency in transportation fuel specifications and availability. Member states that do not have the relevant resources to produce biofuels will easily be able to obtain renewable transport fuels from elsewhere. While it would technically be possible for the European Union to meet its biofuel needs solely from domestic production, it is both likely and desirable that these needs will in fact be met through a combination of domestic EU production and imports from third countries.

Within the past few years, concerns have been raised about whether biofuel production is actually sustainable. If biofuels are a crucial part of renewable energy policy and a key solution to growing emissions in the transport sector, they must not be promoted unless they are produced sustainably.

Although the majority of biofuels currently consumed in the EU are produced in a sustainable manner, the concerns are legitimate and need to be addressed.

The directive therefore sets out stringent environmental sustainability criteria to ensure that biofuels that are to count towards the European targets are sustainable and that they are not in conflict with overall environmental goals. This means that they must achieve at least a minimum level of greenhouse gas savings and respect a number of requirements related to biodiversity. Among other things this will prevent the use of land with high biodiversity value, such as natural forests and protected areas, being used for the production of raw materials for biofuels.

Regardless of whether the raw materials were cultivated inside or outside the EU territory, biofuels can be accounted for with respect to the target of 10% renewable energy in transport and, therefore, with respect to the national targets in terms of renewable energy, and benefit from possible financial support from the member states, only if they fulfil the following sustainability criteria:

— The greenhouse gas emission saving from the use of biofuels shall be at least 35%;
— Biofuels shall not be made from raw material obtained from land with high biodiversity value, such as primary forest and other wooded land where there is no clearly visible indication of human activity, areas designated for nature protection purposes or for the protection of rare, threatened or endangered ecosystems or species, or highly bio-diverse grassland;
— Biofuels shall not be made from raw material obtained from land with high carbon stock, such as wetlands, continuously forested areas;
— Biofuels shall not be made from raw material obtained from peat land.

Although targets themselves do not guarantee success they act as an important catalyst as they encourage investors to commit, enable stable technological deployment and cost reductions, and encourage research.

A critical strategy for effectively promoting energy efficiency is implementing new standards for buildings, appliances and equipment. Significant advances in the efficiency of heating and cooling systems, motors, and appliances have been made in recent years, but more improvements are technologically and economically feasible.

The current status of legislation and the different mechanisms of support for the promotion of renewables, and of RES-E in particular, currently in place at national level need now to be briefly outlined also for a better understanding of the impact that the new mandatory targets imposed by Directive 2009/28/EC may have on the renewable energy policies of each member state.

This table gives the reference values of national indicative targets for electricity produced from renewable energy sources set under Directive 2001/77/EC.

MEMBER STATE	RES-E% 2010 INDICATIVE TARGETS
Austria	78,1
Belgium	6,0
Bulgaria	11,0
Cyprus	6,0
Czech Republic	8,0
Denmark	29,0
Estonia	7,5
Finland	31,5
France	21,0
Germany	12,5
Greece	20,1
Hungary	21,0
Ireland	13,2
Italy	25,0
Latvia	49,3
Lithuania	7,0
Luxembourg	5,7
Malta	5,0
Netherlands	9,0
Poland	7,5
Portugal	39,0
Rumania	33,0
Slovak Republic	31,0
Slovenia	33,6
Spain	29,4
Sweden	60,0
United Kingdom	10,0

AUSTRIA

With a share of 70% RES-E of gross electricity consumption in 1997, Austria was the leading EU Member State for many years. Large hydropower is the main source of RES-E in Austria. More recently, a steady rise in the total energy demand has taken place, and a decrease of the share of RES-E has been noted.

Austrian policy supports RES-E through feed-in tariffs that are adjusted annually by law. The responsible authority is obliged to buy the electricity and pay a feed-in tariff. The annual allocated budget for RES support has been set at EUR 17 million for new RES-E up to 2011. This yearly budget is pre-allocated to different types of RES (30% to biomass, 30% to biogas, 30% to wind, 10% to photovoltaic and other RES). Within these categories, funds will be given on a first demand basis.

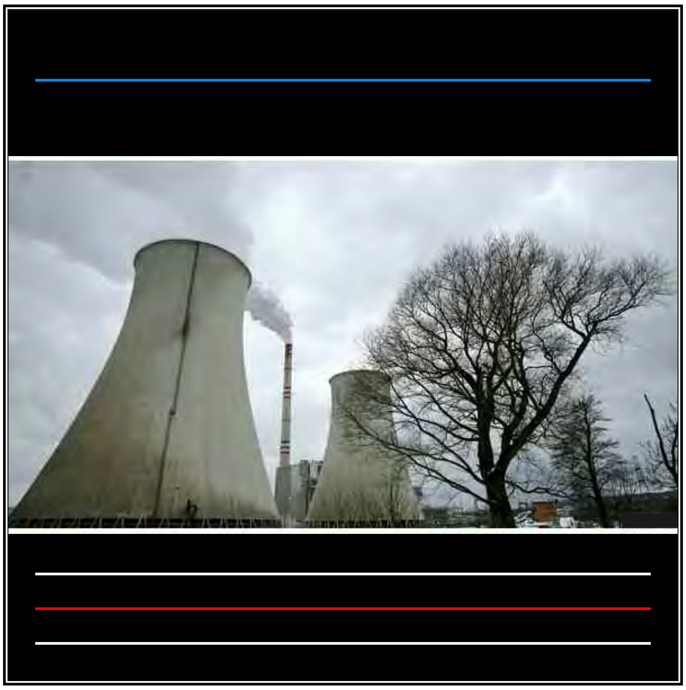
Biofuels are completely exempt from fossil fuel taxes. On 1 October 2007 an Order entered into force regarding a tax rebate for biofuel blends.

A variety of federal programmes for the support of the production of heat and cold from RES is being applied. These consist mainly of investment subsidies.

BELGIUM

With a production of 1,1% RES-E of gross electricity consumption in 1997, Belgium was at the bottom of the EU15. Targets differ between the three regions of the country (Flemish region, Walloon region and the Brussels-Capital Region) and national energy policies are implemented separately, leading to differing supporting conditions and separate, regional markets for green certificates. Policy measures in Belgium contain incentives to use the most cost-effective technologies. Biomass is traditionally strong in Belgium, but both hydropower and onshore wind generation have shown strong growth in recent years.

Two sets of measures are key to the Belgian approach to RES-E: obligatory targets have been set through the obligation for all electricity suppliers to supply a specific proportion of RES-E and guaranteed minimum prices have been foreseen. In all three of the regions, a separate market for green certificates has been created. Due to the low penalty rates that will increase over time, it is at the moment more favourable to pay penalties than to use the certificates. Little trading has taken place so far.



Investment support schemes for RES-E investments are available. Among them is an investment subsidy for photovoltaic. Production of heat and cold from RES is being supported by investment incentives in all three regions. The maximum level of support is as high as 15% in the Walloon region and 20% in both Flemish and Brussels-Capital regions.

BULGARIA

The RES-E target to be achieved in 2010 is about 11% for electric energy consumption. The goal of Bulgaria's National Programme on Renewable Energy Sources is to significantly increase the share of non-hydroelectric RES in the energy mix.

RES-E policy in Bulgaria consists of a green certificate trading system under which public providers are required to supply minimum mandatory quota as a percentage of the total annual electricity production. Highly efficient combined heat and power plants is also included in the tradable green certificate scheme. In Bulgaria, biofuels have been exempt from excise tax since 2005.

In order to promote production of heat and cold from RES, Bulgaria implemented the Bulgarian Energy Efficiency and Renewable Energy Credit Line. RES projects are eligible for a 20% grant. Large-scale hydropower exhibits a high penetration rate. Some pilot projects have been implemented using wind power, but in absolute figures, the contribution made by wind power is minimal.

CYPRUS

The leading RES in Cyprus is photovoltaic, and wind power offers high potential. An issue regarding policy integration has been observed as there is investment at present in a new fossil fuel power plant creating excess capacity. Until 2005, measures that proactively supported renewable energy production, such as the New Grant Scheme, were not very ambitious. In 2006, a New Enhanced Grant Scheme for Energy Conservation and Promotion of the Use of RES was agreed upon. It regulates RES-E policy and provides financial incentives (30-55% of investments) in the form of government grants and feed-in tariffs are part of this scheme. In order to promote the use of biofuels, a measure was taken to exempt the biomass percentage of biodiesel from excise duty, as of 2005.

The New Enhanced Grant Scheme for Energy Conservation and Promotion of the Use of RES also provides financial incentives for RES heating and cooling activities: 30-45% of investment in solar systems for central water heating systems and 40-55% of investment in space heating and cooling can be recovered in this way.

CZECH REPUBLIC

The Czech Republic's legislative framework in relation to RES has been strengthened by a RES Act adopted in 2005 and a Government Order regulating the minimum amount of biofuels or other RES fuels that must be available for motor fuel purposes. Targets for increasing RES in total primary energy consumption have been set at national level. The use of biomass in particular is likely to increase as a result of the new legislation.

In order to stimulate the growth of RES-E, the Czech Republic has decided on the following measures: a feed-in system for RES-E and cogeneration in 2000. The RES Act extends this system by offering a choice between a feed-in tariff, thus a guaranteed price or a green bonus, thus an amount paid on top of the market price.

Premiums to the electricity price are foreseen for producers of electricity from combined heat and power plants. Besides this, investment support from 30-80% is available whenever the applicants are non-profit organizations.

The use of biofuels is being encouraged through an air protection act, which requires that a minimum amount of biofuel, or other fuels produced from RES, is made available to the market. Government Resolution no. 1080 of 20 September 2006 provides for a minimum quantity of biofuels in the range of motor-vehicle fuels without any subsidies or state support.

DENMARK

Due to an average growth of 71% per year, Danish offshore wind capacity remains the highest pro-capite. Denmark is at present close to reaching its RES-E target for 2010. RES other than offshore wind are slowly but steadily penetrating the market, supported by a wide array of measures such as a new repowering scheme for onshore wind.

Denmark has been slow in introducing biofuels to the market and is behind on its EU target.

In order to increase the share of RES-E in overall electricity consumption, Denmark has implemented a tendering procedure for two new large offshore installations. A spot price, an environmental premium and an additional compensation for balancing costs for 20 years is available for new onshore wind farms. Furthermore, fixed feed-in tariffs exist for solid biomass and biogas under certain conditions. Subsidies are available for combined heat and power plants based on natural gas and waste.

The generation of heat and cold from RES is supported by means of tax exemptions. Biomass, being CO2 neutral, is exempt from CO2 duty. Solar heating plants are exempt from both energy and CO2 taxes. The Executive Order *Solar heating obligations in new buildings outside the district heating areas*, adopted in 2001, requires the introduction of solar heating from owners of new buildings, excluding the domestic sector. Solar thermal installations are also eligible for subsidies. Both regulations apply only outside district heating areas.

Biofuels have been exempt from the CO2 tax imposed on ordinary petrol and diesel for transport since January 2005. This is currently the main supporting measure for biofuels. As of 1 January 2010 all filling stations have to sell at least 5.75% biodiesel and bioethanol.

ESTONIA

Estonia's potential lies mainly in biomass, biogas, wind and cogeneration from biofuels. Small-scale hydroelectric is being developed as only about half the potential is currently exploited. By end-2005, 36.2MW were produced from hydroelectric and wind. The use of renewable fuels did not change significantly between 1999 and 2005, and in 2006 the percentage of biofuels in the transport fuel mix was just 0.12%.

For electricity, feed-in tariffs will be paid for some years but not beyond 2015. There is a single feed-in tariff level for all RES-E technologies. Relatively low feed-in tariffs make new renewable investments very difficult. In 2001, a voluntary mechanism involving green energy certificates was created by the grid operator, the state-owned Eesti Energia Ltd.

District heating law promotes the use of indigenous sources and RES for heat production. Biofuels used for transport or heating have been exempt from excise tax since 2005. In 2006 a development plan to promote the use of biomass and bioenergy for 2007-2013 was drawn up, and direct aid is available to expand the energy crop area.

New RES-E regulation in force since 2007 includes three support options: feed-in tariff, premium and certificate of origin, and is valid for RES-E production from facilities with capacity less than 100MW.

FINLAND

Finland continues to adjust and refine its energy policies in order to enhance the competitiveness of RES. Through subsidies and energy tax exemptions, Finland encourages investment in RES. Solid biomass and large-scale hydropower dominate the market, and biowaste is also increasing its share. Additional support in the form of feed-in tariffs based on purchase obligations or green certificates is being considered for onshore wind power.

Biomass is the most important renewable energy source in Finland, with its use accounting for about 20% of primary energy consumption.

The main measures to encourage the use of RES-E in Finland consist in tax subsidies, the RES-E has been made exempt from the energy tax paid by end users, in discretionary investment subsidies, new investments are eligible for subsidies up to 30%, up to 40% especially for wind and in guaranteed access to the grid for all electricity users and electricity-producing plants, including RES-E generators. Taxes imposed on heat are calculated on the basis of the net carbon emissions of the input fuels and are zero for RES. Further encouragement of the production of heat and cold from RES takes the form of direct biomass investment support.

Feed-in tariff for biogas plants started in 2008.

Biofuels benefit from tax exemptions under certain conditions. Biogas used as motor fuel, for instance, is exempt from excise duty. A law on the promotion of biofuels, entered into force on 1 January 2008, obliged fuel distributors to supply a minimum of 2% biofuels to the transport market in 2008, with annual increases so that it will be at least 5,75% by end of 2010.

FRANCE

France has centred its RES approach around feed-in tariffs on the one hand, and a tendering procedure on the other. Hydropower has traditionally been important for electricity generation, and the country ranks high when it comes to biofuel production. France has vast resources of wind, geothermal energy and biomass. Wind power and geothermal electricity have shown growth. In addition, there is potential in the area of solid biomass.

The French policy for the promotion of RES-E includes feed-in tariffs introduced in 2001 and 2002, and modified in 2005 for photovoltaic, hydro, biomass, sewage and landfill gas, municipal solid waste, geothermal, offshore wind, onshore wind, and combined heat and power, a tender system for large renewable projects.

Stimulating the uptake of production of heat and cold from RES is done in three ways: tax credits of 50% are available, a 5,5% reduction in VAT has been introduced for residential energy equipment using RES, and subsidies of up to 40% are granted for biomass heating plants.

Policy exists to ensure electricity is bought from biomass installations of less than 12 MW capacity. There is a tax credit for private individuals who purchase renewable energy products for their homes like wood heating.

Law no. 2005-781 of 13 July 2005 ensured that biofuel use reached 5,75% by 2008 rather than by 2010 as mentioned in Directive 2001/77/EC, and reaches 7% by 2010 and 10% by

2015. Suppliers who do not meet these targets pay an additional tax for polluting activities. Partial tax exemption exists to cover the currently higher costs of biofuel production compared with fossil fuels, with the percentage changing annually, depending on economic conditions. Capital grants are also in place to promote biofuels.

GERMANY

Germany is a EU leader in wind utilisation, photovoltaic, solar thermal installations and biofuel production. Its onshore wind capacity covers approximately 50% of the total installed capacity in the EU. A stable and predictable policy framework has created conditions favourable to RES penetration and growth. Feed-in tariffs for RES-E, market incentives for the production of heat and cold from RES, and tax exemptions for biofuels have proven to be a successful policy mix leading to a very dynamic market for RES. In 2006, about 70% of renewable energy was generated from biomass, and 11,8% of electricity was generated from RES.

Germany has already exceeded its 2010 biofuel target of 5,75%. With the aim of promoting RES-E, Germany through its Renewable Energy Act of 2004 has introduced feed-in tariffs for onshore wind, offshore wind, photovoltaic, biomass, hydro, landfill gas, sewage gas and geothermal, large subsidised loans available through the DtA (Deutsche Ausgleichsbank) Environment and Energy Efficiency Programme.

A Market Incentive Programme provides subsidies for the production of heat and cold from RES, with excellent results in solar thermal and small-scale biomass heat generation.

From 1 January 2007, firms have been obliged to market biofuels using a quota system: 4,4% for diesel and 1,2% for petrol; this will be increased annually. Second generation biofuels, biogas and pure bioethanol will be granted a decreasing tax incentive until 2015.

GREECE

Hydropower has traditionally been important in Greece, and the markets for wind energy and active solar thermal systems have grown in recent years. Geothermal heat is also a popular source of energy. The Greek parliament has recently revised the RES policy framework partly to reduce administrative burdens on the renewable energy sector.

General policies relevant to RES include a measure related to investment support, a 20% reduction of taxable income on expenses for domestic appliances or systems using RES, and a concrete bidding procedure to ensure the rational use of geothermal energy. In addition, an inter-ministerial decision was taken in order to reduce the administrative burden associated with RES installations.

To stimulate the growth of RES-E, Greece has introduced feed-in tariffs in 1994 as amended by the recently approved Feed-In Law. Tariffs are now technology-specific, instead of uniform, and a guarantee of 12 years is given, with a possibility of extension of up to 20 years, fuel taxes are not applied to biofuels.

HUNGARY

Geographical conditions in Hungary are favourable for RES development, especially biomass.

Whilst environmental conditions are the main barriers to further hydropower development, other RES such as solar, geothermal and wind energy are hampered by administrative constraints like the permit process. As regards the policy framework, promotional schemes are being used and refined, and subsidies are available under certain conditions for the development of RES.

RES-E 2010 target was achieved in 2006 (5%), with the main contribution being from biomass. However, domestic production was at 4,4%.

For the promotion of RES-E Hungary as introduced a feed-in system. It has used technology-specific tariffs since 2005, when Decree 78/2005 was adopted. These tariffs are guaranteed for the lifetime of the installation. A green certificate scheme was introduced with the Electricity Act of 2001, as amended in 2005. In July 2007, two advantageous tax levels were introduced for bioethanol. In particular bioethanol for E85 has been completely exempt since 2007. A similar procedure was introduced in January 2008 for biodiesel.

IRELAND

Hydro and wind power make up most of Ireland's RES-E production. Despite an increase in the RES-E share during the past decade, the target is still far off. Ireland has selected the Renewable Energy Feed-In Tariff as its main instrument. From 2006, this new scheme has provided some investor certainty, due to a 15-year feed-in tariff guarantee. No real voluntary market for renewable electricity exists. There is also an absence of a genuine market for biofuels, however, support schemes have been in place since 2005 so this is expected to change.

Between 1995 and 2003, a tender scheme, the Alternative Energy Requirement, was used to support RES-E. Since 2006, the Renewable Energy Feed-In Tariff has become the main tool for promoting RES-E. Feed-in tariffs are guaranteed for up to 15 years, but may not extend beyond 2024. During its first year, 98% of all the REFIT support has been allocated to wind farms.

Since 2005, the Biofuels Mineral Oil Tax relief scheme allows for excise relief on biofuels for a total of EUR 3 million per year. In 2006, a five-year biofuels excise relief package worth EUR 200 million was also approved. The Energy Crops Scheme provides further support, with aid of EUR 45 per hectare for areas sown under energy crops, topped up by EUR 80 of Irish funds. A scheme was launched in early 2007, primarily for vehicle fleets, using pure plant oil: they will receive a 75% grant for modifying engines.

Grant aid is available through the Greener Homes Scheme and the ReHeat Programme for the development of the production of heat and cold from RES.

An Energy White Paper was published in March 2007, setting the energy policy framework for 2007-2020. The government has presented policy proposals to significantly increase the use of biomass in electricity generation by co-firing it in peat-fired power stations.

ITALY

Despite strong growth in sectors such as onshore wind, biogas and biodiesel, Italy is far from the targets set at both the national and European level. Several factors contribute to this situation. First, there is a large element of uncertainty due to recent political changes and ambiguities in current policy design. Second, there are administrative constraints such as complex authorisation procedures at local level. Third, there are financial barriers such as high grid connection costs.

In Italy, there is an obligation on electricity generators to produce a certain amount of RES-E. At present, the Italian government is working out the details of more ambitious support mechanisms for the development and use of RES.

In order to promote RES-E, Italy provides that a priority access to the grid system is granted to electricity from RES and combined heat and power plants. Italy has also introduced the obligation for electricity generators to feed a given proportion of RES-E into the power system.

In case of non-compliance with national targets, sanctions are foreseen, but enforcement in practice is considered difficult because of ambiguities in the legislation.

Tradable Green Certificates, which are tradable commodities proving that certain electricity is generated using RES, are used to fulfil the RES-E obligation. A feed-in tariff for photovoltaic exists. This is a fixed tariff, guaranteed for 20 years and adjusted annually for inflation.

National legislation is being developed, both for the production of heat and cold from RES and for biofuels. Subsidies are already in place for bioethanol production and tax exemptions for biodiesel production.

As yet, no national policy framework exists that supports the production for heat and cold from RES. In the meantime, certain regional and local governments have introduced some measures to promote RES. These have taken the form of incentives for solar thermal heating and compulsory installation of solar panels in new or renovated buildings.

LATVIA

In Latvia, almost half of the electricity consumption is provided by RES, with hydropower being the key resource. The growth observed between 1996 and 2002 can be ascribed to the so-called double tariff, which was phased out in 2003. This scheme was replaced by quotas adjusted annually. Wind and biomass would benefit from clear support since the potential in these areas is considerable.

The two main RES-E policies which have been followed in Latvia consist of fixed feed-in tariffs, which were phased out in 2003 and a quota system which has been in force since 2002, with authorised capacity levels of installations determined by the Cabinet of Ministers on an annual basis.

In addition, biofuels are subject to a reduced excise tax rate. Rapeseed oil is subject to 0% excise tax, regardless of its end use.

LITHUANIA

Lithuania depends to a large extent on the Ignalina nuclear power plant that currently generates up to 70% of total electricity. The National Energy Strategy includes plans related to the start of operation of a new nuclear power plant that will result in a major rise of electricity generation output in 2016. In order to provide alternative sources of energy and electricity in particular Lithuania has set a national target of 12% RES by 2010. The implementation of a green certificate scheme was however postponed for 11 years. The biggest renewables potential in Lithuania can be found in the field of biomass, with an expected nine fold rise in electricity generation between 2006 and 2017. Furthermore, electricity from wind is expected to rise by 54 times between 2006 and 2017.

The core mechanisms used in Lithuania to support RES-E are feed-in tariffs. In 2002, the National Control Commission for Prices and Energy approved the average purchase prices of green electricity. The tariff levels will remain unchanged until December 2020.

In September 2006, the procedure for promoting generation and purchasing of RES-E was updated to include wind, biomass, solar and hydropower plants with a capacity of less than 10 MW.

The National Energy Strategy provides for the improvement of the procedures for the promotion and purchase of electricity from RES to encourage competition among the producers and to introduce the system of green certificates or other systems beyond 2020.

In order to promote biofuels, the Law on Excise Taxes of 2001 provides for excise tax relief. Besides this, the Law on Pollution Tax further stimulates the uptake of biofuels.

Through the Law on Heat of 2003, municipalities encourage the purchase of heat fed into heat supply systems produced from RES. Investment subsidies and loans on favourable terms are also made available by the Lithuanian Environmental Investment Fund.

LUXEMBOURG

Despite a wide variety of support measures for RES and a stable investment climate, Luxembourg has not made significant progress towards its targets in recent years. In some cases, this was due to limitations on eligibility and budget. While electricity production from small-scale hydropower has stabilised in recent years, the contributions from onshore wind, photovoltaic and biogas have now started to increase.

The 1993 Framework Law, amended in 2005 determines the fundamentals of Luxembourg RES-E policy.

Preferential tariffs are given to the different types of RES-E for fixed periods of 10 or 20 years.

The feed-in system might be subject to change due to further liberalisation of the sector. Subsidies are available to private companies that invest in RES-E technologies, including solar, wind, biomass and geothermal technologies.

Tax exemptions are made for biofuels for transport. The setting of maximum levels of tax exemption is foreseen. Pure biofuels are tax-free from 2007 to encourage captive fleets to switch.

To promote the production of heat and cold from RES, Luxembourg provides investment subsidies for combined heat and power plants, for the installation of heat pumps (25%) and for installation of solar thermal (40%).

MALTA

The market for RES in Malta is still at an early stage and, at present, penetration is minimal. RES has not been adopted commercially, and only solar energy and biofuels are used. Nevertheless, the potential for solar and wind is substantial. In order to promote the uptake of RES, the Maltese government has created framework for support measures. It has set national indicative targets for RES-E lower than the ones agreed to in its Accession Treaty, between 0,31% and 1,31%, instead of 5%.

In Malta, RES-E is supported by a fixed feed-in tariff of 46,6 EUR/MWh for photovoltaic installations below 3,7 kWp; and a reduction in value-added tax on solar systems from 15% to 5%.

Since 2005, excise taxes no longer apply to the biomass content in biodiesel.

THE NETHERLANDS

In 2003, after a period during which support was high but markets quite open, a system was introduced that installed sufficient incentives for domestic RES-E production.

Although successful in encouraging investments, this system, based on premium tariffs, was abandoned in August 2006 due to budgetary constraints. Political uncertainty concerning renewable energy support in the Netherlands is compounded by an increase in the overall energy demand. Progress towards RES-E targets is slow, even though growth in absolute figures is still significant.

RES-E policy in the Netherlands is based on the 2003 Environmental Quality of Power Generation policy programme, and comprises source specific premium tariffs, paid for 10 years on top of the market price. These tariffs were introduced in 2003 and are adjusted annually. Tradable certificates are used to claim the feed-in tariffs. The value of these certificates equals the level of the feed-in tariff. Due to budgetary reasons, most of the feed-in tariffs were set at zero in August 2006.

A Guarantee of Origin system was introduced, simply by renaming the former certificate system.

Biofuels have traditionally been supported by means of R&D funds. To date, technological innovations in this field are encouraged by means of financial support. In 2006, a tax relief system was introduced.

The mechanism that was chosen links the quantity of biofuels to the national targets, by requiring of suppliers that regular fuels contain a 2% share of biofuel from 2007 onwards, and a 5,75% share from 2010 onwards.

No resources are specifically allocated to biomass production, but there are instruments for RES-E such as a tax bonus.

Limited investment subsidies are available for RES heating and cooling activities. Feed-in tariffs are also applied to combined heat and power plants.

POLAND

Progress towards the RES-E target in Poland is slow. The penalties designed to ensure an increased supply of green electricity have not been adequately used. The potential of hydropower, biomass and landfill gas is high in Poland. Hydro power plants have not been fully used to date, biomass resources in the form of forestry residues, agricultural residues and energy crops are plentiful in Poland, and landfill gas is promising as well.

Polish RES-E policy includes the Tradable Certificates of Origin introduced by the April 2005 amendment of the Law on Energy of 1997. The Obligation for Power Purchase from Renewable Sources of 2000, as amended in 2003 involves a requirement on energy suppliers to provide a 27,5% minimum share of RES-E in 2010. Failure to comply with this legislation leads, in theory, to the enforcement of a penalty.

An excise tax exemption on RES-E was introduced in 2002. The Energy Act of April 2007 incorporates a principal support mechanism of Certificates of Origin for RES-E: all energy companies selling electricity to end users have to obtain and present for redemption a specified number of Certificates or pay a substitution charge. A liquid biofuel quality requirement regulation entered into force in September 2006.

Since January 2007, biocomponents for liquid fuels and liquid biofuels have been exempt from excise duty. Preferential excise duty treatment was planned to increase under an Act of May 2007. An obligation to add a specified volume of bio-component to fuels was also introduced by two acts in June 2006.

Another element in this policy mix is structural funds, which can be used to improve the infrastructure of biofuels and other RES.

PORTUGAL

What has been adopted so far in Portugal in relation to renewable energy constitutes a comprehensive policy mix, complete with monitoring system. Portugal has been moving further away from its RES-E target between 1997 and 2004. In part, this is due to the fact that the target was not entirely realistic as it was based on the exceptional hydropower performance of 1997. As a consequence, Portugal is not expected to reach its target, even if measures are successful. In 2006, 74% of total RES-E production was from hydropower.

The world's first wave power plant with a capacity of 4 MW is operating, and a licence has been awarded for a photovoltaic power plant with forecast production of 76 GWh per year.

To stimulate the uptake of RES-E, Portugal has introduced fixed feed-in tariffs per kWh for photovoltaic, wave energy, small hydro, wind power, forest biomass, urban waste and biogas. Investment subsidies up to 40% can be obtained. Tax reductions are available.

A law was adopted in August 2007 providing the legal basis for government use of public maritime areas for producing electricity from sea-wave power.

Since January 2006, when Directive 2003/30/EC was transposed into national law, the form of support for biofuel production consisted in the total or partial exemption from excise duty up to a quota set annually, total Petroleum and Energy Products Duty exemption for biofuels produced in certain pilot projects. Besides this, there is the possibility of imposing a quota for biofuels in transport fuels, and of establishing voluntary agreements whenever the biofuel share in blends exceeds 15% in the case of public passenger transport fleets.

A broad range of policy measures has been implemented to ensure the uptake of the production of heat and cold from RES. Investment subsidies are available, and the new Portuguese building code introduces the obligation to install solar thermal systems in certain cases. On top of this, accelerated depreciation on solar thermal equipment investments has been made possible. In the region of Madeira, non-returnable grants are also available for domestic solar thermal systems.

In September 2007, new incentives for the micro-generation of renewable electricity were approved as part of a package for reducing carbon emissions. The micro-generation tariff is EUR 650/MWh for an initial five-year period. By 2015 national micro-generation capacity will be around 200 MW.

ROMANIA

In terms of RES of gross electricity consumption, Romania is on target. The majority of all RES-E is generated through large-scale hydropower. To a large extent, the high potential of small-scale hydropower has remained untouched. Provisions for public support are in place, but renewable energy projects have so far not been financed.

To promote RES-E, Romania introduced a quota system with Tradable Green Certificates for new RES-E in 2004. The mandatory quota increased from 0,7% in 2005 to 8,3% in 2010. Tradable Green Certificates are issued to electricity production from wind, solar, biomass or hydropower generated in plants with less than 10 MW capacity. Mandatory dispatching and priority trade of electricity produced from RES has been introduced since 2004. Legislation on biofuels was transposed into national legislation in December 2005.

The list of priorities of the Romanian Energy Efficiency Fund established in 2002 includes the use of RES for heating.

SLOVAK REPUBLIC

In the Slovak Republic, large-scale hydro energy is the only RES with a notable share in total electricity consumption. An extended development programme with 250 selected sites for building small hydro plants has been adopted. In the Slovak Republic, the highest additional mid-term potential of all RES lies with biomass. The Government has decided to only use this source in remote, mountainous, rural areas, where natural gas is not available.

The Strategy of Higher Utilisation of RES in the Slovak Republic was approved in April 2007.

RES-E policy in the Slovak Republic includes measures that gives priority regarding transmission, distribution and supply of RES-E, guarantees of origin, and tax exemption for RES-E. This regulation is valid for the calendar year in which the facility commenced operation and then for five consecutive years. A system of fixed feed-in tariffs has been in place since 2005.

Subsidies up to EUR100,000 are available for the (re)construction of RES-E facilities.

In 2005, the National Programme of Biofuel Development was adopted. Production of heat and cold from RES is promoted through the Programme supporting Energy Savings and Utilisation of RES aiming to create a favourable climate for investments. Subsidies up to EUR 100,000 are also available for the (re)construction of facilities for the production of heat and cold from RES.

SLOVENIA

Slovenia is currently far away from meeting its RES targets. The potential of solid biomass is high, with over 54% of land covered with forests. This RES has recently started to penetrate the market. Hydropower, at this time the principal source of RES-E, relies on a large amount of very old small hydro plants.

The Slovenian government has made their refurbishment part of the renewable energy strategy. An increase in capacity of the larger-scale units is foreseen as well. In Slovenia, a varied set of policy measures has been accompanied by administrative taxes and complicated procedures.

In Slovenia, the RES-E policy provides that RES-E producers can choose to receive either fixed feed-in tariffs or premium feed-in tariffs from the network operators. According to the Law on Energy, the uniform annual prices and premiums are set at least once a year. Subsidies or loans with interest-rate subsidies are available. Most of the subsidies cover up to 40% of the investment cost. Investments in rural areas with no possibility of connection to the electricity network are eligible to apply for an additional 20% subsidy.

Since 2004, pure biofuels used as motor fuels have been exempt from the excise inspection and payment system. When blended with fossil fuels, a maximum 5% exemption from the payment of excise duty can be claimed. Slovenia applies a system whereby distributors are obliged to place on the market a percentage of biofuels that corresponds to the national target. This measure was introduced in 2005.

Since 2004, Slovenia has supported the growth of heat and cold production from RES through subsidies, up to 40% of the investment, and through loans with interest-rate subsidies.

SPAIN

Spain is currently far from its RES-E target. In 1997, a strong support programme in favour of RES was introduced. In 2004, hydropower still provided 50% of all green electricity, while onshore wind and biomass had started penetrating the market. Photovoltaic energy is also promising, with an average growth rate of 54% per year. Proposed changes to the feed-in tariffs and the adoption of a new Technical Buildings Code in 2006 show increased support for biomass, biogas, solar thermal electricity, and solar thermal heat.

RES-E in Spain benefits from a feed-in tariff or a premium price paid on top of the market price. The possibility of a cap and floor mechanism for the premium is being considered. Recently support for biomass, biogas and solar thermal electricity has been considered. Low-interest loans that cover up to 80% of the reference costs are available. In May 2007 a new renewable energy legislation was passed that increased the tariffs for renewables from 50-100% for biomass, and from 16-40% for biogas.

The fuel tax exemption currently in place is applied specifically to the volume of biofuel.

The production of heat and cold from RES is supported through the new Technical Buildings Code of 2006 which includes an obligation to cover 30-70% of the domestic hot water demand from solar thermal energy and it applies to all new buildings and renovations. The assumed volume of hot water demand and the geographical location of the building determine the exact percentage that applies. Investments in the production of heat and cold from RES are eligible for investment subsidies of 36,4% of the total cost.

SWEDEN

Sweden is moving away from its RES-E target. In absolute figures, RES-E production has decreased mainly due to a lower level of large-scale hydro production. Other RES like biowaste, solid biomass, off-shore wind and photovoltaic have, however, shown significant growth. In Sweden, a comprehensive policy mix exists with tradable green certificates as the key mechanism. This system creates both an incentive to invest in the most cost-effective solutions, and uncertainty for investment decisions due to variable prices.

Swedish RES-E policy is composed of Tradable Green Certificates introduced in 2003. The Renewable Energy with green certificates bill that came into force on 1 January 2007 shifts the quota obligation from electricity users to electricity suppliers, and incorporates a new target of 17 TWh by 2016.

Since 2005, renewable fuels must make up at least 3% of all petrol and diesel consumption for transport operations. Green taxes such as the carbon dioxide tax promote biofuels in an indirect way. In addition, the Swedish government is currently increasing the number of alternative fuel pumps. Finally, a subsidy is granted for investment in filling stations for biogas and other renewable fuels.

In Sweden, the production of heat and cold from RES is supported in an indirect way by raising taxes on fuels. Biofuels, solid waste and peat are tax-exempt for most energy uses. Investment grants are available for solar heating installations.

UNITED KINGDOM

In the United Kingdom, renewable energies are an important part of the climate change strategy and are strongly supported by a green certificate system with an obligation on suppliers to purchase a certain percentage of electricity from RES, and several grant programmes. Progress towards meeting the target has been significant. Growth has been mainly driven by the development of significant wind energy capacity, including offshore wind farms.

The United Kingdom's policy regarding RES consists of three key strands: obligatory targets with tradable green certificate system, in particular renewables obligation on all electricity suppliers in Great Britain to supply a specific proportion of RES-E, Climate Change Levy which means that RES-E is exempted from the climate change levy on electricity of £ 4.3/MWh; grant schemes such as funds reserved from the New Opportunities Fund for new capital grants for investments in energy crops/ biomass power generation, for small-scale biomass/combined heat and power heating, and planting grants for energy crops. A £ 50 million fund is available for the development of wave and tidal power, the Marine Renewables Deployment Fund.

The UK has developed a regional strategic approach to planning and targets for renewable energies.

A five-year capital grant scheme for biomass heat and biomass combined heat and power systems was launched in December 2006. Wood fuel and waste strategies were published in March and May 2007 respectively.

In April 2008 the Renewable Transport Fuel Obligation took effect to ensure the UK meets its 2010 target of 5% of transport fuel from biofuels, however, this falls short of the EU target of 5,75% under Directive 2003/30/EC. Certificates can be claimed when biofuels are supplied and fuel duty is paid on them, enabling certificate trading to take place.

The production of heat and cold from RES is supported by grant schemes and investment subsidies, biofuels are currently supported by a tax exemption.

The different targets set out by the EU and the steps taken by the member states towards a greener Europe are not isolated moves. Against the background of global climate change certain states in the US and Israel set the political goal of becoming 'carbon-neutral' by 2015. To achieve this goal they have developed a local climate-protection-concept with different topics. Especially in the sector of planning and building, they intend to reach a high energy efficiency standard for existing buildings and also for planning new building areas and use renewable energies for the energy supply of planned housing and commercial areas.

UNITED STATES OF AMERICA

The United States has a variety of existing and proposed legislation to encourage both more energy efficient buildings and the use of renewable energies. The primary institutions involved in this effort are states and municipalities. Consequently, there are many innovative approaches to the construction and retrofitting of building to green them and to promote the use of alternative energy, but, as is typical in the United States, these initiatives are decentralised.

There is some coordination through the Mayors' Climate Protection Agreement. In this respect, the mayors of US most large cities have committed themselves to meet or beat the Kyoto Protocol targets.

The existing federal legislation does not impose energy efficiency or alternative energy use duties on either municipalities or individuals. In general, the focus is on information provision, but increasingly mandatory duties are being imposed by the federal states that in turn are imposing more duties on municipalities. The American Clean Energy and Security Act of 2009, includes provisions for a smart grid system. The system may include time of use pricing for individual homes.

A variety of federal acts provide incentives and subsidies for retrofitting and new energy efficient construction. The Energy Conservation and Production Act of 1992, created a pilot programme to ensure a small number of loans for the purchase of existing energy efficient residential buildings and the installation of cost-effective improvements in existing residential buildings. In 2009, the Act was amended to grant the owners of residential buildings who install qualified energy efficiency improvements a tax credit of 30% of the cost of the improvements. States have their own tax credit programs for green buildings.

The federal Department of Housing and Urban Development provides a great deal of best practices information to municipalities. This information includes model building code upgrades to mandate more energy efficient construction.

The Department of Energy (DOE) has developed voluntary labelling standards for consumer appliances such as clothes washers and dishwashers. The DOE also has the power to compel states to adopt commercial energy conservation codes as stringent as a widely accepted nongovernmental standard. These codes are important but do not apply to all residential development.

With regard to Federal Legislation for the Use of Renewable Energy the first federal legislation to encourage the production of alternative energy was passed in 1978. The Public Utilities Regulatory Policies Act encouraged the construction of small hydroelectric and co-generation projects. Public utilities were required to purchase electricity from these sources at avoided cost rates. As concern over Global Climate Change mounted, states took the basic idea further and adopted green portfolio standards for public utilities. Portfolio standards specify the percentage of a utility's load that must be generated by renewable sources. Some states also allow homeowners who generate their own electricity to sell the surplus to the local utility. The United States Congress is currently considering Global Climate Change mitigation legislation that includes weak portfolio standards. The American Clean Energy and Security Act of 2009 requires that 6% of US energy be renewable by 2012 and 20% by 2021.

At the present time, with the exception of the DOE mandated commercial energy codes, there are no federal or state mandated green building standards. Therefore, communities are free to adopt their own energy efficiency standards[3]. Most municipalities use the standards developed by the non-profit United States Green Building Counsel. The Council has developed the Leadership in Energy and Environmental Design (LEED) rating system. The system awards points for all aspects of design from selecting environmentally degraded land to the use of rainwater irrigation. Like airline points programmes, there are four levels of certification: certification, silver, gold and platinum. The certification level is based on the energy saved over a conventional building.

In general, LEED certification is not mandatory. The major of Chicago has committed the city to the goal of becoming the greenest city in the US. To obtain a building permit for a LEED certified building, a process fraught with difficulties including a high level of corruption, developers can choose from a list of menu items' that work for the project. Few cities have mandated LEED certification for large buildings. For individual homes, a few cities have adopted the federal Environmental Protection Agency's Energy Star program standards.

Most states do not pre-empt municipalities from adopting higher energy standards. Municipalities are only prohibited from adopting lower standards.

The promotion of renewable energy is a primarily federal state function. There has been considerable federal state legislation to promote sustainable communities. But, this legislation is primarily concerned with encouraging the development of higher density residential and commercial development clustered around public transportation nodes. The proposed federal legislation dealing with alternative fuels focuses primarily on the production of electricity. The most relevant planning provisions in the legislation are the sections amending the Energy Conservation and Production Act to revise conservation standards for new buildings. The proposed legislation establishes i) standards for a national building retrofit policy for residences; ii) a building energy performance labelling programme; and iii) a rebate programme to assist low income people living in pre-1976 homes to purchase new Energy Star homes.

The renewable energy source with the closest link to land use planning is solar energy. The United States does not recognize a general right of a property owner who installs solar panels to be free from interference by neighbouring structures[4], although interference with solar access may be a nuisance[5]. The sunny state of New Mexico has created a statutory right to solar access based upon the first beneficial use of sunlight for solar power. However, this legislation, which has not been replicated in other states, can be challenged as an unconstitutional taking of property without compensation.

States and municipalities promote solar energy in several ways. Many sunny states such as California and Colorado prohibit home owner associations from imposing private servitudes which prohibit the installation of solar collectors. Many cities have zoning codes specifying the angle of protected solar access to which a building is entitled. Municipal zoning codes in a few cities specify the southern exposure angle for new residential construction.

The next likely alternative energy source in the US is wind power. The United States is seeking to promote wind energy, but municipalities often see themselves as victims of unwanted wind farms rather than active participants in the production and use of this energy. The primary federal incentive for investment in wind energy is the Production Tax Credit of 2,1 cents per KWh for electricity generated from wind. The federal states encourage the construction of windmill farms through a variety of means such as renewable portfolio standards for public utilities.

Were a zoning ordinance to mandate in the installation of individual turbines on new or existing construction or allow them as a matter of right, property owners who install them face the risk that a neighbour could sue for nuisance relief based on the noise and the annoying strobe effect of the turning turbine blades[6]. Cities are beginning to address the nuisance issue through zoning ordinances that promote the use of individual turbines. California had a law between 2001 and 2005 that required communities to adopt small wind turbine ordinances or face review of proposed turbines under a default law that provided for expedited review. Some 21 communities in the United States now have ordinances to regulate small turbines.

ISRAEL

Israel is a small country encompassing characteristics of a developed economy on the one hand, as for its GDP pro-capite it is approximately the 30th country in the world, and of a developing country on the other as it has the highest natural growth rate among the developed economies. Israel's emerging policies regarding energy may therefore be pivotal lessons for a range of other countries that do not yet belong to the richest group of nations.

The country's policies about renewable energy are relatively new. There is no national legislation that imposes renewable energy production, but there is government policy that, if properly implemented, will mandate all government ministries to work together to achieve the goal. In 2003 the government adopted an overall national policy about sustainability, with a distinct energy policy. The production share for renewable sources is currently less than 1% but the target is for 10% by 2020 and 20% by 2030. Given the country's year-round sun on the one hand and relatively scarce open areas suitable for wind farms, the major part of renewable energy will come from solar energy (about 70%), 25% from wind power and 5% from biomass.

There are several factors, most of which unique to Israel, that explain the relative low and delayed target: first, as in most developing countries, until a society becomes more affluence, public policy is oriented to what were conceived to be more basic needs. There are many NGO's active in this area – though less than in many other advanced economies, due to the special Middle East security issues that capture much public attention. While public opinion and therefore public policy has in recent years been showing a growing awareness of environmental issues, water scarcity, the need to conserve water, protect the aquifer and encourage the construction of desalination plants has drawn more attention than the energy issue. Second, Israel's geographic and security context has created a sort of energy island. Unlike Europe and North America, Israeli's electric network is not linked with the grid of neighbouring countries, so that Israel must be totally self sufficient and must be able to accommodate even the infrequent peak periods. Third, unlike other advanced economy countries, Israel has a strong positive natural growth rate alongside a gradual rise in the standard of living. These trends mean that the demand for electricity, and thus for new electric-production facilities, is constantly growing. Every few years there is an energy crisis threat. These combined factors have meant that the Electricity Corporation has been able to wield its influence to go for the traditional power plants. Third, there are no nuclear power plants and none are on the agenda. Fourth, while sunlight is ample, Israel is one of the most densely populated countries in the world. Both solar energy and wind power require large tracts of open space. These are not easy to find and often compete with other environmental considerations, especially opens space and biodiversity preservation.

There is no mandatory national legislation on energy efficiency, but there are indirect policies, mostly based in planning and building law.

In 2008, the government adopted a national incentives policy for private solar energy production to be sold back to the national grid. The incentives are based on a high price offered currently, which is to decline with time. Roof space may be used on either public facilities such as schools and municipal buildings or private buildings being them commercial, industrial or residential and of whatever dimension. During less than one year, a growing number of both public and private entities have been joining the scheme. If the trend grows, it is expected to make the renewable energy goals attainable. Local planning authorities faced with this new trend are now discovering the urgent need to draw up urban design guidelines for the new roof usage.

In 2005 the Israel Standards Institute adopted a Green Buildings Code[7]. It is based largely on the American LEED code, but draws also on EU, German and UK codes. It is a comprehensive code that includes a major passive energy and energy conservation component. In addition to the usual energy conservation elements, the code also sets conditions for concealing open-air laundry drying zones, including apartment buildings. The adoption of the code is elective and it may be applied either to new or refurbished residential or office buildings. Developers or public entities can obtain a Green Building Label at two levels of achievement. The first building to receive this code in 2007 was Bank Leumi in Tel Aviv.

In 2009, the government began incorporating the code in tenders for national infrastructure projects, such as desalination plants. Compliance with the code grants the bidder additional points in the tender. National government is unlikely to support legislation of the Code as a compulsory element for all private construction because the cost of housing is a major political issue.

Municipalities in Israel have relatively weak legal powers and independent financial resources than their counterparts in West European countries. None have yet taken any initiative to create their own energy code or incentives beyond the regulatory instrument available through planning law, discussed next.

National statutory planning is a major legal tool for planning and implementing renewable energy production and conservation on the national level. Although there is no special clause in the planning law that requires energy efficiency, this policy has been indirectly incorporated by means of legally binding national spatial plans. Full compliance with these plans is mandatory on all local plans and building permits, but older plans usually remain in force. The 1965 Israel Planning and Building Law as amended, are used for energy conversation in several ways: solar heating in residential buildings, production of renewable energy, and regulation of new construction, potentially retrofitting as well.

Since the Sixties, Israel was a pioneer in the use of solar energy for household water heating. By means of the Planning and Building Law and the National Standards Institute, solar heating is mandatory in all residential construction, including apartment buildings. The code was changed to require one central energy absorbing facility for each building, and the water containers were moved down to the balconies of the individual apartments.

However, Israel did not continue to pursue additional solar energy policy until very recently.

In recent years national planning policy promotes the establishment of wind and especially solar energy plants. Nationally-owned land is allocated for this purpose. This provides an indirect subsidy, but is also a factual necessity. The land ownership pattern in Israel is such, that there aren't enough inbuilt private land tracts large enough to enable the construction of a solar energy plant on private land. Wind farm developers of small size could perhaps find some private land.

The decisions over the locations for solar energy plans as well as wind-farm areas of significant size are a matter for national-level statutory plans and decisions. Both types of renewable energy sites inevitably create a conflict with other environmental considerations. Two major wind farms were incorporated in national statutory plans a few years ago, after a long battle with opposing environmental movements. They objected on two grounds: the interference with the bird-migration routes as Israel hosts the major migration routes from Europe to the Southern Hemisphere, and the infringement of aesthetic qualities of the scarce open spaces in the hilly regions where the wind turbines were to be sited. Sites for solar plants were difficult to find even in Israel's southern desert area due to conflicts with other land uses and environmental considerations. An operative peace in the Middle East could in the future lead to contracts with Egypt for locating solar plants in the sparsely populated Sinai desert. After much debate, currently there are tenders for the construction and operation of two large solar energy sites in the southern part of the country that is mostly desert areas with many tracts declared as environmentally sensitive areas.

A major national plan approved in 2005 contains a written policy on sustainable development. Such policy is also derived from the general government decision of 2003 mentioned above. Direct implementation through planning regulation is currently only at its start. The district planning commissions, which oversee local planning decisions and are to implement national policy, have recently issued guidelines to local planning bodies. These guidelines contain a major energy component.

The guidelines are advisory, but since district commissions have the authority to decline approval of most local planning initiatives, one can expect that this policy will be gradually implemented through a case by case review. The pace of implementation through this route is, however, expected to be slow because planning bodies area already criticized for over regulation and for causing major delays, and thus raising housing costs, a very sensitive topic.

Much more effective is the national statutory planning policy on compact city development. This has a major indirect influence on promoting energy efficiency through innovative and strict rules. In the Israeli context, the major motivation is not energy conservation but rather efficient use of scarce land resources in order to conserve some open spaces. Efficient use of public transportation is a second goal. Both goals of course also mean energy conservation. Since 2005, and in some parts of the country since the late Nineties, there are nationwide planning rules that mandate minimal density level not just the traditional maximum level. In central cities, this can mean at least 140 housing units per net hectare. It is graded lower in towns further away from the central district. No new ex-urban areas are to be established, unless they are contiguous with built up areas and meet these density requirements. These national policies are legally binding on all local planning decisions, unless they implement plans approved before 2005.

Another effective, though small-scale route is the implementation of the Israeli Green Building Code through *ad hoc* municipal initiatives. Several local governments in high-demand areas, where buyers of housing units can absorb some extra costs and where profits of developer are assured, have began to negotiate with developers over green building certification for a few pace-setting new housing and office projects. The legal basis for this is the same as any other development agreement: it relies on the fact that most new development requires an amendment of the existing statutory plan or at least, the granting of a variance. Thus, the developers very much depend upon the local planning authorities. Although the number of municipal initiatives of this type is still small, experience with similar new policies on other environmental topics, such as leaving water retention areas in built up areas, has proven that after a few successful models, the pace will accelerate.

We stand at a critical point in the energy, economic, and environmental evolution of the world. Renewable energies and energy efficiency are now not only affordable, but their expanded use will also open new areas of innovation. Creating opportunities and a fair marketplace for a clean-energy economy requires leadership and vision. The tools to implement this evolution are now well known. We must recognize and overcome the current roadblocks and create the opportunities needed to put these renewable and energy-efficient measures into effect.

[1] Pursuant to Article of the Treaty establishing the European Community, Community policy on the environment is to contribute to the preservation, protection and improvement of the quality of the environment.

[2] OECD/IEA: *Renewable Energy. Market and Policy Trends in IEA Countries*, p. 94.

[3] To date, preemption issues have arisen with state statutes enacted to regulate the use of solar panels. E.g. Kurcera v. Lizza, Cal.Rptr.d (California Court of Appeals). Solar Shade Control Act did not preempt local government ordinances regulating tree planting that could interfere with active and passive solar energy use.

[4] The leading case of Fountainebleau Hotel Corp. V. Forty-Five Twenty-Inc., So.d (Fla.Dist.Ct. App.) rejected the English doctrine of ancient lights, which recognizes implied easements based on prescription. The case is still good law. Wolford v. Thomas, Cal.Rptr. (Cal.Ct.App.).

[5] Prah v. Maretti, N.W.d (Wis.).

[6] Burch v. Nedpower Mount Storm, LLC, S.E.d (West Virginia).

[7] *Israel Standard (SI): Buildings with reduced environmental impact ("Green buildings").* On energy topics, the code includes requirements relating to the maximum proportion of windows relative to the total wall area, the maximum thermal conductivity (U-value) of different wall sections, rates of night ventilation, and the properties of external wall surfaces. Window sizes have been prescribed according to orientation and climatic regions. Theoretically the standard consists of two compliance options: a prescriptive path in which specific requirements for energy related elements should be followed, and a performance method that measures the energy consumption in the apartment against a reference apartment using a simulation tool. However, the latter has not yet been finalized.

BIBLIOGRAPHY

ALTERMAN R., "National-level planning in democratic countries. An international comparison of city and regional policy making." in *Town Planning Review Special Study* (2001), 4, Liverpool University Press.

——, "Correlation of planning law and renewable energies", in *Proceedings of the Third Conference of Platform of experts in Planning Law*, 21-29 Berlin 2009.

ANTONIO, J.R., "The Power of Wind: Current Legal Issues in Siting Wind Power", in *Planning & Environmental law* (2009), 61, (5): 3-5.

BRAWER, J., VESPA, M., "Thinking Globally, Acting Locally: the Role of Local Government in Minimizing Greenhouse Gas Emissions From New Development", in *Idaho L. Rev.* (2008), 44: 589-593.

CARAVITA, B., *Diritto dell'Ambiente*, Il Mulino, Bologna, 2005

Council Directive 2003/96/E of 23 October, Restructuring the Community framework for the taxation of energy products and electricity in *Official Journal of the European Union* of 31.10.2003: L283/51-L283/69.

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, in *Official Journal of the European Union* of 5.6. 2009: L140/16-L140/62.

Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market, in *Official Journal of the European Communities* of 27.10.2001: L283/33-L283/40.

Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport, in *Official Journal of the European Union* of 17.5.2003: L123/42-L123/46.

European Commission proposal on an integrated energy and climate change package to cut emissions for 21st Century, IP/07/29 of 10 January 2007.

KINGSLEY, B.S., "Making It Easy to be Green: Using Impact Fees to Encourage Green Building", in *The New York University Law Rev.* (2008), 83: 532.

KRZEMINSKA, J., "Are Support Schemes for Renewable Energies Compatible with Competition Objectives? An Assessment of National and Community Rules", in *Yearbook of European Environmental Law* (ed. Oxford UP), November 2007, VII: 125-265.

MACCHIATI, A., ROSSI, G., *La sfida dell'energia pulita. Ambiente, clima e energie rinnovabili: problemi economici e giuridici*, Il Mulino, Bologna, 2010.

PEPE V. (ed.), *Diritto Comparato delle Energie. Esperienze europee.* ESI, Napoli, 2008.

RIVA, G., FOPPA PERDETTI, E., TOSCANO, G., "Renewable energy sources and their applications: problems and aspects to be developed", *International Conference on Integrated Renewable Energy for Regional Development*, Bali 28-31 August 2001: 10-23.

SUSSMAN, E., "Green Development, Climate Change, and Local Land Use Regulation", in *New York University Environmental Law Journal* (2008) 1: 16-32.

TARLOCK, A. D., "Land use regulation: the weak link in environmental protection", in *Washington Law Rev.* (2007), 82: 651-666.

TWIDELL, J., WEIR A.D., *Renewable Energy Resources*, Taylor&Francis, London New York, 2006.

WISER, R., BOLINGER, M., CAPPERS, P., MARGOLIS. R., *Letting the Sun Shine on Solar Costs: An Empirical Investigation of Photovoltaic Cost Trends in California,* January 2006, National Renewable Energy Laboratory Publications, US Department of Energy.

TOWARDS THE SMART GRID

ANDREA SILVESTRI

Andrea Silvestri (1942) is Full Professor of Electrical Power Systems at the Polytechnics of Milan since 1986 and Deputy Director in the Department of Energy.
He carried out research in coordination with ENEL, CESI, AEM, now with A2A, Edison, Sondel, Enel Distribuzione, the Italian Authority for Electricity and Gas.
Mr Silvestri is editor of AEIT *(formerly* L'Elettrotecnica) *of the Italian Federation of Electrical, Electronic, Automation, Information and Communication Technology, and former member of the Editorial Board of* International Journal of Power *&* Energy Systems*".*
He is Chairman of Technical Committees "Symbols and documentation" and "Human exposure to electromagnetic fields. Low frequency" in the Italian Electrotechnical Committee (CEI).
He is the Italian delegate to the international conference Conférence Internationale des Réseaux Electriques de Distribution (CIRED).

→| FUTURES

"Art does not reproduce the visibile; rather it makes visible."

PAUL KLEE

1 ~ FOREWORD

The theme of the "active networks" is one of the most interesting line of development of the electric power systems along the recent and the coming years. This paper will draw more precisely some concepts that are often disseminated by the media, to better address the specific topic of the active networks.

2 ~ SMART GRID AND ACTIVE GENERATION

The topic of the Smart Grids – with some definitional distinctions introduced below – will be outlined in the broader context of the Active Networks, that are networks with massive power inputs of dispersed generation from renewable sources and that will be subjected to a real revolution in the next future.

Active networks are indeed arousing a growing interest among all people involved in electrical power systems, as well as in the Italian and international technical literature. I quote hereby the September 2009 special issue[1] of the *AEIT* magazine of the Italian Federation of Electrical, Electronic, Automation, Information and Communication Technology, a magazine where I am the editor.

At international level, I refer to the ongoing attention from the European Union and to the recent Conférence Internationale des Réseaux de Distribution (CIRED) conference[2], largely dedicated to the Smart Grids.

A clarification of terminology: the networks discussed hereby are the medium voltage (MV) distribution networks, energized by high/medium voltage (HV / MV) primary substations and feeding the secondary cabins in medium/low voltage (MV / LV).

I mentioned the need to deeply rethink the distribution networks, and the reasons why a revolution in electric power systems appears necessary. First, the increasing attention to environmental issues in general and the environmental impact of all energy conversion technologies in particular. In the recent years, spurred by major international directives – citing, among all, the so-called European target 20-20-20 to 2020 – the focus has been drawn on energy conversion technologies scarcely considered so far, such as the dispersed or distributed generation of electricity. From now on, only the term dispersed generation (DG) will be used, since it better expresses the non-predetermined nature – neither spatially nor temporally – of these forms of generation.

In order to significantly increase the amount of renewable energy sources for the conversion to electricity, it is mandatory to catch all opportunities provided by the energy sources which are diffused and dispersed throughout the territory, like the solar photovoltaic, the wind power and small hydroelectric plants.

Moreover, there is the need to exploit other energy sources such as fossil fuels in cogeneration mode (combined production of electricity and heat) and distributed storage systems, which also offer significant opportunities for distributed power generation. As a consequence, it is necessary to develop a new form of interconnection, no longer centralized but widespread distributed.

So far were the energetic considerations. From the viewpoint of the electrical grid, however, the new distributed configuration implies the interconnection of a large number of small generating units, which are by nature neither controlled nor centrally managed. This explains the predicted evolution towards networks with simultaneous double flows (see FIGURE 1): electrical power is injected and/or tapped at various points of a bi-directional network, while data and information for line management run on another type of network.

the possible additional power capacity of the medium voltage distribution network that, in compliance with the current technical constraints, does not require any modification in the existing protection, control and automation equipment of the upstream primary substations.

The analysis was performed on a sample of 400 primary substations, sample already available to the Authority for Electricity and Gas from a previous analysis of the short-circuit currents. That amount represents about the 8% of the Italian MV network, and includes data related to different Italian utilities, areas with different load densities - high, medium and low - and covers quite evenly all Italian regions.

In particular, the maximum installation capacity was determined node by node depending on a number of technical constraints which take into

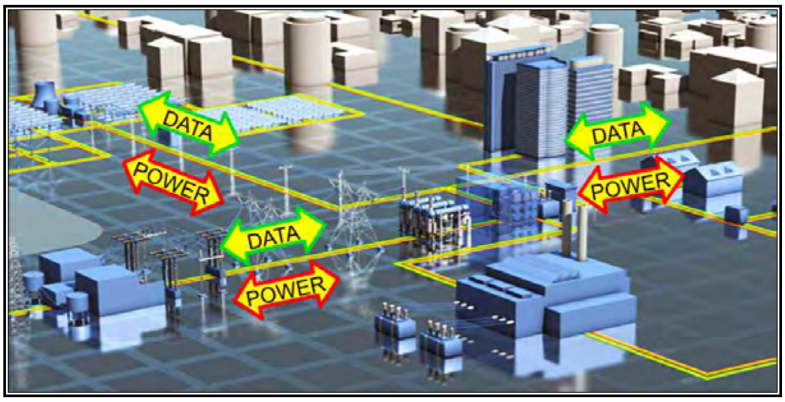


FIGURE 1. Future evolution of the electrical networks.

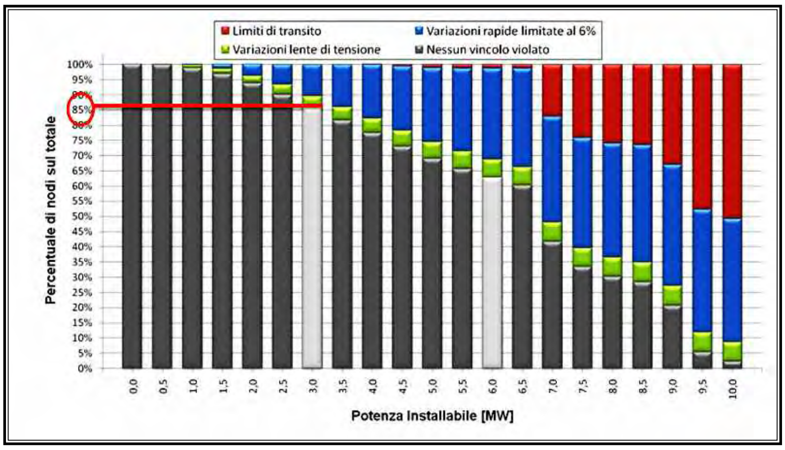


FIGURE 2. Cumulative percentage of nodes with installable Distributed Generation capacity at the value indicated in the abscissa.

3 ~ PENETRATION OF THE ACTIVE GENERATION AND HOSTING CAPACITY

The Politecnico di Milano, and my group in particular, has focused on active networks through a series of analysis carried out on behalf of the Italian Authority for Electricity and Gas (AEEG).

In this study, attached as Annex 2 in the Annex A of the AEEG Resolution 25/09 [3], we investigated

account the network management strategies and the current legal situation

1 ~ short-circuit current;

2 ~ rapid changes in voltage;

3 ~ steady-state capacity of MV lines;

4 ~ slow voltage variations;

5 ~ power reversal.

According to the survey outcomes, the national networks show a satisfactory capacity of accepting the Distributed Generation (FIGURE 2), so as to ensure approximately 3 MW of installed capacity (hosting capacity)[4] for the 85% of the nodes.

4 ~ SMART GRID AND COMMUNICATION

The penetration of the DG in the electrical system, however, shall overcome some obstacles that may prevent the full exploitation of the hosting capacity calculated above. These problems are due not only to the fact that the current distribution facilities are operated as passive networks – with no injection of active power from the users to the network – but also to the levels of the fault currents and, not least, to the amount of power flow for which they were designed.

To address this critical factor and to enable the effective use of the regulating capacity of the DG, it is essential to provide a new model of active network that, beside managing increasing amounts of distributed generation connected to distribution networks – particularly in medium and low voltage – would allow an effective role in the functional optimization of the system, thereby significantly reducing the environmental impact and increasing the degree of reliability and safety.

In this regard, even groups with larger power capacity, up to some tens of MVA, not strictly falling within the definition of the DG, could be employed in order to form intentional self-supplied islands in the absence of a primary network. A further opportunity is related to the electric vehicles: apart from reducing pollution in urban areas, they could improve the use of the distribution networks by covering the load peaks with the batteries themselves: a proper public battery-charging infrastructure may become a new element of the distribution networks (in Italy several projects are being developed by distribution companies, such as Enel, A2A Milan, ACEA in Rome).

The term Smart Grid has therefore become a common expression, attracting a growing interest at several levels. At the international level we notice a steady increase in funding for research projects on Smart Grids, conferences and announcements of innovative equipment; this leads to the apparent paradox that the concept itself of Smart Grid is not univocally shared, since the scientific, the commercial and the political world hold far different positions about its interpretation.

From the scientific viewpoint, the trend is to define a model where advanced ICTs (Information and Communication Technologies, such as sensors, transducers, communication, control, measurement) are integrated into the power grid, opening up new possibilities for the improvement of the system; these possibilities are indicated indeed by the term "smart" to recognize the underlying intelligence of the coordination of different infrastructures, rather than that of the individual component; the reference to a "grid" is meant to include both power signals and communication.

I hereby refer to the definition given by the Sub Committee C6 of Conférence Internationale des Grandes Reseaux Electriques (CIGRE) WG 11 "Active distribution networks (ADNs) are distribution networks that have systems in place to control a combination of distributed Energy resources (DERs) (generators, load and storage). Distribution system operators (DSOs) have the possibility of managing the electricity flows using a flexible network topology. DERs take some degree of responsibility for system support, which will depend on a suitable regulatory environment and connection agreement".

I would like to highlight some critical issue implied by that line of development. First, the communications system must involve both the distributor and the network users. It is evident that such a communication system must be developed on standard protocols, independently from the constructive typology and specific technology employed by each distributor. In other words, there must be a system adapted to include, in progress, new users and new features. Such a system can not be developed according to proprietary protocols, but must be transparent to the users. Indeed, each new user shall be able to actively join the network management and equipped with suitable communication devices to properly interact with the control centers.

Such a system can not be developed without a significant intervention from the regulatory authority. Clear rules will be necessary to manage both the technological specificities and the costs arising from the revolution.

5 ~ ITALY IN THE EUROPEAN CONTEXT

Coming back to the main topic, the active networks, Italy starts from an advantageous position: first, the high and very-high voltage networks are completely controlled and automated, while in other countries the automation and the electronic meters are still in a testing phase. In Italy, as already mentioned, even the medium voltage network is automated, with a number of electronic meters exceeding 33 million units.

These are reasons to believe that the Italian system can be the first to successfully evolve towards the active networks: it is however essential to focus on the most important directions to follow and to take into account the most significant barriers, both from the regulatory and the technological standpoint.

These assumptions are just a prerequisite for a possible active management of the system; throughout the network are also deployed automatic measurement systems, such as electronic meters, which allow the so-called Automatic Meter Reading (AMR), or better to say, Automatic Meter Management (AMM).

We often hear that these two features make the Italian system the first extended Smart Grid deployed on a continental basis. This statement does not seem correct: if we refer to the above definition of Smart Grid, these systems will surely facilitate the access of a new Distributed Generation, but were not specifically designed for that purpose.

Incidentally, with regard to the electronic meters, we noted in the past independent actions taken by the largest utility in Italy, which has actually set its own corporate standard as a national standard, with a number of implications on both technical and regulatory sides that I have no time to address.

An important tool to guide a proper evolution of the system is certainly given by the technical rules of connection. I spend only two words to remember that our research unit is since years active on this issue, having been involved with major roles in the Italian Electrotechnical Committee (CEI) and, at European level, in the Comité Européen de Normalisation en Électronique et en Électrotechnique (CENELEC) to draft the technical standard for the high and medium voltage connection (CEI 0-16[3]), and is now participating to the analogous rule for the connection to low voltage networks (CEI under publication, probably numbered CEI 0-18).

These rules take into account what is the key point to the active networks, the need for an exchange of signals between the control centers of the distribution network (primary substations) and the distributed generators. The CEI 0-16 had introduced the concept of logic signal for the protection against islanding, while the CEI 0-18 has already provided the feature (for the relays associated with generators, the cd interface relays) to receive signals from the distributor. In the future, other signals aimed at the regulation of the local voltage and possible limitation of the active power output will be introduced.

6 ~ SOME ACTION ON THE FIELD OF COMMUNICATION TESTS

SmartDGlab (http://www.fondazionepolitecnico.it/pagine/SmartDGlab.aspx), an interdepartmental laboratory at the Politecnico di Milano , was created under the auspices of the Fondazione Politecnico (FIGURE 3) with the aim of finalizing the applied research in the field of active networks (Smart Grid).

The current technological border is the need of integrating the power grid with appropriate communication channels and with an innovative logic of planning, programming, supervision, monitoring, control and protection of the electrical distribution systems.

At present, SmartGDlab cooperates with the two following active projects.

FIGURE 3. SartDGlab

— AlpEnergy, European territorial cooperation project which brings together energy producers, development agencies, research institutions and local administrations of five different Alpine countries – France, Germany, Italy, Slovenia and Switzerland. Its aim is to develop innovative coordination techniques between generation and load, at level of single distribution network (www.alpenergy.net).

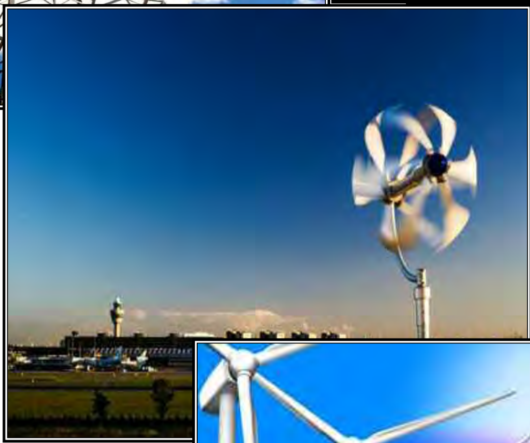
— Milano Wi-Power, an ambitious project undertaken by the Politecnico di Milano dealing with the critical aspects of the communication systems: the specific goal is to test and validate, both through simulations and field trials, possible communication systems able to interrelate the primary substations with the diffused generators. Among the partners: a major Italian utility, the aforementioned A2A, and an important center of applied research ERSE (the former CESI, well known also internationally). Further contacts are underway with ENEL Distribuzione, to activate some of their primary substations and possibly integrate the existing automation systems.

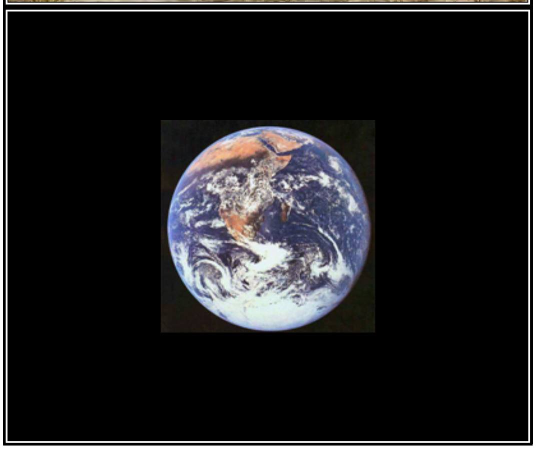
7 ~ CONCLUSIONS

To summarize what has been mentioned above and to arrive at the conclusions, the following are the key points to be highlighted.

First, from my point of view, talking about Smart Grids implies talking of communication systems linking together the primary substations with the network users, the latter being, in the first instance, active users or generators.

A second point is the need to setup communication systems based on largely accepted protocols and not on proprietary protocols, to avoid possible





distortions in the development of the whole process. In this regard, the role played by the regulator AEEG will be essential.

Finally, from the viewpoint of the technology and the research, in which we are particularly interested, it is now time to start-up the relevant pilot projects involving both real distribution networks and laboratory tests.

** I wish to thank my young colleagues Maurizio Delfanti e Marco Merlo for their cooperation, ?as well as our even younger PhD collaborators Davide Falabretti, Gabriele Monfredini, Valeria Olivieri (the latter having particularly helped me in this work) and Mauro Pozzi.*

---

[1] Delfanti, M., Falabretti, D., Merlo, M., Olivieri, V., Silvestri, A., "Impact of distributed generation on distribution networks," in *AEIT* 9 (2009): 20-31.

[2] Delfanti, M., Gallanti, M., Pasquadibisceglie, M.S., Wells, M., Vailati, R., "Limits to dispersed generation on Italian MV networks", in *CIRED 20th International Conference and Exhibition on Electricity Distribution,* Prague 11/08 (2009): 1-5.

[3] Resolution ARG / elt 25/09, "Tracking the development of distributed generation in Italy for 2006 and analysis of the possible effects of distributed generation on the national electricity system."

[4] Bollen, M.H.J., Yang, Y., Hassan, F. "Integration of Distributed Generation in the Power System – A power quality approach", in *ICHQP* 2008.

[5] CEI 0-16, "Rule technical reference for the connection of active users and passive networks and AT MT Companies distributing electricity," February 2008.

ENERGY [R]EVOLUTION 2010

A SUSTAINABLE WORLD ENERGY OUTLOOK

SVEN TESKE[1], THOMAS PREGGER[2], SONJA SIMON[3], WINA GRAUS[4], CHRISTINE LINS[5]

Sven Teske holds a Diploma Engineer (Dipl.-Ing.) from Wilhelmshaven, Germany. He has been Scientific advisor for Greenpeace Germany, Energy Unit (1994-'95); Renewable Energy Campaigner for Greenpeace Germany, responsible for the development of renewable energy campaigns and renewable energy policies development, esp. feed-in laws and liberalization of electricity markets (1995-2004) and from 2005 he is Director of Greenpeace Renewable Energy Campaign at Greenpeace International.

Mr Teske Originally developed the concept for a green utility and founded "Greenpeace energy eG"– Germany's and is Member of the board since 1/2000. Greenpeace Energy eG is the only cooperative in the power sector, today it employs 50 people and supplies green electricity to 90.000 customers in Germany and Luxembourg.

Mr Teske has published over 30 special reports on renewable energies (Global Wind Energy Outlook and Solar Generation). *He is Project leader for the World Energy Scenario "Energy [R]evolution: A sustainable World Energy Outlook". The energy [R]evolution is an independently produced report that provides a practical blueprint for how to half global CO_2 emissions, while allowing for an increase in energy consumption by 2050. Since January 2009 Mr Teske is Lead author for the new* IPCC Special Report Renewables *to be published at the end of 2010.*

→| OUTLOOK

> ***"Freedom is always and exclusively freedom for one who thinks differently."***
>
> ROSA LUXEMBURG

1 ~ BACKGROUND TO ENERGY [R]EVOLUTION SCENARIOS

NEARLY TWO YEARS AFTER PUBLISHING THE FIRST *Energy [R]evolution scenario* in 2007 and 2008 (Greenpeace/EREC, 2007; Krewitt et al. 2007, Krewitt et. al 2009), the new *Energy [R]evolution 2010 scenario* picks up recent trends in global socio-economic developments, and analyses to which extent they affect chances for achieving the still valid overall target: transforming our unsustainable global energy supply system into a system which complies with climate protection targets, and at the same time offers perspectives for a fair and secure access to affordable energy services in all world regions. The *Energy [R]evolution scenario* aims at demonstrating the feasibility of reducing global CO_2 emissions to 10 Gt per year in 2050, while the advanced case reduces to 3.5 Gt/y in 2050. According to IPCC findings is a prerequisite to limit global average temperature increase to well below 2°C (compared to pre-industrial level) and thus preventing dangerous anthropogenic interference with the climate system.

2 ~ THE APPROACH

Both the basic and the advanced *Energy [R]evolution scenarios* are target orientated scenarios which have been developed in a back-casting process. The main target is to reduce global CO_2 emissions to 10 Gt/a in the base case and 3.5 Gt/a in the advanced case by 2050, thus limiting global average temperature increase well below 2°C and preventing catastrophic anthropogenic interference with the climate system (Hansen et. al 2008). As we do not consider nuclear energy as an option that supports the transition towards a sustainable energy supply system, a second constraint is the phasing out of nuclear power plants until 2050.

A 10-region global energy system model implemented in the MESAP/PlaNet environment (MESAP, 2008) is used for simulating global energy supply strategies. The 10 regions correspond to the

---

1 Greenpeace International, Ottho Heldringstraat 5, 1066 AZ Amsterdam, The Netherlands.

2 Ecofys, Kanaalweg 16G, 3526 KL Utrecht, The Netherlands.

3 German Aerospace Center (DLR), Institute of Technical Thermodynamics, Department of Systems Analysis and Technology Assessment, Pfaffenwaldring 38-40, 70565 Stuttgart, Germany.

4 European Renewable Energy Council, 63-65, rue d'Arlon , 1040 Brussels, Belgium.

Corresponding author: Sven Teske, Greenpeace International, Ottho Heldringstraat 5, 1066 AZ Amsterdam, The Netherlands | Große Elbstrasse 39, 22767 Hamburg, Germany, T. +49-40-30618-421, E. sven.teske@greenpeace.org.

world regions as specified by the IEA's World Energy Outlook 2009 (Africa, China, India, Latin America, Middle East, OECD Europe, OECD North America, OECD Pacific, Rest of Developing Asia, Transition Economies) (IEA 2009a). Model calibration for the base year 2007 is based on IEA energy statistics (IEA 2009b, c). Population development projections are taken from the United Nations' World Population Prospects (UNDP 2009).

3 ~ METHODOLOGY AND ASSUMPTIONS

Three scenarios up to the year 2050 are outlined in this report: a *Reference scenario*, an *Energy [R]evolution scenario* with a target to reduce energy related CO2 emissions by 50%, from their 1990 levels, and an *Advanced Energy [R]evolution* version which envisages a fall of more than 80% in CO2 by 2050.

The *Reference Scenario* is based on the reference scenario in the International Energy Agency's 2009 World Energy Outlook (WEO 2009) analysis, extrapolated forward from 2030. Compared to the previous (2007) IEA projections (IEA WEO 2007), WEO 2009 assumes a slightly lower average annual growth rate of world Gross Domestic Product (GDP) of 3.1%, instead of 3.6%, over the period 2007-2030. At the same time, it expects final energy consumption in 2030 to be 6% lower than in the WEO 2007 report. China and India are expected to grow faster than other regions, followed by the Other Developing Asia group of countries, Africa and the Transition Economies (mainly the former Soviet Union). The OECD share of global purchasing power parity (PPP) adjusted GDP will decrease from 55% in 2007 to 29% by 2050.

The *Energy [R]evolution Scenario* has a key target of 50% renewables by 2050. A second objective is the global phasing out of nuclear energy. To achieve these goals the scenario is characterised by significant efforts to fully exploit the large potential for energy efficiency. At the same time, all cost-effective renewable energy sources are used for heat and electricity generation, as well as the production of bio fuels. The general framework parameters for population and GDP growth remain unchanged from the Reference scenario.

The *Advanced Energy [R]evolution Scenario* takes a much more radical approach to the climate crisis facing the world and therefore assumes much shorter technical lifetimes for coal-fired power plants – 20 years instead of 40 years. To fill the resulting gap, the annual growth rates of renewable energy sources, especially solar photovoltaics, wind and concentrating solar power plants, have therefore been increased. Apart from that, the advanced scenario takes on board all the general framework parameters of population and economic growth from the basic version, as well as most of the energy efficiency roadmap. In the transport sector, however, there is 15 to 20% lower final energy demand until 2050 due to a combination of simply less driving and instead increase use of public transport and a faster uptake of efficient combustion vehicles and – after 2025 – a larger share of electric vehicles. Within the heating sector there is a faster expansion of CHP in the industry sector, more electricity for process heat and a faster growth of solar and geothermal heating systems. Combined with a larger share of electric drives in the transport sector, this results in a higher overall demand for power. Even so, the overall global electricity demand in the *Advanced Energy [R]evolution scenario* is still lower than in the *Reference scenario*. In the advanced scenario the latest market development projections of the renewable industry (5) have been calculated for all sectors The speedier uptake of electric and hydrogen vehicles, combined with the faster implementation of smart grids and expanding super grids (about ten years ahead of the basic version) allows a higher share of fluctuating renewable power generation (photovoltaic and wind). The threshold of a 40% proportion of renewables in global primary energy supply is therefore passed just after 2030 (also ten years ahead). By contrast, the quantity of biomass and large hydro power remain the same in both *Energy [R]evolution scenarios*, for sustainability reasons.

OIL AND GAS PRICE PROJECTIONS

The recent dramatic fluctuations in global oil prices have resulted in slightly higher forward price projections for fossil fuels. Under the 2004 'high oil and gas price' scenario from the European Commission, for example, an oil price of just $34 per barrel was assumed in 2030. More recent projections of oil prices by 2030 in the IEA's WEO 2009 range from $2008 80/bbl in the lower prices sensitivity case up to $2008 150/bbl in the higher prices sensitivity case. The reference scenario in WEO 2009 predicts an oil price of $2008 115/bbl. Since the first Energy [R]evolution study was published in 2007, however, the actual price of oil has moved over $100/bbl for the first time, and in July 2008 reached a record high of more than $140/bbl. Although oil prices fell back to $100/bbl in September 2008 and around $80/bbl in April 2010 the projections in the IEA reference scenario might still be considered too conservative. Taking into account the growing global demand for oil we have assumed a price development path for fossil fuels based on the IEA WEO 2009 higher prices sensitivity case extrapolated forward to 2050 (see TABLE 1). As the supply of natural gas is limited by the availability of pipeline infrastructure, there is no world market price for gas. In most regions of the world the gas price is directly tied to the price of oil. Gas prices are therefore assumed to increase to $24-29/GJ by 2050.

	UNIT	2000	2005	2007	2008	2010	2015	2020	2025	2030	2040	2050
CRUDE OIL IMPORTS	barrel											
IEA WEO 2009 "Reference"		34.30	50.00	75.00	97.19		86.67	100	107.5	115		
USA EIA 2008 "Reference"						86.64		69.96		82,53		
USA EIA 2008 "High Price"						92.56		119.75		138.96		
Energy [R]evolution 2010							110.56	130.00	140.00	150.00	150.00	150.00
NATURAL GAS IMPORTS												
IEA WEO 2009 "Reference"												
United States	GJ	5.00	2.32	3.24	8.25		7.29	8.87	10.04	11.36		
Europe	GJ	3.70	4.49	6.29	10.32		10.46	12.10	13.09	14.02		
Japan LNG	GJ	6.10	4.52	6.33	12.64		11.91	13.75	14.83	15.87		
Energy [R]evolution 2010												
United States	GJ			3.24		8.75		10.70	12.40	14.38	18.10	23.73
Europe	GJ			6.29		10.87		16.56	17.99	19.29	22.00	26.03
Japan LNG	GJ			6.33		13.34		18.84	20.37	21.84	24.80	29.30
HARD COAL IMPORTS												
OECD steam coal imports	tonne											
Energy [R]evolution 2010	tonne			69.45		120.59	116.15	135.41	139.50	142.70	160.00	172.30
IEA WEO 2009 "Reference"	tonne	41.22	49.61	69.45		120.59	91.05	104.16	107.12	109.4		
BIOMASS (SOLID)												
Energy [R]evolution 2010												
OECD Europe	GJ			7.4		7.7	8.2	9.2		10.0	10.3	10.5
OECD Pacific and North America	GJ			3.3		3.4	3.5	3.8		4.3	4.7	5.2
Other regions	GJ			2.7		2.8	3.2	3.5		4.0	4.6	4.9

SOURCE 2000-2030, IEA WEO 2009 HIHER PRICES SENSITIVITY CASE FOR CRUDE OIL, GAS AND STEAM COAL; 2040-2050 AND OTHET FUELS, OWN ASSUMPTIONS.

TABLE 1 - **FOSSIL FUEL PRICE ASSUMPTIONS FOR THE THREE SCENARIOS**

COST OF CO2 EMISSIONS

Assuming that a CO2 emissions trading system is established across all world regions in the longer term, the cost of CO2 allowances needs to be included in the calculation of electricity generation costs. Projections of emissions costs are even more uncertain than energy prices, however, and available studies span a broad range of future estimates. As in the previous Energy [R]evolution study we assume CO2 costs of $10/tCO2 in 2015, rising to $50/tCO2 by 2050. Additional CO2 costs are applied in Kyoto Protocol Non-Annex B (developing) countries only after 2020.

PROJECTIONS OF FUTURE INVESTMENT COSTS FOR POWER GENERATION FOSSIL FUEL POWER PLANTS

While the fossil fuel power technologies in use today for coal, gas, lignite and oil are established and at an advanced stage of market development, further cost reduction potentials are assumed. The potential for cost reductions is limited, however, and will be achieved mainly through an increase in efficiency.

TABLE 2 summarises our assumptions on the technical and economic parameters of future fossil-fuelled power plant technologies. In spite of growing raw material prices, we assume that further technical innovation will result in a moderate reduction of future investment costs as well as improved power plant efficiencies. These improvements are, however, outweighed by the expected increase in fossil fuel prices, resulting in a significant rise in electricity generation costs.

RENEWABLES

TABLE 2 summarises the cost trends for renewable energy technologies as derived from the respective learning curves. It should be emphasised that the expected cost reduction is basically not a function of time, but of cumulative capacity, so dynamic market development is required. Most of the technologies will be able to reduce their specific investment costs to between 30% and 70% of current levels by 2020, and to between 20% and 60% once they have achieved full maturity (after 2040). Reduced investment costs for renewable energy technologies lead directly to reduced heat and electricity generation costs, as

TABLE 2 - **DEVELOPMENT OF EFFICIENCY AND INVESTMENT COSTS FOR SELECTED POWER PLANT TECHNOLOGIES**

		2007	2015	2020	2030	2040	2050
Coal-fired condensing power plant	Efficency (%)	45	46	48	50	52	53
	Ivestment costs ($/kW)	1,320	1,230	1,190	1,160	1,130	1,100
	Electricity generation costs including CO2 emission costs ($cents/kWh)	6.6	9.0	10.8	12.5	14.2	15.7
	CO2 emissions* (g/kWh)	744	728	697	670	644	632
Lignite-fired condensing power plant	Efficency (%)	41	43	44	44.5	45	45
	Ivestment costs ($/kW)	1,570	1,440	1,380	1,350	1,320	1,290
	Electricity generation costs including CO2 emission costs ($cents/kWh)	5.9	6.5	7.5	8.4	9.3	10.3
	CO2 emissions (g/kWh)	975	929	908	898	888	888
Natural gas combined cycle	Efficency (%)	57	59	61	62	63	64
	Ivestment costs ($/kW)	690	675	645	610	580	550
	Electricity generation costs including CO2 emission costs ($cents/kWh)	7.5	10.5	12.7	15.3	17.4	18.9
	CO2 emissions (g/kWh)	354	342	330	325	320	315

SOURCE: DLR, 2010 | *CO emission refer to power station outputs only. Life-cycle emission are not considered.

TABLE 3 - **PROJECTED COST DEVELOPMENT FOR RENEWABLE POWER GENERATION TECHNOLOGIES, MARKET VOLUMES AND INVESTMENTS**

PHOTOVOLTAICS (PV)		2007	2015	2020	2030	2040	2050
	ENERGY [R]EVOLUTION						
Global installed capacity	GW	6	98	335	1036	1915	**2968**
Investment costs	$/kWp	3.746	2.610	1.776	1.027	785	**761**
Operation and maintenance costs	$/kW/a	66	38	16	13	11	**10**
	ADVANCED ENERGY [R]EVOLUTION						
Global installed capacity	GW	6	108	439	1330	2959	**4318**
Investment costs	$/kWp	3.746	2.610	1.776	1.027	761	**738**
Operation and maintenance costs	$/kW/a	66	38	16	13	11	**10**

CONCENTRATING SOLAR POWER (CSP)		2007	2015	2020	2030	2040	2050
	ENERGY [R]EVOLUTION						
Global installed capacity	GW	1	25	105	324	647	**1002**
Investment costs	$/kWp	7.250	5.576	5.044	4.263	4.200	**4.160**
Operation and maintenance costs	$/kW/a	300	250	210	180	160	**155**
	ADVANCED ENERGY [R]EVOLUTION						
Global installed capacity	GW	1	28	225	605	1173	**1643**
Investment costs	$/kWp	7.250	5.576	5.044	4.200	4.160	**4121**
Operation and maintenance costs	$/kW/a	300	250	210	180	160	**155**

WIND POWER		2007	2015	2020	2030	2040	2050
	ENERGY [R]EVOLUTION						
Global installed capacity (on + offhsore)	GW	95	407	878	1733	2409	**2943**
Investment costs - onshore	$/kWp	1.510	1.255	998	952	906	**894**
Operation and maintenance costs - onshore	$/kW/a	58	51	45	43	41	**41**
Investment costs - offshore	$/kWp	2900	2200	1540	1460	1330	**1305**
Operation and maintenance costs - offshore	$/kW/a	166	153	114	97	88	**83**
	ADVANCED ENERGY [R]EVOLUTION						
Global installed capacity (on + offhsore)	GW	95	494	1140	2241	3054	**3754**
Investment costs - onshore	$/kWp	1.510	1.255	998	906	894	**882**
Operation and maintenance costs - onshore	$/kW/a	58	51	45	43	41	**41**
Investment costs - offshore	$/kWp	2900	2200	1540	1460	1330	**1305**
Operation and maintenance costs - offshore	$/kW/a	166	153	114	97	88	**83**

BIOMASS		2007	2015	2020	2030	2040	20500
	ENERGY [R]EVOLUTION						
Global installed capacity - electricity only	GW	28	48	62	75	87	**107**
Investment costs	$/kWp	2818	2452	2435	2377	2349	**2326**
Operation and maintenance costs	$/kW/a	183	166	152	148	147	**146**
Global installed capacity - CHP	GW	18	67	150	261	413	**545**
Investment costs	$/kWp	5250	4255	3722	3250	2996	**2846**
Operation and maintenance costs	$/kW/a	404	348	271	236	218	**207**
	ADVANCED ENERGY [R]EVOLUTION						
Global installed capacity - electricity only	GW	28	50	64	78	83	**81**
Investment costs	$/kWp	2818	2452	2435	2377	2349	**2326**
Operation and maintenance costs	$/kW/a	183	166	152	148	147	**146**
Global installed capacity - CHP	GW	18	65	150	265	418	**540**
Investment costs	$/kWp	5250	4255	3722	3250	2996	**2846**
Operation and maintenance costs	$/kW/a	404	348	271	236	218	**207**

GEOTHERMAL		2007	2015	2020	2030	2040	2050
	ENERGY [R]EVOLUTION						
Global installed capacity - electricity only	GW	10	19	36	71	114	**144**
Investment costs	$/kWp	12.446	10.875	9.184	7.250	6.042	**5.196**
Operation and maintenance costs	$/kW/a	645	557	428	375	351	**332**
Global installed capacity - CHP	GW	1	3	13	37	83	**134**
Investment costs	$/kWp	12.688	11.117	9.425	7.492	6.283	**5.438**
Operation and maintenance costs	$/kW/a	647	483	351	294	256	**233**
	ADVANCED ENERGY [R]EVOLUTION						
Global installed capacity - electricity only	GW	10	21	57	191	337	**459**
Investment costs	$/kWp	12.446	10875	9184	5.196	4.469	**3.843**
Operation and maintenance costs	$/kW/a	645	557	428	375	351	**332**
Global installed capacity - CHP	GW	0	3	13	47	132	**234**
Investment costs	$/kWp	12.688	11.117	9.425	7.492	6.283	**5.438**
Operation and maintenance costs	$/kW/a	647	483	351	294	256	**233**

OCEAN ENERGY		2007	2015	2020	2030	2040	2050
	ENERGY [R]EVOLUTION						
Global installed capacity	GW	0	9	29	73	168	**303**
Investment costs	$/kWp	7.216	3.892	2.806	2.158	1.802	**1.605**
Operation and maintenance costs	$/kW/a	360	207	117	89	75	**66**
	ADVANCED ENERGY [R]EVOLUTION						
Global installed capacity	GW	0	9	58	180	425	**748**
Investment costs	$/kWp	7.216	3.892	2.806	1.802	1.605	**1.429**
Operation and maintenance costs	$/kW/a	360	207	117	89	75	**66**

HYDRO		2007	2015	2020	2030	2040	2050
	ENERGY [R]EVOLUTION						
Global installed capacity	GW	922	1043	1206	1307	1387	**1438**
Investment costs	$/kWp	2.705	2.864	2.952	3.085	3.196	**3.294**
Operation and maintenance costs	$/kW/a	110	115	123	128	133	**137**
	ADVANCED ENERGY [R]EVOLUTION						
Global installed capacity	GW	922	1111	1212	1316	1406	**1451**
Investment costs	$/kWp	2.705	2.864	2.952	3.085	3.196	**3.294**
Operation and maintenance costs	$/kW/a	110	115	123	128	133	**137**

shown in FIGURE AF1. Generation costs today are around 8 to 26 $cents/kWh for the most important technologies, with the exception of photovoltaics. In the long term, costs are expected to converge at around 5-12 $cents/kWh. These estimates depend on site-specific conditions such as the local wind regime or solar irradiation, the availability of biomass at reasonable prices or the credit granted for heat supply in the case of combined heat and power generation.

4 ~ COST CURVES: DEFINING THE ORDER OF INVESTMENTS (ÜRGE VORSATZ, 2010)

While energy scenarios play an increasing role within the global, regional and national energy and climate debate, the different ways of setting up scenarios are under discussion. In principle there are 2 different types of scenarios: "Top-down" and "Bottom up" calculated energy scenarios.

Top-down scenarios are mostly cost driven, the cost projections for each technology, fuel costs and CO2 costs have a huge influence for the projected energy mix in the future as the model usually optimizes the mix in the basis of cheapest energy generation. A low cost projection for e.g. nuclear energy or the coal price will result in a large share of nuclear and coal power plants in the electricity generation of the future. However those models are often not very technology specific and in same cases there is not even a distinction between two very different solar electricity technologies to concentrated solar power (CSP) and photovoltaic (pv) as both technologies have very different capacities factors, costs and technical parameters. While "bottom up" scenario are technology driven and have therefore a very detailed breakdown of different technologies and can model energy system more exact. On the downside those models are not cost specific and they do not optimize the economic side of a future energy system. In the past years, both models are moving towards each other. While "top-down" scenarios have a greater level of technical details, bottom up scenarios include more and more economic parameters. The IEA World Energy Outlook – which is the reference scenario for both energy [r]evolution scenarios are in principle bottom up models, but with a greater level of cost assumptions. The section provides an overview about the resulting cost curves of all three scenarios. As "cost curves" do play an increasing role in the energy and climate debate.

GLOBAL RENEWABLE ELECTRICITY SUPPLY CURVES

FIGURE 1 shows the global renewable electricity supply curve for 4 scenarios: IEA WEO[1] (2009), ETP (2010), Greenpeace Energy Revolution (ER) and Greenpeace Advanced Energy Revolution (AER). For the ER and AER scenarios potentials are projected both for 2030 and 2050, while unfortunately no such forecasts were available for the IEA scenarios for 2050. The figures attest the importance of long-term frameworks for renewable energy. Potentials at the same costs more than double between 2030 and 2050 (please note that presently existing capacity is included in these potentials, with hydropower separated into "new hydro" and existing "hydro"). The IEA scenarios find significantly lower potentials at equal cost levels than the ER ones. Both IEA and the ER scenarios find wind as having a large potential at very competitive costs. In the ER scenarios this is followed by biomass and then PV in 2030, while PV becomes cheaper by 2050 than biomass. IEA scenarios project very low costs for CSP, lower than for wind, however, this technology is not expected to add a significant power production capacity to global electricity generation. Similarly, they also project app. half the cost for geothermal power for 2030 as the ER scenarios, however, they see very little potential for this technology; while ER scenarios project fairly large potentials at the highest (ER) or second highest (AER) cost levels from among the technologies. Ocean energy is expected to play a small role, except in the AER scenario, even if its costs are projected to be under that of several renewable electricity generation technologies.

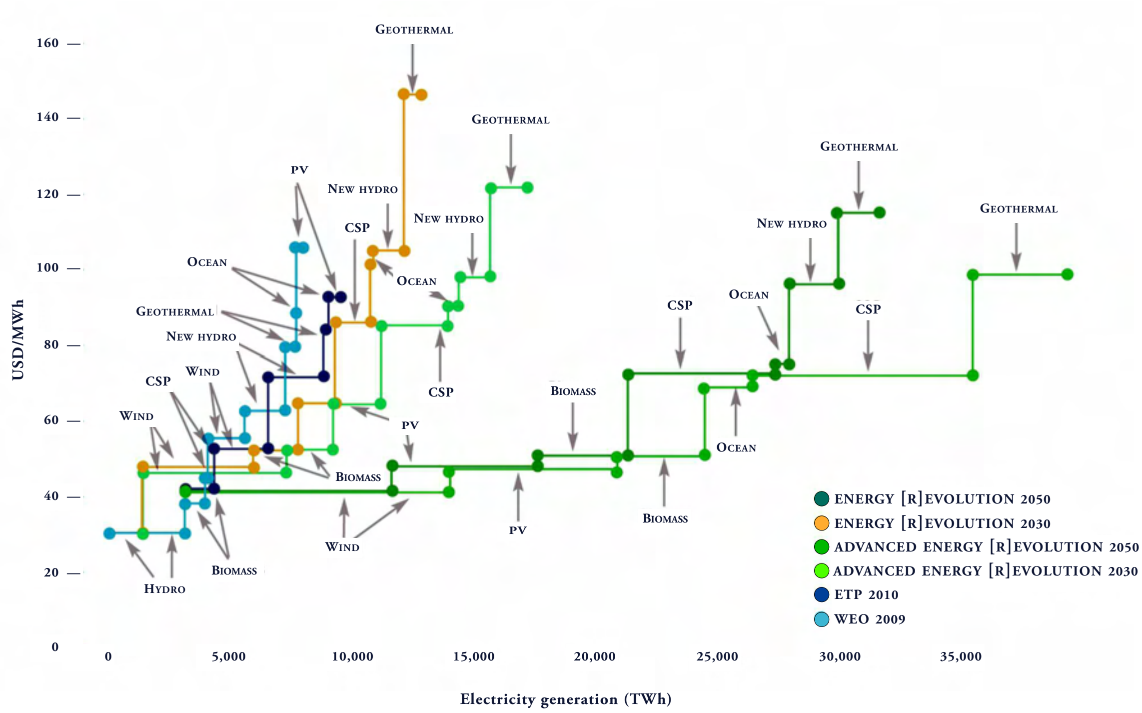


FIGURE 1 ~ **RENEWABLE ENERGY SUPPLY CURVES FOR THE ENERGY [R]EVOLUTION SCENARIO**

5 ~ SHIFTING TOWARDS RENEWABLES: A SUSTAINABLE GLOBAL ENERGY SUPPLY PERSPECTIVE

Worldwide renewable energy resources several times exceed current energy demand, the availability of renewable energy sources however differ between world regions. We use information on renewable energy potentials by world region and technology from (REN21 2008; Hoogwijk and Graus, 2008) as a basis for developing a renewable energy oriented supply scenario. As a response to the controversial discussion on the availability of biomass resources, a study on the global potential for sustainable biomass was commissioned as part of the Energy [R]evolution 2008 project (Seidenberger et al., 2008). The potential for energy crops strongly depends on food supply patterns and assumptions on agricultural production. Results for global biomass potentials from energy crops in 2050 range from 97 EJ in a business-as-usual scenario to only 6 EJ in a scenario which assumes no forest clearing, reduced use of fallow areas for agriculture, and expanded ecological protection areas. The global potential for biomass residues is estimated to be 88 EJ in 2050. With a biomass consumption of 88.7 EJ in 2050 the Energy [R]evolution scenario complies with the most stringent requirements towards sustainable biomass use.

ASSUMED GROWTH RATES IN DIFFERENT SCENARIOS

The Energy [R]evolution scenario is a "bottom-up" (technology driven) scenario and the assumed growth rates for renewable energy technology deployment are important drivers (Neij, L., 2008). Around the world, however, energy modelling scenario tools are under constant development and in the future both approaches are likely to merge into one, with detailed tools employing both a high level of technical detail and economic optimisation. The Energy [R]evolution scenario uses a "classical" bottom-up model which has been constantly developed, and now includes calculations covering both the investment pathway and the employment effect.

6 ~ KEY RESULTS

Today, renewable energy sources account for 13% of the world's primary energy demand. Biomass, which is mostly used in the heat sector, is the main source. The share of renewable energies for electricity generation is 18%, while their contribution to heat supply is around 24%, to a large extent accounted for by traditional uses such as collected firewood. About 80% of the primary energy supply today still comes from fossil fuels. Both Energy [R]evolution scenarios describe development pathways which turn the present situation into a sustainable energy supply, with the advanced version achieving the urgently needed CO_2 reduction target more than a decade earlier than the basic scenario. The following summary shows the results of the advanced Energy [R]evolution scenario, which will be achieved through the following measures:

— Exploitation of existing large energy efficiency potentials will ensure that final energy demand increases only slightly - from the current 305,095 PJ/a (2007) to 340,933 PJ/a in 2050, compared to 531,485 PJ/a in the Reference scenario. This dramatic reduction is a crucial prerequisite for achieving a

	Energy Parameter									
	Generation [TWh/a]							Annual Market Volume [GW/a]		
	> 600 ppm IEA WEO 2008	Reference	E[R]	advanced E[R]	Reference	E[R]	advanced E[R]	Reference	E[R]	advanced E[R]
2020	27708	27248	25851	25919						
2030	33265	34307	30133	30901						
2050	50606	46542	37993	43922						
PV 2020	68	108	437	594	17%	37%	42%	5	26	36
PV 2030	120	281	1481	1953	11%	15%	14%	18	91	124
PV 2050	213	640	4597	6846	10%	13%	15%	40	141	211
CSP2020	26	38	321	689	17%	49%	62%	1	5	12
CSP2030	54	121	1447	2734	14%	18%	17%	2	24	45
CSP2050	95	254	5917	9012	9%	17%	14%	4	44	66
Wind										
on+offshore2020	887	1009	2168	2849	12%	22%	26%	26	74	101
on+offshore2030	1260	1536	4539	5872	5%	9%	8%	60	178	229
on+offshore2050	1736	2516	8474	10841	6%	7%	7%	47	158	202
Geothermal										
for power generation										
2020	119	117	235	367	6%	14%	20%	1	2	4
2030	158	168	502	1275	4%	9%	15%	2	7	18
2050	229	265	1009	2968	5%	8%	10%	2	7	21
heat & power										
2010	2									
2020	6	6	65	66	13%	47%	47%	0	1	1
2030	9	9	192	251	5%	13%	16%	0	3	5
2050	17	19	719	1263	9%	16%	20%	0	6	11
bioenergy										
for power generation										
2020	324	337	373	392	8%	9%	10%	3	4	4
2030	474	552	456	481	6%	2%	2%	10	8	8
2050	650	994	717	580	7%	5%	2%	6	5	4
heat & power										
2020	272	186	739	742	2%	19%	19%	1	13	13
2030	367	287	1402	1424	5%	7%	8%	6	26	27
2050	613	483	3013	2991	6%	9%	9%	4	26	25
ocean										
2020	6	3	53	119	15%	55%	70%	0	2	4
2030	12	11	128	420	13%	10%	15%	0	3	12
2050	28	25	678	1943	10%	20%	19%	0	10	27
hydro										
2020	4164	4027	4029	4059	2%	2%	2%	20	20	21
2030	4833	4679	4370	4416	2%	1%	1%	135	126	127
2050	6027	5963	5056	5108	3%	2%	2%	78	66	67

TABLE 4 ~ NEEDED RENEWABLE INDUSTRY DEVELOPMENT UNDER THREE DIFFERENT SCENARIOS

significant share of renewable energy sources in the overall energy supply system, compensating for the phasing out of nuclear energy and reducing the consumption of fossil fuels.

— More electric drives are used in the transport sector and hydrogen produced by electrolysis from excess renewable electricity plays a much bigger role in the advanced than in the basic scenario. After 2020, the final energy share of electric vehicles on the road increases to 4% and by 2050 to over 50%. More public transport systems also use electricity, as well as there being a greater shift in transporting freight from road to rail.

— The increased use of combined heat and power generation (CHP) also improves the supply system's energy conversion efficiency, increasingly using natural gas and biomass. In the long term, the decreasing demand for heat and the large potential for producing heat directly from renewable energy sources limits the further expansion of CHP.

— The electricity sector will be the pioneer of renewable energy utilisation. By 2050, around 95% of electricity will be produced from renewable sources. A capacity of 14,045 GW will produce 43,922 TWh/a renewable electricity in 2050. A significant share of the fluctuating power generation from wind and solar photovoltaic will be used to supply electricity to vehicle batteries and produce hydrogen as a secondary fuel in transport and industry. By using load management strategies, excess electricity generation will be reduced and more balancing power made available.

— In the heat supply sector, the contribution of renewables will increase to 91% by 2050. Fossil fuels will be increasingly replaced by more efficient modern technologies, in particular biomass, solar collectors and geothermal. Geothermal heat pumps and, in the world's sunbelt regions, concentrating solar power, will play a growing part in industrial heat production.

— In the transport sector the existing large efficiency potentials will be exploited by a modal shift from road to rail and by using much lighter and smaller vehicles. As biomass is mainly committed to stationary applications, the production of bio fuels is limited by the availability of sustainable raw materials. Electric vehicles, powered by renewable energy sources, will play an increasingly important role from 2020 onwards.

— By 2050, 80% of primary energy demand will be covered by renewable energy sources.

To achieve an economically attractive growth of renewable energy sources, a balanced and timely mobilisation of all technologies is of great importance. Such mobilisation depends on technical potentials, actual costs, cost reduction potentials and technical maturity. Climate infrastructure, such as district heating systems, smart grids and supergrids for renewable power generation, as well as more R&D into storage technologies for electricity, are all vital if this scenario is to be turned into reality. The successful implementation of smart grids is vital for the advanced Energy [R]evolution from 2020 onwards.

It is also important to highlight that in the advanced Energy [R]evolution scenario the majority of remaining coal power plants – which will be replaced 20 years before the end of their technical lifetime – are in China and India. This means that in practice all coal power plants built between 2005 and 2020 will be replaced by renewable energy sources from 2040 onwards. To support the building of capacity in developing countries significant new public financing, especially from industrialised countries, will be needed. It is vital that specific funding mechanisms such as the "Greenhouse Development Rights" (GDR) and "Feed-in tariff" schemes are developed under the international climate negotiations that can assist the transfer of financial support to climate change mitigation, including technology transfer.

FUTURE COSTS

Renewable energy will initially cost more to implement than existing fuels. The slightly higher electricity generation costs under the advanced Energy [R]evolution scenario will be compensated for, however, by reduced demand for fuels in other sectors such as heating and transport. Assuming average costs of 3 cents/kWh for implementing energy efficiency measures, the additional cost for electricity supply under the advanced Energy [R]evolution scenario will amount to a maximum of $31 billion/a in 2020. These additional costs, which represent society's investment in an environmentally benign, safe and economic energy supply, continue to decrease after 2020. By 2050 the annual costs of electricity supply will be $2,700 billion/a below those in the Reference scenario.

It is assumed that average crude oil prices will increase from $97 per barrel in 2008 to $130 per barrel in 2020, and continue to rise to $150 per barrel in 2050. Natural gas import prices are expected to increase by a factor of four between 2008 and 2050, while coal prices will continue to rise, reaching $172 per tonne in 2050. A CO_2 'price adder' is applied, which rises from $20 per ton of CO_2 in 2020 to $50 per ton in 2050.

FUTURE INVESTMENT

It would require until 2030 $17.9 trillion in global investment for the advanced Energy [R]evolution scenario to become reality - approximately 60% higher than in the Reference scenario ($11.2 trillion). Under the Reference version, the levels of investment in renewable energy and fossil fuels are almost equal – about $5 trillion each – up to 2030. Under the advanced scenario, however, the world shifts about 80% of investment towards renewables; by 2030 the fossil fuel share of power sector investment would be focused mainly on combined heat and power and efficient gas-fired power plants. The average annual investment in the power sector under the advanced Energy [R]evolution scenario between 2007 and 2030 would be approximately $782 billion.

Because renewable energy has no fuel costs, however, the fuel cost savings in the advanced Energy [R]evolution scenario reach a total of $6.5 trillion, or $282 billion per year until 2030 and a total of $41.5 trillion, or an average of $964 billion per year until 2050.

FUTURE GLOBAL EMPLOYMENT

Worldwide, we would see more direct jobs created in the energy sector if we shifted to either of the Energy [R]evolution scenarios.

— By 2015 global power supply sector jobs in the Energy [R]evolution scenario are estimated to reach about 11.1 million, 3.1 million more than in the Reference scenario. The advanced version will lead to 12.5 million jobs by 2015.

— By 2020 over 6.5 million jobs in the renewables sector would be created due a much faster uptake of renewables, three-times more than today. The advanced version will lead to about one million jobs more than the basic Energy [R]evolution, due a much faster uptake of renewables.

— By 2030 the Energy [R]evolution scenario achieves about 10.6 million jobs, about two million more than the Reference scenario. Approximately 2 million new jobs are created between 2020 and 2030, twice as much as in the Reference case. The advanced scenario will lead to 12 million jobs, that is 8.5 million in the renewables sector alone. Without this fast growth in the renewable sector global power jobs will be a mere 2.4 million. Thus by implementing the E[R] there will be 3.2 million or over 33% more jobs by 2030 in the global power supply sector.

DEVELOPMENT OF CO2 EMISSIONS

While CO_2 emissions worldwide will increase by more than 60% under the Reference scenario up to 2050, and are thus far removed from a sustainable development path, under the advanced Energy [R]evolution scenario they will decrease from 28,400 million tonnes in 2007 (including international bunkers) to 3,700 in 2050, 82% below 1990 levels. Annual per capita emissions will drop from 4.1 tonnes/capita to 0.4 t/capita. In spite of the phasing

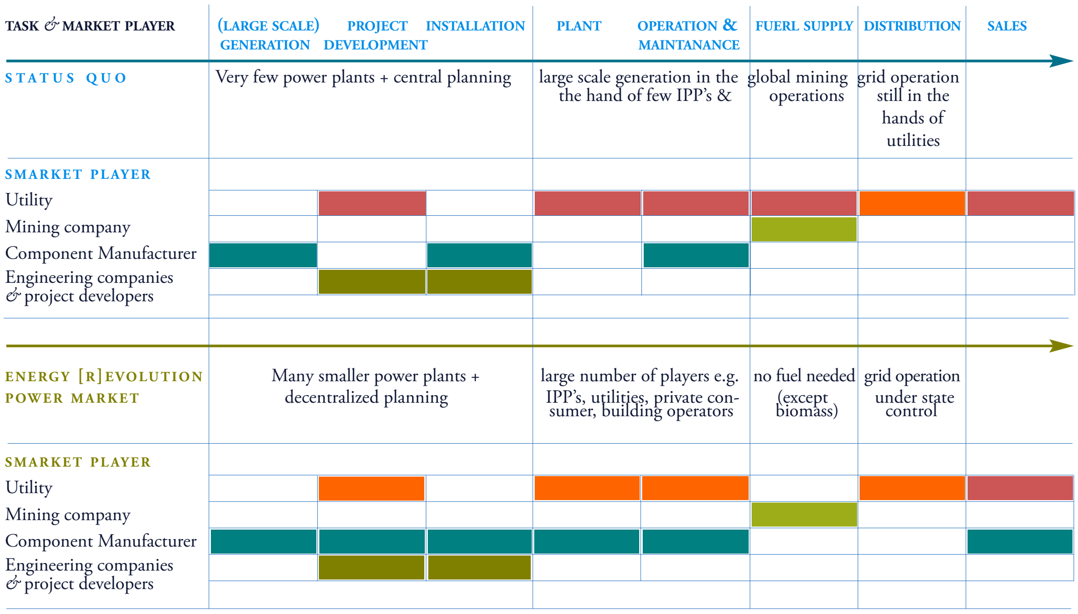


FIGURE 2 ~ VALUE CHAIN POWER MARKET TODAY AND UNDER THE ENERGY [R]EVOLUTION MODEL

out of nuclear energy and a growing electricity demand, CO_2 emissions will decrease enormously in the electricity sector. In the long run efficiency gains and the increased use of renewable electric vehicles, as well as a sharp expansion in public transport, will even reduce CO_2 emissions in the transport sector. With a share of 42% of total emissions in 2050, the transport sector will reduce significantly but remain the largest source of CO_2 emissions – followed by industry and power generation.

CHALLENGING THE BUSINESS MODEL OF TODAY UTILITIES

The Energy [R]evolution scenario will also result in a dramatic change in the business model of energy companies, utilities, fuel suppliers and the manufacturers of energy technologies. Decentralised energy generation and large solar or offshore wind arrays which operate in remote areas, without the need for any fuel, will have a profound impact on the way utilities operate in 2020 and beyond. While today the entire power supply value chain is broken down into clearly defined players, a global renewable power supply will inevitably change this division of roles and responsibilities. The following table provides an overview of today's value chain and how it would change in a revolutionised energy mix. While today a relatively small number of power plants, owned and operated by utilities or their subsidiaries, are needed to generate the required electricity, the Energy [R]evolution scenario projects a future share of around 60 to 70% of small but numerous decentralised power plants performing the same task. Ownership will therefore shift towards more private investors and away from centralised utilities. In turn, the value chain for power companies will shift towards project development, equipment manufacturing and operation and maintenance.

7 ~ CONCLUSIONS

Business-as-usual is clearly not an option for future generations, as this would have dramatic consequences for the environment, the economy and human society. The Energy [R]evolution scenarios show that options for change are at hand. Renewable energies can play a leading role in the world's energy future. Towards the mid of the century, renewable energy can provide close to 90% of the world's final energy needs, at the same time ensuring the continuous improvement of global living conditions, in particular in developing regions. In the days of a global financial and economic crisis, scenario results offer a positive message: investment in innovative renewable energy technologies contributes to economic growth, to the creation of jobs, and in the medium to long term helps to reduce the costs of global energy supply. By moving towards renewable energies, forward-thinking governments can act now to increase employment and investment opportunities.

There is no doubt that a global CO_2 emission trading system will be a key element in the portfolio of policy measures that is required to ensure compliance with climate protection targets. However, while it will take time until a difficult international negotiation process will finally succeed in establishing a global CO_2 trading system, we know from the IPCC 4th Assessment Report that we need urgent action now to curb CO_2 emissions. Complementary policy measures like feed-in tariffs for renewable energies have proved to be cost-effective in many countries, and are easy to implement on a national level. Facing the challenge ahead, there is no time to loose.

[1] Please note that the only investment cost data were available for IEA scenarios, therefore the other cost components, such as fixed and variable capital and generation costs, including OM, have been taken from the ER data.

TABLE A1 ~ **GLOBAL FINAL ENERGY DEMAND IN PJ/A**

PJ/a	2007	2015	2020	2030	2040	2050
TOTAL (incl. non-energy use)	**337329**	**364357**	**374301**	**381812**	**377670**	**368650**
TOTAL ENERGY USE	**305093**	**329380**	**338056**	**343263**	**337271**	**326476**
TRANSPORT	**82068**	**87277**	**88691**	**86355**	**78012**	**69467**
- Oil products	76535	78901	76682	62767	41671	18448
- Natural gas	3131	3327	3253	2878	2130	1424
- Biofuels	1429	3258	4832	8062	9000	9723
- Electricity	973	1772	3574	11888	23420	36354
RES electricity	*171*	*401*	*1321*	*7692*	*19531*	*34613*
- Hydrogen	0	18	349	760	1791	3517
RES SHARE TRANSPORT	**1,9%**	**4,2%**	**7,3%**	**19,1%**	**38,9%**	**68,9%**
INDUSTRY	**99249**	**112145**	**115603**	**118509**	**118870**	**115865**
- Electricity	24995	31759	33787	36531	38720	39770
RES electricity	*4627*	*7622*	*12038*	*20944*	*30606*	*37202*
- District heat	9424	10605	12347	15249	19596	23718
RES district heat	*560*	*2213*	*4542*	*8800*	*15123*	*21468*
- Coal	19546	21902	20114	16417	6334	515
- Oil products	13517	12407	9889	6084	2802	815
- Gas	23872	25277	25926	24663	18398	6025
- Solar	5	741	2182	5518	12048	17457
- Biomass and waste	7878	8991	10042	11197	12252	12564
- Geothermal	12	462	1315	2850	7743	11330
- Hydrogen	0	0	0	0	976	3670
RES SHARE INDUSTRY	**13,2%**	**17,9%**	**26,1%**	**41,6%**	**65,4%**	**86,3%**
OTHER SECTORS	123776	129959	133763	138399	140389	141145
- Electricity	33253	37880	39973	44424	48406	52551
RES electricity	5842	9618	16114	27991	39913	50000
- District heat	6546	7968	9770	12740	16136	18145
RES district heat	439	1701	3610	7160	12504	16629
- Coal	4535	4007	3146	2658	978	23
- Oil products	19059	17886	15015	8687	4329	1090
- Gas	25970	24768	24429	19529	11441	2865
- Solar	378	1380	3834	11373	18762	26992
- Biomass and waste	33884	35345	36084	35758	33587	28815
- Geothermal	152	725	1513	3230	6750	10665
RES SHARE OTHER SECTORS	**32,9%**	**37,5%**	**45,7%**	**61,8%**	**79,4%**	**94,3%**
TOTAL RES	**55376**	**72462**	**97605**	**151116**	**220158**	**284295**
RES SHARE	**18,2%**	**22,0%**	**28,9%**	**44,0%**	**65,3%**	**87,1%**
NON ENERGY USE	**32236**	**34977**	**36245**	**38549**	**40398**	**42174**
- Oil	24832	26267	27026	28444	29627	30761
- Gas	6084	6901	7289	7951	8400	8817
- Coal	1320	1808	1930	2154	2371	2595

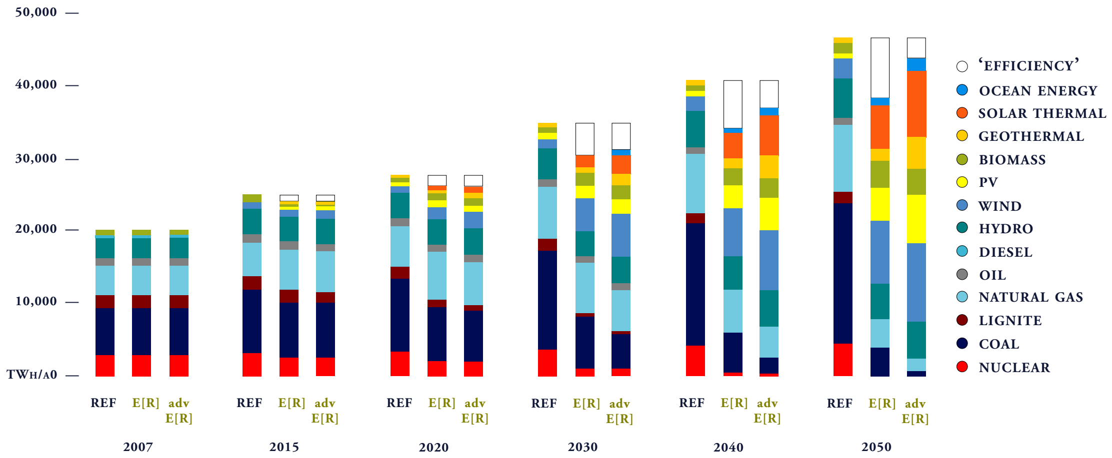
TABLE A2 ~ **PRIMARY ENERGY DEMAND UNDER THE ADVANCED ENERGY [R]EVOLUTION PER REGION**

PRIMARY ENERGY

PJ/A	2007	2015	2020	2030	2040	2050
OECD	230.864	216.760	202.070	180.841	157.571	138.28
NA	115.751	108.607	101.969	90.853	81.332	70.227
Europe	77.525	72.095	66.504	59.077	50.784	46.754
Pacific	37.588	36.059	33.596	30.911	25.455	21.299
Rest	259.335	302.512	314.672	319.802	321.902	327.715
WORLD	**490199**	**519272**	**516742**	**500642**	**479473**	**465995**

TABLE A3 ~ **GDP DEVELOPMENT IN ALL THREE SCENARIOS**

	2007-2015	2015-2030	2030-2040	2040-2050	2007-2050
World	3,30%	3,00%	2,70%	2,44%	**3,39%**
OECD Europe	1,00%	1,80%	1,30%	1,10%	**1,37%**
OECD North America	1,80%	2,27%	1,55%	1,45%	**1,77%**
OECD Pacific	1,10%	1,23%	1,33%	1,40%	**1,27%**
Transition Economies	4,60%	3,77%	2,60%	2,54%	**3,38%**
India	7,00%	5,90%	3,20%	2,50%	**4,65%**
China	8,80%	4,40%	3,20%	2,55%	**4,74%**
Other Developing Asia	7,20%	4,60%	2,50%	2,20%	**4,13%**
Latin America	3,10%	2,50%	2,60%	2,40%	**2,65%**
Africa	4,70%	3,10%	3,40%	3,40%	**3,65%**
Middle East	4,50%	4,00%	2,30%	2,00%	**3,20%**



REFERENCE, ENERGY [R]EVOLUTION AND ADVANCED ENERGY [R]EVOLUTION ["EFFICIENCY"=REDUCTION COMPARED TO THE REFERENCE SCENARIO]

FIGURE AF1 ~ **GLOBAL DEVELOPMENT OF ELECTRICITY GENERATION STRUCTURE UNDER THREE SCENARIOS**

TABLL A4 ~ **GLOBAL: PROJECTION OF RENEWABLE ELECTRYCITY GENERATION CAPACITY UNDER BOTH ENERGY [R]EVOLUTION SCENARIOS**

IN GV

		2007	2020	2030	2040	2050
HYDRO	E[R]	922	1,206	1,307	1,387	1,438
	advanced E[R]	922	1,212	1,316	1,406	1,451
BIOMASS	E[R]	46	212	336	500	652
	advanced E[R]	46	214	343	501	621
WIND	E[R]	95	818	1,733	2,409	2,943
	advanced E[R]	95	1,140	2,241	3,054	3,754
GEOTHERMAL	E[R]	11	49	108	196	279
	advanced E[R]	46	69	238	469	693
PV	E[R]	6	335	1,036	1,915	2,968
	advanced E[R]	6	439	1,330	2,959	4,318
CSP	E[R]	0	105	324	647	1,002
	advanced E[R]	0	225	605	1,173	1,643
OCEAN ENERGY	E[R]	0	29	73	168	303
	advanced E[R]	0	58	180	425	748
CSP	**E[R]**	**1,080**	**2,813**	**4,917**	**7,224**	**9,585**
	advanced E[R]	**1,080**	**3,359**	**6,252**	**9,987**	**13,229**

ACKNOWLEDGMENT

The authors would like to thank the many partners who provided helpful input during scenario development: DLR, Institute of Technical Thermodynamics, Department of Systems Analysis and Technology Assessment, Stuttgart, Germany; Dr. Wolfram Krewitt (†); Dr. Thomas Pregger; Dr. Sonja Simon; Dr. Tobias Naegler, Institute of Vehicle Concepts, Stuttgart, Germany; Dr. Stephan Schmid, Ecofys BV, Utrecht, The Netherlands; Wina Graus; Eliane Blomen, EcoEquity, School of Public Policy, Center for Climate Change and Sustainable Energy Policy (3CSEP), Budapest, Hungary; Prof Diana Ürge Vorsatz, Director, (Cost Curves), Institute for Sustainable Futures (ISF), University of Technology, Sydney, Australia; Jay Rutovitz; Alison Atherton (Employment calculations).

REFERENCES

Graus, W., Blomen, E., *Global low energy demand scenarios – [R]evolution 2008*, Report prepared for Greenpeace International and EREC, PECSNL 073841, Ecofys Netherlands bv, Utrecht, 2008.

Greenpeace/EREC, *Energy [R]evolution – A sustainable world energy outlook*, GPI REF JN 035, Greenpeace International and the European Renewable Energy Council (EREC), 2007, www.energyblueprint.info.

Greenpeace/ EREC, *Energy [R]evolution 2008 – A sustainable world energy outlook*, Greenpeace International and the European Renewable Energy Council (EREC), 2008, www.energyblueprint.info.

Greenpeace/ EREC, *Energy [R]evolution 2010 – A sustainable world energy outlook*, Greenpeace International and the European Renewable Energy Council (EREC), 2010, www.energyblueprint.info.

Hansen, J., Sato, M., Kharecha, P., Beerling, D., Masson-Delmotte, V., Pagani, M., Raymo, M., Royer, D., Zachos, J., *Target Atmospheric CO_2: Where Should Humanity Aim?*, NASA Goddard Institute for Space Studies, 2008. http://www.columbia.edu/~jeh1/2008/TargetCO2_20080407.pdf.

Hoogwijk, M., Graus, W., *Global potential of renewable energy sources: a literature assessment*, Background report prepared for REN21. Ecofys NL PECSNL072975, Utrecht, 2008. http://www.ren21.net/pdf/REN21_RE_Potentials_and_Cost_Background%20document.pdf.

IEA, *World Energy Outlook 2007*, OECD/IEA, Paris, 2007a.

IEA, *Energy Balances of OECD Countries*, 2007 Edition, OECD/IEA Paris, 2007b.

IEA,. *Energy Balances of Non-OECD Countries*, 2007 Edition, OECD/IEA Paris, 2007c.

IEA, *World Energy Outlook 2008*, OECD/IEA, Paris, 2008.

IEA, *World Energy Outlook 2009*, OECD/IEA, Paris, 2009.

Krewitt, W., Simon, S., Graus, W., Teske, S., Zervos, A., Schäfer, O., "The 2°C scenario – A sustainable world energy perspective", in *Energy Policy* 35 (2007): 4969-4980.

MESAP 2008, http://www.seven2one.de/mesap.php.

Neij, L., "Cost development of future technologies for power generation – A study based on experience curves and complementary bottom-up assessments", in *Energy Policy* 36 (2008), 2200-2211.

REN21, *Renewable Energy Potentials – Summary Report*, REN21 Secretariat, Paris, 2008. http://www.ren21.net/pdf/REN21_Potentials_Report.pdf.

Seidenberger, T., Thrän, D., Offermann, R., Seyfert, U., Buchhorn, M., Zeddies, J., *Global Biomass Potentials*, Report prepared for Greenpeace International, German Biomass Research Center, Leipzig, 2008.

UNPD, *World Population Prospects: The 2008 Revision*, United Nations, Department of Economic and Social Affairs, Population Division, 2009. http://esa.un.org/unpp/ (1.2.2008).

ALESSANDRO COLOMBO

THE MANY FUTURES OF ENERGY

The transition towards low-carbon and sustainable energy sources will be neither quick not univocal; rather, it will be characterized by a mix of different technologies and strategies, each featuring specific performances and supported by different groups of interest. The article presents an overview of the most promising opportunities, the related advantages and the main risk factors.

PAUL ALLEN

MEETING OUR 21ST CENTURY CHALLANGES

Many people are only now grasping the serious nature of our present human predicament. Senior experts, scientists, NGO's and political leaders are beginning to appreciate that the most recent evidence on both climate security and energy security reveals a situation more urgent than had been expected, even by those who have been following it closely for decades. In addition, the crisis in the global economy has painfully illustrated the cost and consequences of realising there are problems in the pipeline and not taking the required action in time.

In June 2010 the Centre for Alternative Technology launches its new report ZeroCarbonBritain 2030 – a policy and technology scenario designed to expand on the detail and answer questions raised by our initial report. Through integrating cutting-edge findings from leading experts and researchers from a variety of organisations and disciplines, ZeroCarbonBritain 2030 explores just what it is Britain must do to meet the scale and speed of the challenges defined by the most recent climate science.

A great many solutions to climate security are the same as solutions to energy security and to long-term economic recovery. A flagship of a new economic approach, ZeroCarbonBritain 2030 will show how we can re-focus the ingenuity of the finance sector on the actual challenges at hand. Rather than residing precariously at the end of the peaking pipeline of polluting fossil fuel imports, Britain can head an indigenous renewable energy supply chain powering a lean, re-localised economy. Every field, forest, island, river, coastline, barn or building holds the potential to become an energy and revenue generator, with different technologies appropriate to every scale or location.

ZeroCarbonBritain 2030 clearly illustrates how the parallel de-carbonisation and re-vitalisation of the UK economy would work, creating a single document of immediate relevance to policy-makers everywhere.

GREGOR CZISCH [INTERVIEW]

THE SUPER-GRID

In this interview Dr Czisch explains the feasibility of a power network able to cover the whole European energy demand with sole renewable sources, mostly with wind power, hydropower and biomasses.

The proposal comes from a seven-year technical and economical study of the potential of those sources in different areas and implies an extended power grid interconnecting European and Saharan countries, the latter contributing thanks to their abundant wind resources.

Such a super-grid would not only result in a cheaper and more secure electricity supply than that available today, but would also draw a new model of mutual inter-regional cooperation.

BAHAREH SEYEDI ~ MINORU TAKADA

ENERGY FOR THE POOR: THE MISSING LINK FOR ACHIEVING THE MDGS

This paper calls for universal access to energy as a development objective that is not only necessary to achieve all of the widely recognized Millennium Development Goals (MDGs) but it is also indispensible for 3 billion energy poor whose socio-economic and environmental progress towards sustainable human development is jeopardized by the lack of access to modern energy services. While there is no explicit mention of energy in the MDGs, none of the goals can be achieved without access to adequate, affordable, and reliable energy services. Strong political commitment-from both the North and the South-is critical to move beyond the 'business-as-usual' approach to energy and address the challenges of energy access, sustainability and security head on. The authors call for urgent action towards achieving universal access to modern energy services on the premise of five evidence-based priority actions. The United Nations MDG Summit in September 2010 to be held in UN Headquarters in NY provides a unique opportunity for galvanizing political commitment and for spurring collective action to address energy challenges and to accelerate the achievement of the MDGs by 2015.

CARLO GUBITOSA

THE ENERGY WE ARE EATING

Scientific evidences indicate that the production of meat requires an abnormal consumption of natural resources, such as energy, fresh water, and land occupancy, in comparison with other types of food with equivalent nutritional power.

The article presents, by means of easy-reading tables, the main data related to such an environmental impact, and suggests adopting the most simple but effective remedial strategy: to reduce the consumption of animal proteins in the everyday diet.

SIMONA SAPIENZA

AN ECO-LOGIC MOVE: A RENEWED LEGAL FRAMEWORK FOR RENEWABLE ENERGY SOURCES

The energy and climate policy in the EU and in other states is to bring the use of fossil fuels to a standstill. Part of this policy is energy efficiency and increase of renewable energies resources. To reduce the effects of climate change and establish a common energy policy, the European Union has passed specific legislation and set out certain mandatory and non-mandatory targets especially to regulate electricity produced by renewable energy sources, reduce greenhouse gas emissions and improve energy efficiency by 2020. Different mechanisms of support for the promotion of renewables are currently in place at national level in each EU member state. The different targets set out by the EU and the steps taken by the member states towards a greener Europe are not isolated moves. Against the background of global climate change certain states in the US as well as Israel have set the political goal of becoming carbon-neutral by 2015. To achieve this goal they have developed a local climate-protection-concept with different topics. Especially in the sector of planning and building, they intend to reach a high energy efficiency standard for existing buildings and also for planning new building areas and use renewable energies for the energy supply of planned housing and commercial areas.

ANDREA SILVESTRI

TOWARDS THE SMART GRIDS

In order to increase the amount of renewable energy sources connectable to the electric grid, it is necessary to develop a new form of interconnection, the active networks or Smart Grids, adapted to integrate diffused generators. To achieve such revolution in the power networks, several challenges need to be faced, because the current network is conceived upon a "top-down" model of power flow. In particular, the intercommunication between dispersed and non-homogeneous control units and the setting of an appropriate regulatory framework are the key issues to be addressed.
The article outlines the most relevant projects carried out by the Politecnico di Milano in this area and highlights the potential prime role of the Italian research in the development of the future Smart Grids.

SVEN TESKE

ENERGY [R]EVOLUTION 2010.
A SUSTAINABLE WORLD ENERGY OUTLOOK

The Energy [R]evolution 2010 scenario is an update of the Energy [R]evolution scenarios published in 2007 and 2008. It takes up recent trends in global socio-economic developments, and analyses to which extent they affect chances for achieving climate protection targets. The main target is to reduce global CO_2 emissions to 3.5 Gt/a in 2050, thus limiting global average temperature increase to below 2°C and preventing dangerous anthropogenic interference with the climate system. A ten-region energy system model is used for simulating global energy supply strategies. A review of sector and region specific energy efficiency measures resulted in the specification of a global energy demand scenario incorporating strong energy efficiency measures. The corresponding supply scenario has been developed in an iterative process in close cooperation with stakeholders and regional counterparts from academia, NGOs and the renewable energy industry. The Energy [R]evolution Scenario shows that renewable energy can provide more than 80% of the world's energy needs by 2050. Developing countries can virtually stabilize their CO_2 emissions by 2025 and reduce afterwards, whilst at the same time increasing energy consumption through economic growth. OECD countries will be able to reduce their emissions by up to 90% by 2050.

Energy is Eternal Delight.

WILLIAM BLAKE, *The Marriage of Heaven and Hell.*

SPANDANEWS

BACK ISSUES

Available at www.spanda.org/publications.html GO!

COLOPHON

YEAR I, NO. 1 JANUARY/MAY 2010
ISSN 2210-2175

EDITOR SAHLAN MOMO
GUEST EDITOR ALESSANDRO COLOMBO
EDITORIAL BOARD REBECCA BENTLEY, ALESSANDRO COLOMBO, JAMES JOPLIN, SAHLAN MOMO, LIAM OSBOURNE.
EDITORIAL AND EXECUTIVE OFFICE
LAAN VAN MEERDERVOORT 70
NL-2517AN THE HAGUE | THE NETHERLANDS
T +31 (0) 70 362 6523 | F +31 (0) 70 362 9848
JOURNAL@SPANDA.ORG | WWW.SPANDA.ORG
PUBLISHER SPANDA PUBLISHING

CALL FOR CONTRIBUTIONS *You are warmly encouraged to contribute articles to the Spanda Journal. Help us make this Journal with your pictures, views and stories. Guidelines for contributors* GO!
Submissions to Spanda Journal may be edited for a variety of reasons including the need to shorten them or improve expression.

QUESTIONS AND COMMENTS? GO!

SEND THIS PUBLICATION TO A FRIEND GO!

TO SUBSCRIBE *Journal@spanda.org* GO!

NEXT ISSUE *«Microfinance».*

ISSN 2210-2175