INNOVATION FOR BUILDINGS: FROM SCIENCE TO COMFORT

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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% CO$_2$ Emissions
TOWARDS SUSTAINABLE BUILDINGS: CEEE INNOVATIONS

INNOVATIVE PRODUCT

DEVICES, MATERIALS & METHODOLOGIES

Energy Harvesting
Energy Efficiency
Renewable energy applications
Human centric interfaces
Design thinking

SCIENCE & ENGINEERING

1 level
SIMPLE INNOVATIVE COHERENCE

2 level
COMPLEX ENGINEERING BASED INNOVATIVE COHERENCE

3 level
INNOVATIVE IDEAS FOR COHERENT IMPROVEMENTS

4 level
INNOVATIVE COHERENT METHODOLOGIES

FUNDAMENTAL IDEAS

Complexity level for Energy Efficiency Concepts

1.000,000
100
10

NEED4B
New Energy Efficient Demonstration for Buildings

BRICKER
Energy saving in public building stock

Tribe
Play it!

b/ağ

CEEE/EÇEM
TOWARDS SUSTAINABLE BUILDINGS

Sustainable Buildings

Building Use Objectives
- Integrated Architecture and Engineering
- Sustainable financing, Risk analysis

Stakeholder Limitations
- NSF/TUBITAK
- Georgia Tech

Thermal/Visual Comfort
- Operational Cost

Integrated Building Management
TOWARDS SUSTAINABLE BUILDINGS

3D

4D & 5D

6D

FACILITY MANAGEMENT

COST PLAN

QUANTITIES + SCHEDULING

7D

NEED4B
New Energy Efficient Demonstration for Buildings

Tribe
Play it!

EnergyPlus

DesignBuilder Software
TOWARDS SUSTAINABLE BUILDINGS

Sustainable Buildings

Integrated Architecture and Engineering

Comfort
SCIENCE BEHIND COMFORT

INDOOR/OUTDOOR ENVIRONMENTAL QUALITY

THERMAL COMFORT
- Air Temperature
- Relative Humidity
- Clothing Insulation
- Mean Radiant Temperature
- Metabolic Rate
- Operative Temperature

ACOUSTIC COMFORT

AIR QUALITY
- Aerosols/Pollutants
- Radon
- CO/CO2
- Volatile organic compounds
- Second-Hand Smoke
- Bacteria

VISUAL COMFORT

RADIATION

ARCHITECTURE

OPTICS

SCIENCE BEHIND COMFORT
AREAS OF IMPACT FOR ACHIEVING EE via OPTICS

Radiative Cooling (A. Didari, R. Family)

Sensor Networks (TRIBE, C. Keskin)
SCIENCE FOR RADIATIVE COOLING

Selectively 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.

Silicon oxynitride particles (Si$_2$N$_2$O)
## SUSTAINABLE MATERIALS FOR RADIATIVE COOLING

<table>
<thead>
<tr>
<th>Material</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XPS=</td>
<td>Extruded Polystyrene Foam&lt;&lt;</td>
</tr>
<tr>
<td>Coated XPS</td>
<td></td>
</tr>
<tr>
<td>EPDM=</td>
<td>Black Membrane</td>
</tr>
<tr>
<td>Red Membrane</td>
<td></td>
</tr>
</tbody>
</table>

- **Porous Silisium Powder**
- **Perlite Pumice Cement Composite Materials**
- **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

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
TOWARDS SUSTAINABLE BUILDINGS

Sustainable Buildings

Integrated Architecture and Engineering

Operational Cost
Design or Retrofit alternatives

GURA-W

Risk Information for Energy Performance, Thermal Comfort etc.

Risk Information for Energy Performance, Thermal Comfort etc.

+ Economic Impact

ESCO

ESCO

Financial Institutions

Decision Maker

Financial Options

R. Öcal and M.P. Mengüç, 2015

TOWARDS SUSTAINABLE BUILDINGS: FINANCIAL INNOVATION

TOWARDS SUSTAINABLE BUILDINGS: FINANCIAL INNOVATION
TOWARDS SUSTAINABLE BUILDINGS

Sustainable Buildings

Integrated Architecture and Engineering

Human-Centric Design for Energy Efficiency and Operational Cost
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

- Attitude Toward Act or Behavior
- Subjective Norm
- Perceived Behavioral Control
- Behavioral Intention
- Behavior

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