# ENERGY HARVESTING BRIDGES

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## SITUATION

- Traffic congestion across the UAE roads (quarter a million cars daily on Etihad road only [1])
- Cars affect the environment negatively through carbon dioxide emissions (every gallon of gas burnt emits 24 pounds of CO2 [2])
- Traffic-induced vibrations over bridges can be used to produce clean energy

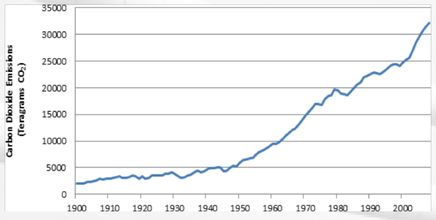


Figure 1: Global Carbon Dioxide (CO2) emissions from fossil fuels 1900-2008 [2]

## CONSTRUCTION

### Problem

- Selection of a proper construction material that can withstand heavy loads and induce vibration in the most efficient way
- Effects of environmental conditions on the durability and stability of the bridge

### Solution

- Concrete should be considered as a primary material due to its ability to induce vibrations
- Stress-strain relationship implementation to eliminate all hazards that might occur in any structure

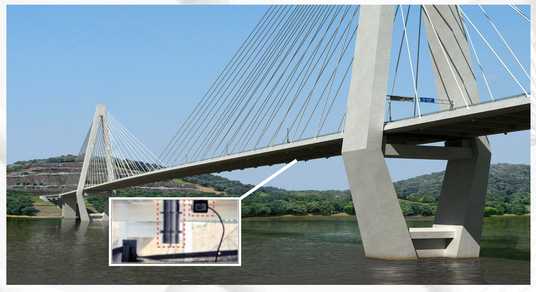

Figure 2: Photograph of the PFIG mounted next to a Crossbow accelerometer underneath the bridge girder photo (3)

### Evaluation

- Concrete is a cost-efficient material that is used widely in construction
- Stress-strain relationship execution to obtain the required temperature that will help in protecting the bridge structure

## HARVESTING

### Problem

- Absorption of vibration over bridges represents a challenge due to its low acceleration, low frequency, and non-periodic timing characteristics [3]
- The accumulative amount of energy that should be harvested from the traffic with various accelerations

### Solution

- Usage of Parametric Frequency Increased Generator (PFIG) as an efficient device that can deal with the given characteristics of bridge vibrations
- The amount of vibration over the bridge is related to the number of PFIG devices that should be used in the harvesting process

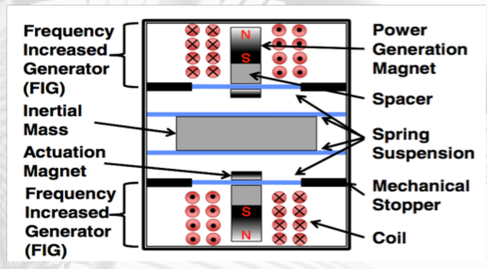


Figure 3: Parametric Frequency Increased Generator (PFIG) conceptual illustration depicting the internal components [3]

### Evaluation

- PFIG generator has been shown to have 10x better efficiency over other reported harvesters in this space, due to its low-frequency non-resonant operation
- Lower maintenance requirement for the PFIG generator

## UTILIZATION

### Problem

- Low acceleration and frequency of vibrations over bridges present a serious challenge toward efficient electromechanical conversion of energy
- Efficient way of storage harvested energy is another challenge during the utilization process

### Solution

- Power management system is being developed to convert and store energy from the vibration harvester and to deliver the stored energy to consumption point
- Using a super capacitor for energy storage to ensure the utilization of harvested power

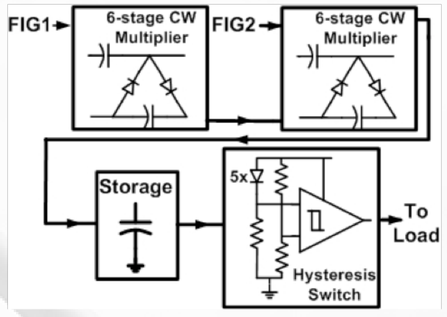


Figure 4: Power management system design [4]

### Evaluation

- Lower maintenance requirement for the power management system
- Reduction of installation cost accompanied with increased efficiency of energy storage

## References

[1] RTA ends Dh24 daily Salik cap from July 15, Emirates 24/7, [online] 2013. http://www.emirates247.com/news/emirates/rta-ends-dh24-daily-salik-cap-from-july-15-2013-06-30-1.512532
[2] Global Greenhouse Gas Emissions Data., EPA," [online] 2010, http://www.epa.gov/climatechange/ghgemissions/global.html (Accessed: 2 March 2014).
[3] T. Galchev, J. McCullagh, R. L. Peterson, and K. Najafi, "Harvesting traffic-induced bridge vibrations," in 2011 16th International Solid-State Sensors, Actuators and Microsystems Conference, pp. 1661-1664.
[4] H. Dong-Ho, K. Daehyun, J. F. Choo, and G. Nam Seo, "Energy harvesting and monitoring using bridge bearing with built-in piezoelectric material," inNetworked Computing (INC), 2011 The 7th International Conference on, 2011, pp. 129-132.