Chatham House Fossil Fuel Roundtable, 22 June 2015

Electricity Vs Fire

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What's wrong with fossil hydrocarbons? Why are so many people so concerned about coal, oil and natural gas? They're not toxic. They have versatile and valuable molecular structures. That's why we use them to make plastics, chemicals, lubricants, fertilizers and pharmaceuticals. Unfortunately, however, that is not the main reason we dig them up or drill for them. The problem with fossil hydrocarbons is what we do with them. Most of the time, and for most of the coal, oil and natural gas we use, what we do with them is burn them. We set fire to them. Our problem is not the fossil hydrocarbons. Our problem is fire.

We don't think of fire as a problem. We evolved with fire. We think of it as cosy and welcoming, the symbol of hearth and home. For most of human evolution, fire has indeed been essential and invaluable. But its greatest contribution may now be one most people might not yet recognize. Fire has made possible the human control of electricity. Electricity, in turn, may save us from fire.

Why do we need to be saved from fire? Think about it. Despite its cosy image, fire is a violent, extreme process, primitive and brutal. It produces the heat we want - but at a temperature so high it's dangerous. Fire rapidly turns resources into waste. Much of this waste is suffocating or toxic. Why can't you breathe in Beijing? Why are governments confronting each other over the Arctic seabed? Why are scientists warning of ever more extreme weather worldwide? All these urgent issues have a common cause - fire. Fire in building heaters, factory furnaces, vehicle engines and power stations is poisoning the air in cities worldwide. The craving to feed fire is why governments obsess about fuel supplies. Fire produces the carbon dioxide disturbing the atmosphere. We have let fire get out of control. Indeed we ourselves are fanning the flames.

Why do we use so much fire? Think of what we do. In purely physical terms, we carry out six activities. We control heat flow. We adjust local temperatures up or down. We make light. We exert force. We move things. We manage information. All these six activities we do with systems. In my new book *Electricity Vs Fire* I call them human activity systems. The six activities give us what we actually want - comfort, illumination, motive power, refrigeration, mobility, information, communication. We have begun to call these 'energy services'. But that is misleading. Indeed the word 'energy' itself is misleading. To scientists and engineers 'energy' is a fundamental concept, the essence of the universe. Since the 1970s, however, we have come to use the word 'energy' just as shorthand for coal, oil and natural gas - fuels to feed fire - and also for electricity, which may be based on fire, or may not. But the different fuels are not the same. They are not interchangeable, especially not with electricity. Smearing all fuels plus electricity together as 'energy' makes too many people, especially politicians, think they are the same - that one can substitute for another.

We talk about 'energy supply' when we really mean 'oil supply' - not the same as 'gas supply' or 'electricity supply'. Why do we need these supplies? That is the key detail we so often ignore. We need fuels and electricity to run *things*. In human activity systems what matters most are the *things* - lamps, motors, appliances, electronics, industrial plant, vehicles and especially buildings. What we

call 'energy services' are actually 'thing services'. Moreover, the better the things, the less 'energy' - the less fuel or electricity - we need to get the services. In all our activities the most important factor is the things, not the fuel or electricity. Oil by itself is almost useless. Natural gas by itself is downright dangerous. Electricity as we use it does not exist by itself. It's a process in things. Fuels are only useful because of *things* - the physical artefacts that do for us what we want to do.

What we call 'energy policy' today still concentrates on fuels and electricity - what we used to call 'fuel and power policy'. It takes the *things* for granted and ignores them, except as aggregates and averages of so-called 'energy demand'. But we do not have an 'energy demand', or an 'energy problem'. We have many different, specific and distinct problems: how best to carry out many different activities, with many different specific things that may - or may not - require fire, a specific fuel or electricity.

Effective policy should foster this crucial competition between *fuel* and *things*. Over the years we have burdened ourselves with a vast array of inadequate things, especially inadequate buildings. But instead of making the buildings better we pour more and more fuel and electricity into them, using more and more fire. That is like opening the bathtaps wider without putting in the plug.

We talk a lot about what we call 'energy efficiency'. In practice, however, when people talk about 'energy efficiency', they mean how well something uses fuel or electricity. This so-called energy efficiency tells you nothing about how well the thing does for you what you want it to to. A well-designed house in a temperate climate, such as a German 'passive house', can keep you comfortable year-round with no fire, no fuel, no electricity at all. For a well-designed building 'efficiency' as the term is commonly used would be meaningless.

We have to stop focusing obsessively on fuel and electricity. Efficiency is not about 'energy', about fuel and electricity - it's about *things*, making *things* better, so we need less fuel and electricity to do what we do, and do it better. The primary objective of a coherent strategy for climate, security and affordability should be to upgrade the things that do for us what we want to do, especially our built infrastructure. Then, while we are improving the things, the physical assets, we should also look much more carefully at the two processes they use - fire and electricity.

We still rely on fire for most of our activities - even when we don't need to, and despite the ever intensifying problems fire creates. To address these problems - pollution, security, climate - we should be aiming to reduce and eventually minimize human use of fire. However, because we have evolved with fire, we have long taken for granted its damaging and dangerous consequences. We still, for instance, consider coal-fired heat and electricity cheap, even as coal fire strangles our cities and upsets global climate. We need to acknowledge and account for the true cost of fire. If we do not, spurious comparisons of cost will lead us to choose disaster.

Even so, moving beyond this Fire Age will not be easy. Fire plays a central role in today's global economy. Some of the world's largest companies, and indeed entire countries, depend for their revenue on feeding fire. We already have a vast worldwide infrastructure, buildings, industrial plant and power stations, that could not function without fire. We have laid out society so that we now depend for mobility on fire, in cars, trucks, ships and aircraft. Nevertheless we use fire in many unnecessary ways, to compensate in particular for the inadequacy of countless millions of buildings worldwide. Simply improving buildings could reduce dramatically our use of fire.

We have even come to treat electricity as though it were fire. We buy and sell electricity just as we buy fuel to feed fire - as a commodity, in short-term batch transactions where what matters is the

price per unit. But electricity is not a commodity. It is a process, happening instantaneously throughout an entire system, including the user-technology that does what we want to do. Indeed making light, exerting force, moving things and managing information are themselves processes. Our human activity systems carry out these processes for us. What we need, what our transactions ought to foster, is access to these processes. Thomas Edison initially charged his customers according to how many lamps they had. They were paying to have electric light available, for access to the process, just as you may now pay rent to have access to the comfort of a home. You do not buy comfort by the unit. Comfort is not a commodity. It is a process. But for too many processes, too many services, we have drifted far along a misguided and dangerous blind alley.

Indeed within the past century we have applied the fire model not only to electricity but much more widely. Apart from food, fuel to feed fire is the only product we make that is intended to be consumed continuously, needing continuous replacement. Everything else we make - clothing, footwear, furnishings, tools, appliances, vehicles, buildings - is, or should be, durable, something that lasts. But we have now stumbled into a global economy modeled on fire and its consequences - a 'Fire Economy', what we call a 'consumer society', whose central function appears to be to turn resources into waste as fast as possible. The oxymoron 'consumer durables' succinctly pinpoints the paradox.

We need urgently to move away from fire as the model for human activities. We need to move beyond this Fire Economy, focused on consumption and destruction of resources, to one focused on process and access to process, within a durable and resilient infrastructure. Electricity holds the key. For the past century electricity has been steadily supplanting fire. Electric heaters and coolers adjust local temperature. Electric lamps give light. Electric motors exert force and move things. Electronics manage information. But we still make most of the electricity itself with fire. We don't need to. We can also harvest natural energy flows, from sun, wind and water, as useful electricity, and we are doing so more and more, around the world. Electricity as a process can now be completely independent of fire. We need urgently to accelerate the shift away from fire-based electricity to what we have come to call renewable electricity. A more telling description is 'fire-free electricity' - physical assets such as wind and water turbines and photovoltaic arrays that turn natural ambient energy into useful electricity. Human activities can become process, not consumption.

We need to establish financial and institutional ground-rules and incentives to make fire-free electricity the norm, and phase out electricity based on fire. That can start - indeed has already started - with governments. With key exceptions, most national governments are laggards. But city governments around the world are already showing the way. They have realized that their most effective leverage is not legislation or regulation. It is their role as major users of fire and electricity - highly desirable customers, who can define the business they want to do and the contracts they offer. They are upgrading their own buildings; replacing public lighting with LEDs; installing local electricity generation and cogeneration, heat networks, private-wire networks and microgrids; and publicizing these and similar projects as demonstrations for private industry and private citizens.

The crucial innovation we need is a new mindset, a new story, a new narrative, that gives us a new way to think about what we do and how we do it. We still rely on what Americans call legacy assets to keep our lights on, and that will not change over night. But minds can change much more rapidly. If we get this new story right, human activity systems may eventually converge toward natural systems. My old friend Amory Lovins says that we know three ways to make a good building material out of limestone. You can cut it into blocks. You can calcine it using fire at 1200 Celsius to make cement. Or you can feed it to a chicken. Weight for weight, eggshell is very strong material.

But we don't know how the chicken does it. And it does it at a chicken's body temperature. Our human energy systems still rely far too much on brute force, on high temperatures and violent phenomena - especially fire. Natural processes can also be violent and destructive - but creative natural processes are subtle and elegant. Can human activity systems function like human bodies, at human body temperatures? What an exhilarating prospect...

We still have a lot to learn. It's going to be hectic, exciting and scary. I can hardly wait.