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Technical note

Challenges to renewable energy: A bulletin of perceptions from international academic arena

Anas Zyadin [a,*], Pradipta Halder [a], Tanja Kähkönen [a], Antero Puhakka [b]

[a] University of Eastern Finland, School of Forest Sciences, P.O. Box 111, 80101 Joensuu, Finland
[b] University of Eastern Finland, Department of Social Sciences, P.O. Box 111, 80101 Joensuu, Finland

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A B S T R A C T

Despite the optimism behind the growth in renewable energy (RE) and its deployment in 2011, and particularly in the aftermath of the Fukushima nuclear disaster, progress has remained inadequate and "*too slow*" in tackling the problem of accumulating carbon emissions in the atmosphere. Caveats have also been surfaced about the future development of RE and energy efficiency technologies since a mosaic of setbacks are hindering large scale clean energy development. In academia, perceptions of clean energy and energy efficiency technologies have been largely investigated from public acceptance point of view and to a narrower extent from the industrial and business landlords' point of view. However, studies that address these challenges to early-stage researchers and professors are limited, though they appear to play a pivotal role in advancing the science of RE. In this context, we conducted a survey-based study among a group of early-stage researchers (PhDs) and professors, who participated in two training courses in the UK and Cyprus. A total of 122 questionnaires were collected from the participants. The study found that progress in RE development was perceived to be developing moderately worldwide and hibernating in some countries. The respondents, regardless of their level of professional expertise and country's income class, perceived the prime factors hindering RE development worldwide were the lack of governmental policies, competition from fossil fuels (conventional and non-conventional), and lack of public awareness and support. Based on the respondents' geographical location, European academics perceived the lack of public support, Asian academics perceived the lack of supportive governmental policies, and African academics perceived the lack of mobilized public finance as key barriers to RE development. The participants emphasized the need to increase financial support for clean energy R&D, gradually adopt the uptake of renewables, and encourage synchronous and gradual elimination of fossil fuel subsidies.

1. Introduction

Deployment of clean energy technologies, particularly in developing countries, is being promoted as a modern strategy for improving the well-being of millions of poor people through providing them with access to electricity and clean cooking facilities [1,2]. Nowadays, renewable energy (RE) is deemed a largely untapped market in which private–public partnerships can deliver sustainable solutions and generate new market opportunities in the light of stagnant economic growth [3]. From the environmental perspective, the proponents of RE perceive that RE technologies are indispensable for offsetting the increasing levels of harmful greenhouse gases. RE resources are environmentally friendly with enormous commercial potential. They are also technically recoverable resources with vast potential worldwide to provide a low-carbon, energy efficient, and economically competitive substitute for the fossil fuel energy sector [4].

Due to the large scale of manufacturing, China's low-cost production, and the over-supply of products, renewables supplied approximately 17% of global final energy consumption in 2011 [1]. RE technologies continued to expand into new markets as photovoltaic (PV) module prices fell by close to 50%, and onshore wind turbine prices fell by around 10% [1]. Global investment in renewable power and fuels increased by 17% to a new record of US$ 257 billion in 2011 [5]. Furthermore, favorable governmental policies and support schemes from international organizations (e.g., United Nations and World Bank) gave a glimmer of hope, albeit modest, of diversified energy production with cleaner sources [1,5,6].

* Corresponding author. Tel.: +358443003228.
E-mail addresses: anas.zyadin@uef.fi, anas.zyadin@gmail.com (A. Zyadin).

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Caveats, however, mushroomed when the International Energy Agency (IEA) published a report entitled "Energy Technology Perspectives 2012: Pathways to a Clean Energy System". The report cites that "*while progress has been made on development and deployment of clean energy, the current rate is too slow*" and it "*will not be enough to limit global warming to two degrees Celsius*". It notes that US$ 24 trillion of further investment is needed by 2050 in the 2 °C scenario [6]. Furthermore, the global investment in RE in 2012, estimated at US$ 244 billion, fell by 12% compared to the 2011 figure due to lower solar prices and weakened US and EU markets [7]. Today, major concerns have surfaced regarding the future of RE sources for a mosaic of economic, environmental, and technical reasons (see Table 1). For instance, in the EU, due to the Eurozone's sovereign debt crisis accompanied by tough austerity measures, the Member States were confronted with the necessity of cutting back subsidies for RE projects as banks tightened their lending policies [1]. In the US, the "*fracking boom*" or "*the Halliburton loophole*" has resulted in lower natural gas prices, which has rendered gas-fired power generation a cost-effective alternative; thus, support in Congress for clean energy has ebbed. As a rebound effect, coal's share of electricity generation has fallen from about 50% to 40%, while natural gas's share has increased from 17% to 27%. The overall coal consumption of the US fell by 20%. This energy trend in the US has led to more coal imports and consumption in Europe. The US Energy Information Administration (EIA) has reported that worldwide coal consumption increased by about 45% from 2003 to 2013, and coal consumption is projected to increase by an additional 44% by 2040. In the arena of energy politics, the prospects for US oil imports from the Arab Gulf region, particularly from Saudi Arabia, are noteworthy: a projected reduction in the US oil imports may result in lower oil prices in the global markets and consequently more oil exports to the more energy demanding Asian markets such as India, Japan, and China. In such a scenario, there is a likelihood that investment in RE technologies will plummet or remain alarmingly inadequate to the 2 °C scenario. Furthermore, politically unstable countries such as Iraq, South Sudan, Libya, and Iran, which have had their oil industry idle, will soon be ready to supply the global market with considerable quantities of oil, thus giving the Organization of Petroleum Exporting Countries (OPEC) and giant oil companies more confidence about the future of the oil industry. It is therefore not surprising the US$ 650 billion of investment in oil and gas infrastructure and exploration in 2012, compared to US$ 244 billion investment in RE development [5,6].

For energy utilities, RE is economically viewed as a "*Christmas decoration*" in global energy markets. It appears that private sector disengagement, the relatively high costs particularly of offshore wind energy and concentrated solar power (CSP), and the competitiveness of non-conventional fossil fuels resources in North America have inhibited RE development worldwide. Besides the aforementioned obstacles, challenges such as weak public awareness and support, especially for energy efficient technologies such as smart grids [8] and carbon capture and storage (CCS) [9], and the lack of mobilized public financial resources [6] have inhibited the large-scale deployment of RE technologies. RE pundits have also pinpointed the emissions associated with mining, transportation, and manufacturing, which require considerable fossil energy inputs [10]. In many developing countries, bureaucracy, corruption in public institutions, struggling financial systems, political instability (such as in the *Arab Spring*), and the dire shortage of fresh water and food insecurity are a set of factors that affect RE-related policymaking.

The scaling up of RE technologies to new markets and sectors has been the preoccupation of numerous governments, think tanks, and institutions around the globe. Consequently, the number of

Table 1
A bulletin of various barriers confronting RE development worldwide as alluded to in the academic events.

Technology	Technical	Economic	Environmental	Market	Institutional	R&D
Photovoltaics (PV)	Intermittency, rare earth elements, land availability, lack of expertise, desert sand accumulation, storage capacity, smart grid availability, low efficiency	Maturation and commerciality, bankability	Wild biodiversity issues, threat to migratory birds, emissions debate, landscape scenery	Volatile prices, supply-demand nexus, oil and gas prices, electricity market and grids' peak load	Subsidies distortion, incentives mechanism, regulatory hurdles	High
Concentrated solar power (CSP)	Lack of expertise, energy storage	High upfront investments	Biodiversity, land rights, emissions debate	Oil and gas market prices	Lack of supportive policies	Medium
Solar water heaters (SWH)	Vapor and dust accumulation, durability, maintenance, lack of technicians and expertise	Affordability of poor people	Rebound effect	Public support	Incentives and regulations	Low
Onshore and offshore	Intermittency, rare earth elements, 25 m/s threshold, lack of expertise and technicians, not dispatchable, lower nameplate capacity, aviation radar interception	Subsidies-sensitive, recession-sensitive, high capital costs and investments.	Bird mortality, scenery, biodiversity, emissions debate	Electricity market price, supply-demand ratios, oil and gas prices	Incentives, subsidies, supportive policies	Medium
Cold-climate wind turbines	Geography and access location, expertise, freezing plates risks,	Maturation, commerciality	Arctic landscape, and integrity	Oil and gas prices	Arctic-related regulations	Low
Geothermal	Test-drilling risks, lack of technicians and expertise, resource locations	High upfront costs, land rights, reliability	Injection fluid leakage, resource depletion, public risks	Oil and electricity prices	Mobilized public fund	Low
Nuclear	Safety measures and costs, lack of expertise and technicians, raw materials depletion	High capital costs, maturation	Terroristic attaches, nuclear waste disposal, proliferation risks	Electricity demand, NG and coal prices,	Sanctions and public support, proliferation risks	Medium
Bioenergy	Technology maturation, lack of expertise, raw materials logistics	Subsidies-sensitive	Emissions audits, biodiversity, staple food risks,	Oil prices, EU policies, coal prices	Transportation, public support	High
Carbon capture and storage (CCS)	CO_2 transport, CO_2 storage sites, maturation, solvents (scrubber),	Capital-intensive lack of public finance	CO_2 leakage, reliability, storage sites	Coal-fired plants retrofit, CDM interim	Regulative hurdles and no public or NGO support	Low
Electric vehicles	Rare earth elements, lithium batteries, modern grid facilities	Affordability, gasoline-vehicle Competitiveness	High emissions manufacturing	Electricity and oil prices	Eco-incentives	High