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Episode #4

# Energy

The future of the digital age: an Internet energy

**The wireless electricity of the future: an interview with Martin Maier**

To take the subject of wireless energy further, Martin Maier, a researcher at the Institut national de la recherche scientifique in Canada (Canadian National Institute for Scientific Research), agreed to answer a few questions for the 2020 Badim on the possible generalisation of wireless electricity and the future of fixed-line electricity.

Martin Maier is a full professor at the Institut national de la recherche scientifique (INRS), the research branch of the University of Quebec system. The INRS is ranked first in Canada in terms of research intensity. Martin Maier joined the INRS as an associate professor in May 2005. He received his masters and doctorate degrees with distinction (summa cum laude) in electrical engineering at the Technical University of Berlin in Germany in 1998 and 2003, with a two-year doctoral fellowship from Deutsche Telekom. During the summer of 2003, he was a postdoctoral fellow at MIT. He was a visiting professor at Stanford University from October 2006 to March 2007. Among his awards, he was co-recipient of the 2009 IEEE Communications Society Best Tutorial Paper Award. He is the author of "Optical Switching Networks" (Cambridge University Press, 2008) and the primary author of "FiWi Access Networks" (Cambridge University Press, 2012).

**Badim: Wireless charging is already a reality in the mobile ecosystem, with smartphones charged by means of induction (Nokia for example). Do you think wireless charging will go mainstream and be available in public spaces ? At home?**

Martin Maier : Wireless charging by means of induction is far from novel. Those of us using an electric toothbrush at home have been benefiting from this technology for quite some time, possibly without knowing it. There might be opportunities for wirelessly charging not only low-power devices such as cell phones but also medium to high power home appliances. Wireless charging has already found its way into public transport. For instance, in Geneva, Switzerland, an electric bus service between airport and downtown will be opened later this year, where wireless overhead charging infrastructures will be installed at intermediate and end bus stops to recharge the battery mounted on top of each bus. Another interesting wireless charging technology is Bombardier’s so-called PRIMOVE wireless e-mobility solution for charging electric vehicles on the fly through underground power lines.

**What problems could be encountered if wireless charging happened to be widely deployed?**

The idea behind wireless charging dates back to Nikola Tesla. In the past, it has failed to be widely deployed due to a number of issues. Among others, some of the key issues are related to efficiency, heat dissipation, reach, charging time, and last but not least safety.

**Could we expect that in the future electricity will be only distributed through wireless networks?**

I think in the case of wireless energy we will see a situation similar to bimodal FiWi broadband access networks. Wireless networking technologies added to the convenience, ubiquity, and mobility, but rely on high-speed deep-fiber access and fiber backbone infrastructures to carry the ever increasing amounts of data, voice, and video traffic. Similar to the evolution of narrowband to broadband access networks, we might witness an evolution from wireless low-power to medium- and high-power networks over initially short to increasingly longer distances. At the aggregation and long-haul transport levels, however, we will continue to rely on high-voltage transmission lines that already exist in today's power grids. It remains to be seen what key players such as the Power Matters Alliance (PMA) with their honorary chairman Vinton G. Cerf, one of the fathers of the Internet and chief Internet evangelist for Google, are able to envision and eventually standardize in the area of smart wireless power and power 2.0.

**Why would high-voltage transmission lines still be used?**

I think that high-voltage transmission lines will keep playing an integral part of the emerging Energy Internet for a number of reasons. First, the transport segment of today's power grids with their supervisory capabilities (e.g., SCADA) is already much closer to the realization of the smart grid vision than their distribution counterparts. Second, in areas such as Québec, where most of the dams and hydroelectricity generators are located in the north of the province, high-voltage transmission lines are needed to transport the generated electricity over long distances to the south of the province, where most of Québec's population lives. Similar observations hold for hydroelectricity from Norway as well as solar-thermal power projects in deserts such as DESERTEC. Third, server farms and data centers with huge processing and storage capabilities did not disappear through the proliferation of peer-to-peer file sharing and user-generated content based Web 2.0 applications. Typically, these server farms and data centers can be found at locations that offer certain advantages, e.g., availability of low-cost real estate and energy supply, and must not be necessarily close to end-users, who remotely connect to them, e.g., video up- and downloads to and from YouTube servers. Similarly, future smart microgrids – operating in an islanded or grid-connected mode – will co-exist with the bulk power grid and may exchange energy bidirectionally, if needed.

**One grid for the future: interview with Martin Maier...**

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**Badim: You have published an article « Le jour où l'Internet sera un fil conducteur de l'électricité » (When Internet becomes electricity main thread). Could you explain in more details your approach? Is it similar to Jeremy Rifkin's one?**

Martin Maier: It all started a few years ago, when we worked on the design of “green” energy-efficient broadband access networks. We have studied various techniques to improve their energy efficiency by concentrating network traffic in the time domain (e.g., scheduling and packet coalescing) and/or space domain (e.g., routing) such that parts of the network become idle and thus can be put asleep for short or extended periods of time, also known as low power idle mode, depending on given traffic statistics. We also developed an energy management system based on advanced network coding techniques, which merge multiple packets into one, thereby reducing the number of required packet transmissions and freeing up bandwidth to be put asleep. Some of these techniques can be found in the IEEE standard 802.3az Energy Efficient Ethernet (EEE), which was approved in September 2010 and represents the first standard on energy efficiency in the history of IEEE 802.3. The motivation of our work was based on the observation that access networks dominate the power consumption of today’s Internet, accounting for roughly 70%.

Over the last couple of years, however, our focus shifted from energy-efficient access networks to smart grid communications infrastructures due to several important lessons learned. First, there exists the so-called Jevons paradox, which claims that “technological progress that increases efficiency with which a resource is used tends to increase (rather than decrease) the rate of consumption of that resource.” As a result, attempts to reduce energy consumption by increasing energy efficiency may eventually raise the demand for energy. Second, according to the GeSi SMART2020 report, the ICT sector is responsible for only 2% of global carbon emissions, whereby roughly 1/4 is embodied carbon stemming from the manufacturing process. To make things even worse, telecoms infrastructure and devices, e.g., access networks, cause only 1/4 of the carbon emissions of the ICT sector, thus rendering their environmental impact marginal. Third, manufacturers seem to be reluctant to become seriously involved due to the trade-offs between energy saving and quality-of-service (QoS) requirements of their clients’ telecommunications networks. Fourth, in its new strategic target area descriptions, the federal research agency of Canada NSERC postulates that communications networks become “less an end in itself than a means to an end” by exploiting them not only for telecommunications per se but also across other relevant economic sectors. Toward this end, our work aims at rethinking the role of optical networks with a particular emphasis on communications, energy, and transport for emerging smart grid and electric mobility (e-mobility) applications as well as bimodal fiber-wireless (FiWi) networks for broadband access.

Our approach is similar to that one of Jeremy Rifkin in that our goal is to unleash the potential of converging new communications/Internet technologies with new renewable energy systems in order to create a future low carbon society of smart microgrids and e-mobility, which hopefully will usher in Rifkin’s Third Industrial Revolution for reaching the targets laid out in the EU’s 2020 agenda and its 2050 low carbon economy roadmap. However, our approach uses a different starting point and tackles the underlying problems from a technological rather than an economic angle. In June 2012, I have launched the cross-disciplinary think tank Lee Chi Networks on reinvented networks. The world in 2030 is expected to increasingly become a world of networks, where shared interest communities will take advantage of advanced information and communications technologies. The vision of Lee Chi Networks builds on the National Intelligence Council report “Global Trends 2030: Alternative Worlds,” a framework for strategic thinking about the future, recently published in December 2012. The two future scenarios, referred to as “fusion – an age of convergence” and “the rise of nonstate actors” are of particular interest to Lee Chi Networks since the 2020s might turn into a golden age for technology and nonstate actors such as megacities, wealthy philantropists, think tanks, and universities might create new technologies that favor greater empowerment of the rising middle classes in a hyper-globalized world (visit **http://www.leechinetworks.com/** for further details). More technically speaking, our goal is to leverage on lessons learned from the Internet and explore innovative smart grid applications. Similarly to Rifkin, we believe in distributed renewables and try to gain a deeper understanding of the similarities between the Internet – “the network of networks” – and the smart grid – “the system of systems,” a term coined in the recently published IEEE standard P2030, one of the first standards on the smart grid. On the other hand, we study the limitations of such similarities given that the Internet is currently moving from distributed toward centralized paradigms (e.g., cloud-computing) and the role of human-to-human communications in the smart grid, which may be viewed as a prime example of the Internet of Things based on machine-to-machine communications. In this context, it is worthwhile to mention Nicholas Carr’s inspiring book “The Big Switch: Rewiring the World, from Edison to Google,” which elaborates on the analogies between today’s in-house computer facilities and utility-supplied computing, e.g., Google, and the in-house generators of the early days and their eventual replacements with modern-day electrical utilities, giving us the options to either repeat history or imagine unforeseen applications and services taping into the distributed storage and processing capabilities available in widely used desktops and laptops via high-speed FiWi access networks.

**WHat do you think about LIFI?**
Light Fidelity (LiFi), also known as visible light communications (VLC), is certainly an interesting alternative access technology, which may find its niche applications, e.g., on airplanes where radio interferences should be avoided. However, it also suffers from a couple of drawbacks. First, LiFi might be well suited for downstream traffic, i.e., traffic from the light source to the end user. However, upstream traffic might be not so straightforward to be realized. Second, LiFi requires that the light source is permanently turned on during data transmission, though at low power levels if no illumination is needed. In the event of a power outage, LiFi becomes unavailable for data transmission. Thus, LiFi seems to be an unlikely candidate for smart grid applications where communications is needed most for coordinating fast recovery and first response actions during (increasingly frequent) electrical power grid blackouts.

**Teclos use today Power line communications technologies for home networks to transport datas as an alternative to Wi-Fi. Will telcos also transport energy?**
Power line communications (PLC) has been studied for decades. To some extent, it resembles wireless communications. The communications channel is subject to a variety of severe physical transmission impairments, but no costly infrastructure build-outs are required since power lines are already in place, at least in most parts of the developed countries. PLC technologies may be used for in-home networking applications inside the home, sometimes also referred to as “last inch access,” as a cost-efficient means to realize home automation, security and access control, energy management, and automated meter reading. Despite recent progress on standards for PLC-based smart homes, e.g., HomePlug AV, and broadband over power line (BPL) last-mile access networks by using couplers to bypass power system elements such as transformers that would hinder broadband signals delivery, it is well known that PLC inherently suffers from a fundamental drawback. Similar to LiFi, PLC might work fine under normal conditions. During power outages, however, they fall short of availability for trouble shooting and fault management of smart power distribution networks.
As for the second part of the question, there seems to be a trend that telcos enter the energy market in both developing and developed countries. For instance, beside KT and Telecom Italia, an interesting example is Deutsche Telekom’s new offering of virtual power plants, where homes deploy combined heat and power plants on site to locally supply both hot water and power, thereby not only reducing the load on the power grid and avoiding transmission line losses, but also rendering local power supply more resilient against power outages. In some developing countries, base stations are powered by local renewable energy sources, most notably solar panels and wind turbines, and surplus energy is used for charging the cell phones of subscribers, who wouldn’t have access to power outlets themselves, for free.

**Do you think that telecommuncation and energy networks will merge?**
In brief, I strongly believe that telecommunications and energy networks will merge to reap the benefits of Rifkin’s Third Industrial Revolution. But it is important to understand in which ways. Despite recent research activities demonstrating that both fiber and wireless media might be also used to transfer small amounts of

energy over limited distances, it is anticipated that fiber and wireless technologies represent the two remaining complementary building blocks of future converged communications networks, while copper remains the energy (but not necessarily data) transmission medium of choice in future smart power grids. Over the last few decades, both types of networks have developed a rich set of engineering techniques and tools separately from each other. Unfortunately, many of today's ongoing smart grid research projects focus on either the communications or power network perspective only without investigating their interplay and complex interactions. To bridge this abyss between the communications and power network communities and enable truly interdisciplinary smart grid research, a first step will be the development of powerful co-simulation tools. Toward this end, Martin Lévesque, a student currently pursuing his PhD in the performance evaluation and co-simulation of smart grid communications infrastructures in our research group, will closely collaborate with EDF R&D on this topic during a four-month internship in Clamart, France.  Beside technological issues, regulations and business models will play a major role in making the energy Internet a reality.

**If telecommunication and energy converge, how would both ecosystems be restructured?**
This development heavily depends on upcoming regulation frameworks and policies, especially in the case of public utilities, which needed an appropriate mandate from their owning governments. The convergence of the telecom and energy sectors will give rise to novel unforeseen products, applications, and services, and will set the stage for new players who recognize the unique opportunities of dealing with some of the key challenges, e.g., intermittent nature of renewables and multimodal e-mobility, in the most resource-efficient and cost-effective manner. Borrowing from Ben Horowitz, I personally believe that products and services that seem outlandish now will pave the way to creating new markets across a variety of different economic sectors and stimulate new desires among the Generation Y, for whom sharing products appears more appealing than possessing or consuming them. As Rachel Botsman, the acclaimed author of the influential book "What's Mine is Yours: How Collaborative Consumption Is Changing the Way We Live," puts it: "The currency of the new collaborative economy is trust" by sharing through the use of appropriate network technologies, giving rise to the so-called share economy.