

# SÜRDÜRÜLEBİLİRLİK

# SÜRDÜRÜLEBİLİR ENERJİ

M. Pınar Mengüç

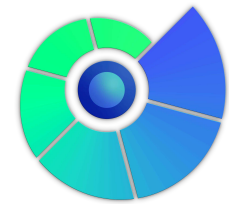
Director, **CEEE**/*EÇEM*  
Center for Energy, Environment and Economy  
Head, Mechanical Engineering Department  
Ozyegin University  
Istanbul, Turkey



Dokuz Eylül Üniversitesi, İzmir  
Kasım 29, 2017



**CEEE / EÇEM**



**Sustainable  
Energy &**

**3 LEED GOLD BUILDINGS**

**4 ONGOING EU PROJECTS  
(3 million USD)**

EU/MarieCurie

TUBITAK

1001

HORIBA

Nano-Scale  
Energy  
Fundamentals

Radiative  
Transfer and  
Thermal  
Sciences

NSF/TUBITAK  
Georgia Tech

Economical  
Aspects and  
Sustainable Finance



Nature &  
Climate  
Change

Energy  
Applications  
and  
Efficiency in  
Buildings



EU  
CAPACITY

EEE Solutions  
for Districts  
and Cities



Multi-Disciplinary  
Industrial  
Applications

bosch\_siemens



Tribe  
Play it!



RESEARCH @  
Center for  
Energy, Environment  
and Economy



G1ST ACADEMIC BUILDING

STUDENT CENTER

2ND ACADEMIC BUILDING

SELİ



CAMPUS GENERAL VIEW

CONCEPT DESIGN: RMJM  
DESIGN DEVELOPMENT: B-DESIGN  
LEED CONSULTANT: ALTENSIS  
EPC CONSULTANT: ONUR EN



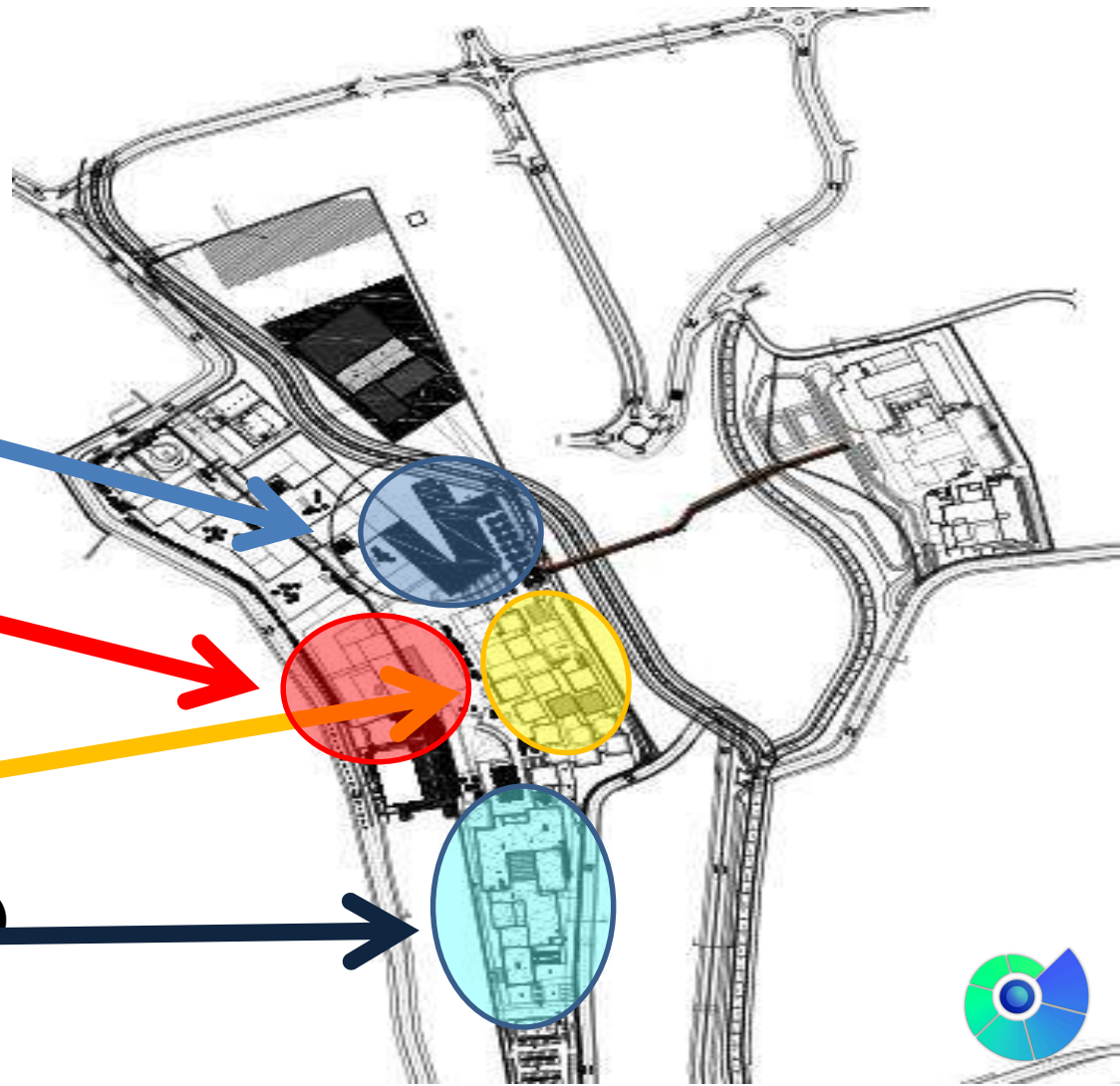
# Özyeğin University

**ScOLa Bldg (NEED4B)**

**Business Bldg (LEED GOLD)**  
72 points

**Student Center (LEED GOLD)**  
70 points

**Engineering Bldg (LEED GOLD)**  
72 points



A new type of campus, following the sustainability principles.

OzU's students, faculty and staff are all part of the eco-system.

All buildings and external spaces follow the concepts based on sustainability.

Innovative teaching paradigms.





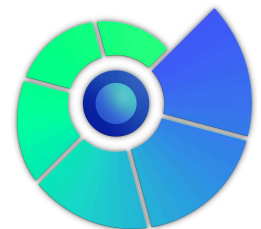
Center for Energy, Environment and Economy  
@ Ozyegin University

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...







**TRIMline**  
Interiors

■ Modüler Bina Dış Sistemleri  
■ Altyapı Sistemleri

**TRIMline**  
Interiors

Çayyolu Üniversitesi Çayyolu Kampüsü

**TRIMline**  
Interiors

■ Modüler Bina Dış Sistemleri  
■ Altyapı Sistemleri

Çayyolu Üniversitesi Çayyolu Kampüsü



**CEEE 211: Coherent Teachings for Istanbul 2050.**

**This course has received the IBM Global Academic Initiative in 2011.**

*ME 373: Technology and Society*

*Required Course for Mechanical Engineering Students.*

*ME 563: Sustainable Energy, Materials and System*

*This course was co-organized with IMSAD.*

## **ENGLISH PREPARATORY SCHOOL READING ASSIGNMENTS**

**YAPI Writings: BİLİMLE BİRLİKTE (M. Pinar Mengüç)**



Optics &  
Thermodynamics



Sustainable  
Energy &  
Buildings



CEEE / EÇEM

ÖZYEĞİN  
UNIVERSITY



# PAST STUDIES AT RTL

**#OPTICS**

**#RADIATIVE TRANSFER**

**#THERMAL SCIENCES**

**#EM-WAVE SCATTERING**

**#NANO-SCALE TRANSPORT PHENOMENA**



**Flames and Combustion Systems**

**Particle Characterization Systems**

**Nano-Scale Manufacturing with Electron-Beam**

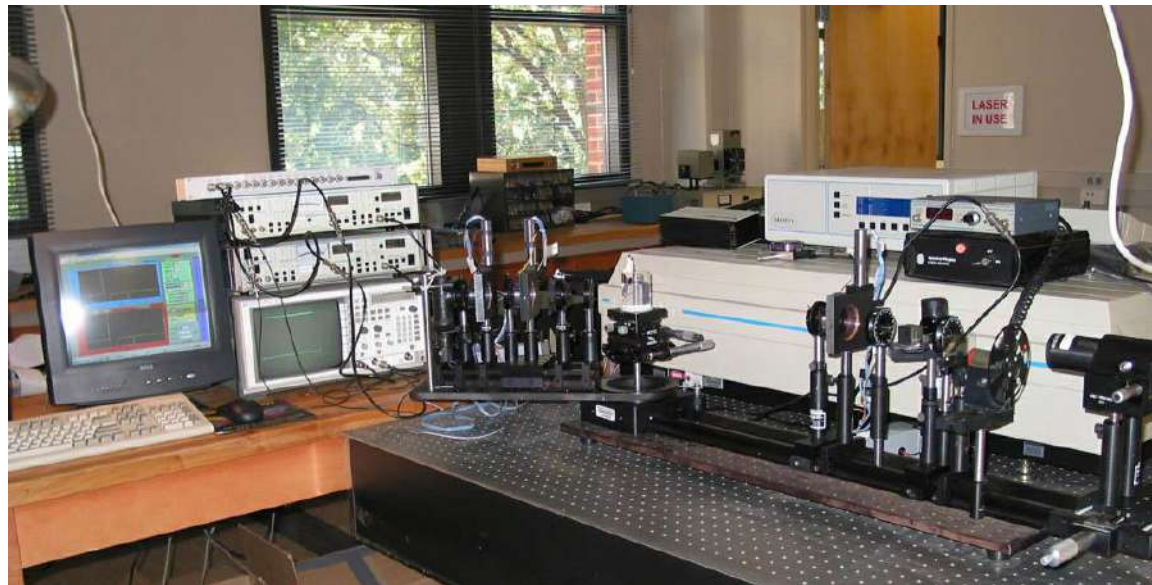
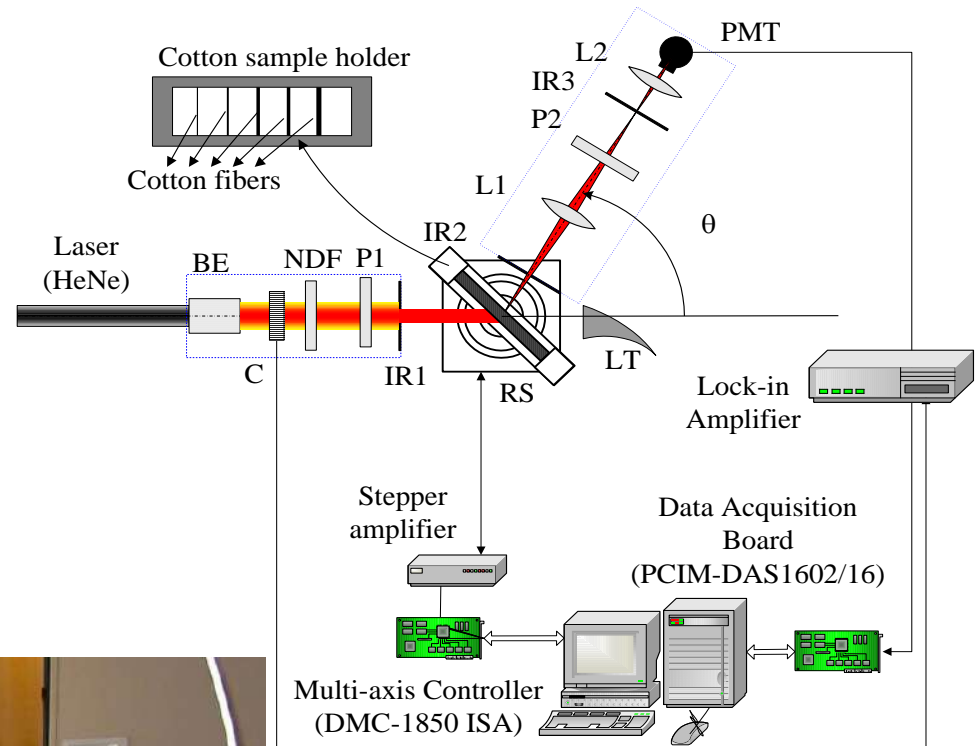
**Nano-Scale Radiative Transfer for Energy Harvesting**



# ELLIPTICALLY-POLARIZED LS SYSTEM FOR NPs

Experimental System:

**Precision Nephelometer.**  
To measure different particle  
shapes and sizes  
down to 50-70 nm



With ...  
S. Manickavasagam, M. Aslan  
JQSRT 2006; JNR 2006

# ELLIPTICALLY-POLARIZED LS SYSTEM FOR NPs



**HORIBA**

R&D 100 Award, 2003



Patent by  
Mengüç and  
Manickavasagam,  
April 13, 2004;  
#6,721,051



# NANO-MEASUREMENTS

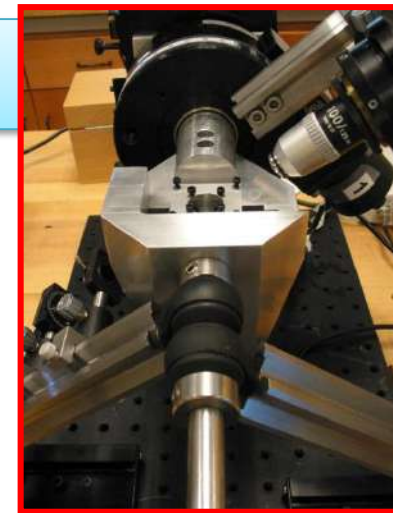
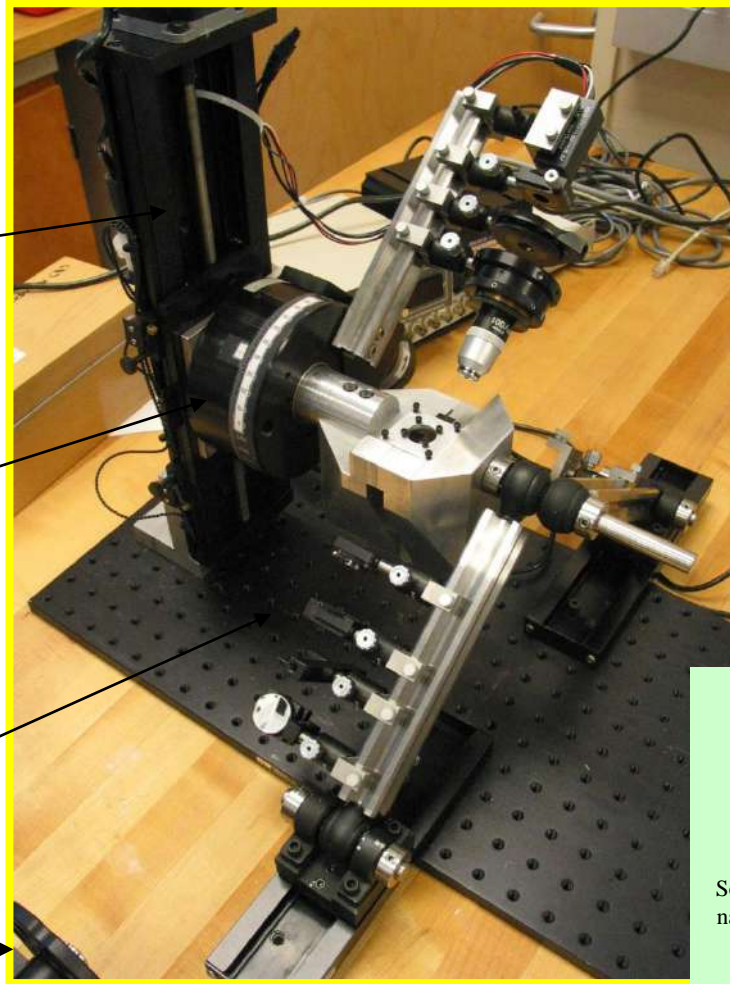


Translation stage to control incident angle

Rotational stage

Incident light optics

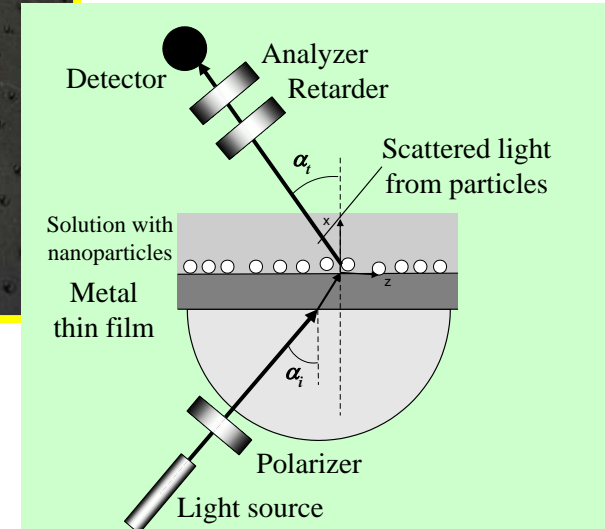
Light source



PMT

Motor Control Unit

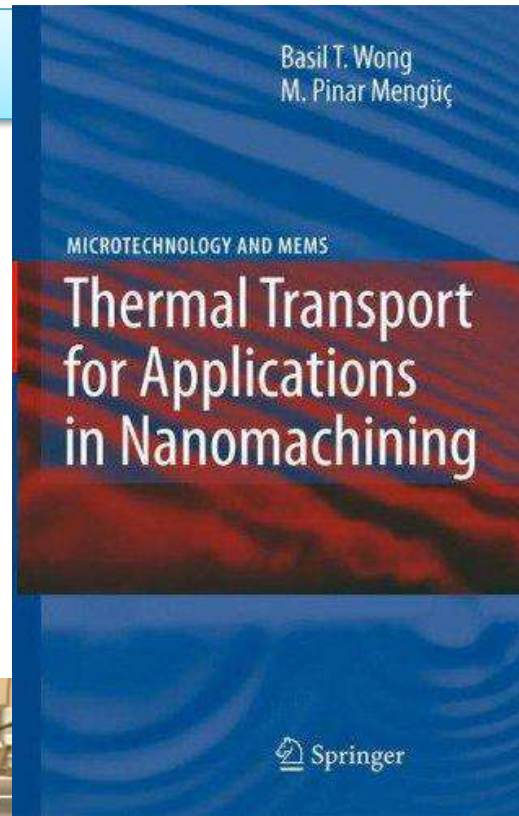
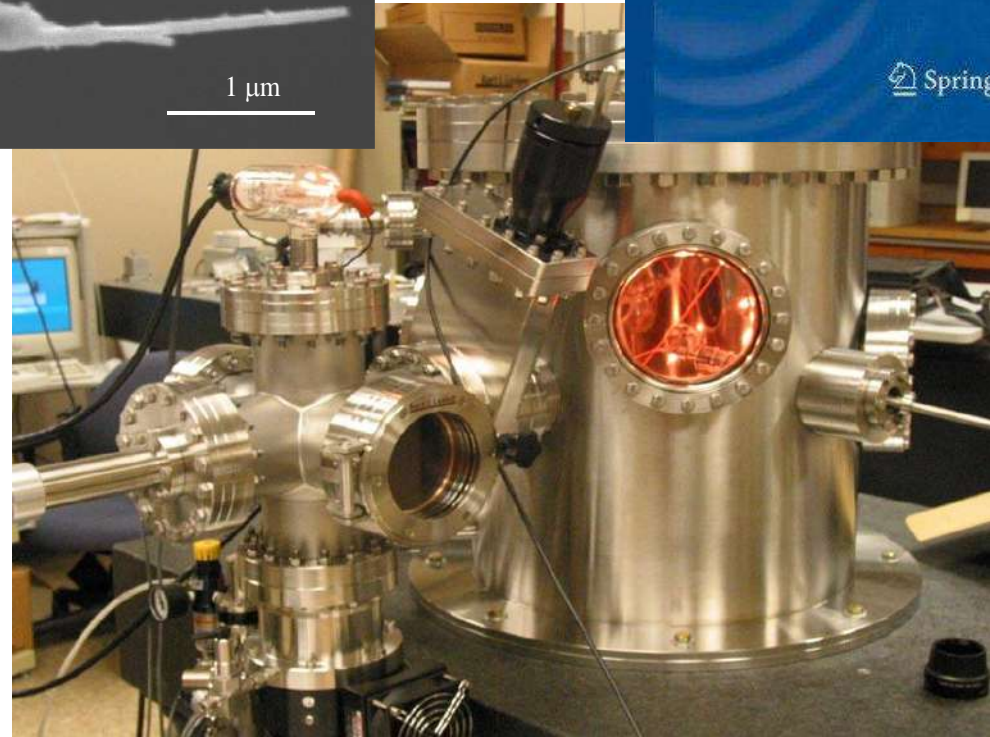
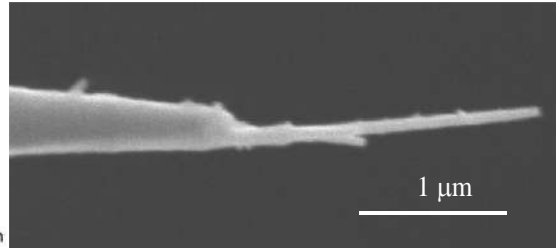
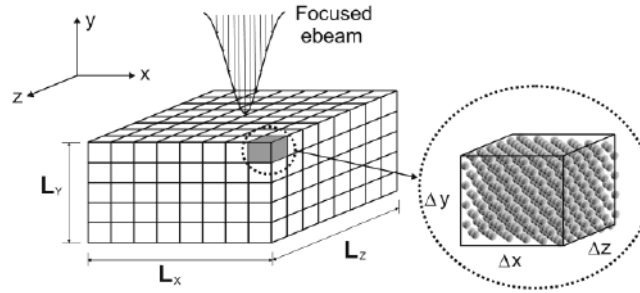
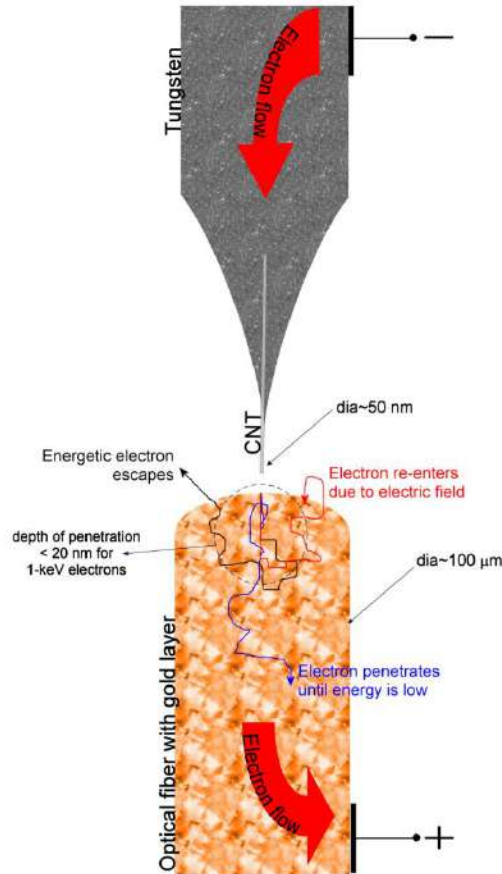
Scattered light optics



With M. Francoeur, R. Vaillon, M. Aslan  
Nano-Scale Diagnostics and Harvesting



# PAST STUDIES AT RTL



Patent by  
Vallance, Rao, Mengüç  
December 9, 2003; #6,660,959

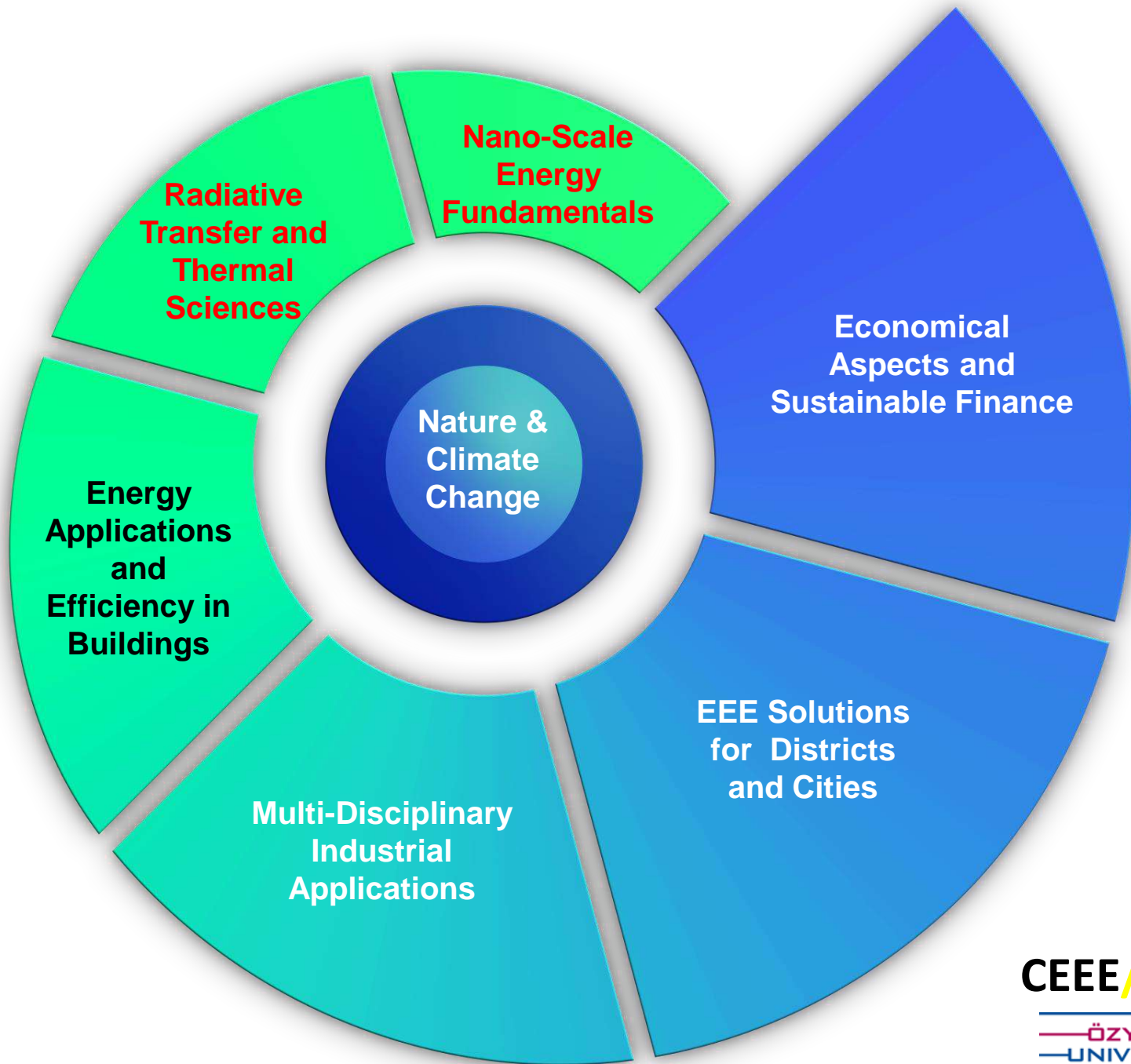
# CURRENT STUDIES AT CEEE

**#RADIATIVE TRANSFER**  
**#EM-WAVE SCATTERING**  
**#NANO-SCALE ENERGY HARVESTING**

**#SUSTAINABLE BUILDINGS**  
**#ENERGY EFFICIENCY**  
**#HUMAN-BUILDING INTERACTIONS**  
**#OPTICS IN BUILDINGS**  
**#COMFORT**  
**#SERIOUS GAME**

**Energy Efficiency in New and Renovated Buildings**  
**Thermal and Visual Comfort**  
**Integrated Engineering and Architecture**  
**Sustainable Materials**





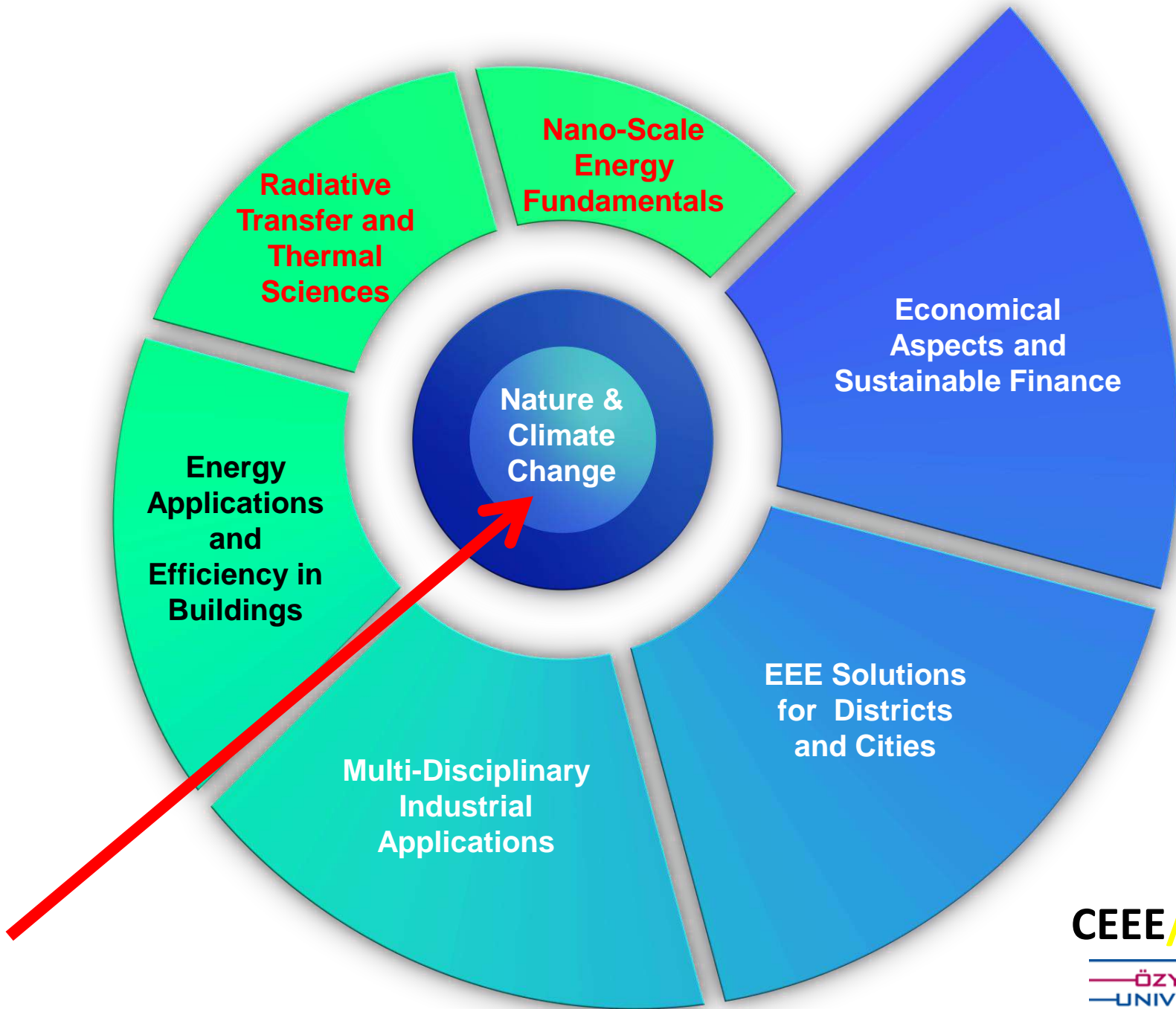


# Center for Energy, Environment and Economy: CEEE/ECCEM

*.... We consider living in harmony with the nature and the development of the strategies to overcome the negative impact of the climate change on our surroundings as the meaningful objectives for all of our activities...*

CEEE at OzU was established in 2009 at OzU to focus on Energy, Environment and Economy and to be a depository of engineering and business knowledge in Turkey for both fundamentals and real-world applications.

Along this line, CEEE aspires to develop solutions and strategies to avoid the negative impacts of climate change to our surroundings. This is only possible with a participative approach by all interested parties, not necessarily only from Turkey, or from the rest of the World.





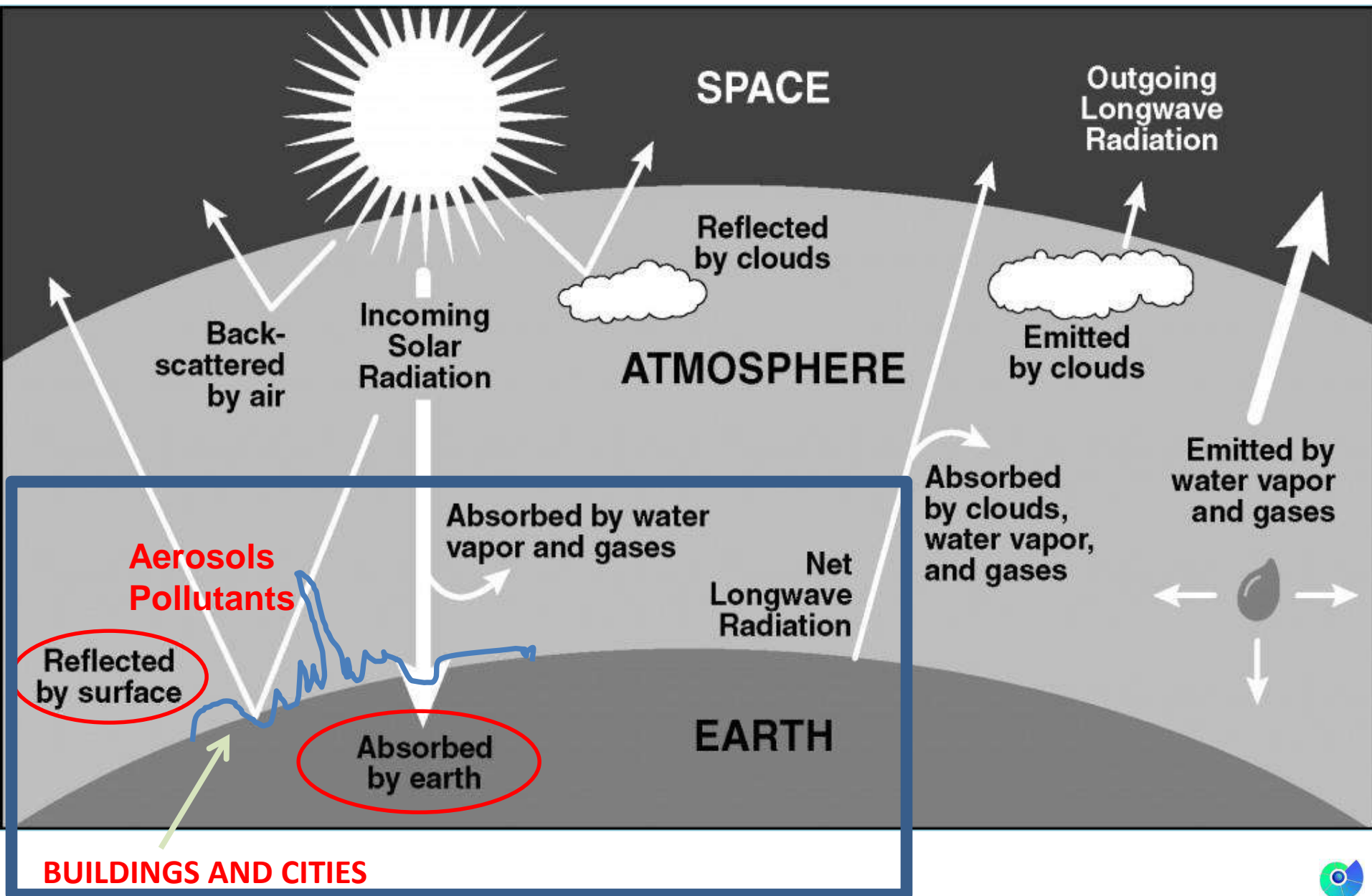
$Q_{\text{solar}}$

Reflected  $Q_{\text{solar}}$   
+  
Emitted  $Q_{\text{terrestrial}}$

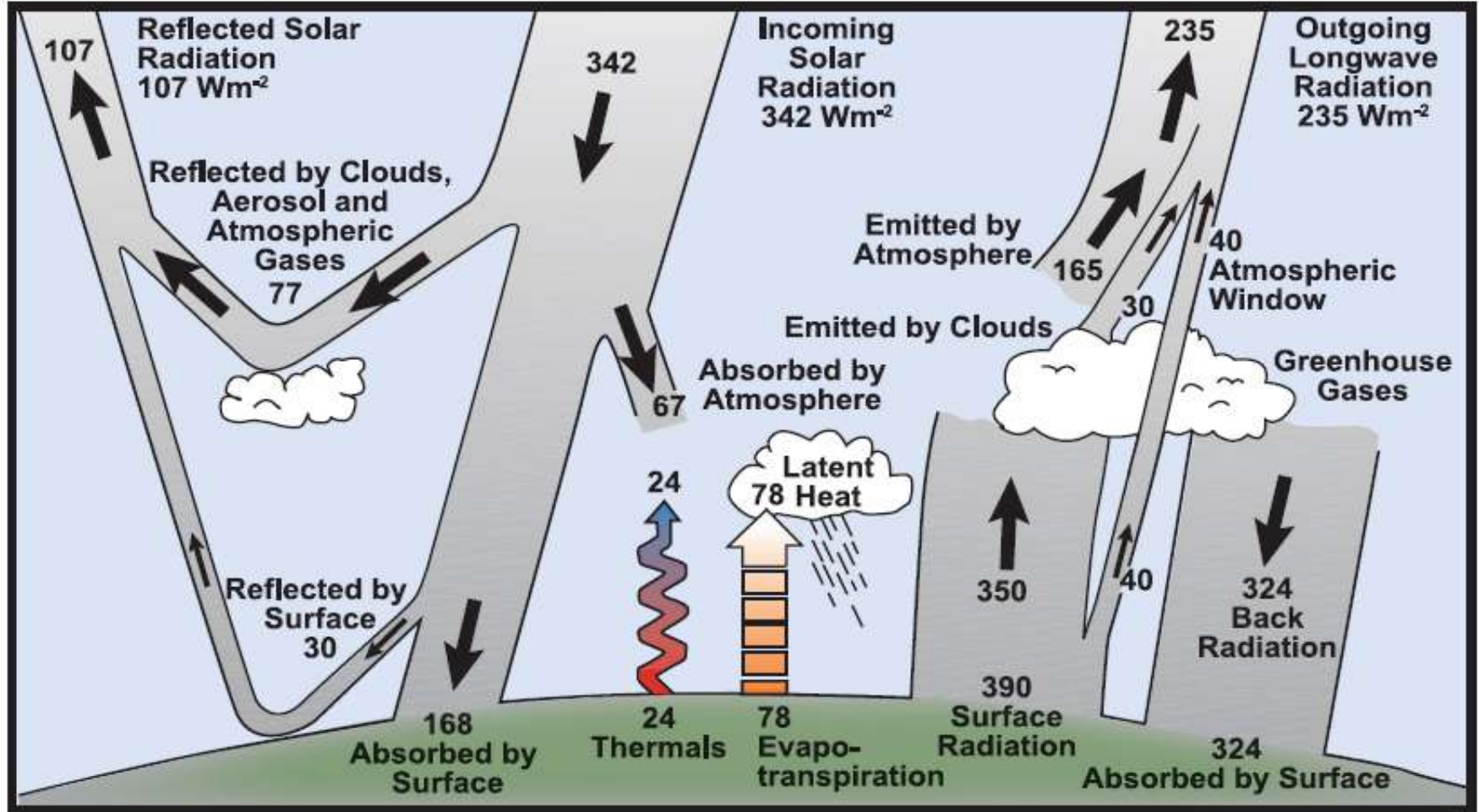
Trapping by  
GHGs  
( $\text{CO}_2 + \text{H}_2\text{O}$ )



# RADIATION TRANSFER & LIGHT SCATTERING



# THERMAL SCIENCES FOR UNDERSTANDING CC

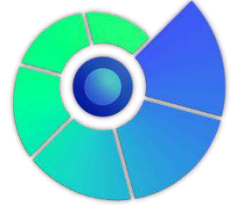


**FAQ 1.1, Figure 1.** Estimate of the Earth's annual and global mean energy balance. Over the long term, the amount of incoming solar radiation absorbed by the Earth and atmosphere is balanced by the Earth and atmosphere releasing the same amount of outgoing longwave radiation. About half of the incoming solar radiation is absorbed by the Earth's surface. This energy is transferred to the atmosphere by warming the air in contact with the surface (thermals), by evapotranspiration and by longwave radiation that is absorbed by clouds and greenhouse gases. The atmosphere in turn radiates longwave energy back to Earth as well as out to space. Source: Kiehl and Trenberth (1997).



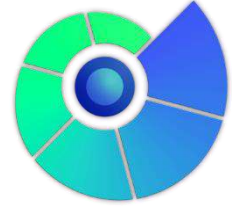


# BİNALARDA ENERJİ VERİMLİLİĞİ



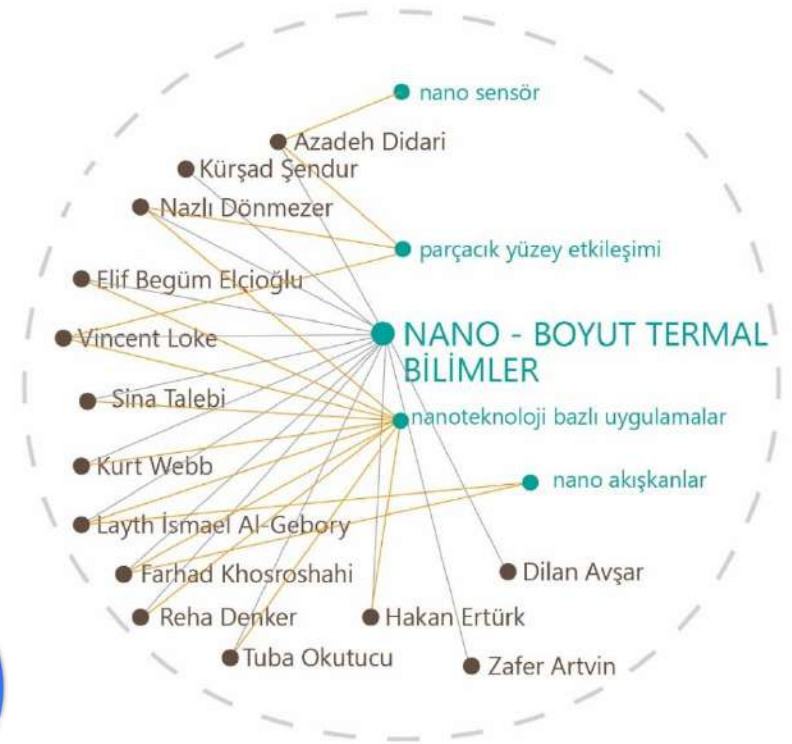
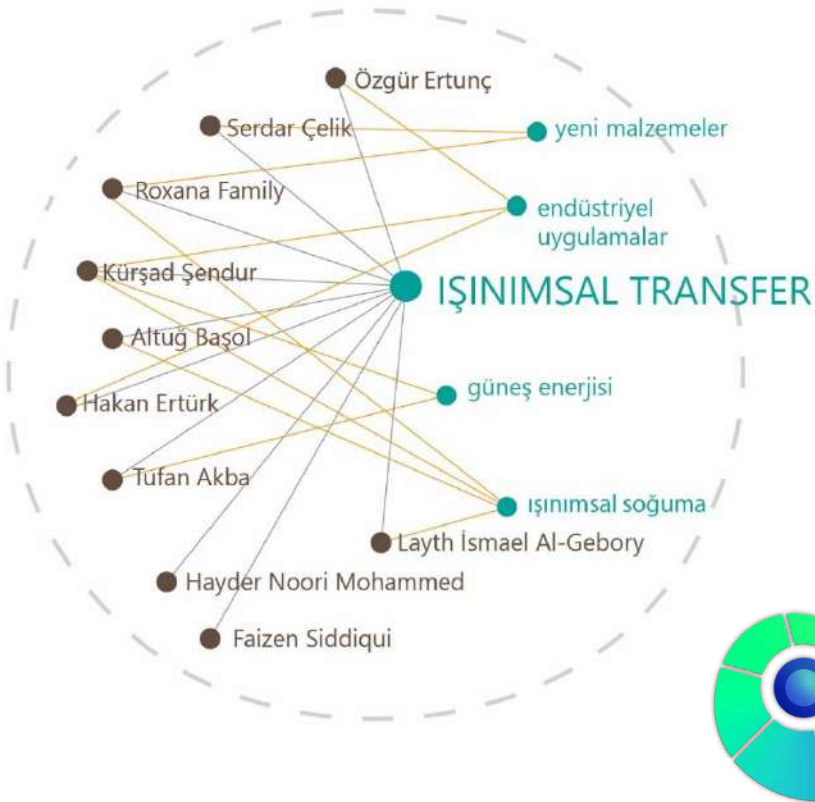


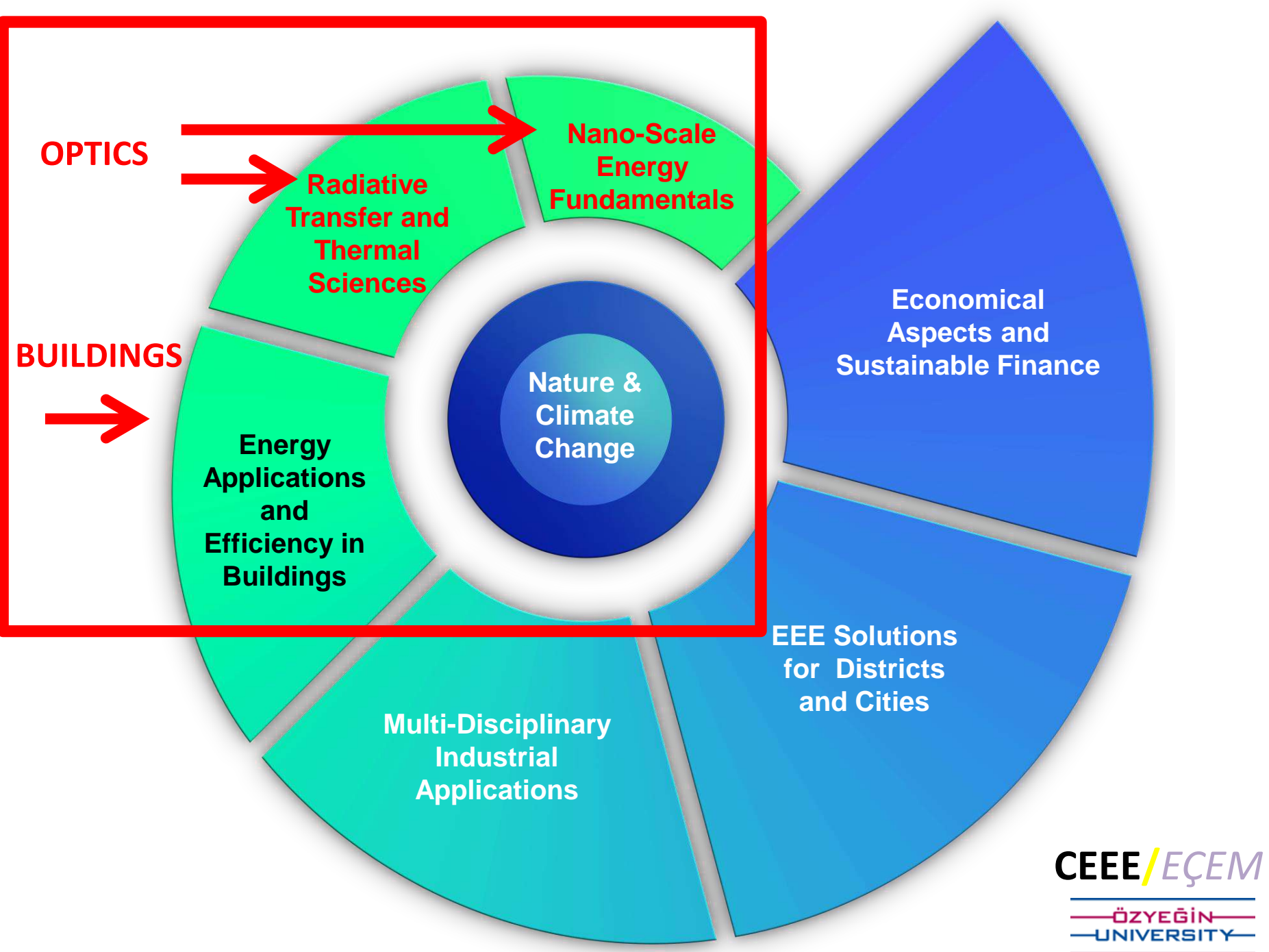
# İNSAN - BİNA ETKİLEŞİMİ



# IŞINIMSAL / ISI TRANSFERİ

# NANO - BOYUT TERMAL BİLİMLER





**OPTICS**



**Radiative  
Transfer and  
Thermal  
Sciences**

**Nano-Scale  
Energy  
Fundamentals**

**BUILDINGS**



**Energy  
Applications  
and  
Efficiency in  
Buildings**

**Nature &  
Climate  
Change**

**Economical  
Aspects and  
Sustainable Finance**

**Multi-Disciplinary  
Industrial  
Applications**

**EEE Solutions  
for Districts  
and Cities**

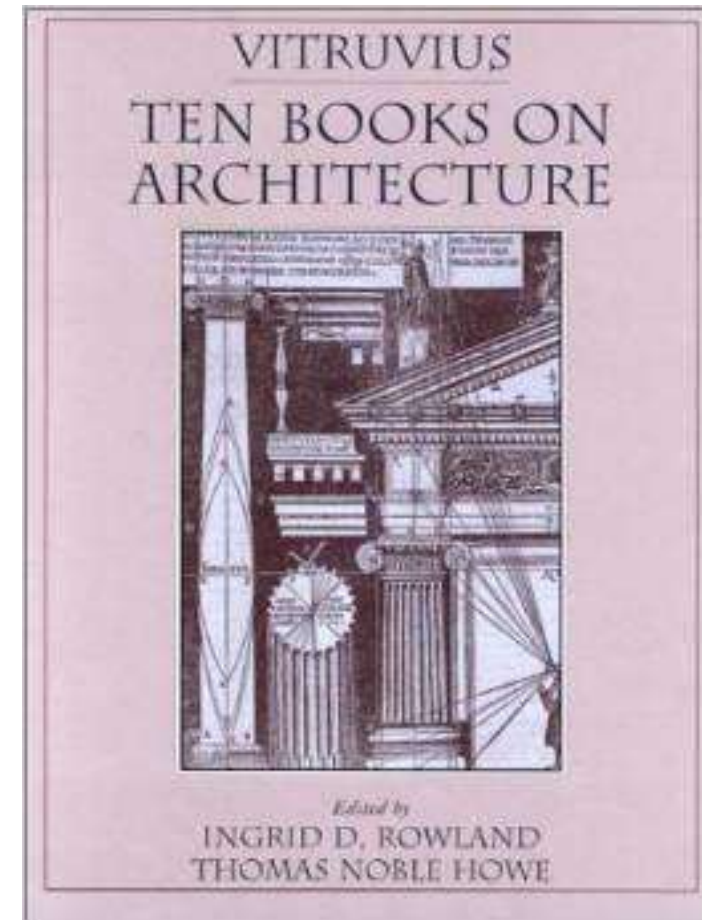
# PERSONAL INSPIRATION

## VITRUVIUS: ARCHITECT OF ROME

### UNDER THE PROTECTION OF CESAR AUGUSTUS

1<sup>st</sup> Century BC to 1<sup>st</sup> Century AD

An architect should be...



The science of optics enables him to introduce with judgment the requisite quantity of light, according to the aspect.



# WHY SUSTAINABLE BUILDINGS?

**Energy efficiency!**

**Low Hanging Fruit... Steven Chu**

# ENERGY MODALITIES

## Harvesting Rejected Energy

Estimated U.S. Energy Use in 2013: ~97.4 Quads

Lawrence Livermore National Laboratory

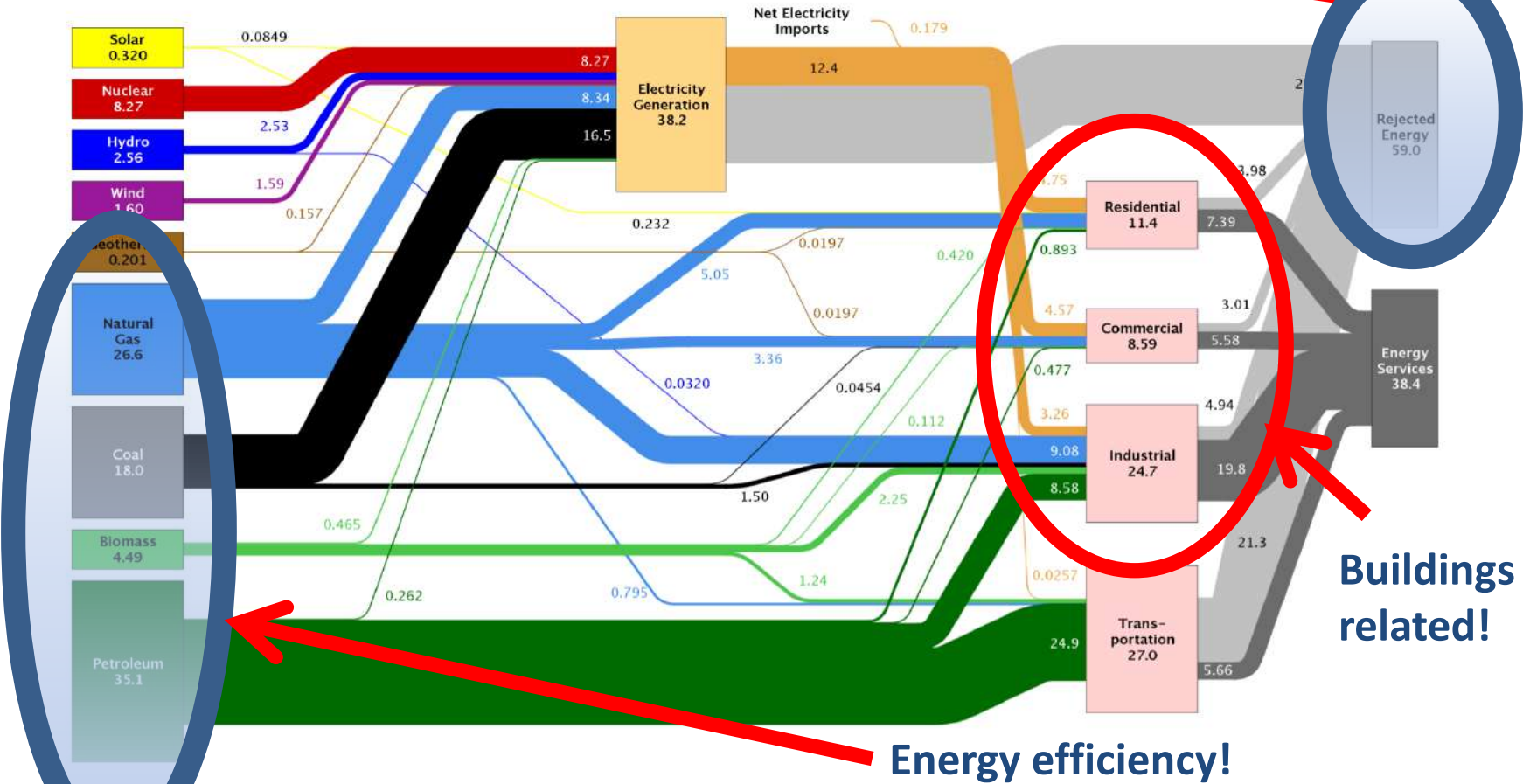
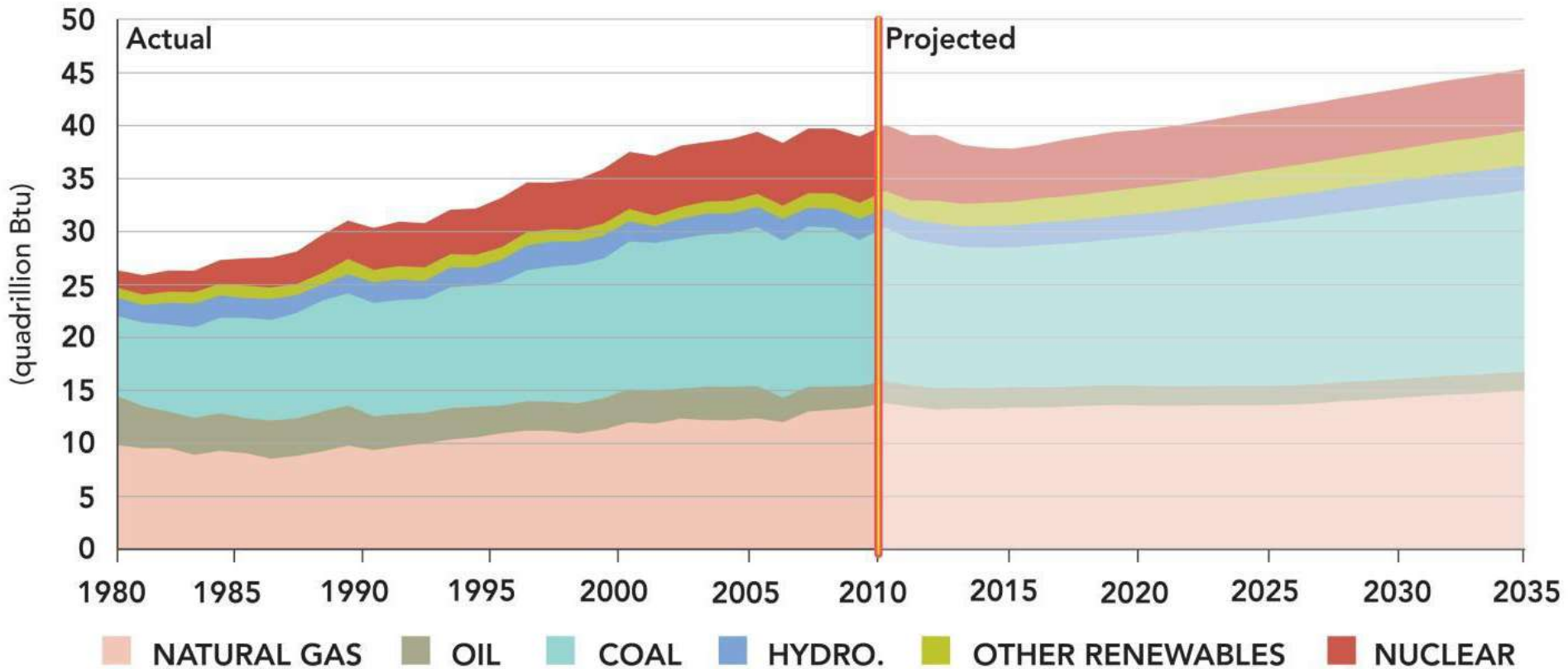


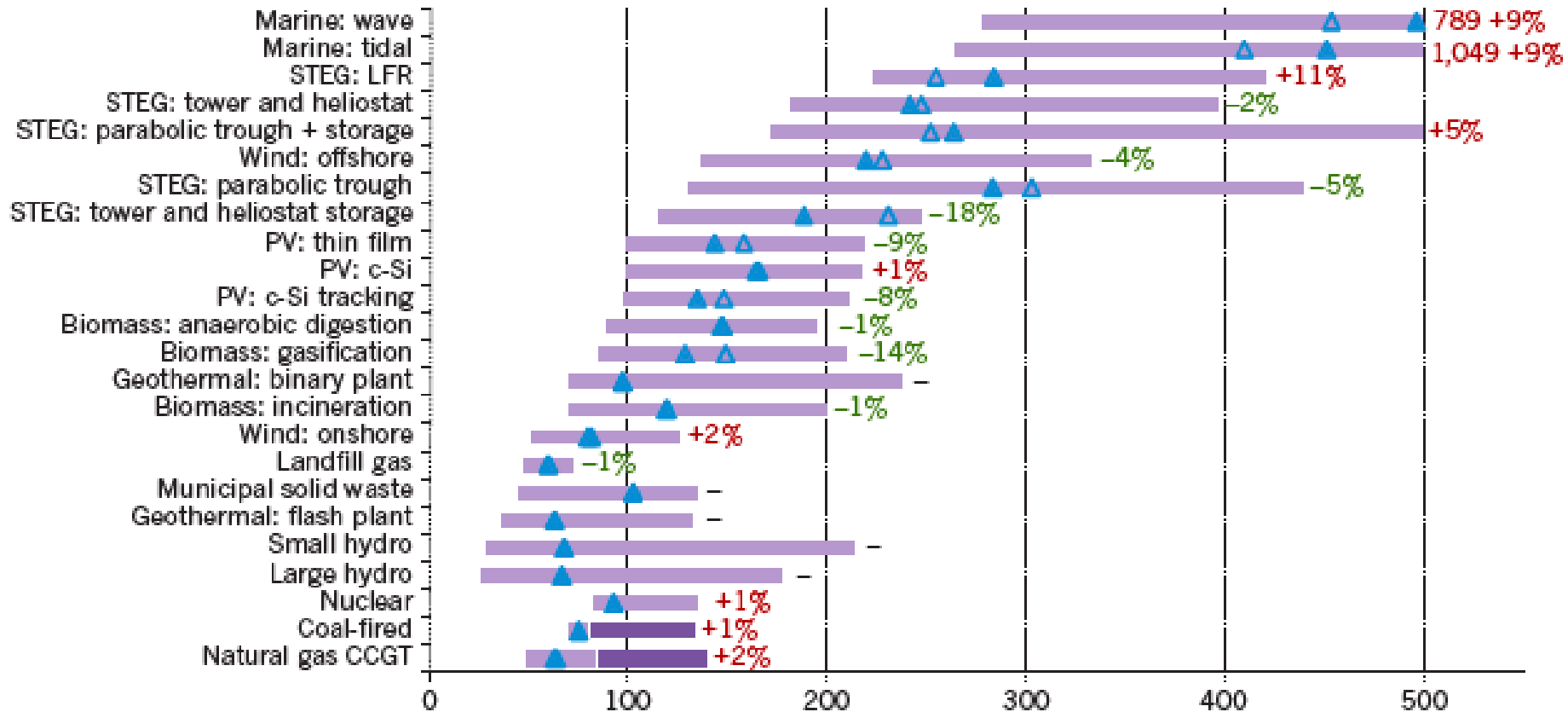
FIGURE 1 Flows of energy through the U.S. economy. The light gray bands on the right indicate energy that performs no useful service (i.e., was wasted), and the dark gray bands on the right indicate energy that is used in the residential, commercial, industrial, and transportation sectors. Note that roughly 88 percent of the energy that presently enters the U.S. economy involves combustion of a fuel, which releases carbon dioxide to the atmosphere (1 quad is  $10^{12}$  BTUs or 293 TWh). SOURCE: Lawrence Livermore National Laboratory, <https://flowcharts.llnl.gov/>.

# ENERGY USE IN BUILDINGS IN THE USA

## BUILDINGS SECTOR PRIMARY ENERGY CONSUMPTION



# COST OF ENERGY



Bloomberg New Energy Finance. *Levelised Cost of Energy Update, Q3 2012*  
<http://www.bnef.com/WhitePapers/download/114> (Bloomberg New Energy Finance, 2012).



# MODALITIES FOR ENERGY RESEARCH

**(1) Energy Generation**

**(2) Energy Conservation**

**(3) Energy Harvesting**

**(4) Energy Efficiency**

# MODALITIES FOR ENERGY RESEARCH

## (1) Energy Generation

### (3) Energy Harvesting



*Depends on effective transfer of energy*

*Radiation Transfer:  
Far-field and Near-field*

OPTICS

## (2) Energy Conservation

### (4) Energy Efficiency



*Sustainable Buildings*

*Integrated Architecture and  
Engineering*

*Comfort, Innovative financing, Risk  
analysis, Radiating Cities*

BUILDINGS

# ORIGINAL CEEE FOCI

**Energy Harvesting:  
Solar PV/TPV  
Solar Concentrating Systems**

**Radiative Cooling  
for Buildings**

Advanced Materials  
System Integration

Nanotechnology  
Financial Systems



**BUILDING INTEGRATED SYSTEMS**

# THE FOCUS

LIGHT

HEAT



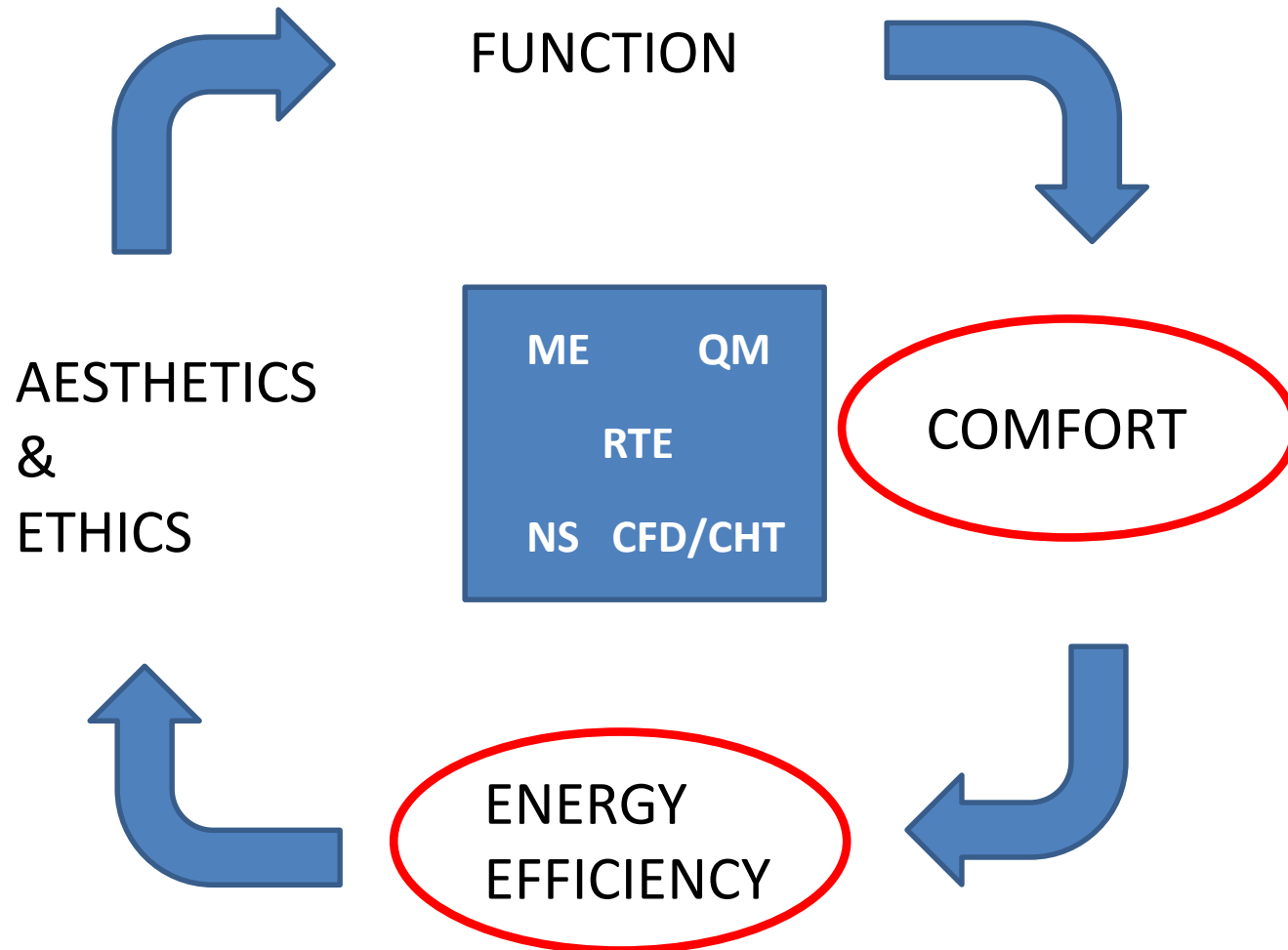
# OPTICS AND BUILDINGS

ME QM

RTE

NS CFD/CHT

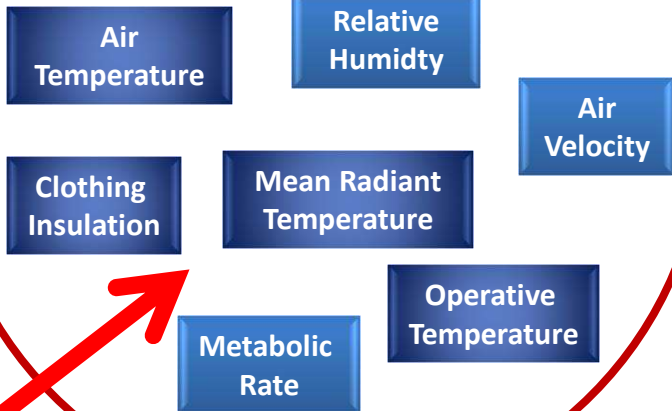
# OPTICS AND BUILDINGS



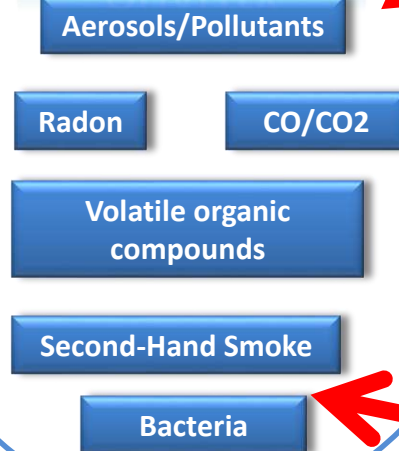
# FUNDAMENTAL STUDIES NEEDED FOR COMFORT

## INDOOR/OUTDOOR ENVIRONMENTAL QUALITY

### THERMAL COMFORT



### AIR QUALITY



### ACOUSTIC COMFORT

### VISUAL COMFORT

THERMAL SCIENCES  
RADIATION TRANSFER

LIGHT SCATTERING

LIGHT SCATTERING

OPTICS  
ARCHITECTURE



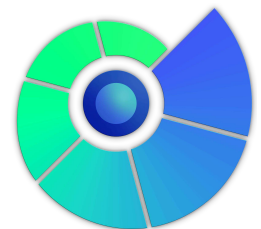
Center for Energy, Environment and Economy  
@ Ozyegin University

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...



# FROM SCIENCE TO SOCIETY

**DEVICES, MATERIALS & METHODOLOGIES**



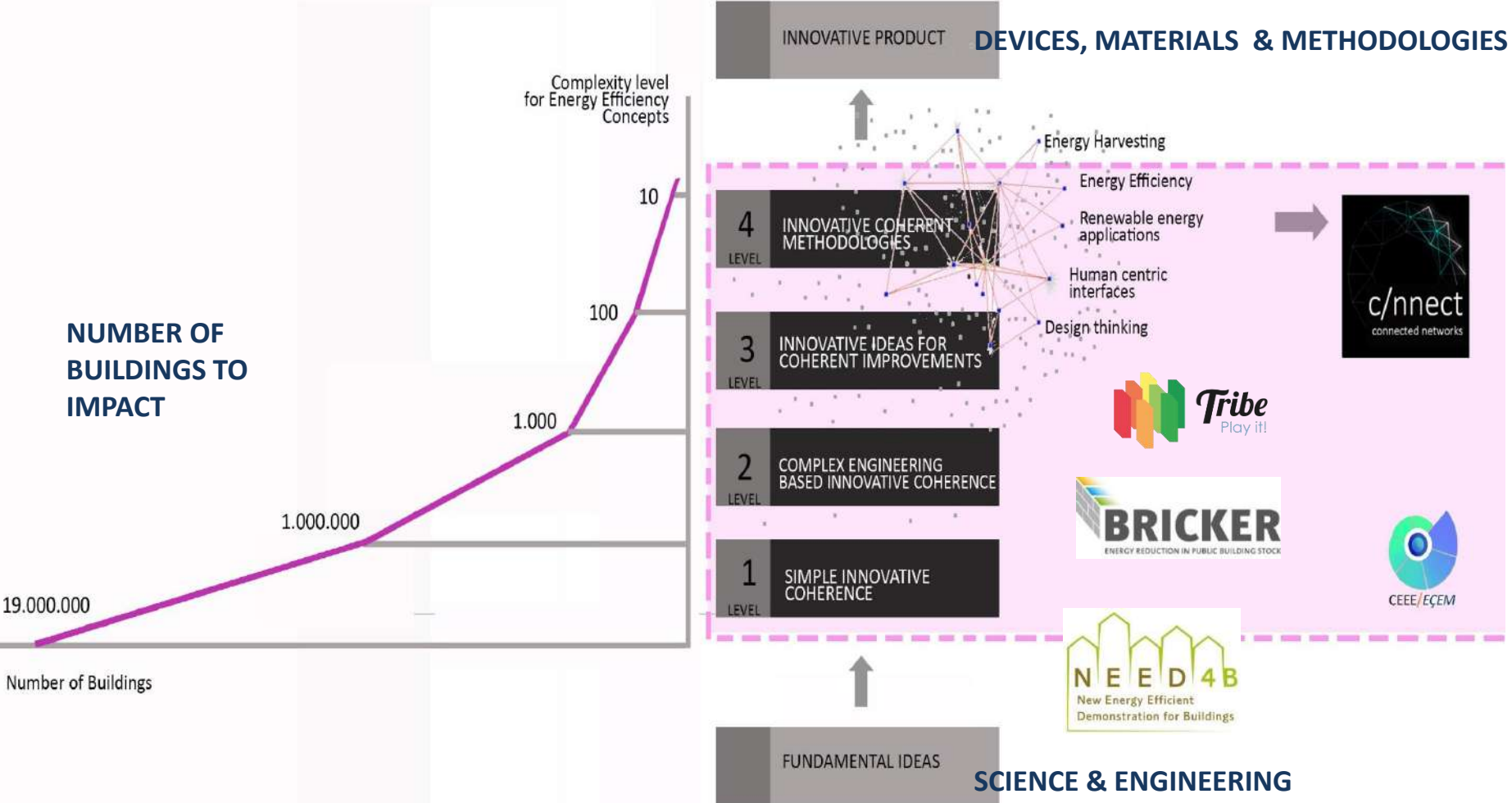
**SCIENCE & ENGINEERING**



# CEEE PROJECTS ON ENERGY EFFICIENCY FOR BUILDINGS



# FROM SCIENCE TO SOCIETY



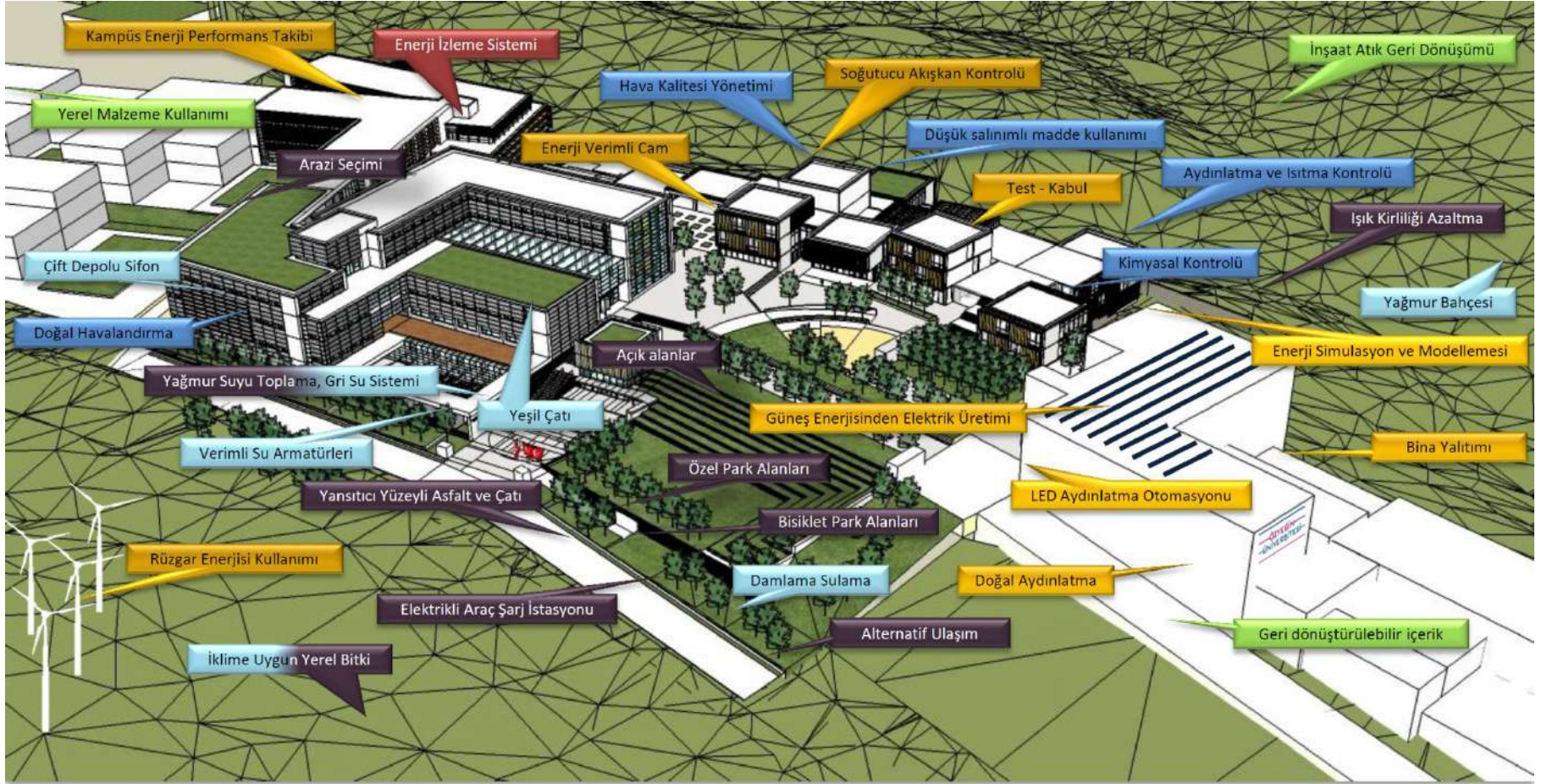
# ENERGY EFFICIENCY FOR NEW BUILDINGS

OZYEGIN UNIVERSITY: SCOLA BUILDING



**NEED<sub>4</sub>B**  
**FP7-PROJECT**  
**TURKISH PARTNERS: OZU-FIBA-B.DESIGN**

# Ozyegin Univ Campus







NEED4B is a an EU-FP7 Project, and applied to one of the campus buildings, SCOLA, at Özyeğin University in Istanbul.

The measurements over the last two years reveal that SCOLA has very low energy

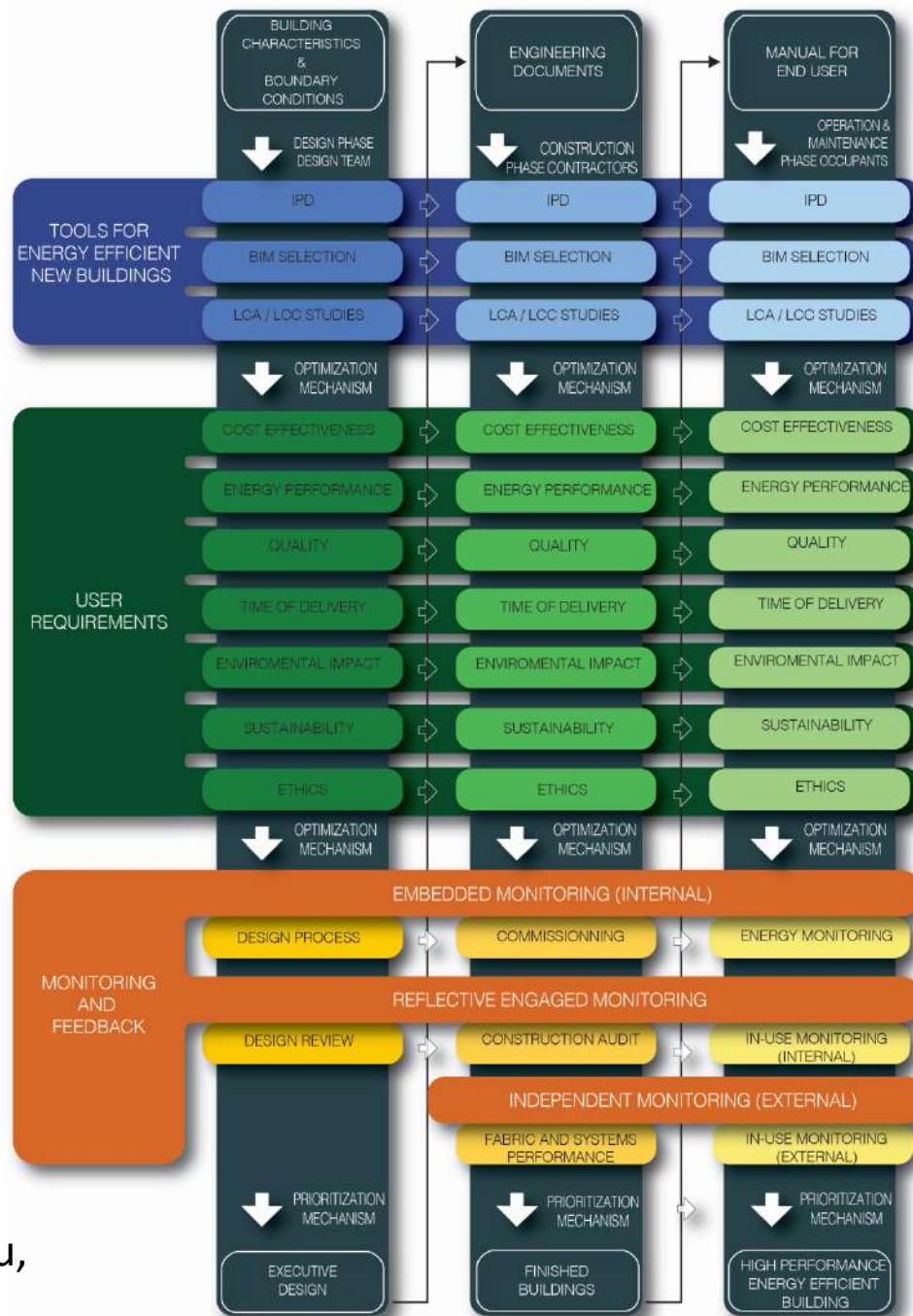
density, only **57** kWh/m<sup>2</sup>/year.

A typical academic building in Turkey uses **255** kWh/m<sup>2</sup>/year in the 2. heating zone.

The real-time measurements of the SCOLA building indicate far better results compared to the different buildings in the university campus, which have been rewarded with LEED Gold or Silver.

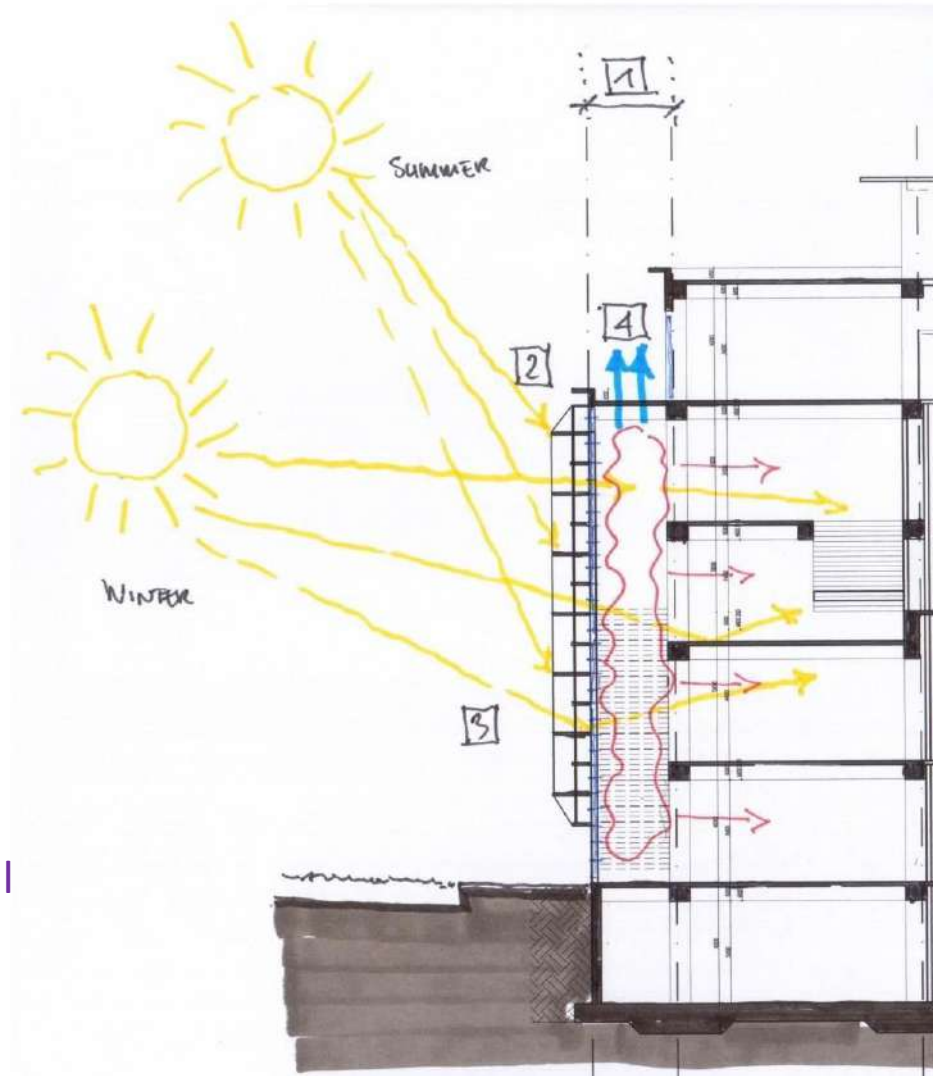






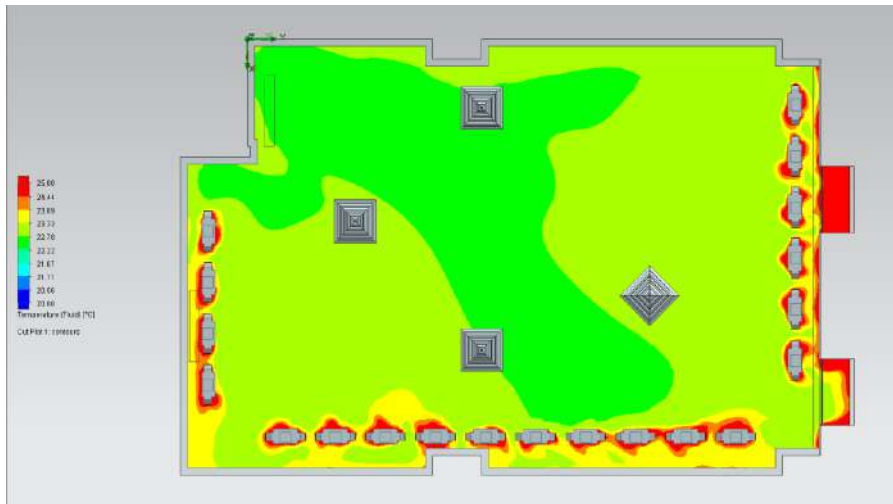
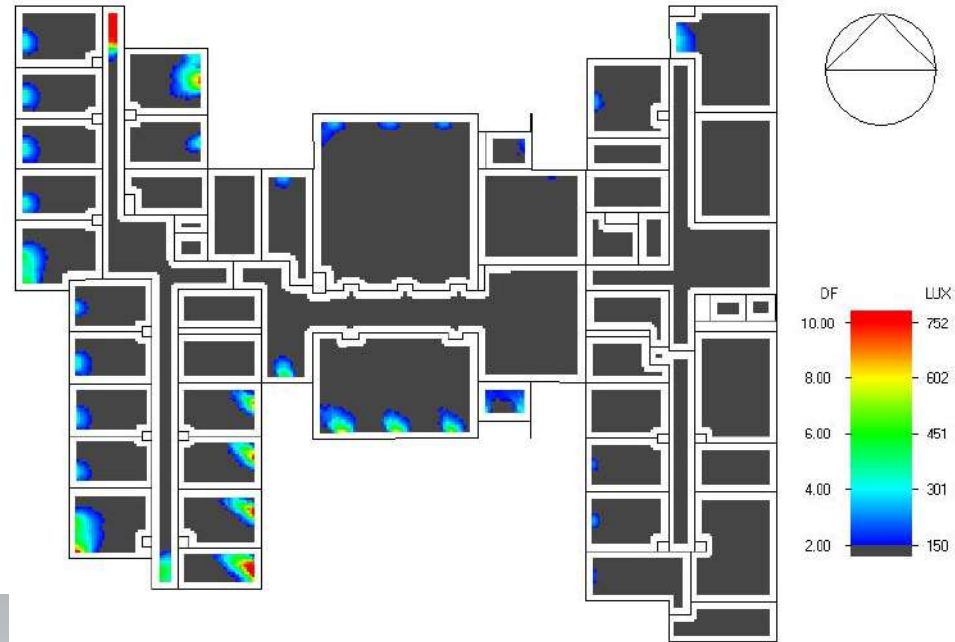
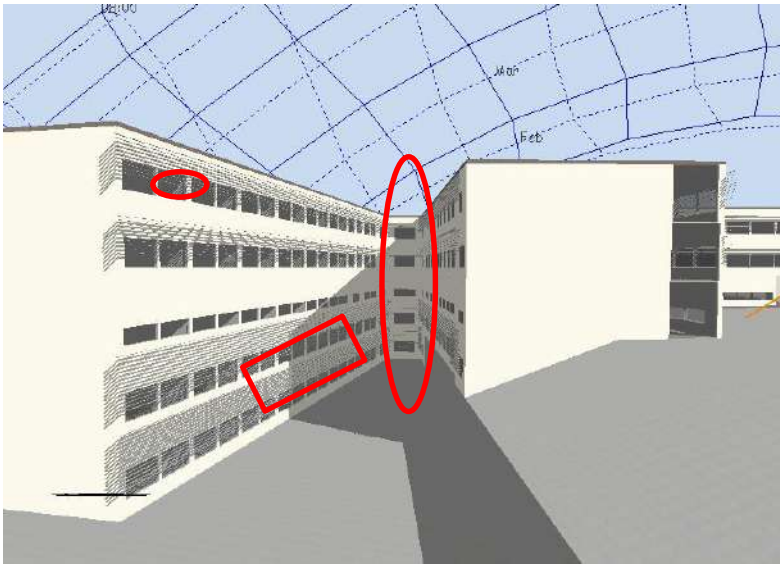
With Yasemin Somuncu,  
Architect, CEEE/EÇEM.

# Design Statement



1. South facade buffer zone
2. Solar Gain Control / Summer horizontal shading elements
3. Solar Gain / Winter horizontal shading elements
4. Exhaust during summer

# Full Building Energy Simulation



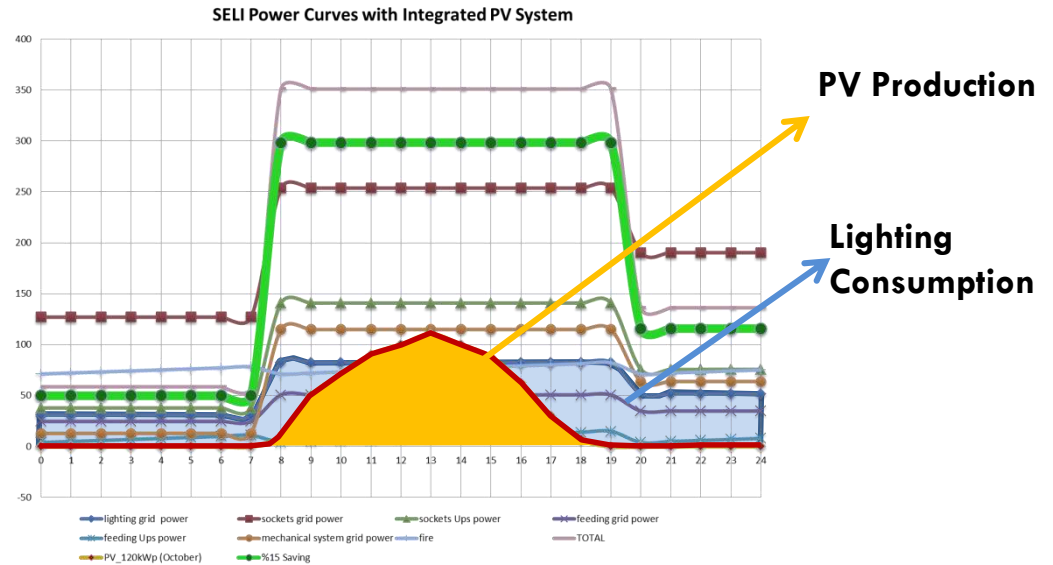
# Innovations & Progressive Technologies

PV PANELS

120 kWp  
CAPACITY

Performance Values

SCOLA Load Curves with PV production in  
October





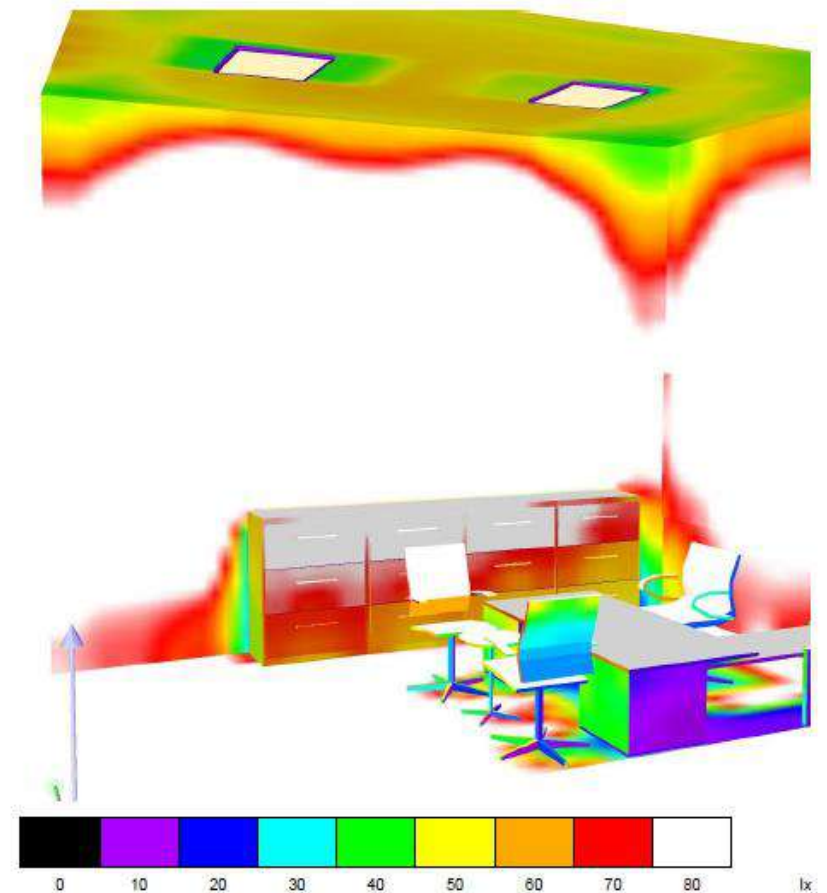
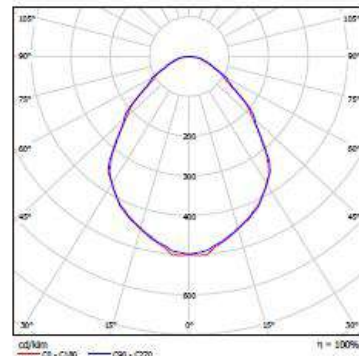
# Innovations & Progressive Technologies

## LED USAGE

3,3 – 5,8 W/m<sup>2</sup> ENERGY DENSITY



İşık yayımı 1:

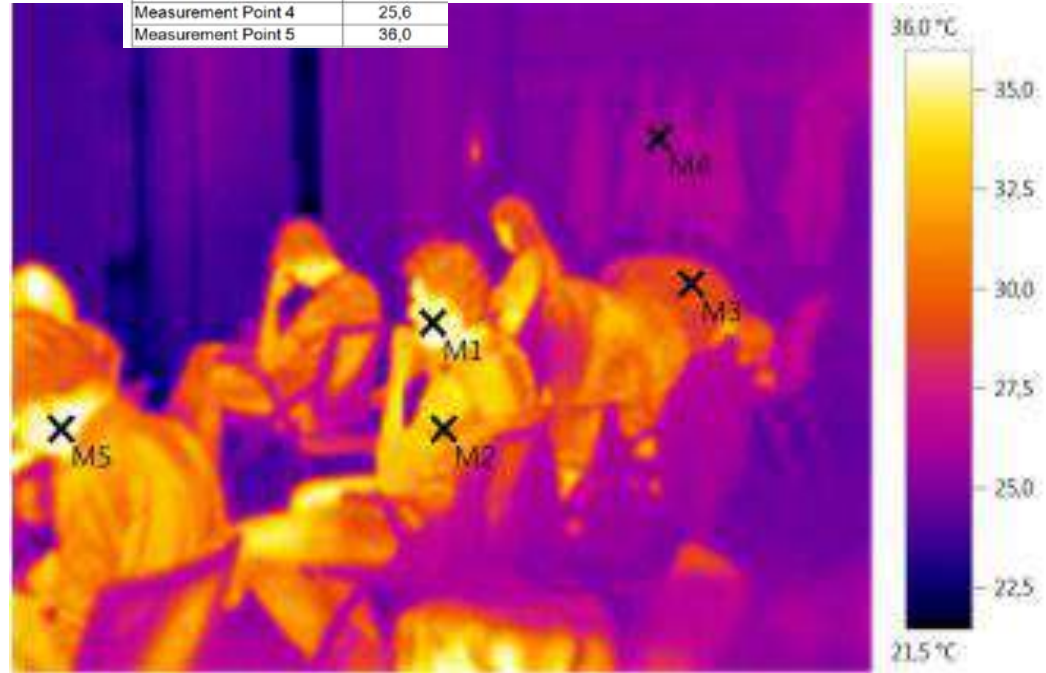


LIGHTING SIMULATIONS FOR OFFICES



# DESIGN AND COMPARISONS

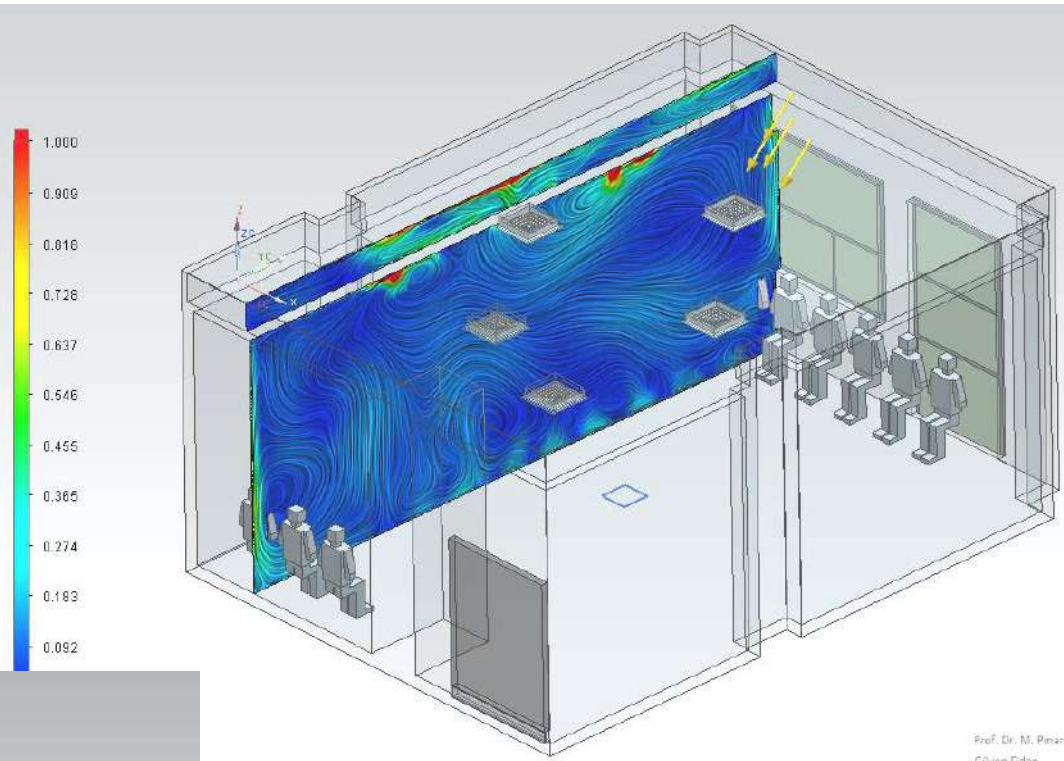
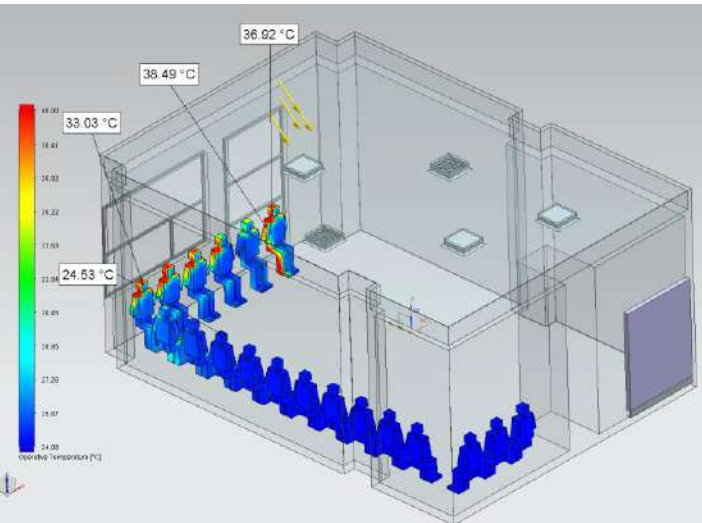
Measurement Subjects	Temp. [°C]
Measurement Point 1	36,2
Measurement Point 2	33,8
Measurement Point 3	29,6
Measurement Point 4	25,6
Measurement Point 5	36,0



## TEMPERATURE AND IR-CAMERA MEASUREMENTS

With Güven Fidan, OzU, CEEE, MSME 2016.

# THERMAL COMFORT VIA CFD w/RADIATION

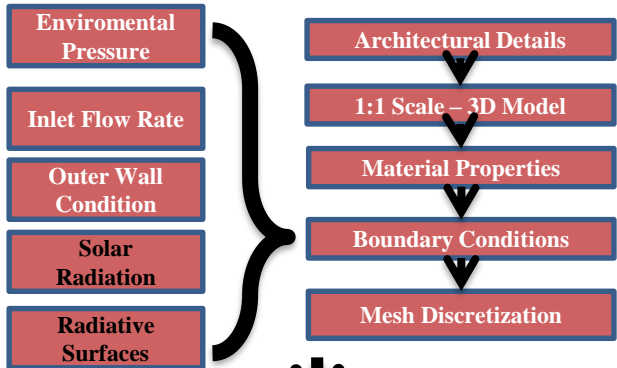


Prof. Dr. M. Pinar Mengüç  
Güven Fidan



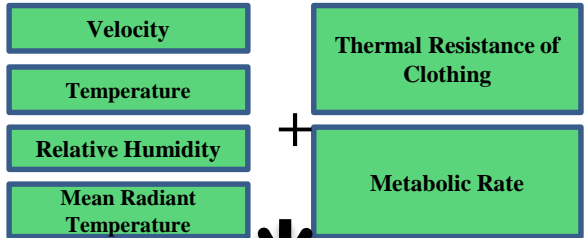
GÜVEN FİDAN

# THERMAL COMFORT VIA CFD w/RADIATION



Governing Equations of Momentum, Mass and Energy + Discrete Ordinates Radiation Model + K-Epsilon Turbulence Model

Simulation Results



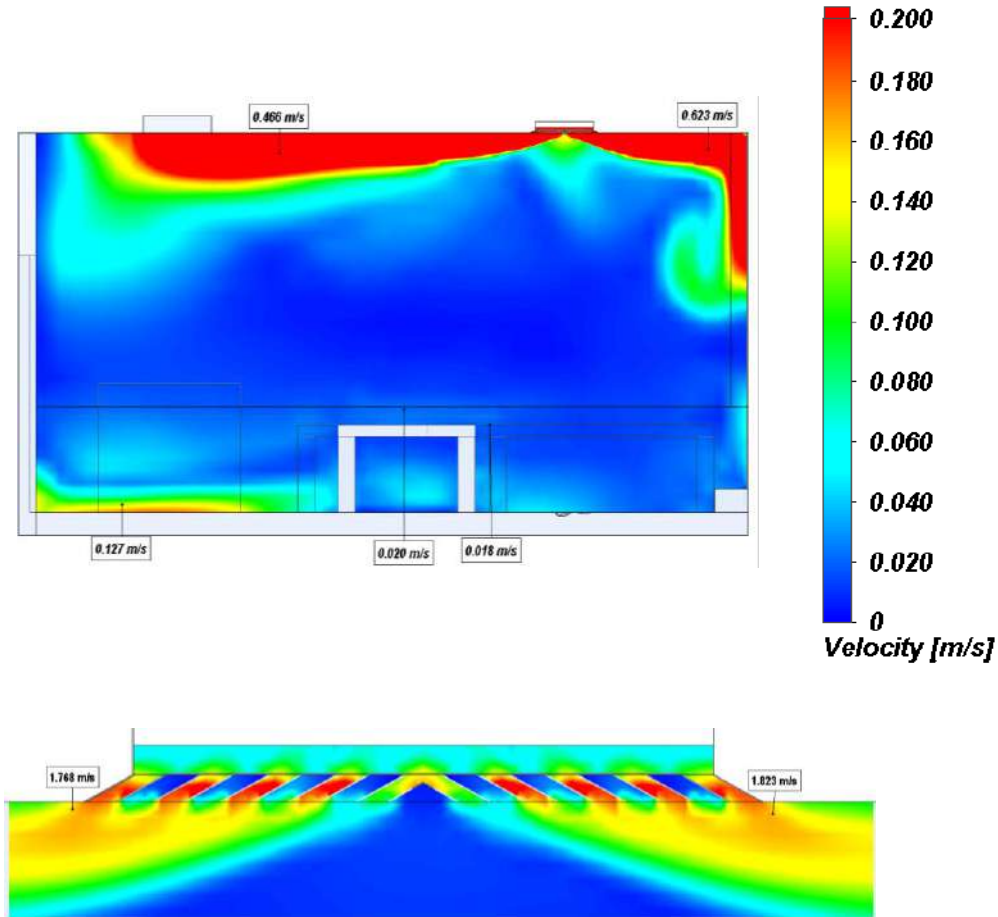
Thermal Comfort Results



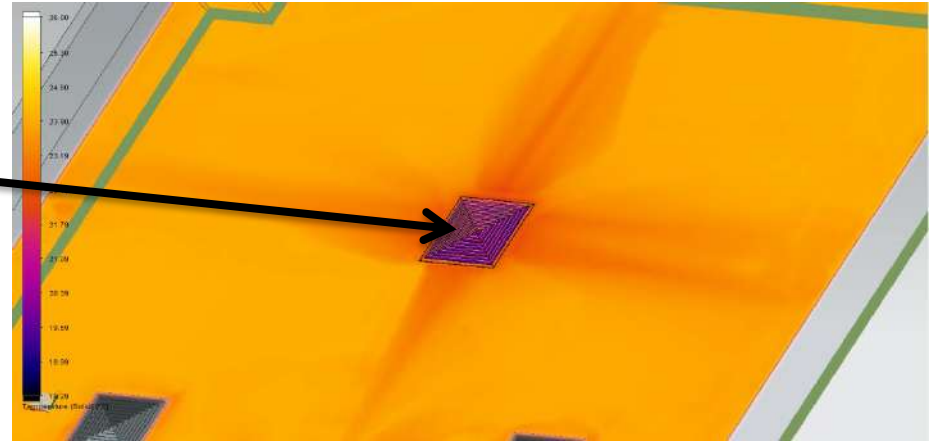
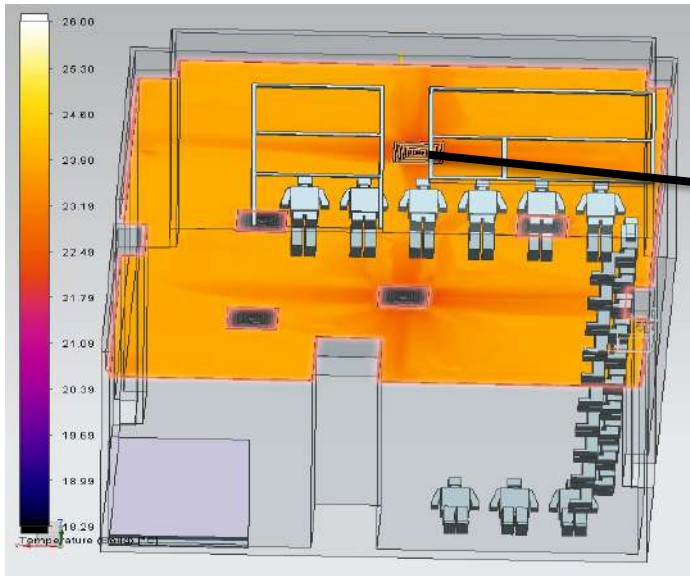
Pre-Processing

Solving

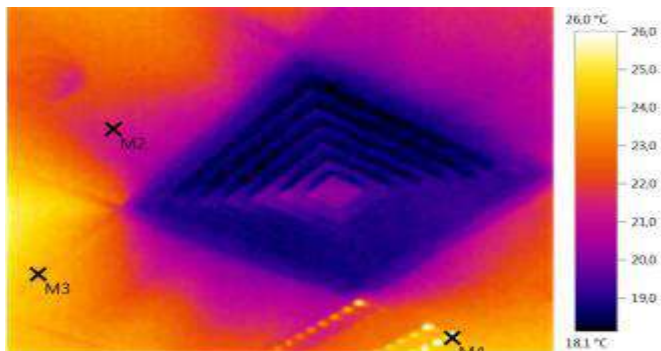
Post-Processing







## Computational Fluid Dynamics

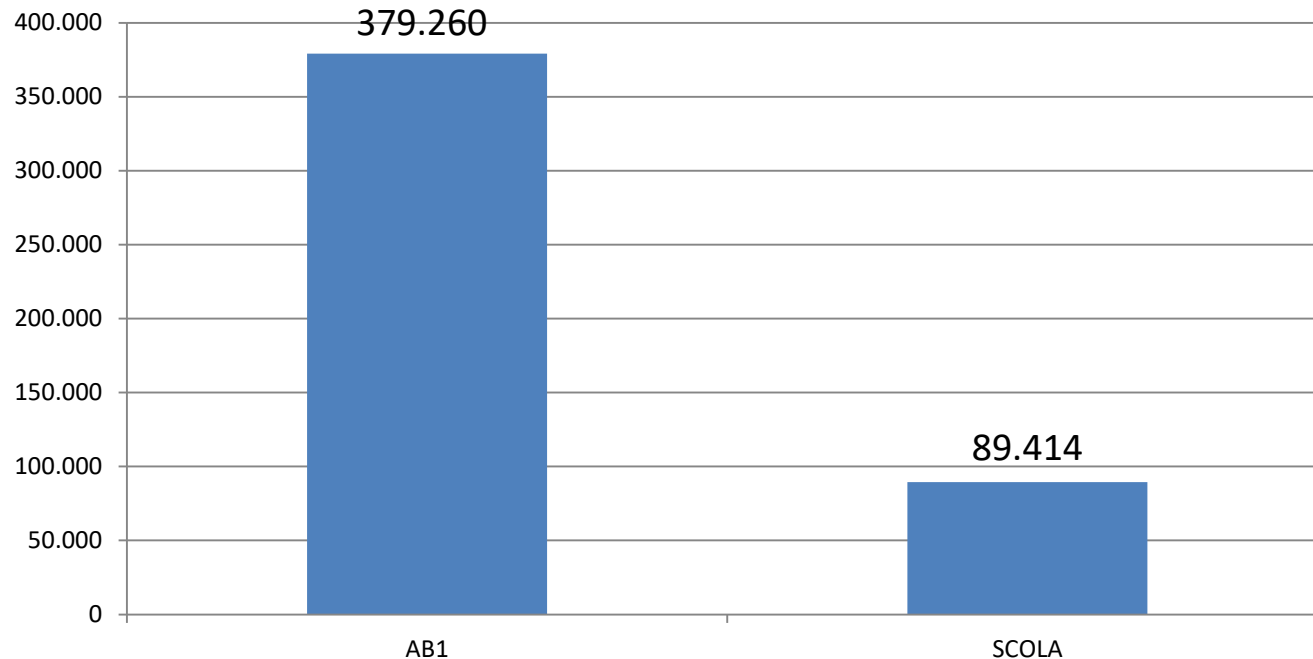


Measurement Subjects	Temp. [°C]
Measurement Point 1	18,4
Measurement Point 2	21,3
Measurement Point 3	24,1
Measurement Point 4	26,7

## Measurements



# TOTAL SAVINGS AT SCOLA: 200,000 USD/year



**AB1: 134 kWh/m<sup>2</sup>/year**

**SCOLA: 57 kWh/m<sup>2</sup>/year**

Typical Academic Building in Turkey (TAB): 220 kWh/m<sup>2</sup>/year

**SAVINGS: %60 vs the best %75 vs the avg**

# ENERGY APPLICATIONS AND RADIATIVE TRANSFER

ADNAN MENDERES UNIVERSITY

MEDICAL SCHOOL BUILDING



**BRICKER**  
**FP7-PROJECT**  
**TURKISH PARTNERS: OZU-ADU-ONUR ENERGY**



**BRICKER** aims to develop a scalable, replicable, high energy efficient, zero emissions and cost effective system to refurbish existing public-owned non-residential buildings to achieve at least 50% energy consumption reduction.

- **DURATION: 4 YEARS (2013-2017)**  
**EU CONTRIBUTION: 8,6 million €**  
**TOTAL BUDGET: 12,9 million €**
- **ADU BUILDING BUDGET: 2,2 million €**
  - **EU CONTRIBUTION: 1,4 million €**



**BRICKER** aims to develop a scalable, replicable, high energy efficient, zero emissions and cost effective system to refurbish existing public-owned non-residential buildings to achieve at least 50% energy consumption reduction.





## Monitoring and Performance Evaluation of Adnan Menderes U Demo Building before Renovation





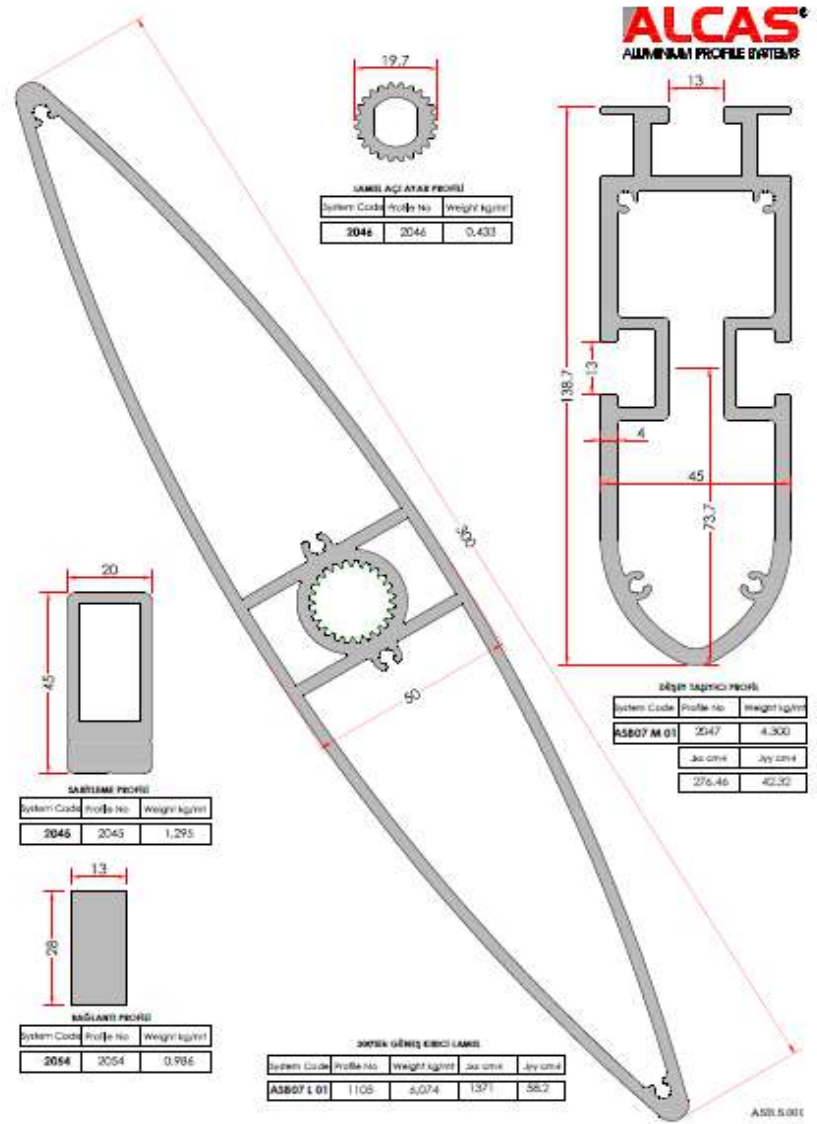
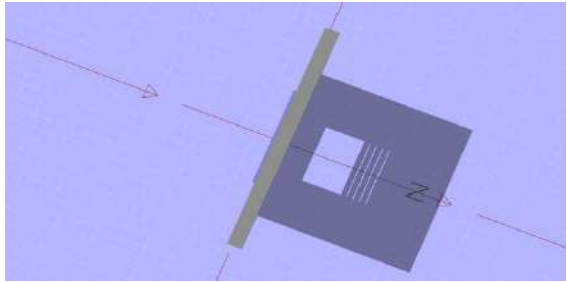
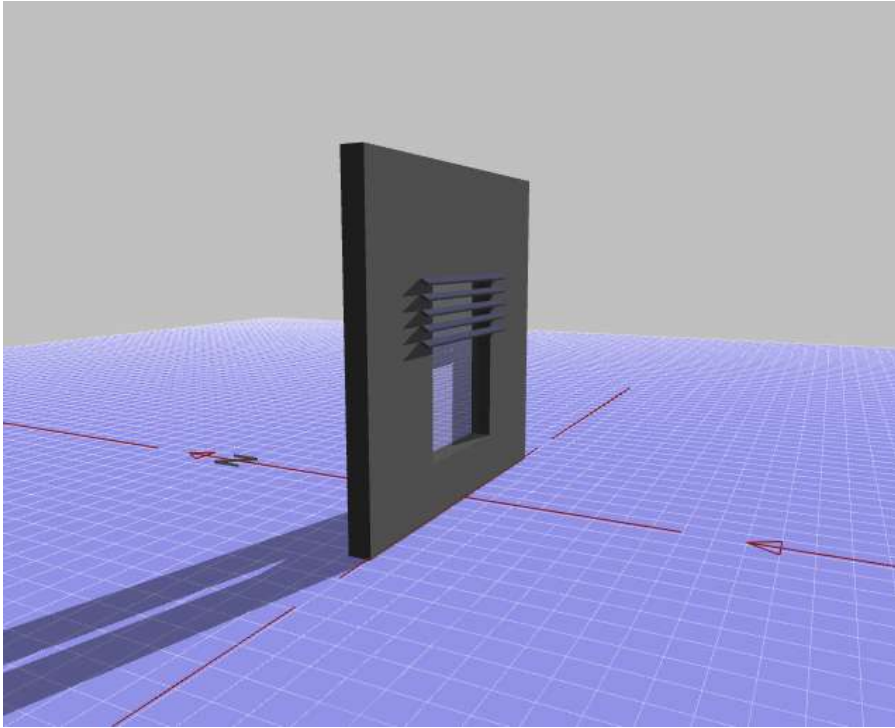
20 modules of the solar collector system PTMx-36 (SOL): Phase 1  
Ground installation over separate foundations for each plate



# HORIZONTAL SUN SCREEN

## Aluminium sun breaker simulation

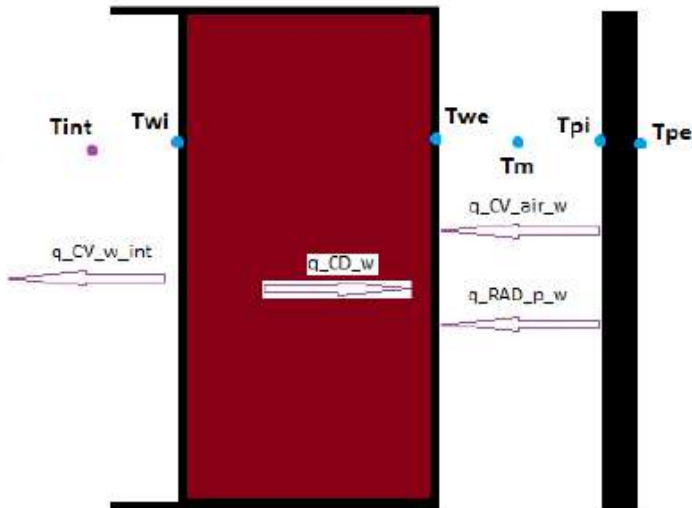
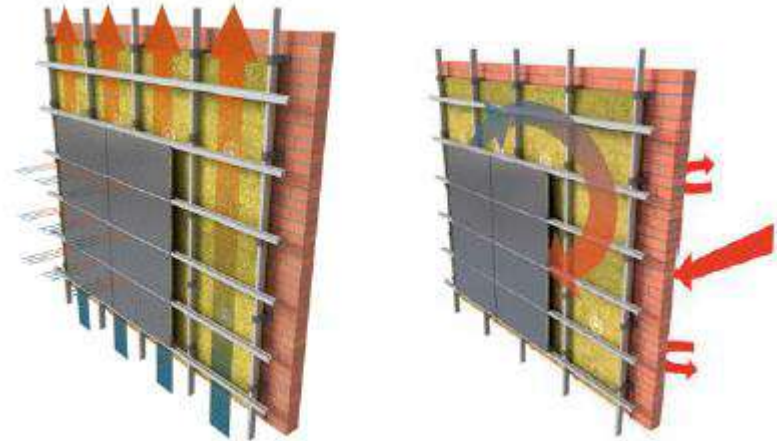
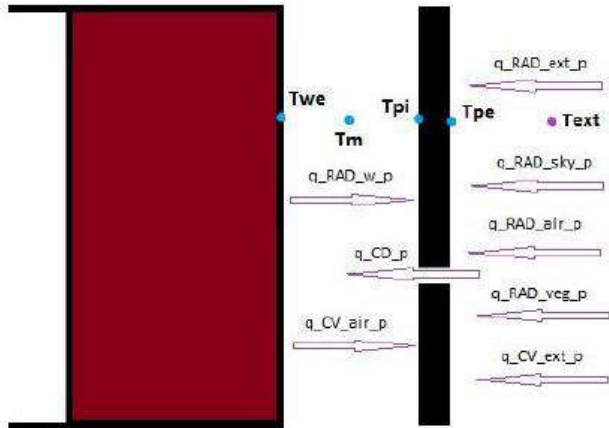
### via ShadowFX V3



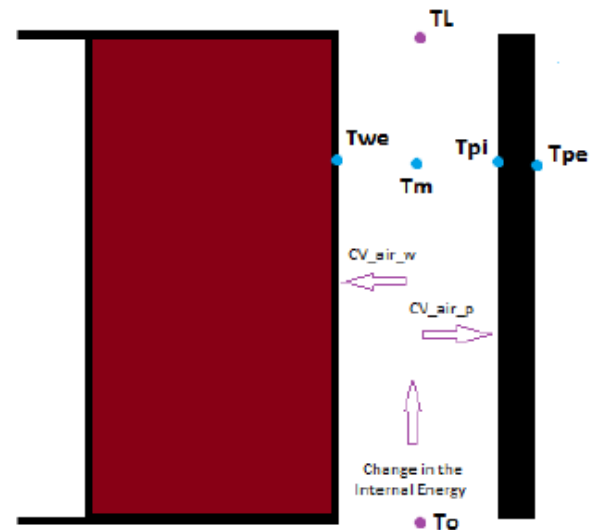


# INNOVATIVE, SUSTAINABLE AND LIGHT WEIGHT VENTILATED FAÇADE

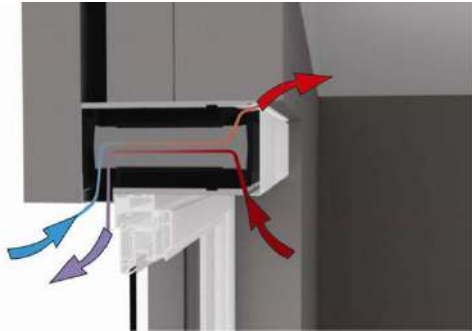
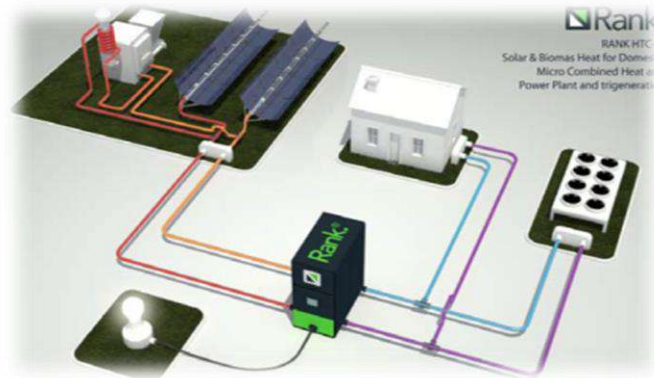
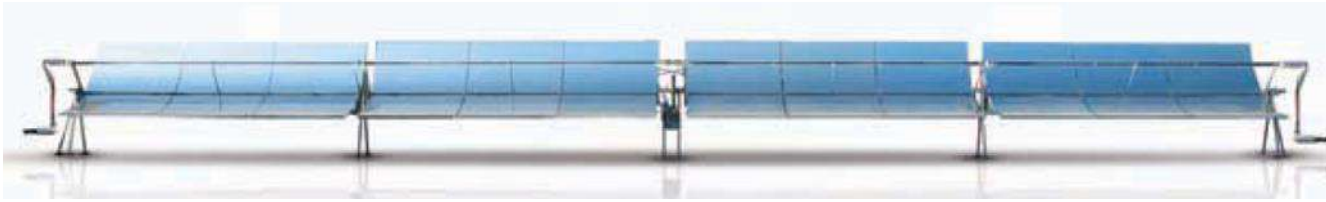
## Energy Balances



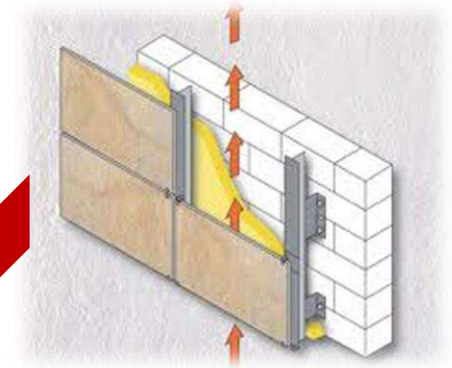
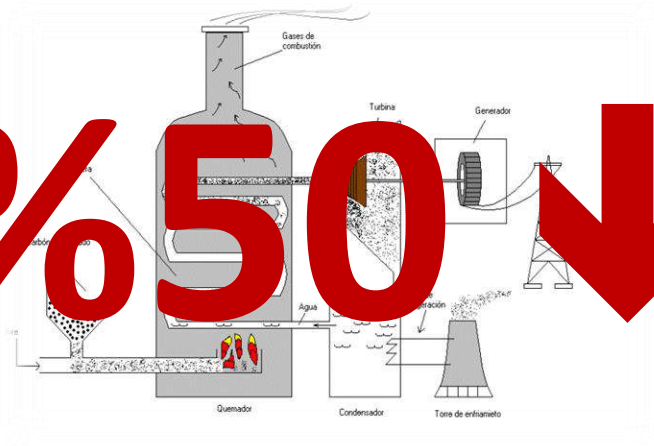
Wall Inputs



Cavity Inputs

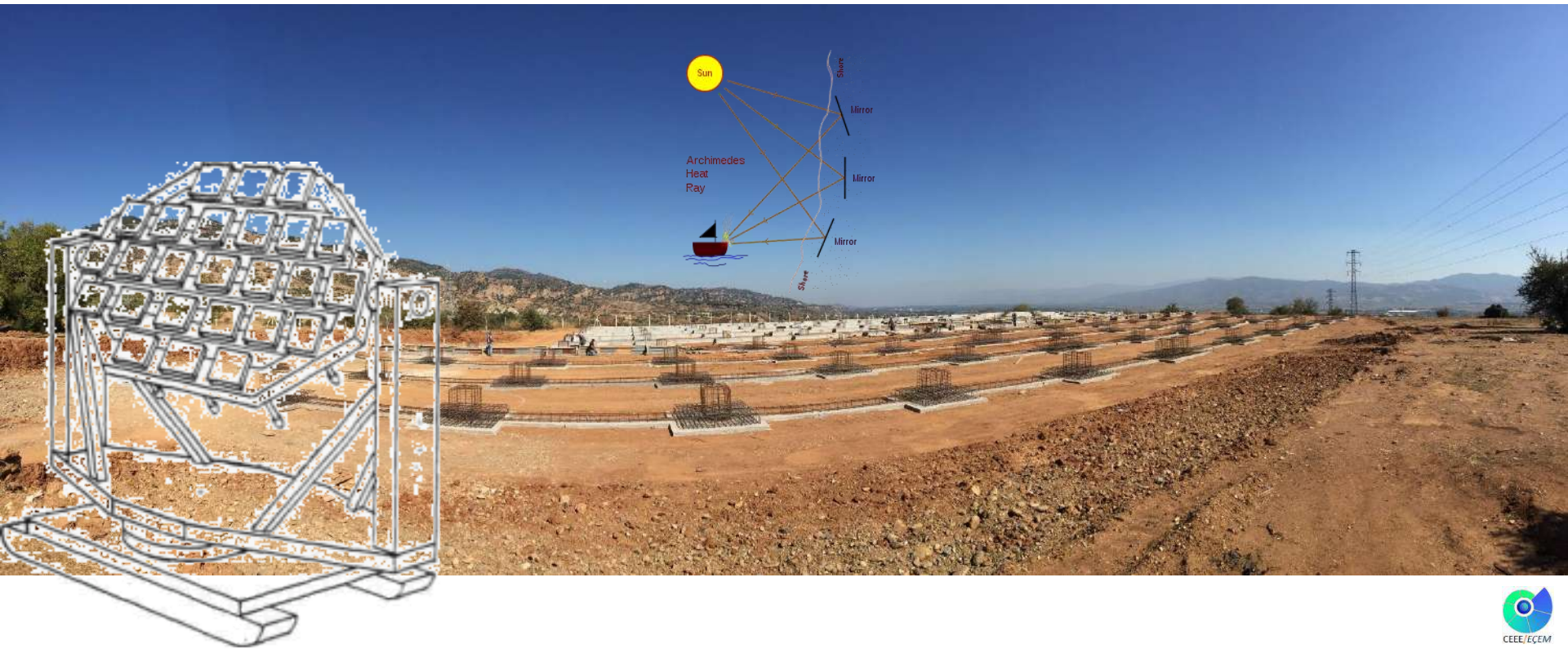


**%50**



# OPTICS & BUILDINGS

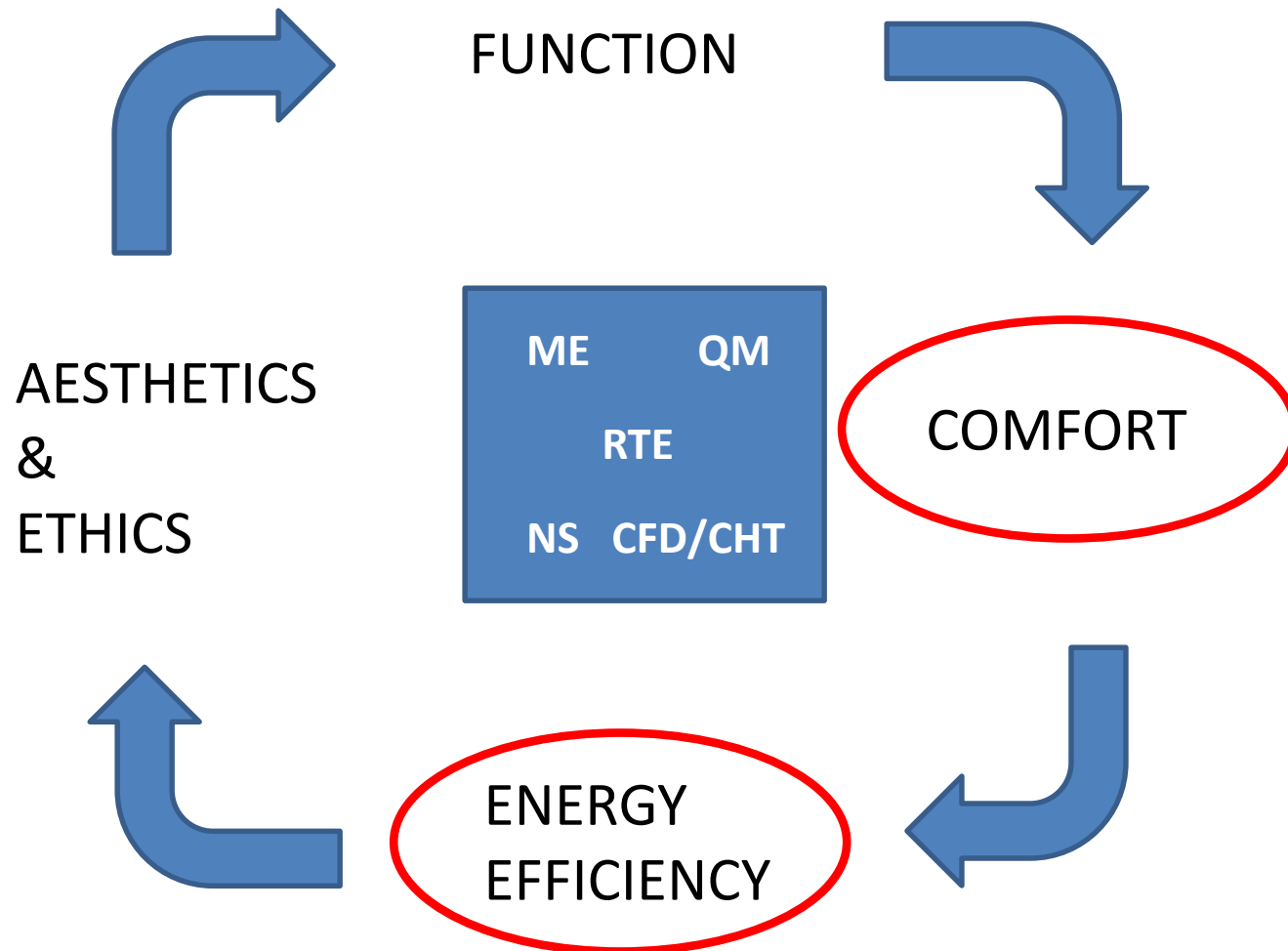
TOTAL SAVINGS (ESTIMATED): 500,000 USD/year



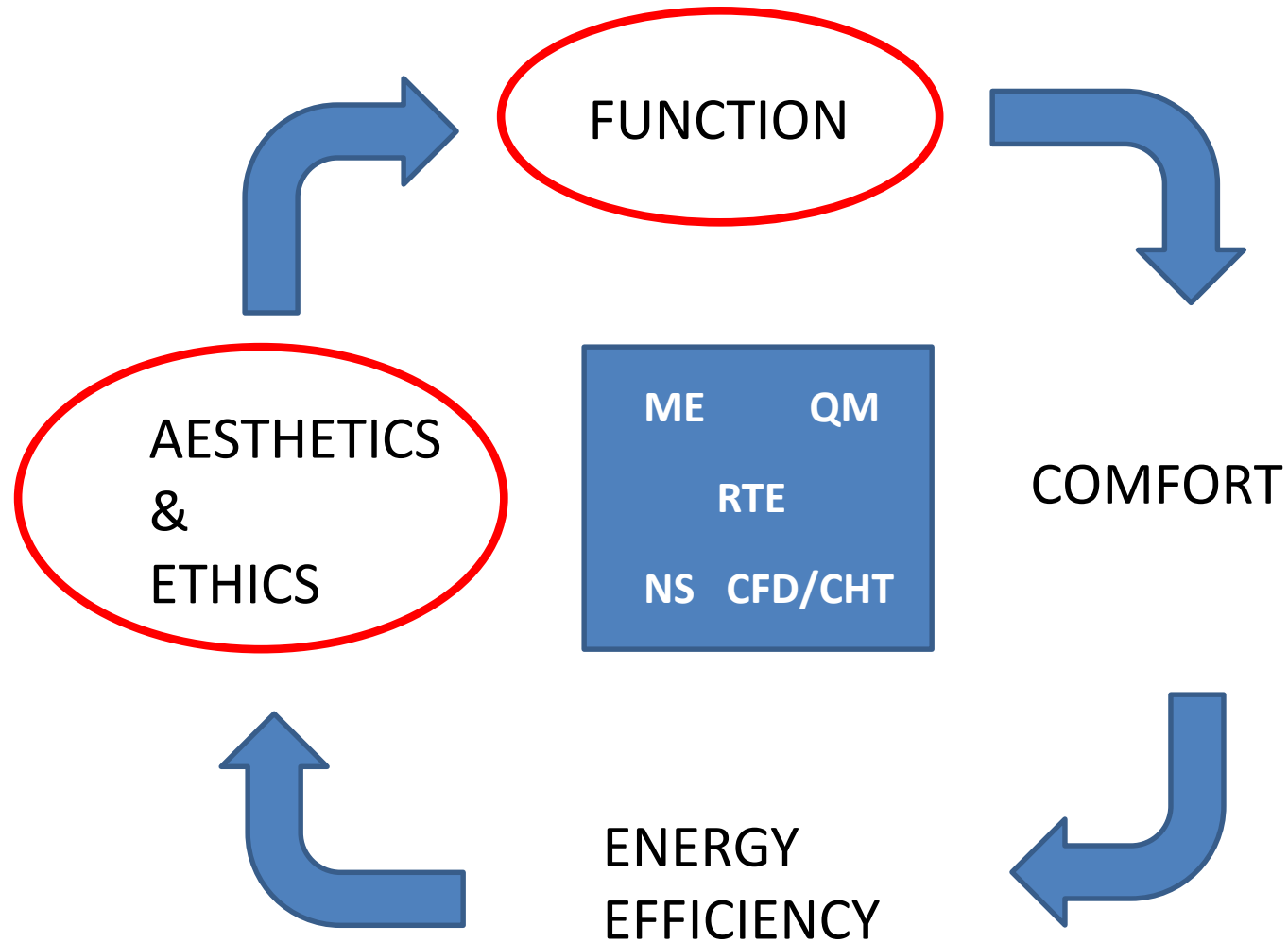


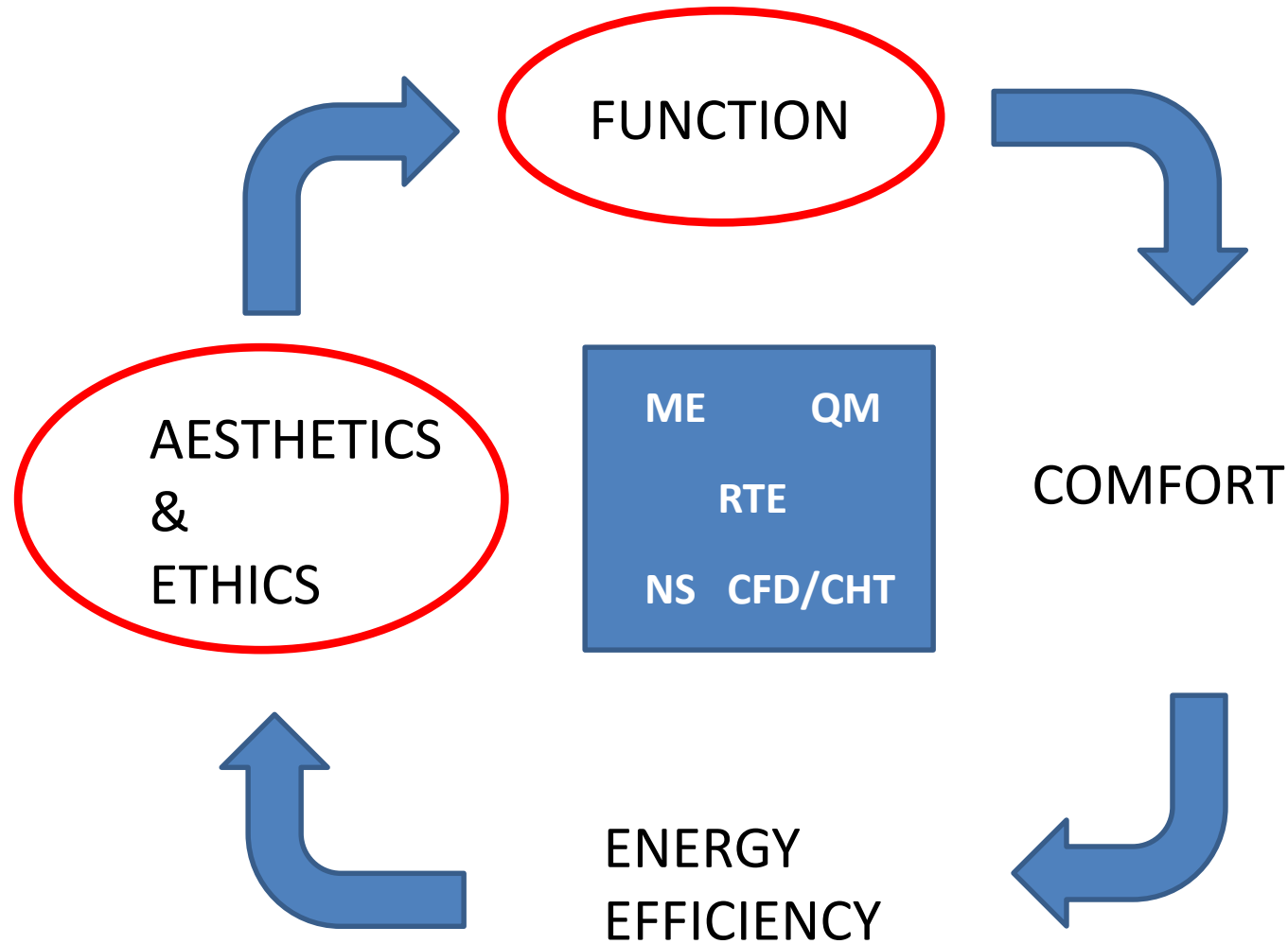
# BEHAVIOR BASED MEASUREMENTS AND IMPLEMENTATIONS

# OPTICS AND BUILDINGS

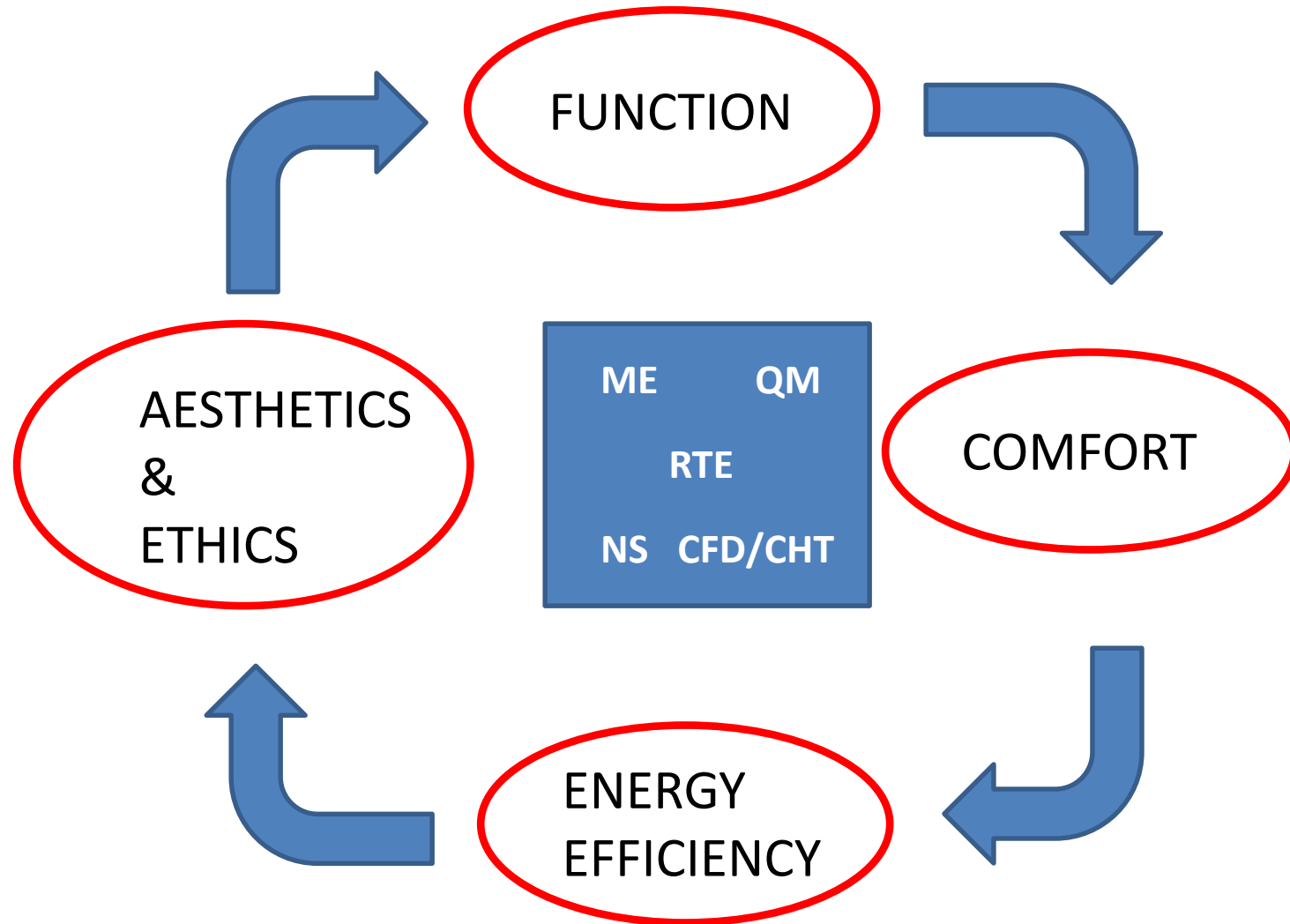


# OPTICS AND BUILDINGS









# ENERGY AND BEHAVIOR

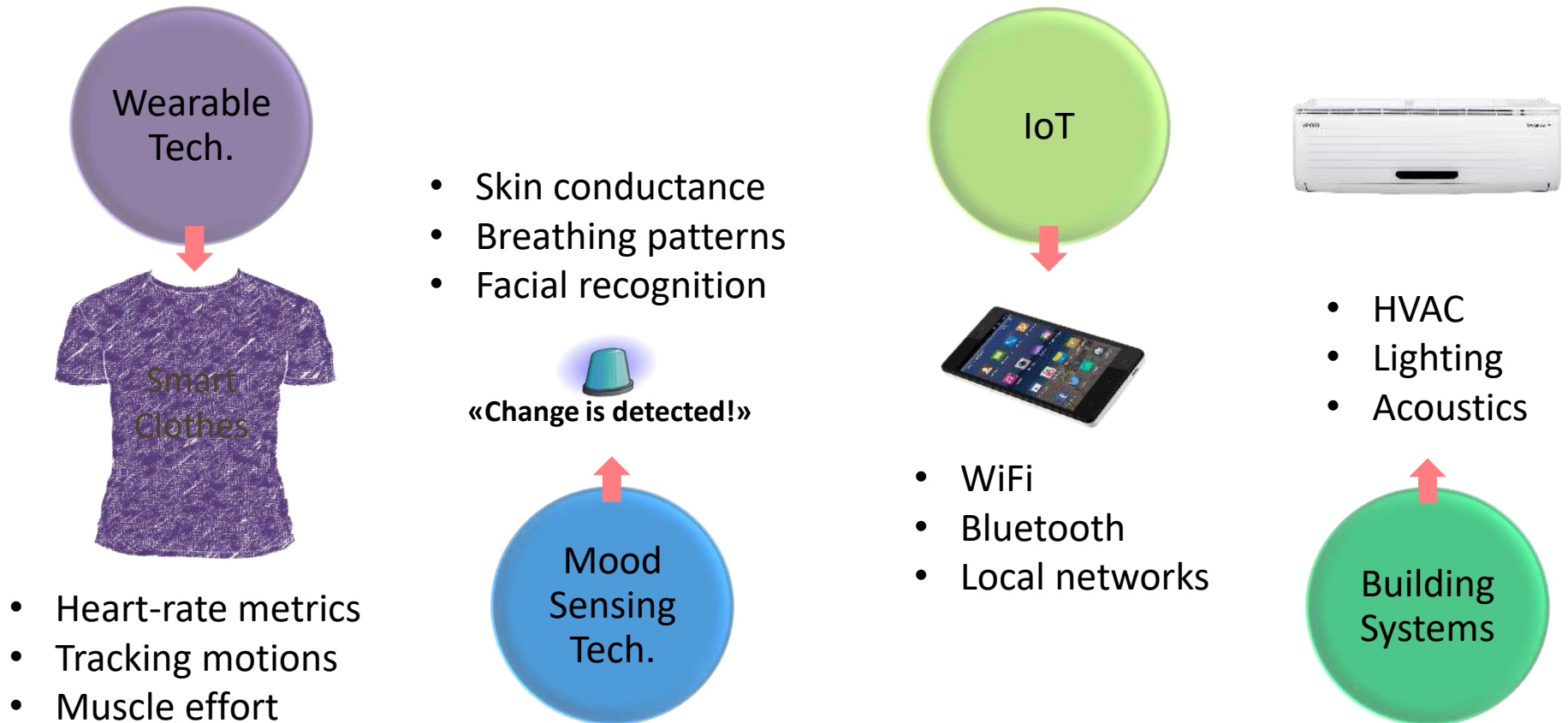
OZYEGIN UNIVERSITY ENGINEERING BUILDING



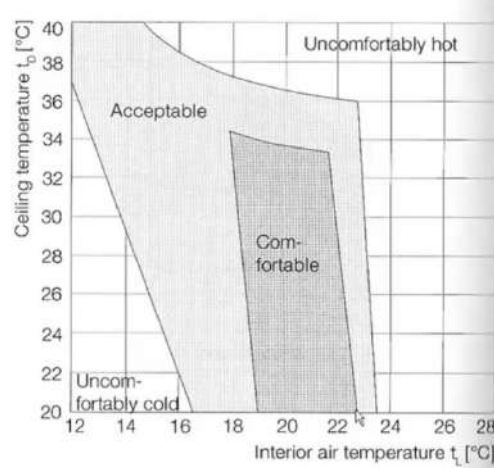
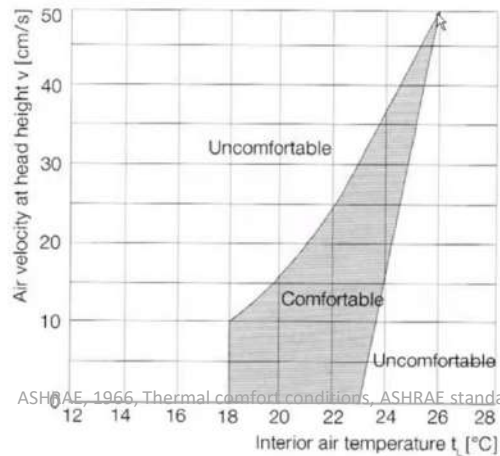
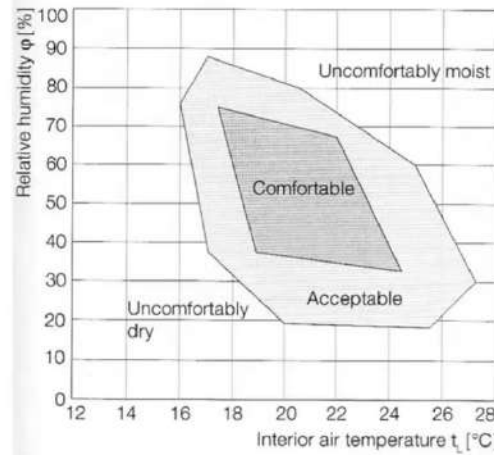
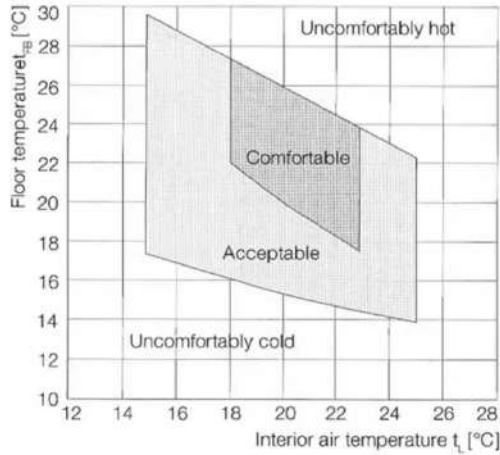
**TRIBE**  
**HORIZON 2020 PROJECT**  
**TURKISH PARTNER: OZU**

# BIG PICTURE: SMART INTEGRATION of TECHNOLOGIES

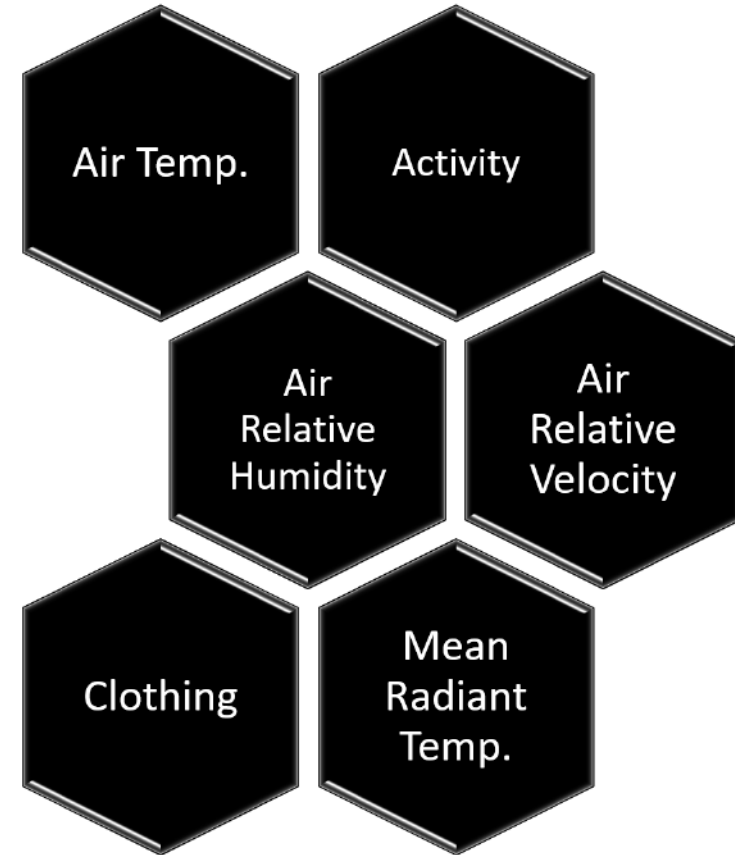
Drawing by: Ebru Tatar, MSME 2018. Elif Tunçel, MSME 2018



# Complex Thermal Comfort?

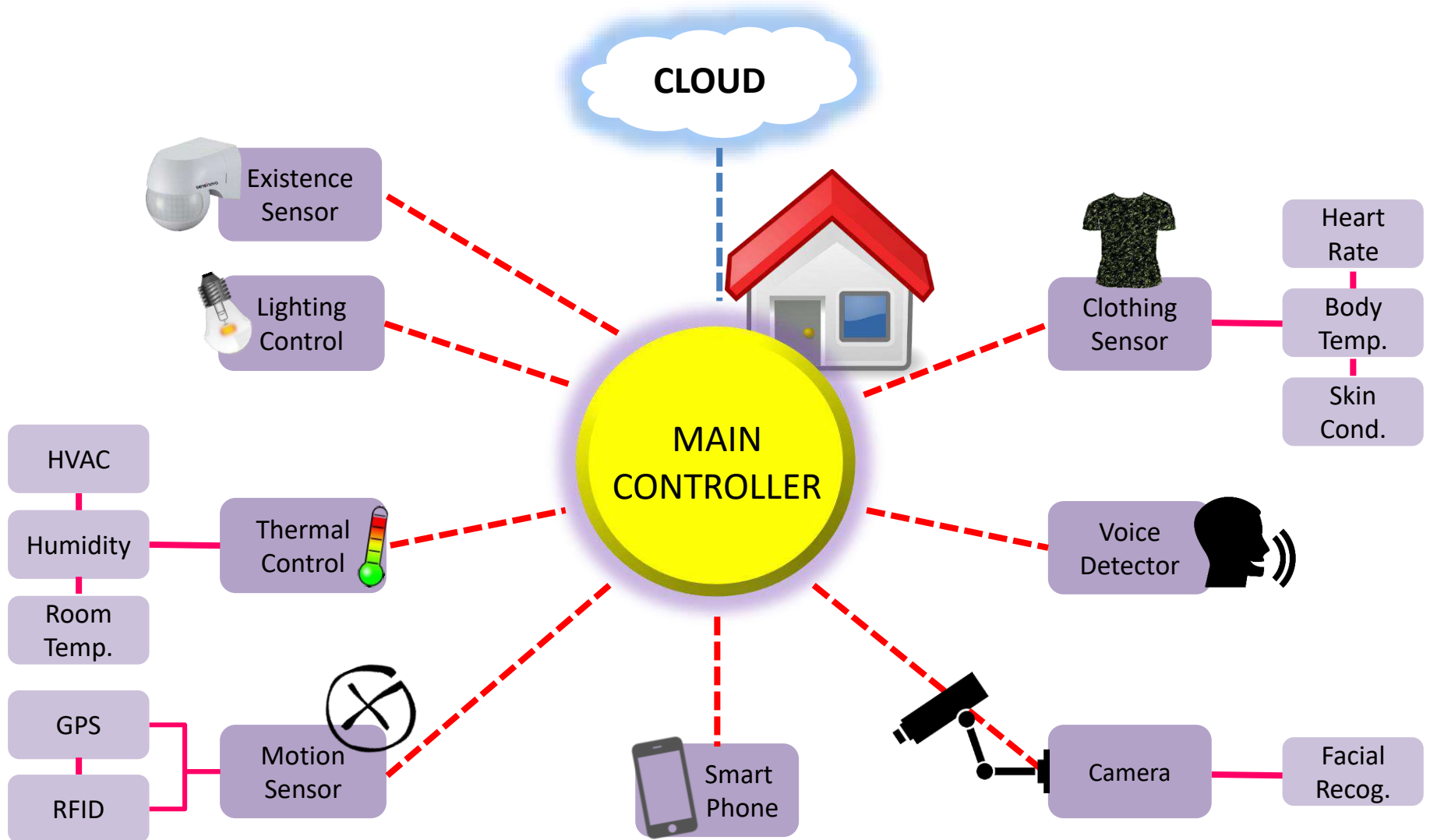


ASHRAE, 1966, Thermal comfort conditions, ASHRAE standard 55.



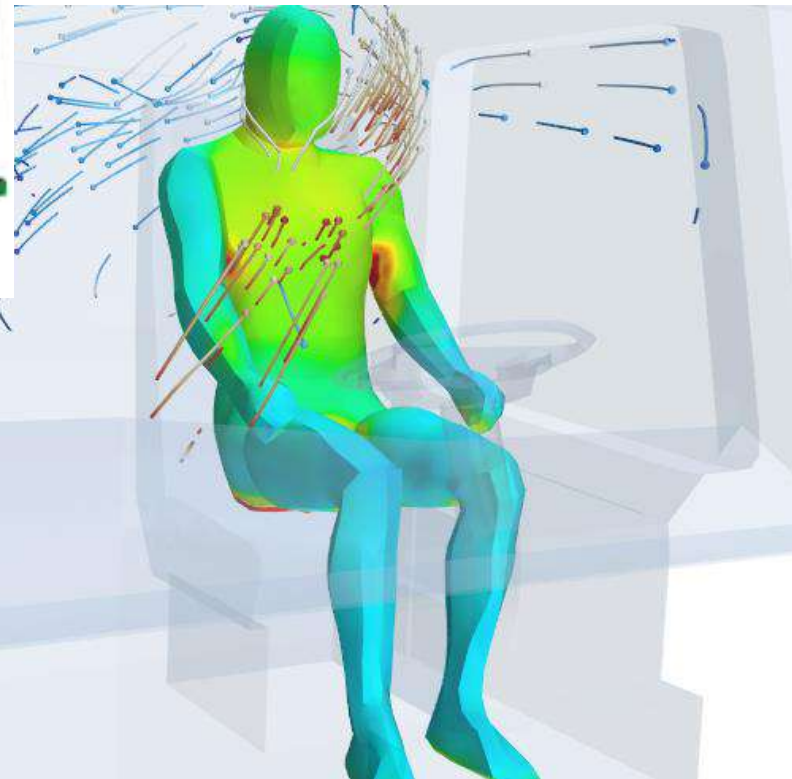
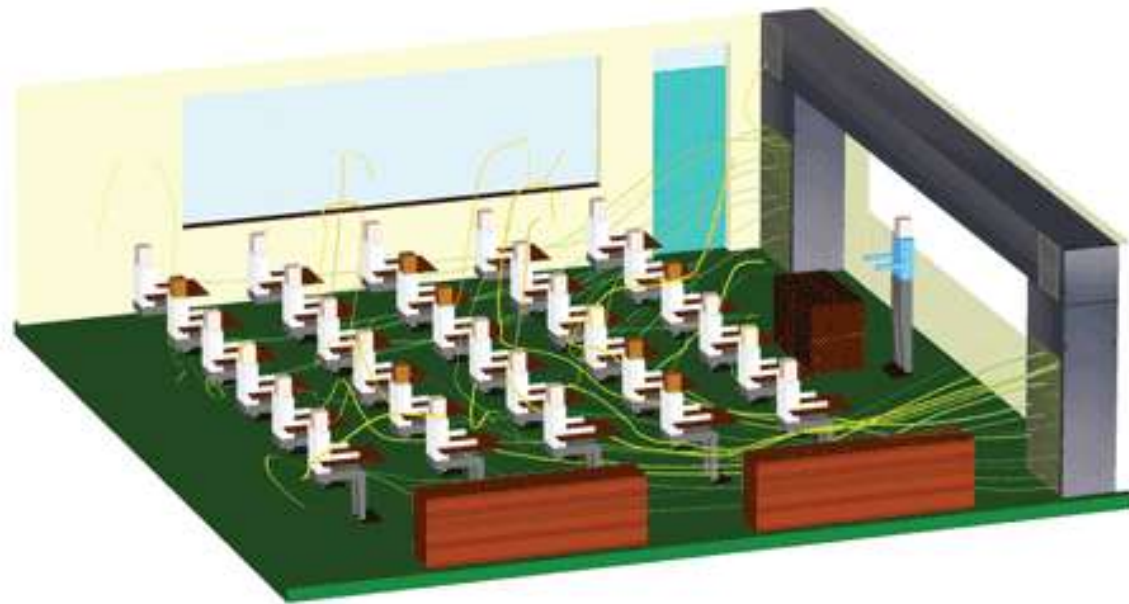


# SYSTEM ARCHITECTURE



Drawing by Ebru Tatar, MSME 2018. Elif Tunçel, MSME 2018; for Schneider Final

# CFD and Star-CCM Thermal Comfort Wizard



Ozyeğin University students:

**Cem Keskin, PhD, 2018.**

Güven Fidan, MSME 2017.

Ruşen Acet, MSME 2018.

Ebru Tatar, MSME 2018.

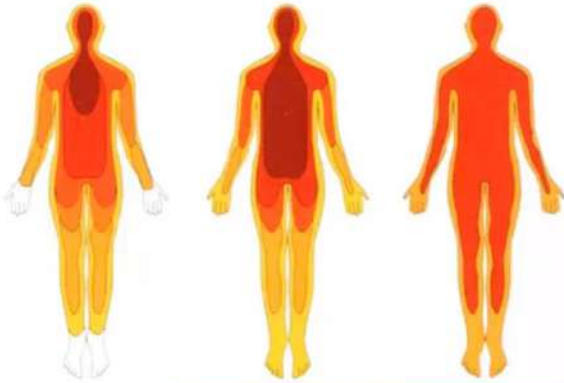
Elif Tunçel, MSME 2018

Temperature of surroundings

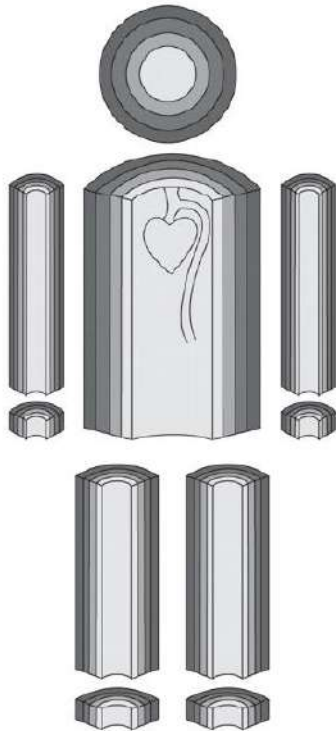
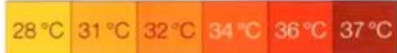
0°C

20°C

35°C

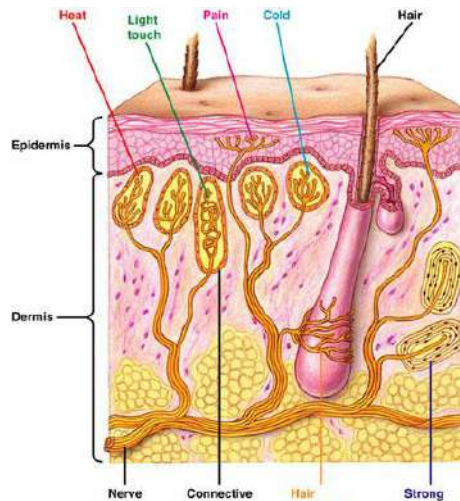
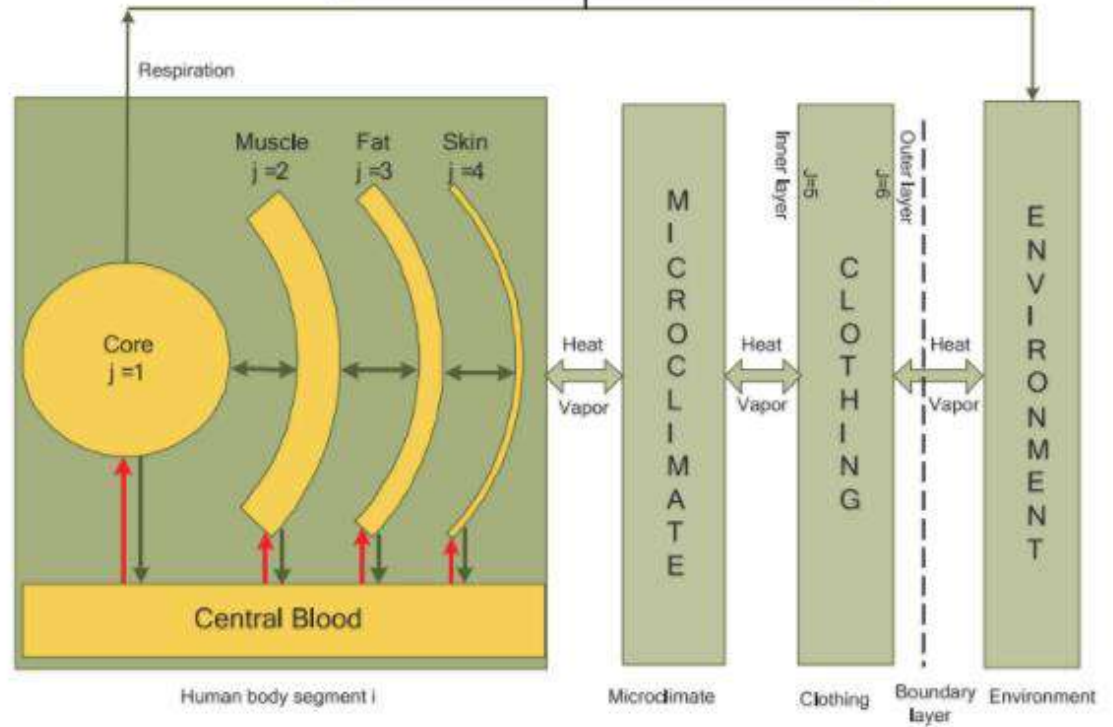


Temperature of body



- core
- muscle
- fat
- skin

### Human / Clothing / Environment System



Ozyeğin University students:

Ebru Tatar, MSME 2018.

Elif Tunçel, MSME 2018



10:52 Fri 11 Jan 2002

Bob Alison



Preferred Temp 21°

Energy efficiency B

Satisfaction 25

Knowledge 44

Climate attitude 52

Norm sensitivity

Help Desks

F. Shaman: Now, where is there a power switch for a lamp

Open Offices

€ 310    ♥ 425

15°    1120 W    323 kWh



CO<sub>2</sub>

Settings    Mail 0

€ 310    ♥ 425    Open Offices    2016-01

15°

Office Workstation X

The modern version of a carpenter's workshop. Except less is crafted and more is modern.

Upgrade to LCD  
200 €    2 ♥    ⚡ -20%    ♥ +2%

Settings    Mail 0

14:29 4 Jan 2002

500    500    107843    0



Settings    Mail 0

8.

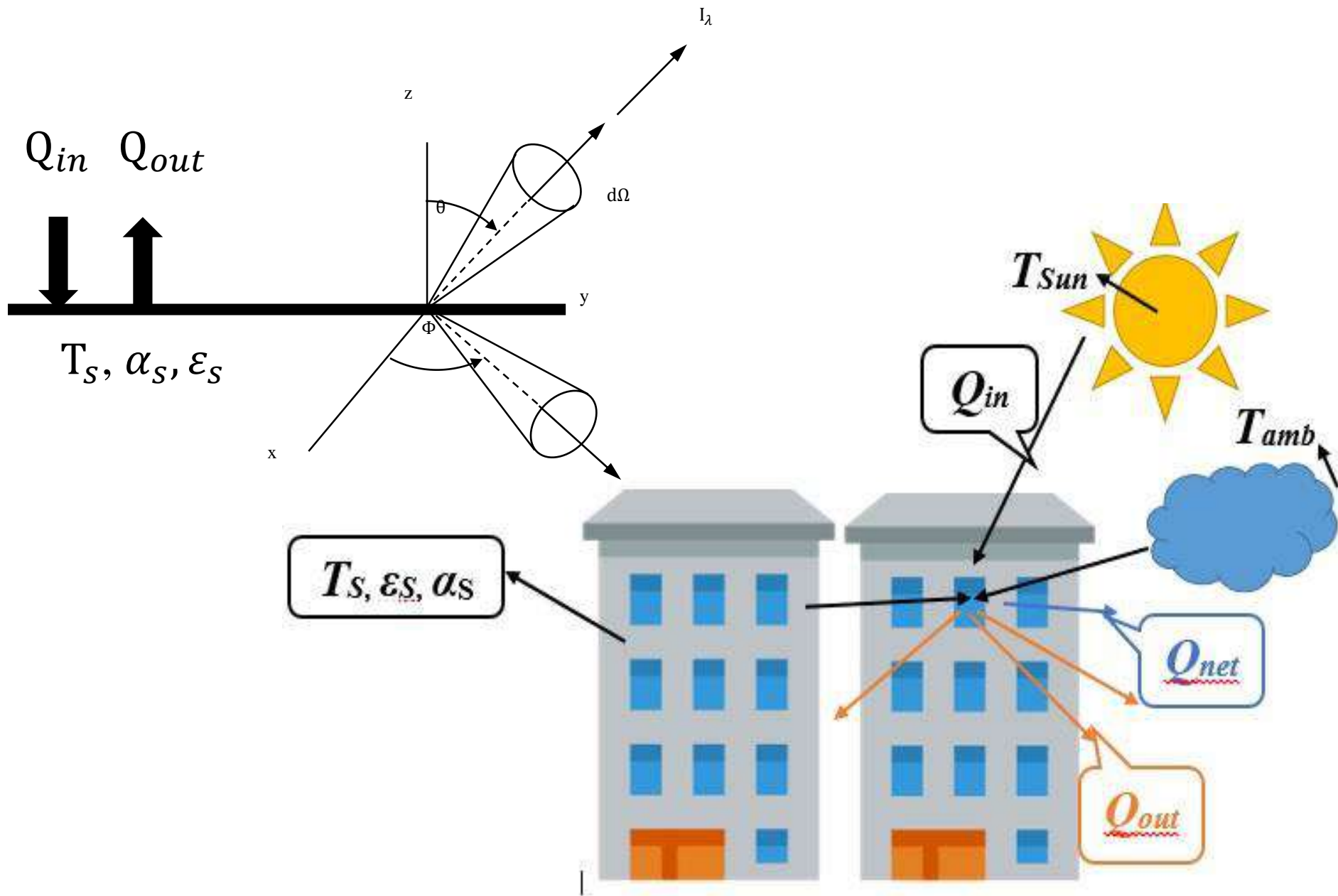


# **OTHER CEEE BUILDING RELATED FUNDAMENTAL RESEARCH**

**Sustainable Building Materials**  
**Radiative Behaviour of Compact Systems**  
**Biologically Inspired Near-Field Radiative Transfer**

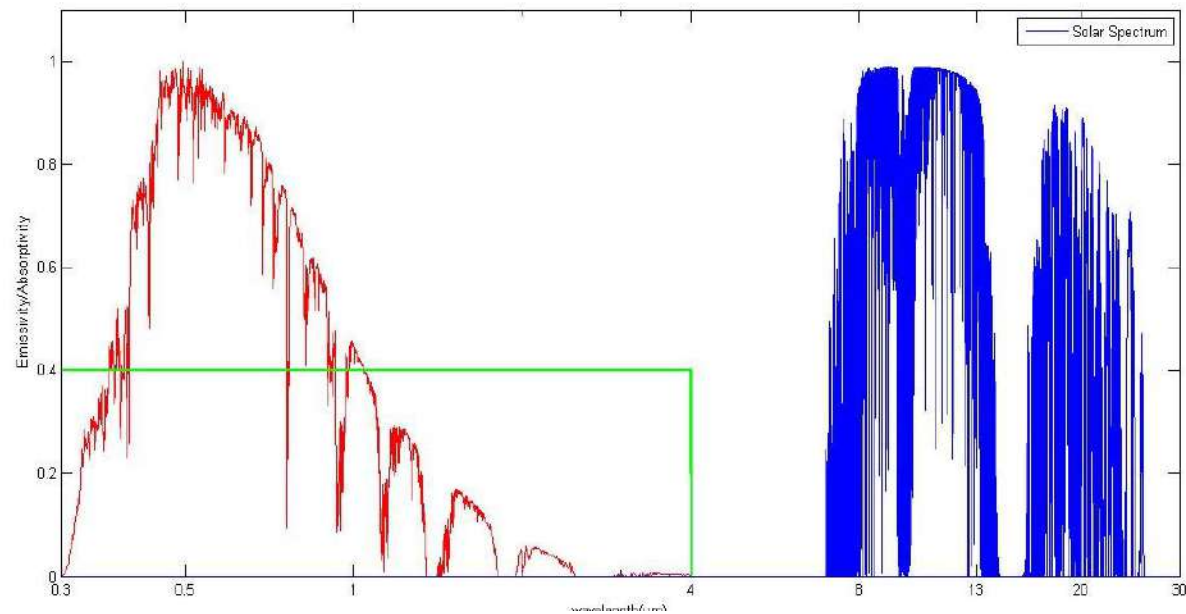
**Radiative Cooling (OzU, SU, BU)**

# RADIATIVE COOLING

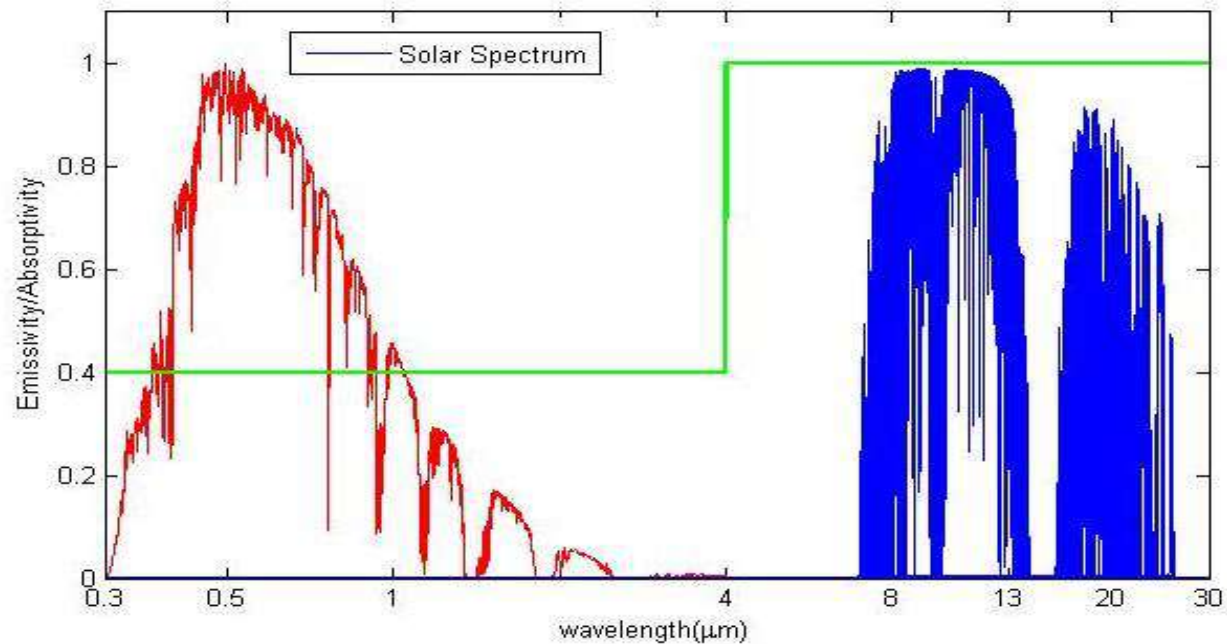


# RADIATIVE COOLING: SPECTRAL WINDOWSC

Original

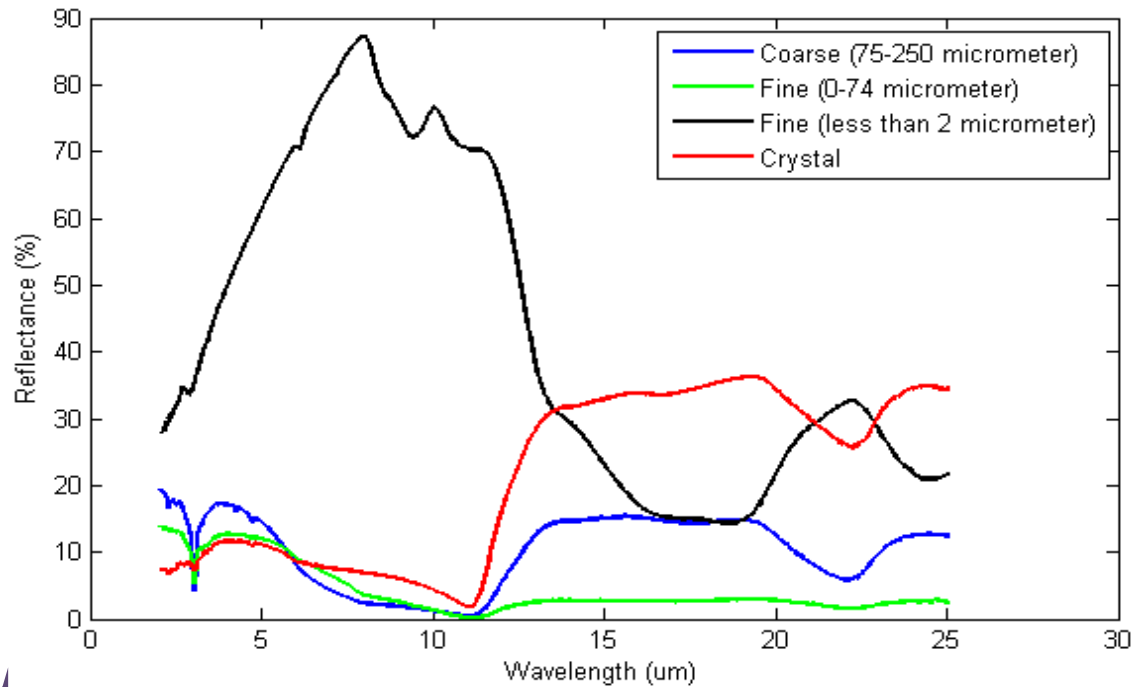
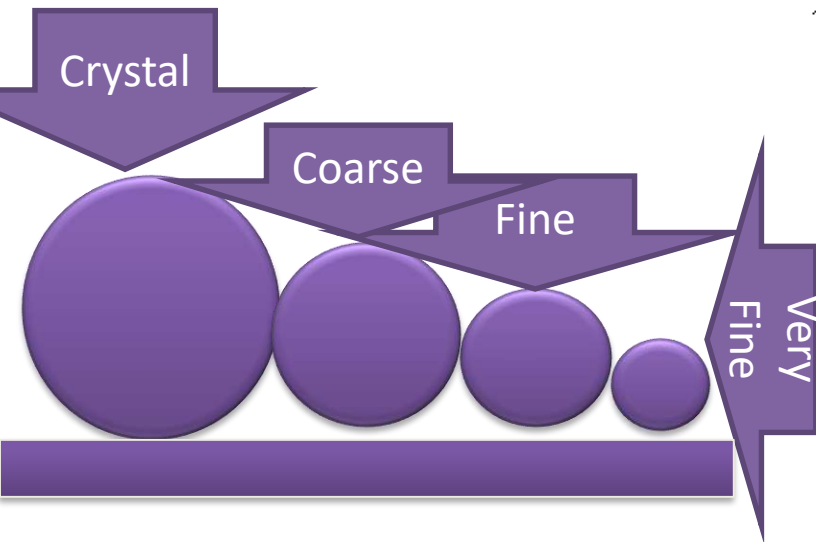


Modified



# EFFECT OF PARTICLES ON SPECTRA





Comparisons as a function of particle size

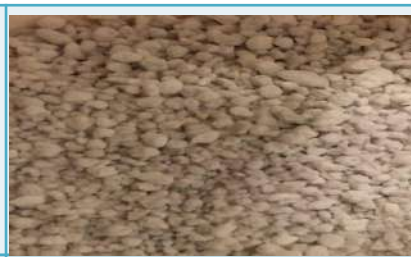



Effect of Particle Size on Radiative Cooling (TiO<sub>2</sub> as a pigment), plotted by Matlab, Data has taken from <http://speclib.jpl.nasa.gov/search-1>



# MATERIALS USED FOR BUILDINGS (OzU) 2016, 2017

<p>XPS= Extruded Polystyrene Foam&lt;&lt;</p>	
<p>Coated XPS</p>	
<p>EPDM= Black Membrane</p>	
<p>Red Membrane</p>	

<p>Porous Silisium Powder</p>	
<p>Perlite Pumice Cement Composite Materials</p>	<p>➔ Bioinsulation</p>
<p>Painted and Coated bioinsulation panel</p>	

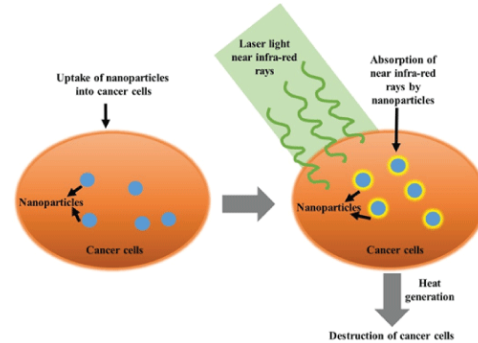
Family and Menguc; 2016

# MODELING NEAR-FIELD RADIATION TRANSFER



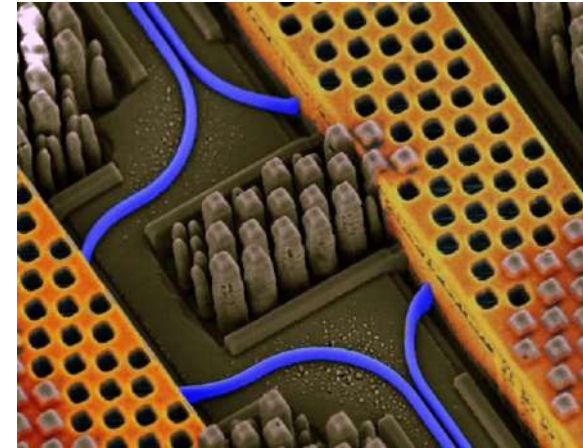
## Energy Harvesting

Source: Google image



## Thermal Therapy

Source: Google image



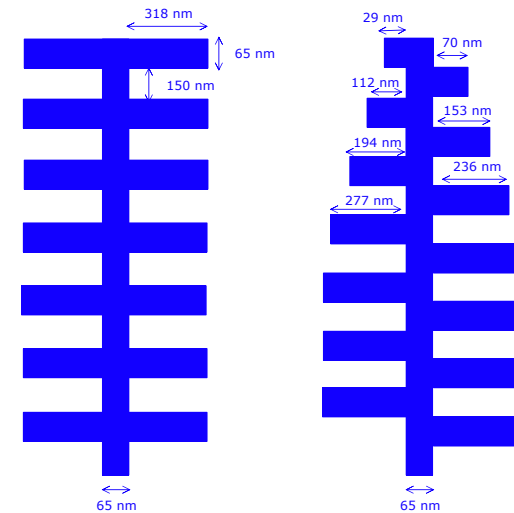
## Integrated Nanophotonics

Source: Google image



## Biologically inspired radiative cooling

Left: Photo of *Superb Starling of Tanzania* bird, middle: *Morpho* butterfly, Photographed by M. Pinar Mengüç, right: schematics of *Morpho* butterfly structure.

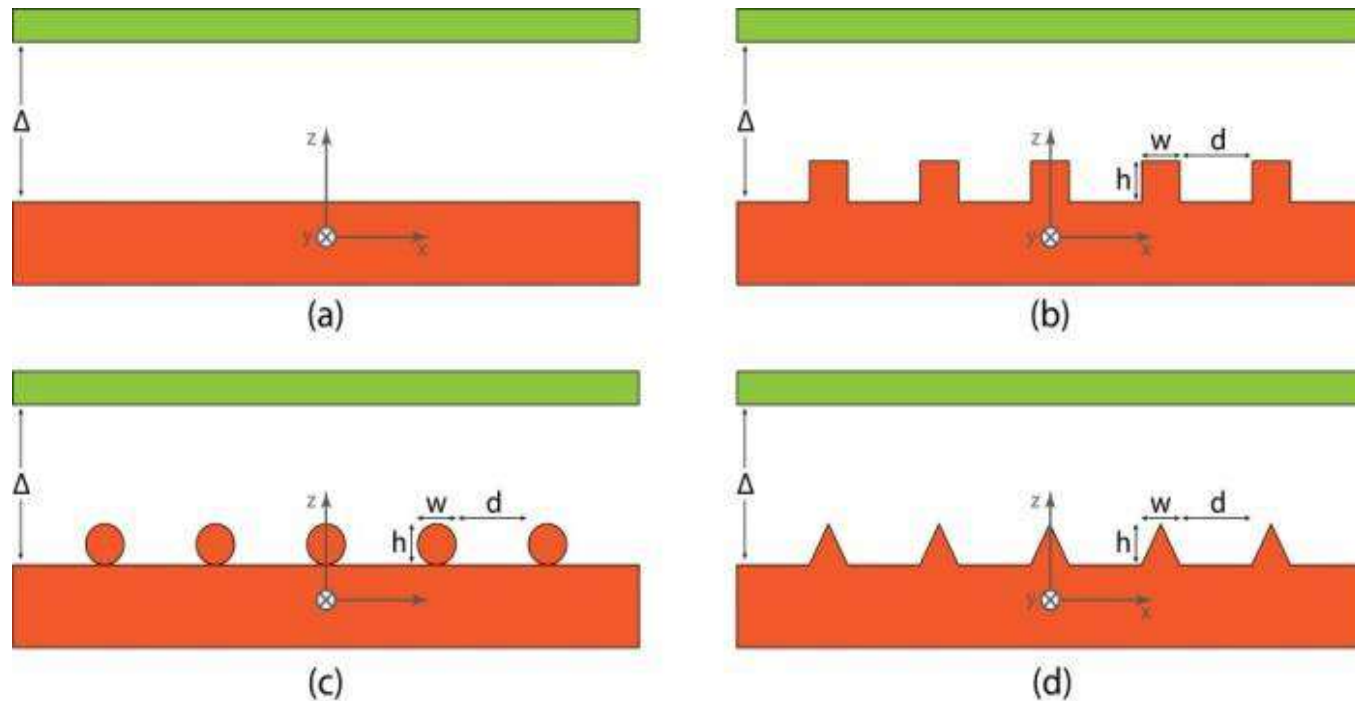


Simple Structure

Original Structure

# RADIATIVE COOLING: VIA NEAR-FIELD EFFECTS

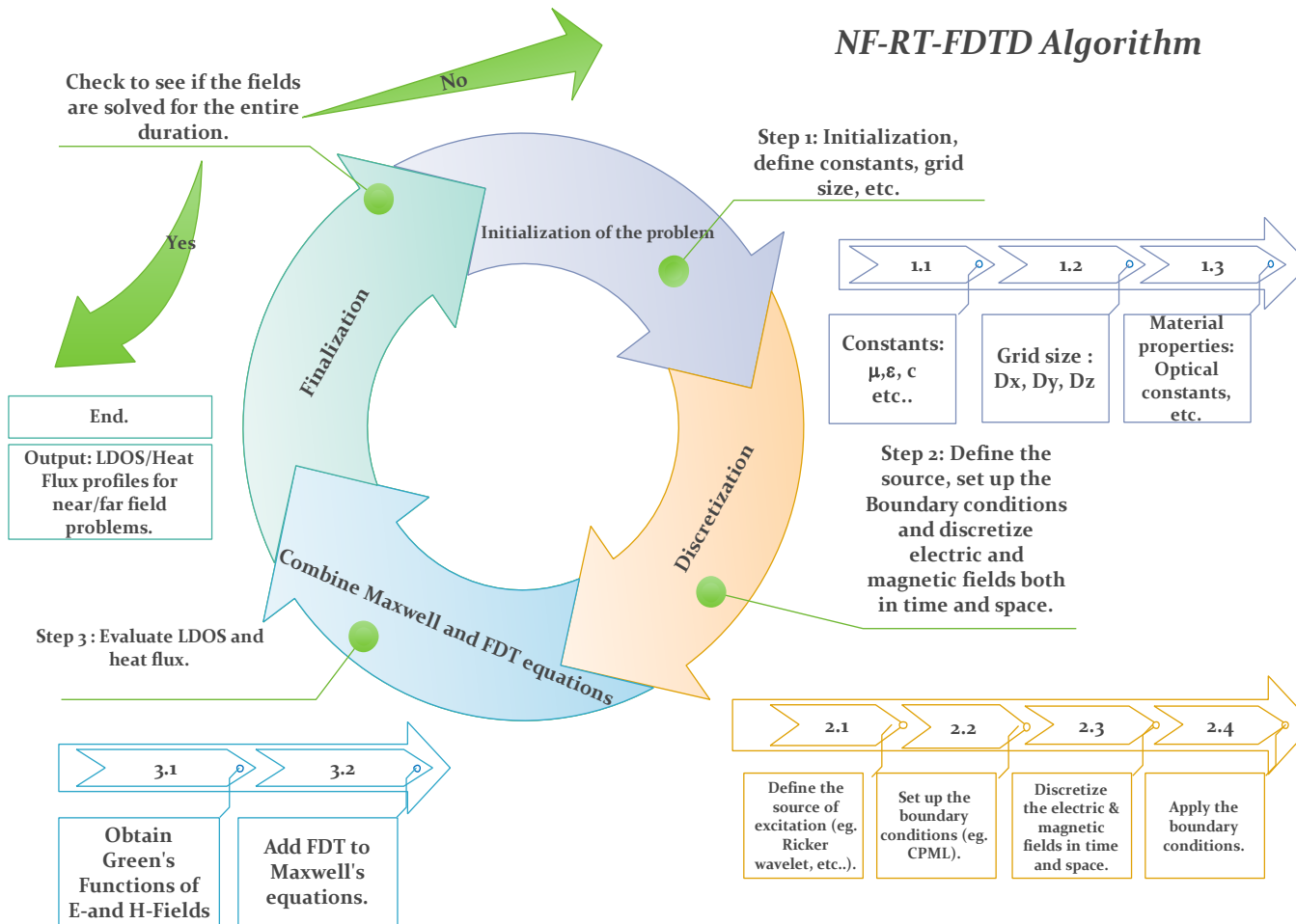
HOW TO USE NEARFIELD RADIATIVE TRANSFER FOR COOLING?



Azadeh Didari, PhD 2016, Ozyeğin University; Senior Researcher, 2016-2018.

# NF-RT-FDTD Code

*NF-RT-FDTD Algorithm*



*NF-RT-FDTD* is a code which solves near-field thermal emission and radiation problems of linear and non-linear nature in complex geometries.

# ÖZYEGİN ÜNİVERSİTESİ





İlk kez 2010 yılında Endonezya  
Üniversitesi tarafından  
oluşturulmuş

**'GreenMetric Dünya  
Üniversiteler Sürdürülebilirlik  
Sıralaması'**

**çevre, ekonomi ve eşitlik**  
kavramlarına odaklanarak  
dünyanın en çevreci  
yükseköğretim kurumlarını

**Yapı ve Altyapı, Enerji ve  
İklim Değişikliği, Atık, Su,  
Ulaşım ve Eğitim**

başlıklarında değerlendiriyor.

# Greenmetric 2015

## Dünya Sıralaması

### ilk 10:

1. Uni. of Nottingham (İngiltere)
2. Uni. of Connecticut (ABD)
3. Uni. of California Davis (ABD)
4. Uni. College Cork (İrlanda)
5. Uni. of Oxford (İngiltere)
6. Uni. of California Berkeley (ABD)
7. Uni. of North Carolina Chapel Hill (ABD)
8. Uni. of Bradford (İngiltere)
9. Uni. de Sherbrooke (Kanada)
10. Northeastern Uni. (USA)

## Türkiye Sıralaması:

Özyeğin Üniversitesi genel sıralamada **İkinci** olurken **Enerji ve İklim Değişikliği** kategorisinde; dünyada 170. **Türkiye'de Birinci** sırada yer aldı.

Yeşil Binalar

Sera Gazı Salınımını Azaltma Politikası

Enerji Tasarrufu Programı

Yenilenebilir Enerji Kullanım Politikaları

Enerji Verimli Cihazların Kullanımı

Toplam Enerji Kullanımı (birey bazında)

İklim Değişikliğine Adaptasyon

# Neden Özyeğin Üniversitesi?



Ranking	University	Country	Total Score	Setting and Infrastructure	Energy and Climate Change	Waste	Water	Transportation	Education
258	Webster University		3797	556	795	1275	355	452	364
259	Universitat Rovira i Virgili		3771	545	900	1350	275	152	549
260	Ozyegin University		3764	378	950	975	566	453	442
261	University of Illinois Springfield		3743	710	703	1275	325	376	354
262	Illinois State University		3732	435	522	1500	325	561	389

# Greenmetric 2016

## Türkiye Sıralaması:

**Özyeğin Üniversitesi**  
Türkiye'den başvuran vakıf  
üniversiteleri arasında **Üçüncü**  
oldu.

GreenMetric 2016 Sıralaması'nda  
**Özyeğin Üniversitesi**  
vakıf üniversiteleri arasında  
**TÜRKİYE ÜÇÜNCÜSÜ**



## Dünya Sıralaması

### ilk 10:

1. Uni. of California Davis (ABD)
2. Uni. of Nottingham
3. Wageningen Uni. & Research (Hollanda)
4. Uni. of Connecticut (ABD)
5. Uni. of Oxford (İngiltere)
6. Uni. für Bodenkultur Wien (Avusturya)
7. Keele Uni. (İngiltere)
8. Uni. of California Berkeley (ABD)
9. Nottingham Trent Uni. (İngiltere)
10. Newcastle Uni. (İngiltere)

## İndikatörlere göre;

- **Su:** tüm üniversiteler arasında **Birinci**;
- **Eğitim:** özel/vakıf üniversiteleri arasında **Birinci**;
- **Ulaşım:** özel/vakıf üniversiteleri arasında **İkinci**;
- **Yapı ve Altyapı:** özel/vakıf üniversiteleri arasında **Üçüncü**;
- **Enerji ve İklim Değişikliği:** özel/vakıf üniversiteleri arasında **Üçüncü**;
- **Atık:** özel/vakıf üniversiteleri arasında **Dördüncü**.

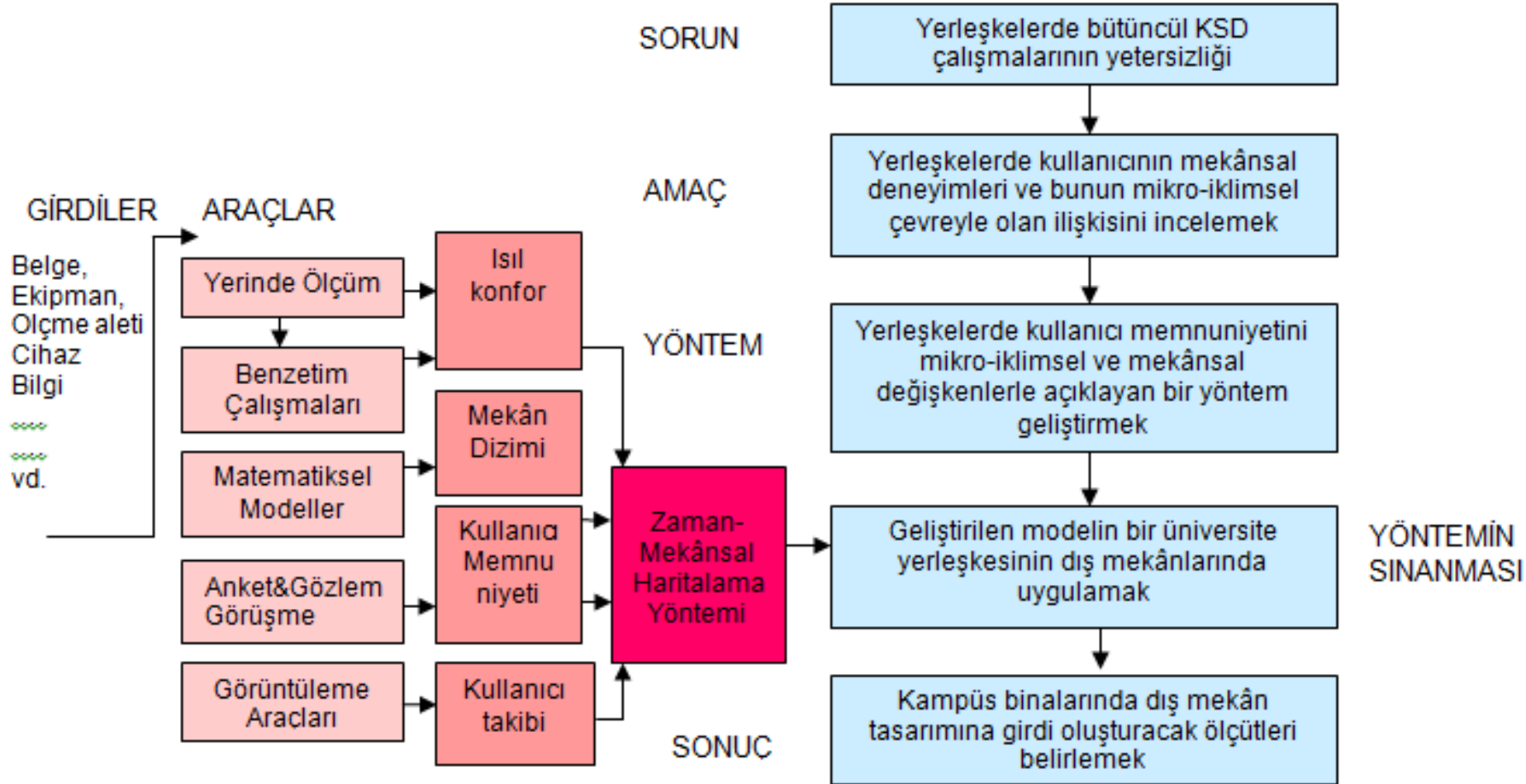
# Çalışmanın amacı ve ulaşılmak istenen hedefler nelerdir?

Son yıllarda önemi daha da vurgulanan çevre ve sürdürülebilirlik yaklaşımları, bu konularla yakın ilişkisi bulunan **çevre kalitesi** ve **kullanıcı memnuniyeti** alanlarında da araştırma ve uygulamaların artmasına neden olmuştur.

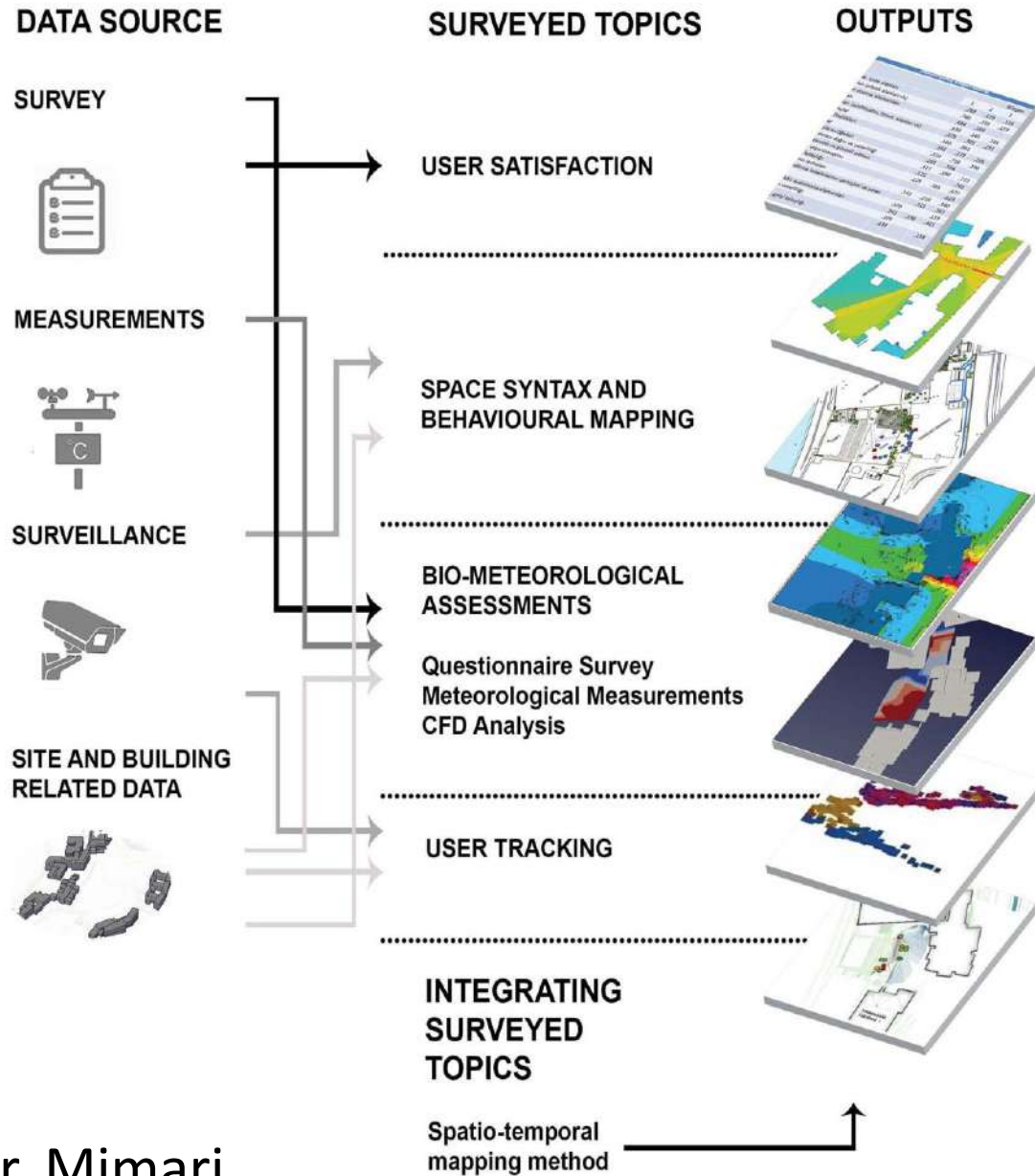
Bu bağlamda, araştırmanın temel amacı

**kullanıcı-çevre-mekân** arasındaki karşılıklı etkileşimin arakesitinde bulunan **dış mekânlarda** kullanıcının mekânsal deneyimleri ve bunun mikro iklimsel çevreyle olan ilişkisini KSD çerçevesinde dikkate alan bir çalışma yürütmektir.



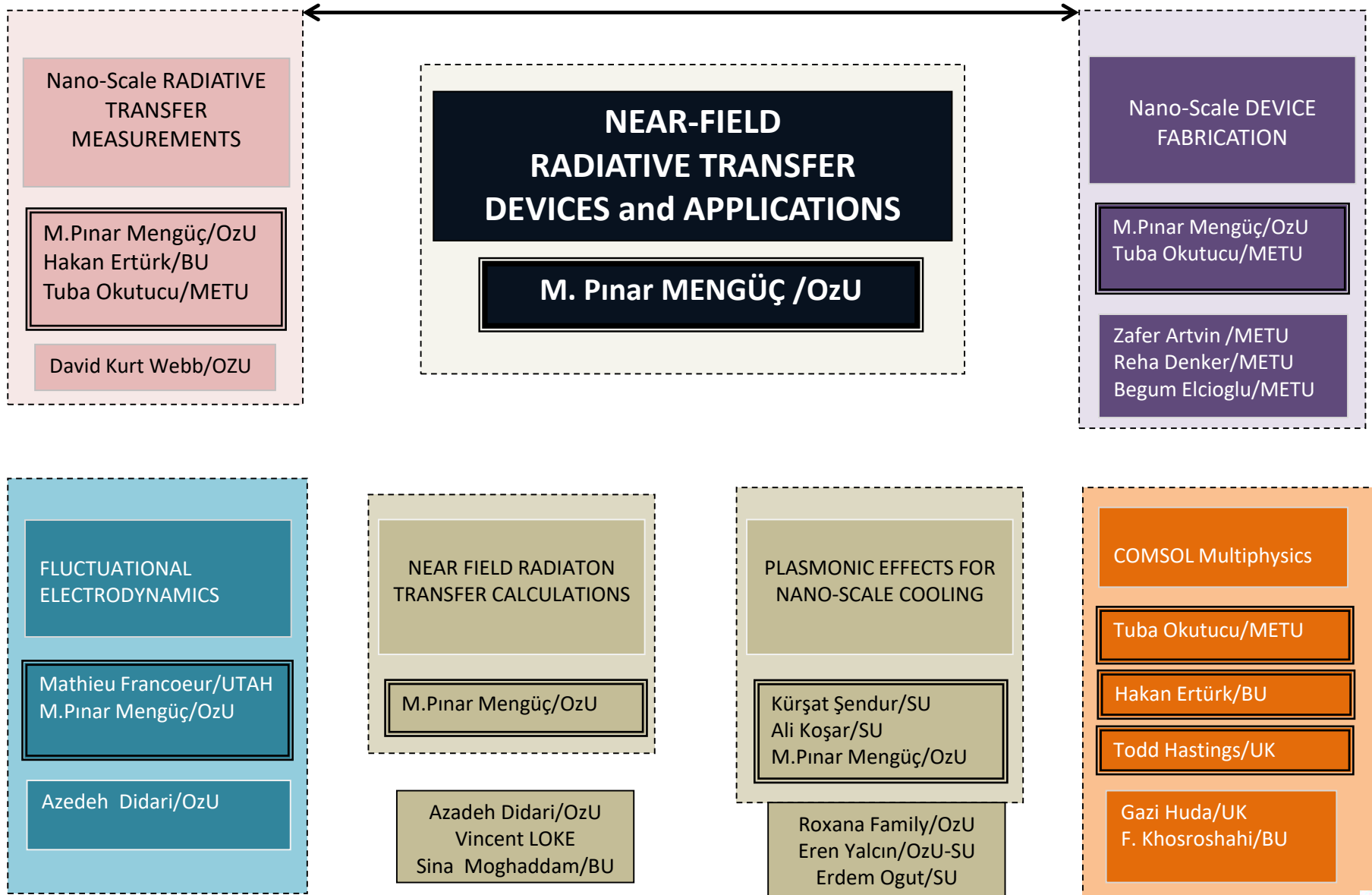


Doç. Özgür Göçer, Mimari  
Çalışmanın modeli ve önerilen yöntem

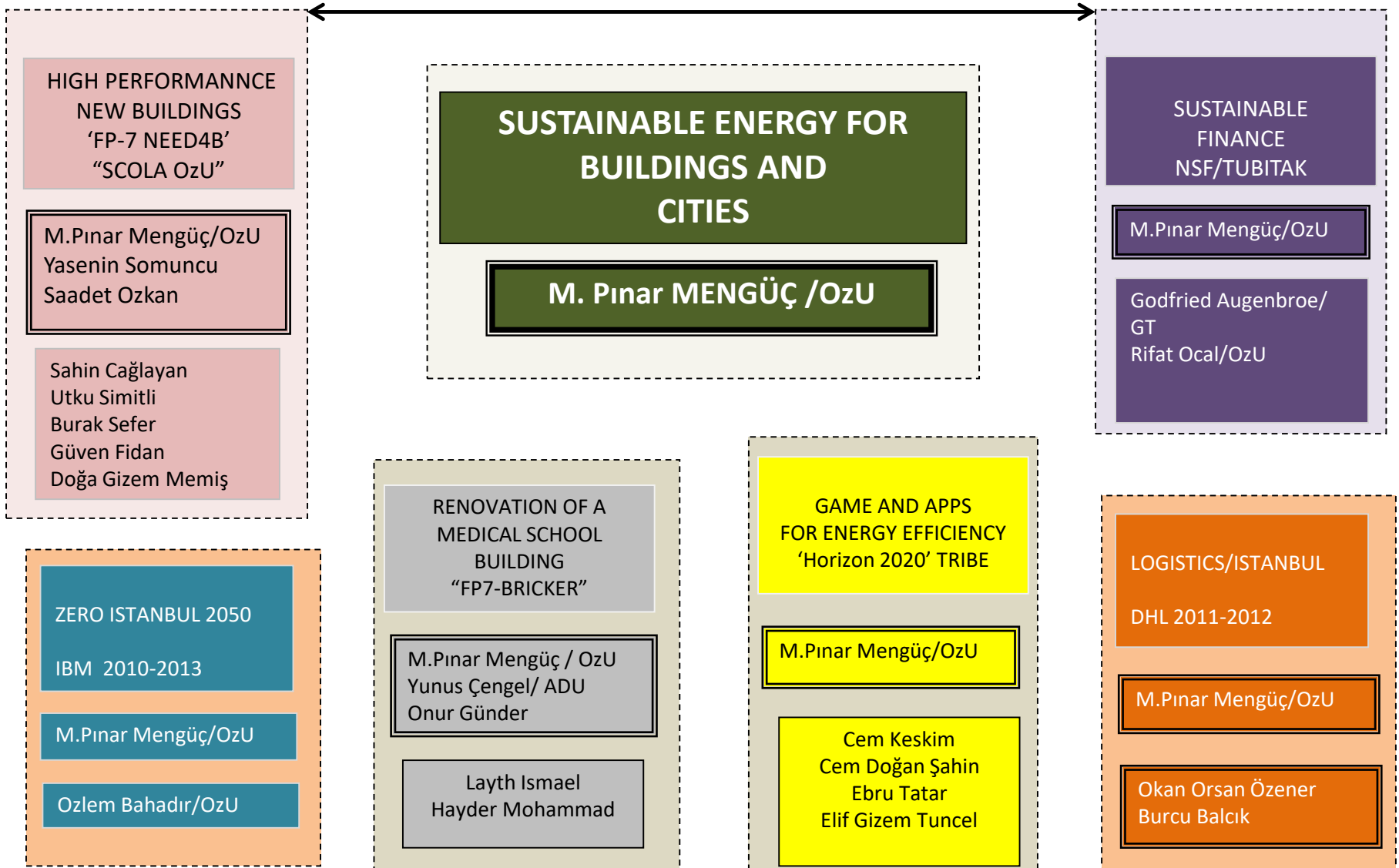


Doç. Özgür Göçer, Mimari

# NEAR-FIELD RADIATIVE TRANSFER RESEARCH AT CEEE/OZU AND IN TURKEY



# SUSTAINABLE ENERGY IN BUILDINGS RESEARCH AT CEEE/OzU AND IN TURKEY





# Disiplinlerarası Araştırmalar Haritası



## >> binalarda enerji verimliliği

#enerji\_verimliliği  
#bütünleşik\_tasarım  
#gerçek\_zamanlı\_takip  
#düşük\_enerji\_tüketimi  
#çevresel\_konfor  
#bütüncül\_ışbirliği, #hastane

## >> insan - mekan etkileşimi

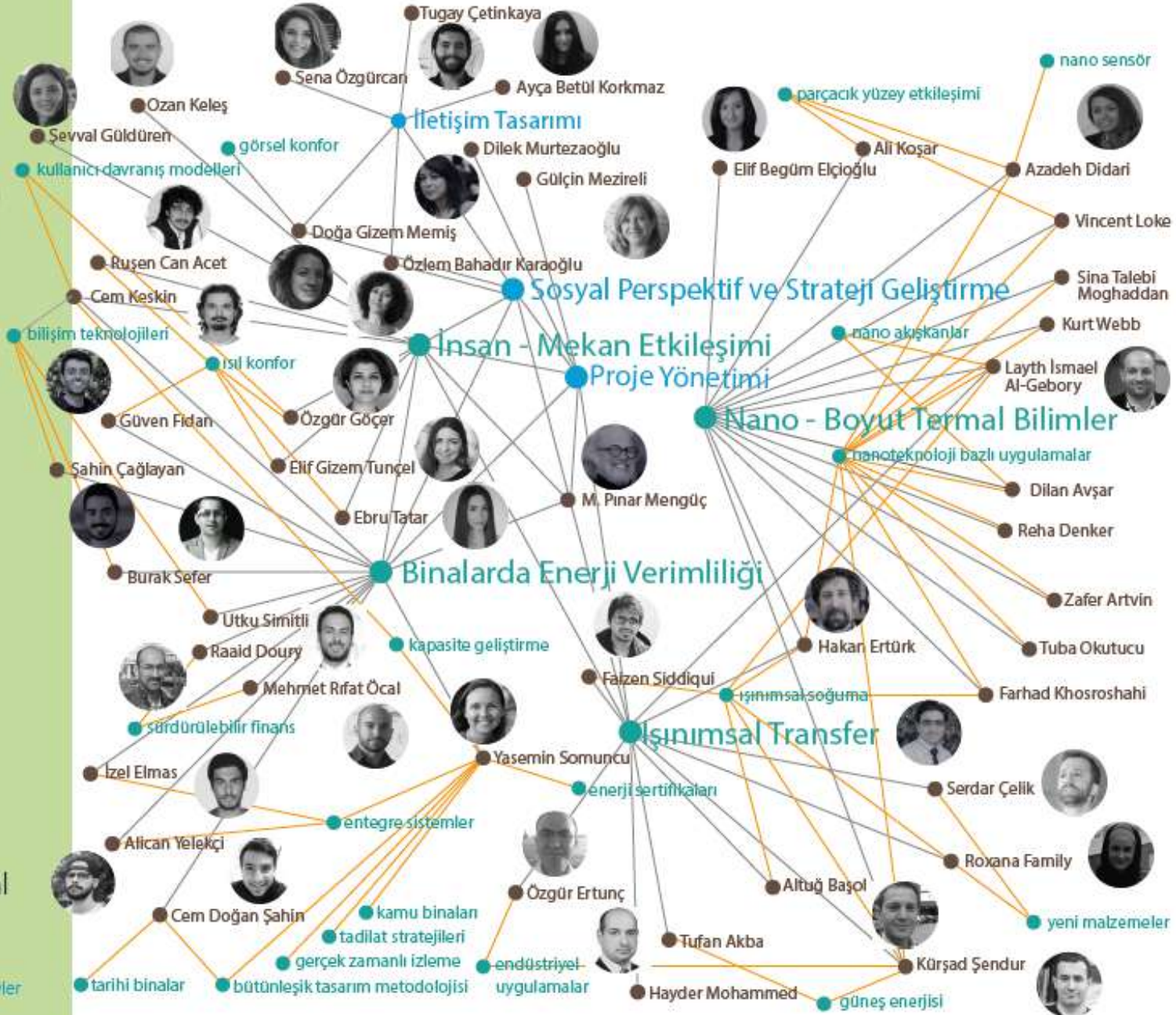
#bina\_enerji\_simülasyonu  
#davranış\_değişimi  
#görsel\_konfor, #termal\_konfor  
#VR #complexity  
#sistem\_tasarım\_düşüncesi  
#ciddiyyon #data\_science  
#düşük\_bina\_ışletme\_maliyeti

## >> ışımsal transfer

#fınnlar, #alev, #güneş\_enerjisi  
#spektrum, #enerji\_verimliliği  
#malzemeler, #cam

## >> nano - boyut termal bilimler

#nanosüspansiyonlar, #sensörler  
#enerji\_harmanlama, #nano-boyut  
#yeni\_malzemeler, #fonksiyonel\_yüzeyler

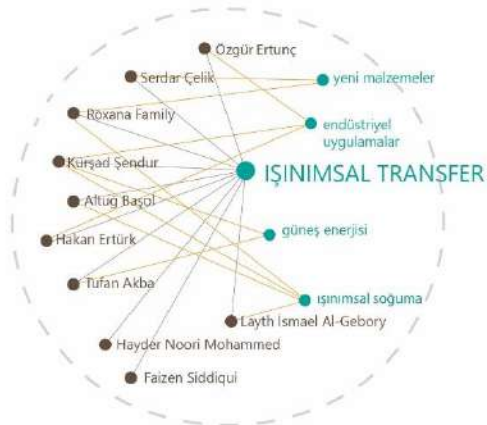




# İNSAN - BİNA ETKİLEŞİMİ



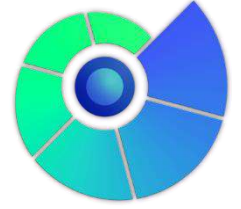
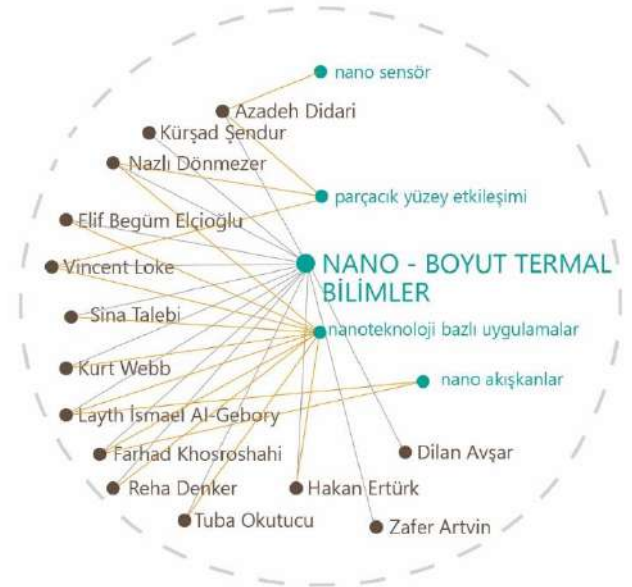
# İŞİNIMSAL / ISI TRANSFERİ



# BİNALARDA ENERJİ VERİMLİLİĞİ



# NANO - BOYUT TERMAL BİLİMLER

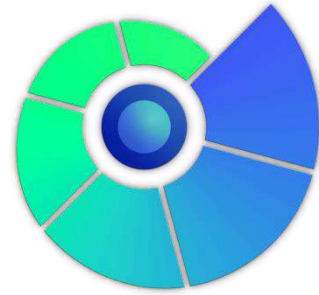


# FUTURE OF CEEE

**#RADIATIVE TRANSFER**  
**#EM-WAVE SCATTERING**  
**#NANO-SCALE ENERGY HARVESTING**

**#SUSTAINABLE BUILDINGS**  
**#ENERGY EFFICIENCY**  
**#HUMAN-BUILDING INTERACTIONS**  
**#OPTICS IN BUILDINGS**  
**#COMFORT**  
**#SERIOUS GAME**

**#DIGITIZED BEHAVIOR**  
**#COLLABORATIVE MULTIDISCIPLINARY STUDIES**  
**#COMPLEX SYSTEMS AND CONNECTIVITY**



*[www.ozyegin.edu.tr/energy](http://www.ozyegin.edu.tr/energy)*

*[pinar.menguc@ozyegin.edu.tr](mailto:pinar.menguc@ozyegin.edu.tr)*

***[mpmenguc.com](http://mpmenguc.com)***