

appreciation of their best performance and recognition of their efforts can be effective in sustaining staff motivation⁹.

Record-keeping is an important activity for strategic planning, monitoring and evaluation of any programme. In this direction, the standard record-keeping from the public health perspective can help monitor and evaluate the service delivery uniformly. Another important observation from this study was the lack of an effective referral system. Referral systems can help the CHOs track the referred cases and follow-up throughout the continuum of care. Furthermore, supportive supervision of CHOs and continuing education can expand coverage of CPHC services beyond conventional ones. They also assist CHOs in developing and nurturing competencies to provide effective care in communities and build relationships within the community as well as with the health system. Periodic short training on behaviour change communication skills, stress management, team-building and conflict management as a part of curriculum at the State Institutes of Health and Family Welfare can help equip CHOs with competencies to navigate complex relationships within the community and the health system.

The HWCs are intended to increase the focus on wellness and lifestyle modi-

fication, particularly related to chronic diseases. Decades of implementing a primary healthcare package for maternal and child health has narrowed the perspectives of the implementers¹⁰, which may impede effective execution of HWCs. In order to provide a comprehensive service delivery package, reorganization of work processes is mandated. Standard operating procedure and the HWC operational guideline in the local context are recommended to optimize the functions of CHOs. More research on human resource management and system strengthening perspectives, particularly in areas such as functions of HWCs, implementation barriers, challenges faced by the CHOs and grassroots health teams, acceptance of technology integration at the HWCs and cost-effectiveness analysis is necessary.

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PRIYA KOTWANI*
APURVAKUMAR PANDYA
SOMEN SAHA

*Department of Public Health,
Indian Institute of Public Health
Gandhinagar,
NH-147, Palaj Village,
Opposite New Air Force Station HQ,
Gandhinagar 382 042, India
e-mail: priya.kotwani@gmail.com

Narratives about the electricity sector

The article by Grover¹ is of great interest not only to electricity generation planners of the government, but to the general public as well because of the huge resource commitments needed for one of the most important infrastructural needs of the country. Although I generally agree with the author's approach towards exploding some of the popular myths about changes needed in electric power generation, there are a few additional points of relevance towards clarification of public perception regarding power planning that are brought about in this communication.

A planning horizon of 20 years is considered as a reasonable period by power planners for making resource commitments to achieve an optimal (minimum cost) capacity addition plan using available technologies. India's electrical energy demand forecasted to rise to 3700 BU in 2040 by International Energy Agency,

referred to in the article, is in close agreement with the Central Electricity Authority's 19th Power Survey Report figure of 3049 BU forecasted for 2036–37 (ref. 2). The latter is based on a combination of time series modelling using past data and an end use method in association with distribution companies, state electricity boards, etc. 'A total shift towards electric vehicles for transportation in the next two decades might significantly raise this estimate.' The correlation between the Human Development Index (HDI) and per capita electricity consumption (as seen from figure 1 of the article) is very poor as the dots corresponding to all the developed countries are dispersed along the entire top horizontal line. A linear correlation between GDP and per capita energy consumption among industrializing countries though with significant dispersion, used by conventional power planners, can be expected

to give a better forecast about the future energy demand as the GDP is directly linked to total productive activities in the country. On the other hand, with HDI defined as the geometric mean of life expectancy index, education index and per capita GNP index, for a country like India, the first two factors not well correlated with GNP would lead to poor mapping between HDI and energy demand³.

As the solar photovoltaic generation is now offered at just two rupees per kwhr, obviously installed capacity of solar and other inexpensive environment friendly renewable sources of power need to be fully exploited before loading other generators to meet the load demand. Fortunately for India, the ratio of national peak load to minimum load is only in range 1.1–1.3. Daily and seasonal generation variation from solar and wind sources is also predictable. As the

installed capacity of renewables become dominant even within next 20 years, all the fossil units and even nuclear units will have to ramp up or down their power output on daily basis to meet the generation gap as decided by a nationwide coordinated control centre. Necessary modifications in the design of such large new units for scheduled load follow operation should be possible. The spinning reserve needed for grid frequency control can be augmented by pumped storage hydro plants and grid scale storage batteries that are becoming commercially available. Additional reactive compensation needed in the form of static VAR systems and synchronous condensers to ensure a satisfactory voltage profile over the grid can be established by detailed load flow studies for all anticipated operating situations. As the necessary models and software needed for optimal power dispatch on hour to hour basis across the entire country are readily available, there should be no insurmountable difficulty to satisfy the energy needs of the country at a rationally determined minimum cost⁴.

Planning for time periods beyond 2040 would be necessarily sketchy because of the difficulties in forecasting the techno-commercial options available that time.

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THANGASAMY SANGARAPPAN

A-303, Cambridge Apartments,
Cambridge Road, Halasuru,
Bengaluru 560 008, India
e-mail: stsamy2001@yahoo.com

Response

Transition to a low-carbon electricity mix

The Paris Agreement was adopted in 2015 by 196 Parties and aims to limit global warming to well below 2, preferably 1.5 Celsius, compared to pre-industrial levels. To achieve this goal, Parties including India announced Intended Nationally Determined Contribu-

tions and in recent months there is a clamour for reaching ‘net zero’ by the middle of this century. Many studies aimed at reducing carbon emissions are being pursued by academics such as the ‘Carbon mitigation initiative’ by Princeton University¹. Based on these studies, certain narratives are prevalent in media. Some narratives transport conclusions derived in a certain context to an altogether different context without looking at issues of applicability. An oft-repeated example is to pronounce that solar and wind can meet all electricity requirements without looking at the density of population of a country. Another common narrative is to compare tariff based on ‘Levelised cost of electricity’ generation, a metric which does not account for intermittency. To provide evidence-supported perspective to readers, I enumerated some narratives and discussed them in detail in a paper².

Thangasamy, although while generally agreeing to my approach, alludes to the practice of adopting a planning horizon of 20 years for capacity addition. However, my paper nowhere gives annual capacity targets; it provides guidance for transition to a low-carbon electricity-mix. The energy-mix and electricity-mix are intertwined and the present energy-mix has been built over almost three centuries. It will take at least half a century to transition to a new energy-mix.

Regarding the correlation between Human Development Index (HDI) and Per Capita Per Annum Electricity Consumption (PCPAEC), he alludes to a difference between a country like India and the industrialized world without providing any supporting argument. In a connected world, differences are not sustainable. One can note rising electricity consumption in India and its neighbourhood. In Singapore, an example not cited in my paper as it is an urban space, PCPAEC is at the same level as the average of countries comprising OECD. The plot of HDI versus PCPAEC of various countries does show large scatter as it includes countries with large differences in population density, percentage of population living in urban spaces, resource endowments, climatic conditions, geographical area and geopolitical situation. However, the trend of first sharp increase in HDI followed by approaching a value of one asymptotically is unambiguous. A detailed analysis for arriving at a more precise target would rob my analysis of

its simplicity. A change of 10–20% from the target of 5000 kW-hour PCPAEC does not change the conclusions of my paper. Considering that the share of electricity in the total final consumption of energy is rising due to convenience of use and minimum environmental effect at the point of use, the proposed target is conservative.

Reference made by Thangasamy to pumped storage and its use in reactive compensation is appreciated, but unfortunately such storage sites in the country are limited. Along with reactive power, lack of mechanical inertia is another issue that needs to be addressed in the case of solar power. Storage and other system effects are not likely to make electricity from wind and solar inexpensive for the consumers as already experienced by countries like Germany. Despite advances in forecasting in generation by solar and wind, reliability remains an issue as demonstrated by rolling blackouts in recent past in California and Australia.

The present approach of aggregating plans, made independently by various ministries and departments sitting in their silos, has to be replaced by an approach based on integrated analysis which factors in availability of resources and characteristics of technologies including indigenous manufacturing capability.

UK is perhaps the first major economy to release a White Paper³ for transition to a net zero future. They have analysed 7000 different electricity mixes in 2050, for two different levels of demand and flexibility, and 27 different technology cost combinations. India needs to launch a similar effort to decarbonize without compromising the dreams of an aspirational India.

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R. B. GROVER

Homi Bhabha National Institute,
Mumbai 400 094, India
e-mail: rbgrover@hbni.ac.in