CLAIMS

1. Energy storage plant, comprising:

a casing ~~(5) for the storage of~~storing a working fluid other than atmospheric air, in a gaseous phase and in equilibrium of pressure with the atmosphere, wherein said casing is a pressure-balloon or has the structure of a gasometer;

a tank ~~(9) for the storage of~~storing said working fluid in liquid or supercritical phase with a temperature close to the critical temperature; wherein said critical temperature is close to the ambient temperature~~, preferably between 0°C and 100°C~~;

wherein the plant is configured to perform a closed cyclic thermodynamic transformation (TTC), first in one direction in a charge configuration and then in an opposite direction in a discharge configuration, between said casing ~~(5)~~ and said tank ~~(9)~~; wherein in the charge configuration the plant stores heat and pressure and in the discharge configuration generates energy.

2. Plant according to claim 1, wherein the working fluid has the following chemical-physical properties: critical temperature between 0°C and 200°C, density at 25°C between 0.5 kg/m^3 and 10 kg/m^3; and/or is ~~preferably~~ chosen in the group including: CO_2, SF_6, N_2O.

3. Plant according to claim 1 or 2, comprising:

- a compressor ~~(3)~~ and a motor mechanically connected to each other;
- a turbine ~~(2)~~ and a generator mechanically connected to each other;
- said casing ~~(5)~~ externally in contact with the atmosphere and delimiting inside a volume configured to contain the working fluid at atmospheric pressure or substantially atmospheric pressure, wherein said volume is selectively in fluid communication with an inlet ~~(3a)~~ of the compressor ~~(3)~~ or with an outlet ~~(2b)~~ of the turbine ~~(2), wherein optionally the casing (5) is a pressure-balloon~~;
- a primary heat exchanger ~~(7)~~ selectively in fluid communication with an outlet ~~(3b)~~ of the compressor ~~(3)~~ or with an inlet ~~(2a)~~ of the turbine ~~(2)~~;

- said tank ~~(9)~~ in fluid communication with the primary heat exchanger ~~(7)~~ to accumulate the working fluid;
- a secondary heat exchanger ~~(10)~~ operationally active between the primary heat exchanger ~~(7)~~ and the tank ~~(9)~~ or in said tank ~~(9)~~;

said plant being configured to operate in the charge configuration or in the discharge configuration;

wherein, in the charge configuration, the casing ~~(5)~~ is in fluid communication with the inlet ~~(3a)~~ of the compressor ~~(3)~~ and the primary heat exchanger ~~(7)~~ is in fluid communication with the outlet ~~(3b)~~ of the compressor ~~(3)~~, the turbine ~~(2)~~ is at rest, the motor is operating and drives the compressor ~~(3)~~ to compress the working fluid coming from the casing ~~(5)~~, the primary heat exchanger ~~(7)~~ works as a cooler to remove heat from the compressed working fluid, cool it and store thermal energy, the secondary heat exchanger ~~(10)~~ works as a cooler to remove additional heat from the compressed working fluid and store additional thermal energy, the tank ~~(9)~~ receives and stores the compressed and cooled working fluid, wherein the working fluid stored in the tank ~~(9)~~ has a temperature close to its own critical temperature;

wherein, in the discharge configuration, the casing ~~(5)~~ is in fluid communication with the outlet ~~(2b)~~ of the turbine ~~(2)~~ and the primary heat exchanger ~~(7)~~ is in fluid communication with the inlet ~~(2a)~~ of the turbine ~~(2)~~, the compressor ~~(3)~~ is at rest, the secondary heat exchanger ~~(10)~~ works as a heater to release heat to the working fluid coming from the tank ~~(9)~~, the primary heat exchanger ~~(7)~~ works as a heater to release further heat to the working fluid and heat it, the turbine ~~(2)~~ is rotated by the heated working fluid and drives the generator generating energy, the working fluid returns in the casing ~~(5)~~ to atmospheric or substantially atmospheric pressure.

4. Plant according to claim 3, comprising an additional heat exchanger ~~(13)~~ operationally placed between the casing ~~(5)~~ and the compressor ~~(3)~~ and between the casing ~~(5)~~ and the turbine ~~(2)~~ to pre-heat the working fluid before compression in the compressor ~~(3)~~, in the storage configuration, or to cool the working fluid from the turbine ~~(2)~~, in the discharge configuration.

5. Plant according to one of the above claims 3 or 4, wherein the motor and the generator are separate elements; or wherein the motor and the generator are defined by a single motor-generator ~~(4)~~ and the plant comprises connection devices between said motor-generator ~~(4)~~ and the compressor ~~(3)~~ and the turbine ~~(2)~~ to connect mechanically and alternately the motor-generator ~~(4)~~ to the compressor ~~(3)~~ or to the turbine ~~(2)~~.

6. Plant according to one of the above claims 3, 4 or 5, wherein the secondary heat exchanger ~~(10)~~ and the primary heat exchanger ~~(7)~~ are configured to operate a super-critical transformation of the working fluid so that said working fluid is accumulated in the tank ~~(9)~~ in super-critical phase~~; wherein optionally the secondary heat exchanger (10) is placed between the primary heat exchanger (7) and said tank (9)~~.

7. Plant according to the previous claim, wherein the tank ~~(9)~~ comprises a separating membrane ~~(31)~~ configured to internally separate the tank ~~(9)~~ into a first chamber with variable volume ~~(32)~~ for the working fluid in super-critical phase and into a second chamber with variable volume ~~(33)~~ in fluid communication with a compensation circuit ~~(34)~~ containing a non-compressible fluid~~, optionally water~~.

8. Plant according to one of the above claims from 3 to 5, wherein the secondary heat exchanger ~~(10)~~ and the primary heat exchanger ~~(7)~~ are configured to operate a sub-critical transformation of the working fluid so that the working fluid is accumulated in the tank ~~(9)~~ in liquid phase~~; wherein optionally the secondary heat exchanger (10) is integrated in the tank (9)~~.

9. Plant according to one of the above claims 3 to 8, wherein the primary heat exchanger ~~(7)~~ is a fixed or moving bed heat regenerator or comprises a water, oil or salt primary circuit ~~(15)~~ with at least one primary storage chamber ~~(17, 18)~~.

10. Plant according to one of the above claims from 3 to 9, wherein the secondary heat exchanger ~~(10)~~ comprises a secondary air or water circuit ~~(20)~~ with at least one secondary storage chamber ~~(21, 22)~~ and is configured to remove heat from the working fluid, in the charge configuration, or to transfer heat to the working fluid, in the discharge configuration, at a temperature below 100°C~~, optionally between 0°C and 50°C, optionally at a temperature close to the ambient temperature~~.

11. Process for energy storage comprising~~, optionally implemented with the plant according to at least one of the previous claims, wherein the process comprises~~:

carrying out a closed thermodynamic cyclic transformation (TTC), first in one direction in a charge configuration/phase and then in an opposite direction in a discharge configuration/phase, between a casing ~~(5)~~ for the storage of a working fluid different from atmospheric air, in a gaseous phase and in pressure equilibrium with the atmosphere, and a tank ~~(9)~~ for the storage of said working fluid in a liquid or supercritical phase with a temperature close to the critical temperature; wherein said critical temperature is close to the ambient temperature~~, preferably between 0°C and 100°C~~; wherein, in the charge phase, the process accumulates heat and pressure and, in the discharge phase, generates energy.

12. Process according to claim 11, wherein the charge phase comprises:

- compressing said working fluid, coming from said casing ~~(5)~~ externally in contact with the atmosphere and delimiting inside a volume configured to contain the working fluid at atmospheric pressure or substantially atmospheric, absorbing energy;
- injecting the compressed working fluid through a primary heat exchanger ~~(7)~~ and a secondary heat exchanger ~~(10)~~ placed in series to bring a temperature of the working fluid close to its own critical temperature; wherein the primary heat exchanger ~~(7)~~ works as a cooler to remove heat from the compressed working fluid, cool it and store

thermal energy, wherein the secondary heat exchanger ~~(10)~~ works as a cooler to remove further heat from the compressed working fluid and store further thermal energy;

- accumulating the cooled working fluid in said tank ~~(9)~~; wherein the secondary heat exchanger ~~(10)~~ and the primary heat exchanger ~~(7)~~ carry out a super-critical transformation of the working fluid so that said working fluid is accumulated in the tank ~~(9)~~ in super-critical phase or wherein the secondary heat exchanger ~~(10)~~ and the primary heat exchanger ~~(7)~~ carry out a sub-critical transformation of the working fluid so that said working fluid is accumulated in the tank ~~(9)~~ in liquid phase; wherein ~~optionally~~ a temperature of the working fluid accumulated in the tank ~~(9)~~ is between 0 °C and 100 °C and wherein a pressure of the working fluid accumulated in the tank ~~(9)~~ is between 10 bar and 150 bar.

13. Process according to claim 11 or 12, wherein said working fluid has the following physical-chemical properties: critical temperature between 0 °C and 200 °C, density at 25 °C between 0,5 kg/m^3 and 10 kg/m^3; and/or it is ~~preferably~~ chosen in the group including: CO_2, SF_6, N_2O.

14. Process according to claim 12 or 13, wherein the phase of discharge and generation of energy comprises:

- passing the working fluid from the tank ~~(9)~~ through the secondary heat exchanger ~~(10)~~ and the primary heat exchanger ~~(7)~~; wherein the secondary heat exchanger ~~(10)~~ works as a heater to transfer heat to the working fluid coming from the tank ~~(9)~~, wherein the primary heat exchanger ~~(7)~~ works as a heater to transfer further heat to the working fluid and heat it;
- passing the heated working fluid through a turbine ~~(2)~~, wherein the turbine ~~(2)~~ is rotated by the heated working fluid and drives the generator generating energy, wherein the working fluid expands and cools down in the turbine ~~(2)~~;

- re-injecting the working fluid coming from the turbine ~~(2)~~ into the casing ~~(5)~~ at atmospheric or substantially atmospheric pressure.

15. Process according to claim 14, wherein in the discharge phase and energy generation, between the primary heat exchanger ~~(7)~~ and the turbine ~~(2)~~, it is provided to further heat the working fluid through an additional heat source ~~(230), optionally chosen from: a solar source, industrial waste heat recovery, exhaust heat of gas turbines~~.