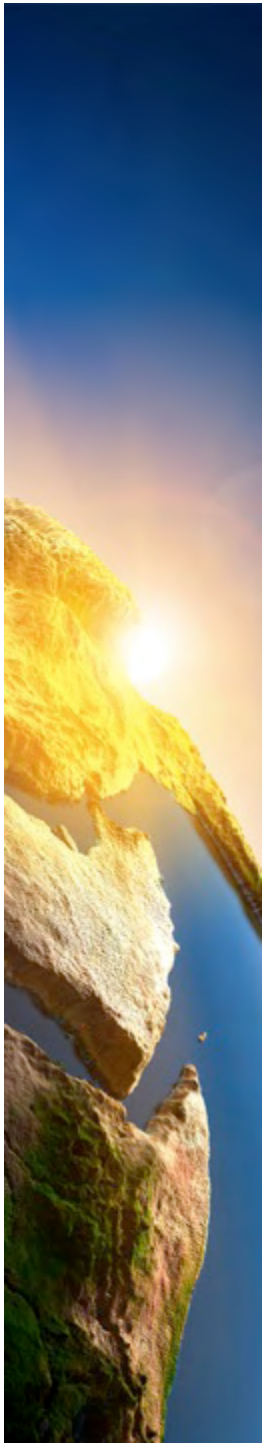
E-Cat Technology

ECAT – a paradigm shift in green energy production »

March 2012



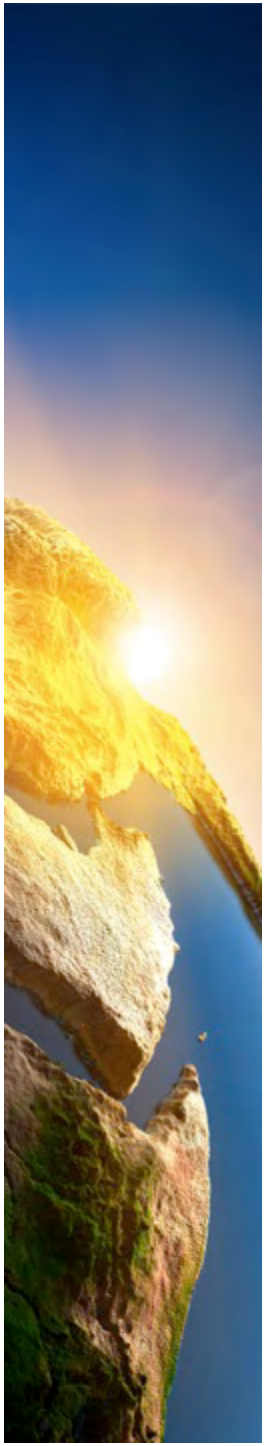
Background

» Andrea Rossi, Italian Inventor (1950)

» Holds several patents in chemistry and physics

» Worked with Department of Defense (DoD) and Department of Energy (DoE) in United States

» US Company Leonardo Corporation (1996)



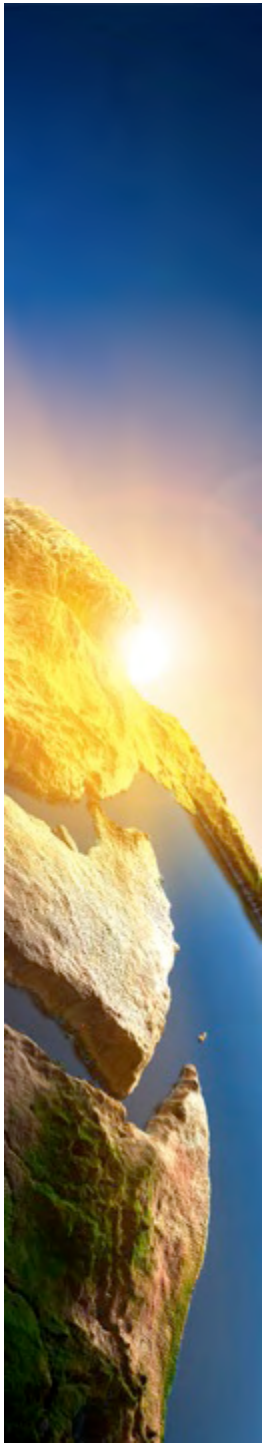
The E-Cat

» The ECAT generates energy by fusing Nickel with Hydrogen to produce Copper.

» This is an exothermic reaction (i.e. produces excess energy).

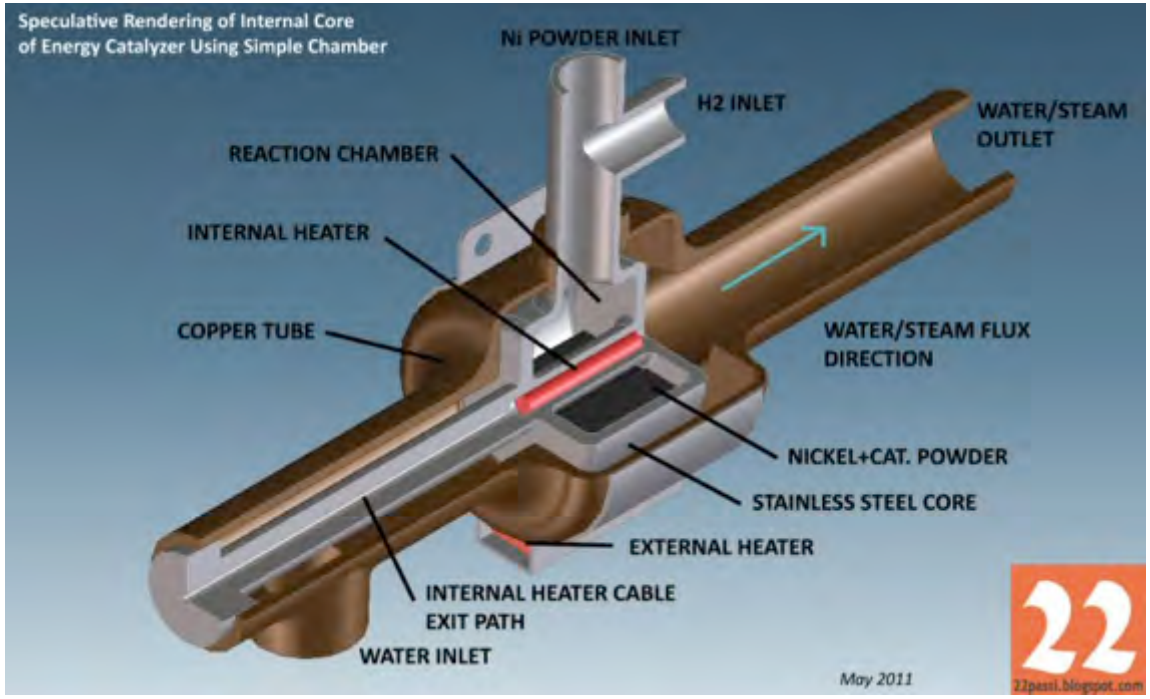
» Invented in 2007 by Andrea Rossi

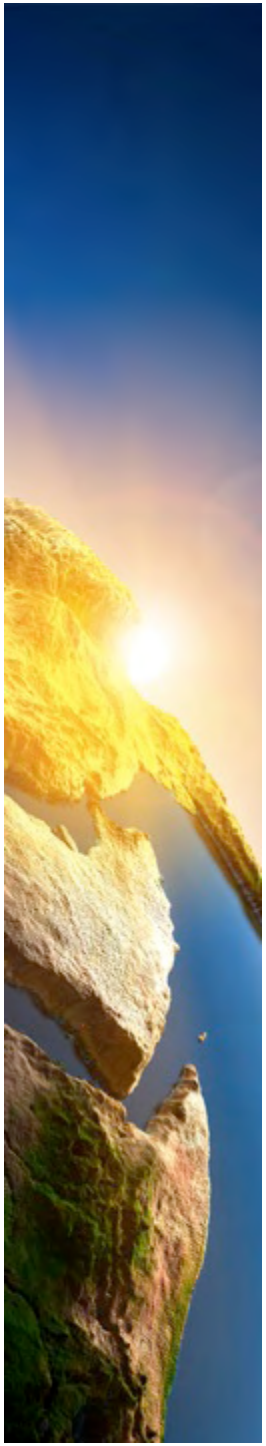
» Currently in two models: 10kW and 1MW Units



Patent

- Patent granted in Italy April 6, 2011 (filed in 2008).
- Italian patent number BO2010E000076.
- International patent applications in progress.



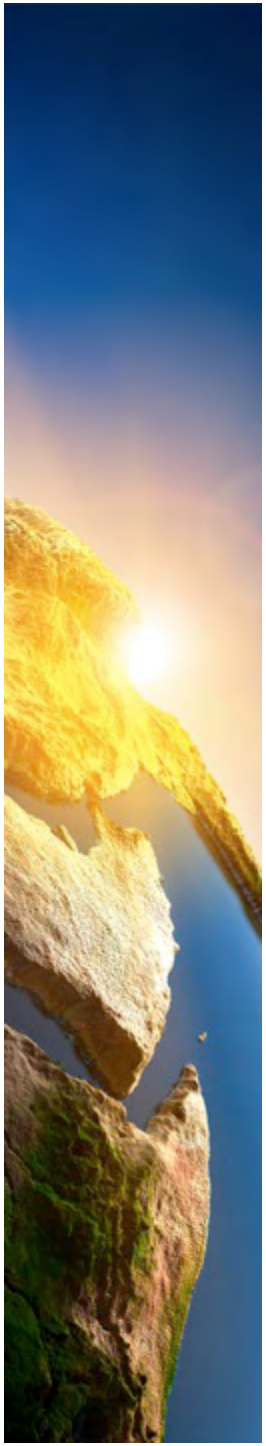


Environmental Aspects

» Environmental friendly reaction substances (Hydrogen and Nickel)

» Environmental friendly waste products (Nickel and Copper)

» No radioactive waste, no pollution, no CO_2.



Sources of Energy

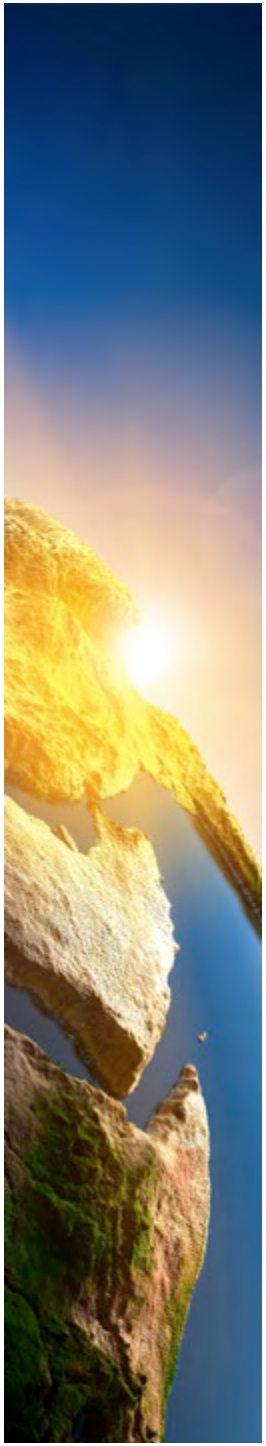
	Pollution Free	Very Safe	In-exhaus-tible	Unlimited	Low Fuel Cost	Low Reactor Cost	Compact	Locate Anywhere	Working 24/7 (4)	Ready Now
Fossil Fuel						✓	✓	✓	✓	✓
Hydro-electric	✓	✓	✓		✓	✓	✓			✓
Wind	✓	✓	✓		✓					✓
Solar	✓	✓	✓		✓					✓
Uranium Fission	(1)		✓	✓	✓		✓	(3)	✓	✓
Plasma Fusion	(2)		✓	✓	✓		✓	(3)	✓	
E-Cat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

(1) Fission reactors produce no pollution during operation, but uranium mining does, and the disposal of radioactive waste (radwaste) and spent fuel are serious and expensive problems.

(2) According to a Los Alamos study, plasma fusion reactors would produce about the same amount of nuclear waste that conventional, present-day fission reactors do, they would not be commercially competitive with advanced fission reactors, and they would not have significant environmental, safety and health (ES&H) advantages over advanced fission.

(3) Fission reactors are located far from cities because there is some risk they will fail catastrophically, and plasma fusion reactors would probably produce large amounts of dangerous radwaste, so it would not be prudent to locate them near population centers.

(4) “Works 24/7” means the energy source is available on demand, and it is available at night, unlike solar energy. Solar or wind energy might converted to hydrogen and stored for times when they are not available, but this would increase cost. Hydroelectric power has to be reduced during droughts. Any energy system must be turned off periodically for maintenance.



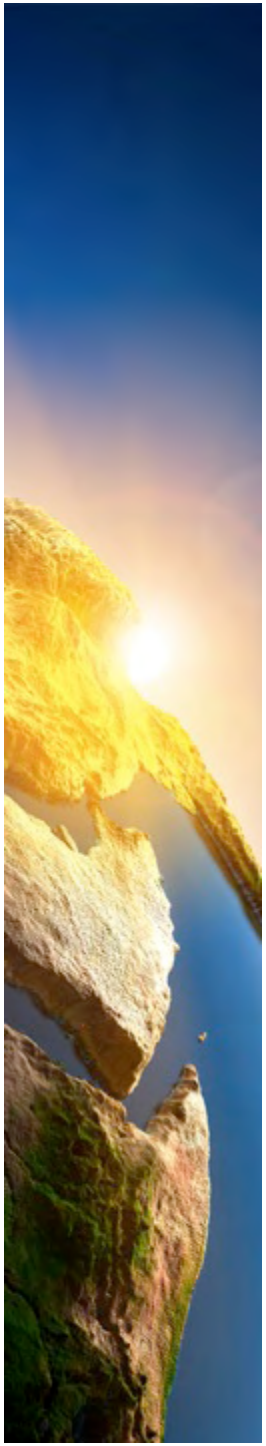
Financial Aspects

» Cheaper than any feasible alternative currently on the market (in terms of size and environmental factors).

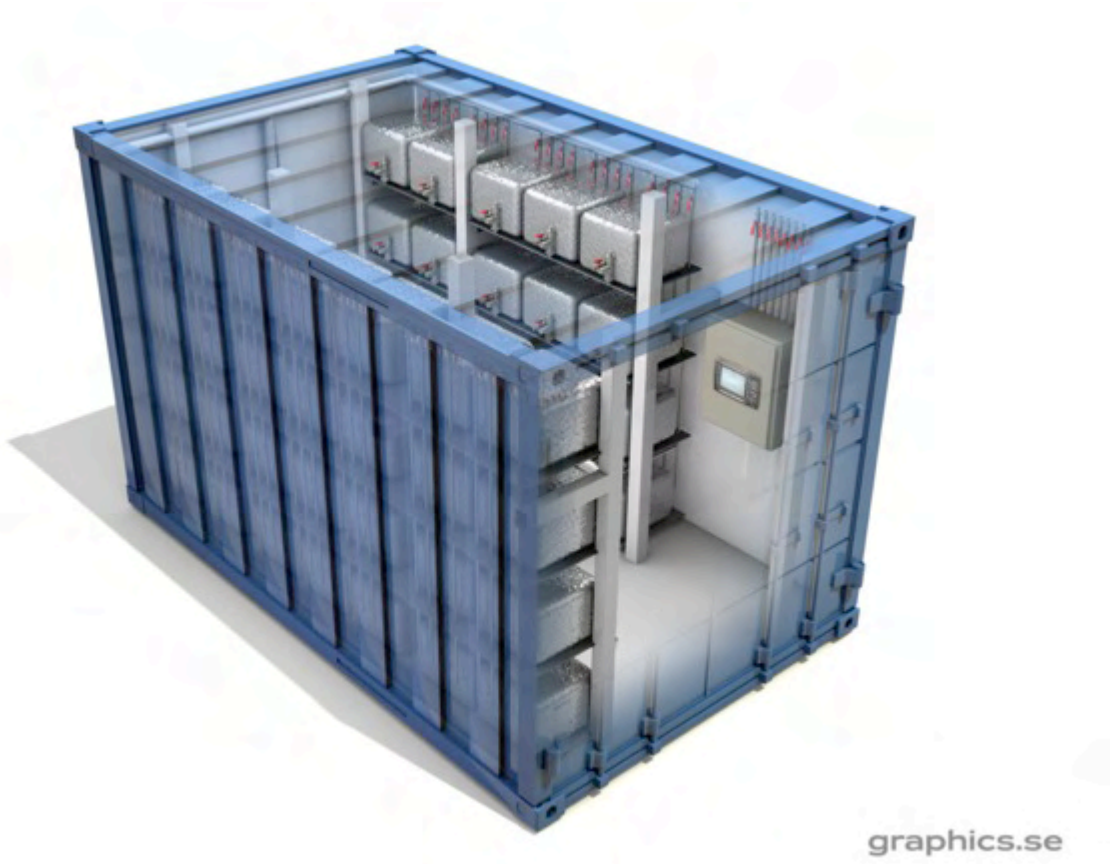
» No CO2 tax.

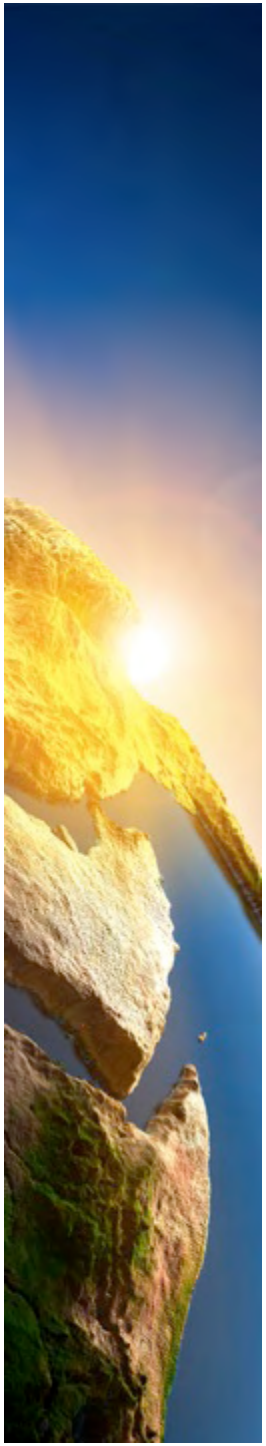
» Potential governmental eco grants in future.

» High Return of Investment (ROI)

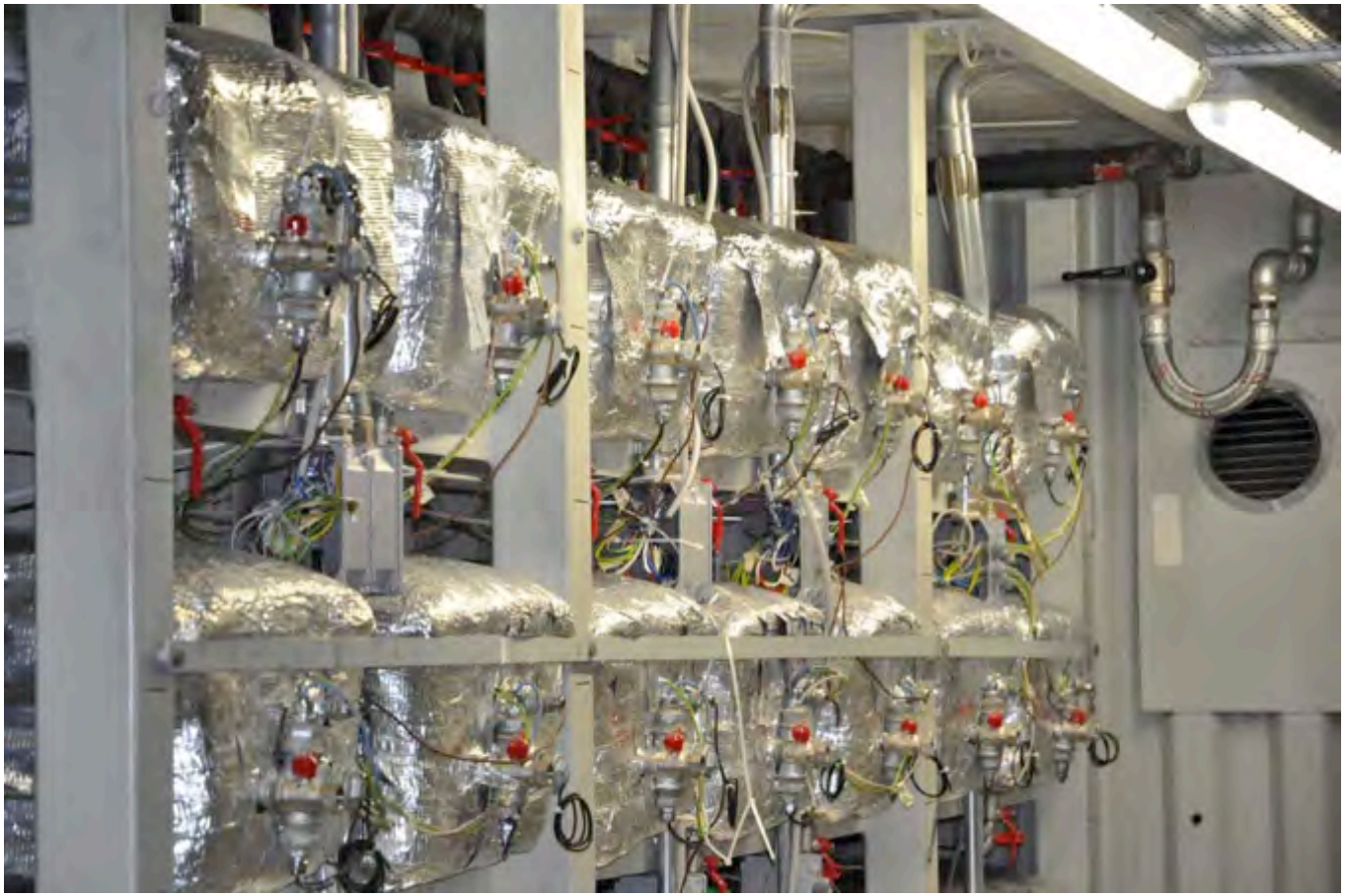


ECAT 1 MW Plant

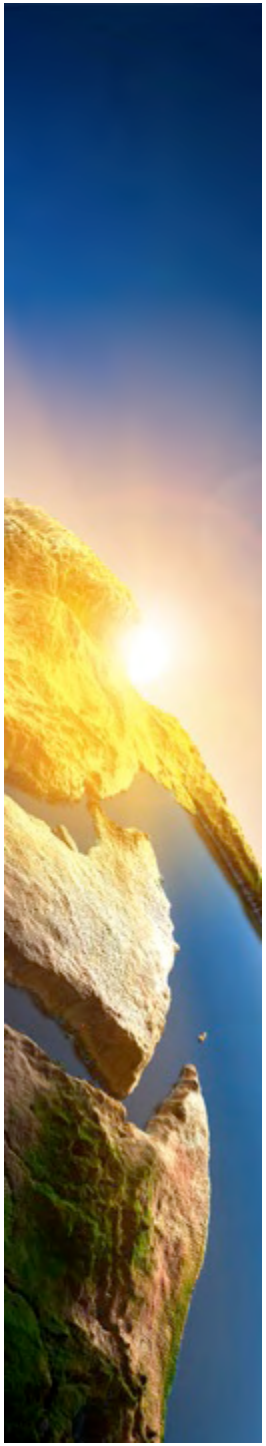




ECAT 20 kW Modules

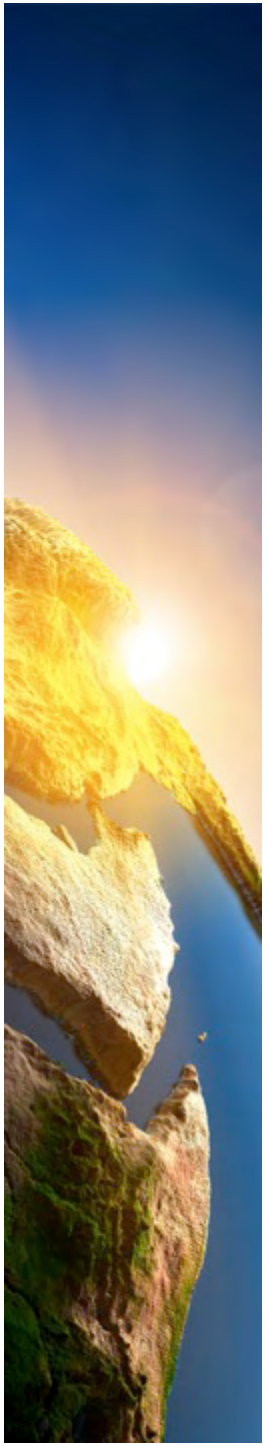


ECAT 1 MW Pictures



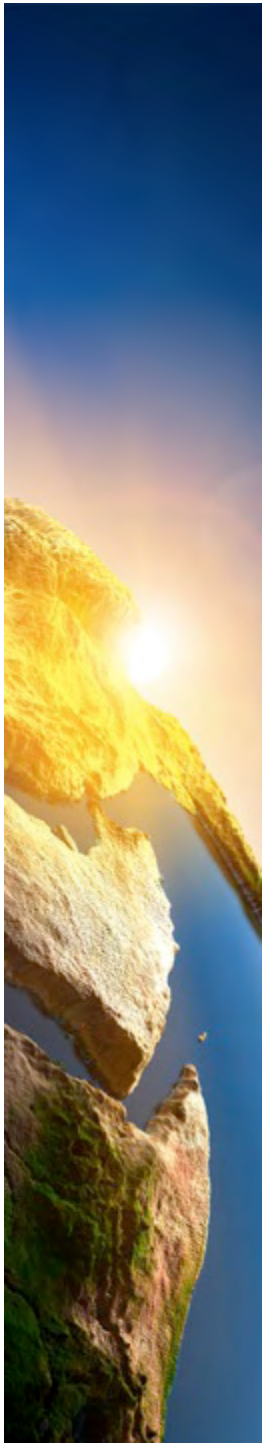
ECAT 1 MW Specifications

Thermal Output Power	1 MW
Electrical Input Power Peak	200 kW
Electrical input Power Average	167 kW
COP	6
Power Ranges	20 kW-1 MW
Modules	52
Power per Module	20kW
Water Pump brand	Various
Water Pump Pressure	4 Bar
Water Pump Capacity	1500 kg/hr
Water Pump Ranges	30-1500 kg/hr
Water Input Temperature	4-85 C
Water Output Temperature	85-120 C
Control Box Brand	Proprietary Hardware
Controlling Software	Proprietary Software
Operation and Maintenance Cost	$1/MWhr
Fuel Cost	$1/MWhr
Recharge Cost	Included in O&M
Recharge Frequency	2/year
Warranty	2 years
Estimated Lifespan	30 years
Price	$1.5M
Dimension	2.4×2.6x6m



Associated Costs

- Operation and Maintenance Cost (including recharge cost) $1/MWhr (0.1 cent/kWhr)
- Fuel Cost $1/MWhr (0.11 cent/kWhr)
- Recharge frequency: twice per year
- Warranty: 2 years
- Estimated lifespan: 30 years
- Electrical input for operation



Leonardo Corp. Collaborations

National Instruments

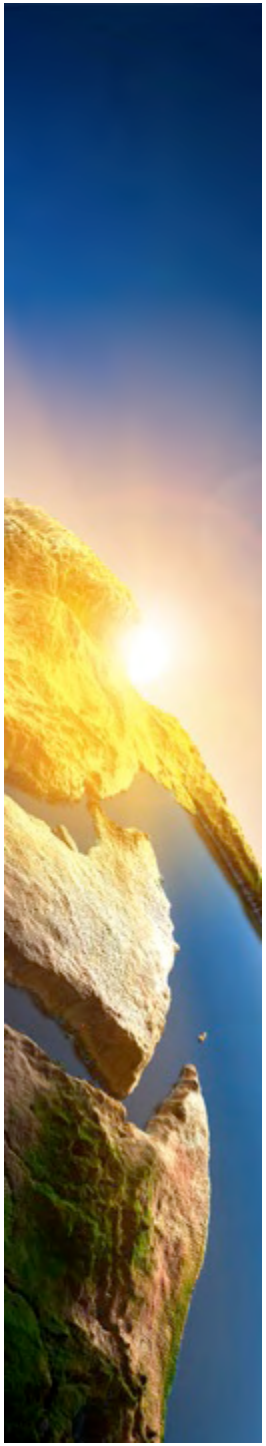
- control box and controlling software

Siemens

- electrical solution >25MW

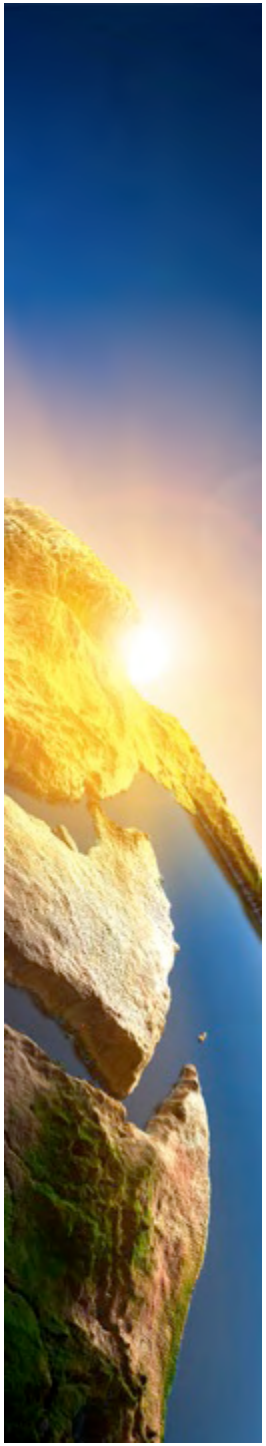
E-Cat-Australia.com

and other sales and licenses around the world



Cold Fusion Process

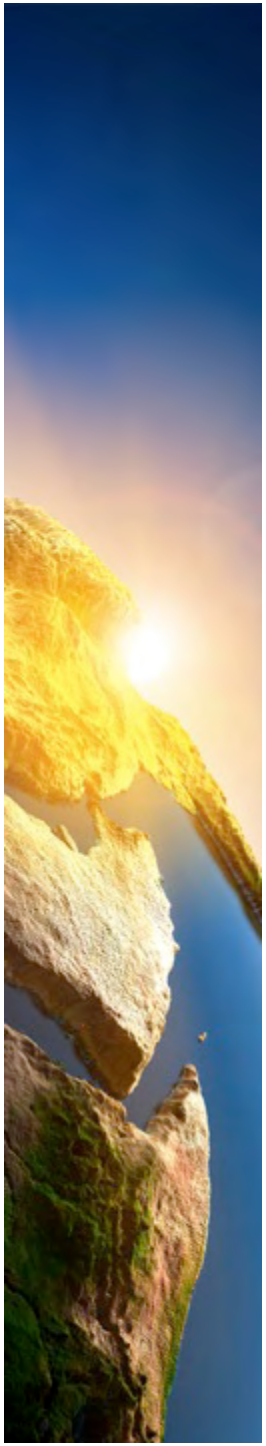
- Exotermic reaction between Nickel and Hydrogen
- Response time (On 30-60 min, Off 30 min)
- Effect density (100kW/l)
- Energy density (100 000x oil)
- Energy reserves (10 billion years)



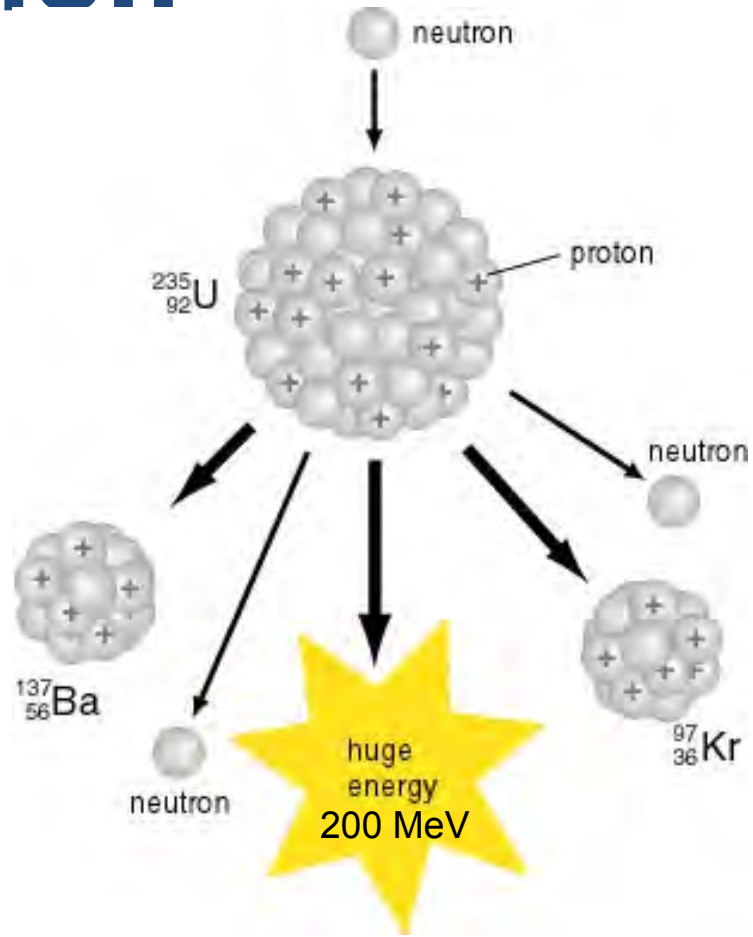
Chemical Energy

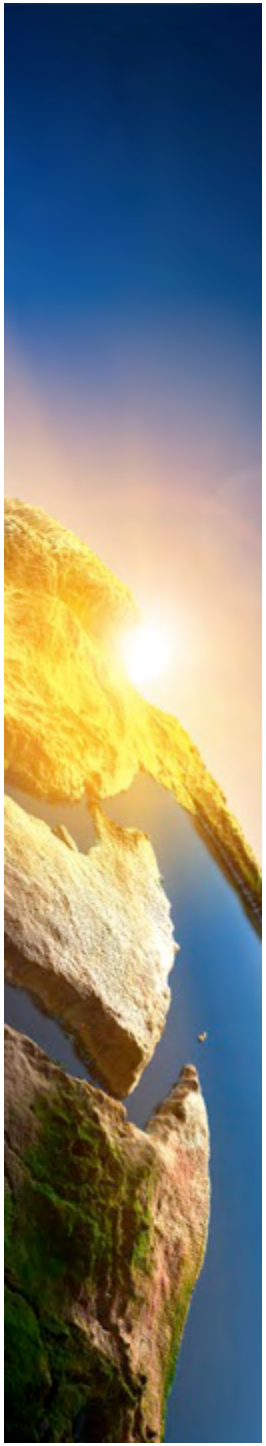
$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O + 3\text{eV} \qquad \left(\frac{140\text{MJ}}{\text{kg}}\right)$$

$$\text{C} + O_2 \rightarrow CO_2 + 4.1\text{eV} \qquad \left(\frac{32\text{MJ}}{\text{kg}}\right)$$



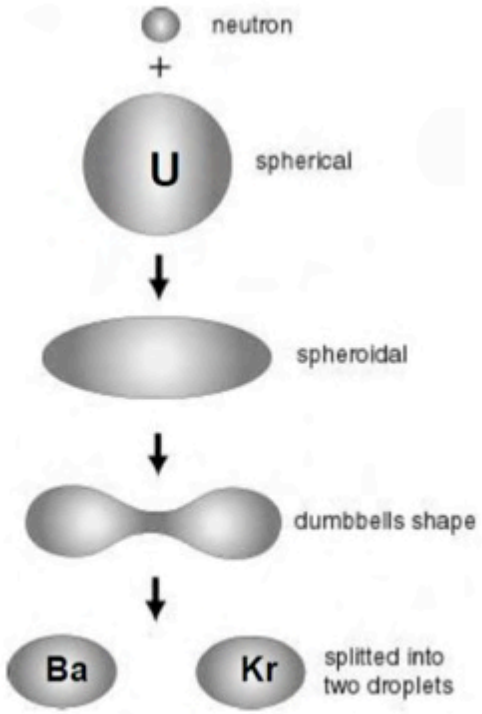
Nuclear Energy - Fission

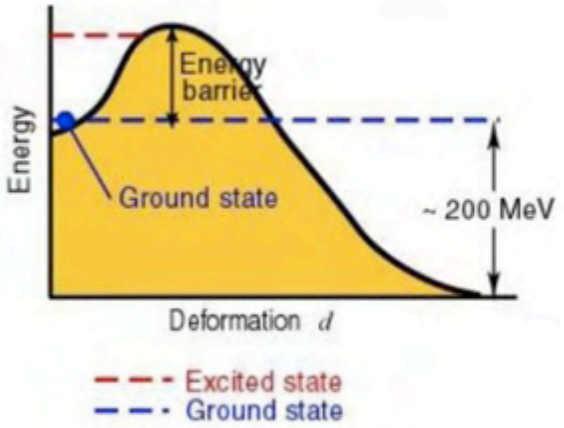




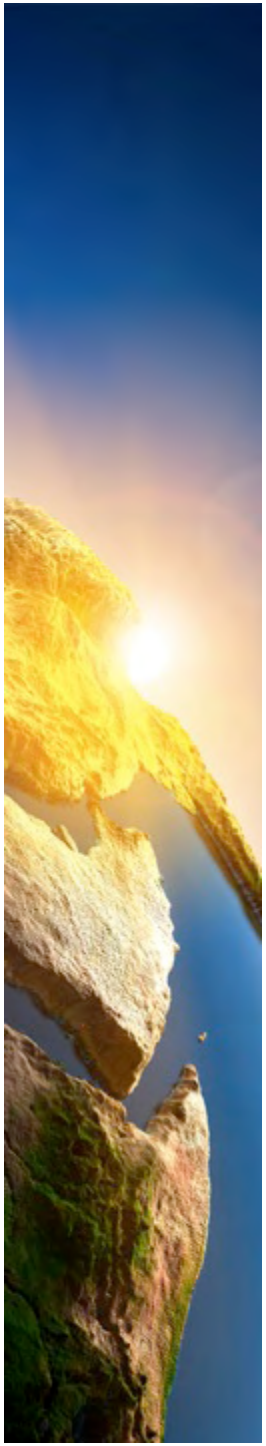
Fission

Uranium core captures neutrons and splits



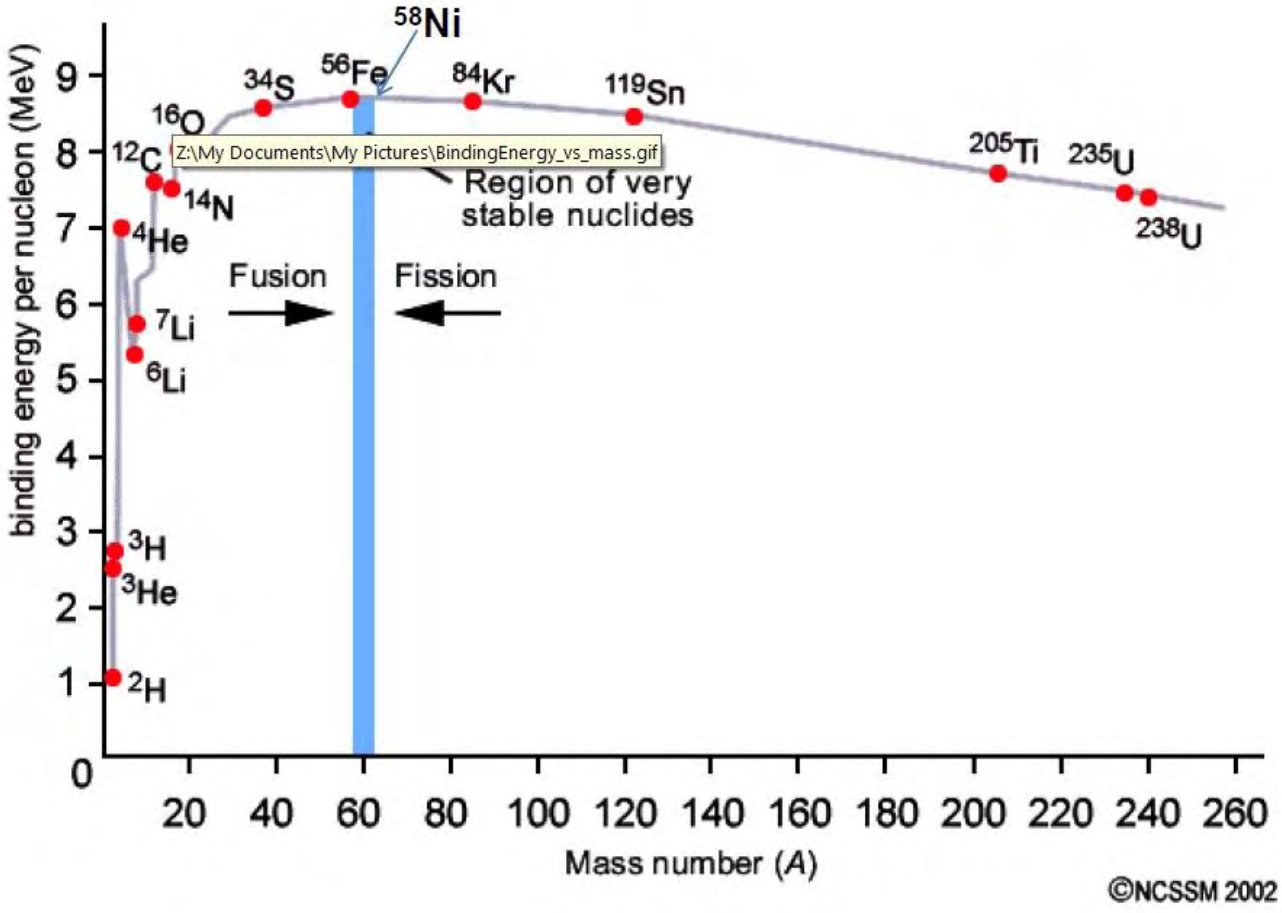


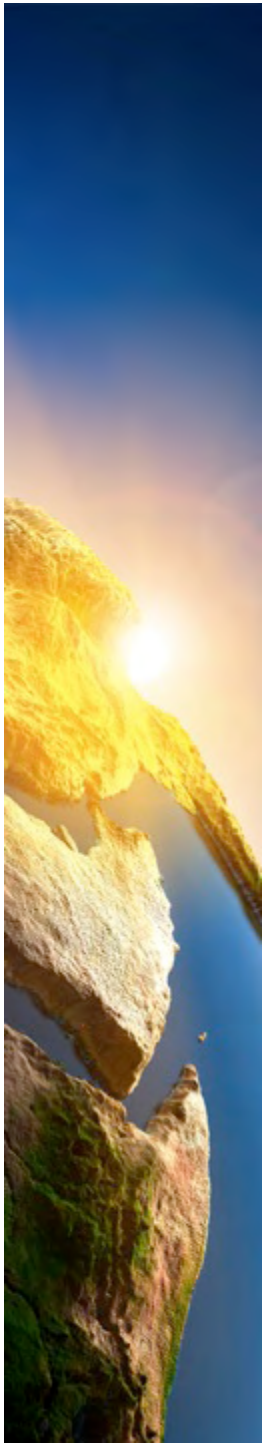
http://www.kutl.kyushu-u.ac.jp/seminar/MicroWorld3_E/3Part3_E/3P33_E/nuclear_fission_E.htm



Binding Energy

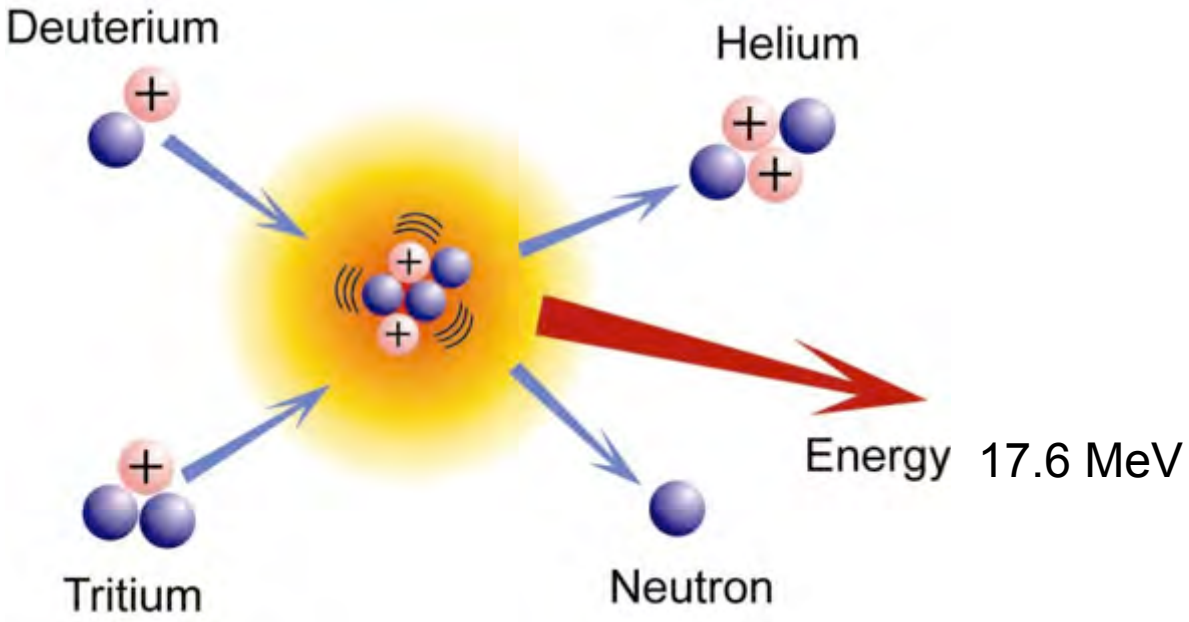
Binding energy per nucleon

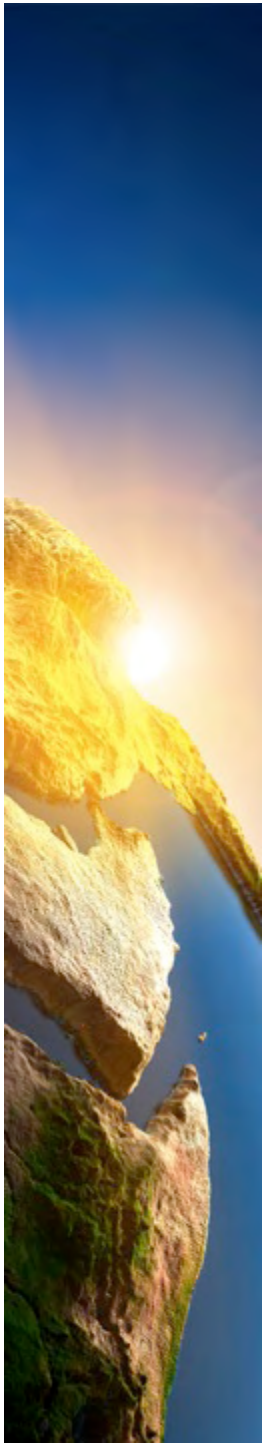




Fusion

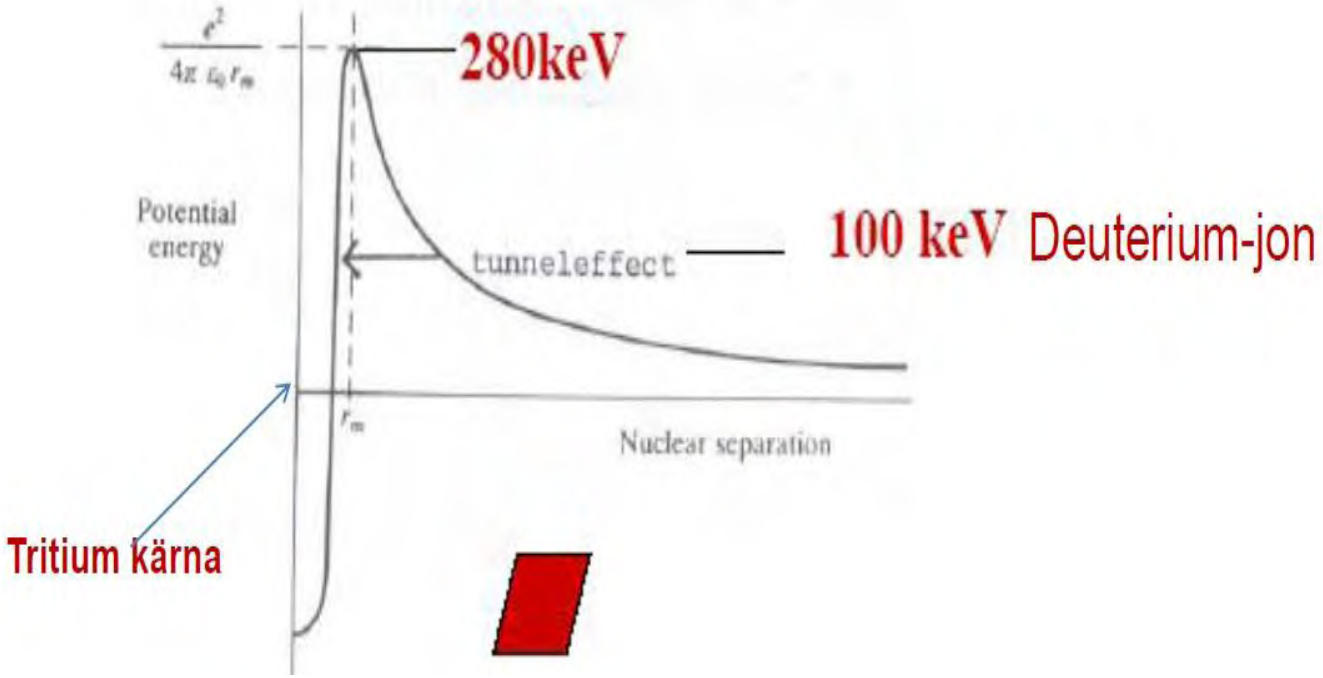
Reactions: d+t → α+n



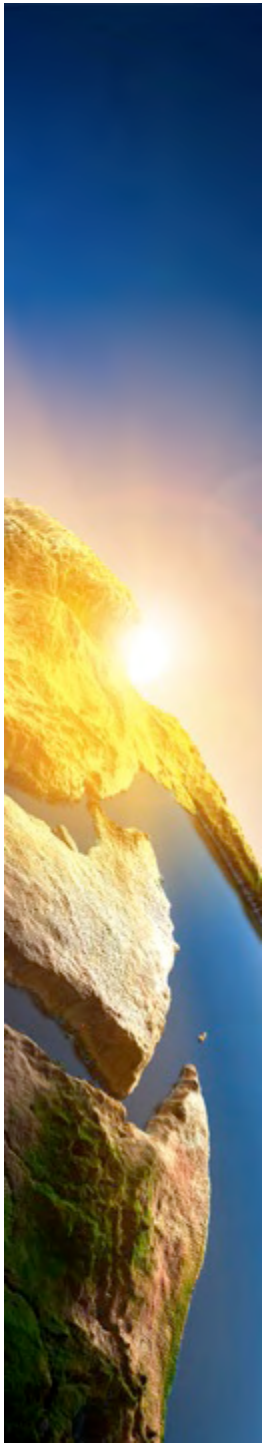


Nuclear Reaction

The positive ions (deuterium from ionized heavy hydrogen) must have enough kinetic energy in order to overcome the repelling Coulomb-barrier to melt with the Tritium core.

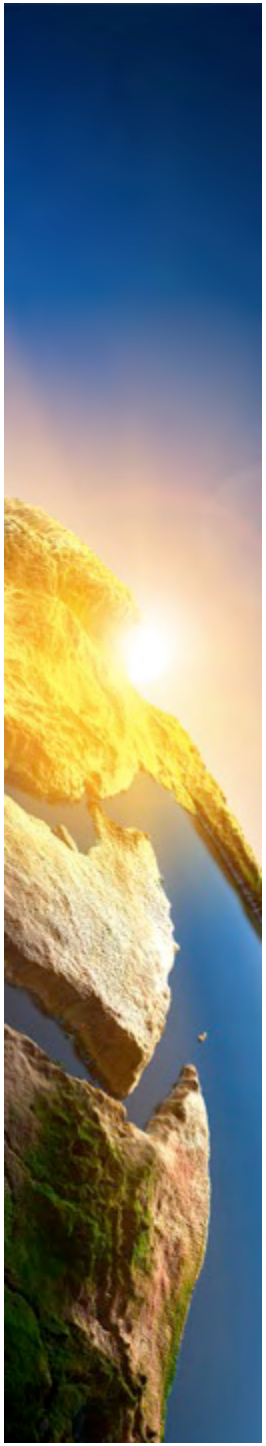


Tunnel effect helps



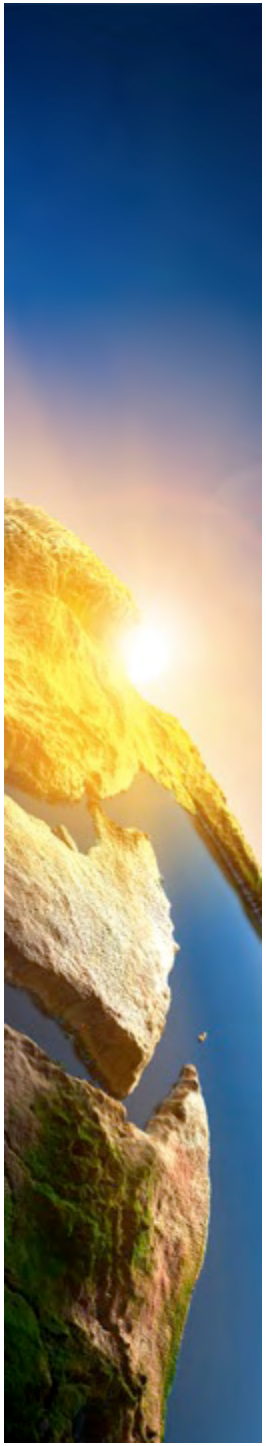
Cold Fusion or LENR

- Ni+H->Cu+3.4-7.4 MeV (Depending on Isotope)
- This is the primary process
- Could exceed 10MeV with secondary processes



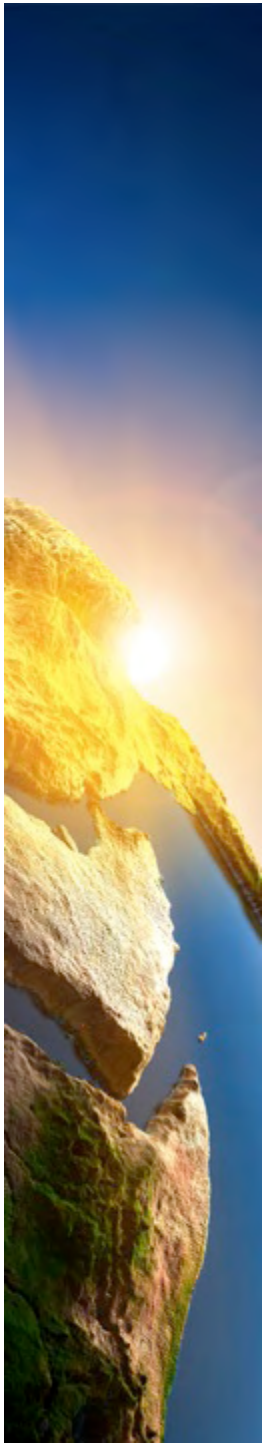
Nuclear vs. Chemical Energy

- Energy density oil: 46MJ/kg or 37MJ/l
- Energy density NiH: 10^7MJ/kg or 10^8 MJ/l
- 1l NiH (9kg) ↔ 2 Ml oil
  - (200 ton or 100 tank trucks)
- 1 barrel of NiH ↔ 1 Supertanker filled with oil



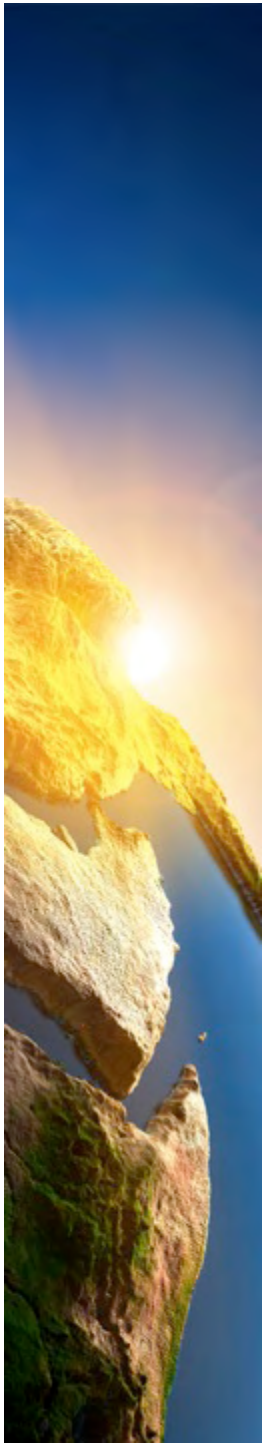
Energy Release

	CHEMICAL	FISSION	FUSION
REACTION	$C+O=CO_2$	$N+U^{235} = Ba^{143}+Kr^{91}+2n$	$^2H + ^3H = ^4He+n$
FUEL	COAL	UO_2 (3% U-235 + 97% U-238)	Deuterium + Tritium
TEMPERATURE	700˚K	1,000˚K	100,000,000˚K
ENERGY J/kg	3.3×10^7	2.1×10^{12}	3.4×10^{14}

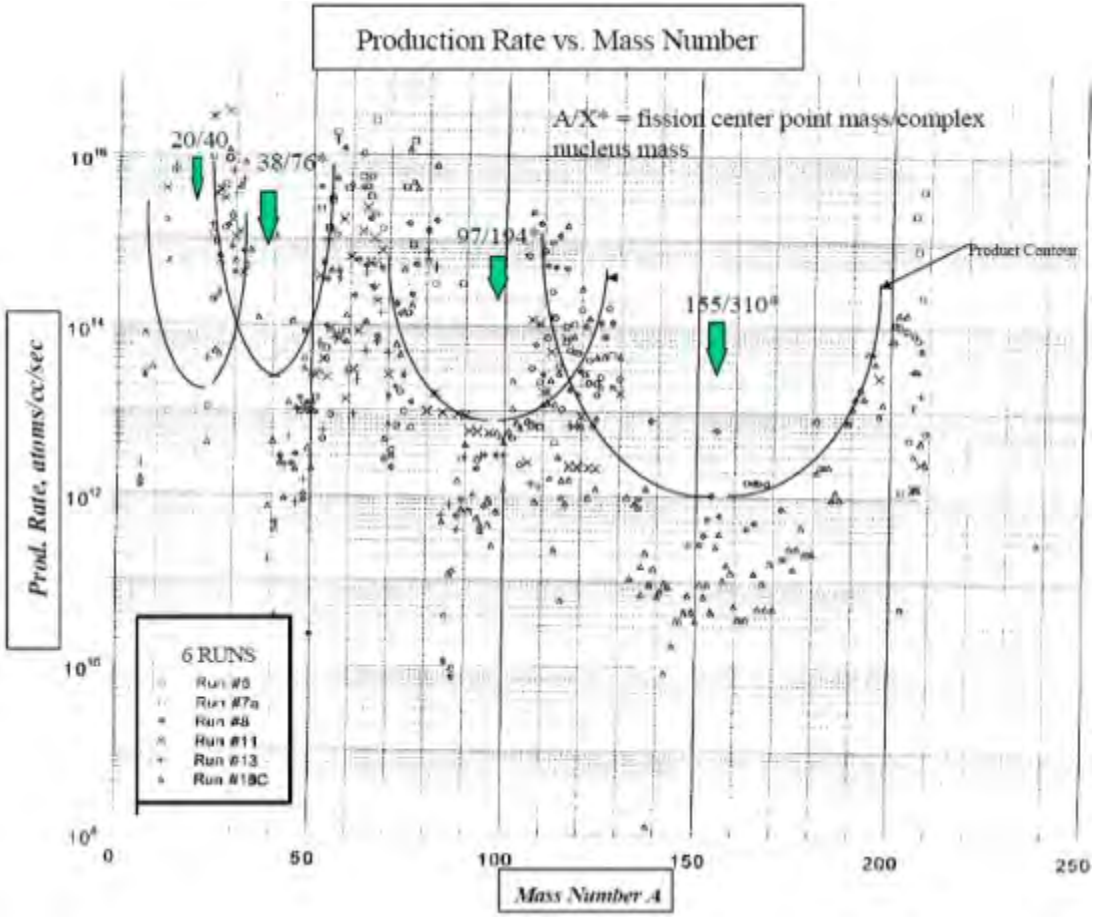


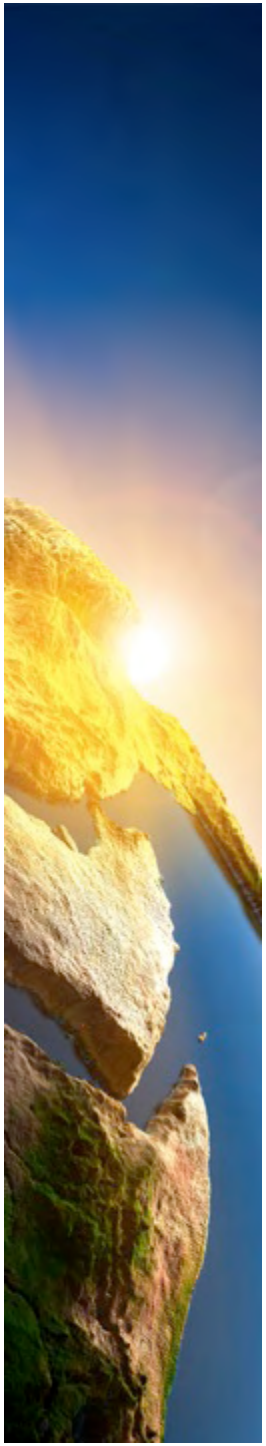
LENR Theories

- Eric Lerner, Plasmons, Bor → Helium
- Yeong E. Kim, protons couples to zero spin, Bose-Einstein condensation
- Hanno Essén, plasma filamentation reduces the Coulomb repulsion
- Widom and Larsen, protons captures electrons, creates thermal neutron
- Hidetsugu Ikegami, lightweight-reactions catalyzed by nickel
- E.N. Tsyganov, increased reaction probability when elements are inside a leading crystalline substance, for example palladium. DD or LiH reactions

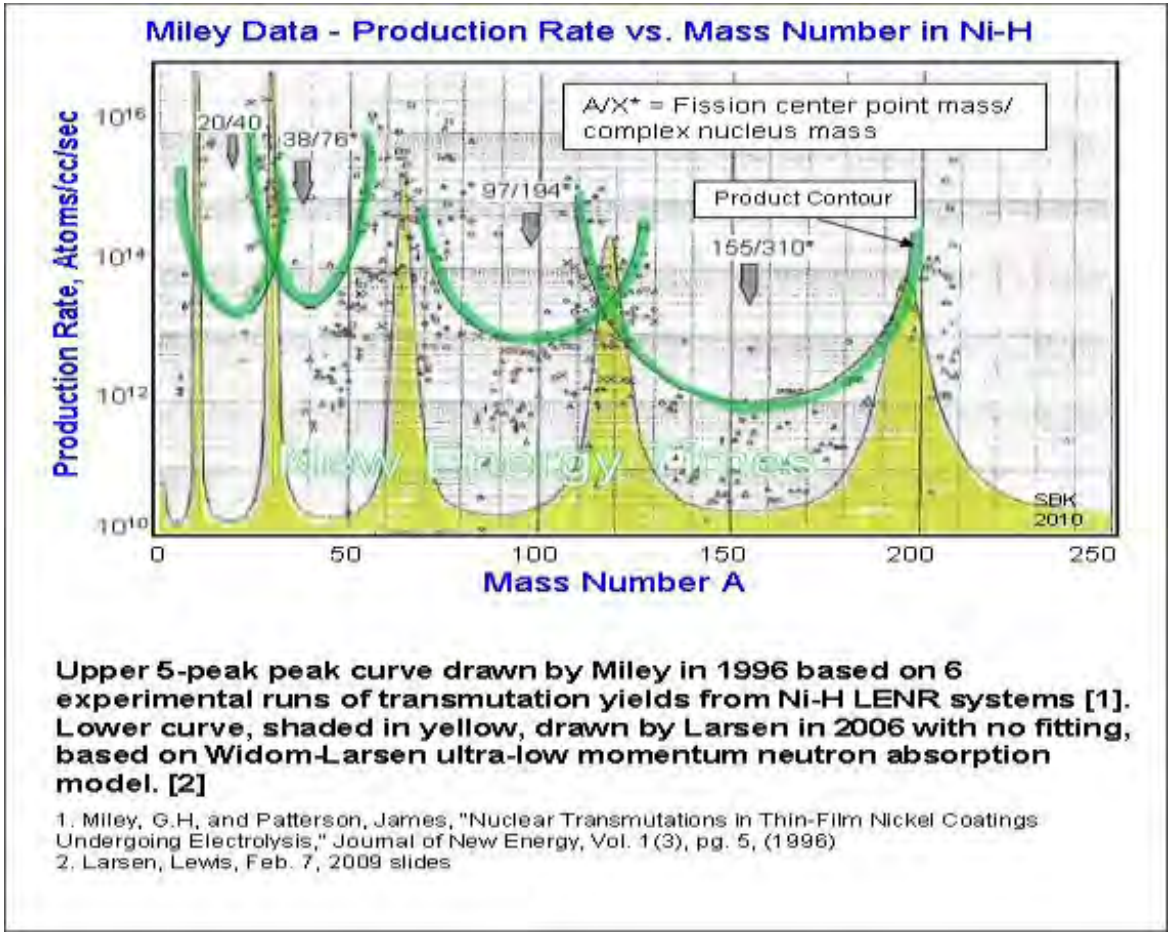


Miley Data


Production Rate vs. Mass Number
A/X* = fission center point mass/complex nucleus mass
20/40
38/76*
97/194*
155/310*
Product Contour
Prod. Rate, atoms/cc/sec
6 RUNS
Run #5
Run #7a
Run #8
Run #11
Run #13
Run #18C
0
50
100
150
200
250
Mass Number A

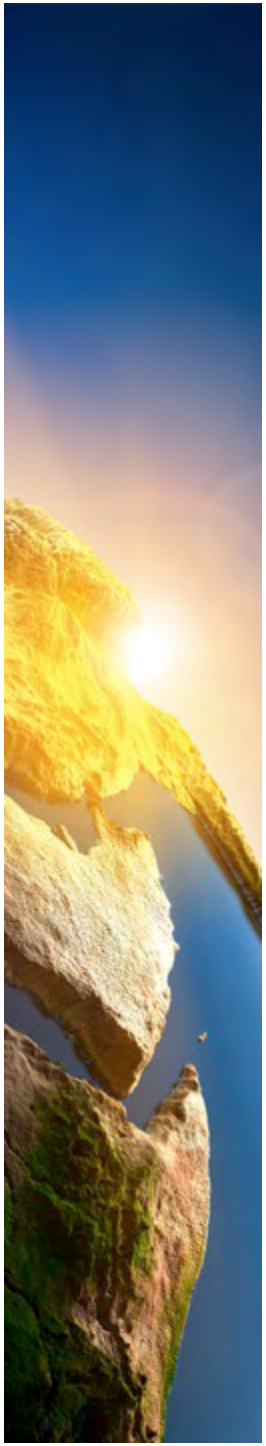


Widom-Larsen Theory



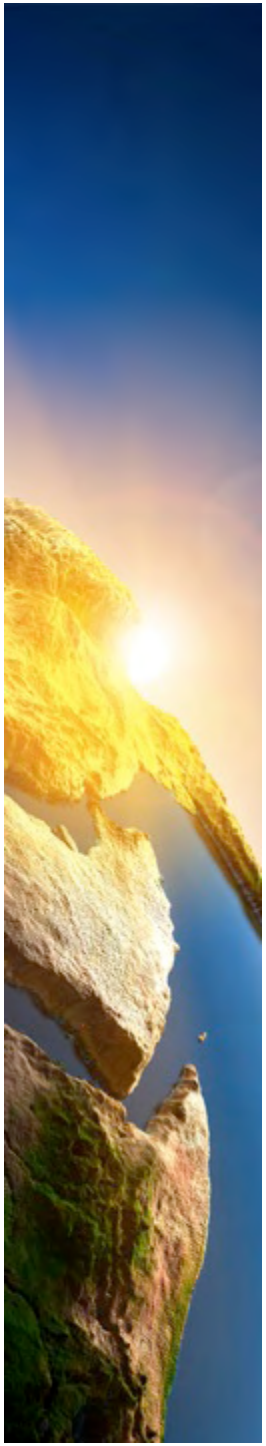
Upper 5-peak peak curve drawn by Miley in 1996 based on 6 experimental runs of transmutation yields from Ni-H LENR systems [1]. Lower curve, shaded in yellow, drawn by Larsen in 2006 with no fitting, based on Widom-Larsen ultra-low momentum neutron absorption model. [2]

1. Miley, G.H, and Patterson, James, "Nuclear Transmutations in Thin-Film Nickel Coatings Undergoing Electrolysis," Journal of New Energy, Vol. 1(3), pg. 5, (1996)
2. Larsen, Lewis, Feb. 7, 2009 slides



People who have achieved a Ni + H reaction

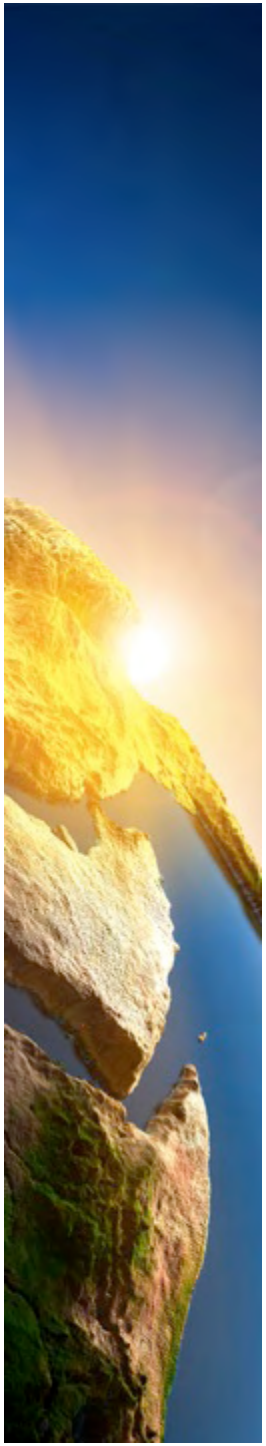
- Andrea Rossi
- R.J.Kokes, and P.H. Anderson, 1959
- Dr. Brian Ahern, Ames National Laboratory
- Dr. Joseph Zawodny, NASA
- James Patterson, 1920 – 2008, A “chemist”
- Quintin Bowles, professor of mechanical engineering at the University of Missouri–Kansas City.
- George Miley, Department of Nuclear, Plasma, and Radiological Engineering, University of Illinois
- Piantelli, University of Siena, Italy
- Robert Godes, President and CTO at Brillouin Energy Corp.
- Thermacore Inc.
- Mike McKubre, SRI
- Francesco Celani, National Institute of Nuclear Physics (Italy’s equivalent of Los Alamos)
- Dr. Eugene Mallove and Dr. Mitchell Swartz, Jet Energy, Inc. Guest lecturers at MIT



NASA Presentations

- Dennis Bushnell 2011-09-22
- Michael A. Nelson 2011-09-22
- Dr. Joseph M. Zawodny 2011-09-22

Interview with Dr. Joseph M. Zawodny 2012-01-13
Interview with Dr. Joseph M. Zawodny

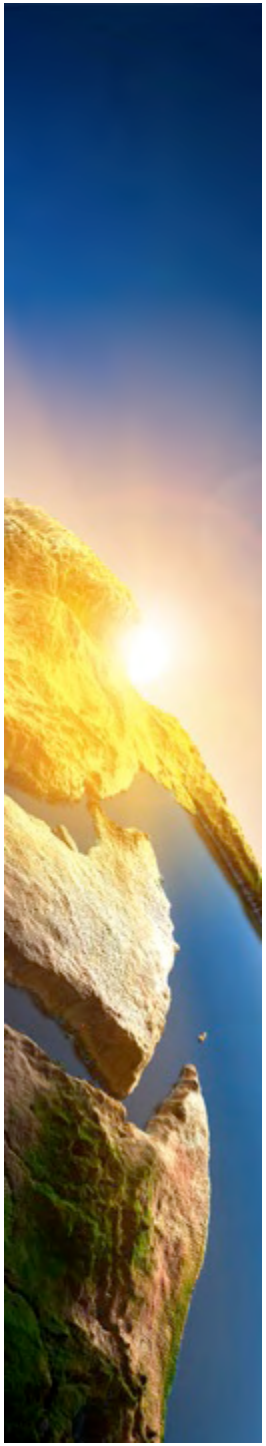


ECAT Links

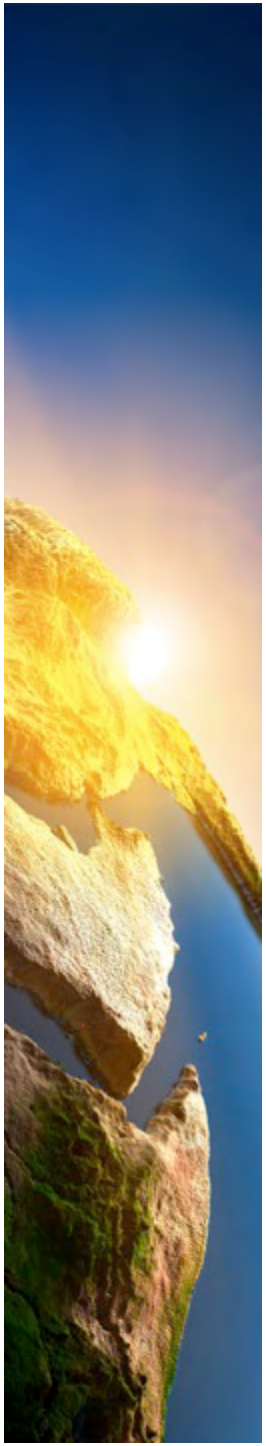
- ECAT.COM
  - ECAT Products
  - ECAT Energy Cost Calculator
  - ECAT Videos
  - ECAT FAQ

- ECAT Demonstrations videos
  - Bologna, October 6th 2011
  - Bologna, January 12th 2012

- ECAT Interview videos
  - Mats Lewan, NyTeknik
  - Roland Pettersson, Uppsala University
  - Prof. Christos Stremmenos, University of Bologna
  - Prof. Sergio Focardi, University of Bologna



ECAT 1 MW Test Plant



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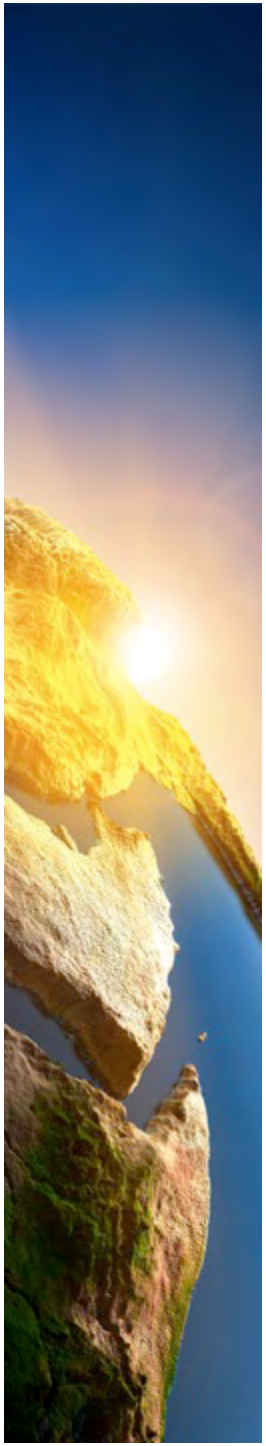
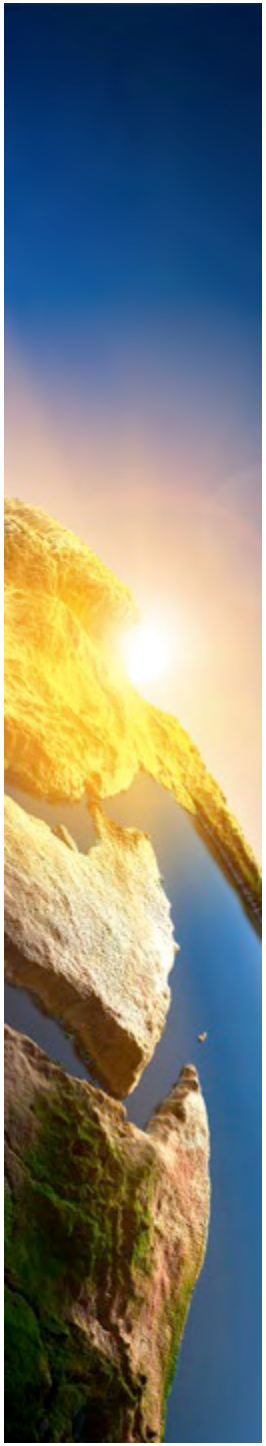


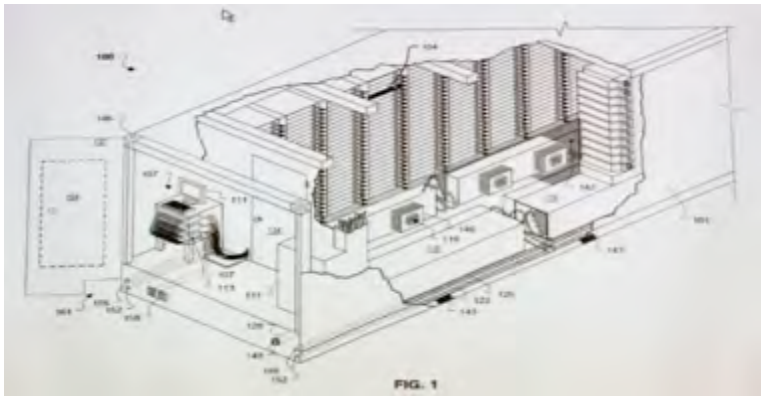
Confidential Information - Siemens

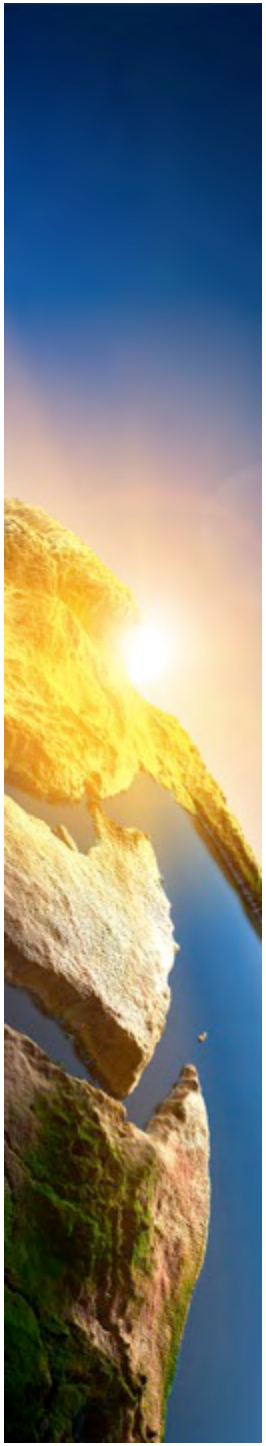
- Hydro Fusion, Leonardo Corporation and Siemens are looking at an electric power solution
- First aim use Heat Transfer Oil in E-Cat up to 250-300C at low pressure. (No phase transition in the oil)
- Use an electric power solution from Siemens with electric generation with steam at 250C, 40+ bar with efficiencies around 30-35%.
- The cost for 1kWe for the Siemens solution will be around €500.
- Target 1 kWe ↔ 3 kWth (33% efficiency)
- To get passed 33% efficiency >25MWe systems is needed



Next Steps

» Large Modular ECAT designs





Modular Design Advantages

- Scalable
- Plug-and-play infrastructure
- Factory pre-assembled: Pre-Assembled Containers (PACs) & Pre-Manufactured Buildings (PMBs)
- Rapid deployment
- De-mountable
- Reduced Time To Market (TTM)
- Reduced construction costs
- Sustainable measures

- Contact: Roger Green
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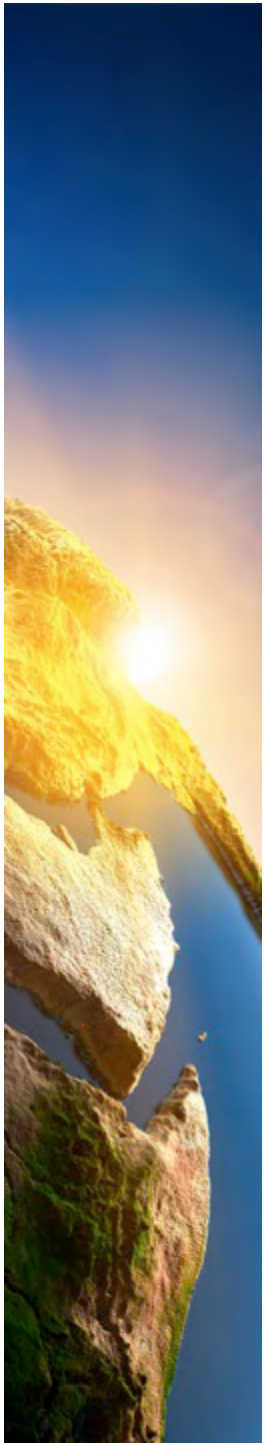

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