

Energy Storage

The Problem

India is expected to face a rising energy demand in future. Presently, India’s energy demand is primarily being met through coal. A minor portion of the total energy demand is being met through other renewable sources viz. solar and wind. Carbon dioxide emissions from coal combustion have been projected to total 1.3 billion metric tonnes in 2030 (TERI, (2006)). More than 30% of the total energy demand arises from the commercial building sector of India which is expected to grow with a rising urbanization in future. Hence to reduce dependence on fossil fuels like coal, energy conservation measures by means of thermal energy storage (TES) in commercial buildings can be an option. TES can help to address the gap between demand and supply of energy by peak load shaving and shifting in commercial buildings of India.

According to an EIA (U.S. Energy Information Administration) projection, the fastest growth in commercial building energy consumption by 2040 will occur in India. Energy consumption in commercial building sector of India is expected to increase by an average of 2.7% by 2040, which is more than twice the global average (EIA (2017) ; (Cabeza et al, 2002)). In India, the building sector consumes approximately about 31% of the total energy production of India. Within this, nearly 9% is consumed by commercial buildings (UNDP (2011)). To tackle the problems arising from growing building energy use, the Indian government had issued the Energy Conservation Building Code (ECBC) in 2007.

A plethora of impediments and barriers exists while installing TES in commercial buildings. These barriers include high upfront costs, challenges in sustained economic benefit generation, dearth of information and awareness, and lack of policy and institutional support. The study analyses the benefits and costs from TES applications in commercial buildings for two technological applications (with ice and hybrid salt as phase change material) in an ex-ante situation when the technology has not yet been applied in commercial buildings of Rajasthan.

Solutions

Interventions	BCR	Benefit per sq ft of building carpet area	Cost per sq ft of building carpet area
Water based thermal energy storage for commercial buildings	2.73	1,448	531
Salt Hybrid based thermal energy storage for commercial buildings	2.56	1,448	566

Total costs and benefits are discounted at 5%. Period of analysis is 15 years.

The full paper by **Anandajit Goswami** Research Fellow, TERI School of Advanced Studies & **Kaushik Ranjan Bandyopadhyay** Associate Professor, IIM Lucknow is available on www.rajasthanpriorities.com/energy.

Thermal Energy Storage for commercial buildings

The Problem

Within the commercial sector of the economy, building energy consumption is increasing rapidly and is expected to follow the same pattern in future.

Heating, Ventilation and Air Conditioning (HVAC) systems are key contributors to peak loads of commercial buildings and contribute nearly 40% of the energy demand of a commercial building in India (Rajan, S. (2016)). There is rise in the demand for controlled climate spaces in the last two decades in mechanically controlled commercial buildings.

To tackle the problems arising from growing building energy use, the Indian government had issued the Energy Conservation Building Code (ECBC) in 2007. Rajasthan was the first state to adopt the code in 2011, while introducing minor additions that came to be known as Rajasthan Energy Conservation Building Directives (R- ECBD). R-ECBD has been made mandatory for commercial buildings. As for Rajasthan, since R-ECBD has already been made mandatory for commercial buildings, TES, if installed in commercial buildings, can reduce carbon emissions considerably.

The Solution

The proposed intervention is TES in commercial buildings of two types based on phase change materials (namely ice and hybrid salt) for the state of Rajasthan.

TES is a form of energy storage technology that "stocks thermal energy by heating or cooling a storage medium so that the stored energy can be used at a later time for heating and cooling applications and power generation."(IRENA, 2016).

TES can help to address the gap between demand and supply of energy by peak load shaving and shifting in commercial buildings of India.

In the commercial building segment of India, the main application of TES therefore would be in the Air Conditioning (AC) segment. TES apart from solving the intermittency problem of renewable sources can be integrated with conventional thermal power stations for storage of excess off-peak energy for use at peak times which may also increase plant efficiency. It is an ex-ante study that has been estimated for a period of 15 years.

Costs

For calculating the discounted cost, the study has taken into account capital cost and O&M cost. Capital costs are considered to be same for both technologies in this analysis as based on the test case parameters comes to an average cost of INR 368 per sq ft. O&M cost is assumed to be 5% of capital costs for ice TES and 6% for salt hybrid TES.

The estimated cost per sq ft of building carpet area of water based thermal energy storage for commercial buildings is Rs. 531 and the same for salt hybrid-based TES for commercial buildings is Rs. 566 at 5% discount rates.

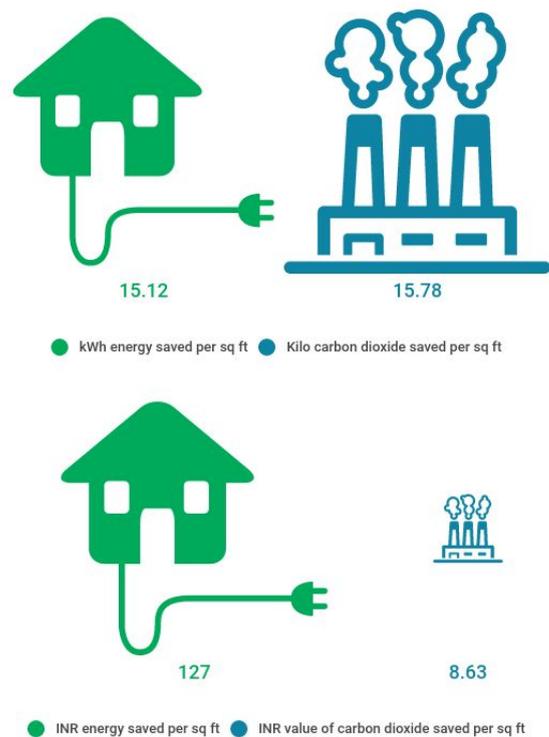
Benefits

The direct benefits have been considered in terms of the energy and carbon emission savings. Indirect benefits could be generated in terms of long term employment generation. The benefits through energy and carbon emission will lead to climate change mitigation measures, reduced coal consumption, reduced emissions with concomitant health benefits.

It has been assumed that the TES system runs for an optimum of 6 hours and can avoid 60% of the energy requirement of the peak load capacity.

The estimated benefits per sq ft of building carpet area for the water or salt hybrid-based TES is Rs. 1,448 at 5% discount rates

Yearly benefits per square foot



Assuming 5% discount rate. Source: Authors paper