

WHY MOORE'S LAW APPLIED TO ENERGY GENERATION IS MORE LIKE MOORE'S CURSE

By Steven D. Lightfoot, P.Eng.



BENJAMIN NETANYAHU, the prime minister of Israel, made a speech in 2010 to the United Nations about hope for the future. In it, he stated: “It took us centuries to get from the printing press to the telephone, decades to get from the telephone to the personal computer, and only a few years to get from the personal computer to the Internet. What seemed impossible a few years ago is already outdated, and we can scarcely fathom the changes that are yet to come. We will crack the genetic code. We will cure the incurable. We will lengthen our lives. We will find a cheap alternative to fossil fuels and clean up the planet.”

Netanyahu, in describing his confidence in the future, was expressing a commonly held assumption—that the history of telecommunications and microelectronic development will predict the development trajectory of a low-carbon/sustainable energy future.

The phenomenon he spoke of is called Moore’s law, named after the co-founder of Intel, Gordon E. Moore, who described the trend of accelerating computing development in the 1960s. He noted that the number of transistors that can be placed inexpensively on an integrated circuit has doubled

approximately every two years and this trend has continued for more than half a century.

One person who has given due consideration to the viability of applying Moore’s law to technological systems and, in particular, energy systems, is Professor Vaclav Smil of the University of Manitoba’s faculty of environment. Smil has written extensively on the history of technological development, taking a multi-disciplinary approach. His basic philosophy can be summarized in one sentence, from his 2006 speech, “Energy at the Crossroads”: “Future technical developments will not conform to simplistic notions of accelerated development and exponentially declining costs of new conversions.” He states further, “Energy transitions span generations and not, microprocessor-like, years or even months: there is no Moore’s law for energy systems.” Smil has even given a name to the belief that transitioning to a low carbon/sustainable energy future will follow a Moore’s law-like trajectory—Moore’s curse.

There is a societal cost of incorrectly believing that Moore’s law applies to energy systems development.

1. Ineffective and wasteful policies. When political leaders have unrealistic views of the likely outcomes of decisions, the result is bad decisions and ineffective policies. For example, Ontario’s *Green Energy Act* (GEA) forces utilities to buy “green” electricity, whenever available, at prices three to eight times the current cost of electricity. This extra cost is passed on to residential and industrial consumers. George Smitherman, former energy minister for Ontario, famously said that any additional cost to consumers would be minimal and that their electricity bills would increase by about 1 per cent each year. The Ontario government’s own Task Force on Competitiveness, Productivity and Economic Progress recently cited a report that shows residential electricity costs are expected to increase at an annual rate of 6.7 per cent to 8 per cent over the next five years. One of the objectives of the act is to reduce carbon dioxide emissions by eliminating the use of coal while keeping electricity costs competitive. Costs are non-competitive and the government’s own departments show that the emission reductions are minimal. The Ontario Power Authority suggested that developing more hydro power near Sudbury was a more effective option, but this was ignored in favour of the GEA.
2. Distracts from pursuing real solutions. The fundamental reason alternative and renewable energies are difficult to implement in the real world is that they are dilute. For this single reason, it is difficult to replace energy-dense fuels like petroleum with renewable energy.

If the ultimate objective is to wean our society off the use of carbon-based fuels while maintaining our material standard of living, the only real-life solution is to electrify as much of our infrastructure as possible (including massively increased public transportation), and expand the use of nuclear power electrical generation. While we in North America dither with renewable energies, France and China are taking the rational path. Nuclear power for electricity generation accounts for 80 per cent of electrical power used in France, while China has 25 nuclear power stations under construction as of 2010.

3. Sets unrealistic expectations with the public. Ask any motivational psychologist about goal setting and they will tell you it is critical to set significant, but achievable, targets for improvement. Without pushing oneself to achieve progressively better performance in any endeavour, the result is stagnation. But setting unrealistic and unachievable targets is no better. Striving for, and then failing to achieve one's goals, leads to demotivation. This demotivation can take many forms. Being sold exaggerated capabilities that are constantly unrealized, leads to a pernicious cycle of disenchantment with authority. This distrust of authority leads to progressively increasing cynicism in the population.

SOME POLICY SOLUTIONS

There is going to be a slow transition to a low-carbon/sustainable energy future. We must act now to implement government policies and regulations that are rational and lead to optimal outcomes for society. Three suggested policies that can be implemented at the provincial and federal levels are:

Set up an independent, apolitical energy advisory body

One of the challenges that democracies face in this regard is having relatively short-term election cycles. Governments and policies change on a relatively short-term basis, frustrating attempts at long-term planning. John Hofmeister, author of *Why We Hate The Oil Companies* and a former executive with Shell Oil, has written about this problem from an American perspective. Hofmeister proposes that US energy policy be set by an independent, apolitical board of governors, in line with what the Federal Reserve Board does for the monetary system. The gov-

ernors' terms would be long, like the federal governors' 14-year terms, to insulate them from political pressures and because energy projects are not short-term.

This kind of governing body, workable in both provincial and federal contexts, might operate as an expanded and more powerful version of the existing National Energy Board. This body would have to work within the constitutional and jurisdictional framework as it exists today, although its power to set policy might need to be increased. This body would comprise objective-minded business people, economists, and engineering and legal professionals who have extensive industry experience and are willing to acknowledge the long-term nature of the energy challenges facing our nation and the impending reality of petroleum scarcity. This body might set energy strategy with significant but realistic targets for weaning Canada and its provinces off carbon-based fuels. The members of this board must be progressive realists, but realists nonetheless.

Prioritize research and investment

All future systems that may be used in a low-carbon/sustainable energy economy are not created equal. There are many realities that have to be considered when evaluating and investing in the development of new energy systems.

The reality of energy density is inevitably at the top of the list. Quoting Smil again: "Rational allocation of research monies should take the magnitudes of these (energy) flows, as well as the typical power densities of these resources, into account." For example, nuclear power is very energy dense, while wave power is dilute and intermittent. Investing large amounts of research money in wave power does not make sense relative to investment in improving the safety and usability of the next generation of nuclear power.

Other realities must also be considered, including practicality, scalability, and commercial and regulatory matters. Smil adds: "Dubious claims made on behalf of small-scale, experimental and demonstration-size techniques are no substitutes for mercilessly critical appraisals based on the first principles; biased promotions of grand theoretical solutions rarely survive brutal encounters with scaling up for large-scale, reliable operations in the real world." All government monies that are invested in new energy systems must be prioritized on those systems with the greatest ability to address real-life issues.

The Canadian Society for Senior Engineers recently released a document, *Energy Compass 2020 and Beyond: A Recommended Canadian Energy Decision Framework*, that outlines the most rational approach to investment in Canada's energy future. One of the report's major recommendations is that, "the use of indigenous nuclear energy be the first choice in provinces in which hydraulic energy sources (hydro power) are either minimal or have been essentially fully exploited, followed by indigenous natural gas, oil, coal, biomass, geothermal, wind, solar and tidal in that order." This prioritization is ranked on energy density and practical usability.

Invest in a public relations campaign to educate the public

Consciously changing our energy systems to rely less (or not at all) on fossil fuels is a long-term affair, and one that is essential. As things stand today, there is a great misunderstanding among the population that there are easy and ready solutions. This is at least partly driven by unaccountable interest groups, that for decades have waged public relations campaigns telling us that the wide-scale use of renewable energies is possible. The reality of the

[POLICY ENGAGEMENT]

political process in democratic states is that politicians are driven by polls and the public mood. If the public believes easy solutions to energy problems are available, politicians will pander to it, with “easy” solutions.

There are no free lunches. Because there is a direct link between energy use and material standard of living, any rapid decrease in energy use patterns will mean a lower material standard of living. For example, forcing automakers to increase mileage will result in cars that are smaller, lighter (and possibly more expensive if using hybrid technology) and probably less safe. If they are electric (electric cars have been around for more than 100 years and have always had limited range), especially when used in Canadian winters, they will be difficult to operate and have a short range of operation. In short, they will be less than what they are today.

We need a public relations campaign to educate about the reality of the energy challenges facing our

society and the importance of energy to our lives. Encouraging politicians to do the right thing requires an educated public that understands the reality of the challenges facing us and the hard choices needed.

THE DANGER OF MOORE’S LAW

There is increasing pressure to develop a low-carbon/sustainable energy future and there is a belief that this transition can and will happen quickly. Moore’s curse, or incorrectly believing that Moore’s law applies to energy systems, leads to over-optimistic views of how things can change, which leads to wasteful and ineffective public policy and distracts our society from pursuing real, if imperfect, solutions.

No doubt your new smart phone, iPad or computer is an amazing device and fully representative of Moore’s law as it applies to micro-electronics. Just don’t assume that its existence will tell you very much about where your electric power is going to come from in 18 months, let alone 10 years.

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