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The Electric Challenge: Getting The Story Right

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Electricity needs a new story. We've been telling the same old story for more than a century now. It's out of date, it's boring and it's wrong. If electricity is to meet the challenge it now faces, and seize the opportunities now to hand, electricity needs a different story, a better story – one that captures the dramatic changes now unfolding around the world.

You know the old story I mean. It's the one we've been telling ourselves and everyone else, all our working lives. Not surprisingly, it's the story behind much of the preparation for this particular conference, as the preliminary papers make clear. It's the traditional story about how we make and use electricity, about how we think of electricity, about how electricity fits into our lives, our economies and our societies. Those of us here today, academics, analysts and commentators, know the traditional electricity story more or less by heart; indeed we're among the key story-tellers. We tell it to politicians, financiers, business people, media people and electricity users, over and over. They listen to us. Sometimes they even act accordingly. The story we're telling matters. It matters particularly when the story we're telling is wrong.

In this traditional story, electricity is a fuel like any other fuel. In this story, someone makes electricity in power stations, and delivers it to users over a network of cables. A better power station is usually a bigger power station, farther away. Producers and users sell and buy electricity as a commodity, by the unit. Someone has to build and operate the power stations and the network. Someone has to finance these undertakings. Since the network is a 'natural monopoly', the government imposes regulations to ensure that all participants are treated fairly. Electricity users are independent. They buy their own electrical equipment and attach them to the system as so-called 'loads'. As they switch loads on and off, the rest of the system has to respond accordingly. Someone has to keep the system stable from moment to moment. Someone has to ensure that the system has enough generation and network capacity to meet the maximum possible load that users can connect. Someone has to keep your lights on – someone else, not you.

For most of the past century this was a pretty good story, good enough to be told and retold all over the world. It helped to make electricity essential to what we think of as modern society. But the traditional story no longer makes sense. It is riddled with holes that are growing harder and harder to ignore. It has lost the plot.

The electricity story used to be a documentary, based on fact. Now it looks more like fantasy, wishful thinking, out of touch with reality. The reality today is that two billion people - one-third of humanity - don't have electricity at all. Those that do have trouble keeping the lights on. The International Energy Agency estimates that electricity will require investment of $10 trillion by 2030 - more one thousand billion dollars every three years. But the past decade has cost many in the electricity business their jobs, their shirts or their companies - tens of billions of dollars of losses already. Future electricity investment could now be so risky it might not happen. The main technologies of traditional electricity - large dams, coal-fired and nuclear power stations, and overhead transmission lines - are all in trouble, financial and environmental. Yet traditional

electricity diehards are now trying to stampede us into more of the same, to make matters worse. The electricity story could become a horror story. We need to rewrite it, fast.

To get the story right we have to get the premises right. To start with, we have to get electricity itself right. Electricity is not a fuel. It's not a commodity. It's a process, occurring simultaneously and instantaneously throughout an entire interconnected circuit. A process cannot be stored. A fuel such as coal, oil or gas comes out of a hole in the ground at a particular place. If you want to use it anywhere else you must carry it there. But you can start the electricity process anywhere, in an extraordinary range of ways, from vast to minute. Electricity exists only in the infrastructure of assets that generate, deliver and use it, and through which it flows. Electricity is a function of infrastructure. Understanding this is the key to the necessary changes. You can produce and use electricity without fuel, but not without infrastructure.

Treating electricity as a commodity is therefore asking for trouble; and it is arriving, as preliminary papers for this conference illustrate. The flow of electricity through the infrastructure is easy to measure; but the price of a unit of electricity is ultimately arbitrary. The so-called 'electricity market' is illusory. The price of a unit depends not only on the price of any fuel involved, but on asset accounting, taxation, regulation, risk, subsidies, network and system effects and other factors usually unmentioned. The arbitrary price of an ephemeral kilowatt-hour is not an adequate basis for the requisite finances, transactions and business relations.

Instead of a quasi-commodity market, we should deal explicitly with the physical assets of the system - generators, networks and end-use technologies. What matters is this infrastructure - who owns it, who has access to it, who uses it and on what basis. What we need is not batch transactions in a quasi-commodity, but contracts for services.

To deliver electricity services more reliably and sustainably we need not only to upgrade the electric infrastructure - all of it, especially the end-use technologies - but to transform it. This is where the new story starts. Traditional electricity is based on a technical model dating back more than a century, to when the best available generating technologies were based on water power and steam power. Economies of scale in generating with these technologies shaped the model. You all know the result. All over the world, a century later, we still generate electricity in large remote central stations as synchronized alternating current, and deliver it to users over a network including long high-voltage transmission lines. The network is essentially radial and one-way. It also has to divide up the electricity to distribute it to loads mostly several orders of magnitude smaller than the generators.

This centralized configuration used to make sense. It no longer does. Consider some of the obvious drawbacks. Most central-station generators operate either intermittently or at only partial load most of the time, misusing costly assets. Fuel-based central generators waste two-thirds of the fuel energy before it even leaves the power plant. On many systems line losses cost another significant fraction. The configuration is inherently vulnerable to disruption, by mishap or malfeasance, over a wide area and almost instantaneously. Traditional electricity assumes that every load is essentially equivalent, requiring the same high quality of electricity. This is akin to our absurd water-management policy, in which we purify water centrally to drinking-water quality, and then use most of it for flushing toilets, washing cars and watering lawns. In the same way, we produce high-quality electricity as required by sensitive loads, then use much of it for undemanding services such as heating and cooling. Most electrical loads, moreover, are inherently intermittent or variable; but large fuel-based generators are inherently inflexible. Traditional arrangements are almost a total mismatch.

Anyone who looks dispassionately at traditional electricity has to think 'There must be a better way to do this'. Fortunately, there now is. The catalogue of innovative generating technologies already or soon to be available extends far beyond steam and water power, with very different attributes. Wind turbines, microhydro, biomass generators, photovoltaics, gas engines, microturbines, fuel cells, Stirling engines and microcogeneration all exhibit economies not of unit scale but of series manufacture; the more we make the cheaper they get. These small-scale generators can often be sited close to loads, even on site, dramatically altering network requirements and operation. Instead of a radial one-way network, a decentralized system would have a two-way meshed network, with loads and generators of broadly comparable sizes more or less uniformly distributed across the system. Monitoring and control technologies now indeed offer the possibility of completely self-stabilizing systems, in which loads and generators talk to each other continuously and react accordingly.

By moving toward innovative decentralized electricity we can tackle directly the most serious shortcomings of traditional centralized electricity. But first we have to explain and clarify this new story to policymakers. Ignore the reported 'cost of generation' by different means. It usually claims that traditional large-scale remote fossil-fired generation is 'cheaper' than smaller-scale renewable or cogeneration closer to loads. Stated in fractions of a penny per unit, with no qualification as to the accounting or financial framework, tax treatment, subsidies, risks, system and network effects or other essentials, including environmental effects, such comparisons are meaningless. They should have no influence whatever on policy. Policy determines costs - not the other way round. That indeed should be the aim of electricity policy, sensibly and coherently developed.

Consider for example taxation. If we treat electricity as a commodity, taxation applies only to the unit price, and to batch transactions in measured amounts. Even for fuel-based electricity this is unsatisfactory. For what we might call 'infrastructure electricity', such as wind, hydro or solar, such tax treatment misses the point completely. If, however, electricity is treated correctly, as an infrastructure issue, tax policy should focus not on flows of electric current but on taxation of assets in electricity infrastructure - all assets, explicitly including end-use technologies and the buildings that contain them. To upgrade electric infrastructure, to improve performance and reliability of services and reduce unwanted side-effects, differential asset taxation is key.

Until recently, such tax policies have been fragmentary, tentative and ad hoc, hardly recognized as energy policy. Now, however, innovative electricity, including small-scale decentralized generation close to loads, offers more cogent reasons and more attractive opportunities to integrate and optimize entire local systems, including both generation and the technologies it drives. End-use technologies - lights, heaters, motors, freezers, electronics and so on - and even passive infrastructure such as buildings are part of the system that delivers comfort, illumination, motive power, refrigeration, information and all the manifold electricity services we take for granted. Upgrading end-use technologies is the most effective way to deliver better services more reliably at lower cost and with lower impact. But most electricity users don't know or care enough to do anything about it. Worst still, companies whose business is selling or delivering units of electricity want us to use more, not less. Inefficient lamps and motors benefit their cash flow. More appropriate tax treatment of electricity assets, especially end-use technologies and buildings, can provide a potent incentive to invest in upgrading infrastructure. It can give the incentive specifically to those whose business it is to deliver better services.

Users do not want reliable 'electricity'; they want reliable electricity services. With local generation, under local control, driving local technologies, the responsibility for keeping the lights on can be

similarly local and coherent, and accordingly much more manageable. Moreover this responsibility can be the focus of well-defined contracts between those enjoying illumination and comfort and those providing them – a more stable, less nerve-racking business than competing to sell ephemeral units of electricity.

To me, this story feels much more coherent and convincing. Regard electricity not as a commodity but as a process delivering services. Improving the whole process benefits reliability and quality of service, while reducing vulnerability to disruption. It also offers the potential to shift progressively away from fuel-based to infrastructure generation, a key to sustainable electricity. If we can set this in train for electricity worldwide, we may eventually begin to recognize that all energy services, even including transport, are not commodities but processes. The challenge is always to optimize the entire process - an inherently positive undertaking for human society.

How do we get there from here? We have to start changing the way society thinks about electricity, and about energy. Everything else follows. That's why we have to get the story right. That's where we come in – we, the policy academics, analysts and commentators. We come in right at the beginning, right here, right now. I hope you'll come with me.