Electricity Access, Decarbonization, and Integration of Renewables: Insights and Lessons from the Energy Transformation in Bangladesh, South Asia, and Sub-Sahara Africa

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Abstract

This chapter provides an introduction to the book, identifies different perspectives, and describes the different sections of the book in more detail. It places the research issues in the context of the "great socio-ecological transformation" and defines different elements of this process. The chapter also includes the main take-away messages from subsequent book chapters.

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Keywords

Bangladesh · Electricity Access · Energy Transformation · Renewables · South Asia · Sub-Sahara Africa

1 Preface

As renewables-based energy transformations are accelerating world-wide, progress can be reported and analyzed from a variety of countries, including from the Global South. This book covers different aspects of the low-carbon energy transformation, with a particular focus two regions, South Asia, and Sub-Sahara Africa, and on one country, Bangladesh. The book results from an international conference, organized by Brac University (Dhaka, Bangladesh), Carnegie Mellon University (Pittsburgh, PA, USA), and Technische Universität Berlin (Germany), and held (digitally) out of Dhaka (Bangladesh) and Berlin (Germany), on March 2–4, 2021. Given that the conference coincided with the 50th Anniversary of independence in Bangladesh, a focus of the book lies on this country and on South Asia in general, but experiences and lessons from Sub-Sahara Africa are also featured, enabling cross-country and cross-regional comparisons. This introduction provides a discussion of the major research issues surrounding these topics, surveys some existing literature, and then describes how the chapters contribute to the debate.

2 The low-carbon energy transformation

As a methodological point of inception, we see the topics of electricity access and renewable integration as part of the socio-ecological low-carbon energy transformation, that is now ongoing in all regions of the world. Driven by the need to reduce the emissions of greenhouse gases, but also of technically and socially acceptable transformation pathways towards stronger citizen involvement, the "great transformation" (WBGU, 2011) knows no borders, and it is present in all corners of the globe, and of the energy system.

There is no consistent framework that would define the borders of what is being "transformed", neither is the objective of the transformation process itself being precisely defined. It can be assumed that energy policies are largely national policies, and that they play out at the local level once it comes to electricity access, so focus on comparative analysis in two regions is justified (here: South Asia, complemented by Sub-Sahara Africa). Also, a focus on the Global South is pre-set by

the central issue, electricity access, even though other topics, such as renewable integeration and grid issues, are certainly relevant in the context of the Global North, too, under quite different regulatory and institutional preconditions.

One way of summarizing the challenges of the great transformation is to see it as a combination of the four D's: Decarbonization, decentralization, digitization, and democratization.[1] In fact, decarbonization as a requirement to abate the climate crisis is a central element, but only one. Decentralization of production and consumption structures is another element of the transformation, given that electricity access is by nature a process targeting industrial and household users that are often dispersed geographically and socially, and thus competition between organizational models of providing it is useful (Karplus & von Hirschhausen, 2019). Along these lines, democratization includes more balanced decisions and the option (not the obligation) of energy users to get involved in decisions on production and distribution as well. The first three D's are sometimes said to be derived from Amory Lovins' (Lovins, 1976, 1979) "soft path" of energy reform, providing, amongst others, a perspective for the energy transformation in Germany, called Energiewende (Krause et al., 1980; von Hirschhausen et al., 2018). Add digitization, which is nowadays a must, where electricity is often coordinated, traded, and paid by means of digital (mobile-based) services.

Thus, major reforms in this transformation context are taking place at different levels:

- The country level, where energy mixes are rapidly changing,
- the corporate level, where large state-owned and private companies are challenged and new actors are emerging,
- and the local level, where technical and regulatory change has made citizen engagement and community power an option to replace or at least complement central supply structures.

The contributions to this book combine all three levels. National policies and (climate and other) targets are key drivers, whereas different organizational models for corporate adaptation exist. Clearly the local level is always present when it comes to access issues, thus the three layers interact closely. Cross-country chapters, mainly on South Asia, complement the picture.

[1] See also https://www.weforum.org/agenda/2018/06/rural-bangladesh-villages-transition-renewable-energy-sebastian-groh/, where disruption is mentioned as an additional D.

3 Focus on electricity access, decarbonization, and integration of renewables

The contributions in this book focus on different aspects of the low-carbon energy transformation by especially taking a micro-level perspective as well as emphasizing the role of decentralized renewable energy solutions (DREs).[2] The flexible and cost-effective deployment of DREs addresses the specific requirements of local households which depend on the respective urban, peri-urban, or rural contexts (Puig et al., 2021).

Furthermore, electricity access and decarbonization have been important topics in international development and sustainability discussions. The United Nations' "Agenda 2030" includes electrification as a goal for sustainable development (Sustainable Development Goal number 7 (SDG7)). It combines the demand for universal access to energy with the expansion of renewable energies.[3] And access is not only needed for individual basic supply, but it is also a key factor in the provision of social services such as education and health, as well as a key added-value component for all sectors of the economy.

Over the past two decades, significant progress has been made in terms of access to electricity in the Global South. In 2015, more than one billion people had no access to electricity (IEA et al., 2018), by 2019 this figure had decreased to approximately 770 million (World Bank, SE4ALL database, 2020b). All in all, the global electrification rate has increased by 12% since the start of the millennium, even despite continued population growth. Significant progress has been especially made in South and East Asia: Around 92% of the population have access to electricity, compared with only 55% in 2001. But the ongoing Covid-19 pandemic shows that the process of electrification is more fragile than assumed. IEA et al. estimate that for the first time in a long while the number of people lacking access to electricity has increased by 30 million (IEA et al., 2021). And global distribution of these developments is highly

[2] DRE systems or applications are small-scale electricity producing units powered by renewable energy sources that supply power to local consumers at or near the side of generation. The electricity producing units may be stand-alone or connected to other generation systems nearby via a grid network. Compared to conventional centralized power generation systems, DREs are a cost-effective way to facilitate rapid deployment and access to electricity to consumers that are not connected to the national grid or that need a steady and reliable power supply (von Hirschhausen et al., 2020).

[3] In addition to sub-goal 7.1 ("universal access to affordable, reliable and modern energy"), sub-goal 7.2 calls for a "substantial increase in the share of renewable energy in the global energy mix".

uneven. In Europe, North America, and developed countries in the Asia-Pacific region an electrification rate of almost 100% rate has been achieved. On the other hand, the African continent as well as some individual countries in Asia and Latin America continue to have low electrification rates. And particularly the gap between rural and urban areas is large. While around 97% of the world's urban areas are supplied with electricity, this figure amounts to only 82% in rural areas. In sub-Saharan Africa, this gap is even more pronounced: 78% of urban users have access to electricity, compared to only 32% in rural areas (World Bank, SE4ALL database, 2020a).

In case of high population density grid extension is easier and more cost-effective. When comparing the option of electrifying rural areas through DRE with the option of extending public electricity grids, experience reveals that standard grid electrification often fails to meet the objective of securing the provision of reliable access to electricity. Grid extension also takes longer and requires a higher investment. Although higher power generation capacities are provided, the reliability of the electricity supply might be compromised by decreased reliability due to a weak grid infrastructure (von Hirschhausen et al., 2020).

DREs have several direct advantages over grid extensions and public grids due to their modular and cost-effective nature, particularly in rural areas. They mobilize national and international resources (including capital), increase energy security and efficiency, and generate new revenues for the local population. The indirect advantages of DREs positively impact individual households as well as communities leading to regional knowledge transfer and capacity building and may also encourage local and national research and innovation (Ferrall et al., 2021).

DRE solutions result in electricity producing facilities being located closer to where their output is consumed. DREs make better use of local renewable energy sources and combined heat and power solutions, as well as decreasing fossil fuel use. They further reduce environmental impacts and economic costs by minimizing transmission and distribution inefficiencies (Heinemann et al., 2020).

Technological advances and significant declines in cost over the past decade have led to the addition of DRE as a feasible low-cost option to electrification in many countries.[4] For example, the levelized costs of energy (LCOE) of solar photovoltaic (PV) power has fallen by 85%, from EUR 0.33 to EUR 0.05 per kWh and the LCOE for wind energy has fallen by 56%, from EUR 0.07 to EUR 0.03 per kWh (IRENA, 2021).

[4] DRE solutions, powered by technologies such as solar PV, hydro power, biogas plants, and wind turbines, include both mini-grid and off-grid systems. Mini-grids are local grids that are separate from the national power grid. They are used to provide energy access to regions not served by the grid, particularly in hard-to-reach areas. Off-grid systems are independent standalone systems for households or businesses.

The total costs to achieve universal electricity access by 2030 are estimated generally as affordable. For example, the International Energy Agency (IEA) estimates that the investment required will be only 35 billion U.S. dollars per year (IEA, 2020). While a large share of electrification progress in recent years can still be attributed to public grid extensions, the share of DRE is increasing steadily. As research shows, DRE is not a stopgap, but rather the optimal long-term supply option, especially in remote areas (Blechinger et al., 2019; IEA, 2017).

Accordingly, the contributions in this book will focus on these different aspects of the low-carbon energy transformation by especially taking a micro-level perspective, where in fact multiple transformations are ongoing. The main aspects can be briefly summarized as follows:

- electricity access, rapidly advancing in many countries and regions, but still facing challenges with a view on attaining the sustainable development goals (SDGs), specifically SDG 7, affordable, reliable, and largely renewable energy access by 2030 (United Nations, 2015; Groh et al., 2016; Karplus & von Hirschhausen, 2019). Another interesting issue is what happens when a country reaches near full electrification (e. g., India and Bangladesh). What is the role of integrated electrification pathways?[5] Is there still a place for micro-grids?
- decarbonization, i. e., a broad movement to abandon fossil fuels at the global scale. While decarbonization was still a wild dream of environmentalists only two decades ago, it has now entered mainstream thinking even in more conservative circles of the energy world, such as the International Energy Agency (IEA, 2020).
- renewable energies, as the large-scale solution to access and decarbonization, though still underdeveloped and requiring a systems approach due to the (small) size and the intermittency of its operations (Papaefthymiou & Dragoon, 2016; Oei et al., 2020; Bogdanov et al., 2021).

Needless to mention that other important topics are less represented in the analysis, such as non-electricity issues and cooking, or the role of technology transfer in these processes. Almost all chapters refer to SDG7, but we do not explore conceptually new ground in this matter, and refer to companion papers (Groh et al., 2016; Pelz et al., 2022).

[5] See *Sustainable Energy for All* for further information: https://www.seforall.org/interventions/electricity-for-all-in-africa/integrated-electrification-pathways.

4 Structure of the book

4.1 Introduction and welcome addresses

The book is divided into an introductory section and three main parts. The introductory part includes the opening remarks and welcome addresses by Mohammad Alauddin, chairman of SREDA, the Sustainable and Renewable Energy Development Authority of Bangladesh, and Bärbel Höhn, special representative for Energy in Africa of the German Federal Ministry for Economic Cooperation and Development (BMZ). Alauddin provides a particular focus on issues of access and renewable energy supply in Bangladesh, whereas Höhn, mainly active in Africa, links Bangladesh and South Asia to Africa, drawing up similarities and differences between both regions. After this overall "Introduction" (Chap. 1), the following three parts of the book unfold:

4.2 *Part I: Energy Sector Reform in Bangladesh@50*[6]

Part I of the book addresses the unique energy sector reform in Bangladesh, as the country attempts sustainable development as a middle-income country. In fact, the rise from Henry Kissinger's basket case, a civil war and poverty shaken, newly independent country in 1971, to one of the powerhouses of Asia in the 2020s, is remarkable. This development has relied largely on extensive growth, though, and was fuelled by fossil fuels, mainly natural gas. In Chap. 2, Ahsan Mansur, Director of the Institute of Policy Studies in Bangladesh, and former Economist with the International Monetary Fund (IMF), and colleagues, report on the economic reforms in the country, and the role of energy in this process: "Powering up a country into the middle-income club—the story of Bangladesh". The country has succeeded in catching up over the last decades, coming to near full electrification, however, questions about the sustainability of the reforms remain, especially in times of the COVID-19 pandemic where significant overcapacity in electricity generation capacity coupled with continuous load shedding

[6] March 26, 2021, marked 50 years since the start of Bangladesh's liberation war, a bloody nine-month campaign that culminated in the nation's independence on December 16, 1971. In 2021, under the slogan ***Bangladesh@50***, the country is celebrating its 50th anniversary of independence, see https://thediplomat.com/2021/02/bangladesh-at-50-the-transformation-of-a-nation/.

and large financial losses of public utilities via extensive subsidies for fossil fuels have thrown up a few doubts.

On the other hand, however, Bangladesh excels as the world's champion of decentral electrification, through solar home systems (SHS), and has shown that swarm electrification, i. e., the interconnection of very small solar home systems, can work. While this story has been told at various occasions, there is no more comprehensive account than the one provided by Nancy Wimmer, advisor to the World Council for Renewable Energy and Director of microSOLAR, in her two books on "Green Energy for a Billion Poor" (Wimmer, 2012), and "Marketmakers: Solar for the Hinterland of Bangladesh" (Wimmer, 2019). Based on a conversation with some of the founding personalities of the world's largest decentralized electrification program, Nancy Wimmer summarizes the experience with SHS deployment and provides an outlook for the challenges lying ahead: "100% electrification—What comes next for Bangladesh?" (Chap. 3). In 2002, when over 70% of the country's rural population had for generations never known electric light, the most dynamic off-grid electrification program in the world was launched, and it became a success story: Within a decade, Bangladesh was on its way to becoming the world's fastest growing off-grid solar market; today, over 5 million systems have been deployed. However, now that over 90% of the households of Bangladesh have access to electricity, what role will solar technology play in the future? Will the solar market move away from SHS towards grid-connected distributed renewable energy systems?

Chapter 4 brings together the issue of decarbonization and renewable energy technologies "Exploring policy options for increasing the share of renewable energy: Technology Choices for Peaking Power in the Context of Bangladesh". Rezwan Khan (United International University), Shahedul Alam (North South University) and colleagues address an issue well-known in the low-carbon energy transformation: Fossil-fuel power plants suffer from high costs and low peak-load capacity utilization. The paper examines different technological choices and existing opportunities in the local context. Different types of storage solutions are discussed, as are "hybrid" solutions where renewable infeed is backed up by traditional fuels.

4.3 Part II: Low-carbon energy transformation in South Asia

Part II covers different aspects of the low-carbon energy transformation in South Asia. In their survey paper, Abdullah Fahimi (University of Lueneburg) and

Kai Stepputat (Technische Universität Berlin) address the "Low-carbon energy transformation and sustainable development in India, Pakistan, Afghanistan, and China" (Chap. 5). Combined, the four countries represent about 40% of the world's population, over 20% of the world's GDP, and about 40% of the world's CO_2 emissions. Therefore, the status and future energy economic development of those countries has a significant impact on the implementation of the Paris Agreement. The paper provides an overview of the current economic status of the countries and identifies energy economic trends and barriers. Results show that currently, climate targets are missed. However, positive decarbonization drivers such as a potential push for renewables can be identified. This can be accompanied by further advantages such as decreasing dependency on the import of fossil fuels and additional liquidity for energy infrastructure, due to fuel cost savings. Significant policy change is required to turn around the situation and to have a chance of reaching any of the set climate goals.

Chapter 6 analyses the "Consequences of lockdown due to COVID-19 on the electricity generation and the environment in South Asia". Shameem Hasan (Ahsanullah University of Science and Technology), and Mirza Rasheduzzaman, and M. Mofazzal Hossain from the Department of Electrical and Electronic Engineering at the University of Liberal Arts in Dhaka (Bangladesh) investigate the impact of the pandemic in terms of reduction of power generation and greenhouse gas emission reductions during the lockdown period. The paper covers carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NO_x), and fluorinated gases for India, Bangladesh, and Sri Lanka. All countries are heavily affected, but India shows the highest level of decline of emissions, in the range of 30%.

Another focus on India is given in Chap. 7, by Neshwin Rodrigues, Raghav Pachouri, Shbbam Thakare, G. Renjit, and Thomas Spencer (TERI, New Delhi, India): "Integrating wind and solar in the Indian power system: An assessment with a unit commitment and dispatch model". The paper explores the pathway to integrating high renewable generation by 2030, with effective balancing of supply and demand. A unit commitment and economic dispatch model simulates the power system operation in detail. The overall share of variable renewables reaches 26% and 32% in the Baseline Capacity Scenario, and the high Renewable Energy Scenario, respectively. Battery storage provides daily balancing while reducing renewable curtailment to less than 0.2% in the high renewable scenario. High renewable penetration is found possible by 2030 in India, at no extra system costs.

4.4 Part III: Lessons from Sub-Sahara Africa

Part III of the book includes four papers on lessons from the energy transformation in Sub-Sahara Africa. In a survey paper (Chap. 8), George Arende and Sofia Goncalves from EIT InnoEnergy (Stockholm, Sweden) analyse "Decentralized electrification pathways in Sub-Saharan Africa". The chapter reviews the barriers to private sector participation in decentralized electrification projects, and the solutions that have been proposed. It investigates economic approaches, solutions, and drivers. Some of the specific technological pathways that have proven fruitful in Sub-Sahara Africa (SSA) are unique to its economic and demographic settings, that otherwise would not be adopted or used in the developed countries. Long-term energy planning with the integration of power pools is instrumental to reduce the capital costs, as well as to increase the market size. Blended financing, together with the already working technologies such as pay-as-you-go, and mobile money will be the pillars to meeting SDG7 goals.

In Chap. 9, Charles Muchunku (energy consultant from Nairobi, Kenya) and Georg Heinemann (Microenergy Systems, TU Berlin), identify "Effective electrification approaches and combinations thereof to meet universal electricity access targets in Eastern Africa". The chapter explores societal challenges of universal access to electricity and provides a broad understanding of how firms in the electrification industry and their environments co-evolve. Until recently there has been little coordination between governments in Eastern Africa and private firms to deliver electricity access. Private sector off-grid electrification approaches have demonstrated the potential to deliver access quickly, at scale and at a lower cost than some on-grid approaches (e. g., grid intensification and grid extension). Governments in Eastern Africa have therefore begun to develop electrification strategies that seek to combine and optimize public led on-grid approaches with private led off-grid approaches to be implemented through public-private partnership arrangements. In addition, large scale on-grid electrification programs are likely to over-extend national electricity utilities, because of the rapid increase in the number and spread of new customers resulting from grid extension and mini-grid projects. This could be mitigated by extending ownership and operation of these projects to private firms who would function as small power distributors—purchasing power in bulk from the national utility and reselling it to consumers.

Two chapters on a particularly captivating country close the book: Tanzania, where ambition on access was particularly high, but results have been mixed so far. Elias Zigah, Mamadou Barry, and Anna Creti from the Chair of Climate Economics and Paris Dauphine University ask a simple question (Chap. 10): "Are mini-grid projects in Tanzania financially sustainable?" While it is commonly

acknowledged that mini-grids are the new pathway to bridging the high electricity access deficit in SSA, comparably few studies have assessed how existing regulations and tariff policies in SSA affect their potentials to attract the number of private investments required to scale-up deployments. The participation of private investors is particularly crucial to meet the annual electrification investment gap of US-$ 16 billon in SSA. The authors study the regulatory framework, the tariff structure, and the subsidy schemes for mini-grids in Tanzania. Additionally, using an optimization technique, they assess the profitability of a mini-grid electrification project in Tanzania from a private investment perspective. The authors find that the approved standardized small power producers' tariffs and subsidy scheme in Tanzania still do not allow mini-grid for rural electrification projects to be profitable. Further research is required to identify successful business models and strategies to improve mini-grids' profitability.

Last but certainly not least, Guglielmo Mazzà from Microfinanza Srl and colleagues address a similar topic in Chap. 11: "Establishing local power markets and enabling financial access to solar and photovoltaic technologies: experiences in rural Tanzania". The introduction of new technological products requires to establish local power markets, including demand, financial resources and providers, supply mechanisms and after-sale services. The financing of renewable energy solutions for rural households partially relies on microfinance institutions and community financial groups. Technology suppliers also provide financial services to expand access to solar and photovoltaic products, applying models mostly enabled by mobile payment systems. The paper assesses the effects of an initiative implemented in Malinyi and Kilombero districts to support the establishment of local solar power markets. The involvement of Village Community Banks to engage communities and develop sustainable financial schemes is evaluated, together with the complexity of combining awareness raising on technological solutions and financial education. Results of the implementation are presented and discussed evaluating different ingredients of the established markets.

5 Concluding Remarks

The conference, and consequently also this book have taken a Global South micro perspective on the energy transformation that the world is currently undergoing. Transformations are hard. Hence, often we tend to draw on a transition mode, many times irrespective of the urgency that required us to change in the first place. The inertia is usually based on legacy infrastructure, and vested interests of incumbents. What makes this book so interesting is that throughout its contribu-

tions it takes a perspective from places where often relatively little legacy infrastructures are in place and vested interests from incumbents are felt "less" due to a bottom-up approach.

However, it would be easy to reason now that this is a perfect combination for leapfrogging, where a (technology) breakthrough is reached by skipping intermediate steps (e. g., the fact that many people in the Global South have never seen a landline, but went straight to the mobile phone, and possibly have picked up this technology much faster than a comparative group in the Global North, which had stronger inertia due to the existence of landlines). Can we infer from here that the Global South will abandon fossil fuels much quicker, and skip building large grid infrastructures with centralized production of electricity in places where it is not needed? And will it directly go to a distributed and decarbonized infrastructure? The answer is a yes and no. "Yes", in the sense that we see several contributions made where this is happening, especially when it comes to rural electrification, but "no", we also see, especially in the context of Bangladesh, that complexities emerge when both approaches are being undertaken at the same time. An attempt to mimic the known centralized grid electrification, based largely on fossil fuels, is complemented by a model that fully embraces the 4 Ds with the world's largest distributed solar electrification program.

It remains to be seen in how far microgrids will take up an increasing role in both the Global North and South. Maybe the question is not if but rather when, and how much time has been lost in transition mode in the interim.

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6 Appendix: A selection of panelists' quotes at the MES2021 Conference

Participants, speakers and invited guests celebrated the MES2021 conference, a fully packed 3-day journey with diverse contributions and fruitful discussion. Hereafter a selection of quotes from notable speakers and discussants is shared, in no particular order and paraphrased at times:

We need to change our thinking going from energy access to energy well-being, the session should not be called Universal Basic Energy Supply, but Universal Basic Energy Services.

– Shonali Pachauri, IIASA during the Universal Basic Energy Services Session.

MES or Microenergy Systems as I understand it, very interestingly, is in fact the missing piece from my own PhD, many, many years ago.

– Vincent Chang, President, BRAC University during his opening keynote.

I am impressed by Bangladesh's progress on decentralized energy systems, and during a visit last year by Prof. von Hirschhausen we found very good potential for academic collaboration.

– Christian Thomsen, President, TU Berlin, during his opening keynote.

How do we avoid a climate disaster? Because all our economic growth has little value if it is just washed away in an instant.

– Sebastian Groh, Brac Business School, during his Opening Panel moderation.

After 100% electrification we need to focus on how we get from quantity to quality.

– Amzad Hossain, Member, Bangladesh Renewable Energy Board during the Contributory Microgrid Session.

Only with decentralized storage, a grid can be resilient. Any country must be strong on storage manufacturing & recycling to be prepared for the energy future.

– Hannes Kirchhoff, SOLshare during the Contributory Microgrid Session.

The grid is a social good, w/o it there is a route to inequality! We need to leverage the grid together with distributed models.

– Chris Wright, Moixa during the Contributory Microgrid Session.

Bangladesh's Prime Minister has committed to 100% RE by 2050—but the country lacks a clear roadmap towards it, let alone a conducive policy.

– Munawar Moin, Solar Module Manufacturers Association of Bangladesh, during the 100% Electrification—What Comes Next for Bangladesh? Session.

The focus needs to go toward energy for productive use, e. g., transport, there are 4M e-rickshaws alone in India and Bangladesh –we need to build a renewable-powered charging platform for them.

– Eshrat Waris, SOLshare during the 100% Electrification, and the e-mobility session, respectively.

Why is it so difficult for developing countries to introduce subsidies toward more decentralized storage?

– Julio Eisman Valdés, ACCIONA Microenergia Foundation

Despite best efforts, the availability and affordability of DC appliances is not in place, and we had to tweak our system to accommodate AC appliances.

– Nithia Menon, Okra Solar/ Daniel Ciganovic, SOLshare in the Microgridders session.

We need to make our national grid smarter.

– Muhammad Hossain, Director General, Power Cell, Bangladesh during the Contributory Microgrid Session.

We need to develop policies to incentivize feed-in from distributed generation and storage, e. g., through community power purchasing agreements.

– Raluca Dumitrescu, TU Berlin, during the research session on Market Design & Tariffication.

Bangladesh is embarking on a new journey after the confirmation a few days back of its graduation from the least developed countries. This is a massive success for the country coinciding with its 50 years celebration of independence. On this new journey, we should reduce our dependency on fossil fuels and raise our share in renewables. For this to happen, we need more innovation in business models, technology such as distributed storage and generation as well as policy reform.

– Mohammad Alauddin, Chairman, SREDA during the Contributory Microgrid Session.

Don't say we have no biomass, we have no wind, we have no land for solar PV—YOU HAVE! Even though your situation is clearly different. When I was a German State Minister for Agriculture and Environment 20 years ago, I heard the same things, but we need to jointly overcome the fossil fuel lobbies.

– Baerbel Hoehn, Global Renewables Congress, during the Powering-up a country into the middle-income club session.

There is USD 1 billion in subsidies for oil & gas per year, while there is no clear subsidy policy for renewables in place to date.

– Mohammad Tamim, BUET, via the chat in Powering-up a country into the middle-income club session.

"If you understand something in only one way, then you don't really understand it at all", Marvin Minsky, the co-founder of MIT's Artificial Intelligence Laboratory

– quoted by Nancy Wimmer, Microsolar.

The bottom line is, the GoB has committed to 100% electrification of some form by 2021 and it has followed through, but one of the weaknesses of the strategy has been that generation capacity was increased too massively—we are paying for a lot of idle capacity—the burden falls on the consumers or the Bangladeshi citizens. You can make any power project viable if you make the PPA high enough, incl. capacity payments, that's the role of the regulator where a better job needs to be done.

– Ahsan Mansur, Policy Research Institute of Bangladesh, in the Powering-up a country into the middle-income club session.

The energy pricing policy needs to be tackled, this is a jungle, the time has really come to sort this out. Unless we get the pricing right, we will not have the optimal technical or social mix. On renewables, we need to make a move, everybody around us is doing it, even if we must do this with subsidies, we need to explore this much more thoroughly.

– K.A.S. Murshid, Bangladesh Institute of Development Studies, in the Powering-up a country into the middle-income club session.

Most of the VCs are run by men, no wonder that less than 3% of women-led business get access to VC funding. Interestingly, women-led businesses are also not asked the same questions during the DD compared to men-led businesses,

more emphasis is put on risk than on growth potential—this is a skewed process as growth focused DD processes get 7x more funding.

– Cécile Dahome, Sevea, during the Empowering Women through Renewable Energy Entrepreneurship session.

If we talk about rural female entrepreneurship, we need to talk market linkages.

– Aziza Sultana Mukti, SOLshare, during the Empowering Women through Renewable Energy Entrepreneurship session.

PAYG companies in Sub-Saharan Africa are nowhere close to what has been done in Bangladesh but in 99% of off-grid conferences it is not being talked about—why?—there is no domestic local currency financing, no local manufacturing industry. Businesses in Bangladesh must ask themselves the question why we didn't venture out into those markets.

– Sanjoy Sanyal, Regain Paradise, during 100% Electrification—What Comes Next for Bangladesh?

We need to investigate e-rickshaws, and we will, we must look also into the larger transport sector from the perspective of green energy and sustainable urban development.

– Angelika Fleddermann, GIZ BD, during the Outlook session.

At SE4ALL we look at the hot and the cold side of SDG 7, the hot side is access to clean cooking which has no silver bullet but it's a huge need. The cold side is the entire aspect of cooling and cold chains which gained prominence recently triggered by the diverse cooling requirement of the COIVD-19 vaccines.

– Hadley Taylor, SE4ALL.

The hardest part of every single project is not the design, nor the tech in general, it is the institutions, the permits, the politics of will, we spend 10times more on political logistics than on anything else. The stronger the community sense for a project is, the easier to push all this heavyweight uphill—we need more sociologists & psychologists.

– Daniel Kammen, UC Berkeley during a Q&A session with Bernd Moeller, Europa Universitaet Flensburg.

MES—Microenergy Systems was born in Bangladesh as the microenergy project, micro is the small part, and the beauty was what we had found in Bangladesh back in 2002 in the solar home system program but also why small here is so powerful.

– Daniel Philipp, MicroEnergy International, during the Small is beautiful session.

A lot of the psyche of the university comes from empathy, comes from solving the problems of the masses in the spirit of its founder Sir Fazle Abed—this has taken the university forward!

– Sonia Bashir Kabir, Board of Trustees at Brac University during the Outlook Session.

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