Stopping climate change in the Middle East – Ways out of an unfolding catastrophe

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Structure

1. Arabs and climate change

The way the energy-dependent global economy is ticking today is anything but sustainable because it is based on massively burning fossil fuels like oil, gas and coal. The result is a dramatic increase of climate damaging carbon-dioxide (CO2) emissions. The consequences of climate change will have a dramatic impact on the Middle East and the Mediterranean region.

When Arab officials are faced with this fact, they often respond with, "Climate change? What climate change?" Others argue like US oil corporates, claiming current climate changes are natural phenomena and not connected to any human activity. Some Arab officials even charge that the whole issue is a "*plot by the West to sell us new technologies*" or a "*Zionist plot to demonise oil and push Arabs into poverty*".

What strikes is the lack of knowledge among Arab decision-makers about the main causes of climate change, what could be practically done to stop it and that there still can be a booming Arab economy after the oil age.

Arab leaders' defensive and sometimes hysteric reaction to the keywords "*climate change*" and "*cut CO2 emissions*" is understandable in a region that has enough political and economic problems ranging from the Palestinian-Israeli conflict to civil wars in Iraq and Sudan, huge discrepancies between poor and rich in most societies and visible pollution in the air of cities as well as along rivers and coastlines.

Most Arab leaders ignore the issue of climate change despite the fact that denial will lead to their societies paying a high price in the future. And this price will be paid with lots of money and many human lives.

Sadly, environmental protection is not high on the agenda of Arab governments, the Environmental Sustainability Index found out. Its scores, given to 146 countries, are attributed to substantial natural resource endowments, low population density, and successful management of environment and development issues. Finland ranked first, followed by Norway, Uruguay, Sweden and Iceland. The index put Iraq at 143, Kuwait at 138, Saudi Arabia at 136, Lebanon at 129 and the UAE at 110. The three best Arab states ranked 55 (Tunisia), 83 (Oman) and 84 (Jordan). Israel landed at 62.

Fact is that a United Nations panel including scientists from all over the world agrees that climate change is one of the biggest threats facing humanity. The main reason is the global rapid growth in energy production and consumption since the 1950s. Burning coal, gas and oil, but also intensive agriculture or the cutting of forests emit CO2 that heat up the Earth. The result is more devastating freak weather events such as flash floods, storms, heat waves, mudslides or droughts. This greenhouse effect also leads to the melting of icepacks in the North and South poles, causing sea levels to rise – also in the Mediterranean.

The undisputed and credible source of this assessment is the UN's Intergovernmental Panel on Climate Change (IPCC), which has been established "*to assess scientific, technical and socio- economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation*". In October 2007, the IPCC and former US Vice President Al Gore were awarded the Nobel Peace Prize because they helped galvanise international action against global warming.

In the Mediterranean region, climate change has started to undermine efforts for sustainable development. It adds to existing problems of desertification, water scarcity and food production, while also introducing new threats to human health, ecosystems and national economies.

In January 2007, the European Union published a report dealing with the disasters that will take place along the northern shores of the Mediterranean. Assuming a global 3 degree C rise due to climate change, the basin would face crippling shortages of both water and tourists by 2050 and tens of thousands will die of heat in southern Europe. The annual migration of rich northern Europeans to the south could stop – with dramatic consequences for the economies of Spain, Greece and Italy. If these countries will be hit so badly, one can imagine the economic and health impacts climate change will have on the Maghreb states, Egypt, Palestine, Israel, Lebanon and Syria.

Meanwhile, the International Energy Agency (IEA) warned of an oil supply crunch in five years. Demand is expected to rise at more than 2 per cent annually. Supply, the IEA calculates, will not be able to keep pace. Nations outside the Organisation of the Petroleum Exporting Countries (OPEC) are expected to add about 1 per cent to supplies per year. That puts most of the burden on OPEC, in particular Saudi Arabia, which would face capacity constraints itself.

Ironically, the United Arab Emirates, Oman, Kuwait and Saudi Arabia could eventually face gas shortages as they seek to sustain development plans. In the late 1990s Oman, believing it had ample gas resources, encouraged the establishment of energy-hungry fertiliser plants and an aluminum smelter, but today it faces a supply-demand gap, as development of new gas supplies failed to live up to expectations. Qatar, which boasts some of the world's largest known gas reserves, recently announced a moratorium on the development of gas projects from its North Field until it completes a review to assess its reserves. In Saudi Arabia, a petrochemicals project has stalled due to a lack of gas supply.

All these Gulf countries are reliant on gas for power generation and water desalination plants and many have oil projects that rely on gas re-injection to maintain and increase oil production. Now growing industrial demand is competing for future supply. The most important factor in this equation is the huge rush by the whole manufacturing world to go to where energy sources are cheap – at least for the time being.

Climate changes are of concern not only from an environmental viewpoint, or in regard to regional water supply. The social ramifications of climate change in countries of the Middle East are very likely to politically destabilise the region, by causing waves of environmental refugees from countries including Egypt, as happened in the tragic case of Darfur, Sudan. The expected economic impact base and to the residential areas of millions of people in the Middle East could lead to dramatic political implications. Climate change is therefore a peace and security issue, too.

2. Positive initiatives

Very few Arab leaders have accepted that the scientific case on climate change has been made. They are determined to ensure their countries' economic wealth is not harmed in the process of dealing with this issue. Here are examples about positive initiatives:

a. Abu Dhabi

In April 2006, the Gulf emirate embraced renewable and sustainable energy technologies. As the first major oil-producing nation to take such a step, it launched the "Masdar Initiative", a global cooperative platform for engagement in the search for solutions on energy security, climate change and sustainable human development.

The Abu Dhabi Future Energy Company (ADFEC) is the government-owned organisation mandated to develop and execute Masdar, a strategic initiative with four objectives: help drive the economic diversification of Abu Dhabi; maintain and later expand Abu Dhabi's position in evolving global energy markets; position Abu Dhabi as a developer of technology, and not simply an importer; make a meaningful contribution towards sustainable human development. The key objective is to position Abu Dhabi as a world-class research and development hub for renewable energy technologies, while ensuring that it maintains a strong position in world energy markets.

According to Masdar**,** the Gulf real estate sector has no choice but to address sustainability issues if it wants to deliver the 500 billion dollars of developments planned for the next seven years in the region. Unless steps are taken to address the sector's energy and water consumption, waste and carbon generation levels, the region's infrastructure would not be able to match growth projections. Planned developments will require an additional two million cubic metres of water per day, 75 million additional megawatt hours of energy per year, all while producing an additional 3.5 million tons of solid waste and 300 million tons of carbon emissions per year (the figures represent approximately a 100 per cent increase from current levels).

Masdar CEO Dr. Sultan Al-Jaber said last October: "This level of growth is not sustainable."

The Abu Dhabi ruling family has realised that unless a change occurs in the current energy, water and waste consumption rates of developments, Gulf states would undoubtedly bottleneck the existing infrastructure, choke the planned capacities of utilities and damage the environment.

By 2009, the first stage of Masdar City, the world's first zero-carbon and zero-waste urban development, is to be finished. It is designed in two squares, one large square, and a smaller square. Shaded walkways and narrow streets will create a pedestrian friendly environment in the context of Abu Dhabi's extreme climate. The surrounding land will contain energy farms, research fields, plantations and dense green spaces so that the city will be entirely self-sustaining, following the principals of "One Planet Living" (OPL), a set of ten guiding principals of sustainability, proposed in a joint initiative by WWF and Bioregional Development, whereby everyone lives within their fair share of the Earth's resources.

This car-free "walled-city" would include the ADFEC headquarters. During the second phase, the larger square of the city is to be completed and during the third phase, the smaller square of the city. The whole city of Masdar is expected to be completed by 2015.

Masdar is to have several main power sources to meet the energy that the city will demand:

- A photovoltaic power plant
- A solar plant using parabolic troughs which uses the Concentrated Solar Power (CSP) technology that heats liquid to very hot temperatures that are then used to make steam flow through a turbine to make electricity
- and the waste-to-energy plant.

There will also be both wind and photovoltaic energy farms located in the land surrounding the city. The city will house clean technology companies as well as a research and development institution established in cooperation with the Massachusetts Institute of Technology (MIT).

The Masdar project in Abu Dhabi

b. Egypt

The growth of energy-intensive industries – steel, aluminum, cement, fertilisers and petrochemicals – has helped boost foreign direct investment in Egypt. But the proliferation of such industries is a mixed blessing. Energy-intensive

industries eat up crucial resources. Their growth coincides with rising domestic demand for gas, putting a huge burden on the treasury as energy subsidies have swelled.

Last August, Egypt tackled this politically sensitive issue by introducing a new pricing policy to phase out gas and electricity subsidies for energy-intensive industries as the government seeks to create pricing predictability for investors and ensure its energy resources are effectively used. Energy subsidies are a huge burden on the treasury, which could save about 30 billion Egyptian pounds ($5.3 billions, €3.9 billions) over the next five years with the introduction of the policy. The new pricing formula – the country's first of its kind – will initially affect 40 companies in sectors including steel, cement, fertilisers and petrochemicals, but will also be applied to new entrants into those industries.

Energy subsidies cost 20 billion Egyptian pounds a year, with 4 billion going to industry, of which the 40 most energy-intensive companies receive about 70 per cent. Lesson learnt: Cutting energy subsidies is a prerequisite for energy saving.

c. Egypt

The Egyptian government has set a target of only 3% of energy from renewables by 2010, greatly under-utilising the available potential. Indigenous natural gas and oil reserves, on which Egypt's electricity generation currently relies, are expected t be depleted in about 30 or 40 years. This makes the transition to alternative energy sources a pressing need to avoid economic mayhem.

Egypt is planning to build a Concentrating solar power (CSP) plant with a 140 MW capacity. This is a step forward, but much more should be done to secure affordable and secure energy supplies in the future. According to Greenpeace, Egypt has over 80 times more energy readily available from renewable sources thanis needed for current electricity production. This available clean energy is a mix of hydropower, geothermal, biomass, wind power and photovoltaic solar panels.

Real change is already happening in Cyprus and Israel.

e. Cyprus

In August 2007, the Greek Orthodox Church in Cyprus announced plans to invest 234 million US dollars in solar energy. Archbishop Chrysostomos II said the church would build a factory that would make photovoltaic panels to capture the sun's energy. The government has warned of power cuts in 2008 if the island does not secure additional electricity supplies. The move follows criticism of the state-run Cyprus electricity authority's apparent failure to cope with increased demand during past heat waves which triggered power cuts.

A common sight in Cyprus and Israel – but not in the Arab world – is the use of solar heaters. They are very simple devices that collect solar energy, transform it into heat and provide it to the water. Then the water is pumped to the house. In this way a significant saving of energy takes place since there is almost always hot water in the house, without the use of any kind of fuel.

In Cyprus, the sun can provide warm water 350 days out of 365 a year to an ordinary house with 5 people. Over 90 percent of homes there have solar water heaters. They are required to do so by law.

Solar water heaters on the roof of a house in Jerusalem

f. Israel

Did you also know that in 1980 Israel passed a law requiring every new building to have solar water heaters? Today more then 90% of Israeli households have them.

Did you know that an Israeli company has built the world's largest solar energy plant in the world? Between 1984 and 1990, Luz built this plant in the Mojave Desert in California. The system is based on the CSP technology (the one that will also be used my Masdar in Abu Dhabi). The Israeli company Solel took over Luz and will be upgrading the system with newer technology to increase the efficiency of the plant.

Meanwhile, Israel is poised to build the largest solar power plant in the world. The station is being planned in the Negev desert and will also be the first ever built in Israel. Initially it will supply 100 mw of power and grow to 500 megawatts, about 5 percent of the country's current generating capacity. Construction is to be completed in 2012. Twenty such plants would make Israel independent from importing fossil fuels for electricity production. Solar energy plants in the Negev could theoretically produce all the Israel's power on 225 square kilometers of suitable land.

The Israelis believe that if a huge Solel plant is built in Israel and is shown to be successful, it will make the company a strong competitor on the world scene, and international projects could be financed in the Third World by the World Bank. Luz's patents were inherited and improved by Solel. In a joint research project between Solel and Israel's National Center for Solar Energy, co-funded by the National Infrastructure Ministry and the U.S.-based Belfer Foundation, the Israelis said that new advances have been made in solar technologies.

Concentrated solar power (CSP)plant in the Mojave desert, California, USA

The primary obstacle in the use of solar power in Israel until now has been price. Producing electricity with solar energy now costs in Israel 1.5 times more than using coal or petrochemicals. But as oil prices rise and solar power goes into mass production, the price gap will disappear at some point.

In November 2006, the Israeli government decided that 2% of energy must be renewable by 2007, with an additional 1% every three years.

3. Wrong paths

Arab leaders should be aware of the fact that some governments and corporates in developing nations have been promoting outdated, dangerous or highly controversial technologies as a solution to climate change. These are:

a. Nuclear energy

Nuclear power remains the most dangerous form of energy. A disaster like the one in the Chernobyl nuclear power plant in the Ukraine in 1986 can happen any time and any place. The history of the Nuclear Age is a history of tragic accidents. Even during normal operation, radioactive materials are regularly discharged into the air and water. The so-called new generation of nuclear power is also anything but safe.

A solution for the long-term storage and treatment of radioactive waste has yet to be found. Highly radioactive spent fuels need to be isolated from the biosphere for hundreds and thousands years. Radioactive waste remains dangerous for hundreds and thousands of years and radiation can lead to cancer and birth defects. There is not a single safe disposal option for the highly radioactive waste produced by nuclear power stations worldwide. In almost all countries waste is stored in bunkers, below surface or above ground, while governments are corporates are searching for ways to safely store it for thousands of years to come. These “intermediate” storages are expensive and require extensive safety measures because they may be targeted by violent groups.

If the global energy market was a level playing field, where energy pricing would reflect the true costs of producing energy from different sources, nuclear power would be economically insane. All countries using this technology have seriously underestimated the full costs of nuclear power. Not a single nuclear power plant was ever built without massive direct or indirect subsidies. There is a huge gap between the expected costs of decommissioning and waste storage of the currently operating plants in the EU and the money set aside for that purpose by the operators. The hidden costs of waste disposal, decommissioning of plants at the end of their lifespan and provisioning for accidents have never been adequately accounted for, and will result in a massive burden on future generations. The decommissioning costs alone could be as high as 500 billion Euros for the power stations currently operating within the EU.

The nuclear industry currently hopes to use the climate crisis to stage a nuclear revival, arguing that nuclear power is cheap, emission-free and thus has a role to play in securing low-emissions supply of energy. But nuclear power is not at all CO2 emissions free, if these emissions in relation to uranium mining, transportation, plant construction and decommissioning and waste storage are included in the calculation. It has been calculated that, for example, in the UK with its 23 nuclear reactors, doubling nuclear capacity would cut CO2 emissions by no more than 8%. Globally, tripling nuclear capacity by 2050 might contribute 12.5%-20% to the necessary emission reductions. But such scenarios – one plant every two weeks – have no link to political reality, and the costs would be astronomic.

In Europe, every Euro invested today in nuclear power could save about ten times more CO2 emissions if it was invested in energy conservation measures instead.

Another critical issue is that radioactive material from nuclear power plants can be used to build atomic weapons. The global expansion of nuclear power could well contribute to an increase in the number of atomic weapons states. So far India, Israel, South Africa, Pakistan, North Korea, and of course the five official nuclear weapons states (USA, Russia, United Kingdom, France and China), have developed arsenals of atomic weapons using their “peaceful” nuclear power facilities. The spread of nuclear technology significantly increases the risk of atomic arms proliferation. Smuggling of nuclear material, including from civil nuclear programs, also presents a significant challenge. The International Atomic Energy Association (IAEA) has recorded over 650 confirmed incidents of trafficking in nuclear or other radioactive materials since 1993. In 2004 alone, almost a hundred such incidents occurred.

Algeria

Unfortunately, several Arab governments have been voicing their interest in going along the nuclear path – such as Egypt, Morocco and Algeria. French President Nicolas Sarkozy visited Algeria in July 2007 and said he is willing to share French civil nuclear expertise. He also mentioned the possibility of training Algerian engineers in France, home to Europe's biggest nuclear power operator, Électricité de France (EDF), and the world's biggest nuclear power group, Areva.

Algeria has the world's eighth largest proven gas reserves, and it is a leading gas exporter to the European market, providing about 13 per cent of the continent's total gas consumption. Despite its rich resources, it is considering its post-fossil fuel future. In June 2007, it signed a co-operation agreement with the US to explore possible common projects in the field of civil nuclear technology. The Algerian government has not yet decided to launch a nuclear programme but the country's energy minister, Chakib Khelil, has said it was under consideration. “Algeria has uranium resources and also research facilities. We are looking for any partners who can help us develop. So we don't exclude nuclear power, it's an option in the long term, so we are working on it."

Egypt

Egyptian authorities in September 2006 resumed a nuclear programme that had been frozen since the 1986 Chernobyl catastrophe. They want to build a 1,000 megawatt power station at Al-Dabah on the Mediterranean coast west of Alexandria. This decision appears to be the first stage of a plan to build three light-water reactors there. Studies related to the plant are be finished by the end of 2007.

Plans to build a CSP plant is estimated at 140 million US dollars for 140 MW, or about 1 million US dollars per MW. In comparison, the cost to build the proposed nuclear power plant is estimated at 1.5 billion US dollars for 1000MW – about 1.5 million US dollars per MW. This means that the nuclear option is not only dangerous but economically insane because it is one and a half times the costs of concentrated solar thermal power plants (CSPs).

On should also note that US estimates for the development of an Egyptian nuclear power plant are much higher, averaging 4.0 billion US dollars for a 1200MW which is over 3 million US dollars per MW – three times the cost of CSP. In addition, these costs are just the building costs; they do not include the costs of decommissioning and dealing with nuclear waste, costs of nuclear fuel – problems which do not exist with renewable energy.

b. "Clean coal" and carbon capture & storage

Whenever coal is burned, CO2 is produced. Depending on the type of power plant, a large quantity of this greenhouse gas will dissipate into the atmosphere and contribute to climate change. A coal power plant discharges roughly 720 grammes of carbon dioxide per kilowatt hour, a modern gas-fired plant releases about 370g CO2/kWh. Some western corporates are proposing a new technique for reducing the CO2 released by power plants. In this scheme the CO2 is separated, and then trapped in the oceans or pumped underground. Both methods – capture and storage – have limitations. Even after employing proposed capture technologies, a residual amount of CO2 – between 60 and 150g CO2/kWh - will continue to be emitted.

Ocean storage on a massive scale would result in the acidification (reduction of pH) of large areas and would be detrimental to many ecosystems. CO2 disposed of in this way is likely to get back into the atmosphere in a relative short time.

The Carbon Capture and Storage (CCS) technology is still a dream and, if ever realized, would mean pumping CO2 in the seas or underground – and hoping it would not hurt and never leak out. In any case, underground CO2 storage technology reminds me very much of the problems we currently face with nuclear waste in many countries. No one knows were to store it safely for thousands of years. And if you do manage to hide it underground in an allegedly safe mine, then there is no guarantee that it would not leak at some point. Actually, underground CO2 and nuclear waste storage means dumping huge problems on future generations.

The dangers of underground CO2 storage are very high. Empty oil and gas fields are riddled with holes drilled during their exploration and production phases. These holes have to be sealed over. Normally special cement is used, but CO2 is relatively reactive with water and attacks metals or cement, so that even sealed drilling holes present a safety hazard. To many experts the question is not if but when leakages will occur. Because of the lack of experience with CCS, its safety is often compared to the storage of natural gas.

A number of serious leaks from gas storage installations have occurred around the world, sometimes requiring evacuation of nearby residents. Sudden leakage of CO2 can be fatal. CO2 is not itself poisonous, and is contained (approx. 0.04 per cent) in the air we breathe. But as concentrations increase it displaces the vital oxygen in the air. Air with concentrations of 7 to 8% CO2 by volume causes death by suffocation – after 30 to 60 minutes.

Although CO2 normally disperses quickly after leaking, it can accumulate in depressions in the landscape or closed buildings because CO2 is heavier than air. It is equally dangerous when it escapes more slowly and without being noticed in residential areas, for example in cellars below houses. The dangers from such leaks are known from natural volcanic CO2 degassing. Gas escaping at the Lake Nyos crater lake in Cameroon in 1986 killed over 1,700 people. At least 10 people have died in the Lazio region of Italy in the last 20 years as a result of CO2 being released.

4. Solar revolution

The Arab world has only a few decades before oil reserves run out. Investing today solely in oil and gas exploration would lead to Arab societies hitting at some point thick, oily walls. What is needed is a shift towards massive investments in energy efficiency methods and environmentally friendly technologies.

The bottom line is: Arab need to diversify their economies because living in denial will lead to economic and social mayhem.

Currently, the development of renewable energy sources like solar, wind and biomass in the Arab world has been low in spite of the immense potential for the use of these solutions. This market has been stifled by a combination of constraints, such as the absence of long-term policy planning, a weak or non-existing legal framework, the high initial capital costs and the lack of technological and commercial skills as well as information.

Even though Arab states have not been interested in these energy solutions for many years, something seems to have changed recently. Abu Dhabi started moving in the right direction. Governments and the private sector in this Gulf emirate have realised the inevitability of economic diversity and putting climate change issues on the top of the list of priorities in the process of social development.

I believe that the economic future of Arab world is definitely solar.

In one day, the sunlight which reaches the Earth produces enough energy to satisfy the world's current power requirements for eight years. Even though only a percentage of that potential is technically accessible, this is still enough to provide just under six times more power than the world currently requires. On a global average, each square metre of land is exposed to enough sunlight to produce1,700 kWh of power every year. The average irradiation in Europe is about 1,000 kWh per square metre. In the Middle East, it is 1,800 kWh.

It is therefore mainly a question of Arab political will to convert sunlight into heat and electricity as efficiently, sustainably and cost-effectively as possible. Here are the main solar technologies to produce energy:

a. Photovoltaics (PV)

PV technology involves the direct generation of electricity from light. A photovoltaic system does need bright sunlight in order to operate, and can generate electricity even on cloudy days.

Photovoltaics panels in the South, and in Germany

There are four types of PV system

a. **Grid connected:** It is the most popular type for homes and businesses in the developed world. Connection to the local electricity network allows any excess power produced to be sold to the utility. Electricity is then imported from the network outside daylight hours.

b. **Grid support:** A system can be connected to the electricity network as well as a back-up battery. Any excess solar electricity produced after the battery has been charged is then sold to the network. This system is ideal for use in areas of unreliable power supply.

c. **Off-grid:** Completely independent of the grid, the system is connected to a battery via a charge controller, which stores the electricity generated and acts as the main power supply. Typical off-grid applications are repeater stations for mobile phones or rural electrification. Rural electrification means either small solar home systems (SHS) covering basic electricity needs or solar mini grids, which are larger solar electricity systems providing electricity for several households.

d. **Hybrid system:** A solar system can be combined with another source of power – a biomass generator, a wind turbine or diesel generator – to ensure a consistent supply of electricity. A hybrid system can be grid connected, stand alone or grid support.

Although the worldwide PV market has been growing at over 40% per annum in recent years, the contribution it makes to electricity generation is still very small. Development work is focused on improving existing modules and system components and developing new types of cells in the thin-film sector and new materials for crystalline cells. It is expected that the efficiency of commercial crystalline cells will improve by between 15 and 20% in the next few years, and that thin-film cells using less raw material will become commercially available. The importance of PV derives from its great flexibility and its enormous technical potential for rural electrification for the two billion people currently having no access to electricity.

b. Concentrating solar power plants (CSP)

Concentrating solar power (CSP) plants, also called solar thermal power plants, produce electricity in much the same way as conventional power stations. The difference is that they obtain their energy input by concentrating solar radiation and converting it to high temperature steam or gas to drive a turbine or motor engine. Large mirrors concentrate sunlight into a single line or point. The heat created there is used to generate steam. This hot, highly pressurised steam is used to power turbines which generate electricity.

In sun-drenched regions, CSP plants can guarantee large shares of electricity production. Four main elements are required: a concentrator, a receiver, some form of transfer medium or storage, and power conversion. The three most promising CSP technologies are:

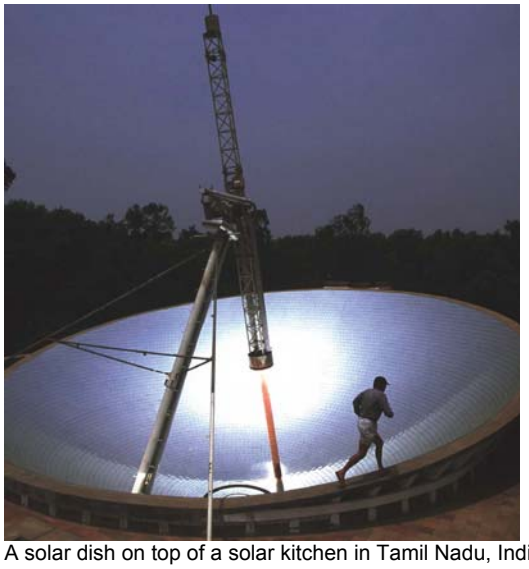
e. **Parabolic trough:** Trough-shaped mirror reflectors are used to concentrate sunlight on to thermally efficient receiver tubes placed in the trough's focal line. A thermal transfer fluid, such as synthetic thermal oil, is circulated in these tubes. Heated to approximately 400°C by the concentrated sun's rays, this oil is then pumped through a series of heat exchangers to produce superheated steam. The steam is converted to electrical energy in a conventional steam turbine generator. In California, such a 354 MW CSP plant is connected to grid.

f. **Central receiver/Solar tower:** A circular array of heliostats (large individually tracking mirrors) is used to concentrate sunlight on to a central receiver mounted at the top of a tower. A heat transfer medium absorbs the highly concentrated radiation reflected by the heliostats and converts it into thermal energy to be used for the subsequent generation of superheated steam for turbine operation. Although solar tower plants are considered to be further from commercialisation than parabolic trough systems, they have good longer-term prospects for high conversion efficiencies. Projects are being developed in Spain, South Africa and Australia.

A field of more than 600 huge mirrors angled to reflect the sunlight of Andalusia onto a concrete tower. The heliostat mirrors track the progress of the sun, harvesting its power. The mirrors reflect and focus the sun's rays to the top of the tower where heat of 250C is absorbed and transmitted to a steam-driven generator. It is Europe's first commercially operated power station. Its operator, Solucar, claims that it generates 11 Megawatts of electricity. The energy it produces is enough to power up to 6,000 homes. Eventually it should produce enough power to supply the needs of Seville's 600,000-strong population.

g. **Parabolic dish:** A dish-shaped reflector is used to concentrate sunlight on to a receiver located at its focal point. The concentrated beam radiation is absorbed into the receiver to heat a fluid or gas (air) to approximately 750°C.This is then used to generate electricity in a small piston, Stirling engine or a micro turbine, attached to the receiver. The potential of parabolic dishes lies primarily in decentralised power supply and remote, stand-alone power systems. Projects are currently planned in the United States, Australia and Europe.

   CSPs can only use direct sunlight and are therefore dependent on high irradiation locations. Egypt, the Maghreb and Gulf states Gulf, for example, have a potential which far exceeds local demand.



A solar dish on top of a solar kitchen in Tamil Nadu, India.
It captures enough energy to generate heat to cook daily for 2,000 people.

h. **Solar thermal collectors for heating and cooling:** Small solar thermal collector systems for water and auxiliary heating are well developed today and used for a wide variety of applications. See the rooftop landscape in Israel and Cyprus.

c. Hydrogen

Let us imagine all over the Arab world millions of square kilometers of solar panels producing directly via photovoltaic panels and CSPs electricity and hydrogen. Producing hydrogen in a sustainable way would create a clean economy in which energy is stored and transported by pipelines or tankers. When burning hydrogen in heating systems, energy plants, vehicles or aircraft the only water is released into the atmosphere.

The vision of turning Arab states into exporters of clean electricity and hydrogen can only occur if governments and the private sector carry out massive investments in this technology and in a new global infrastructure over a period of several decades. Under this strategy, oil countries would slowly reduce their oil output while increasing their export of clean electricity and hydrogen. Oil reserves would last for centuries, and future Arab generations could still profit from them.

Producing hydrogen on an industrial scale in the Arab world is not a dream because the technology is there and the idea is not so new: Dubai took in 2005 a cautious step towards the eventual production of renewable hydrogen in close cooperation with German car maker BMW. The emirate was the departure point for a tour of ten liquid hydrogen-powered sedans halfway around the globe to drum up support for this zero-emission technology. A study on this experiment recommended further action along the path to producing hydrogen from solar energy.

One would assume that hydrogen would be difficult to sell in the Gulf, the world's main source of oil. But this is anything but paradoxical. It is a matter of survival because the cry for sustainability is becoming increasingly urgent.

From Morocco to Iraq and from Syria to Yemen large unpopulated and desert areas could be used to produce hydrogen from solar energy. Clean hydrogen made there would save our climate and secure the economic survival of the Arab world in the post-oil era.

5. Arab policies for a solar age

a. The Kyoto Protocol

The Kyoto Protocol was adopted at COP 3 in Kyoto, Japan, on 11 December 1997. It commits nations to individual, legally-binding targets to limit or reduce their greenhouse emissions. 175 states have ratified the Protocol by end October 2007. Of these, 36 countries and the EU are required to reduce their greenhouse emissions below levels specified for each of them in the treaty.

The individual targets add up to a total cut in greenhouse emissions of at least 5% from 1990 levels in the commitment period 2008-2012. The Kyoto Protocol entered into force on 16 February 2005.

The targets cover emissions of the six main greenhouse gases, namely: Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6).

Arabs states should play a more active role in negotiations on a new round of emission reduction targets for the second commitment period of the Kyoto Protocol (2013-2017). The next chance is during the international meeting on climate change in Bali, Indonesia, next December. Our planet urgently need a new agreement which can deliver the CO2 emission reductions in line with what science is telling us is needed: 50% by 2050, in comparison with 1990.

b. Policies, measures and instruments to mitigate climate change

Greenpeace has produced a 2007 report highlighting the benefits of a sustainable energy path for the Middle East. The region according to the report includes Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen. Population in these countries is predicted to reach 350 million by 2050. To meet their needs economic development based on “business as usual” would lead to an enormous increase in climate-damaging and polluting energy production and consumption.

The report sets out the framework to achieve an energy system that meets the needs of the regions’ people without compromising their environment, security or economies. Two different scenarios were used for comparison to outline and explain a range of possible paths for the future energy supply systems and to discuss their consequences. The ‘business as usual’ describes current energy demand growth patterns and highlights the massive financial, security and environmental consequences of following current policy measures. “*It is the road to environmental and economic ruin and threatens global and regional security*,” the report said.

Greenpeace’s Energy Revolution Scenario outlines policy choices that would radically reduce future energy consumption while maintaining economic development. This path promotes energy efficiency programmes and sustainable renewable energy sources.

The key argument is that countries in the Middle East have a great wealth of conventional energy sources and are blessed with an abundance of renewable energy resources such as solar, wind, geothermal and hydro. By tapping the limitless supplies of renewable energy the Middle East could not only provide for its own needs, but make a significant contribution to its economies by exporting electricity from clean energy sources to other regions.

The key finding in the Greenpeace scenario: “*Satisfying energy demand through the application of renewable technologies, energy efficiency programmes and decentralised power systems can be achieved while maintaining economic growth. It does not mean a regression to a pre-industrialised economic model. It means that developing countries, such as those in the Middle East, can attain the same high standard and quality of life as that enjoyed by so-called ‘developed’ countries without destroying the environment. This is achieved by de-coupling economic growth from energy consumption. Using new renewable energy technologies and energy efficiency and conservation programmes, economic growth can continue without a massive increase in energy use and therefore pollution*.”

Arab governments can implement a number of policies and laws to achieve C02 emission reductions at a significant scale:

- Make the “Ecological Footprint” as prominent a metric as the Gross Domestic Product (GDP). The Ecological Footprint is a resource management tool that measures how much land and water area a human population requires to produce the resources it consumes and to absorb its wastes under prevailing technology. Today, humanity's Ecological Footprint is over 23% larger than what the planet can regenerate. In other words, it now takes more than one year and two months for the Earth to regenerate what we use in a single year. We maintain this overshoot by liquidating the

planet's ecological resources. By measuring the Ecological Footprint of a population (an individual, a city, a nation, or all of humanity) we can assess our overshoot, which helps us manage our ecological assets more carefully. Ecological Footprints enable people to take personal and collective actions in support of a world where humanity lives within the means of one planet.

- End monopolies: End the monopolies of state-run utilities and open the energy sector to the private investor.

- Establish a decentralised energy system: Medium-scale renewable energy plants and small ones could be installed on rooftops, office facades, factory roofs, etc. The cumulative impact could be enormous. Local energy networks will proliferate. By establishing a more appropriate infrastructure and regulatory regime which encourages renewables, a decentralised model could reduce the electricity system's contribution to climate change. By boosting the market for renewable generation and related technologies, it would also stimulate innovation. It would deliver an electricity supply far less vulnerable to system failures.

Decentralising energy would also democratise energy, providing real opportunities for local political leadership on climate change, and curbing the influence of the centralized industry's powerful vested interests. By enabling local action and empowering individuals and communities as producers, decentralisation has the potential to bring about a massive cultural change in our attitude to and use of energy.

In global terms, decentralising energy could revolutionise the lives of the billions of people who currently lack access to basic energy services. Decentralised energy is highly flexible, allowing solutions to be tailored to local conditions and be installed much faster than a centralised system.

Overhauling outdated electricity infrastructures and pursuing a decentralised pathway would lead to:

- slashing CO2 emissions
- bringing down energy consumption levels
- delivering enhanced energy security
- driving technological innovation and real competition in energy markets
- fostering the inherent economic advantage of renewable technologies
- saving consumers money in the longer term
- increasing public involvement in tackling climate change
- increasing opportunities for local political leadership in the energy sector
- reducing the influence of vested interests

- Pass laws on feed-in tariffs (FIT): The photovoltaic market is expanding so fast in Italy and Greece because both countries introduced FIT similar to Germany's which guarantees producers a fixed price for electricity generated from photovoltaic plants. In Germany, the FIT system of payments was introduced in 2000 to cover the full costs involved in producing solar electricity. This sparked a boom. Germany will have about 900 MW of installed solar capacity by the end of 2007, according to the German Solar Industry Association (BSW). This will be almost 20 times as much as in 2000 when there was just 44 MW installed capacity. The German government currently offers a remuneration of about 49 euro cents for a KW/h photovoltaic electricity.

In Italy, the installed solar capacity could increase tenfold to reach 100 MW in 2007. The Italian government has said it aims to have 3,000 MW of installed photovoltaic capacity in place by 2015. Under the new Italian renewable energy law in February 2007, as much as 49 euro cents is to be paid for every KW/h of photovoltaic electricity. Payment is guaranteed for 20 years.

Spain introduced a similar FIT system in 2003 that also sparked a rapid expansion of its photovoltaic market. In 2006, the Greek government passed a renewable energy law offering as much as 50 euro cents for each KW/h of electricity from photovoltaic plants with 100 kW of peak power output or less that are located on islands. Athens has said it wants installed photovoltaic capacity increase to 840 MW of by 2020.

In a nutshell, FIT would

- reduce CO2 emissions,
- created jobs,
- helped secure domestic energy supply,
- guaranteed investment security,
- drive technological innovation,
- and provide fair market conditions.

- **Introduce tax incentives** to stimulate the development and diffusion of renewable energy and energy efficiency technologies.

- **Cut fossil fuel subsidies**, but expect and prepare for stiff resistance by vested interests.

- **Transport**: promote the purchases of cars emitting less then 120 grams of CO2 per kilometer by introducing a CO2 tax on cars (the more you emit, the much more you pay taxes).

Arab leaders need to face the fact that climate change is already hitting them – and that they must deal with it. No one is saying that oil and gas should be left untouched underground. But to help avert climate change, a global cut of greenhouse gas emissions should go hand in hand with much less oil, gas and coal being burnt. This must not mean an economic disaster for Arab oil-producing countries. In the contrary: It can be a historic chance, and this chance is solar power – produced by photovoltaic panels and solar thermal plants.

"*The oil age will end long before the world runs out of oil*," Former Saudi Oil Minister Sheikh Zaki Yamani has said. The question now is whether Arab leaders are up to the challenge of developing economies that rely much less on oil and therefore diversify in a sustainable way. Time is running out.

6. Sources and links

Climate change

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- The UK's Stern review on the economics of climate change, http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm
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- An overview of nuclear facilities in Iran, Israel and Turkey – A Greenpeace Briefing: http://www.greenpeace.org/raw/content/mediterranean/reports/an-overview-of-nuclear-facilit.pdf

Solutions

- The Ecological footprint concept, http://www.footprintnetwork.org/
- The "One living Planet" concept, http://www.oneplanetliving.org/
- Policies, measures and instruments to mitigate climate change, http://www.ipcc.ch/SPM040507.pdf
- The Greenpeace energy [R]evolution scenario: A sustainable pathway to a clean energy future for Europe. Greenpeace and the Institute of Technical Thermodynamics of the German Aerospace Center (DLR), have developed a blueprint for the EU energy supply showing how Europe can lead the way to a sustainable pathway, http://www.greenpeace.org/international/press/releases/energy-revolution-investment and http://www.greenpeace.org/international/press/reports/energy-revolution-a-sustainab; see also report on decentralising power, http://www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/7154.pdf
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