



ISTANBUL

SMART METROPOLES

Integrated solutions for Sustainable and Smart Buildings & Cities

INNOVATION FOR BUILDINGS: FROM SCIENCE TO COMFORT

M. Pinar Mengüç

Center for Energy, Environment and Economy
Özyegin University
Istanbul, Turkey



Center for Energy, Environment and Economy @ Ozyegin University

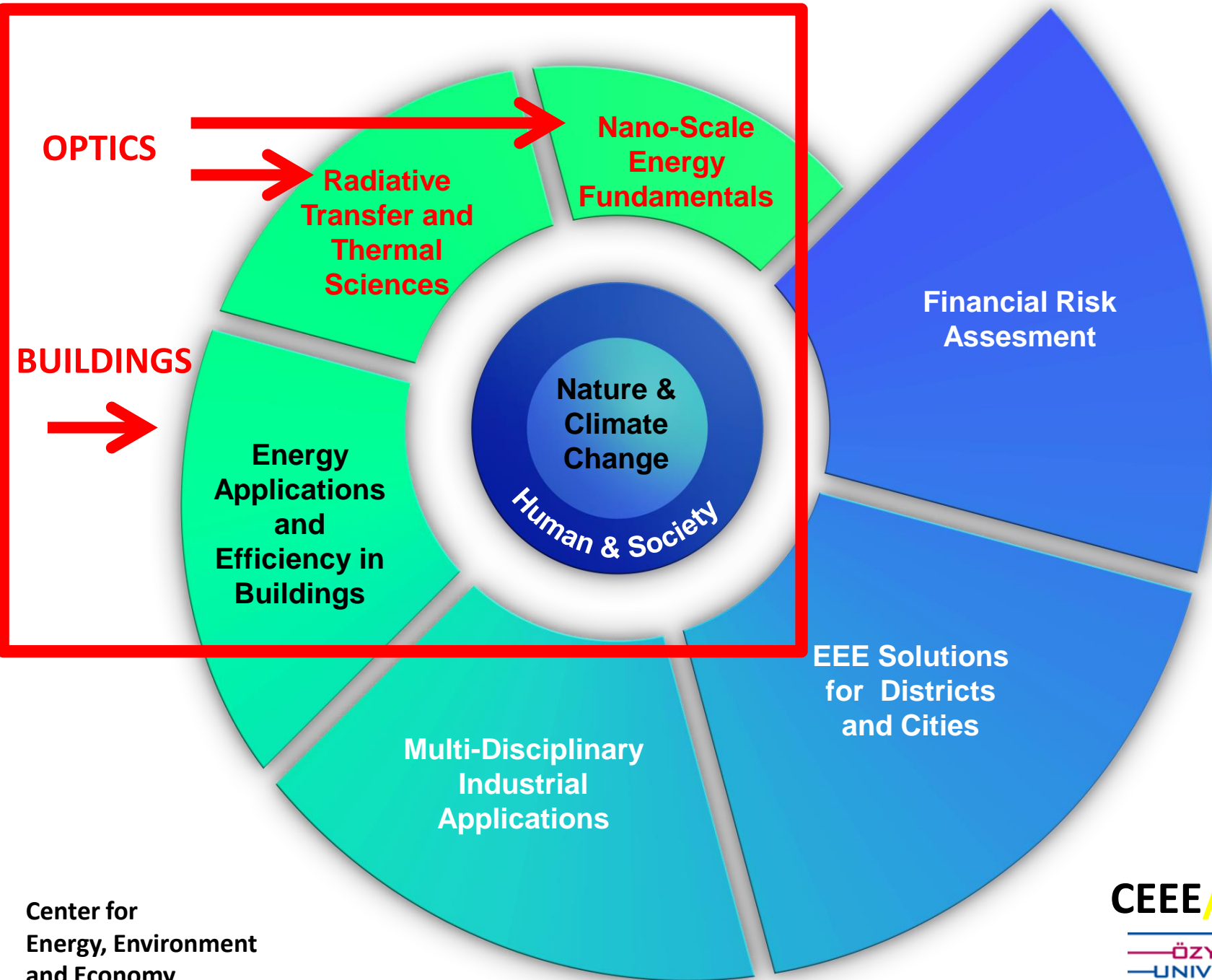
A Sustainable Energy Center!

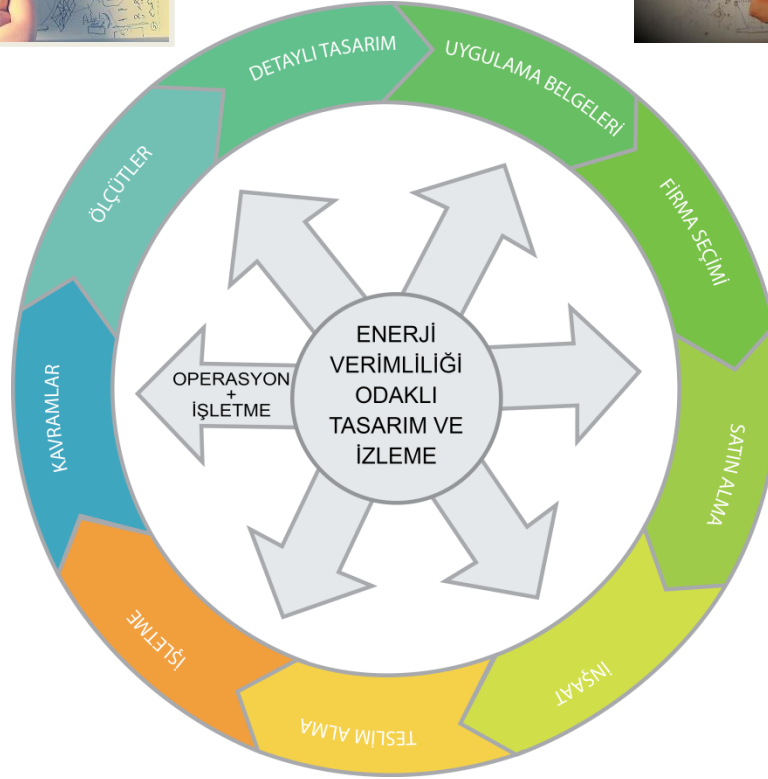
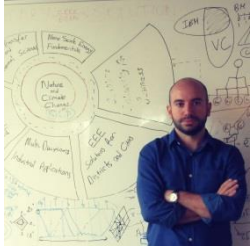
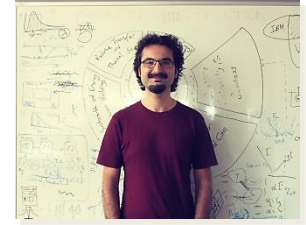
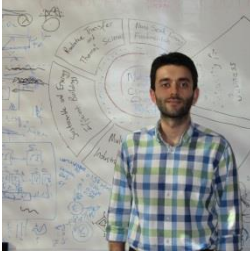
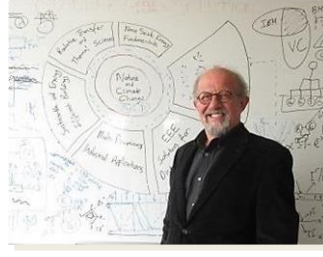
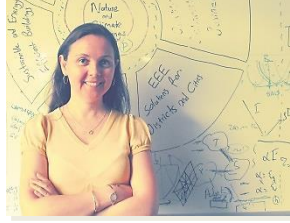


Ozyegin University Campus View (in 2011, there was nothing in this view!)



Solar PV, Green Roofs, Solar Shades, Facades, Smart Automation...TRIBEPACK



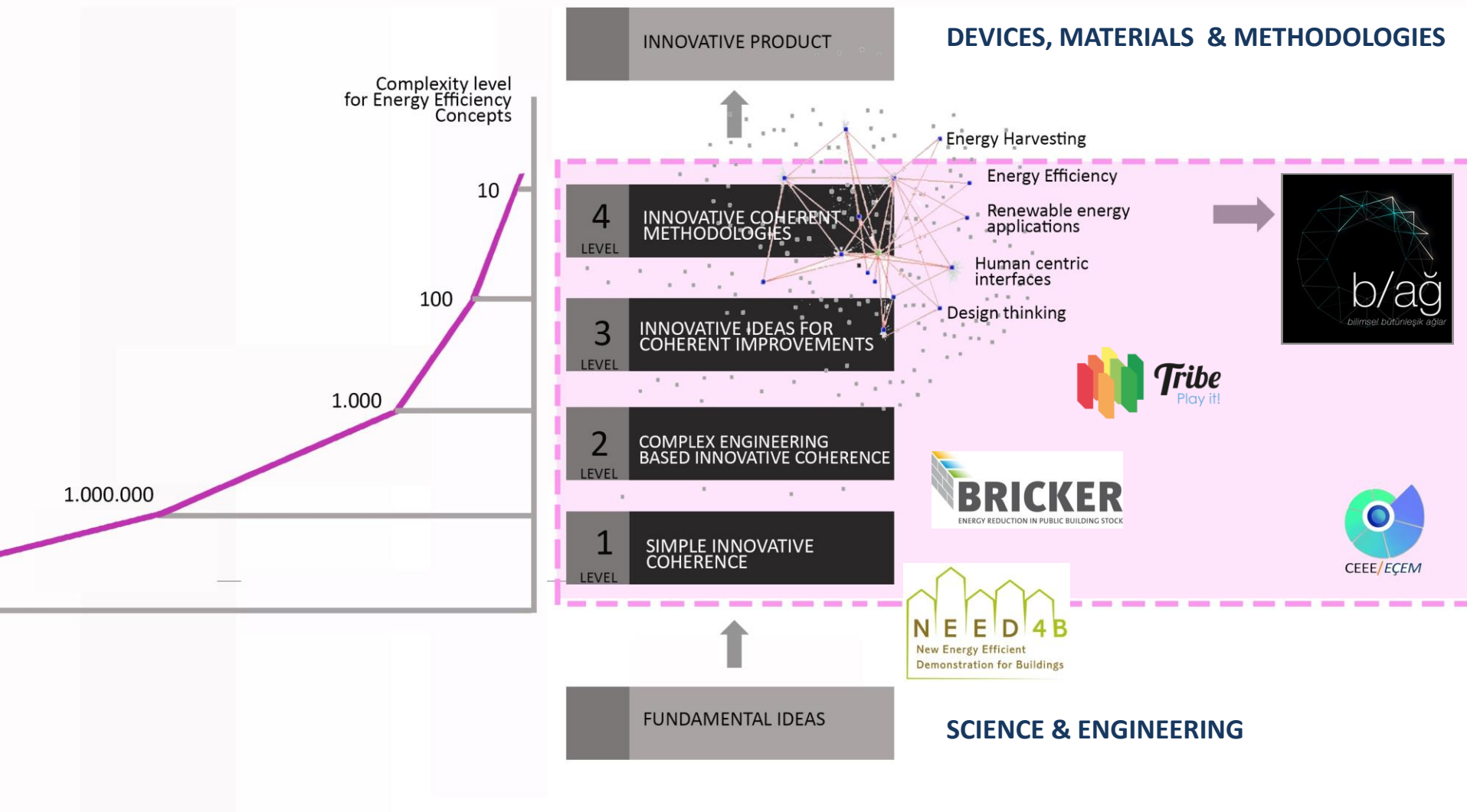


Buildings

about 40% of Energy Use

about 40% CO₂ Emissions

TOWARDS SUSTAINABLE BUILDINGS: CEEE INNOVATIONS



TOWARDS SUSTAINABLE BUILDINGS

Sustainable Buildings

Building Use Objectives

Stakeholder Limitations



Integrated Architecture and Engineering



Sustainable financing, Risk analysis

NSF/TUBITAK
Georgia Tech

Thermal/Visual Comfort

Operational Cost



Integrated Building Management



TOWARDS SUSTAINABLE BUILDINGS



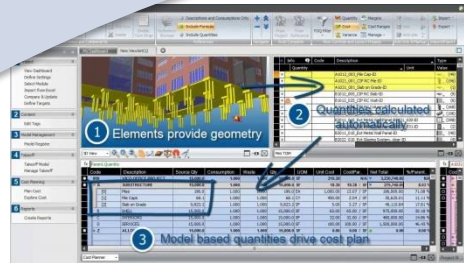
4D & 5D

6D

7D



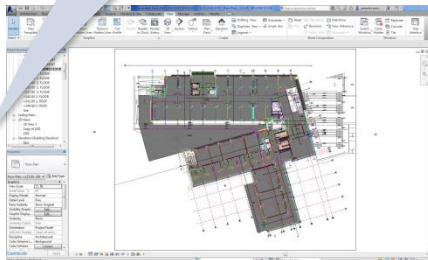
3D



COST PLAN

FACILITY MANAGEMENT

QUANTITIES
+
SCHEDULING



Sustainable Buildings

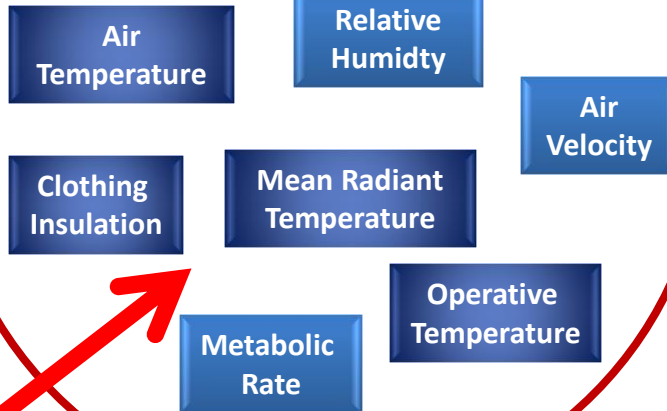
Integrated Architecture and Engineering

Comfort

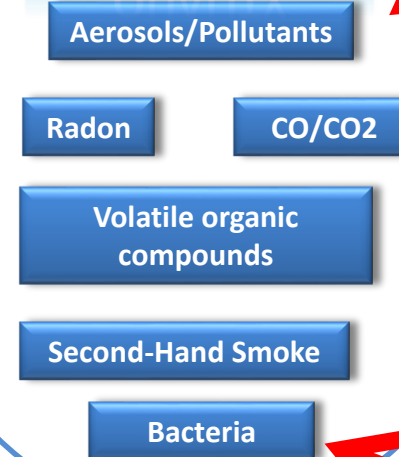
SCIENCE BEHIND COMFORT

INDOOR/OUTDOOR ENVIRONMENTAL QUALITY

THERMAL COMFORT



AIR QUALITY



ACOUSTIC COMFORT

VISUAL COMFORT

RADIATION
TRANSFER

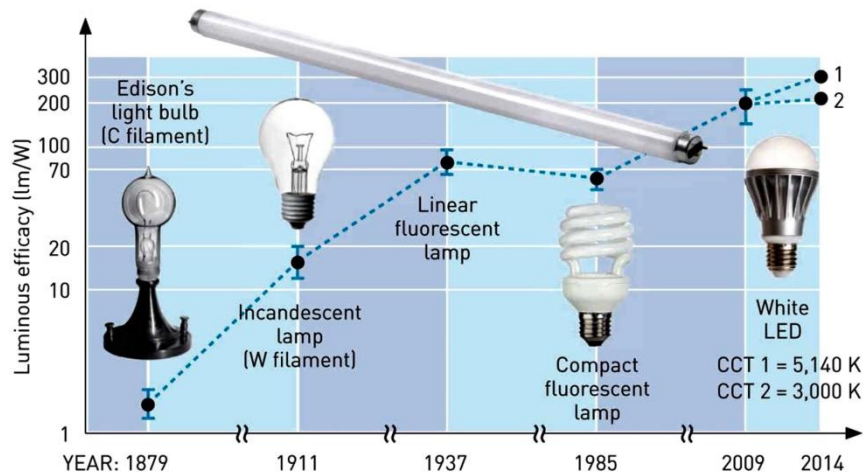
LS

LS

OPTICS
ARCHITECTURE

AREAS OF IMPACT FOR ACHIEVING EE via OPTICS

7

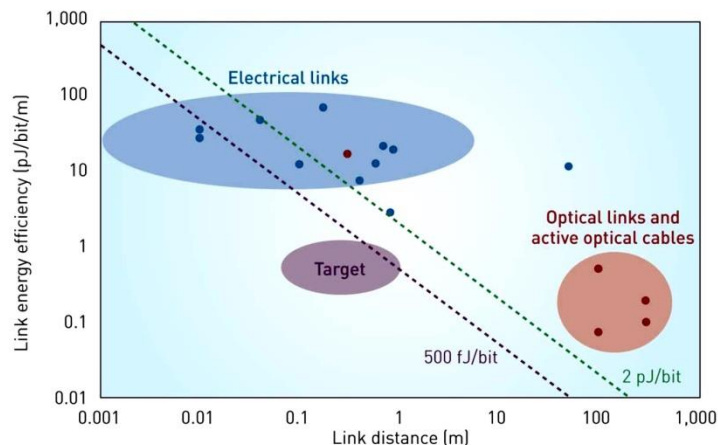
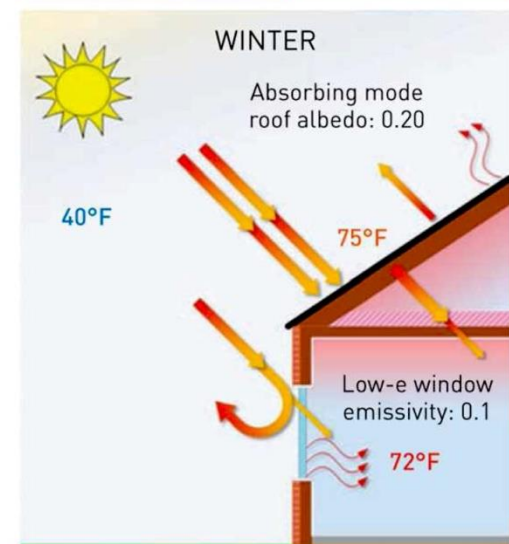
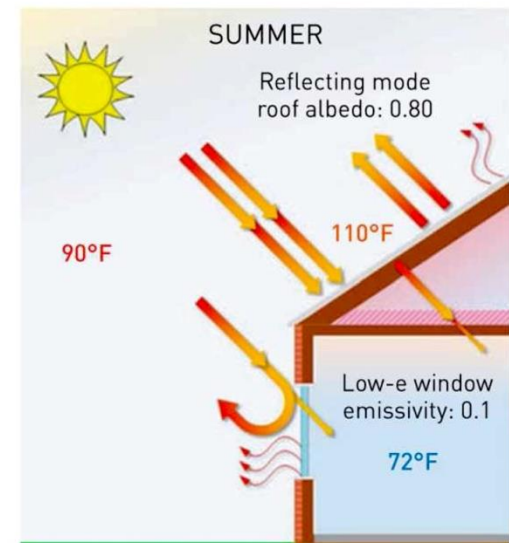


Evolution of luminous efficacy, from Edison to LED. White LED device performance is shown for correlated color temperature (CCT) of 5,140 K and 3,000 K.

Adapted from Fred Schubert/CCT Source: Cree Company, 2014; Osram Company, 2014

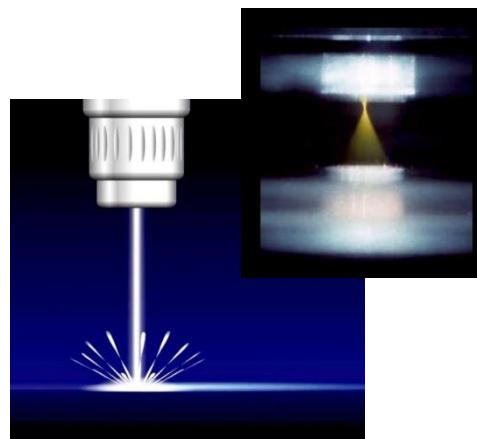
Radiative Cooling
(A. Didari, R. Family)

Sensor Networks
(TRIBE, C. Keskin)

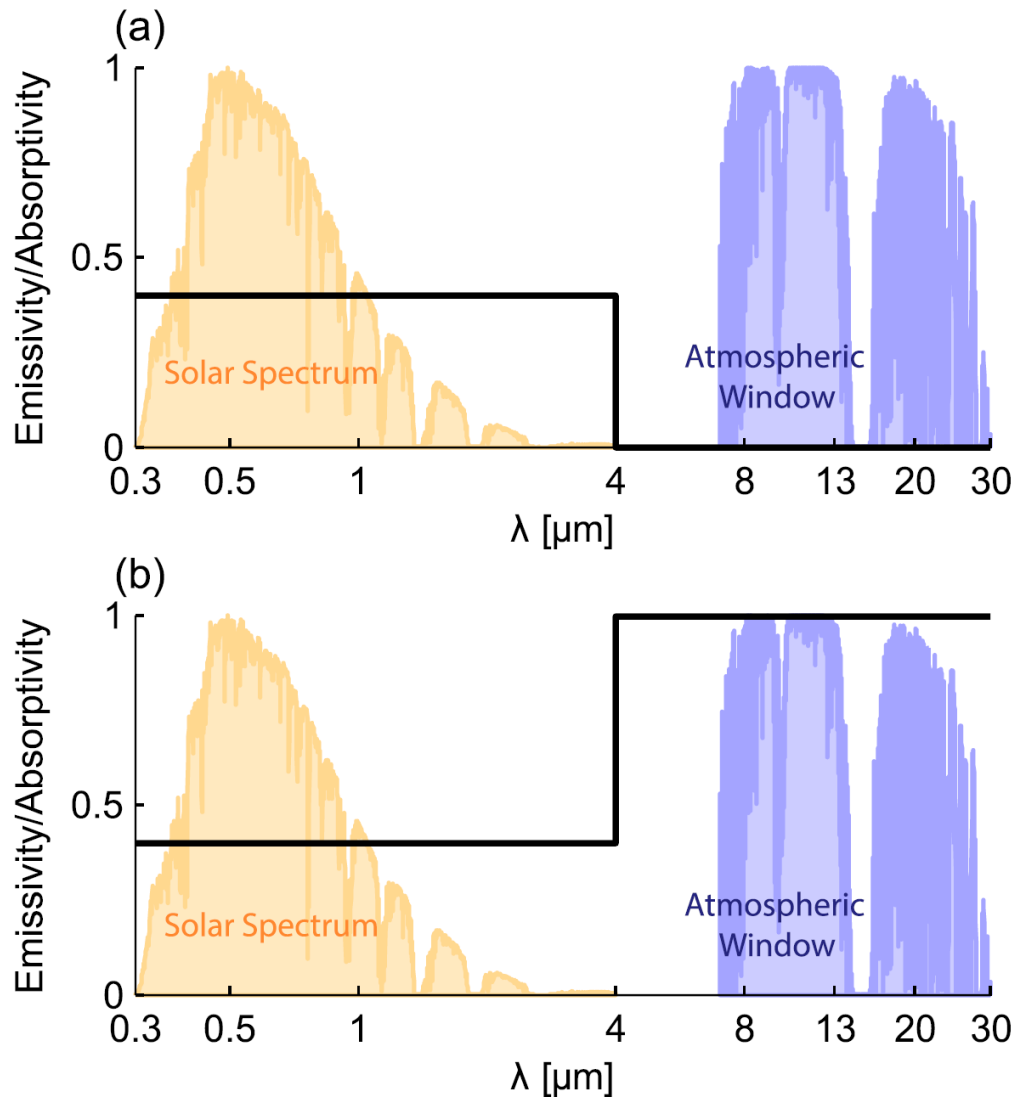


Energy efficiency of electrical and optical links, including active optical cables.

A. Krishnamoorthy et al., IEEE J. Sel. Top. Quantum Electron. **17**, 357 (2011)



SCIENCE FOR RADIATIVE COOLING

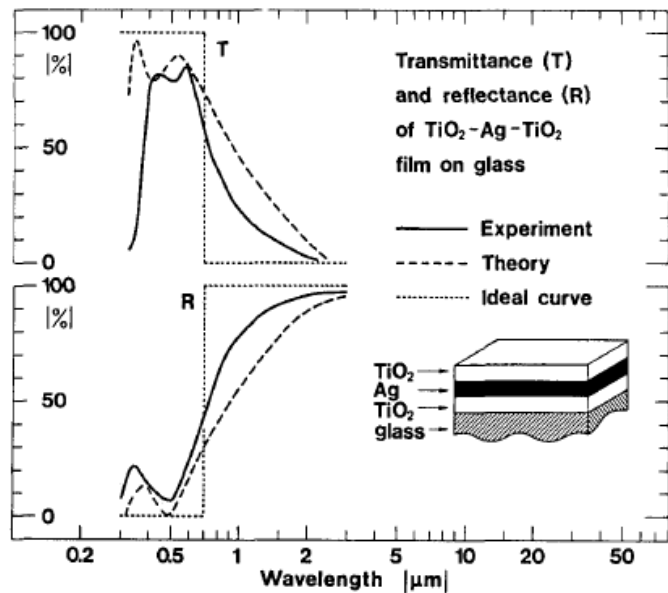
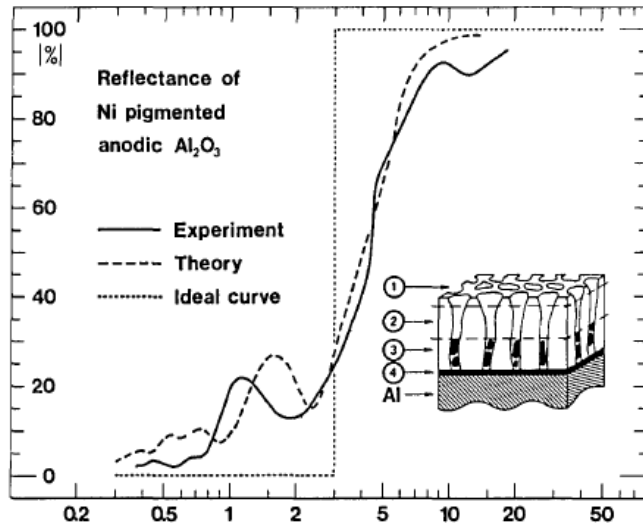


Selective Emission and Absorption by Designer Surfaces at Spectral Atmospheric Window

Figure from
E. Rephaeli....S. Fan, Ultrabroadband ...
for Radiative Cooling , Nano Letters,
Vol. 13, 1457-1461, 2013.

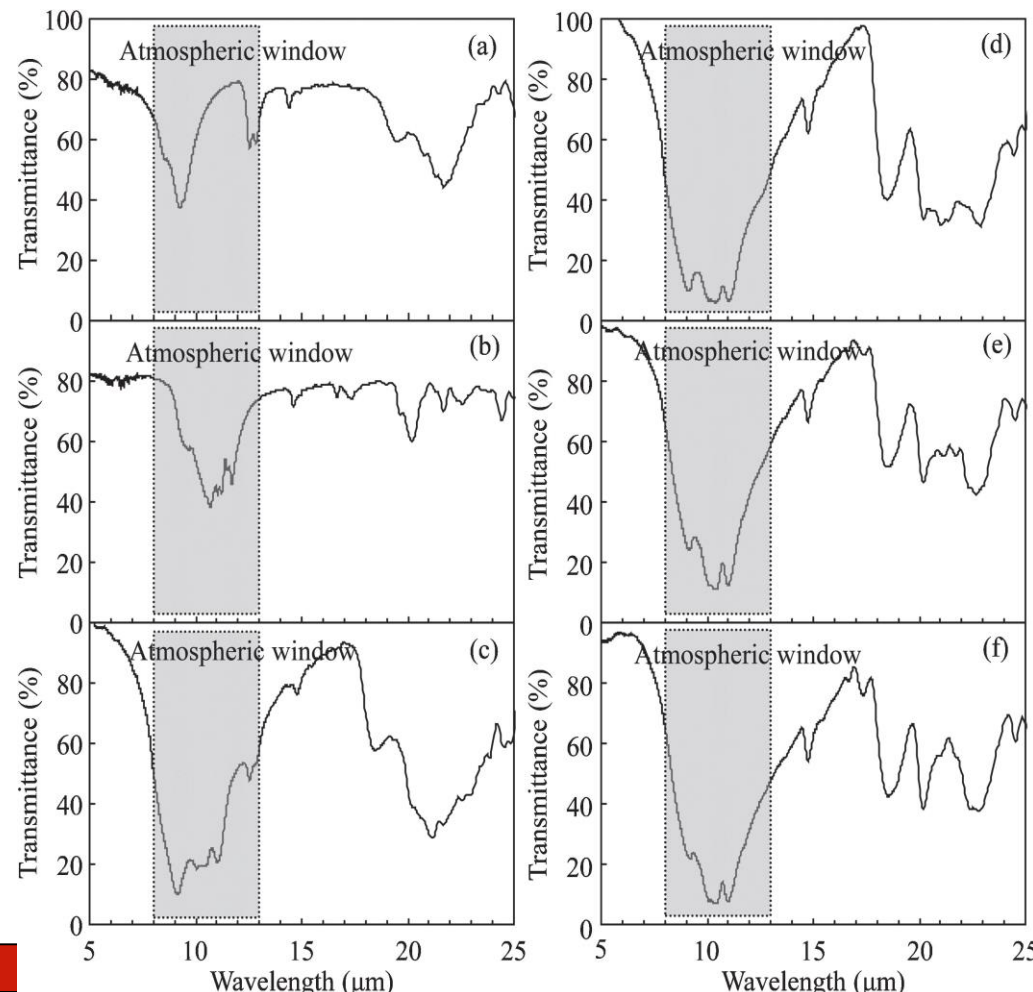
SELECTIVE EMISSION AND ABSORPTION FOR RADIATIVE COOLING

C.G. Granqvist, Applied Optics, Vol. 20, No 15, August 1981



Hidetoshi MIYAZAKI, Shigeki YOSHIDA, Yosuke SATO, Hisao SUZUKI and Toshitaka OTA, "Fabrication of radiative cooling materials based on $\text{Si}_2\text{N}_2\text{O}$ particles by the nitridation of mixtures of silicon and silicon dioxide powders", Journal of the Ceramic Society of Japan 121 [2] 242-245 2013

Silicon oxynitride particles ($\text{Si}_2\text{N}_2\text{O}$)



SUSTAINABLE MATERIALS FOR RADIATIVE COOLING

XPS=
Extruded Polystyrene
Foam<<



Coated XPS



EPDM=
Black Membrane



Red Membrane



Porous Silisium
Powder



Perlite Pumice
Cement
Composite
Materials



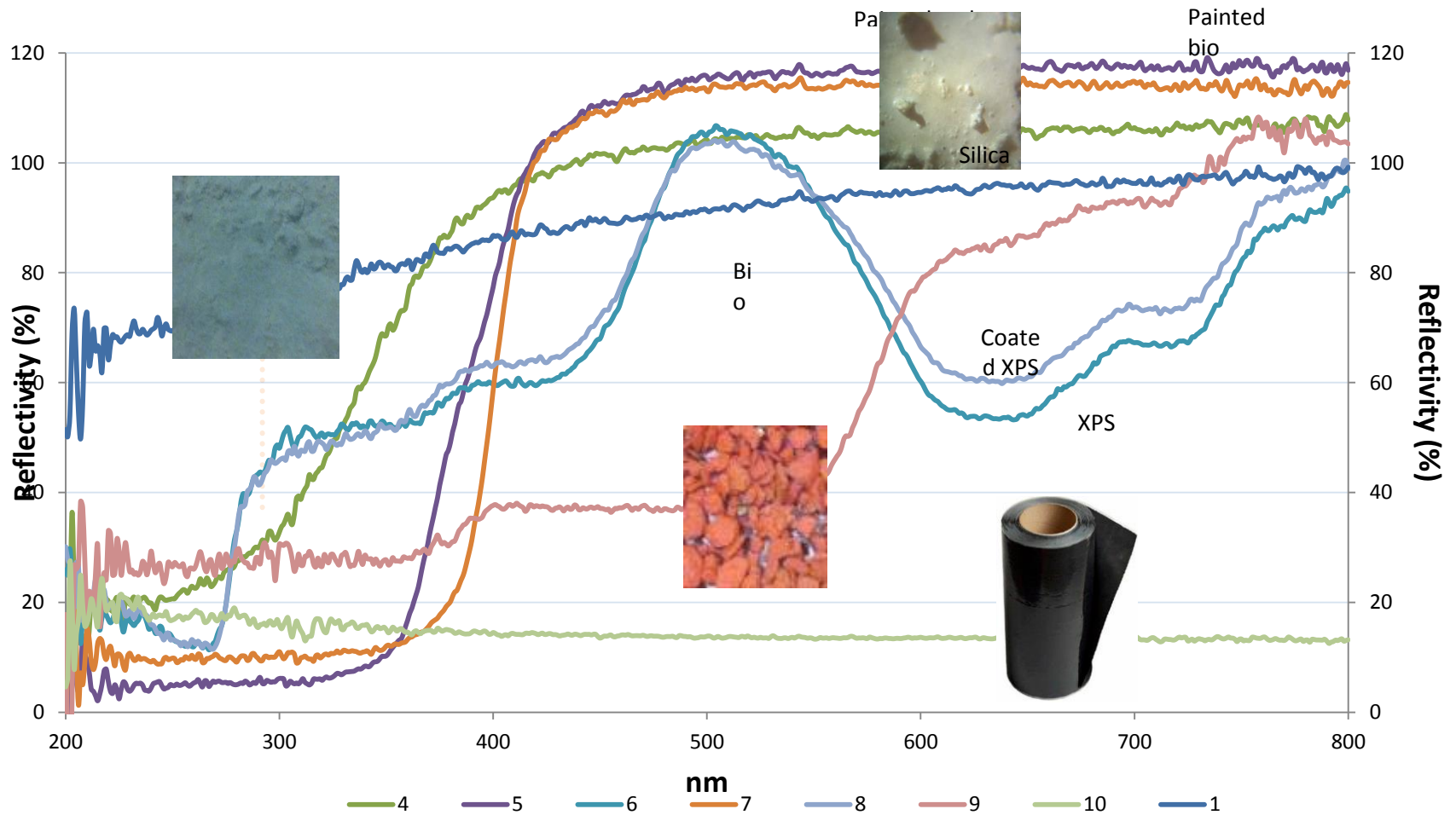
Bioinsulation

Painted and Coated
bioinsulation panel



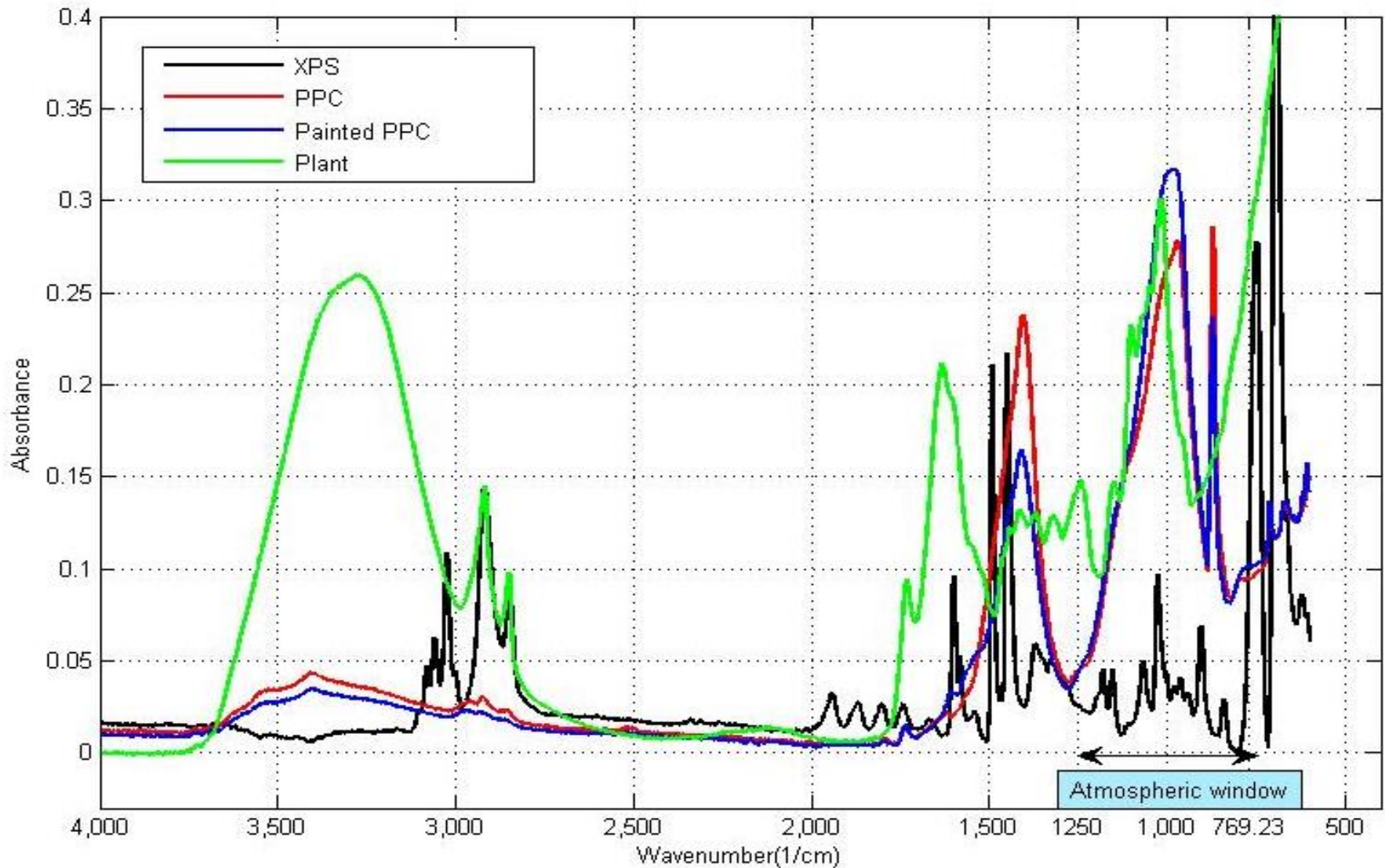
R. Family and M.P. Mengüç, 2016

SUSTAINABLE MATERIALS FOR RADIATIVE COOLING



R. Family, M.P. Mengüç, 2016,

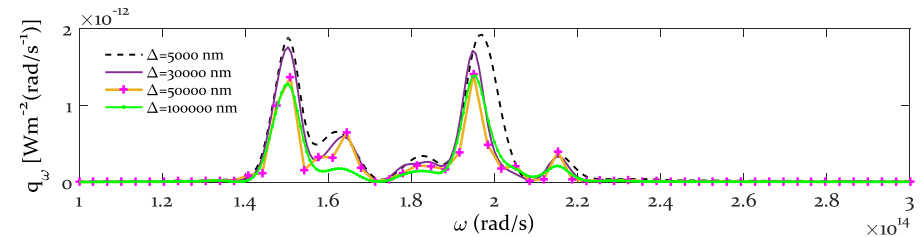
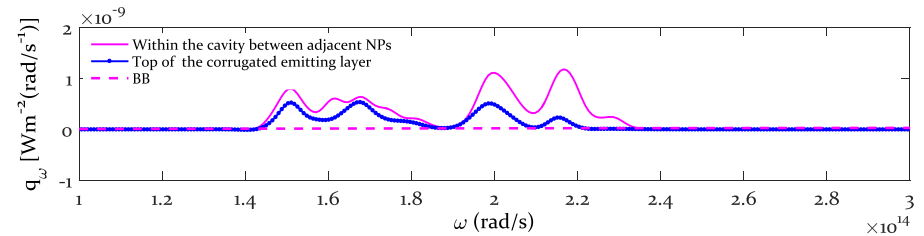
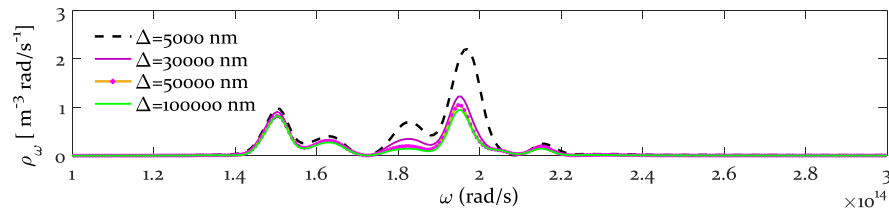
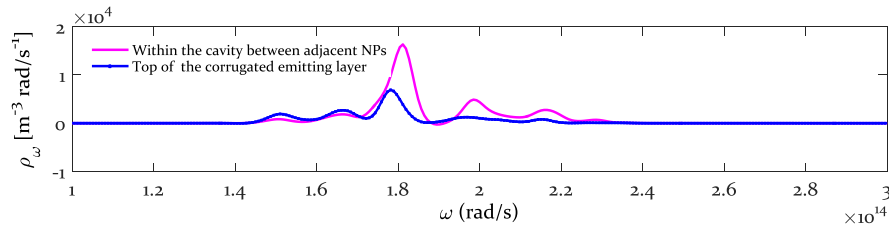
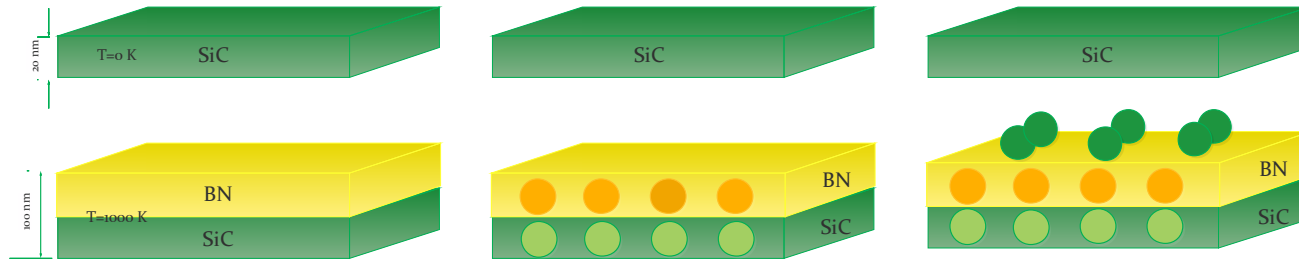
SUSTAINABLE MATERIALS FOR RADIATIVE COOLING: FTIR



R. Family, M.P. Mengüç, SBE'2016

NEW CONCEPTS BASED ON NEAR-FIELD RAD TRANSFER

Near- to Far-Field Emission Characteristics of SiC-BN Mesoporous Metamaterials (Near- to Far-Field Results)



A. Didari, M.P. Mengüç, 2015-2016

Sustainable Buildings

Integrated Architecture and Engineering

Thermal Comfort

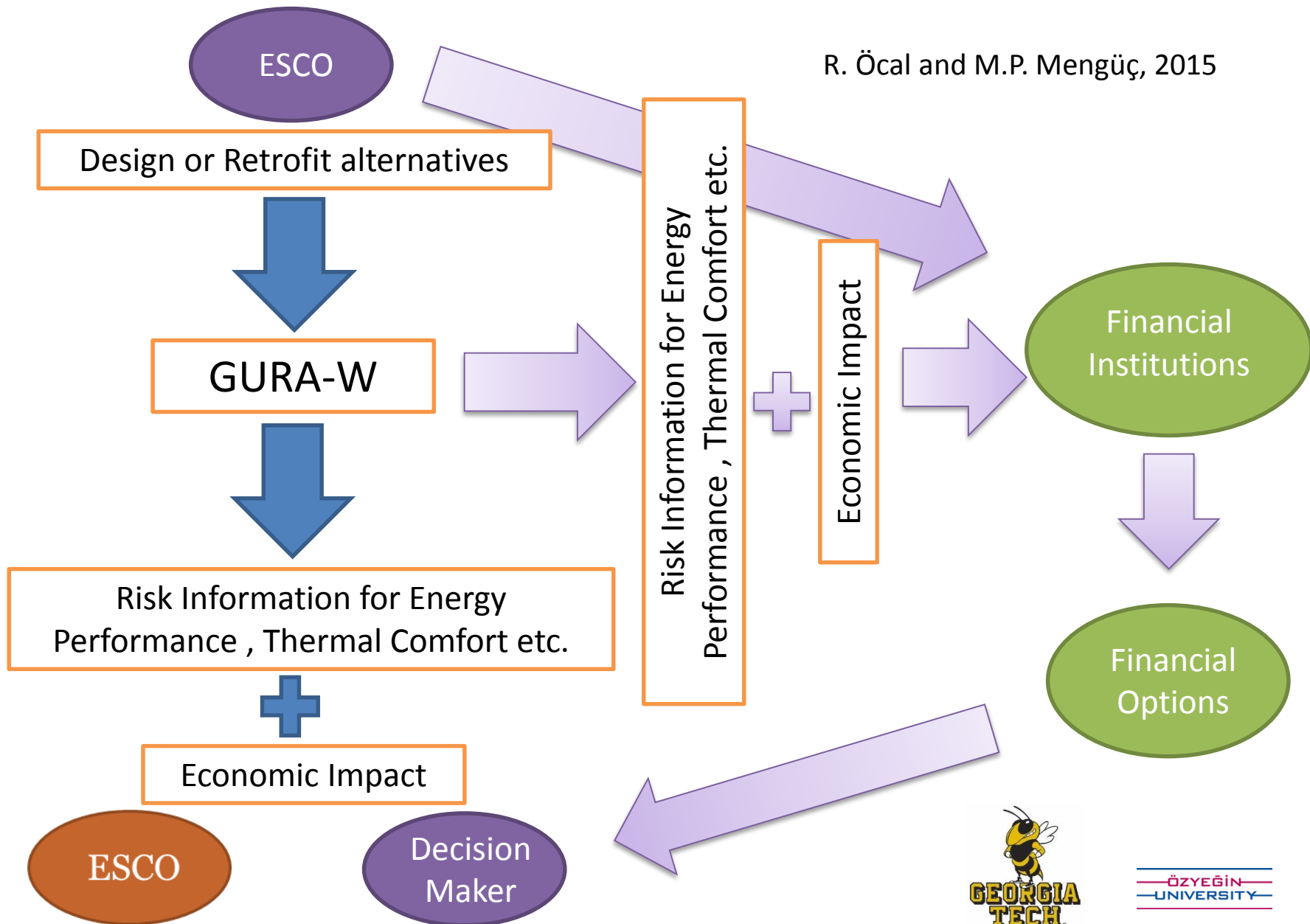
Sustainable Buildings

Integrated Architecture and Engineering

Operational Cost

TOWARDS SUSTAINABLE BUILDINGS: FINANCIAL INNOVATION

R. Öcal and M.P. Mengüç, 2015



Sustainable Buildings

Integrated Architecture and Engineering

**Human-Centric Design for
Energy Efficiency and
Operational Cost**

HUMAN-CENTRIC DESIGN FOR BUILDINGS

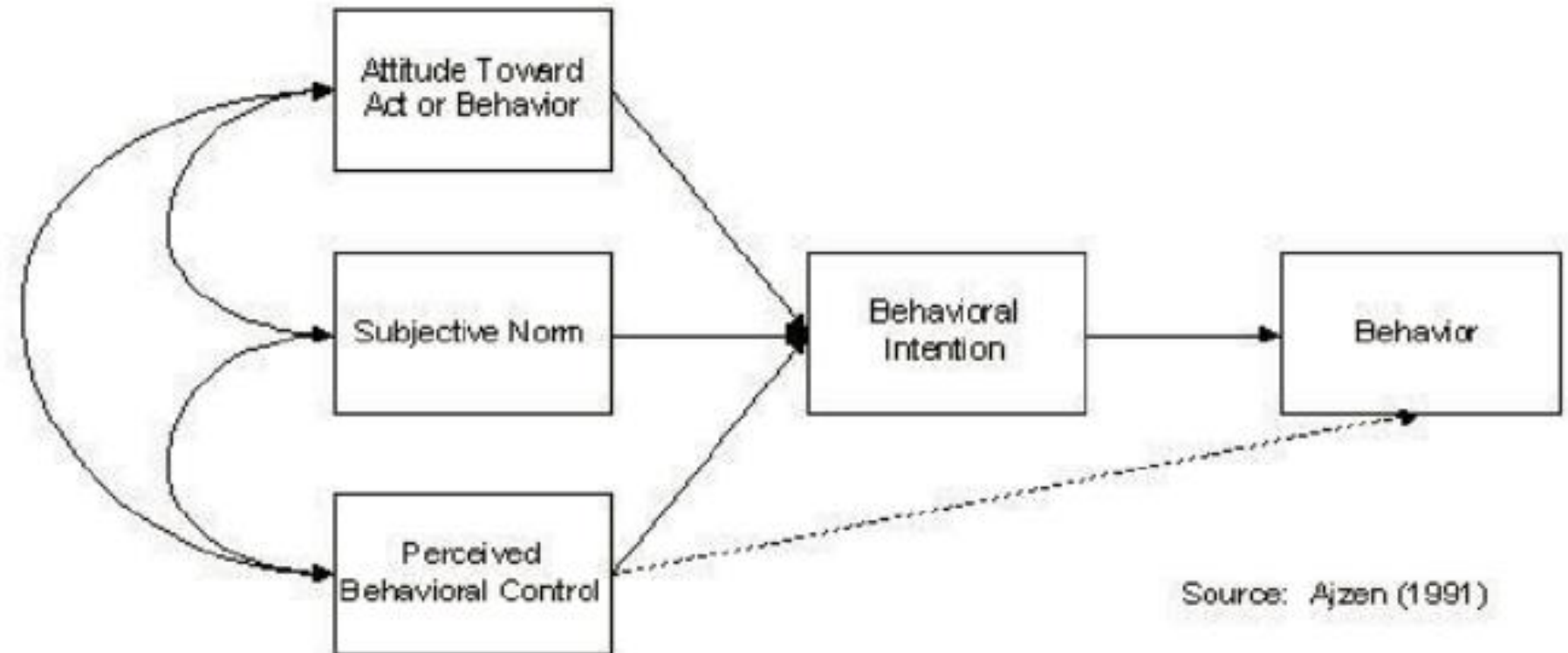
TRIBE: "TRaIning Behaviours towards Energy efficiency: Play it!"

Horizon 2020 Project: Turkey (OzU), Austria, Sweden, Spain, France



Cem Keskin and M.P. Mengüç, 2016

TRIBE: Behavioral Model



Source: Ajzen (1991)

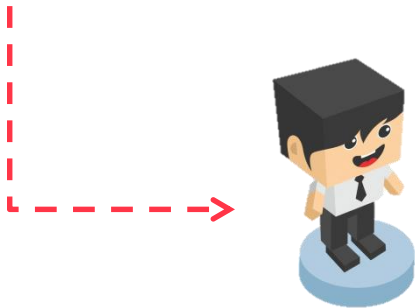
HUMAN-CENTRIC DESIGN FOR BUILDINGS



HUMAN-CENTRIC DESIGN FOR BUILDINGS

TRIBE: Video Game

Analysis of users behaviours



Real data obtained from the pilots



Cem Keskin and M.P. Mengüç, 2016



Center for Energy, Environment and Economy @ Ozyegin University

A Sustainable Energy Center!



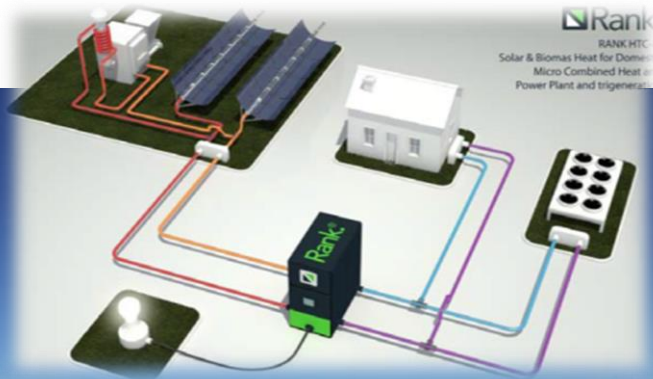
Ozyegin University Campus View (in 2011, there was nothing in this view!)



Solar PV, Green Roofs, Solar Shades, Facades, Smart Automation...TRIBEPACK



Center for Energy, Environment and Economy @ Ozyegin University



Adnan Menderes University Campus View (in October 2016, ...wait for 2017!)
Solar Concentrating Power Systems, Organic Rankine Cycle for trigeneration ...

... INNOVATION FOR SCIENTIFIC & SOCIAL CONNECTIVITY

CEEE/EÇEM



...stay tuned!

Ö. Bahadır, D. Gizem Memiş and M.P. Mengüç, 2016



www.ozyegin.edu.tr/energy

pinar.menguc@ozyegin.edu.tr