Pd/Ni Clusters for D/H TSC Jitterbug Fusion

Frank Dodd (Tony) Smith Jr. - 2012, 2014

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Clusters of Palladium atoms (also clusters of atoms of Nickel and similar elements) have two basic structures:

Icosahedral and Cuboctahedral

1 - Icosahedon <-> Cuboctahedron Jitterbug Transformation

2 - Pd/Ni clusters with absorbed Deuterium or Hydrogen have two states:

Icosahedral with Tetrahedral absorption sites

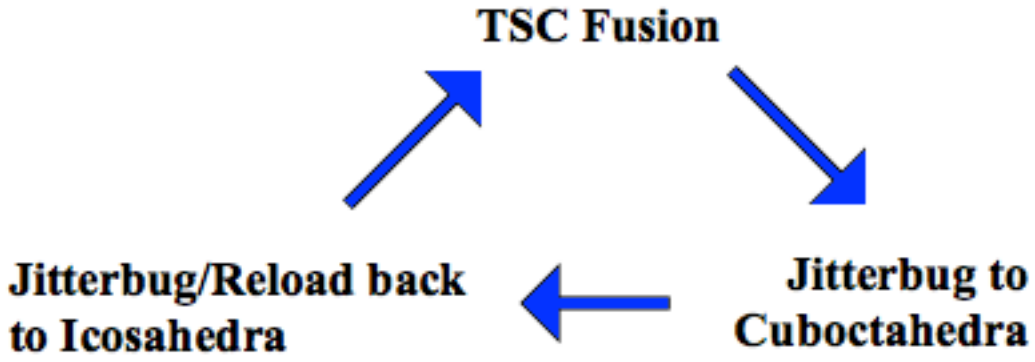
Cuboctahedral with Octahedral absorption sites

3 - Tetrahedral Symmetric Condensation (TSC) in PdDx produces Fusion.

4 - Icosahedra TSC Fusion Triggers Jitterbug to Cuboctahedra.

5 - Cuboctahedra Jitterbug back to Icosahedra and reload TSC sites.

6 - Repeat the Cycle:



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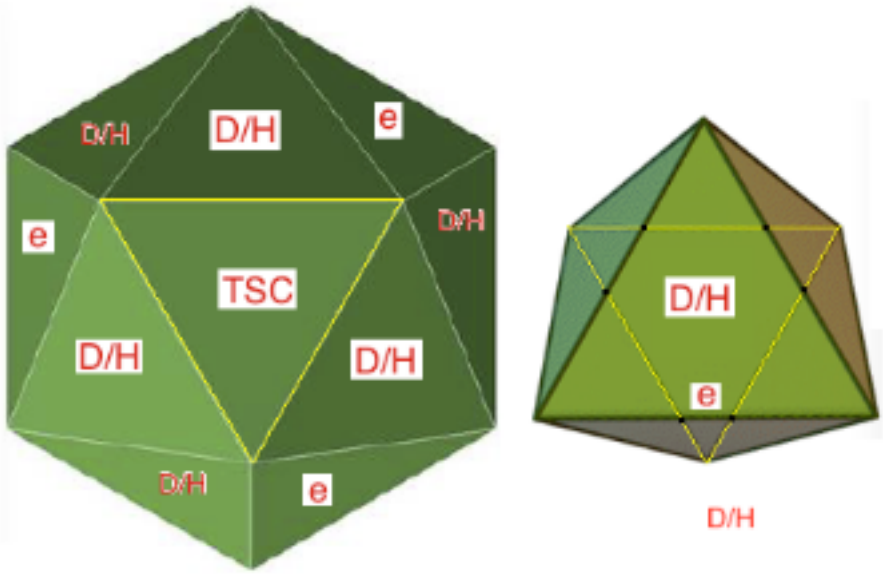
NOTE - Most of the detailed quantitive discussion in this paper is for Pd / D Fusion
but Nickel / Hydrogen is very similar to Palladium / Deuterium
so some of the mutually applicable images etc also indicate Ni / H Fusion.

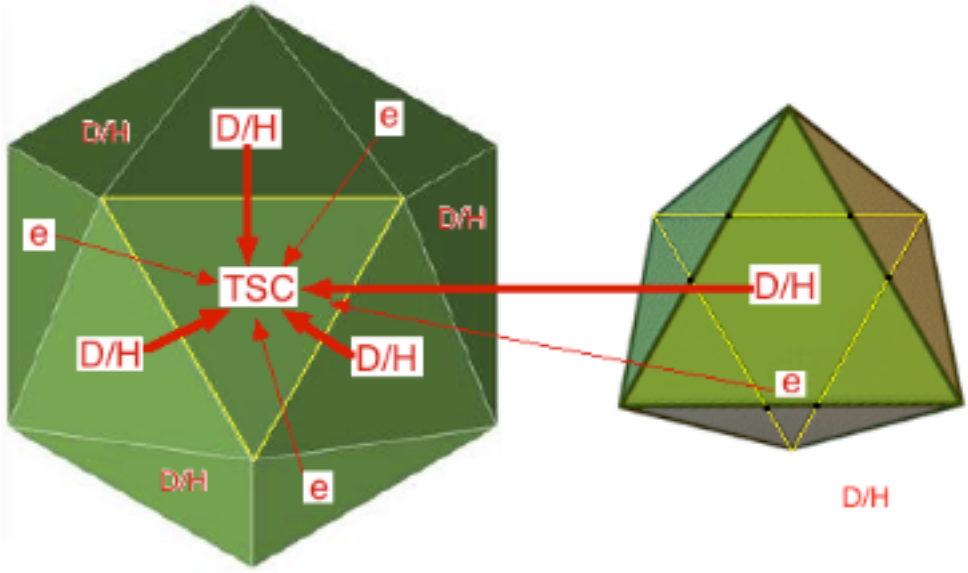
Akito Takahashi has developed a Tetrahedral Symmetric Condensate (TSC) model for fusion D+D+D+D -> 8Be and H+H+H+H -> 4 He in Pd and Ni atomic clusters. This paper describes the geometry of Pd/Ni atomic clusters and how it enables TSC fusion of D/H within the Pd/Ni clusters.
The icosahedral state at the beginning of the TSC process is the stable ground state. The basic TSC structure is a half-icosahedron with 10 approximate tetrahedra and approximate octahedron. The tetrahedra and octahedra are approximate because they do not fit together exactly within Pd/Ni atomic clusters because they must be slightly deformed from exactly regular tetrahedra and octahedra in order to fit together in our physical flat 3-dimensional space.
Details of the deformation are being studied by Klee Irwin and his coworkers Fang Fang, Julio Kovacs, and Garrett Sadler. Discussion with them led to the ideas described in this paper.

The vertices of the half-icosahedron and octahedron are positions of Pd/Ni atoms. As to the half-icosahedron tetrahedral cells (images adapted from Wikipedia):
The central cell marked TSC is the cell in which the TSC fusion reaction takes place at the end of the TSC process. The 3 cells marked D/H (large type) contain 3 of the 4 D or 4 H nuclei for TSC fusion. The 3 cells marked e contain the electrons for those 3 D/H nuclei. The 3 cells marked D/H (small type) contain 3 D or H nuclei that will be reloaded by the Jitterbug process into TSC fusion position.

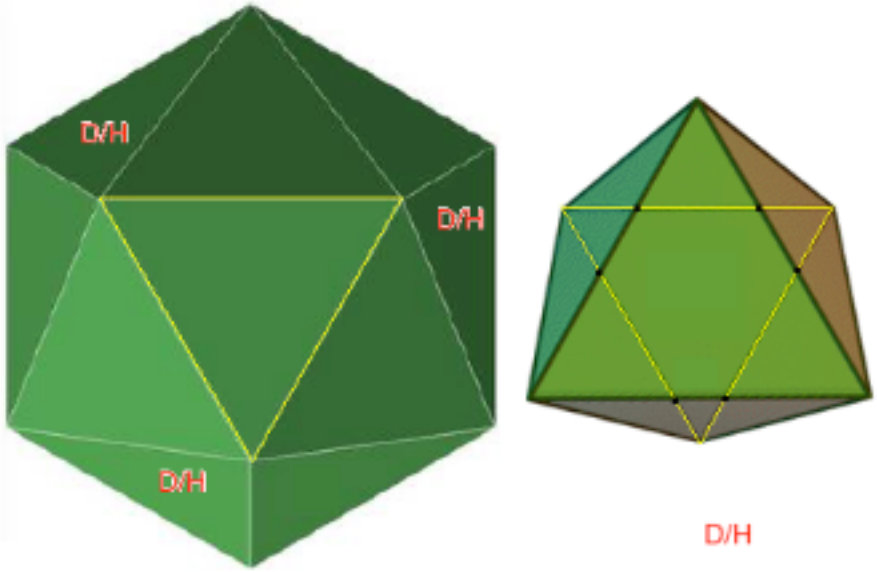


The octahedral cell marked D/H e (large type) is located in the atomic cluster directly above the TSC cell such that the TSC top face coincides with the bottom face of the octahedron. It contains the 4th of the 4 D/H nuclei for TSC fusion and its electron.The D/H (small type) outside the octahedral cell is for reloading.

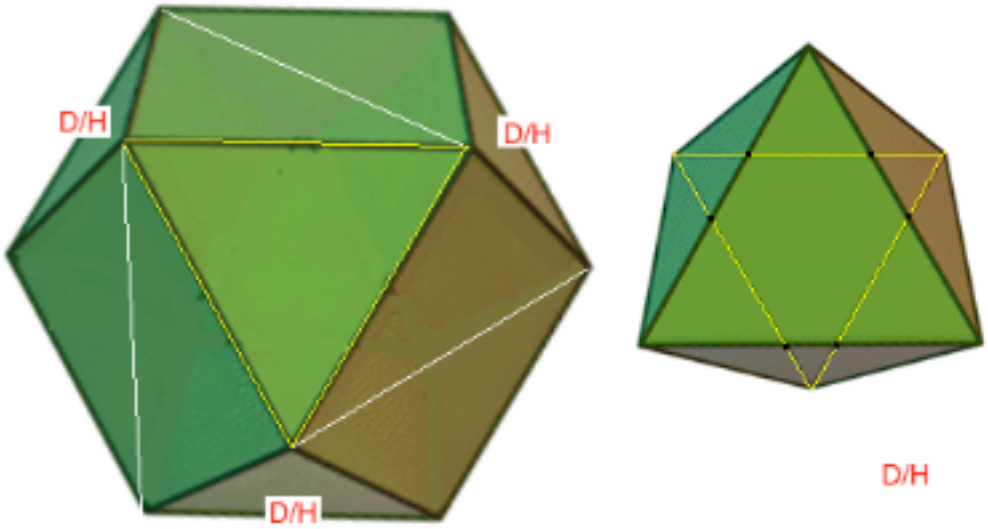
In TSC fusion the 4 D/H nuclei, Coulomb-shielded by their electron clouds, condense at the center of the TSC cell where their fusion produces 8 Be / 4 He.



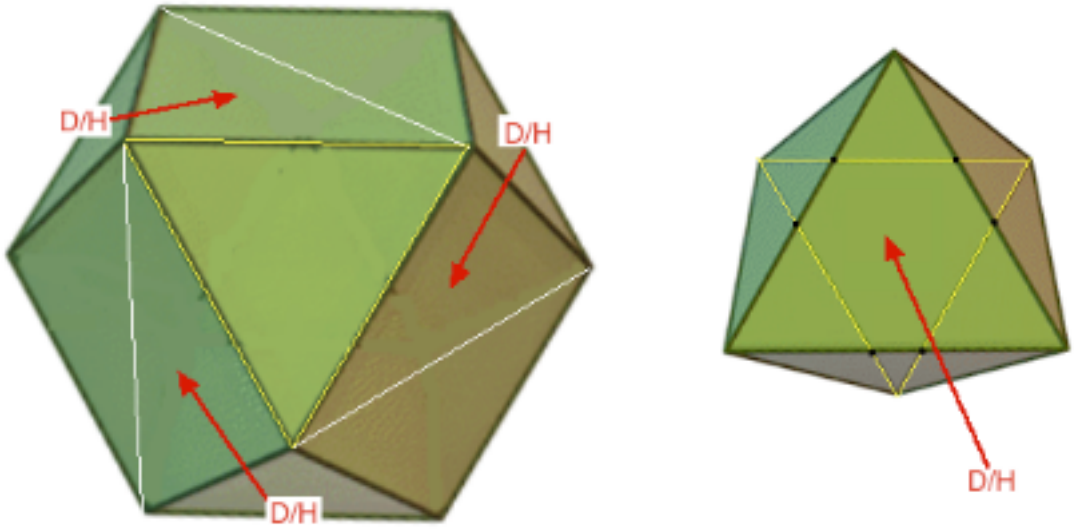
Immediately after TSC fusion



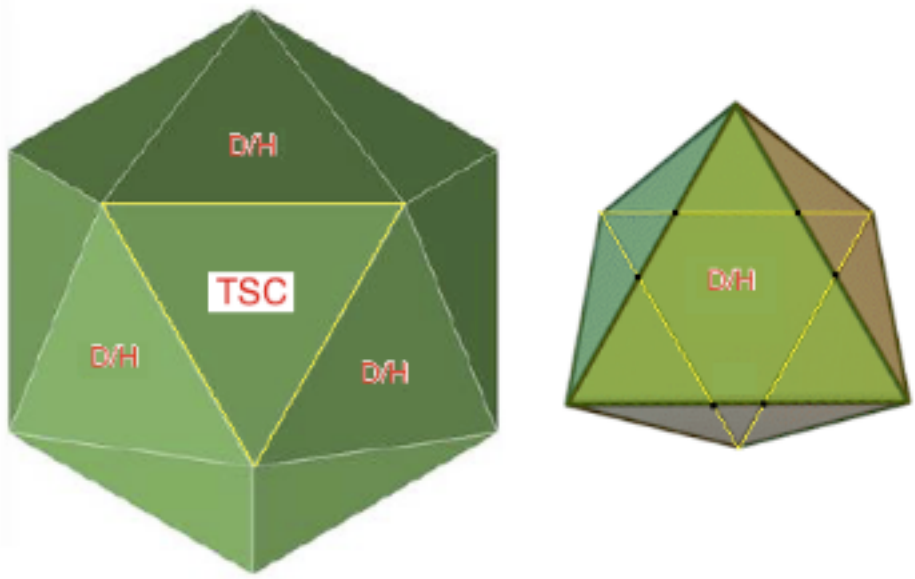
the TSC fusion cell and the D/H fuel cells and their associated e cells are empty but the D/H (small type) reloading cells contain the D/H for Jitterbug reloading. The TSC fusion energy released drives the Pd/Ni cluster state by a Jitterbug transformation to an expanded cuboctahedral state.



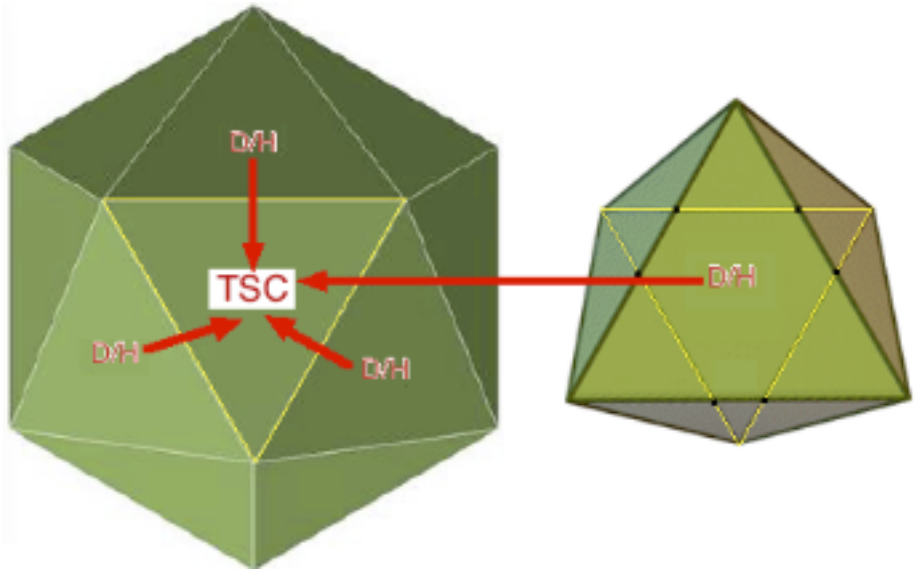
As Buckminster Fuller showed (Synergetics Macmillan 1975, 1982) a cuboctahedron is made up of 8 tetrahedral and 6 half-octahedral cells. 2 of the icosahedral tetrahedra correspond by Jitterbug to one of the cuboctahedral half-octahedra.
The Jitterbug expansion having produced large empty octahedra-type cells,
the D/H (small type) flow from their smaller tetrahedral cells into the larger empty octahedral-type cells



Since the icosahedral cluster state is the stable ground state,
the reloaded cuboctahedral state goes by Jitterbug transformation
to the reloaded icosahedral state



whereupon a new cycle of TSC fusion begins:



(The images above, adapted from Wikipedia, are somewhat oversimplified such as by not indicating the reloaded electron cells and the next-order reloading D/H reloading cells.)

What is the overall structure of the Pd/Ni clusters ?

There are two basic structures that are Jitterbug Transforms of each other:

Icosahedral and Cuboctahedral

n = number of shells
N = number of Pd atom vertices
d = diameter of icosahedral configuration in nm
C = number of cells in icosahedral phase
CT = number of tetrahedral cells in icosahedral phase
CO = number of octahedral cells in icosahedral phase

n	N	d	C =	CT +	CO
0	1	0.27	0 =	0 +	0


icosahedral

cuboctahedral

1	13	0.70	20 =	20 +	0


icosahedral

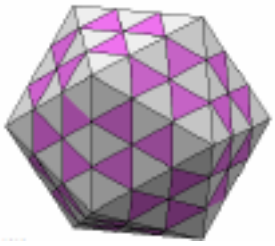
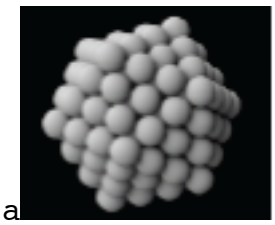
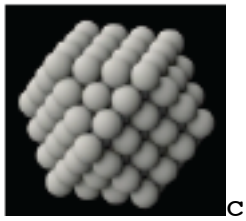

cuboctahedral

2	55	1.13	100 =	80 +	20


icosa


cubo

3	147	1.56	280 =	200 +	80


icosa


cubo

4	309	2.00	(icosa and cubo images not shown)		

(Images from: Polyhedral Clusters by Lord et al; Frank and Kasper in Acta Cryst. 11 (1958) 184-190; Mackay in Acta Cryst. 15 (1962) 1916-1918; vimeo.com/27662398 by Yan Liang (L2XY2) August 2011. Data for n, N, and d from Shtaya-Suleiman dissertation Gottingen 2003.)

How many TSC fusion sites are in a Pd/Ni cluster ?

A TSC Fusion Site has (icosahedral phase) a half-icosahedron plus an octahedron.

The 13-atom Pd/Ni cluster has a full icosahedron (two half-icosahedra) but does not have the necessary octahedron and so is not a TSC Fusion Site.

The 55-atom Pd/Ni cluster has a full icosahedron (two half-icosahedra) and two octahedra to form 2 TSC Fusion Site.

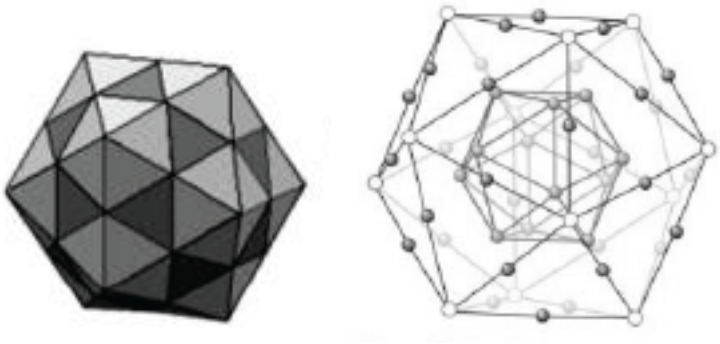
The 147-atom Pd/Ni cluster has the 2 TSC Fusion Sites of the 55-atom TSC cluster plus 12 more half-icosahedra in its outer shells along with octahedra for each, so it has 14 TSC Fusion Sites.

How do the Icosahedral Clusters grow to 147 atoms ?

Eric A. Lord, Alan L. Mackay, and S. Ranganathan say in
"New Geometries for New Materials" (Cambridge 2006):
"... The Mackay icosahedron is obtained by packing tetrahedra and octahedra around an icosahedron [12 vertices]...
if an octahedron is placed on every face of an icosahedron, the angular gap between neighboring octahedra can be closed by a very small deformation, to bring them into face contact [12 + 20 x (6-3)/2 = 42 vertices]...

... The concave regions of the resulting polyhedron can

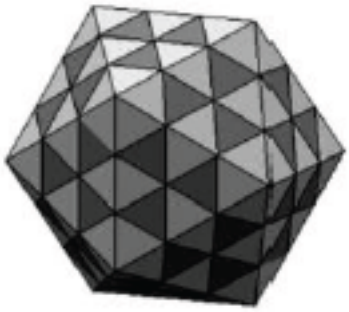
be filled by five-rings of tetrahedra [42 + 12 = 54 vertices]...



... The 54-atom Mackay cluster ...[triangles: dark = octahedra; light = tetrahedra]...

The process can be continued ...[with octahedra on each of the 12x5 = 60 outer cell faces of 5-rings thus adding 60 x (2/2 + 1/3) = 80 vertices and creating **12 TSC structures similar to half-icosahedra at the 12 vertices of the cluster**.

This also creates concave places for 30 pairs of tetrahedra adding no vertices plus 12 tetra-5-rings adding 12 vertices for a total of 54+80+12 = 146 vertices.



The 146-atom cluster **has 12+2 = 14 TSC sites**]...".

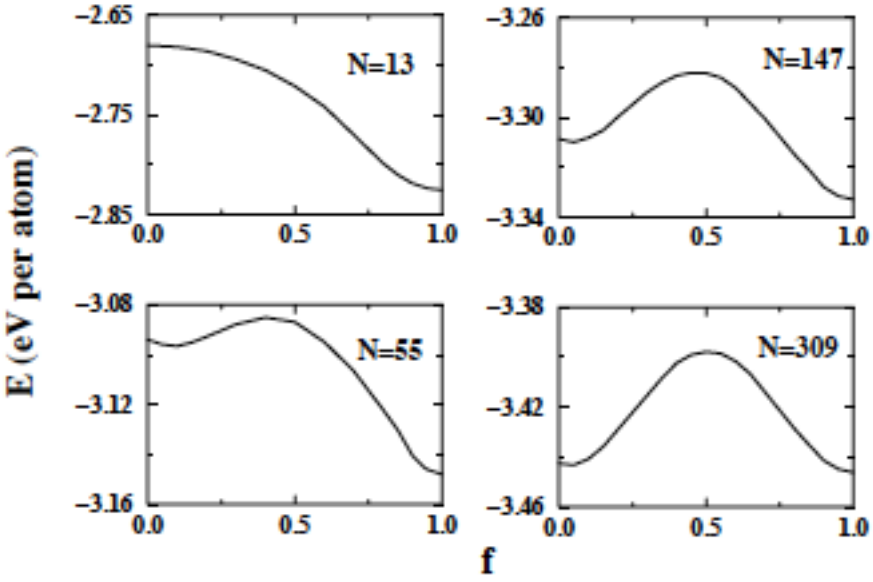
Lord et al use 12, 54, and 146 atoms for Mackay clusters
while Liang uses 13, 55, and 147 atoms.
The difference is whether or not the center vertex is counted, that is,
not so much a real physical difference but a difference in math convention.

What about more than 147 atoms ?

As more layers are added, the deformations of tetrahedra and octahedra accumulate and eventually destabilize the structures necessary for Jitterbug and TSC Fusion.
The next Mackay cluster beyond 147 atoms has 147+162 = 309 atoms.

Barretau, Desjonqueres, and Spanjaard in Eur. Phys. J. D. 11 (2000) 395-402 say:
"... the icosahedron is the preferred structure at small sizes, and the critical size at which the relative stability becomes favorable to cuboctahedrons is N = 561 for PdN clusters ...[for which]... For N = 13 the cuboctahedron is ... unstable.

For N = 55, 147, and 309 atoms the cuboctahedron is metastable and slightly distorted. Its transformation to a perfect icosahedral structure needs an activation energy of 12 meV for N = 55, 28 meV for N = 147 and 45 meV for N = 309. The activation energies involved in the inverse transformation are 61 meV for N = 55, 51 meV for N = 147 and 48 meV for N = 309.
...[compare 47.6 MeV for each TSC Fusion event]...



... The evolution of the potential energy profile of homogeneously relaxed ... PdN clusters during the Mackay [Jitterbug] transformation for increasing values of N. f is a fraction of the displacements ... f = 0 and 1 correspond to the ... cuboctahedron and icosahedron, respectively ...".

N = 309 is disfavored for TSC-Jitterbug Fusion with respect to N = 147 for two reasons:

energy levels are too close for rapid Jitterbug cubocta to icosa transition

N = 309 Pd Cluster is too large (2 nm) to fit through 1.5 nm expanded Sodium Zeolite Y pore

It seems that **147 atoms is optimal for TSC fusion**.

How many D/H atoms can live in a 147-atom Pd/Ni cluster ?

F. Calvo and A. Carre say in Nanotechnology 17 (2006) 1292–1299
"Structural transitions and stabilization of palladium nanoparticles upon hydrogenation":
"... Cuboctahedra ...[and]... icosahedra ... contain exactly the same number of atoms. ... In the case of ... the 147-atom Pd cluster ... the favoured structure in the pure metal is the three-layer icosahedron.

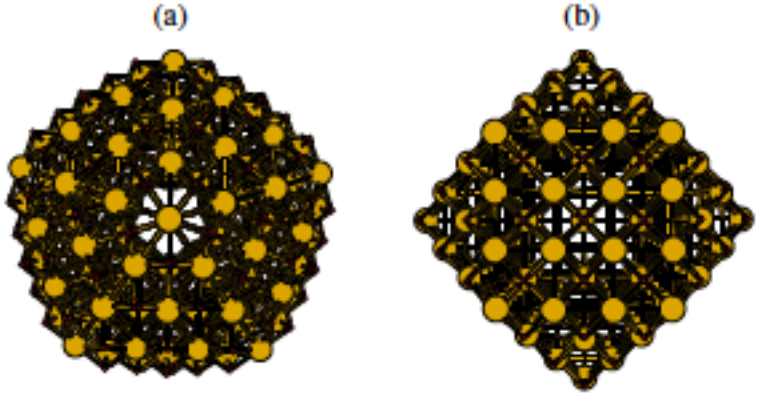


Figure 1. Palladium clusters fully loaded with hydrogen.
(a) $Pd_{147}H_{200}$, I_h symmetry; (b) $Pd_{147}H_{164}$, O_h symmetry.

..."

Since the minimum full load for Icosa or Cubocta Pd/Ni 147-atom clusters is 164 D/H atoms, no more than 3 cycles of full TSC fusion (each consuming 56 D/H nuclei) can occur without replenishment of D/H from the surroundings of the clusters (such as immersion of the clusters in D/H gas).

How long does it take Deuterium to load into Palladium ?

Wang, Hara, and Watanabe in Materials Transactions, Vol. 48, No. 3 (2007) pp. 560 to 565 say:
"... Pure Pd, Pd-4 at%Pt and Pd-8 at%Pt ... powders smaller than 200 mesh (**<**74 **m**m) were prepared ... hydrogen absorption ...[by Pd-4 at%Pt]... was extremely fast and attained to equilibrium within tens of seconds. Hydrogen absorption by Pd and Pd-8 at%Pt was also very fast ...".

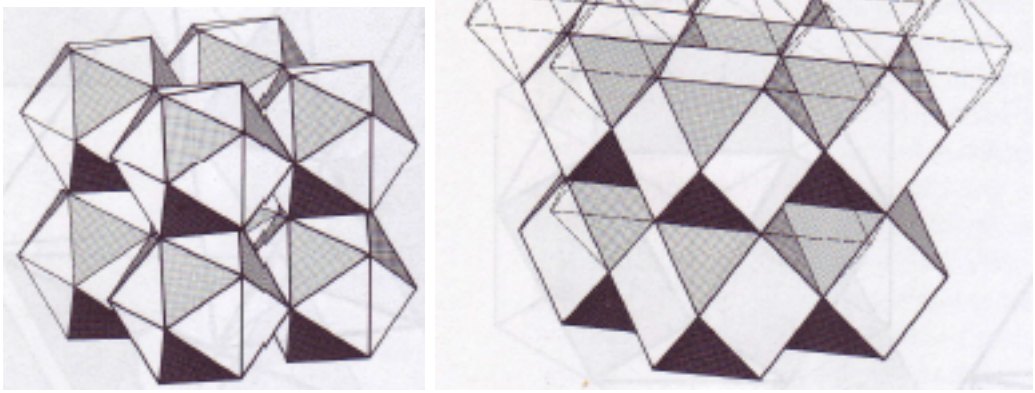
Tens of seconds is much longer than the times for TSC Fusion and for Jitterbug so it determines the time duration of one TSC-Jitterbug Fusion Cycle
and
for the purpose of rough calculations it seems reasonable to take

36 seconds = 1/100 hour = time duration of one TSC-Jitterbug Fusion Cycle.

This time is much shorter than the usual loading time for old-type Cold Fusion experiments using Palladium rods, discs, much-larger-than 1.5 nm powder, etc because there are only 3 layers of Pd atoms in 1.5 nm 147-atom Pd clusters.

What is the Jitterbug Transformation ?

Icosaahedra and Cuboctahedra both have 12 vertices so that it is possible to transform them into each other. Buckminster Fuller called that transformation the Jitterbug



(images from Synergetics by Buckminster Fuller (Macmillan 1975, 1982))

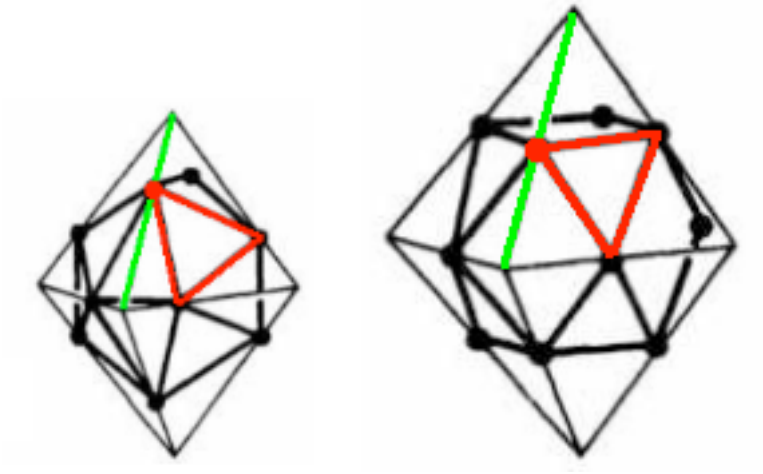
To make Cuboctahedra (unit edge length) from Icosahedra (unit edge length) choose 6 pairs of Icosahedra triangle faces (white in the above images) and lengthen the common edge of each pair by a factor of sqrt(2). That expansion flattens each of the triangle pairs to produce 6 square faces of the Cuboctahedron. The other Icosahedral 20 - 2x6 = 8 (shaded) triangle faces are rotated and become the other 14 - 6 = 8 triangle faces of the Cuboctahedron.

,
thus increasing the number of faces from 8+6 = 14 to 8+(6+6) = 20
while keeping the number of vertices constant at 12.

There are two ways to choose a diagonal of an Icosahedron triangle face pair in the construction, corresponding to the two possible orientations of an Icosahedron.

Choice of diagonal for one Icosahedra triangle face pair forces (by requiring consistency) the choices for all other face pairs of all Icosahedra.

The triangle faces of the Icosahedron/Cuboctahedron are rotated by a Golden Ratio



(images adapted from Geometrical Frustration by Sadoc and Mosseri (Cambridge 2006))

angle defined by
sliding Icosahedron vertices on the edges of a circumscribing Octahedron
from points dividing edges into Golden Ratio segments
to points dividing edges into two equal segments
so that the Octahedron then circumscribes a Cuboctahedron.
If the edge lengths of the Icosahedron/Cuboctahedron are kept the same
then the Octahedron surrounding the Cuboctahedron will be an expansion
of the Octahedron surrounding the Icosahedron.

Just as in the choice of a Cuboctahedron square diagonal to be compressed,
there are two ways in which the edge could be divided into Golden Ratio segments,
corresponding to the two possible orientations of an Icosahedron.

Choice of Golden Ratio segments for one edge forces (by requiring consistency)
the choices for all other edges.

The volume expansion of the Jitterbug Transformation
from Icosahedron (unit edge) to Cuboctahedron (unit edge) is:

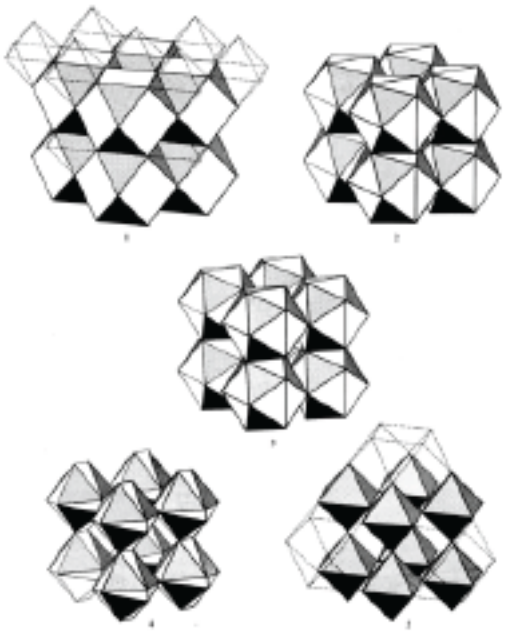
Icosahedron volume = (5/12) (3 + sqrt(5)) = 2.18169499
Cuboctahedron volume = (5/3) sqrt(2) = 2.3570226

Icosahedron/Cuboctahedron volume ratio = 0.9256147947

Cuboctahedron/Icosahedron volume ratio = 1.0803630254

Why do Jitterbug Transformations move D/H among the cluster cells ?

The Jitterbug Transformation proceeds:
from the cuboctahedral state (top left)
to an intermediate state (top right)
to an icosahedral state (center)
to another intermediate state (bottom left)
to a dual cuboctahedral state (bottom right)



(images from Synergetics by Buckminster Fuller (Macmillan 1975, 1982))

and then back up in reverse order to the original cuboctahedral state.

Since the dual cuboctahedral state interchanges octahedra and cuboctahedra with respect to the original cuboctahedral state,

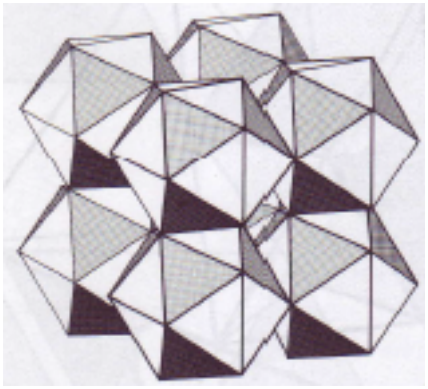
the D/H fusion fuel nuclei are moved from cell to cell
by the Jitterbug transformations

thus enabling

reloading of fusion fuel into the TSC fusion cell sites.

Pd/Ni and D/H Fusion from Jitterbug TSC: Mechanical Analogy

(with Colt Series 80 Government 10 mm Delta Elite version of Browning's M1911 semi-auto)



"... The M1911 ... use[s] ... the short recoil ... action ... Cycle ...

1. Ready to fire position. [Slide] is locked to barrel, both are fully forward.

[Icosahedral Pd with D atoms in TSC positions]

2. Upon firing, [slide] and barrel recoil backwards a short distance while locked together. Near the end of the barrel travel, the [slide] and barrel unlock.

[Firing = D-D Fusion]

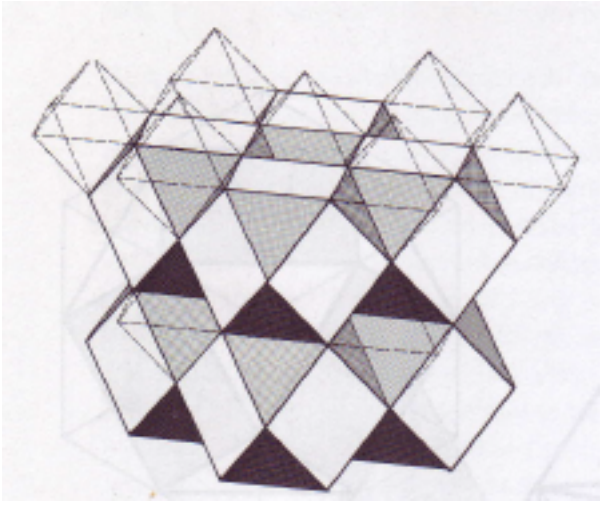
3. The barrel stops, but the unlocked [slide] continues to move to the rear, ejecting the empty shell and compressing the recoil spring.

[Recoil Spring = Icosahedral Stability Phase induces transformation of Cuboctahedra]

4. The [slide] returns forward under spring force, loading a new round into the barrel.

[Loading New Round = Cuboctahedral D atoms moved to Icosahedral TSC positions]

5. [Slide] locks into barrel, and forces barrel to return to battery.

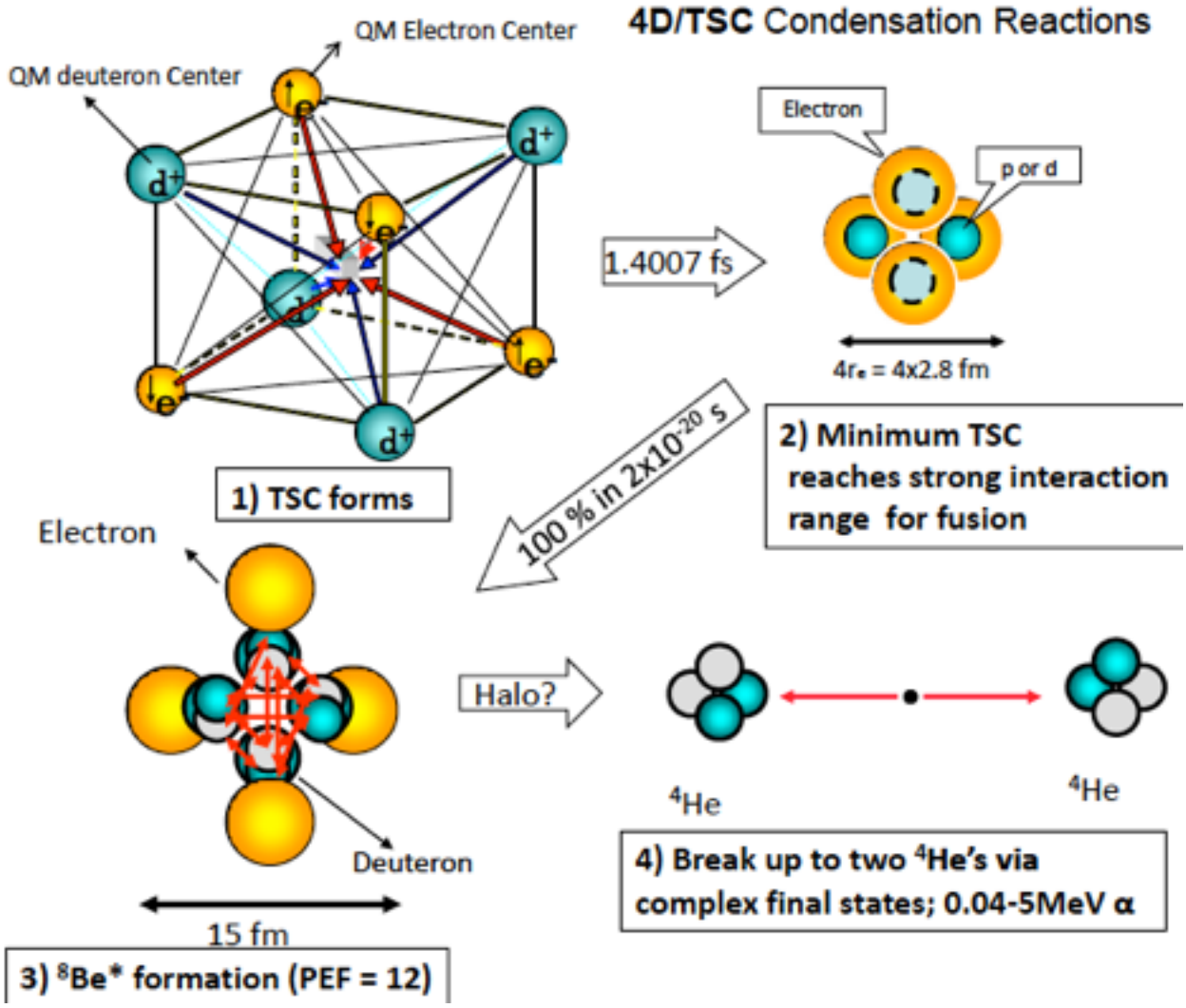


... The very first short-recoil-operated firearm was also the first machine gun, the Maxim gun. ... Vladimirov also used the short recoil principle in the Soviet KPV-14.5 heavy machine gun. ..."

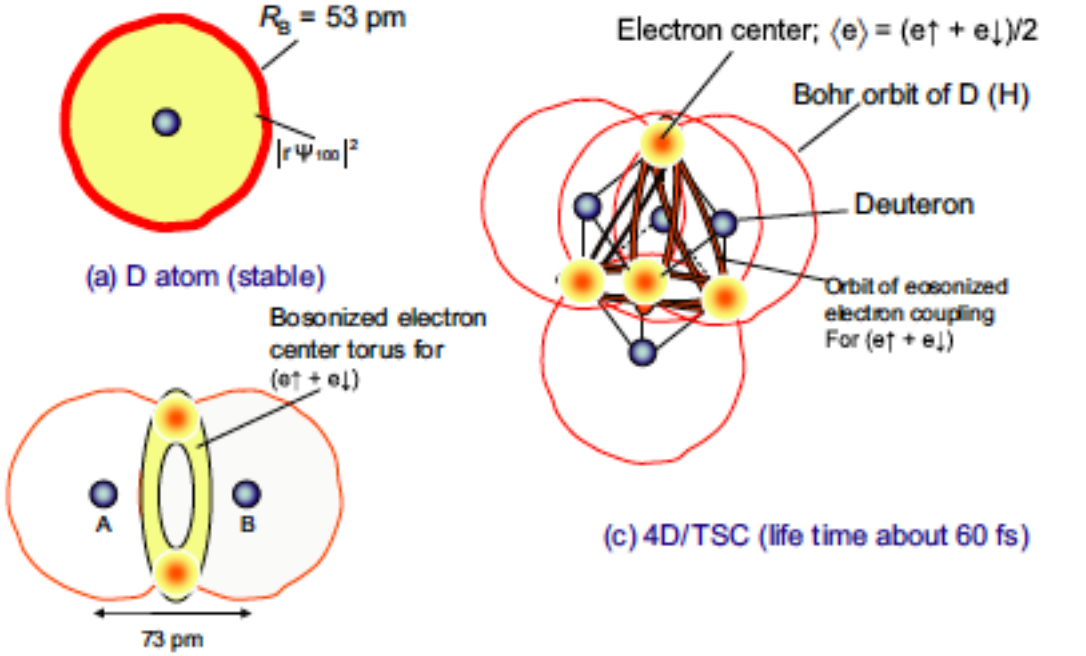
(quote from Wikipedia entries on M1911 pistol and on Recoil operation)

How does TSC Fusion work ?

Akito Takahashi in Physics of Cold Fusion by TSC Theory by Akito Takahashi ICCF17 12-17 August 2012 and J. Condensed Matter Nucl. Sci. 33 (2009) 33-44 and J. Condensed Matter Nucl. Sci. 1 (2007) 129-141 "... proposed ... **deuteron fusion process by ... Tetrahedral Symmetric Condensate (TSC)** ...
Every particle in TSC can make central squeezing motion with same velocity, to keep charge neutrality of total TSC system ... this squeezing motion can be treated as Newtonian mechanics until when four deuterons get into the range (about 5 fm) of strong nuclear interaction. ... TSC starts Newtonian squeezing motion to decrease linearly its size from about 100 pm radius size to ... the minimum size state ... as shown in ... Semi-classical view of squeezing motion of TSC, <e> = (e↓ + e↑)/2 for QM view at four electron centers ...



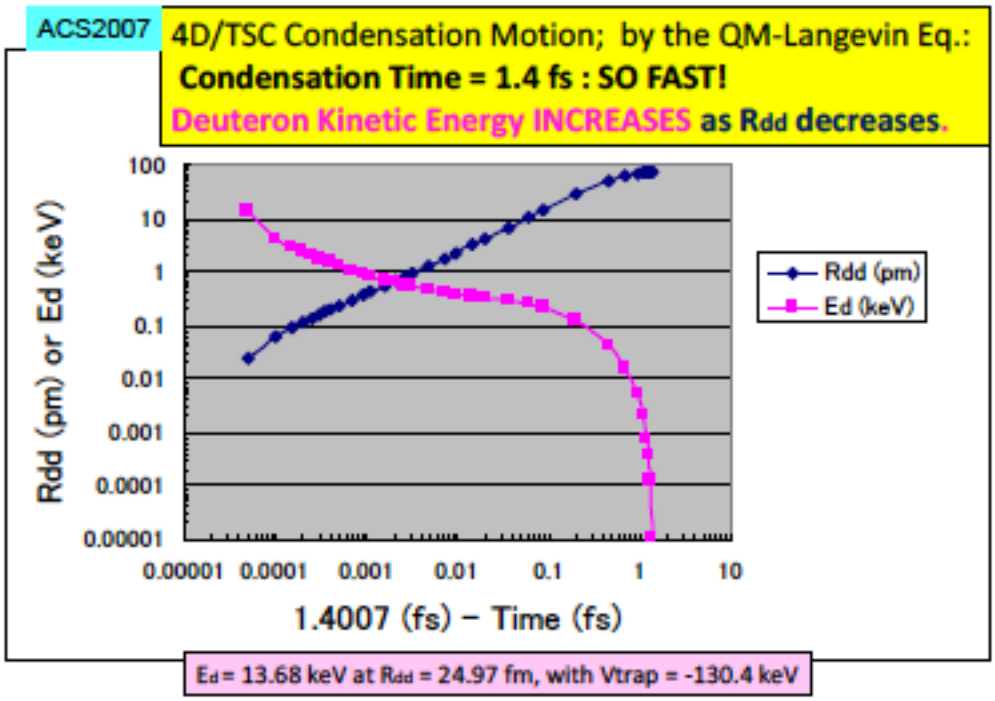
[**Note that the TSC process is spontaneous not requiring initial stimulus**.]
... Classical squeezing motion ends when four deuterons get into the strong force range (5 fm) and/or when four electrons get to the Pauli's limit (about 5.6 fm for e-e distance). Here for Pauli's limit, we used the classical electron radius of 2.8 fm ... Since the range of strong interaction is comparable to the classical electron diameter (5.6 fm) ... the intermediate nuclear state 8Be* will be formed just after the minimum size state ...
Immediately at ... 8Be* formation ... 4d-cluster shrinks to much smaller size (about 2.4 fm radius) of 8Be* nucleus, and four electrons should go outside due to the Pauli's repulsion for fermions. Shortly in about few fs or less (note; Lifetime of 8Be at ground state is 0.67 fs), 8Be* will break up into two 4He particles ...[with energy released of about 47.6 MeV, mostly as photons of a few keV energy each] ... when TSC is just formed ... averaged electron position (electron center of <e> = (e↓ + e↑)/2, Bosonized electron pair ...) ... locates at vertexes of regular cube with tetrahedral combining orbits and outer dilute clouds ...



... At ... cube ... vertexes ... three Bohr wave functions superpose and electron density is about nine times larger than that of outer dilute cloud. Therefore, the semi-classical treatment of central squeezing motion by Newtonian is approximately fulfilled for "coherent"central averaged momentums for eight particles. ...

As soon as 4D/TSC(t=0) state with D2 molecule size (Rdd = 74 pm) is formed ...

the QM-Langevin equation gives numerical solution for time-dependent Rdd and mean relative kinetic energy of d-d pair of a face of 6 TSC (d-e-e-d-type) faces, as copied from reference and shown in Fig.10. ...



... The 'adiabatic' size of 4D/TSC reaches at a few tens fm size in 1.4 fs, so fast. With adiabatic 4D/TSC size around 20 fm, 4D-fusion takes place by ...

D + D + D + D -> 8Be* (Ex= = 47.6 MeV: J*) ...

Fusion yield per 4D/TSC generation is calculated by integrating time-dependent fusion rate by the Fermi's first golden rule ... that was very close to 1.0, namely 100%, during the very small time interval of ca. 2 x 10^(-20) s in the final stage of condensation.

Mean relative kinetic energy of neighboring d-d pair of 4D/TSC-minimum is ca. 14 keV, which is accidental resembling value to the hot fusion experimental devices as ITER (DT plasma).

...

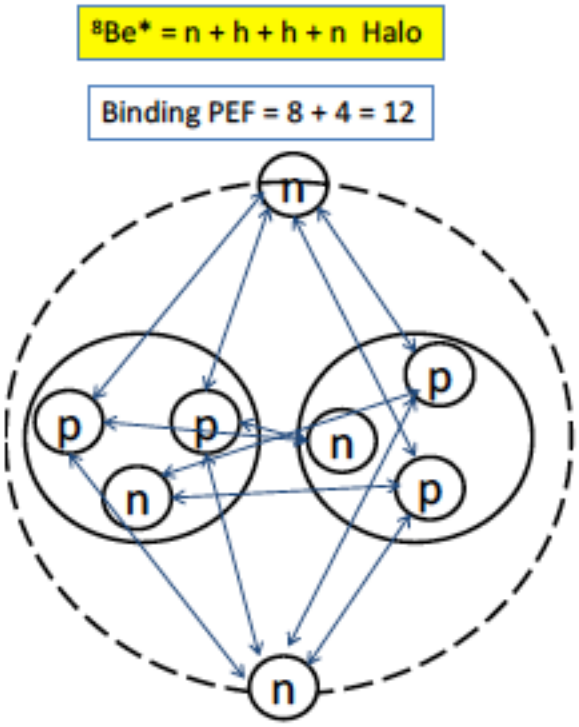
the quantitative study on the TSC formation probability in D(H)-loaded metal systems is yet to be done by solving many-body time-dependent problems under organization field of condensed matter. It is challenging work ...".

Akito Takahashi said in a September 2014 email message:

"… my recent theory of nucleon-halo model (JCF13, attached)
maximum alpha-particle energy from 8Be* by 4D-fusion is 17 MeV …
23.8 MeV alpha particles should not be emitted
either by the 4D-fusion or by the DD fusion …".

His paper JCF13 says

"… The 8Be* (Ex = 47.6 MeV) may damp its excited energy
by major BOLEP (burst of low energy photons) process
from <n-h-h-n> nucleon-helion halo state ...



... to 8Be-ground state …
A complex decay scheme is proposed …

Major decay channel is modeled as an electro-magnetic transition of BOLEP
to the 8Be-ground state which breaks up into two 46 keV alpha-particles ...
BOLEP is modeled as emission of ... stochastic burst events
of ca. 1.5 keV averaged energy photons ...
Minor channels are modeled as BOLEP transitions to lower ... states
(Ex = 34, 27.5, 22.98, 22.0, 20.1, 16.6, 11.4 and 3.04 MeV),
from where two-alpha beak-up channels open ... emit[ting] ... alpha-particles at
17, 13.8, 11.5, 11, 10, 8.3, 6.9, 5.7 and 1.55 MeV
... which meets ... with observed data by Roussetski et al ...
The asymmetric break-up from the EX = 34 MeV state
has a branch to emit 5.2 MeV triton,
which will induce secondary D-t reaction ... to emit 9-19 MeV (En) neutrons ...".

47.6 MeV x 14 TSC Sites / 147-atom Pd Cluster x 4.45 x 10^(-17) Watt-Hours / MeV =
= **2.965 x 10^(-14) Watt-Hours / 147-atom Pd Cluster for each Jitterbug Cycle**

Mass of 147-atom Pd Cluster 147 x 106 x 1.66 x 10^(-21) = 2.587 x 10^(-17) milligrams
so **a milligram of 147-atom Pd Clusters gives about 1 KiloWatt-Hour each Cycle**

Iraj Parchamazad Experiments show Heat from Pd Clusters of the size required for Jitterbug / TSC Fusion

The size required for Jitterbug / TSC Fusion is a Palladium atomic cluster whose ground state is icosahedral and can easily Jitterbug Transform into a cuboctahedral state and whose size is large enough to contain several TSC Fusion Cluster sites, which are a half-icosahedron plus an octahedron.

The 13-atom Pd/Ni cluster (0.70 nm) has a full icosahedron (two half-icosahedra) but does not have the necessary octahedron, so it is too small to contain a TSC Fusion Cluster site.

The 2-shell 55-atom Pd/Ni cluster (1.13 nm) has a full icosahedron (two half-icosahedra) and two octahedra for only 2 TSC Fusion Cluster sites.

Clusters of between 56 and 147 atoms contain from 2 to 14 TSC Fusion Cluster sites by partially fillng the 3rd shell of atoms.

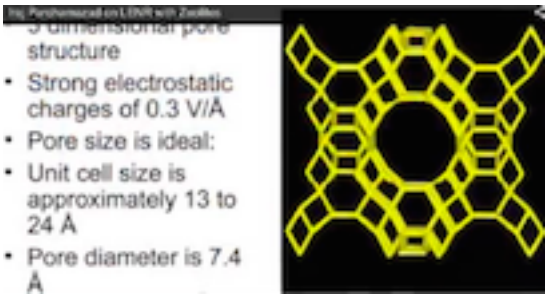
The 3-shell 147-atom Pd/Ni cluster (1.56 nm) has the 2 TSC Fusion Cluster sites of the 55-atom Pd/Ni cluster plus 12 more half-icosahedra in its outer shells along with octahedra for each, so it contains 14 TSC Fusion Cluster sites.

Clusters of between147 and 309 atoms contain at least 14 TSC Fusion Cluster sites
The 4-shell 309-atom Pd/Ni cluster is 2.00 nm in size, so it is disfavored with respect to the 3-shell 147-atom cluster for use with Sodium Zeolite Y whose pore size is 0.74 nm expandable to 1.5 nm.

Iraj Parchamazad has experimented with Palladium embedded in Zeolites, getting consistent heat production.

Iraj Parchamazad uses **Sodium Zeolite Y**
also known as faujasite. The Wikipedia page for faujasite says:
"... The faujasite framework consists of sodalite cages which
are connected through hexagonal prisms.
The pores are arranged perpendicular to each other.
The pore, which is formed by a 12-membered ring,
has a relatively large diameter of 7.4 Å [0.74 nm]
The inner cavity has a diameter of 12 Å [1.2 nm]
and is surrounded by 10 sodalite cages. ...".

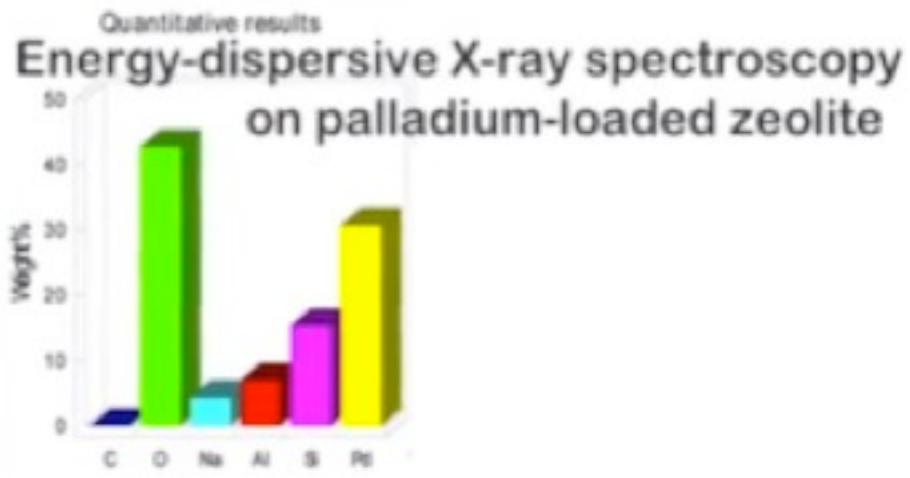
Ruby Carat and Melvin Miles interviewed Iraj Parchamazad of University of La Verne in 2012. In that video interview Iraj Parchamazad said that the Zeolite cavity size can oscillate and vary, enlarging up to about 2.4 nm.



A corresponding enlargement of pore size is to about 1.5 nm
which would permit a 3-shell 147-atom Palladium cluster to enter the Zeolite Cavity.

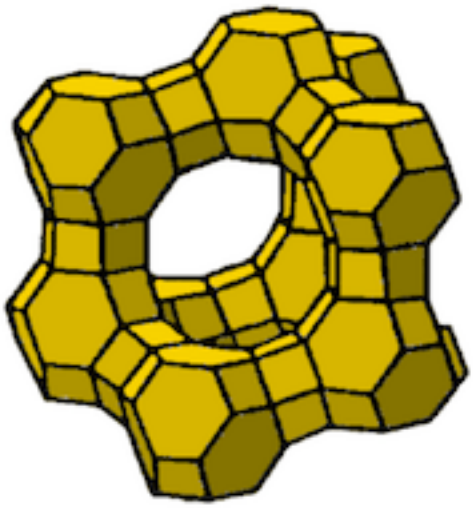
Iraj Parchamazad did not use Sandia's 1.5 nm Palladium clusters in his Zeolite
but
used an organometallic solution containing Palladium atoms.
After putting that into the Zeolite he heated the Zeolite
to burn off Carbon, Hydrogen, and Oxide
leaving a Zeolite and some Palladium.
Then he exposed the Zeolite/Palladium to Deuterium,
and got excess heat 10 out of 10 times, indicating fusion.

As to how much Palladium was put into the Zeolite, he found



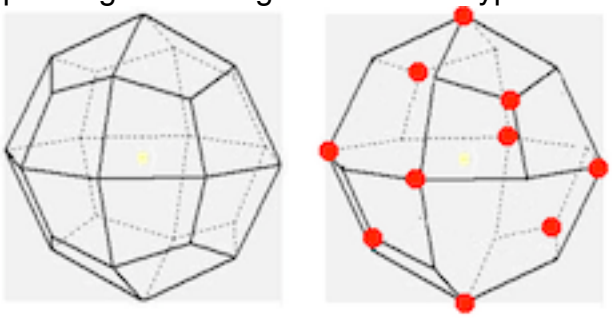
To use those results to see how many Palladium atoms were in each Zeolite Cavity, look at the detailed structure of Sodium Zeolite Y.

Each Zeolite Cavity is surrounded by 10 sodalite cages which are arranged in a 3-dimensional Diamond network as shown in this image



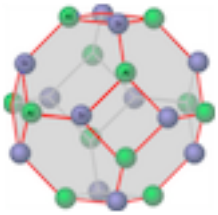
from
http://www.vurup.sk/sites/vurup.sk/archivedsite/www.vurup.sk/english/products/molek/slovsit1/english.html

The Zeolite Cavity has geometric symmetry related to an isometric trapezoid
with the 4 holes corresponding to deleting 4 octahedral-type 3-face groups



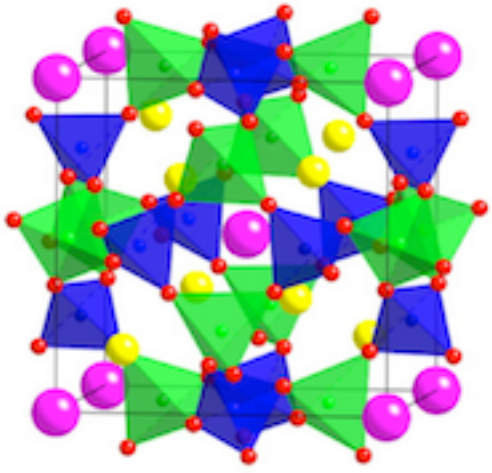
The 10 red dots correspond to the 10 sodalite cages.

Each sodalite cage is a 24-vertex truncated octahedron as in this image from Wikipedia



A more detailed view of a sodalite cage from
http://som.web.cmu.edu/structures/S099-sodalite.html

has red dots for Oxygen and pink spheres for OH and yellow spheres for Sodium
and blue tetrahedra for Silicon and green tetrahedra for Aluminum



It shows that of the 24 vertices of the sodalite cage,
12 are Aluminum and 12 are Silicon
so
each Zeolite Cavity has 10 x 12 = 120 Aluminum atoms.

To see the number of Aluminum atoms in each Zeolite Cavity
look at Iraj Parchamazad's graph of the weights of Aluminum and Palladium
and consider that their Atomic Weights are 27 for Aluminum and 106 for Palladium.
Looking at the graph,
it appears that the weights are about 7 for Aluminum and 32for Palladium
so **the number of Palladium atoms in each Zeolite Cavity** is about

Npd/z = 120 x (32 / 7) x (27 / 106) = 140 atoms

which is roughly equal to the number of atoms (147) in a 3-shell Pd atomic cluster

The 3-shell 147-atom icosahedral Palladium atomic nanocluster
contains 14 TSC Fusion Sites
and each TSC Fusion event produces 47.t6 MeV

47.6 MeV x 14 TSC Sites / 147-atom Pd Cluster x 4.45 x 10^(-17) Watt-Hours / MeV =
= **2.965 x 10^(-14) Watt-Hours / 147-atom Pd Cluster for each Jitterbug Cycle**

Mass of 147-atom Pd Cluster 147 x 106 x 1.66 x 10^(-21) = 2.587 x 10^(-17) milligrams

so that **a milligram of 147-atom Pd Clusters**
can produce roughly 1 KiloWatt-Hour
in each TSC-Jitterbug Fusion Cycle

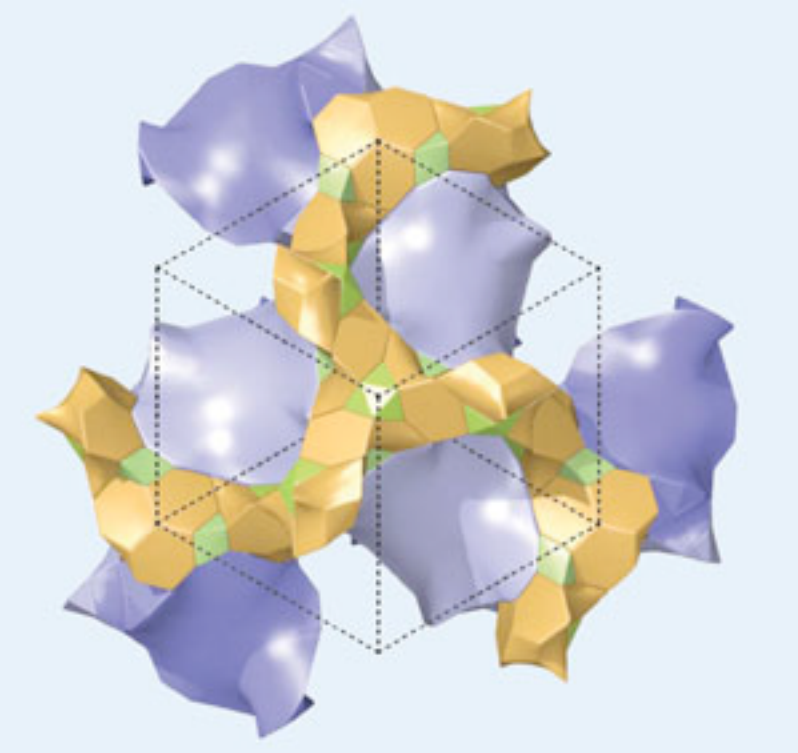
If 36 seconds = 1/100 hour is taken as the Cycle time
then

a TSC-Jitterbug Fusion device with 1 milligram of Palladium
in the form of 147-atom Pd clusters with D-Loading
should produce 100 KiloWatt-Hours in an hour.

147-atom Pd clusters have diameter about 1.5 nanometers.
1.5 nm Pd Clusters have been produced
at Sandia National Laboratories
and University of New Mexico Center for Micro-Engineered Materials
according to a Journal of Catalysis article "Facile, surfactant-free synthesis of Pd nanoparticles for heterogeneous catalysts" at
http://www.flintbox.com/public/filedownload/2871/2011-038%20Science%20Direct%20Article
by Patrick D. Burton, Timothy J. Boyle, and Abhaya K. Datye.

I would like to see experiments
with Zeolite directly using Sandia 1.5 nm Palladium NanoClusters.

If there is difficulty with getting the Sandia Clusters
to fit into the Sodium Zeolite Y
then
I would like to see experiments
with Zeolite ITQ-37



which has pore size about 2 nanometers.
(Royal Society of Chemistry, 29 April 2009 and Sun et al, Nature 2009)

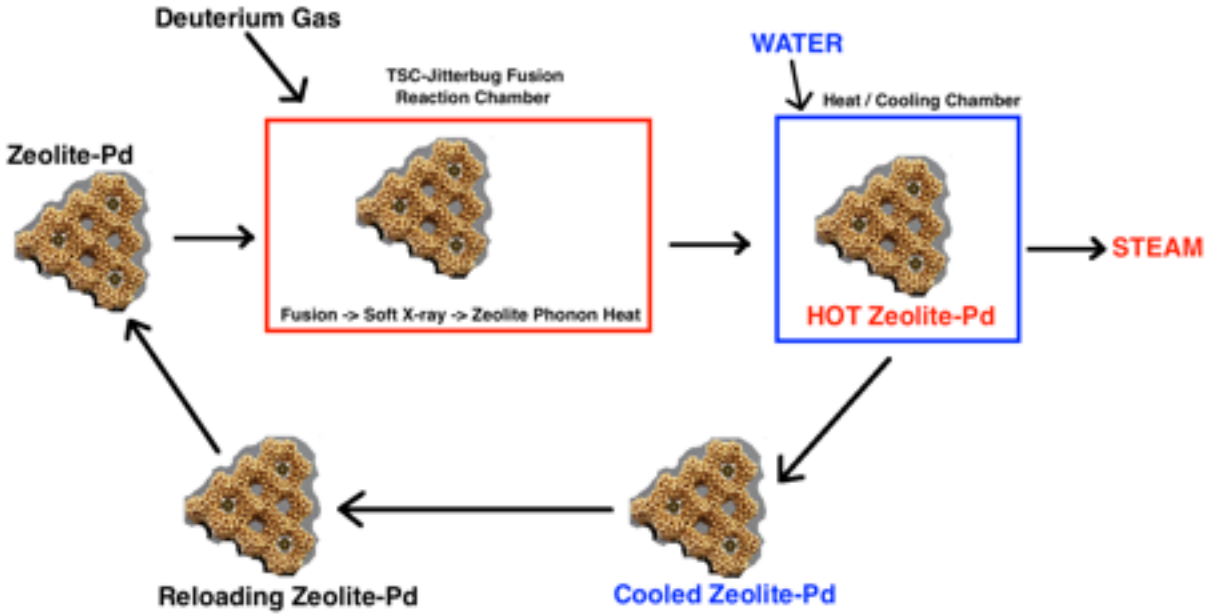
After Palladium TSC - Jitterbug Zeolite fusion has been established the next step is production of useful amounts of energy.

Most of the TSC fusion energy is in photons of a few keV energy, which energy can be used as **Heat** or in an **UltraCapacitor**:

Heat

According to a 7 June 2012 techthefuture.com web article by Tessel Renzenbrink:
"... Zeolite is a mineral that can store up to four times more heat than water ... zeolite retains a hundred percent of the heat for an unlimited amount of time ... When water comes into contact with zeolite it is bound to its surface by means of a chemical reaction which generates heat. Reversely, when heat is applied the water is removed from the surface, generating large amounts of steam.
The transference of heat to the material does not cause its temperature to rise. Instead, the energy is stored as a potential to adsorb water. The ...[German Fraunhofer Institute]... scientists used these particular properties to turn zeolite into a thermal storage system. They created a storage device and filled it with zeolite pellets.
To charge the pellets, they exposed them to heat.
To retrieve the energy they simply added water. ...".

Here is my design for a TSC-Jitterbug Zeolite Pd-D fusion heat engine:



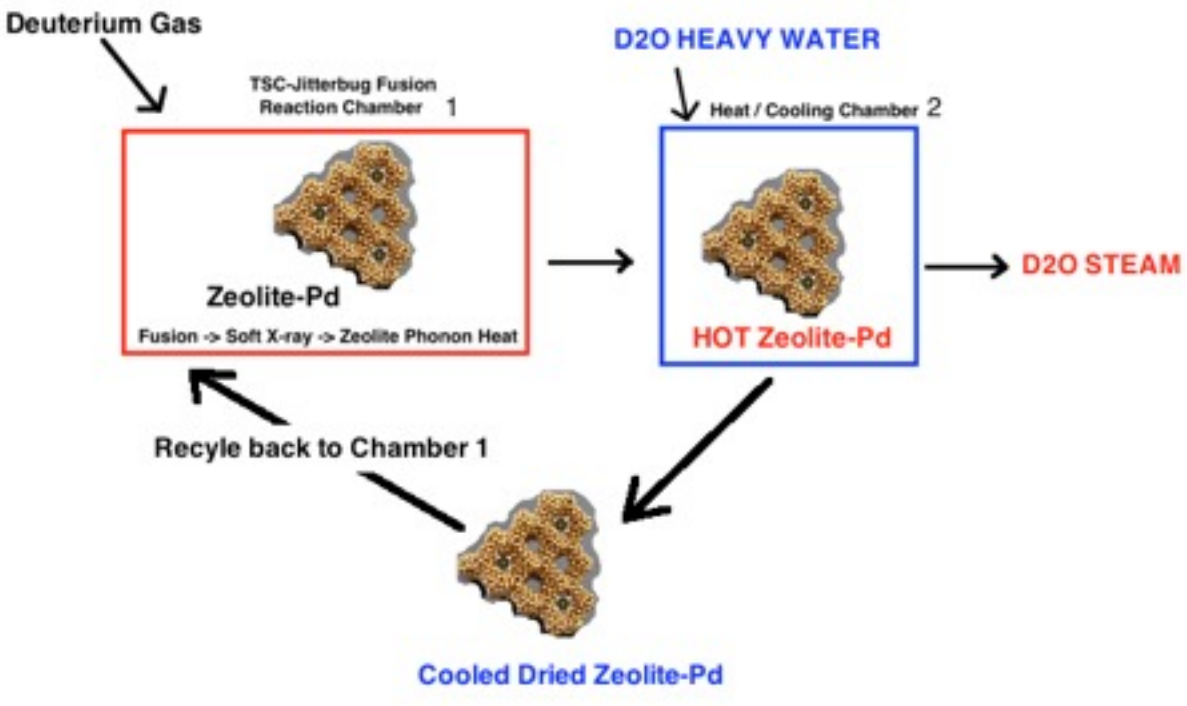
(Zeolite-Pd images adapted from
Calvo amd Carre in Nanotechnology 17 (2006) 1292-1299 and from
http://gwenbeads.blogspot.com/2014/04/infinite-skew-polyhedron-faujasite-4446.html)

In October 2014 Melvin Miles raised an issue that worries me, asking
"… would … the D in Pd-D … exchange with H in H2O …" ?
and saying
"… many experiments have shown that H acts as a poison
in stopping the excess heat effect in the Pd-D system …".

It would be nice if the proposed experiment showed that
the H2O only interacted with the Zeolite itself to extract heat and produce steam
but did not do any exchange of H for D in the D-loaded Pd inside the Zeolite cavities
however things do not always turn out "nice" (which is why we do experiments)
so if experiment does show H for D poisoning of the Pd clusters
(therefore interfering with the TSC process)
then how to change the setup to get rid of that problem ?

Here is my suggestion: Use Heavy Water D20 in the second chamber

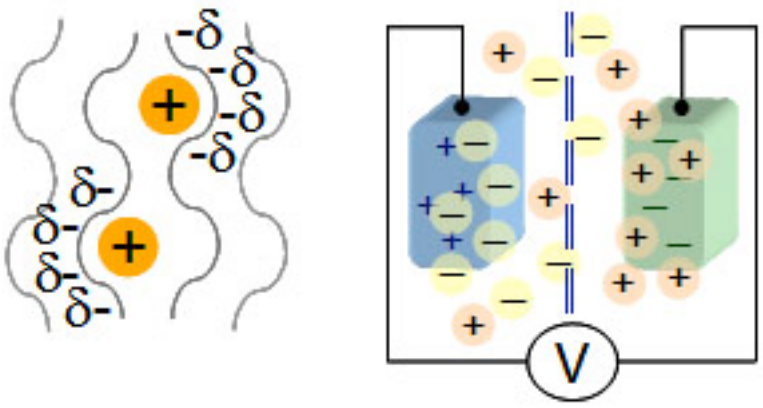
It would be more expensive - price about $1,000 per liter for 99.8 atom % D
according to Fisher Scientific
http://www.fishersci.com/ecomm/servlet/fsproductdetail?productId=806445&campaign=GblChem-US_Acros-Organics-US&adwordskeyword=heavy%20water&adgroup=Deuterium-Oxide&gclid=CL_zh8SLtMECFRJp7Aod6xgAwg
but if the D from D2O were to exchange with D in loaded Pd nanoclusters
there would be no poisoning problem.



By recycling the D2O steam maybe the D2O Heavy Water expense would be mostly
a front-loaded capital expense and not a continuing operating expense.

UltraCapacitor

Victoria Soghomonian of Virginia Tech said "... In an electrically conducting zeolite-like material, an electrical double-layer may form between a charge in a pore and the framework, resulting in electrical double-layer capacitive electrical energy storage. The ionic electrical double-layer (EDLC) forms the basis for ultracapacitors, here formed between mobile ions in an electrolyte and electrons in a conducting substrate. ...



... left panel in figure illustrates how the double-layer concept carries over to a zeolite-like material, where a positive charge residing in a zeolite pore may induce a distribution of compensating charges from electrons in the framework.
The schematic concept of an EDLC with two conducting zeolite-like frameworks attached to an external voltage source, is depicted in the right panel ...
An ion membrane is located in-between, permeable to the electrolyte ions.
One framework is positively charged and hosts negative ions inside its structure, the other vice-versa.
Experimentally, we set up a model consisting of two single crystals immersed in KCL solution. Modeling the set-up with circuit elements to best fit to the observed curves, we deduce that the framework shows an expected improvement in capacitance over mesoporous carbon. ...".