CLAIMS:

1. A membrane element configured for filtration of water while simultaneously co-generating hydrogen, wherein the membrane comprises at least one anode electrode and at least one cathode electrode, each is in communication with said membrane; further wherein said membrane is adapted for electrolysis of at least a portion of said water to simultaneously at least partially generate hydrogen therefrom.

2. The membrane element according to claim 1, wherein at least one of the following is held true (a) said membrane configured for filtration of water when a pressure difference is provided across said membrane; (b) said membrane is configured for osmotic and/or gauge pressure driven filtration of water; (c) said membrane is selectively permeable membrane configured to at least partially purify feed water when a pressure difference is provided across said membrane; (d) wherein at least one selected from a group consisting of said at least one anode electrode, said at least one cathode electrode and any combination thereof is made of at least one material selected from titanium, carbon fiber, carbon cloth, graphene and any combination thereof; (e) at least one selected from a group consisting of said at least one anode electrode, said at least one cathode electrode and any combination thereof is at least partially coated or at least partially cladded with at least one catalyst, wherein said catalyst is selected from a group consisting of iridium oxide, ruthenium oxide, tantalum oxide, titanium oxide, platinum, and platinum oxide and any combination thereof; (f) wherein at least one selected from a group consisting of said at least one anode electrode, said at least one cathode electrode and any combination thereof is provided in the form of at least one selected from a group consisting of mesh, plate, cloth, fiber, sintered body and any combination thereof; ay any combination thereof.

3. The membrane element according to any one of claims 1 -2, wherein at least one of the following is held true (a) the membrane comprises a salt rejection layer and a support layer, the at least one anode electrode and/or at least one cathode electrode comprising the salt rejection layer and/or being provided in, on or between one or both the salt rejection and support layers; (b) the membrane element includes at least one selected from a group consisting of feed spacers, permeate spacers and any combination thereof; and the at least one anode electrode and/or the at least one cathode electrode are provided by the feed or permeate spacer or are provided on or

adjacent one or other of the feed and/or permeate spacers or are coupled to at least one selected from a group consisting of feed spacers, permeate spacers or are at least partially coated or at least partially cladded on at least one selected from a group consisting of feed spacers, permeate spacers and any combination thereof; (c) wherein at least one electrode is formed from graphene; (d) at least one electrode is provided in the form of a grid or parallel spaced apart strips, wherein at least one electrode is in the form of a full or partial coating or a full or partial cladding of the permeate and/or feed spacer; (e) wherein a catalyst is provided on one or both of the anode electrode and the cathode electrode; (f) said membrane element further comprising collecting means for collecting the dissolved hydrogen in the product water or optional reject flow for subsequent extraction by degasification or gas membrane separation; and any combination thereof.

4. The membrane element according to any one of claims 1-3, wherein the water filtration process is selected from the group consisting of reverse osmosis, pressure retarded osmosis (PRO), forward osmosis (FO), ultrafiltration, microfiltration and nanofiltration.

5. The membrane element according to any one of claims 1-4, wherein a low current density below 100 mA/cm^2 is applied across the electrodes to enable electrochemical splitting of the water to occur, preferably being below 10 mA/cm^2; especially below 5mA/cm^2, ideally below 1 mA/cm^2.

6. A method of generating hydrogen during pressure driven water desalination process, comprising steps of:
    a. supplying feed water to at least one membrane, comprising at least one anode electrode and at least one cathode electrode, in communication with said membrane;
    b. filtering said water; while simultaneously co-generating hydrogen;

    wherein said step of co-generating hydrogen comprising step of applying either a potential difference or current between said at least one anode electrode and said at least one cathode electrode; thereby

    generating by electrolysis hydrogen and oxygen from at least a portion of at least one selected from a group consisting of the feed, product water and any combination thereof.

7. The method according to claim 6, wherein at least one of the following is held true (a) said step of filtering said water additionally comprising step of applying a pressure differential across said membrane to draw feed water through said membrane to form a product water; (b) at least one selected from a group consisting of said at least one anode electrode, said at least one cathode electrode and any combination thereof is made of at least one material selected from titanium, carbon fiber, carbon cloth, graphene, and any combination thereof; (c) at least one selected from a group consisting of said at least one anode electrode, said at least one cathode electrode and any combination thereof is at least partially coated or at least partially cladded with at least one catalyst, wherein said catalyst is selected from a group consisting of iridium oxide, ruthenium oxide, tantalum oxide, titanium oxide, platinum, and platinum oxide and any combination thereof; (d) at least one selected from a group consisting of said at least one anode electrode, said at least one cathode electrode and any combination thereof is provided in the form of at least one selected from a group consisting of mesh, plate, cloth, fiber, sintered body and any combination thereof; (e) said method further comprising collecting the dissolved hydrogen in the product water or optional reject flow for subsequent extraction by degasification or gas membrane separation; and any combination thereof.

8. The method according to any one of claims 6-7, wherein the water filtration process is selected from the group consisting of reverse osmosis, pressure retarded osmosis (PRO), forward osmosis (FO), ultrafiltration, microfiltration and nanofiltration.

9. The method according to any one of claims 6-8, wherein a low current density below 100 mA/cm^2 is applied across the electrodes to enable electrochemical splitting of the water to occur, preferably being below 10 mA/cm^2; especially below $5mA/cm^2$, ideally below 1 mA/cm^2.

10. A water filtration module configured for pressure driven filtration of water and simultaneous electrochemical splitting of at least a proportion of the water for the co-generation of hydrogen, the module comprising:
    a feed water inlet;
    at least one membrane element as claimed in any one of claims 1-5;
    a product water outlet; and
    optionally a reject water outlet.

11. The module according to claim 10, wherein at least one of the following is being held true (a) the membrane comprises a salt rejection layer and a support layer, the at least one anode electrode and/or at least one cathode electrode comprising the salt rejection layer and/or being provided in, on or between one or both the salt rejection and support layers; (b) the membrane element includes at least one selected from a group consisting of feed spacers, permeate spacers and any combination thereof; and the at least one anode electrode and/or the at least one cathode electrode are provided by the feed or permeate spacer or are provided on or adjacent one or other of the feed and/or permeate spacers or are coupled to at least one selected from a group consisting of feed spacers, permeate spacers or are at least partially coated or at least partially cladded on at least one selected from a group consisting of feed spacers, permeate spacers and any combination thereof; (c) wherein at least one electrode is formed from graphene; (d) at least one electrode is provided in the form of a grid or parallel spaced apart strips; (e) at least one electrode is in the form of a full or partial coating or a full or partial cladding of the permeate and/or feed spacer; (f) a catalyst is provided on one or both of the anode electrode and the cathode electrode; (g) said module further comprising collecting means for collecting the dissolved hydrogen in the product water or optional reject flow for subsequent extraction by degasification or gas membrane separation; and any combination thereof.

12. The module according to any one of claims 10-11, wherein the water filtration process is selected from the group consisting of reverse osmosis, pressure retarded osmosis (PRO), forward osmosis (FO), ultrafiltration, microfiltration and nanofiltration.

13. The module according to any one of claims 10-12, wherein a low current density below 100 mA/cm^2 is applied across the electrodes to enable electrochemical splitting of the water to occur, preferably being below 10 mA/cm^2; especially below 5mA/cm^2, ideally below 1 mA/cm^2.

14. A system for pressure-driven water purification with the simultaneous co-generation of hydrogen, the system comprising:
    a feed water inlet;
    at least one membrane element according to any one of claims 1-5 or module according to any one of claims 10-13;
    at least one pump to apply a pressure to the feed water;

a power source to provide a potential difference to the electrodes of the membrane element;

a product water outlet; and optionally a reject flow outlet; and,

a hydrogen outlet within the product and/or reject flow.

15. A process for pressure driven water purification with simultaneous co-generation of hydrogen, the process comprising:

supplying feed water from a feed water inlet to a membrane element according to any one of claims 1-5 or module according to any one of claims 10-13;

applying a pressure differential across the selectively permeable membrane of the membrane element to draw feed water through the membrane to form a product water and optionally a reject flow;

applying a potential difference between the electrodes of the membrane element to cause simultaneous electrochemical splitting of at least a portion of at least one of the feed and/or product water to form hydrogen and oxygen; and

collecting the product water and optionally a reject flow, and hydrogen.

16. The process according to claim 15, wherein at least one of the following is being held true (a) said process further comprising collecting dissolved hydrogen in the product water or optional reject flow for subsequent extraction by degasification or gas membrane separation; (b) the pressure driven water filtration process is selected from the group consisting of reverse osmosis, pressure retarded osmosis (PRO), forward osmosis (FO), ultrafiltration, microfiltration and nanofiltration; (c) wherein less than 5% of the feed and/or product water is split to form hydrogen, preferably the less than 1 %; more preferably less than 0.05%, especially 0.01%, ideally less than 0.01%; (d) a low current density below 100 mA/cm^2 is applied across the electrodes to enable electrochemical splitting of the water to occur, preferably being below 10 mA/cm^2; especially below $5mA/cm^2$, ideally below 1 mA/cm^2; (e) said process further comprising delivering feed and draw solutions of different osmotic and gauge pressures to opposing sides of the selectively permeable membrane element; applying a current across the electrodes of the membrane to split the low salinity solution into hydrogen and oxygen; and collecting the hydrogen and oxygen; and any combination thereof.