

'A Tale of Two Cities'

The transition of the electricity sector

Ralph Sims

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Article abstract

There is no doubt that the issue of environment has become one of the most important of our generation. Whether people contest global warming with passion or want to preserve planet Earth with the most radical methods, the issue generates ardent debates that leave no one indifferent. After having spent nearly four years at the International Energy Agency in Paris, Ralph E. H. Sims has recently returned to his position as Professor of Sustainable Energy and Director of the Centre for Energy Research at Massey University in New Zealand. He is also an IPCC (Intergovernmental Panel on Climate Change) Co-ordinating Lead Author for several IPCC reports covering energy supply, integration and transport. In an essay based on a solid knowledge of the environmental issues and written with a dose of imagination and a touch of humour, he offers his perspectives on a rather dark future for those who prefer the status quo and a brighter one for those who defend a vigorous action in favour of the environment.

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Abstract: There is no doubt that the issue of environment has become one of the most important of our generation. Whether people contest global warming with passion or want to preserve planet Earth with the most radical methods, the issue generates ardent debates that leave no one indifferent. After having spent nearly four years at the International Energy Agency in Paris, Ralph E. H. Sims has recently returned to his position as Professor of Sustainable Energy and Director of the Centre for Energy Research at Massey University in New Zealand. He is also an IPCC (Intergovernmental Panel on Climate Change) Co-ordinating Lead Author for several IPCC reports covering energy supply, integration and transport. In an essay based on a solid knowledge of the environmental issues and written with a dose of imagination and a touch of humour, he offers his perspectives on a rather dark future for those who prefer the status quo and a brighter one for those who defend a vigorous action in favour of the environment.

Résumé: Incontestablement, l'enjeu de l'environnement s'est imposé comme l'un des plus importants de notre génération : que l'on défende avec force les méthodes les plus radicales pour préserver la planète ou que l'on conteste avec véhémence le réchauffement climatique, le sujet suscite des débats passionnés et ne laisse, des citoyens aux dirigeants, personne indifférent. Après avoir passé près de quatre ans à l'Agence internationale de l'énergie à Paris, Ralph E. H. Sims a retrouvé récemment son poste de professeur spécialiste des énergies renouvelables et directeur du Centre pour la Recherche sur l'énergie à l'université Massey de Nouvelle-Zélande. Il est également un auteur/coordonateur de plusieurs rapports pour le Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC). Dans un essai-fiction reposant sur une connaissance précise des enjeux et écrit avec une dose d'imagination et un zeste d'humour, il offre ses perspectives sur le futur auquel sembleraient se condamner les partisans du statu quo et le chemin qui pourrait s'ouvrir devant les tenants d'une action plus vigoureuse en faveur de l'environnement.

Ce texte fait partie du dossier publié sur Sens Public : « Embrasser le 21^e siècle, enfin ?¹ »

¹ <http://www.sens-public.org/spip.php?article721>

A Tale of Two Cities – The transition of the electricity sector

Ralph Sims

Based on the lives of fictional people, these two tales² contrast a business-as-usual, fossil fuel future out to 2050 and beyond (Bleak House), with a more optimistic future (Great Expectations) in which new clean technologies have been rapidly adopted to provide citizens with safe and secure energy services at all times, at a relatively cheap price, and also giving a reduction in annual greenhouse gas emissions.

The article has been modified from the "Vision" contained in the 2009 International Energy Agency publication, Cities, Towns and Renewable Energy – Yes In My Front Yard³, also written by the author. In reality, the world in 40 years time might end up being somewhere between these two scenarios.

'Bleak House'

2015

On a day with yet another record high temperature, Jay was not too surprised to hear his office air conditioner being turned off automatically at 5pm by the power utility to avoid exceeding the peak load capacity of the supply system. The brand new office building had been designed and built by the engineering company that now used it as their headquarters. Jay had worked for them since graduating last year with the same *Bachelor of Engineering* degree that his father had received 30 years earlier.

He left work to drive home through the city suburbs, knowing that the roads would be congested all the way at this time of the evening. However, crawling along in the traffic did give him time to read the many advertising signs, especially those posted everywhere from the government saying: "A bright future is assured– our coal resources will last for decades."

² *A Tale of Two Cities*, *Bleak House* and *Great Expectations* are classic novels written by English author Charles Dickens in the late 19th century.

³ Available from http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2183

However, the billboards didn't mention that the world price of coal had soared in recent months due to the rapidly growing demand after the end of the global financial crisis in 2011. With the local natural gas fields nearing depletion, a liquefied natural gas (LNG) terminal was under-construction on the coast. However, perceived risks had constrained the planned expansion of the national gas distribution network and led to the electricity demand increasing even faster than had been anticipated.

Jay knew there was growing evidence that climate change was causing these extreme summer temperatures. Flooding in the city was also now becoming routine. As a result city ratepayers were being levied in order to fund the construction of five metre high levees all along the river flowing through the town. The City Council had accepted that a loss in value for the riverside properties would be necessary in order to better protect the rest of the city, but the influential owners were objecting.

Jay's current engineering position involved analysing national policies that could impact on the firm's core business of building coal-fired power stations. For example, plans to construct a new pebble-bed reactor nuclear power plant had suddenly been put on hold again since the state-owned utility company had surprisingly only just realised that there was a world shortage of key alloy components as well as trained nuclear engineers. In addition, a proposed shared storage site for the world's high level nuclear waste had failed to reach agreement. So a further delay of 15 to 20 years left room to build more coal-fired integrated gasification plants in the mean time.

The government's hopes that carbon dioxide capture and storage (CCS) technologies would be added to these new coal-fired plants in the region had been dashed when it was found that the closest suitable storage site identified was adjacent to an earthquake fault line and also leakage was highly likely since many exploratory wells had been drilled around the area when seeking more oil. Hence, the risks were deemed too high to proceed. It was considered by the utility that CCS would be unlikely to occur for some years yet, thus avoiding the additional cost on generation. Therefore business-as-usual was the obvious way to proceed, which more than suited Jay's traditional engineering company.

Using his cell phone feature, Jay turned on the air-conditioning in his apartment by remote control when he was still 20 minutes away knowing the power company would soon turn off the system as part of their rolling black-out strategy brought in to reduce peak loads. Upgrading the local power lines to carry more current was planned, but this area of the city had lower priority and it would probably take some years before it was accomplished. On arriving at the studio apartment, a quick check of his E-mails showed his power bill was due, but with the additional comment: *The company values you as a customer but is sorry to inform you that once again*

electricity prices will have to be increased due to rising coal-prices. “Maybe now is the time to think again about investing in a solar water heater”, Jay contemplated.

2030

Jay took his two near-teenage boys down to the nearby rainwater drainage channel to build a dam from sticks and mud. The water was fairly murky but he thought they would be all right just paddling in it. The boys had recently done a study of hydro-power dams at school and learnt about the increasing competition for water use around the world because much of the upstream water was now needed for increased irrigation during the frequently drier summers.

The hot, dry conditions had also affected the power output from the coal-fired power stations that his company had built a decade ago since the water used for cooling the plant had become a degree or so warmer. As a result, the thermal power plants were running at considerably lower efficiencies than for which they had been designed. Also, as a result of increased demands for air-conditioning cooling, the power plant was running at full capacity and the river water temperature had risen to be above the legal limit and the fish were struggling to survive. But, since keeping the lights on was the main priority, the government had turned a blind eye to this breach of environmental regulations by the utility.

A carbon charge on Co2 emissions paid by the thermal generators was first imposed by the government in 2020, after the rest of the world had finally agreed to universal climate change mitigation policies. But since it remained small, the state-owned utility was still able to show a handsome profit.

After Jay and the boys returned home he continued to work on a new coal gasification plant with CCS being built in the region by the Chinese company that now had a near global monopoly on the technology. Jay's job was to see which would be the most cost-effective design for this specific site. At the current international carbon price, and with uranium and LNG supplies both becoming scarce, Jay was confident that now was the right time to proceed. However, he still had to convince those living nearby that there were few risks involved from Co2 leakages.

Jay had previously done some analysis to show open-cast mining was the most economic option for the remaining coal reserves. Now the world demand for coal was growing, the mining company was keen to increase its land area by around 65 000 ha, currently covered by native forests. Jay was not so sure whether this was a good thing as emissions from deforestation would significantly increase the total carbon burden of the nation. However, since his company stood to benefit from further involvement, he decided to keep this analysis to himself.

2050

Leaks in Jay's 70 year old apartment block roof had been getting worse. A grant sought for the roof renovation by the building owners, also enabling them to retrofit solar PV cells and heating systems had been integrated into the roofing tiles, had been declined. In spite of the best intentions by the local government, all grant funding was being diverted to pay for critical climate adaptation measures such as renewing the building foundations that were collapsing due to the underlying clay sub-soil drying out in the hotter summers, and further increasing the height of the levees as the rising sea levels increased the river depth up-stream.

His grandchildren had visited recently but he knew they did not really enjoy coming to this decaying old part of the city. The eldest grandchild was already planning her future career as a carbon trader. She had thought about becoming an electric power line planner, but did not like the idea of being given the authority to displace people from their homes and farms to ensure the power got to where it was needed at all costs. Jay had advised all his grandchildren to consider training as sustainable energy advisors because this, he thought, was where the future now lay.

Looking back on his own career, he noted that only the coal-fired power plants suitable for adding CCS retrofits had been allowed to continue operating and, due to lack of foresight in planning for CCS retrofits when most of the plants were built, these were relatively few in number. But what caused Jay to reflect the most was why, when the threat of climate change had been understood for so long, had decision-makers not taken some drastic steps to combat it earlier in history. On planning his retirement, Jay and his wife had contemplated moving to one of the thriving new cities being built in some of the more wealthy countries of Africa. As the United States President had predicted some 40 years previously, the countries with good renewable energy resources and the ability to best use the newly developing technologies, (then in their infancy), would become the future world leaders.

'Great Expectations'

2015

Joy sat comfortably in her sunny new office. Having recently graduated with the new *Bachelor in Sustainable Energy and Building Design* degree, she was less in awe than some of her older colleagues that the building remained comfortable all year round whilst using only a third as much electricity compared with the similarly sized, 1980s, tinted glass building across the road.

Since the District Plan approved in 2012 had ensured that all new buildings would have solar water heaters installed, the architects had integrated solar panels into the roof and followed stringent design and orientation guidelines in the Building Code to enable the building to capture solar heat in winter, gain shade in summer, and benefit from natural ventilation and natural light. The small extra capital costs involved would soon be paid off by the electricity savings made. Joy's new job involved explaining to other building owners where the benefits of energy efficiency lay.

At 5pm, her message device told her the next electric bus with a seat available would be outside her office building at 17:09 hours. On the route home she always enjoyed catching a glimpse of the wind turbines on the hills since she had invested in a small ownership share, as had many others living in the vicinity. Early concerns over the variable power output had been largely overcome by more accurate weather forecasting; integration of demand-side management controls, and the construction of a back-up bioenergy combined heat and power (CHP) plant. In addition, the operators of the local network had been trained to run a more flexible system giving priority access to local wind, bioenergy and solar generation before importing any power from the national grid.

On reaching her small, terraced house, she could just hear the low hum of the ground source heat pump which had been extracting heat from inside the house intermittently during the day as the ambient temperature rose. The meter in the entrance showed at a glance that the house had experienced a steady temperature of 20°C all day long; the solar hot water temperature had risen to 62°C with no need for any electric back-up; and the payment currently being made to the local power company was only \$0.08/hr, mainly for the refrigerator. Even at this low cost, Joy still liked the idea of generating some of her own power on-site, with any excess to be sold to the grid.

2030

The shares that Joy owned in the three local wind-farm co-operatives had paid sufficiently high dividends recently for her to spend a few days travelling overseas. Air fares had increased due to the international carbon charge, but this had been partly offset by many airlines using

cheaper, 2nd-generation, biofuel blends. She had just returned from visiting several African countries which had developed rapidly after realising the full benefits of producing biomass on a sustainable basis for their own production and consumption of electricity, process heat and liquid fuels. Adequate food and fibre production had been maintained due to improved farm management, including a significant reduction in the wastage of water, fertilisers and chemicals by applying new methods. The additional revenue, including from incorporating carbon into their soils in the form of “bio-char”, had proven a good incentive for farmers to take-on the new technologies and want to learn more. The dream of true integrated production of food, fibre and animal feedstocks along with biomass grown for CHP feedstock and biofuels, and without any further deforestation occurring had been made possible.

Electricity generated from wind turbines, small run-of-river hydro schemes, and concentrating solar power systems, was being sold into the nearby cities. The extra revenue was welcomed by the landowners who were also pleased to welcome eco-tourists, such as Joy, coming to learn about these new techniques and to observe the resulting societal benefits to the local communities.

On returning home from her vacation, she was pleased to recall having taken the initiative 10 years ago to have encouraged the company’s Board of Directors to diversify into installing renewable energy technologies. She had explained then how being able to give professional advice on their selection and integration into buildings and existing energy systems would become good business. Now that almost all homes and buildings had “smart meters” installed, (enabling the owners to save money by avoiding peak power charges and to earn revenue by selling any power generated in excess to the local demand at any moment in time), sales of solar PV panels, micro-turbines, and horizontal wind turbines fixed along the roof ridge, had rocketed.

Joy’s own home was used as a demonstration by the local power distribution company, which owned the lines and from which she was leasing her solar equipment. Details of the dwelling’s varying power demand and supply variations were monitored on a one minute averaging basis. Most people were interested in learning how to manage such a system to avoid high demand loads when necessary, but without impacting on their convenience or lifestyle.

2050

Joy’s niece arrived, having driven her electric pod (with “artificial photosynthesis” organic solar collector coatings integrated into the paintwork) along the automatic “super-conductor highway” which, once reaching it, had immediately taken over control of her vehicle. Travelling north she still found it hard to believe what Joy had told her, that cows and sheep used to graze this countryside, now covered in grapefruits, grapevines and greenhouses, interspersed with

concentrating solar power and energy storage systems. All unused organic material was collected for use in biomass refinery plants that produced a range of bio-products, including liquid biofuels and 2nd generation bio-char which was pulverised and then incorporated into cropping soils as a conditioner and water-absorbant. As a result, crop yields were higher and carbon was removed from the atmosphere, leading to the hope that negative global carbon emissions could actually be achieved within the next decade. It was now internationally agreed that the only way to stabilise atmospheric greenhouse gases below a target of 450 ppm Co₂-equivalent was by severely reducing emissions further each year with the aim of soon reaching negative emissions.

Her aunt had recently retired after 35 years working for the same progressive energy company. The last coal-fired power station that had not been suitable for CCS retrofitting had been closed down a decade ago. Joy was able to explain to her that throughout her working life, she had watched the CCS technology develop after a slow start, but that today, when linked with biomass conversion technologies, it was also helping to actually reduce Co₂ atmospheric concentrations. She and Joy had also discussed the demolition plans for the few old-fashioned, ugly transmission line pylons remaining near the now decommissioned power plant. They could both understand why people in the old days did not want them built close to where they lived, and how public opposition had led to the integration of superconductor electricity grids into the new electric highways that she had been travelling on.

Joy helped her niece super-integrate her electric pod with the house in order to get a rapid recharge of the digital storage system, but also, when necessary at times of peak load, to help the overall energy system by adding to the total storage on-line that could be called upon and that earned some useful revenue. The meter installed in the vehicle recorded all the charging, discharging and back-up that the vehicle storage supplied.

Joy's new house incorporated all of the very latest smart appliances and communication technologies and used virtually no external energy for heating or cooling. She knew this was why her niece was always keen to come and visit. On rare occasions when the solar roof did not collect enough energy to heat, cool or top up the latest energy storage device based on scandium/molybdenum/silicon gels, Joy could import electrons from the national grid using the innovative, high frequency, laser-tronic radiation beams. Surplus power could be exported in a similar manner. The new "ultra-smart" meter in the hallway recorded time-of-use, time-of export, time-of-import and calculated the costs and revenue earned based on the relevant time-of-use tariffs that were in place at those particular times.

Based on her years of experience working with the electricity industry, Joy understood how thousands of micro-generators – some similar to her own, others using different technologies – were synchronised and controlled as a virtual power station in her neighbourhood. Large

traditional hydropower plants, (or nuclear and thermal CCS plants in other regions) continued to remain in operation to give base load stability. However, over the past two decades or so, the predicted growing power demands had been partly offset by improved energy efficiency measures and the uptake of more solar water heaters and ground source heat pumps. Demand was also partly met by the increased total capacity of the distributed energy systems. She had explained on many occasions at community seminars how the central internet-based system controls the varying supply/load balance at any given moment. As a result, the power supply was reliable, the cost savings were substantial – even after allowing for the capital investment of the mass produced technologies – and the entire power sector was now fully decarbonised.

In summary

These two visions are presented simply to stimulate the reader to contemplate the question of what sort of world people may want to inherit. They are examples of possible futures with very different but plausible outcomes, based on the social and political choices being made today. Both are based around the deployment of technological developments and market realities that could, at least in theory, occur in many countries. Either scenario could conceivably occur during the next few decades. Whether people in general would be happier with their lifestyles under one scenario more than the other is difficult to assess. Certainly it seems today that ready access to abundant supplies of energy for many people, mainly in OECD countries, does not appear to increase their “happiness rating” above those with access only to basic energy services (assuming they have sufficient food and clean water supplies).

Significant investment in appropriate RD&D today is essential if the desired transition to a *Great Expectations* energy future is to be achieved (Fig. next page). Accepting the strong likelihood that there will be technological developments by 2050 that have not even been thought of today, there still remains the opportunity for the present generation to influence the sort of world we would like the future generations to inherit.

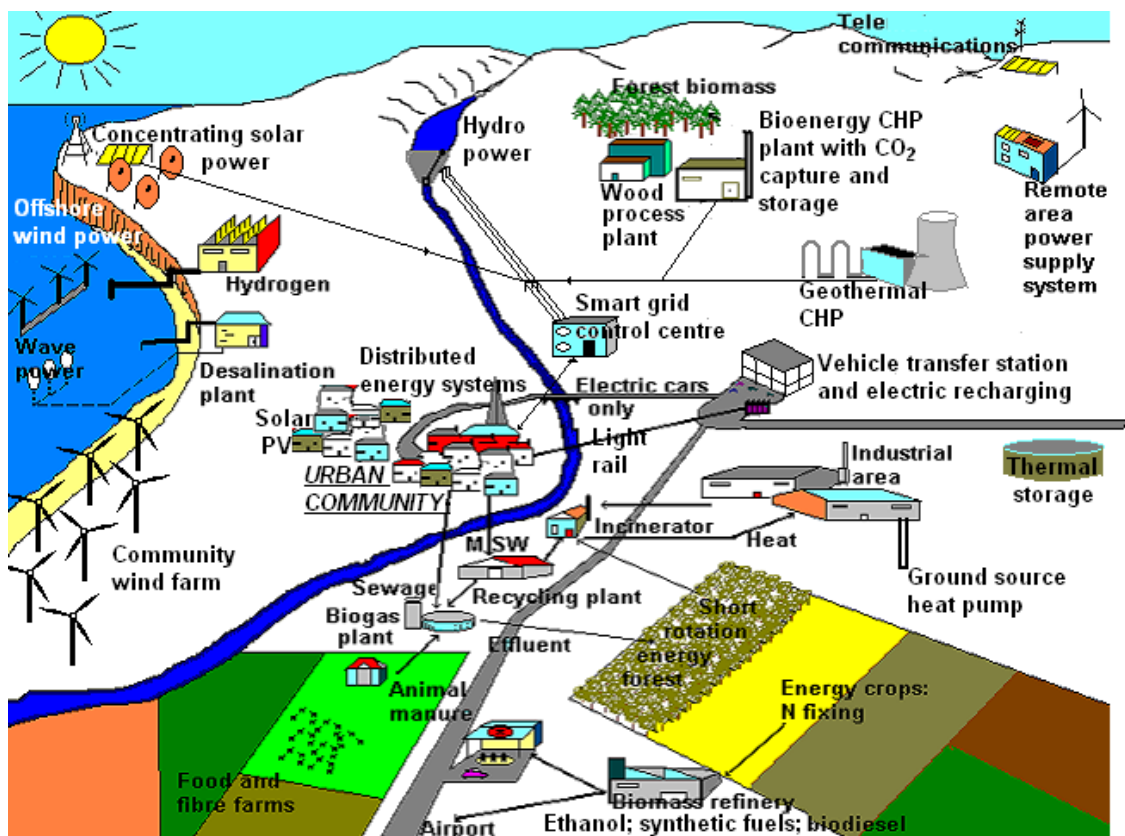


Fig. Producing significant shares of heat, power and biofuels from locally available resources including solar, wind, ocean, geothermal, energy crops and biomass from wastes, could be a future option for a municipality.