THE THREE CHALLENGES FACING THE ELECTRICITY SECTOR

The global electricity sector is facing three major challenges: the security of supply to keep up with ever-mounting demand, the fight against climate change, and the global trend toward massive urbanization. Electricity will play a key role through low-emitting energy-generation technologies that reduce greenhouse gas emissions. These technologies already exist. Success will depend on how public policies are used to encourage innovation.

Needs and limitations and more willingness on the part of policymakers to encourage innovation programs. The first challenge will be to invest enough to keep up with the growing demand for global energy while keeping final energy costs under control. The International Energy Agency estimates that 1.4% of global GDP will have to be invested in the energy system between 2010 and 2035, or $33 trillion over 25 years. Two-thirds of these investments will need to be in emerging and developing economies to satisfy the projected 2% annual growth in primary energy needs while the remaining third will be required to replace outdated infrastructure in OECD countries.

In terms of fossil fuel production and the electricity sector, most of the energy infrastructure required to satisfy needs 25 years out has yet to be constructed. The magnitude of the challenge cannot be understated given serious and ongoing uncertainty of the outlook for the global economy, fossil fuel prices, and future environmental regulations. These uncertainties have been underscored by the recent crises – economic (financial crisis of 2008, euro zone crisis), industrial (Deepwater Horizon, Fukushima) and geopolitical (Arab Spring) – that the world has seen.

The second challenge relates specifically to the regulation of greenhouse gas (GHG) emissions. To have a 50% chance of limiting the global temperature increase to 2°C in relation to turn-of-the-century levels, global emissions will have to be reduced 50% between now and 2050, whereas under a business-as-usual scenario, emissions would almost double by that year. The energy sector is on the front line, as two-thirds of global GHG emissions are carbon emissions linked to that sector.

The third major challenge is massive urbanization, particularly in emerging and developing countries, where the trend is particularly visible since cities, even when they develop in a relatively disorganized fashion, offer a better chance of escaping poverty than rural areas. Urban growth rates have reached unprecedented levels: it took 130 years for the population of London to rise from 1 million to 8 million, but Bangkok saw the same increase in 45 years, Dhaka in 37 years and Seoul in 25 years. By 2030, the urban population will likely have doubled from 2 billion to 4 billion worldwide. Cities account for two-thirds of global energy consumption today and this will probably rise to three-quarters in 20 years. They are also responsible for 70% of global energy-related CO2 emissions and a large majority of local air pollution. This has made energy optimization a key to managing both social and environmental externalities of modern cities. To be efficient, this optimization will need to go hand in hand with systemic and long-term planning of “sustainable cities”.

To meet these three challenges simultaneously, electricity should play a decisive role within the energy system.

Tackling climate change: Electricity on the front lines
Electricity currently accounts for 40% of carbon emissions

produced by the energy sector, or 25% of global greenhouse gas emissions. A direct link can be traced between this current state of affairs and the generation mix used to keep up with ever increasing demand for electricity: two-thirds fossil fuels (41% coal, 26% gas and oil) and one-third carbon-free sources (14% nuclear, 16% hydroelectric, and 3% other renewables). Coal generation emits roughly one tonne of CO2 per MWh compared with 450 kg for combined-cycle gas turbine technology.

The IEA has made the point that the power sector is expected to account for 70% of the emissions reductions required of the energy system by 2030 to limit the temperature increase to 2°C. This will only be possible with simultaneous efforts in terms of demand-side management, which the IEA scenario assumes will enable a 40% reduction in sector emissions; massive reductions in emissions from electricity generation, with average carbon content declining by 60% by 2030 and 90% by 2050; and, further downstream, the replacement of fossil fuels with low-carbon electricity for an ever larger number of end-uses (transportation, industry and housing).

The challenge may appear daunting but is by no means insurmountable. For the next two decades, we already have low- and no-carbon generation technologies that are competitive.

On the demand side, technologies exist for a wide range of end-uses: thermal insulation in buildings, efficient lighting, more efficient electric motors, heat pumps, solar-powered water heaters, etc. Energy efficiency will make a key contribution in helping the electricity sector reduce emissions. On paper, the cost associated with related measures could be relatively low, but there is a need to monitor transaction costs, which are generally hidden and can reflect asymmetric information, behavioral patterns, household budget constraints, or the interests of the concerned parties (e.g. well-known problems that arise between tenants and owners).

On the supply side as well, there are technologies that can deliver lower-carbon electricity at an affordable price ($60-90 per MWh in OECD countries). Examples include supercritical coal-fired plants (efficiencies of up to 45%) and combined-cycle gas turbines. Most importantly, carbon-free technologies like hydroelectric, nuclear and wind power are available.

Hydropower capacity could be increased three- to fourfold from the current level, mainly in developing countries, at a competitive cost. Since hydropower is capital-intensive, financing must be facilitated in the least developed economies. It will also be crucial to monitor the impact of dams on biodiversity, population resettlement, and integrated water resource management.

Nuclear power is also competitive. Without prejudging the full results of analyses of the recent Fukushima accident, it seems clear that projects will be subjected to more restrictive and selective standards, with more emphasis placed on observance of the highest safety standards: this will mean plants which further reduce risk in the face of extreme events, and national safety authorities and international governance bodies (IAEA, WANO, WENRA) that have more power in terms of controls, permitting and the sharing and implementation of best practices. These are key elements for the technology to be accepted. Acceptance also hinges on clear and consistent permitting and public debate procedures for the entire cycle (from fuel to waste management, with plant operation in between). For nuclear power to be competitive, industrial operators must be able to control costs as well as construction times, taking advantage of economies of scale and standardization. This was one of the main reasons why many projects fared so well in Continental Europe in the 1980s while economic failures were seen in the UK and US.

As regards wind power, land-based turbines are rapidly nearing maturity (10-30% more expensive than already-competitive generation technologies). In regions with abundant wind (more than 3,000 hours, e.g. Texas), onshore wind can be competitive already, if indirect costs resulting from the intermittent nature of the resource are well managed. These indirect costs can be broken down into three categories: costs associated with network expansion to allow transmission and development in a larger number of areas, cost of investments in additional facilities to guarantee that demand can always be met, and costs associated with dynamic network management to maintain the supply-demand balance in the short term. The IEA estimates the additional costs for a system drawing 15%-30% of its energy from wind generation at €15/MWh, or more, depending on the overall energy mix.

These technologies can make a difference. The power systems of Sweden and France, where over 90% of electricity comes from nuclear and hydro plants, emit less than seven tonnes of CO_2 per capita, compared with over 11 tonnes in Denmark and Germany, where coal makes up close to 50% of the mix (Eurostat figures, 2008).

The next two decades represent a real window of opportunity: even assuming significant efficiency gains, the IEA still projects that 5,000 GW of new capacity will come online between now and 2030, which is more than current global capacity (installed capacity in 2008: 4,720 GW). These low- and no-carbon technologies must therefore be deployed massively to avoid locking the global electric system into the same high-carbon path for a few more decades.

The importance of innovation

In the longer term, the technologies being developed today will round out our portfolio. The challenge will be to invest enough in

R&D to ensure that they emerge, cost less, and can be deployed after 2020 or 2030.

Photovoltaic solar is a case in point. Its economic maturity is measured very differently in different parts of the world. In California, sunshine is sufficiently abundant that full costs can be below €250/MWh in the residential market, while system benefits (sum of net avoided costs, from generation to distribution) can exceed €100/MWh since generation is closely correlated to peak demand (possibly avoiding network costs as well). The technology could therefore be considered mature in regions such as California within ten years if costs are halved. In Europe, where sunshine is half as abundant, generation costs are still around €300-500/MWh in the residential sector and system benefits are closer to €50/MWh. This means costs will need to be reduced by a factor of between six and ten, pushing back economic maturity into a more distant future.

Carbon capture and storage encompasses a range of complex technologies, some aspects of which have already been mastered: we know how to capture and transport carbon, and have a relatively good grasp of some storage techniques. The goal now is to integrate these various steps and move from prototypes (pilot projects of no more than a few tens of MW) to the industrial scale (for plants with capacities of 600-1,000 MW). Costs must also be reduced: the cost per tonne of CO2 is currently estimated at between €60 and €100 and can be as high as €150, meaning the technology would cause coal-fired electricity prices to double or triple. Further studies must also be conducted to test the long-term reliability of storage in underground aquifers, and carbon transport infrastructure must be developed.

Carbon-free electricity could thus play an increasingly important role in creating sustainable cities since it can meet all urban energy requirements while also reducing both carbon emissions and local pollution if substituted for fossil fuels, especially in heating and transportation. Across the entire chain, from decentralized generation to conversion into final energy services, the development of “smart” solutions will facilitate communication and the optimization of energy consumption in buildings and public spaces, transportation, decentralized generation and possibly, in the more distant future, electricity storage.

The role of public policies

There is thus no need to count on an as-yet-unidentified miracle technology to set lofty targets for decarbonizing the electricity sector. On the other hand, the transformation will come at a cost, one that must absolutely be kept in line by collectively forging public policies that create efficient incentives for consumers and producers. These policies should meet three criteria.

Firstly, they must be geared more to the long term. Time constants are long in the power industry: investment processes require three to 15 years, while plants are designed to remain in service for between 30 and 60 years, and the corresponding transmission and distribution infrastructure at least that long. A building’s lifespan can exceed 100 years.

It is generally difficult at an institutional level to set regulations that provide visibility over several decades. At the same time, the stability and predictability of market regulations over long periods depends in large part on how costs to society are kept in check. If there are doubts about these costs being efficiently managed, the risk of reversals in public policy increases considerably. A good illustration is the way in which solar incentives have been available in fits and starts in Germany and Spain: since feed-in tariff instruments did not control the quantities deployed, an unexpected surge in total subsidy amounts led the governments of these countries to abruptly change their policies.

Cost control, however, is not merely a matter of sound policy-instrument design. It is also a question of adapting the type of public intervention to the maturity of the technologies.

For mature technologies, the goal should be to encourage massive deployment in the market over the next 20 years. These options (carbon-free wind, nuclear and hydro power on the supply side; heat pumps and enhanced insulation for demand-side efficiency) are competitive with a carbon price of €0 to 50 per tonne, which could be directly financed by the market on the condition that the carbon value is fully integrated into energy markets with a long-term view, and that some market imperfections that are hindering deployment are removed.

For not-yet-mature technologies, the cost of CO2 avoided is typically a few hundred euros per tonne higher. The first step to change this state of affairs will be to launch and support R&D and experimentation programs, for instance through public-private partnerships, international research organizations and demonstration funds. This will enable massive deployment further down the road, within a decade or two, if the gap in competitiveness is bridged.

Secondly, public policy must be founded on a coherent combination of price signals and related regulatory measures – and this at all levels of the production and consumption chains.

At every level, prices must reflect total costs to ensure investment financing over the long term and an economically efficient selection of mature low- and no-carbon technologies. In the electricity sector, additional measures are usually required to assure that investments are made in generation and transmission infrastructure in a timely manner. For instance, public debates must be opened well in advance to address acceptance concerns, permitting systems must be clear and stable to avoid delays in investments, and technical standards must be established to facilitate the integration of intermittent generation.

Further downstream, efficiency standards for electric appliances and homes can be a way to address the problems of high transaction costs (e.g. the cost of obtaining information or finding a qualified contractor) and information asymmetry (unawareness of the most efficient solutions). As mentioned above, this assumes that real costs will be reflected in final prices to avoid a rebound effect. This is an essential dimension of smart meters and smart homes, bearing in mind that the situation of the most vulnerable customers must be taken into account as well.

Lastly, we must acknowledge that the devil is in the details. Ill-adapted policies can result in serious systemic failures, as was illustrated by California's electricity crisis in 2000 and 2001, when poor market design and inconsistent regulations resulted in rolling blackouts. In Europe, the initial design of the CO2 quota system had the perverse effect of encouraging investment in coal generation since new build benefited from free allowances, a distortion that will be eliminated from the EU emissions trading scheme in 2013.

Concerns about climate change, energy security and rapid urbanization call for electricity to play an enhanced role in the energy system and economy, and the coming decades will be a real test. To attract sufficient long-term investment, effectively deploy technologies by order of maturity, and encourage technological progress, we will have to work together toward institutional innovation. Serious and chronic uncertainty about energy prices and future growth are such that the creation of a long-term collective strategy and the design of adapted regulations will be decisive. Particular attention must be paid to ensuring that interaction between the deregulated market and the regulations under which it operates gives efficient incentives over the long term, while guaranteeing that quality of service is maintained and that the full costs of energy services are kept in check.

Source : http://www.paristechreview.com/2011/09/12/three-challenges-facing-electricity-sector/