

THE DEPARTMENT OF MECHANICAL & AEROSPACE ENGINEERING
STANFORD S. AND BEVERLY P. PENNER
DISTINGUISHED LECTURES**A New Type of Heat Engine,
Using LED's as Refrigerators***Eli Yablonovitch*

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Friday, March 3, 2017 4:00 p.m.-5:00 p.m.
CMRR Auditorium, UC San Diego

ABSTRACT

Very efficient light emitting diodes (LED's), surprisingly, do actually become cold as they operate, since LED light carries away entropy. This cooling requires superb LED efficiency.

Of course, we now know that the photovoltaic cell and the LED are really the reciprocal of one another. The slogan: "A great solar cell has to be a great LED" has led to all the new solar cell efficiency records.

What if the electrical output of a photovoltaic cell drives an LED, and the LED light in turn drives the photovoltaic cell? You might fear that it would become a perpetual motion machine. Instead it becomes a heat engine in which a small amount electricity can efficiently provide refrigeration, or conversely a small temperature difference can generate electricity. Such an electro-luminescent heat engine, in which photons are the working fluid, can be more efficient than the competing science, thermo-electrics, in which electrons are the working fluid.

BIO

Eli Yablonovitch is Director of the NSF Center for Energy Efficient Electronics Science (E3S), a multi-University Center headquartered at Berkeley. Yablonovitch introduced the idea that strained semiconductor lasers could have superior performance due to reduced valence band (hole) effective mass. With almost every human interaction with the internet, optical telecommunication occurs by strained semiconductor lasers.

In his photovoltaic research, Yablonovitch introduced the $4(n^2)$ ("Yablonovitch Limit") light-trapping factor that is in worldwide use, for almost all commercial solar panels.

His mantra that "a great solar cell also needs to be a great LED", is the basis of the world record solar cells: single-junction 28.8% efficiency; dual-junction 31.5%; quadruple-junction 38.8% efficiency; all at 1 sun.

He is regarded as a Father of the Photonic BandGap concept, and he coined the term "Photonic Crystal". The geometrical structure of the first experimentally realized Photonic bandgap, is sometimes called "Yablonovite".

His startup company Ethertronics Inc., has shipped over 1.7 billion cellphone antennas. He is a Co-Founder of Luxtera Inc., the world leader in Silicon Photonics.

He has been elected to the NAE, the NAS, and as Foreign Member, UK Royal Society. Among his honors is the Buckley Prize of the American Physical Society, and the Isaac Newton Medal of the UK Institute of Physics.