Three case-studies and three different models to overcome energy efficiency barriers and unlock energy efficiency potential.

SAPIENZA
UNIVERSITÀ DI ROMA

7th AIEE Energy Symposum on Energy Security 2022

16th December 2022 - Plenary Session:

"*Energy efficiency and the future strategies of the energy industry*"

Federico Santi

Professor of Energy System Analysis and Modelling

Energy efficiency has Multiple Benefits and it is crucial for Energy Security

Technical energy efficiency and structural changes of the economy are a key factor to reduce fossil fuels imports

Energy Efficiency's **multiple benefits**:

- Energy Security (long-term and short-term, regional scale and national scale)
- Decarbonization
- Pollution prevention and health
- Energy access
- Economy (resources optimization, cost reduction, public budget, etc.)
- Society (job creation, productivity, modernization, digitization, etc.)

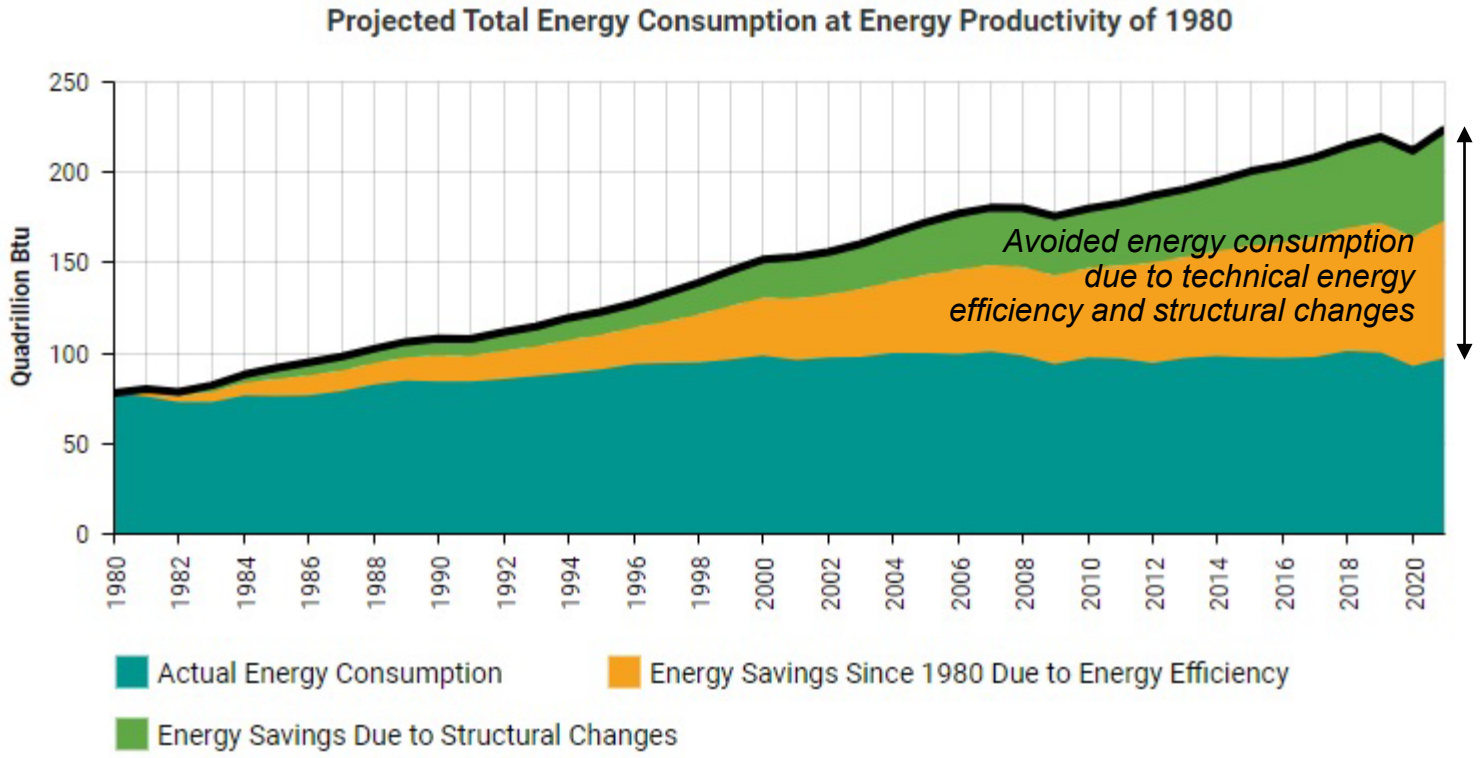
Energy Efficiency is the «first fuel»

US energy consumption would be 60% higher without Energy Efficiency investments

ACEEE American Council for an Energy-Efficient Economy

The U.S. would have produced **78%** higher carbon emissions, or an additional 3,810 Mt of CO_2 in 2021, without energy efficiency investments.

Had U.S. energy productivity remained at the level observed in 1980, U.S. energy consumption would have been **more than double** its current value, to achieve the same level of our current economic growth.



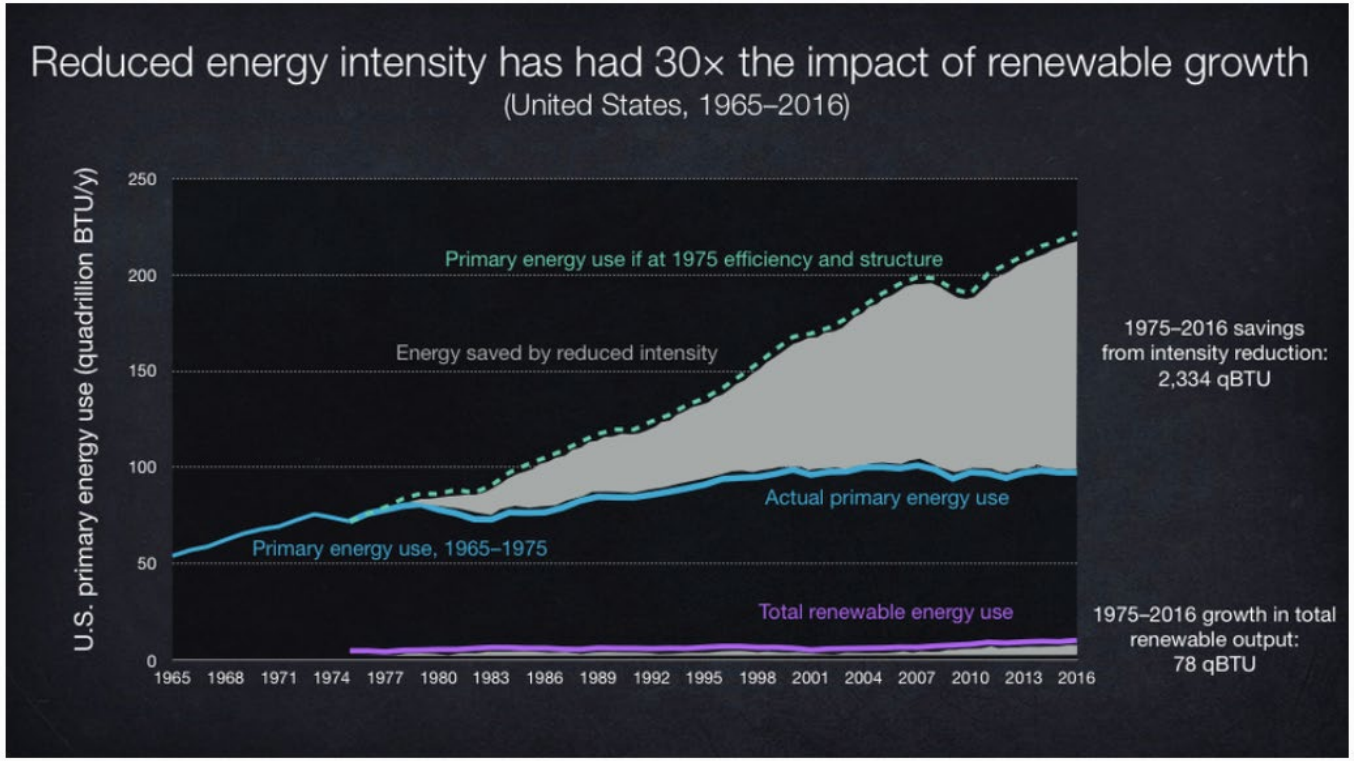
Source: Energy Efficiency Impact Report 2023 Edition (preview)

Energy Efficiency is the «first fuel»

Avoided energy use from EE had an impact 30 times greater of the growth of renewables in US

RMI Rocky Mountain Institute

1975-2016 savings from intensity reduction (*2334 qBTU*) have an impact more than **30 times greater than the growth of renewables** in the same period (*78 qBTU*)



Rocky Mountain Institute analysis from U.S. Energy Information Administration annual data.

ROCKY MOUNTAIN INSTITUTE

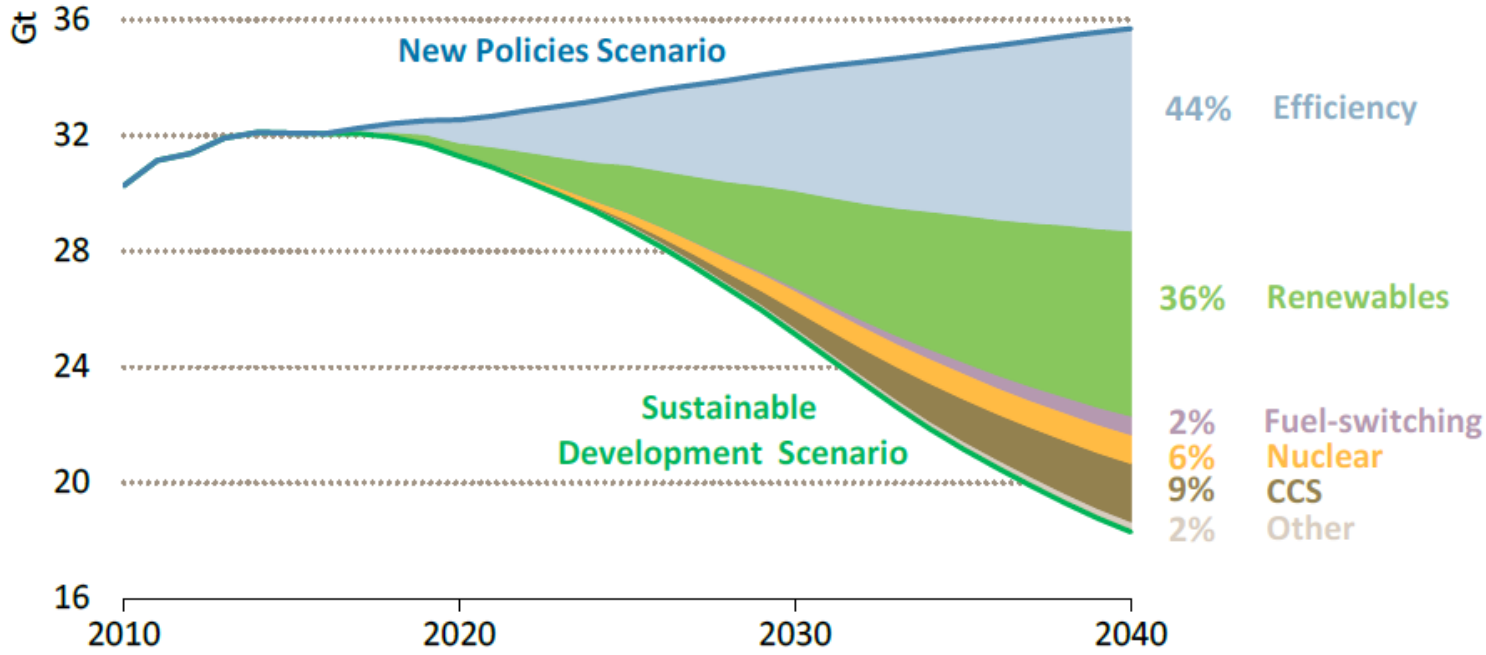
Energy efficiency is the main lever to decarbonize the energy system

In a «2° C» scenario, >40% of the total CO2-eq emissions savings must come from Energy Efficiency

Energy Efficiency's contribution
to limiting climate change
will be strongest as part of a package
of measures, including increasing
the supply of renewable energy.

IEA WEO 2017 (*updated, i.e. NZE 2050…*)
has shown that when combined with other
measures, efficiency will realise
over 40% of the carbon emissions reductions required to meet global climate change mitigation goals,
the largest single contribution.

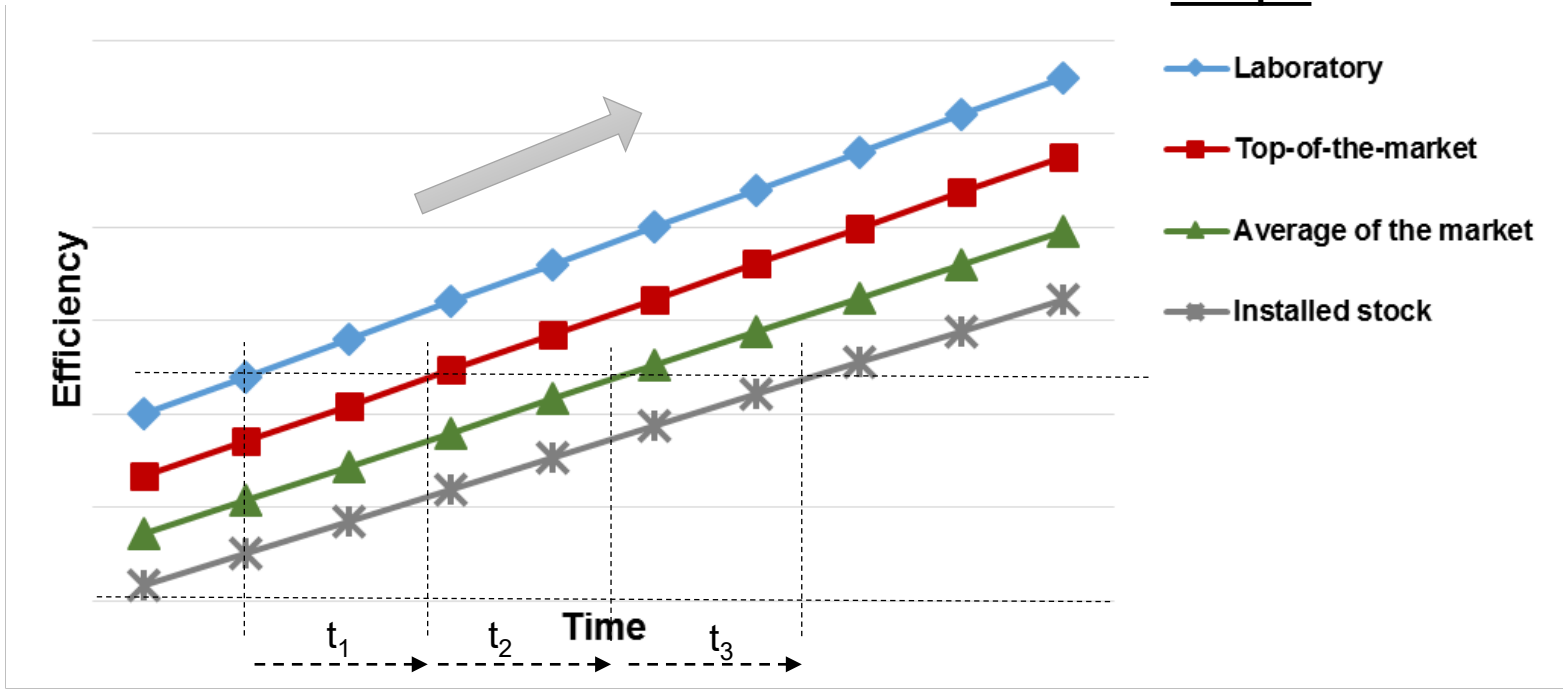
Global carbon dioxide (CO2) emissions reductions in the IEA WEO 2017
New Policies and Sustainable Development Scenarios

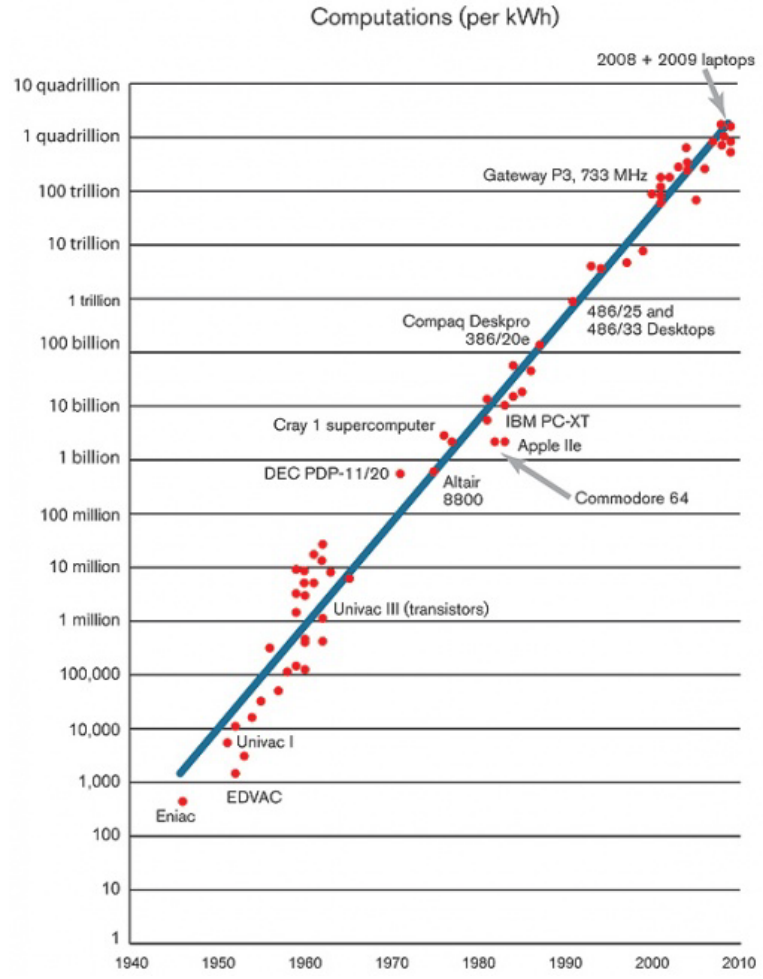


Energy efficiency has to contribute -120 EJ in 2040 to limit climate change

Energy efficiency increases “naturally”

But policies/actions are needed to accelerate the increase in energy efficiency





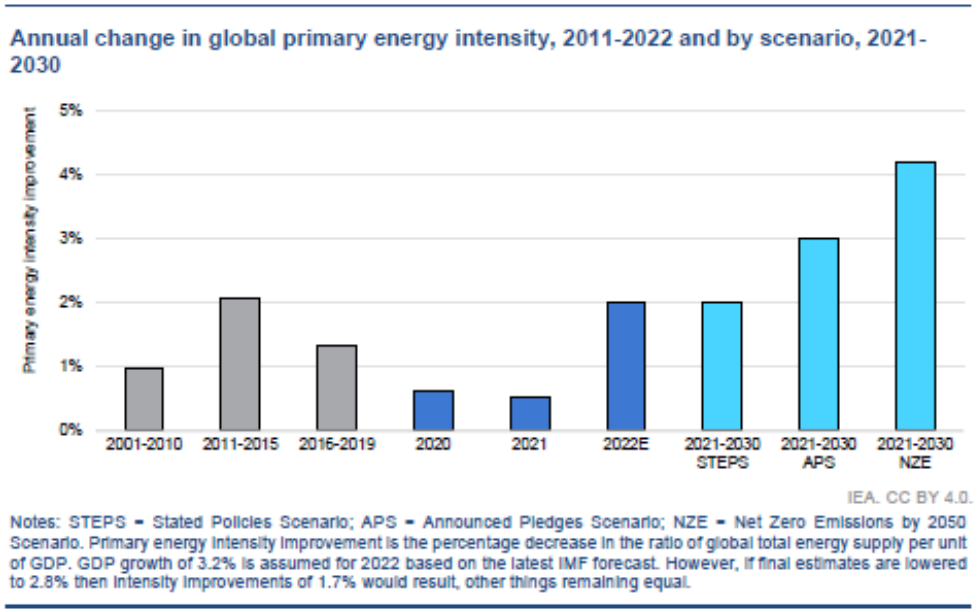
The time to pass from the laboratory to the “top-if-the-market” technology (t_1), or to the market average (t_1+t_2), or to the installed stock (t_1+t_2+t_3) can be reduced through appropriate policies/actions (*incentives, mandatory standards, tax credit, labeling, etc.*)

Energy intensity is not on track to reach the decarbonization goals

Yes: policies/actions are needed to accelerate the increase in energy efficiency…

Energy intensity annual improvement is still far off track from achieving the **4% per annum** needed, on average, from 2020 to 2030 to correspond with the pathway outlined in the Net Zero Scenario.

Italy is the 3rd G20 Country in energy intensity ranking, there is space for significant improvement, mainly due to the improvements in energy technologies.



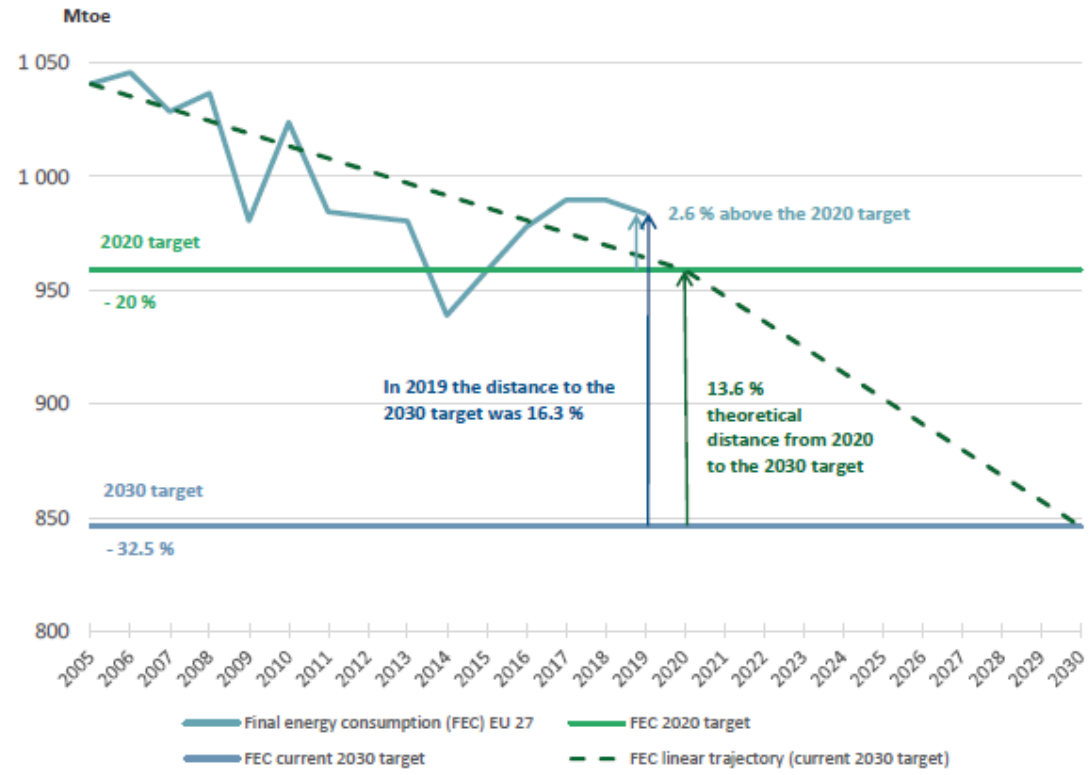
A new challenging EU target for Energy Efficiency to 2030: REPowerEU

«Fit-for-55» package aimed to reduce EU final energy consumption by 36% by 2030 compared with 2007

The European Union revised its Energy Efficiency Directive in July 2021 as part of the “Fit-for-55” Package, which aims **to reduce GHG emissions by 55% by 2030**.

The European Commission is aiming to reduce final energy consumption by 36% by 2030 compared with 2007. Member states now must achieve new savings of 1.5% of final energy consumption a year between 2024 and 2030, twice the current rate of 0.8%.

The **REPowerEU** strategy is aimed at making Europe independent of Russian fossil fuels before 2030, in light of Russia’s invasion of Ukraine. This has included increasing to **13%** the **binding EU energy savings target for 2030**, up from 9% in the Energy Efficiency Directive, doubling the deployment rate of **individual heat pumps to reach 10 million cumulative units over 2023-2027**, and accelerating electrification.



Source: ECA, based on DG ENER data, 2020.

Some barriers hinder the increase of energy efficiency

Energy efficiency is not the “core-business” of energy consumers, this is the main obstacle

Lack of **Knowledge, Information, Education/Training**
(citizens, operators, public/private managers, contractors, etc.)

Lack of **Financial Resources**
- no-core investments
- opportunity cost of capital
- limited access to outside finance
- no guaranteed performance/payback

Impact over **Operations**
- business interruption
- retrofitting/life cycle integration of EE
- procurement management, business organization

“Hedonic” **Behavior**
(more about waste of energy than energy inefficiency)

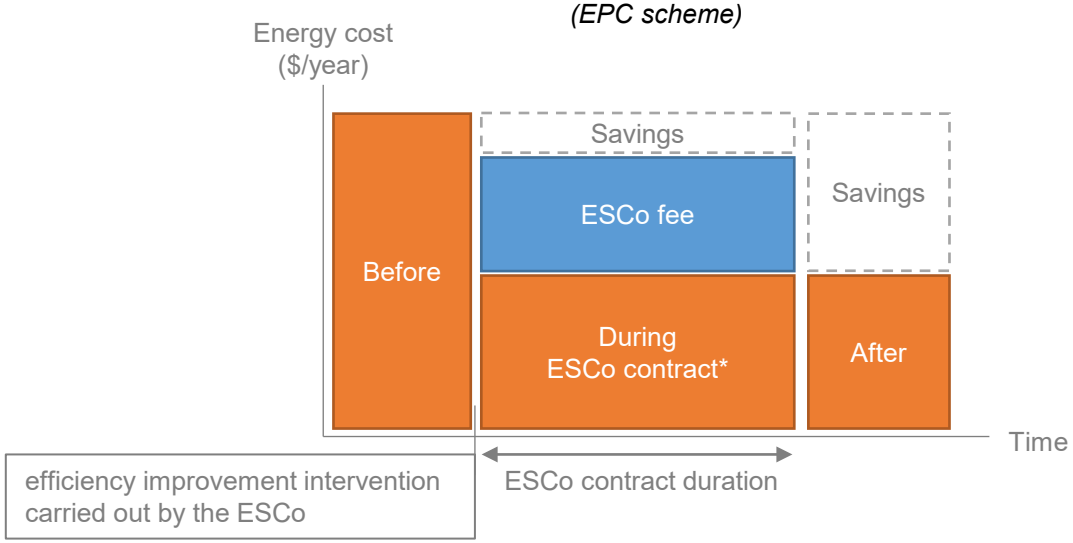
An (apparently) simple model to overcome some barriers to energy efficiency

Outsourcing to Energy Service Companies (ESCO): a Way to Externalize Energy Efficiency Activities and Risks

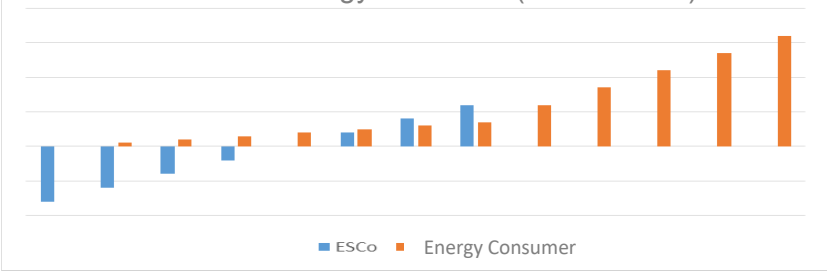
The ESCO provides the energy efficiency intervention plus a full-service O&M at its own cost and risk, guaranteeing any perfromance during all the service period (5-8 years):

- **Zero investments**/equity for the energy consumer
- **ESCO Fee < Guaranteed Energy Savings**
- Shared Benefits of Energy Savings
  + Modernization/Digitization/Renewal/Retrofitting «for free»
- No uncertainties about O&M costs and performances, neither about pay-back time (**guaranteed performances**)
- Technical Activities and Risk **Externalization** (audit, design, tenders, contractors management, etc.)
- **New services** (es. Demand Response, flexibility, DG, etc.) linked to EE enabled by the presence of an ESCo/aggregator

ESCo Conceptual Model
(EPC scheme)



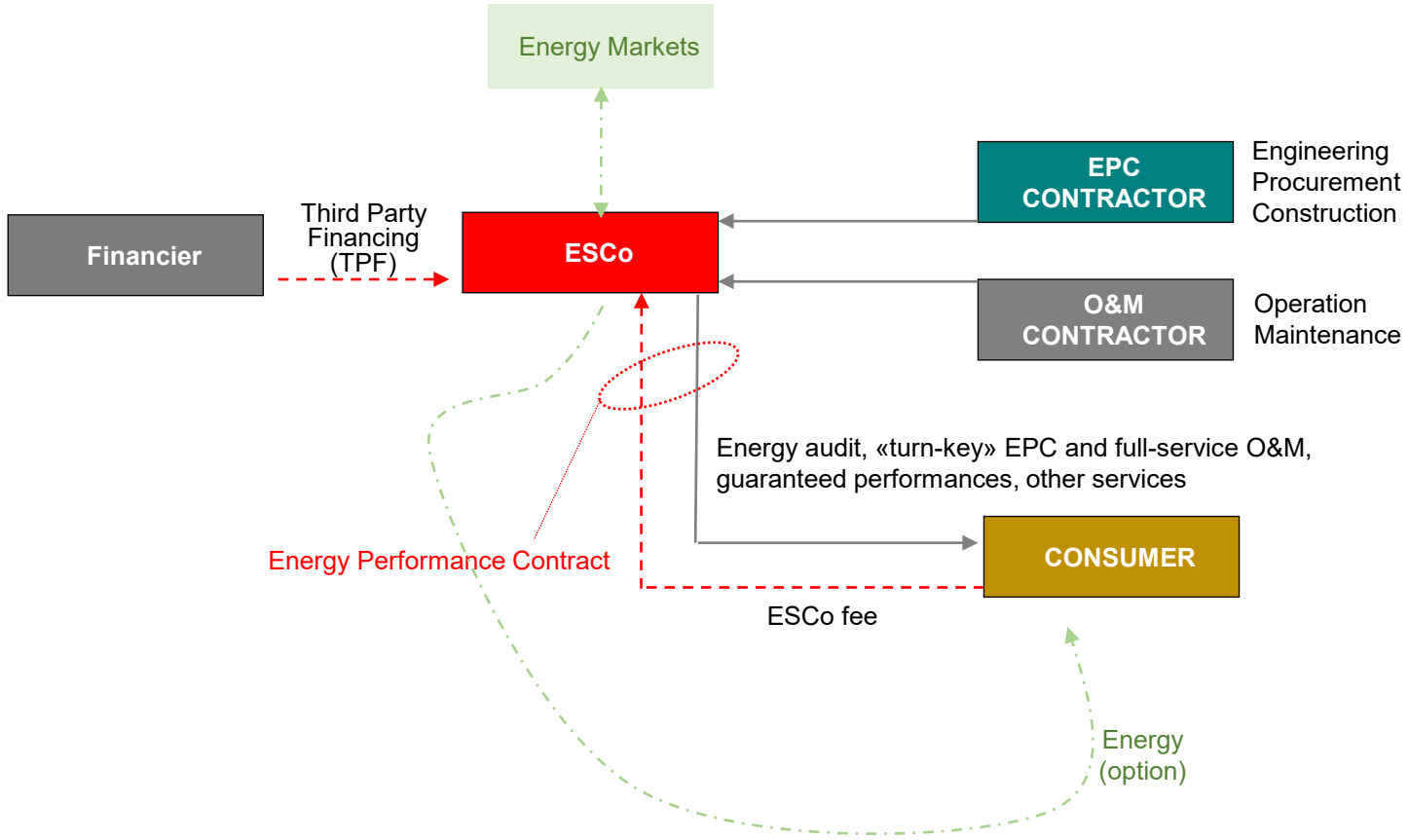
Cumulated cash flow for the ESCo
and for the energy consumer (Esco's client)



Typical scheme of an energy efficiency project in ESCo model

Energy Performance Contract is the most important aspect of an ESCo project

- Energy Efficiency **is** ESCo's core business
- EE Project can be financed by third parties (**TPF**) through the ESCo
- **EPC/O&M services** can be purchased by the ESCo and supplied to the consumer
- **Energy** can be provided to the consumer through the ESCo itself **or** by other energy suppliers (both options are valid)
- EPC (Energy Performance Contract) is different from EPC (Engineering Procurement Construction) ….
- Typical duration: 5 to 8 years



Some figures about ESCo revenues worldwide

Worldwide, ESCo market size exceeds 38 billion dollars (2021), largely dominated by China and US

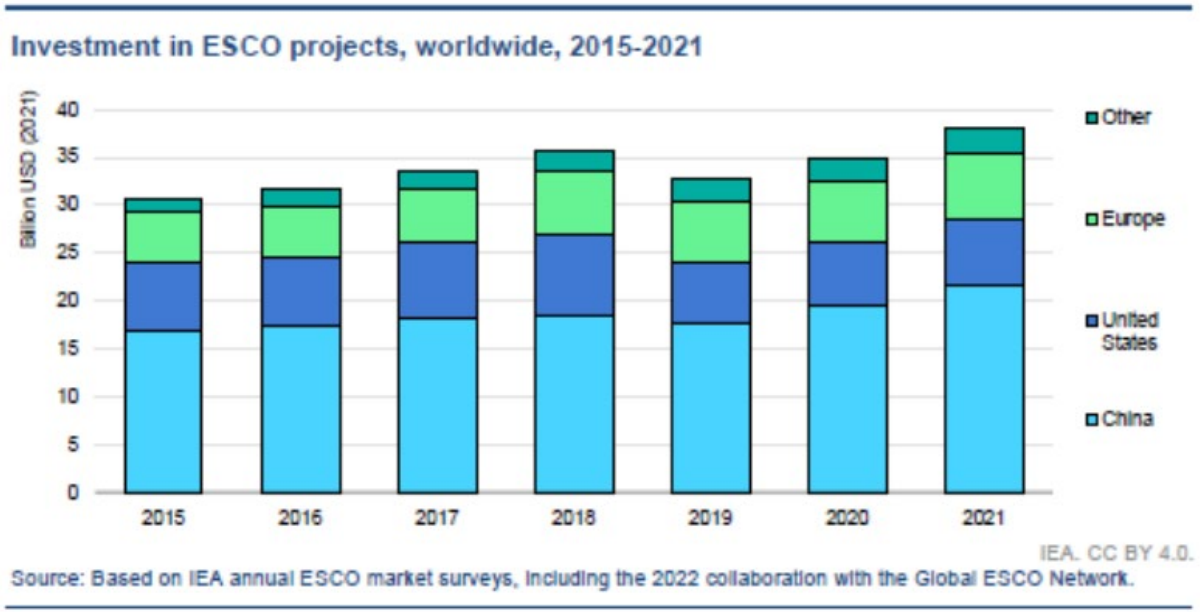
The global ESCO market increased **9%** to **USD 38 billion** in 2021.

Investment in **China, the biggest market,** grew by 9% to USD 22 billion.

ESCO interventions in **buildings dominate** in many markets in Europe, North America and Asia, and in 2021 reached over 50% of market share in China for the first time.

In November 2022, the European Investment Bank finalized a EUR 220 million fund to target energy efficiency and behind-the-meter renewable energy investments and **support ESCOs across the EU**.

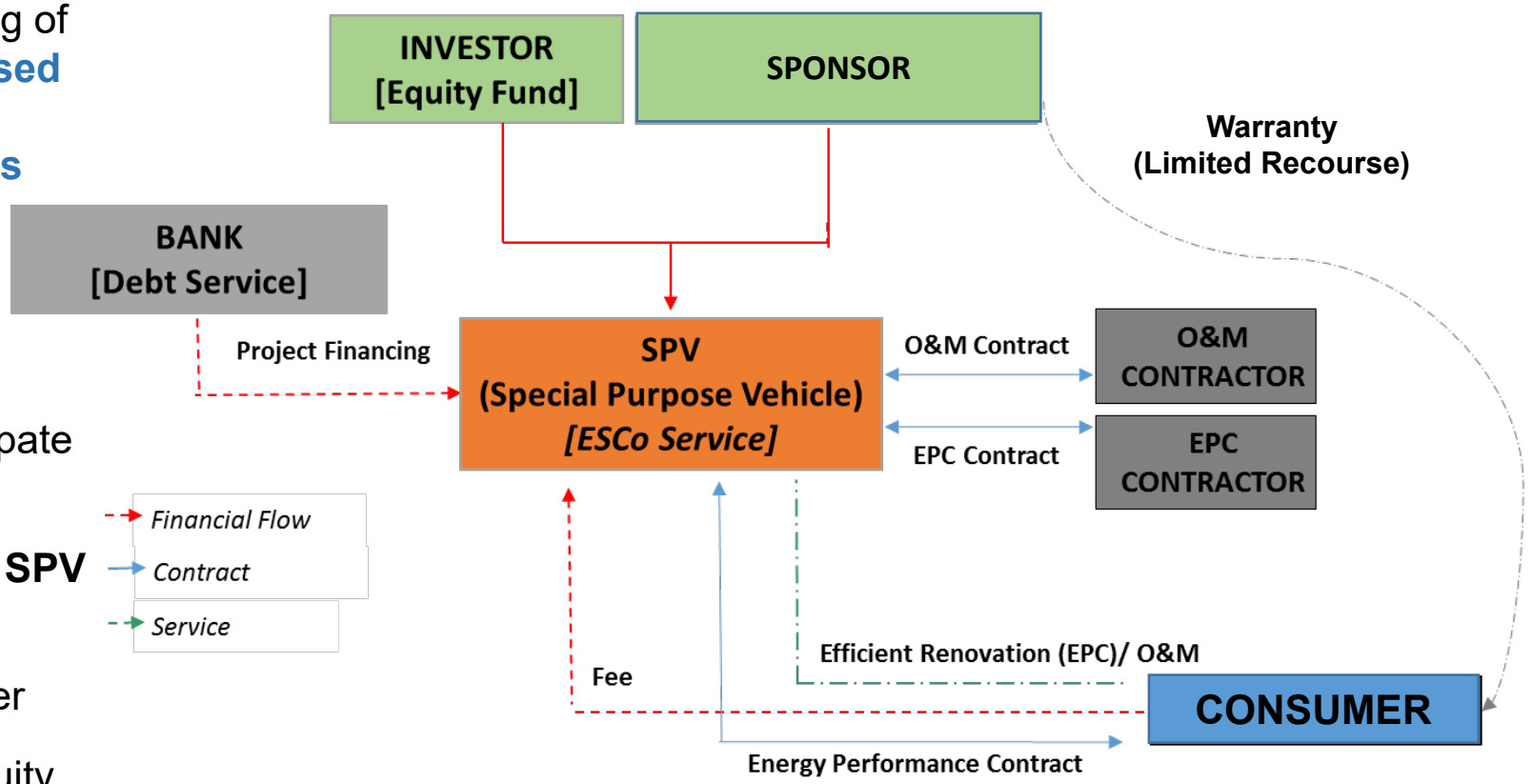
Credit risk on the client's side, a lack of demand and **trust** in the ESCO industry, as well as **administrative and regulatory barriers**, remain among the most important challenges.



Banking project financing can overcome EE financial barriers

Combining "limited recourse" Project Financing bank technique and ESCo model can help to involve the banking system more in energy efficiency projects

- Project finance is the long-term financing of infrastructure and industrial projects **based upon the projected cash flows of the project rather than the balance sheets of its sponsors.**
- Combining the ESCO model and the bank project finance technique can be an effective way to increase the interest of the banking system to participate in energy efficiency projects
- The ESCO services are provided by an **SPV**
- The **Sponsor** could be an ESCo or a corporation controlled by the consumer
- An **investor** can be involved, i.e. an equity fund



An case study in the supermarket sector

Banking Project Financing combined to ESCo model has been applied in the supermarket sector in Italy

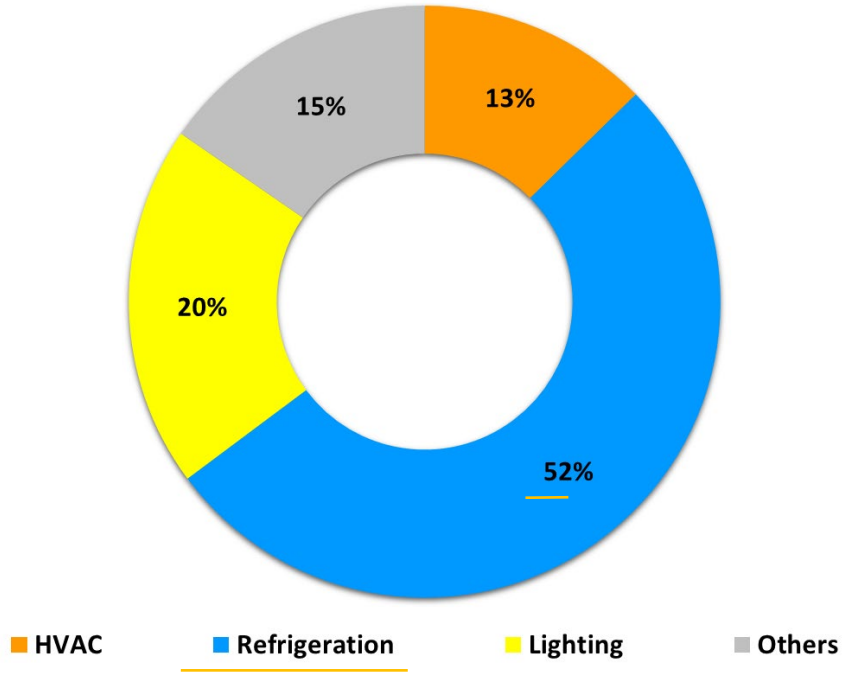
Worldwide, supermarkets consume more than 3.5%
of Total Final Energy Consumptions in Commercial Sector

Total World Electricity Consumption in Supermarkets is **equal** to the Total Italian Electricity Consumption (around **300 TWh/year**)

Supermarket sector is energy intensive due to food refrigeration and the energy consumption structure by service is **peculiar:**

3 services cover more than 80%-90% of the total energy consumption

Typical Supermarket Energy Consumption Structure by Energy Service (Italy)



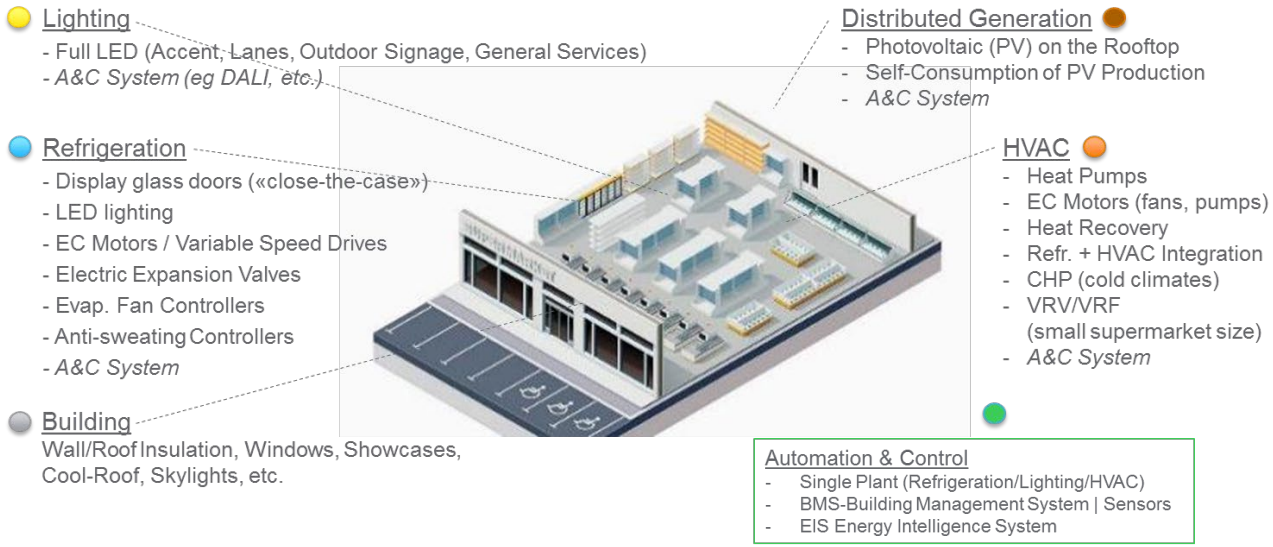
Technology Gap and Potential Energy Saving

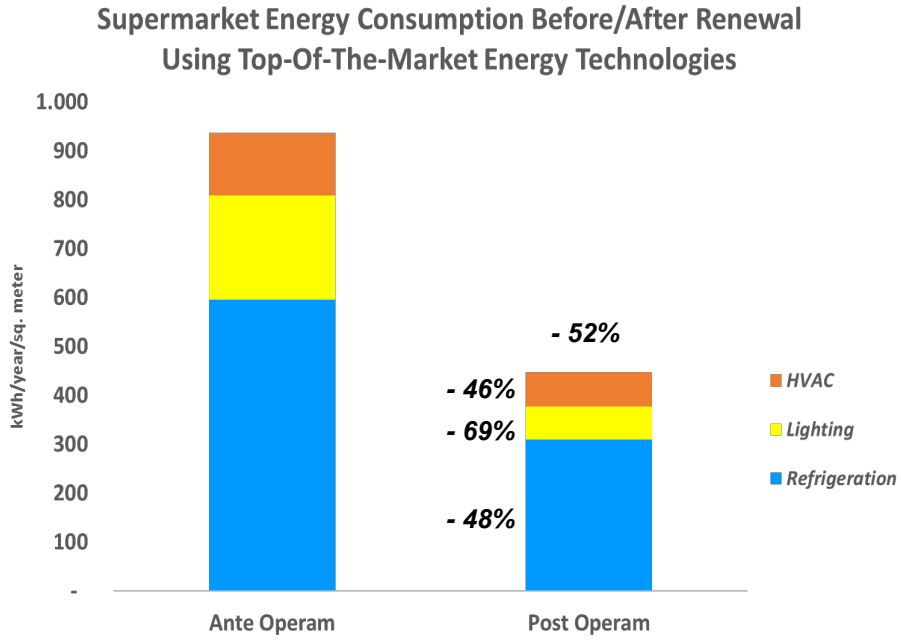
Top-Of-The-Market Energy Technology Allows > 50% Energy Saving

Supermarket average renovation time: every **10-15 years**
(sales network upgrade: 5%-10%/year)

Lighting, Refrigeration, HVAC, A&C: significant **gap** between *top-of-the-market* technologies and installed ones

Huge energy saving potential: about **50%**, convenient and achievable





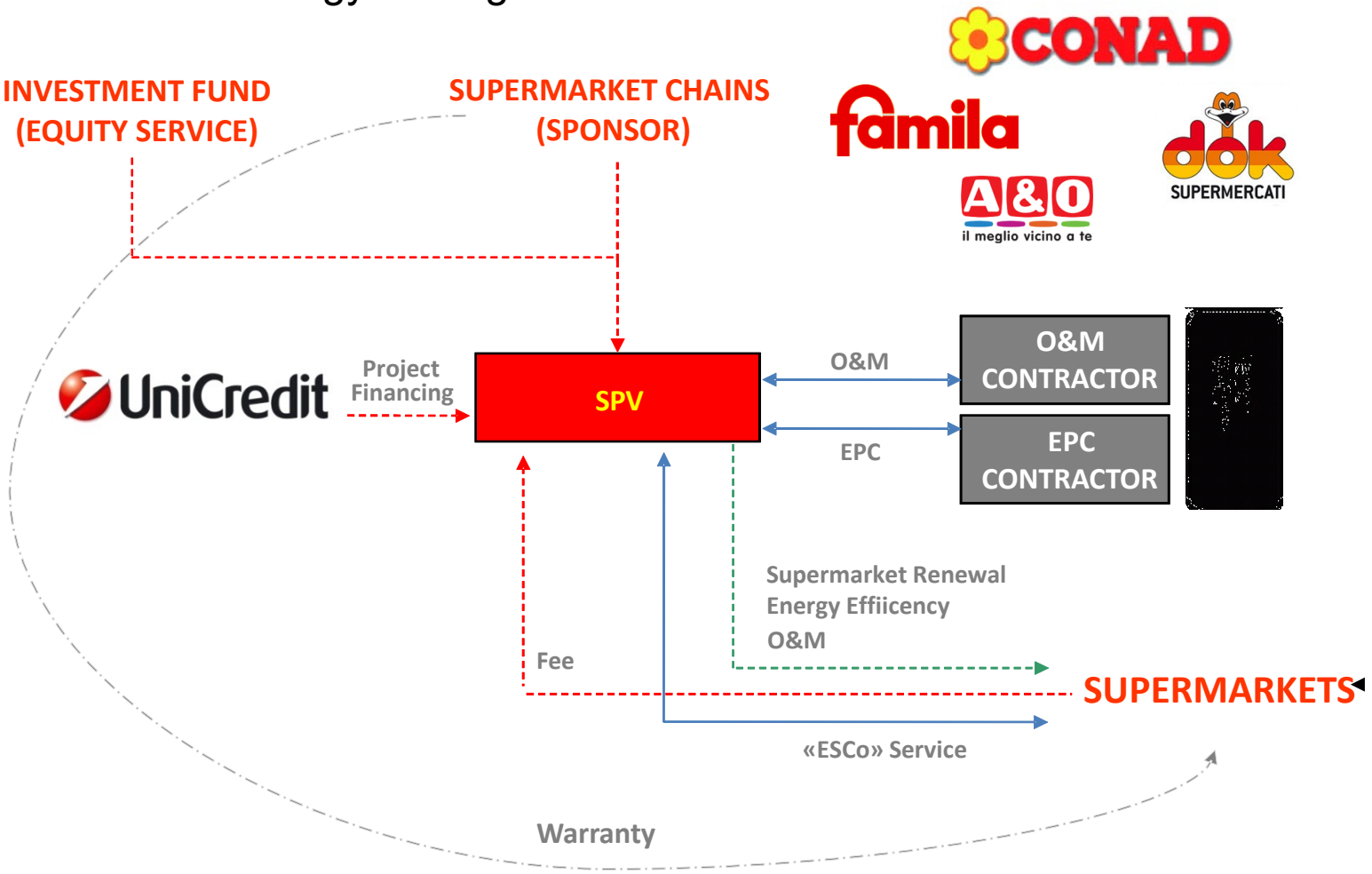
Supermarket based in Rome (Italy)
Fully renewed in 2014 (> 5 years monitoring)

Savings: 60-120 €/y/m^2
1% of sales, but 20% to 100% of EBIT
Energy saving can double supermarkets EBIT
(*Energy Star: in the US, 1$ saved = 59$ increase in sales*)

Project Finance applied to EE projects in 35 Italian supermakets

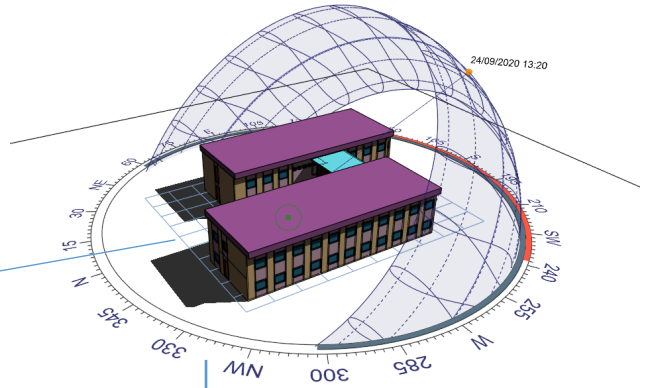
Top-Of-The-Market Energy Technology Allows > 50% Energy Saving

- **35 supermarkets** (various brands)
- **3 SPVs** (3 different investors)
- **61 M€** total investment (49 M€ debt)
- Debt/Equity: **80%/20%**,
  DSCR < 1.4, WACC < 3%
- PF contract duration: **10 years**
- (Measured) Energy Savings: **-50%**
- End-of-life supermarkets, to be renovated (no stranded costs)
- Supermarket are highly satisfied: they are «smart by design» and measures sale increasing due to the «green» renewal



A similar model: EE of a large Research Center facility in Rome (1)

An example of ESCo model combined to Project Financing in **Public Private Partnership (PPP)**



nZEB

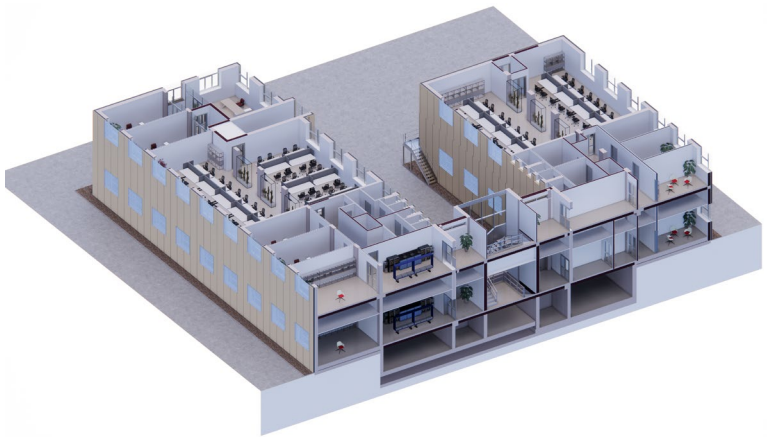
- Renovation of n. 7 buildings to nZEB (20.000 sqm)
- 7 MW solar farms
- LED street lighting

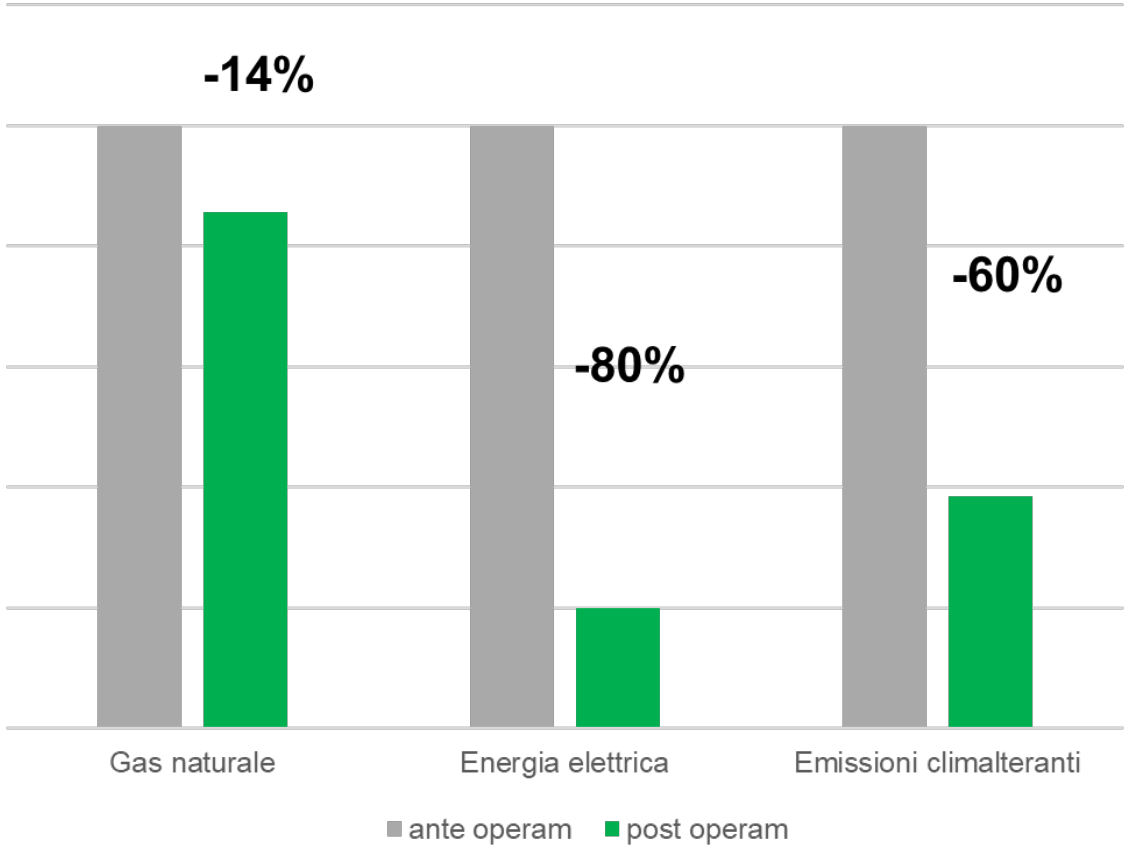
Solar farm connected to the internal MV grid

Energy efficiency of a large Research Center facility in Rome (2)

An example of ESCo model combined to Project Financing in **Public Private Partnership (PPP)**

- About 30 M€ of total investment (PPP)
- Zero equity from public partner
- 15 years PPP Energy Performance Contract
- Buildings renovation to nZEB
- HVAC Electrification (heat pumps + PV + digital)
- Decarbonization of the WHOLE research center: -60%





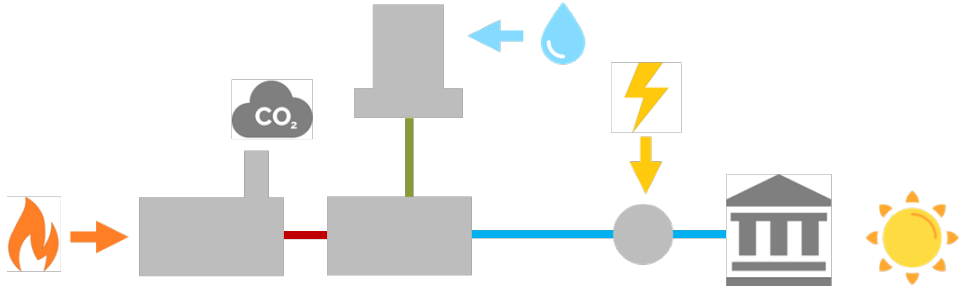
Energy efficiency of the National Gallery of Modern Art in Rome (1)

A traditional scheme of retrofitting a large historical building directly developed by an energy customer

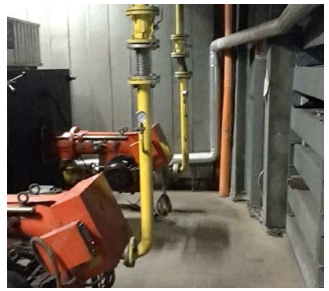
Energy efficiency of the National Gallery of Modern Art in Rome (2)

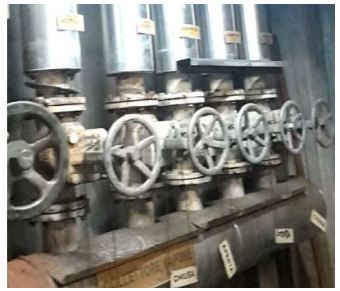
BEFORE:
Natural Gas Boilers + Lithium Bromide Absorption Chillers

Winter

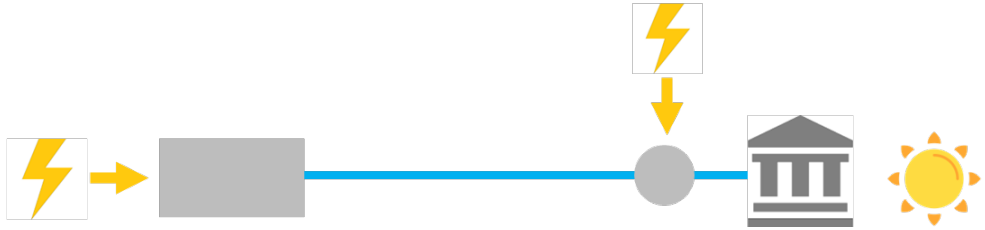


Summer





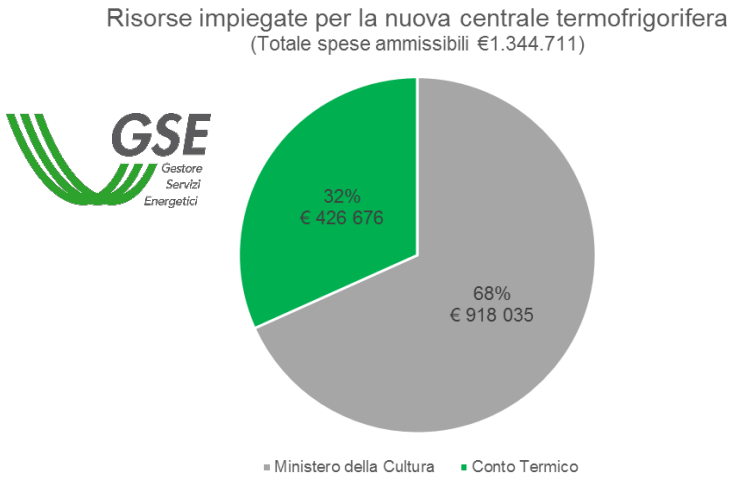
AFTER:
Electric Heat Pumps (4 x 500 kWe)



Energy efficiency of the National Gallery of Modern Art in Rome (3)

Electrification of HVAC

- **NO MORE** Natural Gas (-0.8 MScm/year)
- Tot. Electricity Comsumption **REDUCED** (-8%)
- **Decarbonization (CO_2 eq.) -81%**
- NO Water Consumption for HVAC
- Energy Cost Reduced (-1 M€/year, **-44%**)
- Total investment 1.5 M€ of which **1/3 granted** by GSE as **incentive** (Conto Termico 2.0)



	2017 Q1+Q2+Q3	2022 Q1+Q2+Q3	
	Gas naturale 639.435 Smc	Gas naturale 0 Smc	Gas naturale ELIMINATO
	Energia elettrica 2.081.721 kWh	Energia elettrica 1.917.402 kWh	- 8% Consumi di energia elettrica
CO_2	Emissioni climalteranti 1.913 tCO_2	Emissioni climalteranti 354 tCO_2	- 81% Emissioni climalteranti

	2022 Centrale a gas, Q1+Q2+Q3	2022 Nuova centrale, Q1+Q2+Q3	
	Acqua per raffrescamento 5.760.000 litri	Acqua per raffrescamento 0 litri	5.760.000 litri RISPARMIATI
€	Spesa energetica € 1.670.000	Spesa energetica € 930.000	€ 740.000 RISPARMIATI

Following some statements from IEA Energy Efficiency Rep. 2022

In the 3 cases above some general guidelines from IEA has been followed and their validity has been confirmed

- Conduct an energy savings audit to identify areas for energy efficiency improvement
- Replace old inefficient equipment and prioritize retrofitting outdated building stock
- Accelerating the replacement of old, inefficient equipment with new, compliant appliances
- Switch fuel from gas heating to electric heat pumps in buildings

Heat pumps are a key technology to increase efficiency and phase out the use of fossil fuels for space heating and other end uses. The number of installed heat pumps has grown by 10% per year over the last five years to reach **180 million in use in 2020**.

In the Net Zero Emissions by 2050 Scenario, the stock of installed heat pumps reaches **600 million by 2030**.

In Europe, heat pump sales increased by around 7% to 1.7 million units in 2020, and heat pumps now heat 6% of all buildings. This brought the estimated stock of heat pumps in Europe to nearly 15 million units.

Conclusion and key messages (1)

- Energy efficiency has **multiple benefits** and it is the **1st fuel** and the **1st lever to decarbonize** the energy system, worldwide. It increases "naturally" but policies/actions are needed to **accelerate**
- Globally, the energy intensity should decrease by **4% per annum** between 2020 and 2030 to reach the decarbonization goals
- Energy efficiency is normally **out of the *core-business*** and finds cultural, financial and operational **barriers**
- To externalize energy efficiency services and risks to an "Energy Service Company" (**ESCo**) of different nature is a way to help energy consumers **to overcome some barriers**, avoiding direct investments and debts, keeping energy efficiency projects *off-balance*, gaining guaranteed savings, modernizing facilities
- ESCo market is growing at a rate of **9%/year**, mainly in China and US. Buildings are the dominant sector in this market.
- Recent technology trends and perspectives shows that **electrification** of HVAC through electric **heat pumps** coupled with **PV** systems and **LED** lighting is the most effective strategy to decarbonize the building sector, especially at the Italian latitude

Conclusion and key messages (2)

- **Banking Project Finance can be combined to ESCo model** in order to involve the banking system more and than to overcome financial barriers and unlock the global energy efficiency potential

- **Public Private Partnership Project Finance can also be combined to ESCo model** to overcome the energy efficiency barriers typical of the public organizations and unlock their energy efficiency potential

- Energy efficiency projects directly developed by energy consumers **with the support of specialized technical advisors** can also represent an effective way of overcoming some energy efficiency barriers, when the **energy consumer is focused on sustainability** and has resources, capacity and a strong commitment as well as an easy **access to good incentives**

- Three Italian case studies are presented as examples of the three approaches above, to **show their feasibility and** benefits

- Evidence shows the importance to maintain an holistic approach to energy efficiency and to direct all efforts towards the implementation of the concept of "***Efficient by design***", **including energy efficiency in a modernization/digitization strategy**