ENERGY CHANGES THE WORLD'S OUTLOOK
***Fortune Turkey* Interview of Carmine Difiglio**
English Translation

Energy plays the leading role in all scenarios that predict the future. Is it possible to achieve sustainable energy targets? Sabancı University Istanbul International Energy and Climate Center (IICEC) Director Prof. Carmine Difiglio says that the industry should change very quickly and widely. Will it really be like this?

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There is a complete transformation in the Energy Sector. For example, there is an influx of investors to renewable energy sources. Because such investments are encouraged all over the world. An investment of between 436 billion and 649 billion dollars is expected in the renewable energy and efficiency areas over the next decade for each year. Among these, solar energy will have the biggest share with an annual investment of 169 billion dollars. The rest will be in wind energy and energy consumption areas. Yes, this image seems promising at first. However, many countries including Turkey are still persisting for fossil fuel energy policy. Government policies, public resources and incentives are reserved for both fossil fuel investments and renewable energy investments simultaneously. This binary situation does not give a consistent view for sure. Doesn't the continuation of an energy system based on fossil fuels contradicts the objectives of fighting against climate change? Of course, it does. We talked about the decisions that will shape the future of energy, policies in this field, and geopolitics of energy with Sabancı University Istanbul International Center for Energy and Climate (IICEC) Director, Prof. Carmine Difiglio.

What Energy Transformations Can We Expect?

Difiglio: Projecting forward presents a dilemma. Despite the flourishing industry of "futurists" anticipating what the world will look like over the next century, it is impossible to predict how advancing science and technology will change the future. Two areas are particularly dynamic; biological sciences and artificial intelligence. Each of these has the potential to produce enormous economic and societal changes. Combined, their potential consequences are unimaginable. I mention this only to put the best available projections of the world's energy outlook into the proper context. Notwithstanding the inherent uncertainties about projecting the future, we need to develop energy scenarios for the next 20 to 40 years because energy capital is long-lived and this capital stock needs to be tracked as we analyze the consequences of emerging energy technologies and governments' energy policies. In fact, government policies often reflect energy models since their insights often guide governments' research and development activities, fiscal policies and regulations – the main elements that comprise energy policy.

Energy modelers necessarily rely on economic trends, expected advances in known energy technologies, linear programming methods and the available intelligence on new emerging energy technologies. Sometimes, modelers use an "end-focused" calculation of what's needed to avoid unacceptable emissions of greenhouse gases. These calculations can provide energy sector roadmaps to sustainability. The International Energy Agency's Energy Technology Perspectives publications are a good example of this approach. In contrast, the IEA's World Energy Outlook modeling approach begins with national energy policies and then projects the

energy sector consequences of these policies. This approach leads to a more reliable guide as to what will happen.

Both approaches are useful but I will focus on the IEA's World Energy Outlook here to answer this question. It suggests that offshore wind will become much more important in the EU, solar PV will expand worldwide more than any other power technology and that we can expect large cost-effective reductions of GHG emissions in the power sector. The World Energy Outlook also shows that, the transport sector remains a difficult problem from a CO2 perspective. Despite a very good outlook for battery electric vehicles to help achieve a cleaner and more efficient passenger transport, they will have only the most limited impact on freight consumption. Even with continued improvements in fuel efficiency, oil consumption will likely continue to increase, albeit at a progressively slower rate. By 2040 it might level off and begin to decline, but that is probably too late to achieve global GHG emission goals.

Much will depend on the next anticipated alternative fuel, hydrogen. Whether it can realistically be expected that widespread commercial uptake can occur in the transport sector before 2030 is an important question. If not, it will be past 2040 before hydrogen vehicles would achieve a significant impact to reduce GHG emissions. In addition, how much hydrogen fuel cell vehicles would actually reduce emissions depends very much on how they are fueled. The easiest way to introduce commercial refueling uses electrolysis of water at service outlets. Except in a handful of countries, fueled this way, hydrogen vehicles produce more GHG emissions per km of travel than a gasoline vehicle and 2.7 times the emissions than a battery electric vehicle. Consequently, hydrogen vehicles should be fueled from merchant plants using processes that produce low CO2 emissions, for example, the reforming of fossil fuels with carbon capture or electrolysis of electricity from renewable energy or nuclear power. Supply of hydrogen from merchant plants would also require new pipeline and trucking infrastructure to a retail sector that installs new underground hydrogen tanks to serve a fleet of fuel cell vehicles that has to be simultaneously marketed. The success of each new business venture (fuel production, fuel transport, distribution, retail sales and vehicle manufacturing), depends on the success of every other. These are daunting commercial challenges but may be necessary to reduce CO2 emissions in transport.

The introduction of the electric vehicle was greatly enabled by the ubiquitous availability of its fuel, electricity. Consequently, electric vehicles could be recharged at home and office garages and recharging stations could be installed at almost any location such as commercial parking lots or even the parking lots of restaurants serving highway traffic. Still, hydrogen can be important before it becomes significant in transport, for example by reducing fossil fuel use in industry. Electricity can replace many industrial needs but hydrogen can replace the high temperature services now provided by fossil fuels.

These are some snapshots of where our energy transition is headed, especially with respect to the challenge of reducing greenhouse gas emissions. Nonetheless, extrapolations of current energy technological trends could be mistaken. Unexpected technological opportunities and unanticipated changes in societies' energy service demands could cause large deviations from what we now expect. If we witness these surprises, it is likely that it won't just be the energy sector that is affected, but many other aspects of commerce, industry and society will be different than we now imagine.

Did the energy sector catch the growth pace necessary to meet the needs of the global economy and the growing population?

Difiglio: The energy sector has proved to be very successful in fulfilling industries' and consumers' energy needs as long as other economic and political factors are in place. For example, about 600 million people in Sub-Saharan access do not have access to electricity. 300 GW of appropriately sourced power generating capacity is needed to ameliorate this problem. In addition, due to the solar resources of Africa as well as the appropriate scale afforded by renewables, especially for rural people, renewable energy could provide the bulk of this new capacity. Appropriate power generating and microgrid technologies exist and are ready to be deployed. But these need to be integrated into the economic development aspirations of African countries. The success to achieve widespread delivery of such services depends on many other factors that are outside the control of the energy sector. African energy poverty remains one of the world's most important human development challenges and deserves greater support from donor agencies and countries.

How would you like to evaluate the current position of the energy sector in terms of sustainability targets?

Difiglio: The current trajectory of the world-wide energy sector will fall short of the emission reductions necessary to avoid unacceptably high atmospheric greenhouse gas concentrations unless there is a significant shift of worldwide policies and measures to implement them. The International Energy Agency's expected trend scenario ("Stated Policies") shows annual 2040 CO2 emissions that are about twice as high (35.6 gigatons) than what is needed for a sustainable pathway (15.8 gigatons). Based on various IPCC modeling probabilities, if emissions are limited to 16 gigatons by 2040, and then 10 gigatons by 2050, the global temperature rise in 2100 would be below 2 degrees C.

Policy measures are not in place to achieve this. Despite three decades of negotiating a world-wide climate agreement, we only have the Paris Accord that has no enforcement mechanism beyond "naming and shaming." Considering the dependence on fossil fuels in some of the largest and fastest-growing economies, can we be confident that this will be an effective deterrent against these countries using more fossil fuels?

Right now, global policy measures, despite all the impressive gains for renewable energy, are not expected to produce IEA's sustainable development scenario. The current policy focus also requires detailed intervention by governments. Perhaps broader policies, such as the carbon tax, should have a greater role since they operate through the market economy without governments having to prescribe exactly how industry and commerce should achieve lower emissions. Advocates of the carbon tax point out that, when established with increasing severity over time, the industry has the lead time to make capital investments and can then rely on the economic returns from those investments if they achieve greenhouse gas savings. It's often pointed out that a carbon tax may be more permanent than detailed interventions that may be abandoned later because they prove to be ineffective or have unintended consequences.

A wide variety of specific climate initiatives could be replaced with a carbon tax. Economic theory suggests that this might produce more cost-effective emission reductions and that they would more fully penetrate the entire economy. Nonetheless, there are arguments against this approach, some of which reflect the skepticism of market theory and place greater trust in

governments to determine resource allocation. These important debates show how energy policies and overall economic policies are intertwined. What we do know, if measures are not increased worldwide (with or without broad pricing policies such as a carbon tax), is that we are not going to reduce worldwide emissions sufficiently to avoid unacceptably high greenhouse gas concentrations.

What are the developments and related potential scenarios to shape the Turkey energy outlook in the near future?

Difiglio: The Istanbul International Center for Energy and Climate (IICEC) possesses a model of the Turkish Energy Economy built on "bottom-up" calculations reflecting a detailed inventory of every existing or planned power plant, an inventory of all other energy capital and the current and expected economic and thermodynamic performance of each energy technology. Using this analysis, IICEC has developed scenarios for Turkey as part of its forthcoming Turkey Energy Outlook. The Turkey Energy Outlook includes a Reference Scenario that will show the outcomes of current policies and trends, and an Alternative Scenario to achieve more challenging targets for localization, including less dependence on imported energy and imported energy equipment as well as realizing untapped energy efficiency potential. This is achieved through increased renewable and nuclear energy and wider efficiency improvements backed by policies, market forces and technology advancements. It also brings about more market transformation to produce gains for the energy ecosystem and the wider energy economy.

What would you say about the current dependency level on fossil fuels? What are the future expectations in this regard?

Difiglio: IICEC's Turkey Energy Outlook will show a rapidly decreasing reliance on fossil fuels in the electricity sector. This is achievable due mainly to the government's support for renewables and the economic competitiveness of renewable energy. Policy objectives to introduce nuclear power into power generation portfolio also contributes to lowering fossil fuel imports. As just mentioned, the transport sector is more challenging. Even with the significant uptake that IICEC expects for electric cars in Turkey, and government initiatives to reduce the share of road transport, Turkey will still need oil imports for road freight where electrification is not expected on a large scale. Mode shifts to rail will help and hydrogen-powered trucks could well be in Turkey's future but the time horizon for this is more difficult to predict. Again on the demand side, Turkey will still need gas imports to supply natural gas for heating in buildings and some industries. Energy efficiency potential also provides savings potential in fossil fuel imports.

What are the geopolitical tensions which would bring uncertainties in the energy?

Difiglio: After U.S. reserve oil production capacity dropped to zero by 1970, the United States was no longer able to balance world supply and demand and stabilize world oil prices. This had been accomplished by the Texas Railroad Commission that set monthly Texas oil production quotas based on world market conditions from about 1930 to 1970 and produced an era of relatively stable oil prices. With the oil embargo of 1973, we saw the first consequence of no U.S. reserve capacity as oil prices quadrupled and then, again in 1979-1980 oil prices doubled with the Iran-Iraq War. Since then, geopolitical tensions on energy were synonymous with concerns about the Middle East and North African oil production. We've now entered a new era where hydraulic fracturing has reestablished a strong role for the United States in

maintaining stable oil prices in the face of unplanned outages of oil production. In addition, the ample supplies of oil have made the world oil market much more competitive.

Geopolitical tensions about gas have recently overtaken concerns about oil. Specifically, there are controversies about Europe's dependency on Russian natural gas supplies. However, just as tensions in the oil market were initially reduced by the substantial increase in non-OPEC oil production capacity in the decades following the 1973 oil crisis, we could see the same thing happen in the international gas market. Increased gas supplies and the diversification of gas supplies should ameliorate concerns about the role of any particular supplier especially if all suppliers are obligated to respect competitive market rules.

Turkey is playing an important role in this with the opening of the TANAP pipeline bringing Azerbaijani gas into the market. Turkey could play an even more important future role if it established a physical natural gas hub and trading center. This would establish a much-needed hub pricing for the region and ensure that gas transit and trading through Turkey reflects competitive market conditions. Spot LNG supplies from multiple countries are also giving consumers an advantage in negotiating pipeline gas contracts. We should expect market forces over the next several years to create continued supply diversity and reduced geopolitical tensions about natural gas trade.

Are the precautions taken enough to increase energy efficiency?

Difiglio: Energy efficiency is the most challenging energy policy problem, not only in Turkey but around the world. In particular, the building energy efficiency problem has not been solved in many places around the world and this is a "low-hanging-fruit" for saving energy if the right incentives can be devised to encourage retrofits and strengthen new-building efficiency measures. Part of the energy efficiency problem in all sectors is having a business model for not using energy. It is more natural to make money by selling energy. Energy efficiency is often quoted as the "first fuel" but we should not forget that it is also an area where sustained actions are needed to achieve longer term significant benefits. This is part of the reason that strong leadership from policy makers is needed to achieve energy efficiency.

Regulations and incentives are required. For example, Turkey's recent National Energy Efficiency Action Plan establishes many important actions such as new energy efficiency requirements for new buildings and the establishment of an energy performance certificate program for existing buildings. These building policies, as well as the policies for the other energy sectors, will be discussed quantitatively in IICEC's forthcoming Turkey Energy Outlook. What I can say here is that we need to see "Action Plan" policies world-wide to make energy efficiency a top climate priority for the planet. Many have said that energy efficiency is the largest and most cost-effective clean energy supply. I fully agree with that.

What about the oil demand outlook?

Difiglio: Oil demand growth is tapering off and the IEA shows it slowing to zero by around 2040 with growth in freight, aviation and petrochemicals offsetting reductions in oil consumption by private automobiles. This outlook suggests that the oil market will remain competitive although questions remain about what oil production additions will be made to offset declines from existing fields. Right now, there may be too much confidence that the United States will continue to increase world oil supplies indefinitely and too little concern about major oil companies suspending most of their complex projects due to low prices.

What are the current, traditional energy security risks? What are the new dangers that the states should pay attention to?

Difiglio: I've already mentioned the major traditional risks. The new danger concerns cyber-security of the electric grid which is part of a larger cyber security problem. These threats range from independent malicious actors to the potential use of cyber warfare by states. Modern electricity services are taken for granted until they suddenly disappear. Temporary blackouts, while infrequent, are not unfamiliar events and societies manage to cope with them when they occasionally happen due to extreme weather events or other problems. What hasn't been experienced is an extended urban blackout where civil disorder and chaos may make citizens feel that they are trapped inside of a dystopian zombie movie. While this does not receive a lot of attention, it is probably the most important energy security risk faced by economies that are increasingly dependent on economy-wide systems of electronics and computers that have insufficient cyber security safeguards.

Every element of the electric generating system, from power capacity, transformers, transmission and distribution grids, and smart end-use, is vulnerable to malicious attacks. In addition, as our grids become more sophisticated and take advantage of digitalization, they indeed become more vulnerable to attack unless resiliency is built-in. While I don't have objective numbers to back this up, I believe that the cyber security investments are one or two orders of magnitude below what the problem deserves. My perspective on this comes from my experience as Deputy Assistant Secretary for Energy Policy at the U.S. Department of Energy (DOE).

Consequently, I will only speak for weaknesses in the U.S. environment, but I imagine that the problem is not very different in other countries. One problem is the complex structure of power sector regulations and distribution of regulatory authorities among different actors which has made it quite difficult to give any single player an authority for cyber security. The DOE did not have adequate power to enforce cyber security and its $100 million budget authority was very low.

As a result, the legal structure to require cyber security measures is almost entirely lacking. In addition, cyber security is such a fast moving technological problem. That's why, even if DOE had the authority, it is difficult to know exactly what the most effective measures would be. Cyberspaces are rapidly evolving as well as the inter-relationships among them. This is one of the reasons that the Internet is so dynamic and successful. Cyberspaces have different qualifications as to who should be in them. One group that is necessary to all cyberspaces is the platform or network personnel that manage it. Intruders not only bypass the safeguards controlling who enters different cyberspaces but also capture the authority to operate as network personnel and control the space. This may be done for criminal profit by accessing passwords and committing bank fraud, bribery or other criminal activity. The intention may be to sow disinformation or shut down services for a variety of motives from personal revenge to cyber warfare. Coming up with systematic measures to prevent these intrusions and deceptions is quite difficult because too little is known about each of the cyberspaces that may be vulnerable.

Fortunately, the cyber security of vital infrastructure can often be significantly enhanced with only basic and obvious changes to obsolete network practices. For example, hackers recently gained access to a U.S. nuclear plant by phishing, something that should have detected by maintaining good computer security awareness. Fortunately, the hackers did not gain access to

systems that controlled the nuclear reactor, but the incident highlighted the need to correct obvious security flaws. The largest problem really is indifference to the problem.

Given the developments in the energy systems, is the world still dependent on the oil supply of Middle East?

Difiglio: Yes, the Middle East still produces almost a third of the world's oil and the world needs that oil supply. Markets are now much less sensitive to relatively small long-lived outages from the region or large short-lived outages due to high levels of commercial oil stocks. This represents a change from past years when oil markets were hypersensitive to oil supply risks. However, this should not be a signal to be complacent about oil security. The United States might not continue to supply the lion's share of future world oil demand growth. Investments in complex conventional oil projects have dramatically declined, production from mature fields continues to be masked by higher U.S. production and supply risks still remain among several major oil exporting countries.

Depending on a complicated interplay of many different and uncertain factors, a tight oil market with greater oil supply risks could re-emerge. If so, future unplanned oil supply outages could again cause large price spikes that would damage the economies of industrialized countries. Consequently, maintaining global strategic oil stocks remains a priority. Ensuring and coordinating strategic oil stocks remains a key responsibility of the International Energy Agency. It is also one of the reasons that the IEA is engaging the large energy-consuming countries outside of the OECD, as over half of the world's oil consumption is outside of the OECD. While China is doing its part to hold emergency oil stocks, few other non-IEA countries maintain significant reserves.

Turkey's economy is expected to play a key role in the energy sector until 2040 by increasing orientation to local sources.

Difiglio: In IICEC's Turkey Energy Outlook, renewable energy plays the key role in the power sector, particularly from wind and solar PV out to 2040 as well as bringing down Turkey's carbon footprint, reducing its energy import bill and increasing the localization of the Turkish economy. Geothermal and biomass capacities also increase substantially while hydro remains an important part of the total installed capacity. A large majority of net power capacity additions from 2020 to 2040 will be from renewable energy in IICEC's Alternative Scenario.

Renewables offer an important potential for energy supplies beyond power sector. A particularly important use is providing energy from Turkey's rich geothermal resource base. As discussed above, achieving transformation in the transport sector is more difficult but Turkey's targets and initiatives to introduce electric vehicles, improve vehicle efficiency, shift passenger and freight traffic from road to rail and electrify rail lines will all produce economic and environmental benefits as well as contributing to the localization of the Turkish economy and reduced dependency on energy imports.