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Viewpoint

CEST conversation with Prof. Marc A. Rosen: Evolving responsibilities and contributions in science and engineering for global carbon neutrality transitions

Marc A. Rosen[1,*], Yuekuan Zhou[2,*]

[1] Faculty of Engineering and Applied Science, Ontario Tech University, Oshawa, Ontario, L1G0C5, Canada
[2] The Hong Kong University of Science and Technology (Guangzhou), Guangzhou 511453, China
*** Corresponding author:** Marc A. Rosen, marc.rosen@ontariotechu.ca; Yuekuan Zhou, yuekuanzhou@hkust-gz.edu.cn

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Introduction

Prof. Marc A. Rosen is a Professor of Mechanical & Manufacturing Engineering at Ontario Tech University (formally University of Ontario Institute of Technology) in Oshawa, Canada, where he served as founding Dean of the Faculty of Engineering and Applied Science. Prof. Rosen has served as President of the Engineering Institute of Canada and of the Canadian Society for Mechanical Engineering. He has received numerous awards and honors, including an Award of Excellence in Research and Technology Development from the Ontario Ministry of Environment and Energy, the Engineering Institute of Canada Smith Medal for achievement in the development of Canada, and the Canadian Society for Mechanical Engineering Angus Medal for outstanding contributions to the management and practice of mechanical engineering. Prof. Rosen received a distinguished scholar award from Toronto Metropolitan University (formerly Ryerson University) and a Mid-Career Award from University of Toronto. He is a fellow of the Royal Society of Canada, the Engineering Institute of Canada, the Canadian Academy of Engineering, the Canadian Society for Mechanical Engineering, the American Society of Mechanical Engineers and the International Energy Foundation.

Dr. Yuekuan Zhou is an Assistant Professor at the Hong Kong University of Science and Technology (Guangzhou), Affiliate Assistant Professor in Department of Mechanical and Aerospace Engineering, The Hong Kong University of Science and Technology. World's Top 2% Scientists (2021–2024) for both Career-Long Impact and Single-Year Impact. Best paper award in CUE 2020, winner of excellent PhD Award (2021) in the 2nd International Conference on Energy and Built Environment. At present, as first/corresponding author, Dr. Zhou has published over 100 papers in top journals, like *Nature Communications, Energy & Environmental Science, Cell Reports Physical Science*, Renewable & Sustainable Energy Reviews and so on. Total citation over 4000, H-index 42, 6 highly cited papers. As a PI, he has hosted several national/provincial/university projects with total amount over eight million RBM. He was invited as an external reviewer for the ASTAR mega low-carbon project in Singapore (over millions RBM). His research aims at achieving smart zero-energy and zero-carbon district energy systems for carbon neutrality and climate change mitigation, via cleaner power

production, energy-efficient system design and operation, innovation in smart energy integration, multi-objective optimization on nonlinear dynamic behaviours with artificial intelligence. He has rich experience in theoretical modeling, system analysis and multi-objective optimization of energy systems. Editor board member of Energy Nexus (IF 8.0), Carbon footprint, AI & materials, Young Editor board member of Nexus (Cell press). Member of the editorial board for the journal *Clean Energy Science and Technology* (CEST) and serve as an associate editor in the field of distributed energy systems and smart energy.

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Question 1:

Dr. Yuekuan Zhou:

Firstly, as you know, we successfully organized our first international conference in July this year and invited global professional researchers to share and discuss their latest studies. In that conference, you gave a wonderful and comprehensive keynote entitled "Exergy Analysis for Efficiency Improvement and Environmental Impact Mitigation." You illustrated the viewpoints presented in that lecture through examples and case studies to enhance the audience's understanding and emphasized the potential of exergy analysis. What do you think about this international conference, and do you have any recommendations on how to significantly improve the global impact of our conference?

Prof. Marc A. Rosen:

Thank you very much. It's a pleasure to be here and to interact with you. I enjoyed participating in the conference, and I'm happy to discuss it further. You asked what I thought of the conference. Simply, I found it very interesting. It was on an excellent and timely topic. Clean technology and clean energy are both critical areas for us right now. When I say "us," I mean our countries and the world. Some of the major challenges we face are being addressed in this conference, which means it can have a very important impact on how we move forward as a society. So overall, I found it to be an excellent conference that attracted a great array of very qualified people. It was interesting to hear the different viewpoints from experts who really understand their fields.

As for your second question, on ways to possibly improve the conference, I laud you for asking as I'm sure all conferences can be improved. Some ideas. Getting the word out and getting more people interested from a broad array of countries brings a fruitful mix of people together. I would suggest that the conference tries to go beyond pure research into the innovation area where we straddle pure research and getting research into the marketplace. We should look to bring in people from industry to talk about the implementation of research, even possibly some government representatives to discuss strategy and policy that allow us to take the research and make it practical in the real world. Introducing

sustainability and sustainable technology as an extension of clean energy is to me a good idea, to be more holistic.

Question 2:

Dr. Yuekuan Zhou:

Thank you very much. We will definitely take your suggestions into account for our next conference. My second question is about carbon neutrality. Carbon neutrality has been regarded as one of the important pathways for sustainable development worldwide. However, different countries and regions have set different targets and timelines for achieving carbon neutrality. From your perspective, what are the critical factors behind these differences? And how can we make optimal decisions when investing in various technologies?

Prof. Marc A. Rosen:

Thank you for that interesting and important question. Carbon neutrality and managing our carbon emissions is perhaps one of the biggest challenges humanity faces. It is certainly a shared global challenge because no one country can fix the climate change problem on its own. For instance, the emissions from all countries get into the atmosphere and disperse around the world, and then all country's share them whether we like it or not. We can't set up borders to keep out emissions. So carbon neutrality is indeed important for all countries.

The critical factors behind the way different countries have handled climate change are many. Firstly, each country is allowed to set its own priorities and timelines under the international agreements, which is sensible because different countries have different issues they're struggling with more than others. And those are the ones they will focus on. Other countries will have different issues that make more sense for them. That's all fine in principle. But, overall, it seems that most countries have set targets and actually put activities in place to move forward, but they really propose too little and have pushed the timeline for carrying them out further into the future. That's a problem. Some would argue that that's almost a delaying tactic. If you push the timeline out farther, you may be able to avoid dealing with an issue almost permanently by doing so repeatedly. But I think it makes more sense for urgent action to be taken in the near term. We're seeing too much evidence to just ignore that climate change is something we have to deal with. It is difficult to address, I understand, and certainly needs better international coordination and cooperation. As I said, no one country can fix this problem on its own. Even a small country like mine, Canada, can do very little in the global sense, even though we're trying to clean up our act. But in the bigger scheme of things, all countries, big and small, need to step up and coordinate so that no one country feels it's carrying the burden while leaving other countries to do very little. Clearly it's a challenge, but I think we have to work hard at it and coordinate and cooperate internationally better.

When it comes to optimizing decisions, I think the word "optimization" is interesting here, as I feel from one perspective that optimization approaches could actually be used, referring to the technical definition of mathematical optimization. It could help us find the best way to share the burden and make sure that, for efforts

we undertake, we find the optimal activity to direct them so as to get the biggest reduction in carbon emissions and the biggest impact on fighting climate change for the investments made. So mathematically, that would be an interesting approach. I understand that this answer so far is more for the technical people than it is for the general public and laypeople. But considering your question more broadly, I feel that finding technology that makes the most sense locally for addressing regional problems as well as globally to help the international community fight global issues like climate change is important. It is necessary to find the right technology that fits your circumstances. I know when it comes to renewable energies, some countries have solar energy and wind easily accessible. Others have geothermal. Several countries have adopted nuclear technology. In Canada, we have in Ontario, my province, more than 50% of our electricity derived from nuclear energy, which works for us and helps us reduce our emissions. In fact, my province phased out the use of fossil fuels in all but extreme circumstances for electricity generation. Transition approaches are also needed to make sure that we don't try to do too much at once and shock the economies of the world, making it very difficult to move forward. Rather we need to have a gradual transition where we go from conventional to cleaner technologies, introducing them at a rate that societies can absorb, so as to implement them successfully.

Dr. Yuekuan Zhou:

Thank you very much. I totally agree with your decisions. Actually, in the Hong Kong Special Administrative Region of China, we have also taken several actions. For example, in 2018, the Hong Kong government set a target for the feed-in tariff. In Hong Kong, we have a lot of high-rise buildings, and most of the carbon comes from the energy consumption in the building sector. In order to encourage stakeholders in buildings to install renewable energy, like building-integrated photovoltaics, or implement energy-efficient solutions to reduce energy consumption in buildings, they set a policy that if you install renewable energy and generate 1 kilowatt-hour of electricity, no matter whether you use it in the building or sell it to the power grid, then you can get 3 to 5 times the price of the retail electricity price. For example, in Hong Kong, if you purchase one kilowatt-hour of electricity, then you have to pay $1. But if you generate 1 kilowatt-hour of electricity, then the government will give you 3 to 5 Hong Kong dollars. In that case, a lot of stakeholders will try to install renewable energy on-site. These are some strategies they have already implemented.

Prof. Marc A. Rosen:

I agree. Those actions make a lot of sense, too.

Question 3:

Dr. Yuekuan Zhou:

The third question is about the discussion about hydrogen and battery energy. These two forms of energy are currently very popular, both in industry and academia. Hydrogen and batteries, when combined with renewable energy, are considered the most promising technologies for low-carbon transitions. However, when we take into account the embodied carbon emissions of the associated

devices, such as batteries, the goal to reduce carbon emissions becomes more complex. We must consider the battery's lifecycle, including materials, manufacturing, recycling, and so on. Hydrogen also faces similar issues because if you use a renewable electrolyzer process, you have to invest in electrolyzers and fuel cells. It's questionable whether these methods are truly clean. From your perspective, what are the contributions of hydrogen and batteries to low-carbon and sustainable transitions? And what should we pay attention to when utilizing these advanced technologies?

Prof. Marc A. Rosen:

This is very interesting. We continuously hear about advancements in battery technology and their impacts on the automotive sector. Hydrogen is just behind, emerging as a solution that will help us address some of the issues associated with battery technologies, particularly in the automotive sector. Overall, I believe these two technologies are making significant contributions and moving us forward. But they need to be managed properly and holistically. We can't just focus on the positive aspects and ignore the negative ones. We have to look at both the good and the bad, and make sure that we take advantage of the benefits while managing and addressing the challenges along the way. Both hydrogen and electrical systems are key to our shift away from fossil fuels, but we have to be careful. For instance, with batteries, there are material supply issues. Lithium-ion batteries are currently favored, but we are not very good at recycling and reusing them. We urgently need to advance in this area. When considering lithium resources, geologists tell us that at the current rate of usage, if everyone switched to electric vehicles, we would quickly deplete our resources, probably within a few years. So, electric vehicles could become a problem in the long run if we don't find alternative energy storage options. However, batteries do show us that we can do things differently, transporting people in ways that don't rely on fossil fuels. Hydrogen vehicles, I believe, will follow battery electric vehicles because they don't rely on batteries to the same extent. They use hydrogen as a fuel, which, if produced cleanly from renewable energy, can be very clean and not contribute to climate change or carbon emissions. If managed properly, hydrogen could provide a renewable energy system where we convert renewable energy like solar and wind into clean hydrogen fuel, with the only emission when it is used being water vapor. The material requirements are not as extensive as with batteries, hydrogen energy systems are flow systems, whereas an electric vehicle is essentially a large battery on wheels. Going forward, managing material issues and recycling for batteries is crucial. We also need to maintain capabilities such as driving range to meet people's expectations and ensure all-weather operation for fuel cells and batteries, especially in regions with extreme temperatures. Lastly, I think we need to involve people in decision-making and educate them about the importance of these issues, so they have better awareness, and take ownership and demand changes rather than resisting them.

Dr. Yuekuan Zhou:

Thank you very much. I completely agree with your opinion. In fact, through research in my group, we've noticed that when electric vehicles are charged by

coal-fired power plants, it's difficult to claim that electric vehicles are cleaner than traditional internal combustion engine vehicles, considering the entire lifecycle carbon intensity. However, when renewable energy sources like solar PV and wind turbines are integrated to charge electric vehicles, they can become cleaner than traditional vehicles. This shows that electric vehicles are more promising, especially when combined with renewable energy. For batteries, storage, and fuel cells, we've also noticed that the energy efficiency of the hydrogen system is problematic. For example, if we use 1 kilowatt-hour of electricity to generate hydrogen through an electrolyzer and then use that hydrogen in a fuel cell to generate electricity, the total efficiency is around 40 to 50%. This is much lower than the efficiency of batteries, which could potentially make the carbon emissions of the entire system higher. We still face many challenges in the electrification and hydrogenation transition. Thank you for this question and for sharing your cutting-edge technology insights and state-of-the-art viewpoints on these advanced technologies.

Question 4:

Dr. Yuekuan Zhou:

Regarding our *Clean Energy Science and Technology* journal, the goal of our journal is to gather important ideas from researchers in the global clean energy field to publish and promote significant scientific achievements with the support of two editors-in-chief. Professor Fan Xianfeng at the University of Edinburgh and Professor Yang Weiming at Beijing University of Chemical Technology. The journal has developed rapidly and successfully. We have assembled over 200 editorial board members all over the world, including many young scholars. My question is, at the pace of scientific research, what is it that you most want to share with them, and how can we make our platform more successful worldwide?

Prof. Marc A. Rosen:

This is a very germane question when you have a young journal, as allowing it to grow is important. First, I want to congratulate you and the editors and publisher. The journal has indeed gotten off to a really good start. And it is publishing a lot of very interesting and very important research. I follow it, and some of the articles in particular are very related to my area. So I do read them carefully when I have time. Thus, the journal has been doing wonderfully to start, and I offer congratulations on that. In terms of moving it ahead, I think there are some ways you can expand journals and try to refine them. Certainly, some of the things that I think are important are maintaining high quality in terms of the research presented, making sure that it's of the utmost quality, making sure that it's important research related to the major problems that we face or areas where major advances are occurring. Those are the papers that people really find important and impactful, and allow us to move forward. So that's always important. And it's a self sustaining approach, as high quality attracts higher quality. It's also important to have high impact papers that people find helpful practically, not just a curiosity that a few people read and then they effectively disappear. High impact papers help us move forward on major issues, whether it's

combating climate change or implementing renewable energies or other clean technologies. Those are the papers that can have a huge impact and will attract a lot of attention. On the negative side, we have to avoid unscrupulous players. There've been problems in publishing, people who pad papers with their own references or people that try to rig the reviewing system to get papers published. That shouldn't be permitted. We all have to remain alert and vigilant. We all have to deal with AI and generative AI, and how it can generate papers or generate reviews, and make sure that we don't let it downgrade the quality of our journals. It's quite important, based on this, that we look out for the negative side. On the positive side, though, to close, I very much like the idea that your journal has used of having complementary conferences to go with the journal. The journal attracts a lot of high-quality researchers, but having them able to interact, whether it's live at a conference, or even virtually through a platform like Zoom, allows that interaction, that cross-fertilization where different ideas are discussed. I find that that's better than just reading the paper on its own. Thus, having the conferences is a wonderful way to allow the journal papers to be discussed. At the same time, conferences allow new papers to be presented that can be suggested for publication in the journal when they're very important and indicative of high-quality research. So I think that this dual approach should continue, as I feel it's a nice combination that is productive and fruitful. Overall, I offer my congratulations on a great conference and a great journal.

Question 5:

Dr. Yuekuan Zhou:

Thank you very much. Actually, during the past few years, we have already published several volumes with very high-quality papers. We notice that we've met several challenges. For example, for high-quality paper submissions, generally, because we are young, it seems that it's relatively sometimes difficult to invite very highly impactful journal articles. We don't know whether in Canada, people of researchers care about the impact factor of a quality of the journal. So currently we do not have one, but soon later we will have, we are sure we will have a very good impact factor. And so during this stage, we are trying our best, working together with our editorial board members, to invite these high-quality papers. The second challenge we met is that for the peer review process, some researchers are quite busy. Sometimes researchers, like us, we are working in the university, we are teaching. We review papers for other journals each year. In my research group, we review over 200 papers, so we do not have enough time. But sometimes due to the busy schedule, we ignore something, or sometimes we have to frequently send emails to remind these reviewers. So from your point of view, how can we effectively manage these two challenges and contribute to our CEST journal very well in the near future?

Prof. Marc A. Rosen:

Those are both very significant challenges that all journals face, especially making sure a journal gets indexed and gets an impact factor. It's important for researchers. You mentioned the situation in Canada and, yes, we care about that

too. I know in many countries, universities don't even consider a paper of importance and high quality unless it's published in a high-quality journal with a good impact factor. So clearly it's important. Now, in terms of taking care of attaining a high impact factor, I think the best way is not to focus on what can a journal do to improve the impact factor. But rather, it should publish good quality research from good quality researchers. Sticking to that leads to a high integrity and high quality journal, and I feel a good impact factor will follow naturally. I'm suspicious when journals say: What can we do just to improve the impact factor for its own sake? I disagree with that approach, and instead feel the journal should focus on becoming a really good quality journal, and then the impact factor will be good. It will follow. So maintaining high quality, I believe, will allow a good impact factor to come in time. A journal of course has to apply, and that takes time, but a good result will usually come. In terms of reviews, yes they are difficult to get. That is not just an issue that your journal faces. We face it everywhere, and every journal I'm associated with faces it: getting people to agree to do reviews and then to do a thorough quality review. You mention hundreds of requests per year; I feel the same thing, as I receive two or three requests per day, it seems, and it's overwhelming. So I usually just have to say no. I have enough work to do with just performing a few of reviews, but I can't accept all of the requests. It's a struggle. I think there are steps journals can do to make the situation better, however. One is related to the fact that most journals ask reviewers to do the work voluntarily, and I feel you more or less get what you pay for. If you pay nothing, you're lucky to get a review, and it's usually not going to be a thorough review. If you really want good quality reviews, I think some sort of compensation model where even a token amount is paid to reviewers would get more people saying, yes, I can do the review, and then putting in the time to do a good thorough review. In general, I think that model in journals needs to shift away from where reviewers are expected to do the work as a volunteer activity.

Question 6:

Dr. Yuekuan Zhou:

Thanks. I think your suggestions are very useful. We will try to implement these suggestions in our future paper invitation and peer review process. Then we move to the final question. I don't want to occupy too much of your time. The final question is about *Clean Energy Science and Technology*, which has been widely explored and started for global researchers and listed as creating critical pathways for SDG, which means the Sustainable Development Goals. So developing a worldwide platform with annual activities equally is quite important. And that is the aim for our journal. So from your perspective, to create and establish a very good CEST platform, what are the fundamental but essential factors, and what responsibilities do our editors, managers, editorial board members, and even authors have to take to build up this good platform?

Prof. Marc A. Rosen:

That's a major undertaking. It's very broad to try to keep track of all the work going on for the SDGs and then to document and categorize so that there's a list

of what's been achieved and what's been done. But it's very important. It would be very helpful to researchers to know where advances are being made, but it's a massive undertaking. So it's wonderful to hear that you're going to be doing that, and I'm interested in learning more about it. I can't imagine the challenges in terms of doing it well because you, although you have what's published in your journal and can have a reference on that, gathering all the other information can be quite a task, especially since the amount of research going on in the world seems to always increase, almost exponentially. And keeping track of it is a challenge for any researcher, just in his or her field. To try to do it more broadly, from a journal's perspective, is a big challenge and getting the number of people you need to do that properly and be focused on that will be important. Having some very active people that believe in this and want to make sure we get all the information recorded will be critically important. I would look forward to seeing the results. It would certainly help me and my team to see where advances are being made that we might otherwise have missed.

Dr. Yuekuan Zhou:

Thank you very much. I think we have already finished all the questions we would like to get the answers from you. So later, I will briefly introduce the success and the information of our journal because we have a global audience. *Clean Energy Science and Technology* journal provides a forum for information on research, innovation, education, development, and demonstration in the areas of clean energy technologies through clean energy production, energy efficiency, waste to energy, big data, and artificial intelligence, and so on. The journal publishes original research papers, review articles, communications, commentary, letters, comments, and perspective papers. Authors are encouraged to submit manuscripts which bridge the gaps between research, development, and implementation. The bridge of coverage ranges from advanced and innovative technologies, energy-efficient and low-carbon systems, together with AI-driven smart energy for sustainable energy transition and policies. *Clean Energy Science and Technology* belongs to Universe Scientific Publishing. And we have successfully recruited over 200 outstanding researchers to cooperatively build up the platform. Since the first issue of the journal launched in September 2023, we have especially invited Professor Yang Weimin's high-quality cover article. The title is "Drawn of Clean Energy: Enhanced Heat Transfer, Radiative Cooling, and Firecracker Style Controlled Nuclear Fusion Power Generation Systems." And now more and more high-quality articles are being published. We welcome global submissions to *Clean Energy Science and Technology* journal. And our team will try our best to provide the best service to our authors and readers. That's a brief introduction for our journal and the latest achievements we have. I think we have already finished the interview process, and thanks, Professor Mark. Thank you very much for attending our interview, and best wishes for all the audience.

Prof. Marc A. Rosen:

Thank you for having me and best wishes for success to you and your research and the journal.

Conflict of interest: The authors declare no conflict of interest.