Osmotic-hydraulic energy storage & recovery system with large landscape solar evaporation pond of saturated salt water

Lead organization:
Kiwaho laboratory of energy & ecology Inc.

Principal investigator:
Yanming Wei

Primary technical category:
Grid Scale (Non-Battery) Storage

Additional technical area:
Solar - Non-PV + Osmotic energy

Project cost:
$3 million

Duration:
36 months

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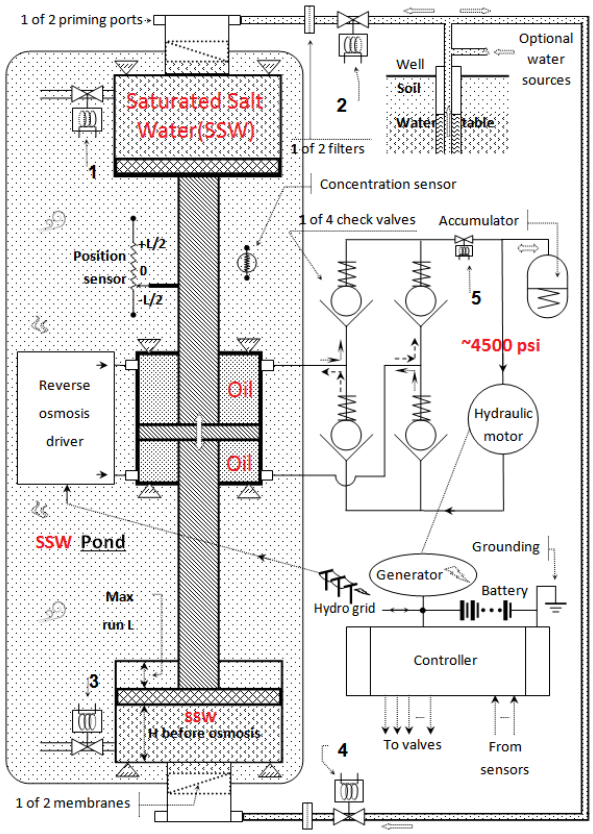
1. EXECUTIVE SUMMARY

We learned lesson from the failed Norway riverwater-seawater blue energy project, and reinvented a disruptive cleantech!



This promising project will shoot the toughest double summits: economic gridscale energy storage + economic solar energy harvest; and the former can easily challenge nowaday prevailing practice – the Pumped Storage Hydro, as well as the latter can be more competent than photovoltaic.

We say **NO** to the hopeless riverwater–seawater system, but **YES** to the (freshwater | seawater) – SubSaturatedSaltWater (SSSW) + solar evaporation + hydraulic oil retardation transmission, so as to reach optimistic osmotic pressure up to 20x augment + membranes demand up to 400x saving!

Our pending patent creatively convert the retarded osmotic pressure to hydraulic oil pressure inside the conjugate cylinder block, then oil current is rectified, subsequently a market-available hydraulic motor is driven for power generation. In fact, it is the **FO (Forward Osmosis)** that output energy.

As to the **RO (Reverse Osmosis)**, there are double ways: **1st** use cheap off-peak hydropower to drive a similar oil-aquasolution conjugate cylinder block, so as to re-concentrate the storage SSSW; **2nd** let the sunshine evaporate the SSSW pool. These two ways can even work simultaneously, and in fact, the latter does indirectly harvest solar energy even in night & cloudy day, because forever evaporation.

Although the power density of solar evaporation pond is humbly 3 (regular climate) ~10 (desert) w/m^2, its extreme cheapness does make it the "Rolls-Royce of the poor". In future, the Great Salt Lake can be converted to a 10 GW osmotic powerplant!

The system structure is open and flexible for different foci: pure storage + recovery, solar harvest + storage + recovery, changing desert to oasis by intake of seawater + production of salt & freshwater & hydro, etc.

For more details, please read our patent fulltext and blog articles:

Our published patent application can be download from USPTO or our website US15/902651
Blog 1: Osmosis energy era is looming ...
Blog 2: Big pseudo wetland based solar-osmosis tandem power station with multiple benefits

2. INNOVATION AND IMPACT

Long time ago, humankind found the osmotic pressure is formidable, even the commercial hydraulic pressure sadly feels inferior, for example, it is about 500 atmosphere pressure for water oozing into the saturated salt solution!

About half century ago, American Israeli professor Sidney Loeb invented the PRO (Pressure Retarded Method) method to harvest osmotic energy. Unfortunately his invention has never been commercialized until today.

Osmotic power is greatly dependent on the maturity degree of membranes.

Nowadays, the price and quality of water semi-permeable membranes loom rosy. Especially, the water purification demand is advancing steadily membrane technology development.

With the readiness of the no-longer-expensive membranes market, the long-time-expected PRO-based blue energy industry should supposedly grow mature.

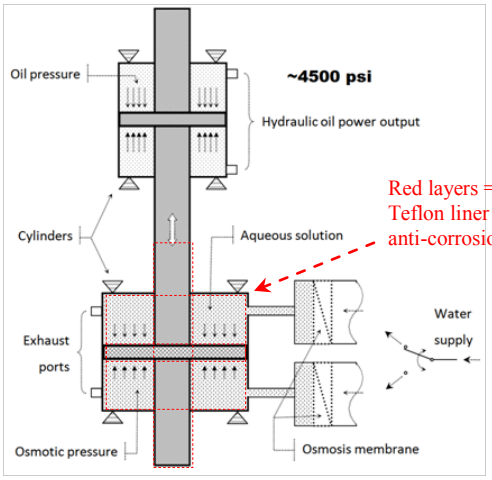
But why still be a dream? Our answer: **wow, it is frustrated by certain technical taboos**!

The fatal taboo: commercial hydraulic equipment must only use those engineered mineral oils, of course, aqueous solution is strictly prohibited. Engineers know exactly why this taboo must exist.

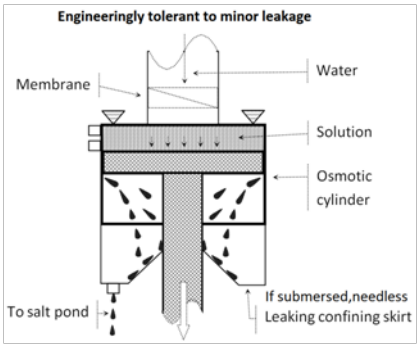
This world is never perfect, even ugly in some corners. Therefore, due trade-off has to be applied to the due time and due space for due performance, and perfectionists may often confront failure. Anyway, all our inventions just follow this philosophy.

Our deep research proves that: provided technical trade-off acceptable, the dead PRO technology can surely revived.

Veni vidi vici, our attempt led to eventual successful design of such **P**ressure **T**ransformer (**PT**):



Don't mind the minor water leakage



Some ugly leakage? No problem, provided it is minor enough, e.g. 0.1% of inflow, then engineeringly acceptable. Just be contentment & don't be fastidious, because viscosity performance of water is inferior to the engineered hydraulic oil.

Erosion in the aqueous end? No big deal. If all water-contacting metal surfaces are lined with **Teflon** coating/socks, or if using special stainless steel, then, anti-corrosion may be effective. However, only servicing that aqua-end is cheap enough and as convenient as changing motor oil.

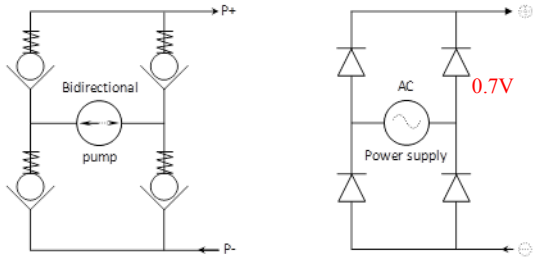
The other challenge is how to automatically enable the energy conversion cycling.

In previous figure, the water supply is drawn switchable to the conjugate osmosis chambers. A smart central logic controller shall take care of the endless periodic switching, so as to get **AC** (Alternating Current) oil flux, i.e. generate a **virtual AC oil pump**.

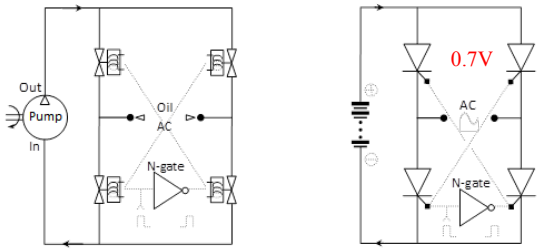
To conveniently get mechanic power, then an **oil AC-DC** bridge rectifier converts the **AC** fluidic power to **DC** (Direct Current), so as to drive a market-procurable common hydraulic motor.

The oil rectifier is simply consisted of 4 check-valves, like as diodes (0.7V saturated voltage), so its efficiency is almost 100%. The analogy is showed in the left of following figures.

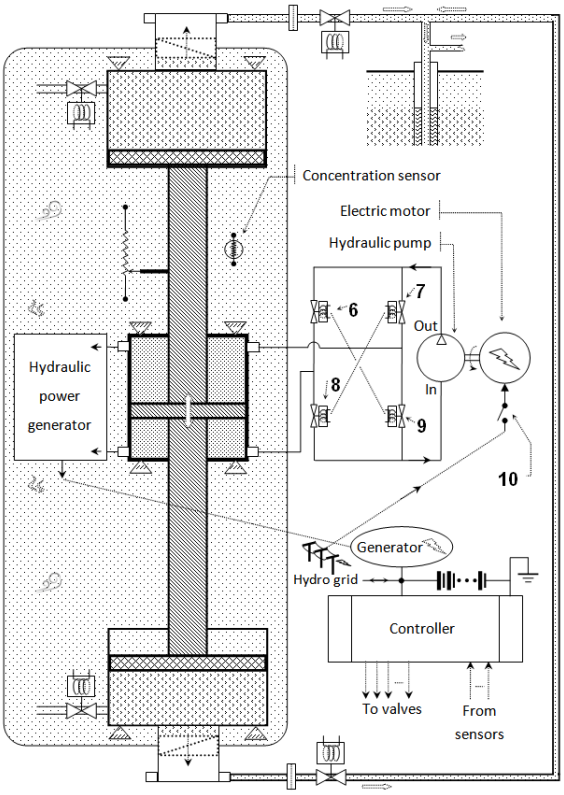
Oil current **AC-DC** rectifier & the equivalence

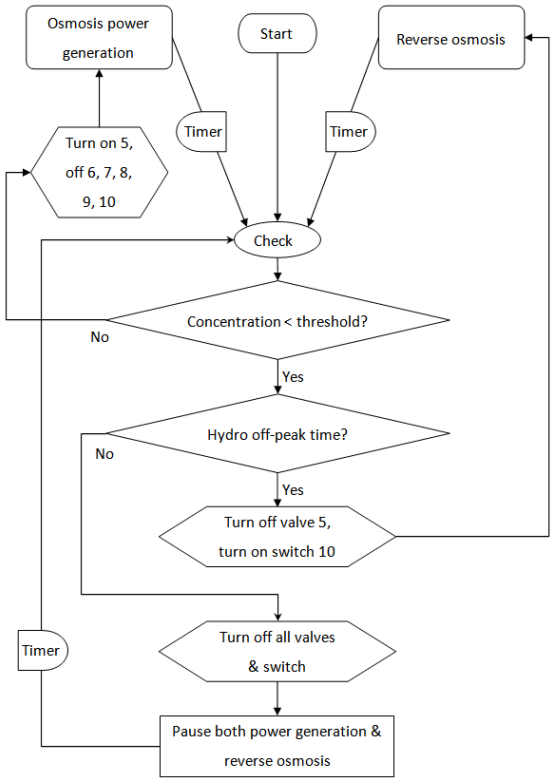


Oil current **DC-AC** inverter & the equivalence



By reverse use of the afore-mentioned **PT**, the **RO** can be done with the help of an **oil DC-AC inverter** that comprises 4 electromagnetic valves and oscillatory electric trigger (refer to above right figure). The **off-peak** cheap hydro powered electric motor drives a hydraulic motor, then the **virtual oil AC pump** is generated as the output of the inverter, so to reciprocate the **PT** axle for squeezing freshwater out and concentrating the storage **SSSW**. See these figures for details:





Why the pioneer Statkraft lost further interest after first attempt?

Yes, taboos can be evaded if everything just follows technical conventions, but unfortunately you may get little even no gain.

The said Norway company tried to harvest energy from riverwater mixing seawater. However osmotic pressure is merely 27 atms, i.e. about 20 times less than the saturated salt water.

Of course, a regular hydro turbine can satisfy the pressure, but the low power density turbine is far more expensive and cumbersome than a hydraulic motor with same power rating. Statkraft used a Pelton spoons turbine as shown below.

The length of above hydraulic motor is equivalent to the pencil, but its power even larger than the left monster-scale: Pelton hydro turbine 4kw

Above monster turbine can only output 4 kw, in contrast, for same power hydraulic motor, its size is equivalent to a car starter motor.

Not only that, but also 400 times more membranes have to be used, than our compact design with osmotic-hydraulic trade-off at same power. Why? Because power is proportional to the square of pressure, analogous to the electric formula: Volt^2/Resistance.

With those tremendous cost & volume & weight amplification, but little power, how can the Statkraft osmotic power station profitable and sustainable?!

Their one-way-pass design just skims less harvestable energy, which may frustrate them.

Another fatal bug is that: they don't have a proper transmission to adapt ever-changing salinity gradient & loads for adequate retardation!

Our conclusion & the vista of future great impact

Indeed, trade-off is a kind of art! With this lovely trade-off, a huge market is emerging for the untapped osmotic blue energy storage and recovery.

Conventional hydraulic system is based on the over-mature technology, and many parts or components are standardized for decades and decades. Supposedly, as long as the market drives deep to the aqua-oil hybrid hydraulic demand, the great stakeholders such as Eaton, Parker etc. can be capable of producing whatever matchable huge amount supply.

Furthermore, our other new invention will technically enable PRO commercialization:

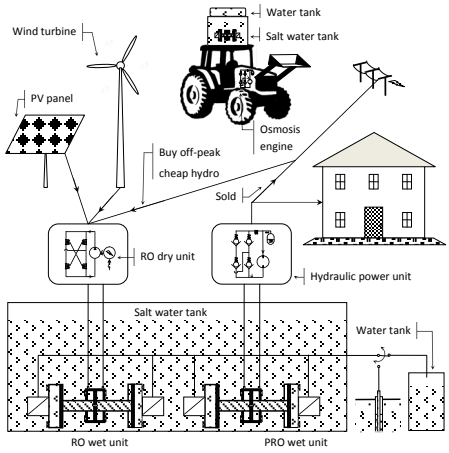
Wei-Trump Powertrain = Gearless Automatic Digitostat Fluid Power Continuously Variable Bidirectional Regenerative Transmission

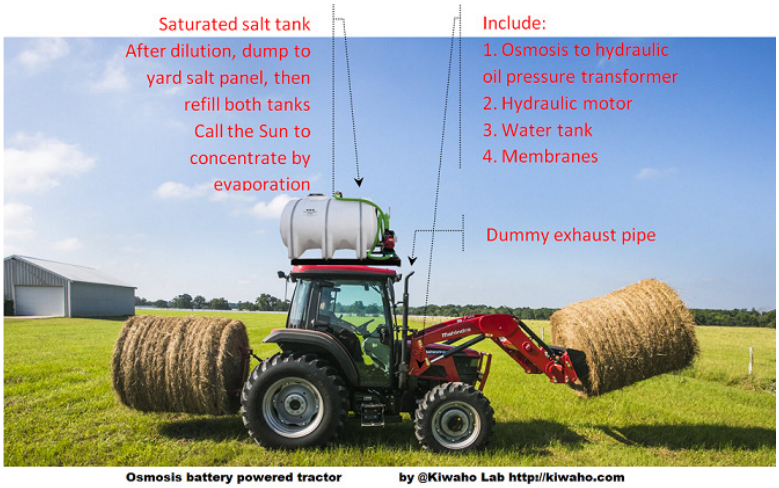
For details: http://kiwaho.com/ck

Solar-osmosis tandem blue energy

⋆ Application for homesteads with limited land

Following figure and picture illustrate a masterplan to use the osmosis-hydraulic system as a huge capacity battery for vehicles and storage device for other renewable energy sources.





For energy storage only purpose, it no longer allocates land lot for evaporation pool, but for the photovoltaic panel array, so as to take advantage that the PV panels can output more power than the "salt panel" per unit land usage, despite the cost will increase significant percentage.

Instead of a large surface pool, large volume tanks are used, and tank's surface area can be minimized if wish by proper geometry design, because of no longer natural evaporation.

During shiny days, the PV panels can power electric motor for reverse osmosis. The conventional expensive DC-AC inverter can be eliminated for cost saving, because a DC motor is more convenient to drive the hydraulic pump for RO.

During windy days, a wind turbine can also output electricity, and in a joint RO effort, it behaves similar to the PV panels in next series of actions.

During those times that are cloudy or night or windless, the hydro grid can be a RO helper, as long as the cheap off-peak price is enabled.

As to the consumer side, the energy in the non-electrochemical "osmotic battery" tank can either be used online by its owner, or sold to the hydro grid during peak demand time for good profit. There are 2 ways for using the energy in situ, one is send into house for appliances, the other is used as transferable special "fuel" to accommodate the demand of mobile machines with osmosis engines, such as the pictured tractor, forklifts, etc.

***Farmland industrialization by upconversion to solar-osmosis tandem blue powerplant**

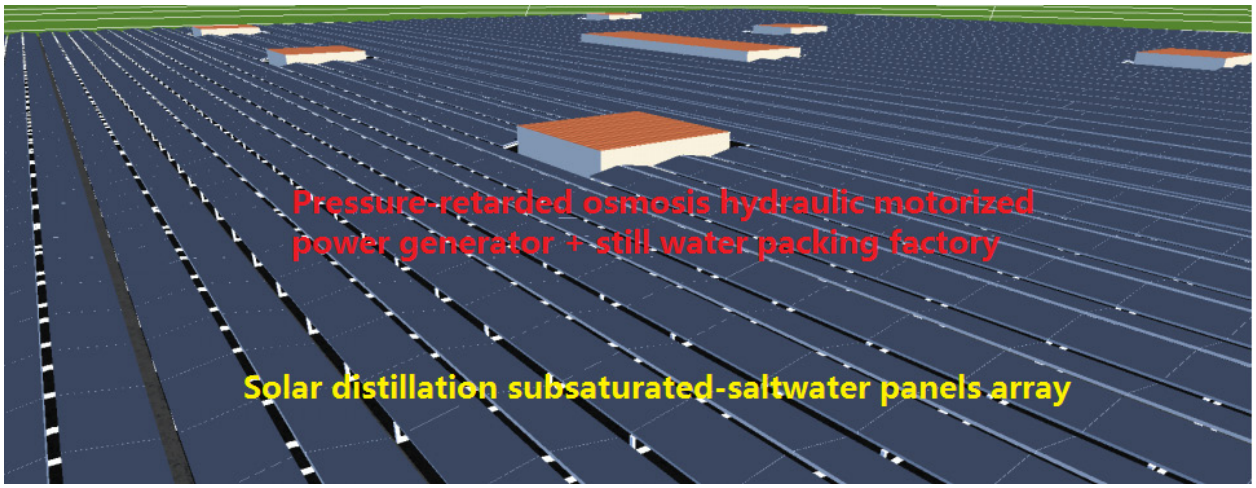
Some countries have too many surplus lands for domestic food demand, and have to rely on international trade of soybean or other grains.

With land upconversion to solar-osmosis tandem blue powerplant, this situation can be easily modified for rural industrialization, as well as defuse climate crisis of global warming, because the landscape of converted farmlands will be vast pseudo wetlands, which evaporation cooling effect on Earth is better than crops.

In whatever far future, non big country is affordable to cover all farmland with PV panels; but if wish, it's probable to cover with cheap puddles or ponds for solar-osmosis tandem system.

The decentralized mini grids of omnipresent blue power stations will phase out almost all kinds of fossil fuels, then our next generations will live up to a better environment without worries of troublesome GHG emission.

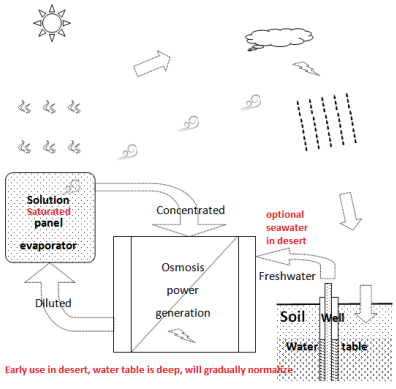
Of those converted lands, if let small partitions for solar distillated drinkable water production, it will fix both big problems: clean water & energy!

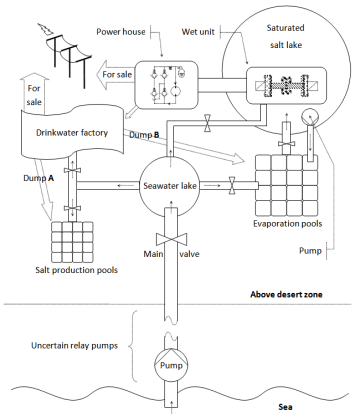


⋆ Change desert to oasis by massively seawater intake

Following intuitive & informative figures and pictures can easily speak for themselves.

The SSSW osmotic pressure is ~54MPa, equivalent to 5400m waterhead, thus, for those ~1000m elevation deserts, the generated value of salt product + electricity + freshwater > pump cost!





***Harvest cold energy**

Oceanside only? hot climate zone only? No such thing! In fact, anywhere applicable, even the coldest midland of Canada, because icing can also re-concentrate or recharge diluted exhaust saltwater. As fusion heat is just about 1/8 of vaporization heat, so the blue power is more efficient in winter, though extra job is needed to skim off the ice sheet.

The produced ice is clean with tiny or without salt residue, so it's potable.

Farmlands have enough space to pile up ice, and wait for summer to melt it.

Maintenance on blue power farm can also create numerous employment opportunities.

****Forward looking**, its success will strengthen the national energy security, and induce chain-booming of relevant industries, e.g. the hydraulic production industry, membranes makers, etc. Now we are seeking partners from those prime manufacturers of hydraulic parts, e.g. Parker Hannifin, and landowners of west dry states, e.g. the Intrepid Potash.

3. Pilot project

We are fundraising for a pilot project of 30 acres 1MW solar-tandem blue power farm.

Budget $3M, i.e. $3000/kw capital cost for land productivity rating: 72 kwh/m^2/year.

Seeking partners to recommend location, supply membranes, land preparation, etc.

Afraid of risk? I offer special provision for your conditional investment on our recent private-public partnership with Canada government program (click it for detail):

Breakthrough Energy Solutions Canada

The government can grant 50% to 75% of total budget of project, and now I already received invitation letter to bid.

As prior independent R&D exhausted our cashflow, we are not affordable for the rest 25% to 50% capital, thus have to seek complementary fund from outside.

I can guarantee that you only need promise to invest by conditional offer: shall the government not fund us, you can cancel the deal if wish so; only when government is going to initialize the funding, then you should transfer your money.

We can sincerely negotiate allocation of equity shares to ensure your interest.

To match cofounder's max investment, the project budget can *subject to* ***scale down***.

4. TEAM ORGANIZATION AND CAPABILITIES

4.1 Organization.

Kiwaho laboratory of energy and ecology Inc.

We are aiming to power world with clean energy originated from the sun-cooking-earth!

As a private hi-tech R&D laboratory, our scientists are working harder than those peers in government laboratories who are highly paid by taxpayers, because we have to fight for shortage of funds or resources, and be prodded by risk awareness of venture for surviving in free market. Therefore, please patronize our services and intelligence properties, and help us prosper with your enthusiastic support. In return, we will try our best to promote job opportunities & economic growth in the patron's community or country by promoting our technologies.

4.2 Capabilities, Facilities, Equipment, and Information.

Our business scope:

* Proprietary intelligent properties: creating, transferring, licensing, supporting, improving, consulting, …

* Front-End Engineering Design, FEED studies for clients planning state-of-art clean-tech energy projects;

* Think-tanking for governments on science & technology envisioned energy & ecology tactics & strategy.

From the day one, we have committed to be non-exhaustible headspring of innovations, fast pacing on and on!

Kiwaho is a Canada nationwide company headquartered temporarily in suburban of capital city Ottawa, but we are actively trying to re-root or re-headquarter to anywhere, provided a smart strategic individual/company/government investor sincerely & warmheartedly invites us.

Corporation number: 852516-1 Business number: 809297047RC0001

DUNS: 203411665 NATO CAGE code (NCAGE): L0E80

5. TECHNOLOGY TO MARKET

5.1 Techno-economic analysis.

The indirect solar energy cost: < $0.05/kwh, in consideration of land use, operation cost, such as filters frequent change, membranes replacement, maintenance, etc.

System equipment and land engineering:

Capital cost per kw (equipment) < $3000/kw, spent in membranes, raw salt, generator, land preparation, installation, etc.

The puddle or pond depth depends on demand of energy storage duration.

If the concentration of exhaust salt water is set about 70% of SSSW, then the approx energy density 5 kwh per ton of salt.

Given the salt mass 35% in SSSW and $100 per ton salt, then there is 0.35/5= 0.07 ton salt in stock per kwh, i.e. $7/kwh.

In comparison with the $300/kwh of gridscale electrochemical storage, this $7/kwh is far advantageous, even negligible. If luckily there is a natural salt lake, then $0/kwh.

5.2 Technology to Market Strategy.

Peer-viewed scientific papers
Youtube video making
Education courseware making
Advertising
Pilot project exhibiting
Turn-key project promotion
Licensing discount for important customer

6. BUDGET

Total: $3,000,000

Manpower cost: 3 (scientists + senior engineers) in 3 years, = 3 x 3 x $100,000 = **$900,000**

Land preparation: $3000/acre, subtotal 30x3000 = $90,000, include some drilled wells.

The left over $2.1M is for engineering and manufacturing, and the cost breakdown is planned in following table:

Task or stage	budget	Comment
Materials (mainly membranes) + tools	$1,300,000	**$1300/kw**
Smart transmission for retardation	$150,000	
Grid feed-in	$100,000	
Collaboration with other entities	$450,000	
Technology-to-Market agenda	$100,000	
Total	**$2,100,000**	

7. SCHEDULE

We start from seeking funds and partners for financial support and collaboration. These potential sources of funds are focused: government, venture capitalists; and these potential partners are focused: national laboratories, membranes manufacturers, hydraulic parts manufacturers, large size landowners, potash miners.

Time frame allocation

Partners seeking: **1~2** months

Outsourcing parts and materials: **1** month

Designing the central logic controller module & transmission: **3** months

Hydraulic partner customize the aquasolution to oil pressure transformer cylinder block:

3 months. Teflon coating in aquasolution side may be needed.

Assembling the osmotic engine: **1** month

Testing & debugging & re-engineering cycle: **3** month

Benchmarking: **1** month

Preparing SSSW solar pond & wells drilling, etc: **1** to **2** months

Integrating the pond and osmotic engine: **2** months

Feed-in interface with grid hydro: **3** months, need negotiation with local hydro company

System testing energy storage by grid hydro input, peak-time output: **2** months

Tuning & debugging entire system: **3** months

Logging & collecting experiment data: **1** month

Writing scientific paper: **1** month

Writing new invented patent application if any: **2** months

Some stage may overlay in time axis, and the total **36** months is preset.

8. PERSONAL QUALIFICATION SUMMARIES

Yanming Wei

- engineering master degree in industrial automation, as well as almost diversified 30 years work experiences.
- already filed the patent from USPTO, and will apply for PCT within 1 year for global IP protection.
- maverick polymath in many domains of science and technology with great insight and wisdom vision.
- Strong curiosity in science, especially physics, thermodynamics, aerodynamics, optics, mechanics.
- Strong entrepreneur ambition and good health.

Pending or grant Patents:

- US 16/354,251, filed on Mar 15, 2019
  Digital-switching fluidic power supply and hydrostatic transmission with regenerative brake
- US 15/902,651, filed on Feb 22, 2018
  Osmosis energy storage & recovery system and indirect solar powerplant
- US 15/848,097, filed on Dec 20, 2017
  Osmosis battery & high magnetic field generator & superconducting ionic current loop