Kema Webinar

The real challenges in transition to eco-friendly power networks

March 17th, 2022

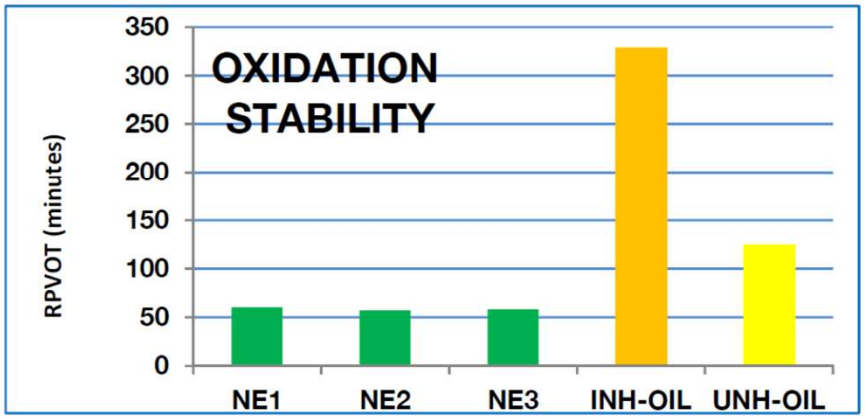
Natural Ester Filled Transformers

Basic Information

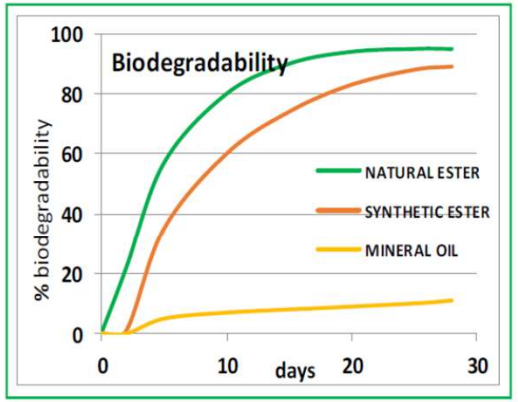
Soy

Rapeseed

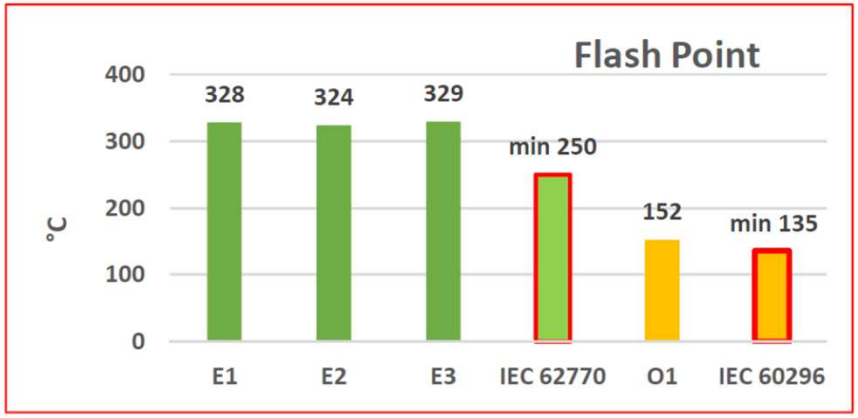
Sunflower



Poor chemical stability



Biodegradable



Self-extinguished and almost non-flammable

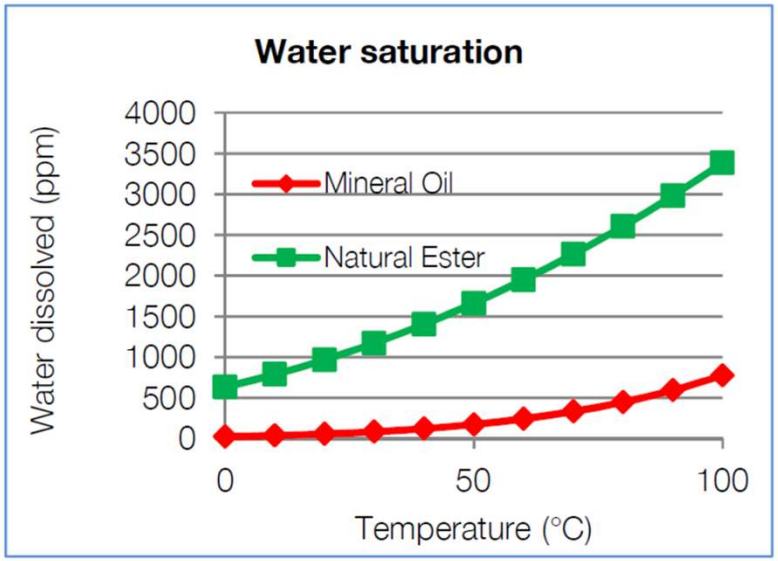
Natural Ester Filled Transformers

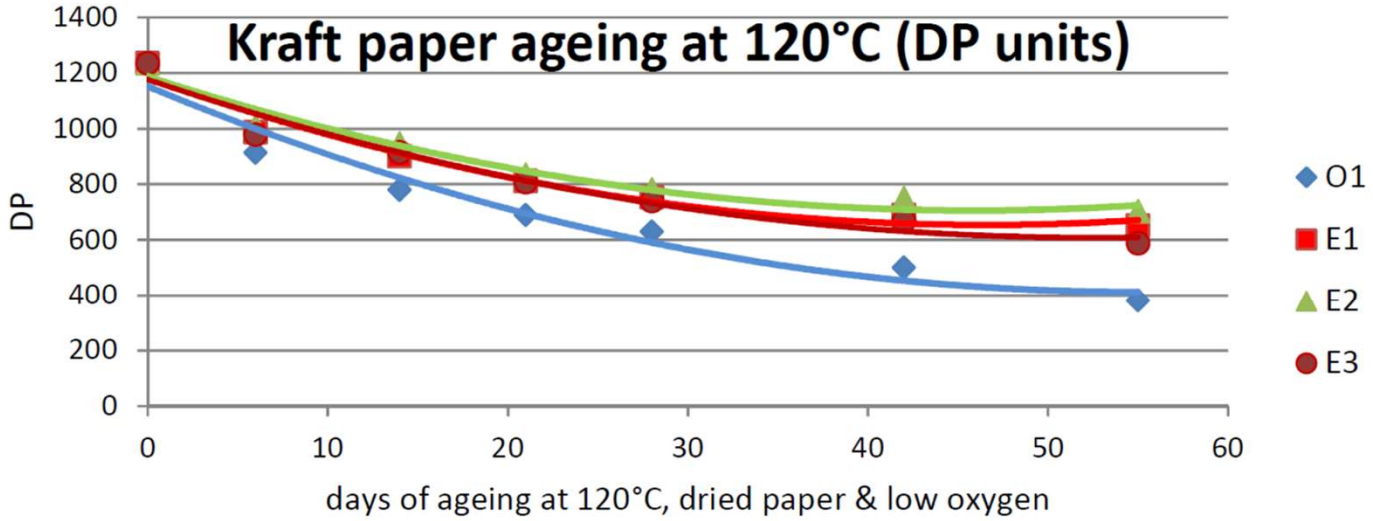
Basic Information

$$LifeExpe\tan ce\,(years) = \frac{\frac{1}{DP_1} - \frac{1}{DP_0}}{A * 24 * 365} * e^{\frac{13350}{T+273}}$$

Water and acidity

Hot spot temperature





Natural Ester Filled Transformers

Pros & Cons (technical)

	FLASH POINT (°C)	BIODEGRADABILITY (%)	VISCOSITY (mm^2/sec)	THERMAL CONDUCTIVITY (W/m°K)	POUR POINT (°C)	PD inception (kV)
MINERAL OIL	140 - 160	< 20	7-10	0,126	< -50	38
NATURAL ESTER	350	> 90	30 - 40	0,17	-20	34

Global benefits

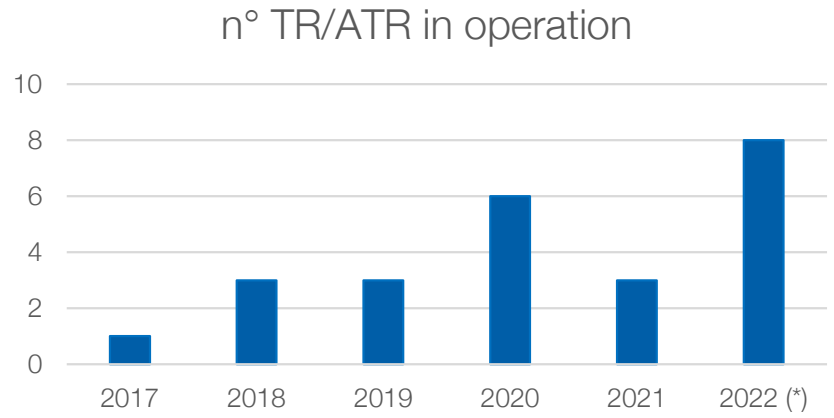
- Very low environmental impact in case of serious failure (oil spill, fire, etc.)
- In perspective, lower plant costs for fire protection systems (elimination of fire walls, etc.)
- Extension of transformer operating life (solid insulation less stressed)
- Possible reduction of insurance premiums
- Company Image (sustainability, respect for the environment, etc.)

Natural Ester Filled Transformers

TERNA Pilot Project

Project Data	
Nominal Power	250 MVA
Permanent Overlow	375 MVA
Nominal Voltage	400/135 kV
Connection Symbol	Yna0
On Load Tapping Range	± 10%
Cooling System	KDAF
Construction Year	2016-17
Oil	Cargill FR3

Today and tomorrow



To date there are 16 Natural Ester filled (Auto)Transformer in operation, without any problem.

A further 21 transformers are in production, of which 8 (*) are expected in operation during 2022.

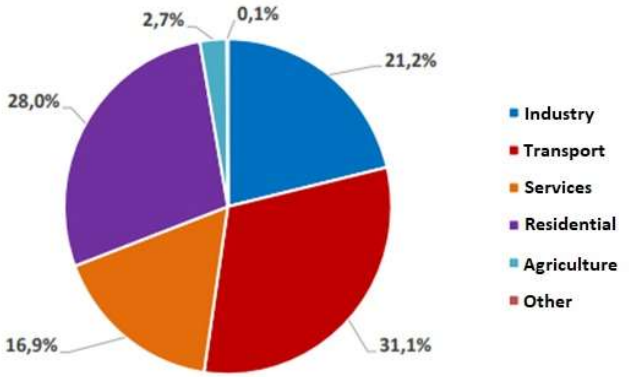
NZEB HV Electrical Substation Buildings

Legislative Context: Energy Transition

Directive EU 2018/844

The European Union is committed to elaborate a sustainable, competitive, safe and decarbonised energy system, by 2050. In order to achieve this objective, Member States and investors must adopt measures by 2050, to achieve the long-term objective of greenhouse gas emissions and **decarbonise the housing stock, responsible for around 36 % of all CO2 emissions in the Union**

Final energy uses in Italy



About 28% of energy consumption is used in the residential sector and 16.9% in the services sector (tertiary, public administrations)

NZEB HV Electrical Substation Buildings

Objectives and Achievements

The aim is to define, from a design, architectural and functional point of view**, Substation Buildings at «nearly zero energy».** The goal was achieved through the study of appropriate interventions to be implemented on the building envelope together with the adoption of "smart" technological systems, in addition to the use of supplementary power solutions from solar renewable sources.
The design solutions have been defined for both existing and new buildings.

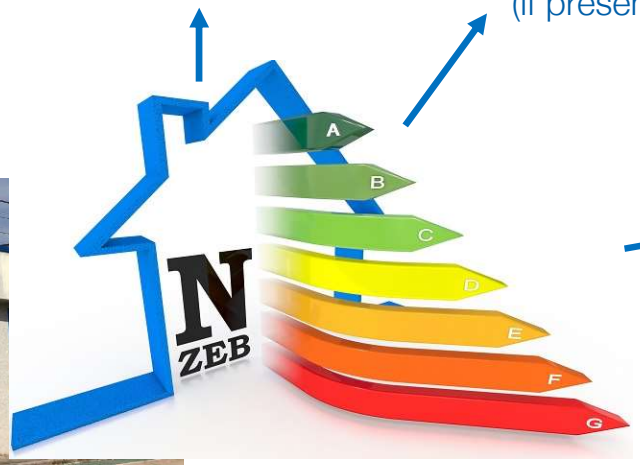
Air-source heat pump for **air-conditioning and ventilation system** and decommissioning of thermoconvectors heating systems

Target Energy class: **A2 or upper, depending on the climatic zone**

Heat pump water heater with storage (if present)

Envelope solutions: mineral fiber insulation on the perimeter walls and on the lower horizontal surfaces, without changing the structural solutions adopted in the current Terna Standard Project

Photovoltaic system, connected «in island» and to **storage batteries** to **maximize the use of electric energy**



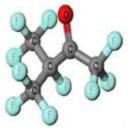
LED Lighting Systems

Windows: **thermal break windows with low-emissive glass**

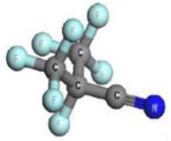
A **A3 or A2 class**, depending on the climatic zone, together with the condition of the **NZEB** building, was reached on the basis of a classification of the actual substation buildings on average equal to B-C class.
The simulations on the HV Electrical Substation Buildings have led to an efficiency of all the subservices of the building.
Considering the example of an Integrated Building (150kV ES), the benefits in terms of saved energy consist in lower emissions of C02 (about **3,4 t per year saved**).

SF_6 Replacement

Available technologies



C5-Flourketone 5110



Flournitrile 4710

Clean-Air

Vacuum

Hitachi Energy

Point of discussion

- ✓ Breaking Equipment available up to 145 kV
- ✓ Breaking behaviour with capacitive and inductive loads
- ✓ Overvoltages on vacuum breaking
- ✓ Further study on decomposition by-products
- ✓ Possibly differents standards to be managed

Pilot Project

Next year the first 2 bays 145 kV (possibly with different technologies), completely SF6 Free will be installed

The first «green» autotranformer in Italy

Thank you for your attention

Terna Rete Italia
TERNA GROUP