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Author : ??.?????????

Date : May 10, 2019

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China Fusion Engineering Test Reactor

The China Fusion Engineering Test Reactor (CFETR) is a proposed tokamak nuclear fusion reactor in China.[| CFETR construction is planned for the 2020s as a demonstration of the feasibility of large scale fusion power generation.

The project would include two phases of operation. The first phase aims to demonstrate steady-state operation and tritium breeding. The second phase would include an update of the system to obtain fusion power production of 1 GW or 1000 MW (compared to ITER's 500 MW) and a fusion gain higher than 12, with tritium self-sufficiency.

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1. http://news.mit.edu/2018/nas-report-right-path-fusion-energy-1221 [December 21, 2018]
2.https://news.newenergytimes.net/2017/10/06/the-iter-power-amplification-myth/
3. http://www.nextbigfuture.com/2015/07/china-will-bigger-than-iter-test.html

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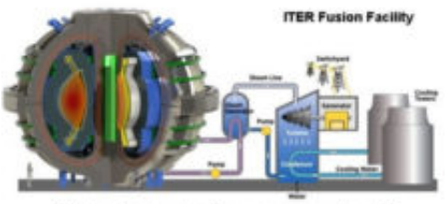

National Academies study recommends a pilot fusion energy program that aligns with MIT's fusion approach and SPARC project.

A new report on the development of fusion as an energy source, written at the request of the U.S. Secretary of Energy, proposes adoption of a national fusion strategy that closely aligns with the course charted in recent years by MIT's Plasma Science and Fusion Center (PSFC) and privately funded Commonwealth Fusion Systems (CFS), a recent MIT spinout.

Fusion technology has long held the promise of producing safe, abundant, carbon-free electricity, while struggling to overcome the daunting challenges of creating and harnessing fusion reactions to produce net energy gain.

It recommends continued U.S. participation in the international ITER fusion facility project

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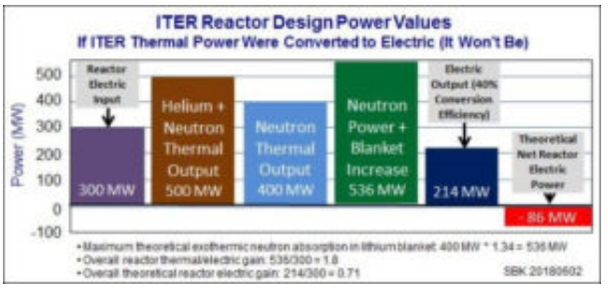
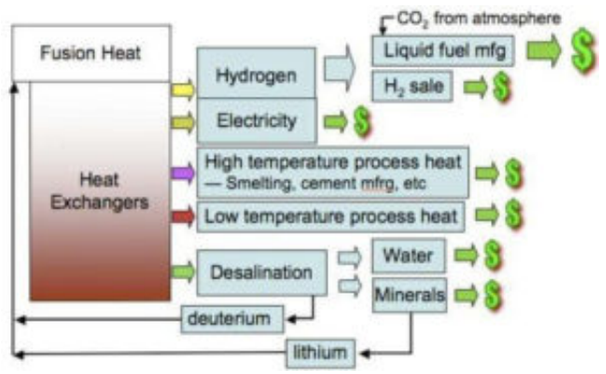
2018 ????????? ???? ??????? [Anhui] ??????????? ???????? ??????????? EAST [Experimental AdvancedSuperconductingTokamak]?? ???????? [100 ????????? ?????? C (212 ????????? ?????? F)] ?????????? ?????????, ?????????? ???????? ????????? ?????????? ????? ?????????????. ???? ???????? ???? ?????????, 2050 ??????????? ????? ???????? 1000 ???? ???? [Mwe] ?????? ???? ????????? ??????????? ???????? ????????? ????? ????????? ??????? ???????? ???????. ?????? ?????????? ????? ??????????? ????????? ????????? 2020 ??????????? ????? ??????? ?????????? ??????????????. ?????????? ??????? ????? ????? ????? 500 Mwe ITER ??????????? ????????? ????????? ??? ???????? ????? ?????????? ??????? ????????? ????????? ???????? ???????.





Fusion Heat and Desalination Plants

in Tamil Nadu, India

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2050??1000MWe??????????????????
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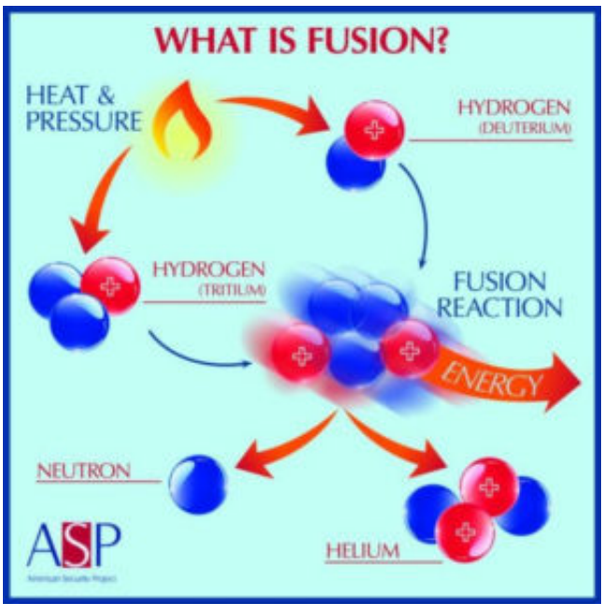
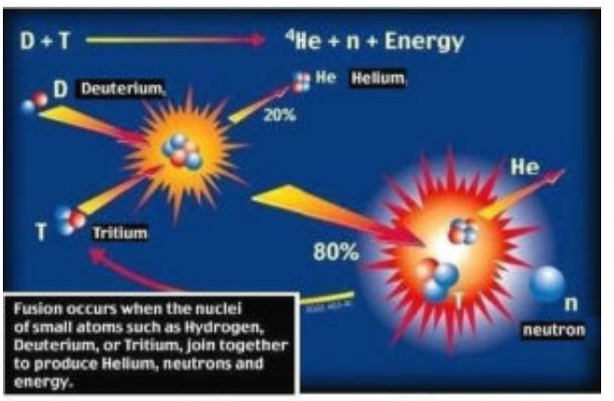
1. 2006-2045: Join and fully support the construction, operation and experiments of ITER; enhance the support for pe-xperiments on EAST, HL-2M and J-TEXT;
2. 2020: Start to construct the Chinese Fusion Engineering Testing Reactor (CFETR) .
3. 2030: Complete the construction of CFETR (P_f~200MW and test of SSO and tritium self-sustained)
4. 2040: Complete the upgrade of CFETR (P_f ~1 GW, Q_{eng} > 1).
5. 2050-2060: Complete the construction of Prototype Fusion Power Plant (PFPP) (~1GWe, Power Plant Validation)





அணுப்பிணைவு இயக்கம்

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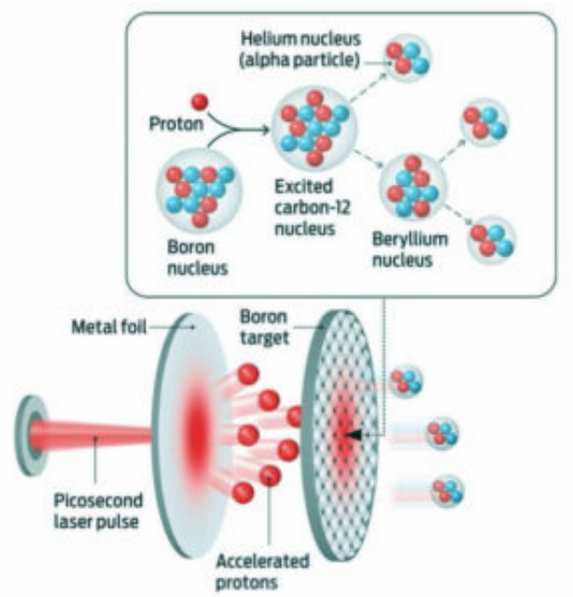

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2017 ???????? 28 ??? ???? ??????? ?????? ?????? ???????? ???????????? ????? ???????????????? [Max Planck Institute for Plasma Physics] ???????????????? ??? ????????? ???????????????????. ????? 60 ????? ????? ?????? ????? ?????? [Nuclear Fusion] ????????????? ???????? ???????? ?????????? [Isotopes] ????????? ????????? & ????????????? [Tritium & Deuterium Isotopes] ????????? ????????? ???????????? ????? ?????????.??&??????????[Boron& Hydrogen]??.??????????????????????????????????,??????? ??????? ?????????? ?????????? ???????? ?????? ??????? ??????, ?????? – ???? ?????? ?????? ???????? ????????? ???????? ???????? ????? ????? ??? ?????????????.

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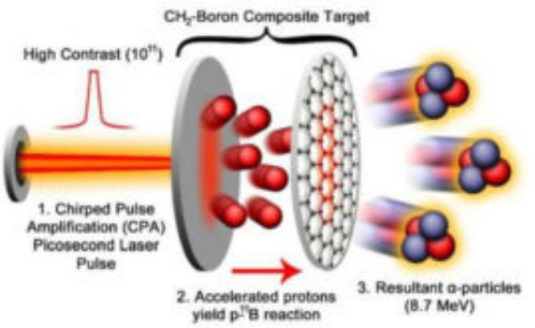
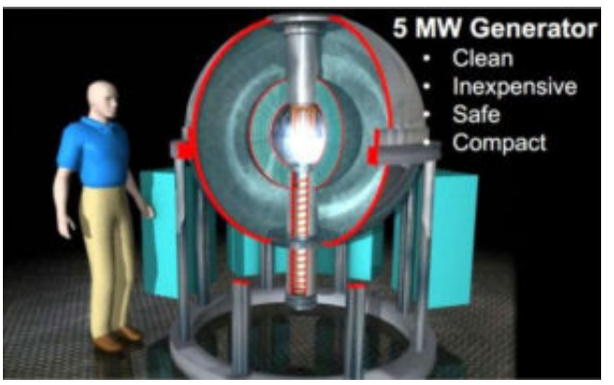
Beams] ???????????????.



????????? ???? ?????????? : ???? ???? & ?????? -11 ?????? [Hydrogen -0] [One Proton and Boron -11 (Boron with 6 Neutrons)] ?????????? ?????? ??????? ???????? [100,000 times More density than ITER Fuel], ?????? ????????? [5 ????????? ?????? F (3 ????????? ?????? C)], ??? ??? ?????? ?????? ????????? ??????????, ?????? ??????? [Helium -4] ?????????. ???? ??????????????????????????????????????[Plasma],????????????????????????.??????? ????????? ??????? ????????? ????? ??????? ????? [Donut – Shaped Chambers] ??????. ??????? ???? ??????? ???????? ???????? ????????. ???? ?????????? ??????????? & ??????????????????[Deuterium&TritiumIsotopes]??????????????????????????????? [SuperheatedPlasma]??????????????????????????????.????????????????????????? ??. ???????? ????? ?????????? [High Energy] ??????? ???? ?????? ??????????? ????? ???????? ??????????? ??????????.



Hydrogen – Boron Hot Fusion Reactor

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2017 ???????? 28 ??? ???? ????????????? ????? ???????? ??? ??? [Nuclear Fuel Reactor] ????????????? ???????? ????????-1 & ??????-11 [Hydrogen-1 & Boron-11]. ???? ???????? 1 ??????????????????????????,??.???? ??3???????-4????????[??????????????????] [Alpha Radiation] ??????????? 8 MeV ?????? ????????????? ???????????. ITER ????? ??? ???????,H–B???????????????,?????????????????????[HighEnergyNeutron]????????. ?????????????–??. ???????????????–??.

Laser fusion experiment yields record energy
at Lawrence Livermore's National Ignition Facility

In the early morning hours of Aug.13, 2013, Lawrence Livermore's National Ignition Facility (NIF) focused all 192 of its ultra-powerful laser beams on a tiny deuterium-tritium filled capsule. In the nanoseconds that followed, the capsule imploded and released a neutron yield of nearly 3x10^15, or approximately 8,000 joules of neutron energy – approximately three times NIF's previous neutron yield record for cryogenic implosions.

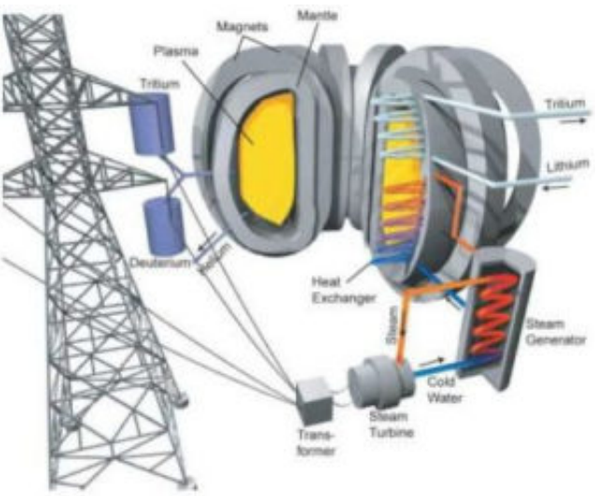
The primary mission of NIF is to provide experimental insight and data for the National Nuclear Security Administration's science-based stockpile stewardship program. The experiment attained conditions not observed since the days of underground nuclear weapons testing and represents an important milestone in the continuing demonstration that the stockpile can be kept safe, secure and reliable without a return to testing.

??????? ??????? ????? ???????: ??? ????????????? ???????? ???????? ???????? ???????? [Deuterium – Tritium Pellet [D-T Pellet] Fuel Capsule] ????????? ??????? ??????? ???????? ????? ???????? ?????? ???????. ???????? ???????? ???? ???????? ?????? [D-T Pellet] ???????? ???????, ?????? ?????????? ????? ?????? ??????? ????????????.

???? ??????????? [Associate Director, NIF National Ignition Facility for Fusion Power]

??: ?????????? ?????? ?????? ???????? ????????? ???????? ???? [Premature Breakdown] ???????. ?????? ????? ??????? ?????????? ???????? ?????? ?????? ???????? [Hohlraum–> Hollow Room] ??????? ???????? ????????? ????? ???????? ???????????.

???? ??????????? [Associate Director, NIF National Ignition Facility for Fusion Power]



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“???????? ?????? ???????????? ??????????? (Nuclear Fusion) ?????????? ?????????? ??.?????????????(NuclearFission)?????????? ??? ?????????? ????????????? ??????? ?????????.”

???? ??????? ???? – ??????????? ???????? ????? ?????. (June 28, 2005)

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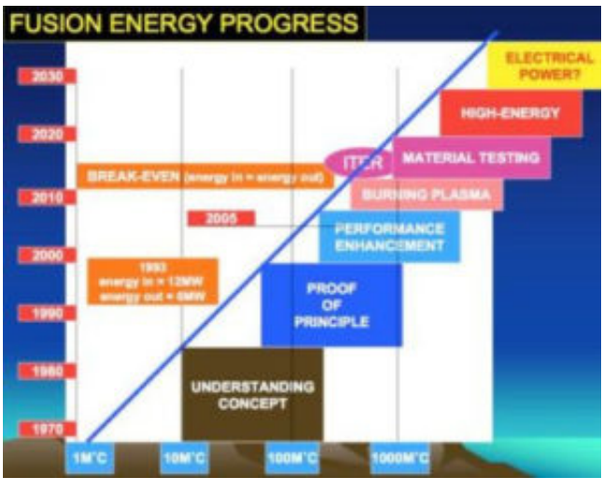
??[DeptofEnergy’sLawrence Livermore National Lab] [National Ignition Facility- NIF] ???????????????? ????????? ????? ??.???????????????? ??????? ???????????? [National Ignition Facility – NIF] ???????? ?????? ????? 192 ????? ??????????????????????[1.8??????????????????](megajoulesofenergy)???????????500 ?????? ?????? ??????? ?????? [tetrawatts power – 10^12 watts] ????????????. ???? ???? ???????????? ??? ???????? ????????? ????????????? ????? ??????? ???????????? ??? 1000 ?????? ?????. ?????? ???????? ??? ???????? ??????? ?????????? ????????? ????????.

??? ??? ???????? ????????. ??????? ????? ??????, ???????? ????? ??????? ????? ?????? [Journal Physics of Plasmas] ?????????? ????????? ??????????. ??????? ????? ?????? ????????? ???????? ????? ???????? ??, ??????? ?????? ??????? ?????????? ??????????? ????????.



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1. ??????? ???????????? [Equilibrium of Forces] :

??.???????????? ??.????????????????????????????????. ??????????????????[InertialConfinement]???????????????.??????????????? ???????? ???????????? ??????? ???? ????????.

2. ???????? ???????? [Plasma Stability] :

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3. ???????? ?????? [Transport of Particles] :

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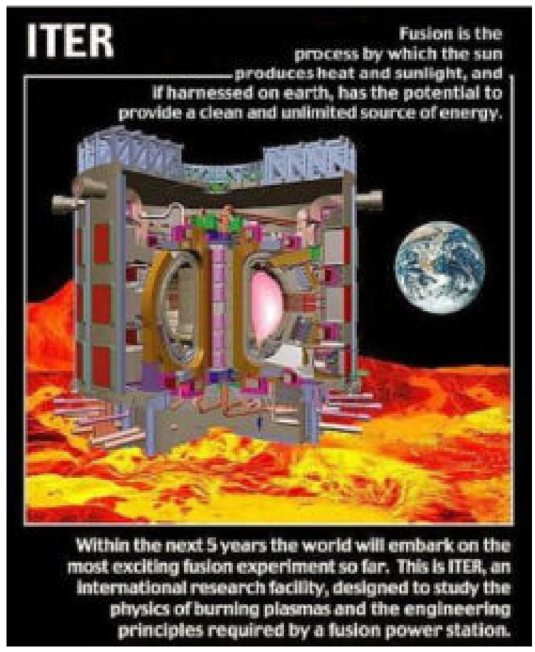
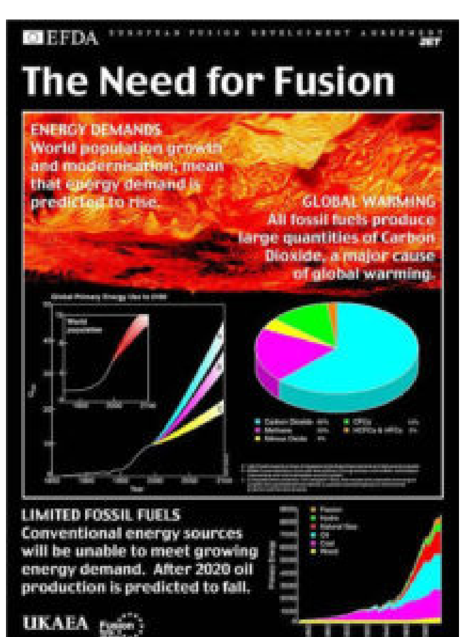


“?????????? ??????? ????????? ?????? ????????? ???? ???????? ???? ????????????? ?? ?????? ????? ?????????? ????? ??? (ITER) ??? ?????? ???????? ???? ???????? ??????????????.”

??????????? ?????? ?????????? ?????? (UK Atomic Energy Agency) (June 28, 2005)

“?????????? ????? ?????????? ????? ????? (ITER) ???????? ??????? 2005 ????? ????????? ?????????.???. ?????????????????????????????????(????????????????,?????,?????????,????,????, ???????) ???????? ?????????? ??????? ????????? ??????? ???????????????.”

???? ?????????? ??????? (European Commission) (June 28, 2005)

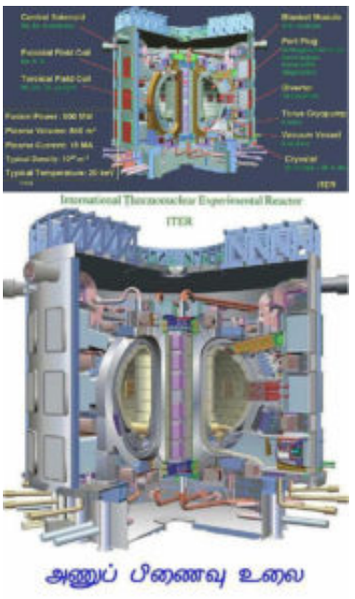


“????? 15 ????????? ?????????? ????? ?????????? ????? ????? (ITER) ????? ????????? ??, ?????????? ????? (IAEA) ????????????? ????????. ?????? ??????? ???????? ????????????? ??? ????? ??????? ???????????????????? ???????? ????? ????????? ???? ????????.”

??????? ?????????? (Deputy Director General & Haed IAEA Nuclear Science and Applications) (June 28, 2005)

“?????????? ????? ?????????? ????? ??? (ITER) ????? ???????? ????? ?????????? ??? ??????? ???????????? ????????????? ????????? ????????? ????? ???????? ???????????.”

????????? ?????? (??????? ??????? ????????) (June 28, 2005)



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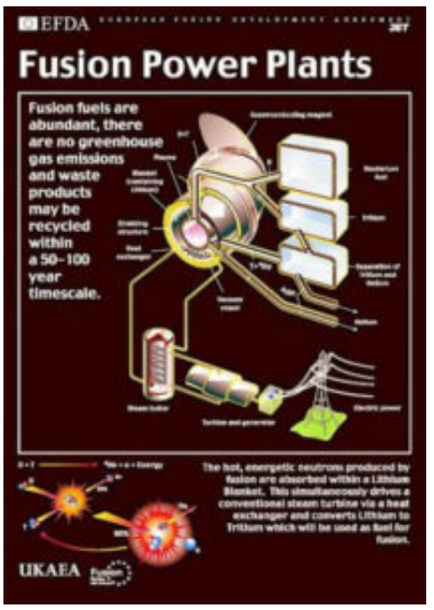
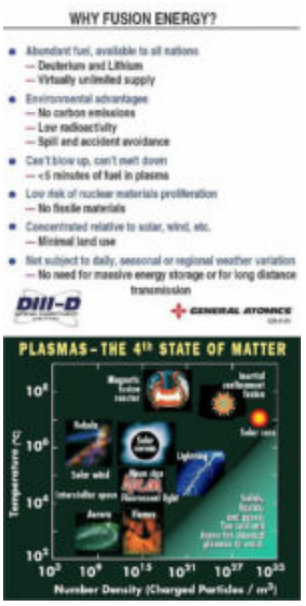


??282005?????????????????? ?????????? (?????????? ???????, ?????, ?????????, ????, ????, ???????) ????????? ?????????? ????? ?????????? ????? ??????? [International Thermonuclear Experimental Reactor (ITER)] ?????????? ????????? ??????? ??????? ??????. ITER ?????????? ??????? ?????????? ?????????? ??????? (???????????, ????????, ???????, ???????, ????????, ???????, ??????????, ???????, ???????????, ???????, ???????…), ?????, ?????????, ????, ????, ???????, ???? ??????, ???????. ?????? ???????????? ?????????? ??????? 50% ???? ??????? ???????????. ?????????? ?????????? : ?????????? ???????? 60 ??.??. (37 ????) ????????? ????????? “???????? ???????? ????????? ?????” (Cadarache in France).



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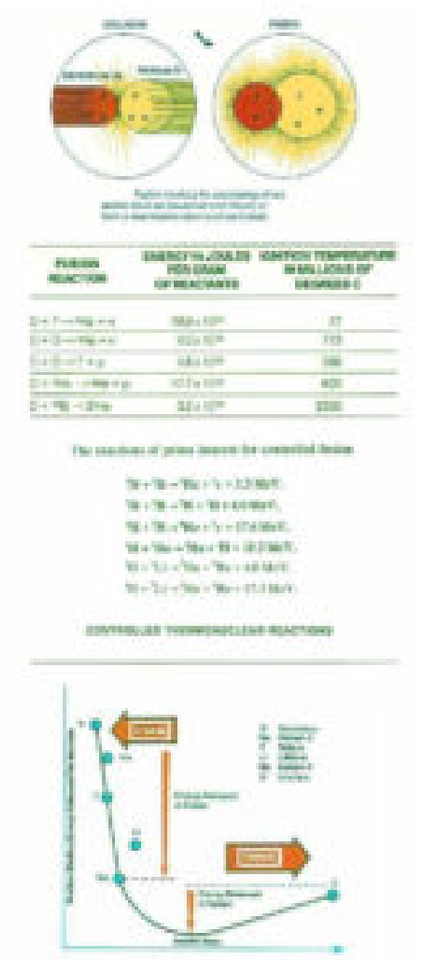
— ????? ??????? ???????? : 500 MW
— ?????????? ????? : 14 MeV (Million Electron Volt).
— ????? ????? ?????? ????? : 0.57 MW/Square meter
— ???????? (???? ???????) ???? ???? : 6.2 ?????.
— ???????? (???? ???????) ???? ???? : 2.0 ?????
— ???????? ??????????? : 15 MA (Million Amps)
— ???????? ???????? : 837 ???????? ?????.
— ?????????? ????? ???? 6.2 ??????? 5.3 T (Toroidal Field)
— ????? ??????????? ??????? ???? : 78 MW
— ??????? ??????? ????? : 12 ????????? ????? (2005 ???? ???????)



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10 ????????? ?????? ????????? ?????????? ???????? ???????? (???? ???????) ???????
??.?????????
??????? ???????? ????????? ??????????????? (High Energy Neutrons) ????????? ! ???????
?????????? (Isotopes of Hydrogen) ??????????? & ????????? (50% Deuterium & 50% Tritium)
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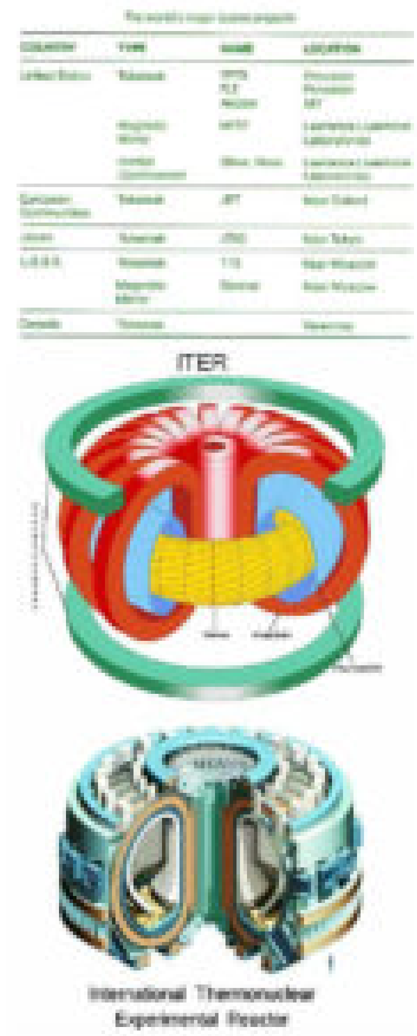
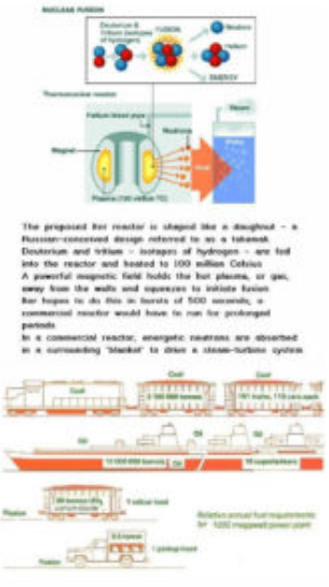


??? 10 ????????? ?????? ????????? ?????? ??????????? ???? ???? ????????? ????? ???????? ???????????.???. ??? ?????????? ????????? ?????????? ???? ???? ??????????????. ???? ????????????? ?????? ???????????? ?



1.???
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2. ??????? ???????? ?????????? ??????????? ?????? ??????????.
3. ????????? ??? ?????????? ????????? ???????????????? ?????? ???????? ?????????????.
4. ?????????? (Microwaves) ????? ?????? ????? ?????????? (Laser Beams) ???????????
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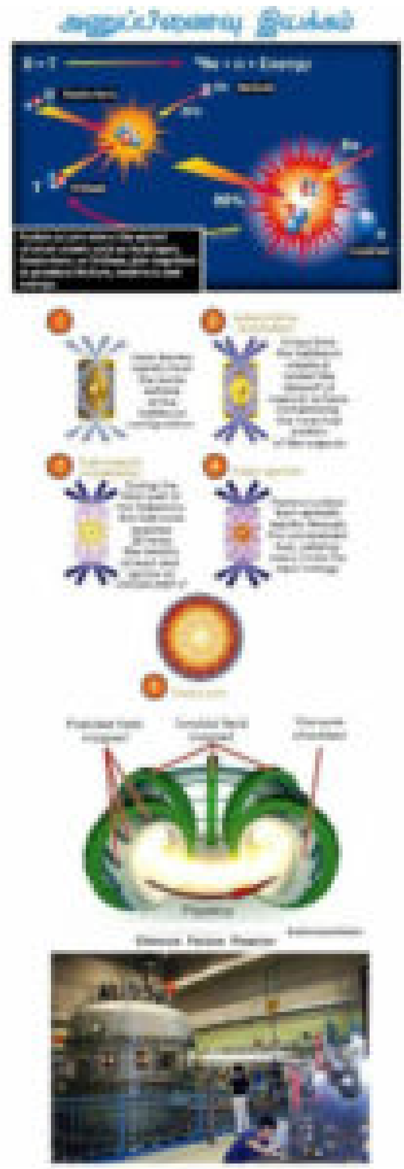
1. ???????? ???? (Plasma Confinement) (?????, ????????????? ??????????)
2. ???????? ???? (Inertial Method).
3. ??????? ?????? (Magnetic Method).



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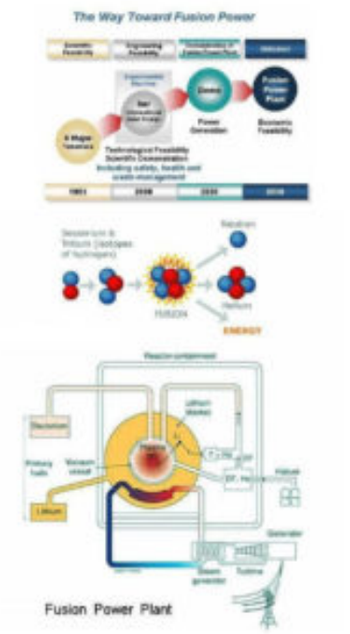
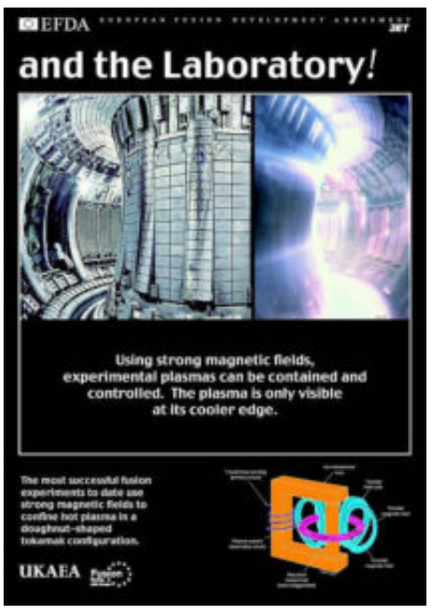
??????????????????????[FusionEnergy]????????????????,?????????????????????????? ??????????[PlasmaReactor]!??????????????????????????????????,????????????????? ????? ???????? ????????? ????, ???????? ???????? ????? ???? ??????? ?????????!4000 ??????????????????,?????????????????40?????????????MW?????????????????????? ????????????????????????????!????????????????????????????20??????????????K ????????? ????????, ?????? [Earth ‘s Atmosphere] ???????? ??? 400 ????????? ?????? ?????????! ????? ??? ???????, ????????? ??????? ???? ????????????? ??????????. ??????????? ???????? [Density] ???????? ???? 12 ??????. ??????? ?????? ??????????, ??? ?????????[Gravitation]??????????????,??????????4???????????????????????????? ????? ????????, ????? ??????? ?????? ??????? ??????????????. ??? ?????? ?????? ???? ??,?????????????????????????????600?????? ??!???????????????????????????? ?????? ????????????, ???????? ????? ???? ???? ????????????, ???????? ????????, ????????????? ???????? ???????? ?



1952??????????????????????????????????,1953??????20????????????????????????????? [Thermo-Nuclear Weapon] ???????? ???????? [H-Bomb] ????????? ????? ????? ??? ??.?????????????????????????? ??? ??? ?????????? ?????? ????????? ????? ???? ?????? ????????????? ?????? ??????????!????????? ??????????? ???? ?????? ???????? ????????? ????????????????? ???! ??????? ?????? ???????? ??????????? ??????? ???? ??????? ????????????? ????????? ???????????????????.????? ????????? ??????????? ??????? ???? ?????????? ??????? ????, ??!?????????????????? ??????? ???????? ????????? ????????????? ??? ???????????????? ???????? ??????????????, ????????? ????????????????? ??????? ????????!



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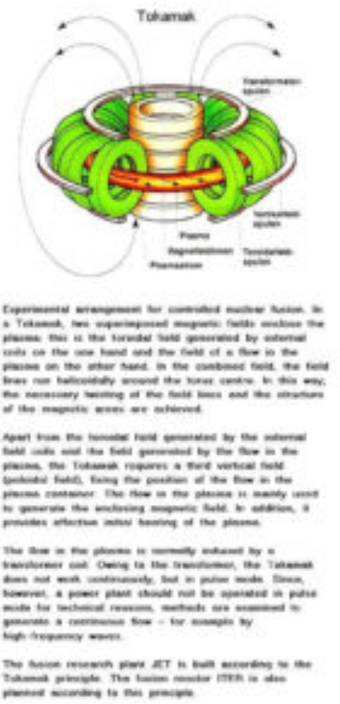
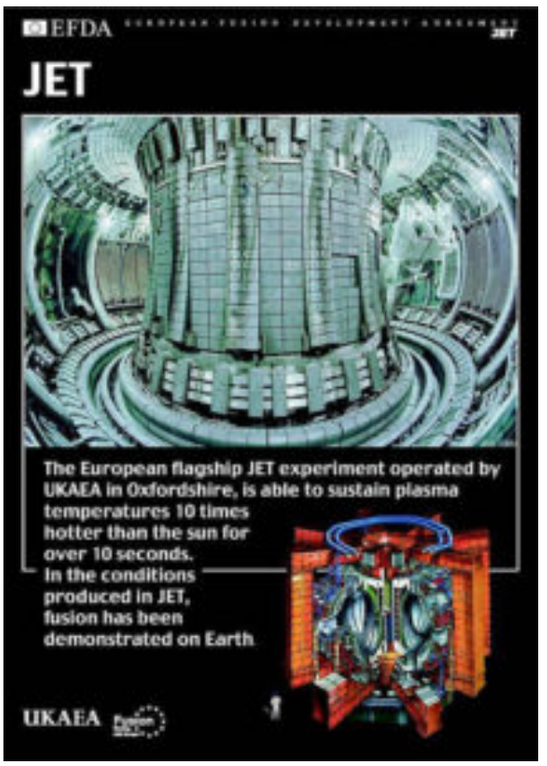
???????? ?????????? ?????? ‘??????????’ [Isotopes] ?????. ????? ????????????? [Deuterium], ????????? ????????? [Tritium]. ?????????? ??????, ??? ?????????? [Proton] ????????? ??????, ???????? ?????????? [Neutrons] ????????? ????? ????????? [Elements]. ?????????? ??? ???????????? [Electric Charge] ????, ???????? ???????????? [Atomic Mass] ???????.??????????????????????????[PeriodicTablesofElements],??????????????????

?????????? ???? ???????. ????????????? ?????? [Molecule] ?????? 7000 ??? ?????? ????????????????,??????????????????????????????????????.????????????????????? ??? ?????? [Heavy Water Uranium Reactors] ???????? ????, ???????? ??????????. ???????? ?????????????[CANDU]????????????????????????,????????????????????,???????? ????? ?????????? ??????? ???? ???? ????????? [Light Elements] ???????? ????????? ???????????. ????????? ???????? ???? ???????? ????, ???? ?????????? ????????, ?????????????,?????????,????????????????,[?????????????+?????????]??????????? ???? ????? ??????? ????????, ?????? ?? ??????? ????? ?????? ???????, ?????????? ??.?????????????????????????????? ??????, 80 ????????? ?????? C.

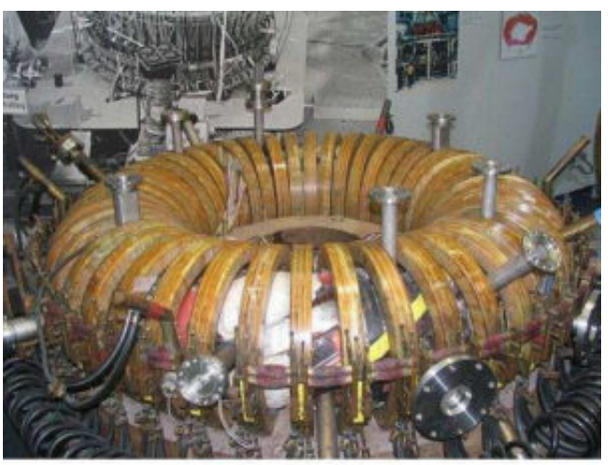


?????????????+?????????–>???????+??????????+17.6MeV?????Deuterium+Tritium –> Helium +Neutron +17.6 MeV Energy

???[Fusion Reactor]‘????????’ [Tokamak] ??????, ??????? ???????? ??????? ????? ????? [Donut] ????????? ?????? ??? ??????????????????????????.‘????????‘??????????????????????????.??????????:??? ??????? ???? [Toroidal Magnetic Chamber]. ???????? ?????? ??????? ???????? ??????? ?? ????????? ?????? ?????????? ????????? ?????? ??????? [Plasma] ????????? ??????????? ???!?????????????????????????? ????? ????????????????! ??????? ?????? ??? ???????? [Four States of Matter] ???????. ??????, ??????, ????, ???????[Solid, Liquid, Gas & Plasma]. ????????????????????, ????? ?????????????[Positive, Negative Ions] ???????? ??????? ?????? ???? ??????????[Electrical Conductor] ???????. ???????? ??????? ???????? ?????? ???????? ????????? ???????????, ????? ???? ????????? ??????? ?????????????, ????????????? [Helium Blanket for Plasma & Heat Transport Medium] ???? ??????. ??????? ????? ???? ????? ?????????? [Heat Exchanger] ???????? ????????? ??????? ??????[Turbine Generator] ?????? ?????????. ????????????? ?????????????????????, ??????????????????????????????????????1981???????? ??????????? ?????? ????????.



?????? ??? ????????? ???? ??????? ???????? [Plasma Confinement] ??????????? ??????? ????????????. ???????? ???? ‘?????????? ???? ???????? ‘ [Gravitational Confinement Fusion]. ???????????? ?????, ??????? ????????????? ???????? ?????? ??????, ?????? ?????????? ?????? ????????. ???????? ???????? ???????? ??????? ????????! ????????, ‘?????????? ???? ????????’ [Magnetic Confinement Fusion]. ??????? ????????? ??? ??????? ?????. 1950 ??? ????? ????? ????????? ???????? ?????????? ???? ????????. ??????????? ???????????? ???????? [Tokamak] ????????. ???? ??????? ???????, ?????? ??????? ?????????? ?????????? ??????? ????????: ??????, ?????, ???????? [Temperature, Time & Density]. 200??,????????????????? ????. ???? ???? ‘????? ????? ‘ [Lawson Criterion] ????? ???????. ????????? ????: ‘???????? ???? ????????’ [Inertial Confinement Fusion]. ????? ????? ???????? ?????????? [Laser Beams] ???????? ??????????? [Implosion] ????????? ???? ??????? ????? ??????? ???????? ????? ?????????????. ??????? ???????????? ??? ?????? [Nuclear Weapons] ????? ?????, ????? ???????????????? ???? ????????.



Fusion Power Generator

அணுப் பிணைவு சக்தி ஜெனனி

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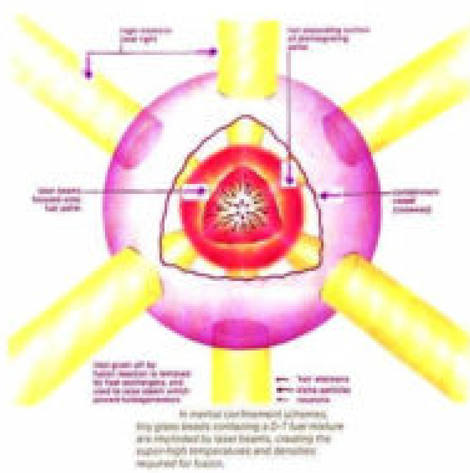
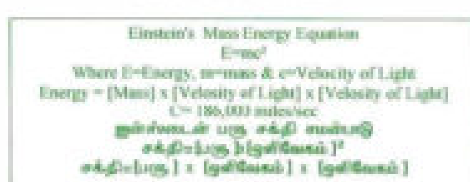
????? ????? ????????? ????? ????????? ?????? ????????? ???????? ??????????? [Radioactivity] ???? ???? ?????! ???????? ????????? ????? ??????????? ????? ????????! ????????????? ???????? ????, ????????? ?????????? ???????????? ????? ????????????? ??????? ?????? ????????? ????, ??????? ????????? ??? ?? ??????? ?????? ??????? ????????????! ?????? ???????? ????????? ??????? ?????? ?????? ??????? ?????! ????? ??? ????????????????????????!?????????????????[Environment]?????????????????????? ???????! ?????? ??????? ??????? ?????? ????? ????????? ???????????! ?????? ?????? ??,?? ???????????????.??,??????????????????? ?????? ?????????!



Laser Fusion Reactor



????????? ??????????? ?????????? ?????? ??? ??????? 2 ????????? ???????? ???????? ??????! ??? ?????? ??????, ??????? 50 ????????? ????? ???? ?????????? ????? ??????? ????????. ?????? ????? ????? ??????? ??????????? ????, ????? ?????? ??????????? ???????????, ??? ????? ???????? ?????????? ?????? ???????? ????????? ???? ?????? ?????????? ????????! ??????? ??????? ????????? ????? [Lithium] ?????? ????? ????? ??????????????!?????????????????????????????.??????????????????????????????? [HighVacuum]????????????????????????????????!?????????????????????????????,???? ???,????????????????????? ????? ??????????? ??????? ???????, ???????? ?????? ????? ????? ???????? ????????, ??????? ??????????? ????? ????????? ?????? ???????.

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??.?????? ?????? ????? ??????????? ????? ?????????? ???????? ??????? ??????. ???????? ?????? ????? ??????????? ???????????????? ????????? ???????? ???????! ???????? 1000 MWe ??????? ?????? ??????? ??????? ??? 0.6 ???????? ??? [1320 ???????] ?????????! ?????? ??,???????????????????? ??????????????????[HighVoltageElectricity]??????????????!??????????????????????????? ????????, ???????????? ?????? ???????? ????? ???????, ??????? ?????? ??????? ??????????? ????? ??????? ???? ????? ???? ??????? ????????? ?????????! ?????? ????? ???????????? ???????? ????????????. ??????????? ???? ??????? ??????????, ??? ????? ????? ???????? ?????? ??????. ????? ??? ???????? ??????, ???????????, ?????????????

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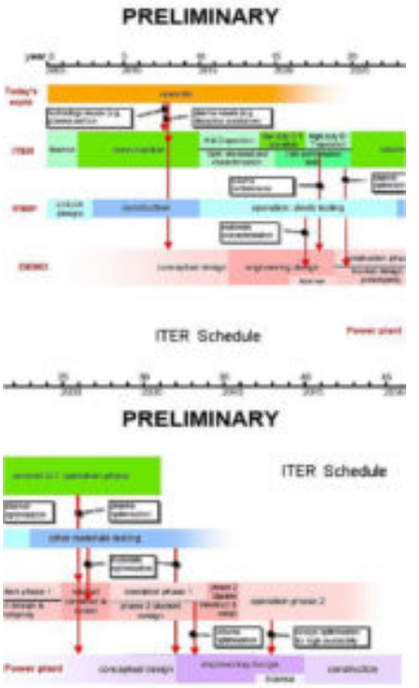

????? ???????? ????????? ????????? ?????????? ??????? ????????? !

??? ???? ?????? ?????????? ???????? (Fusion Fuel Deuterium +Tritium) 10,000 ??? ????????????? (Fossil Fuel) ????? ???????? ????????? ! ??????? ???????? ???????? ???????????, ???????? ?????????? ?????????? ?????????? ???????? ???? ?????? ?????????? ????????? ????????? ???????????????????! ?????????? ????????? ?????????? ?????? ?????????? ????????? ???????????? ????? ??? ?????????? ?????????? ??????? ???????? (Long Term High Level Fission Product Wastes) ?????? ! ??? ??????? ?????????? 2005 ???? ??? ITER ????? ????????? ????????? ?? ?????? ?????????? ???? ??????? ! ??? ???? ???????????. “12 ????????? ??????? 10,000 ???????? ????????? ?????????? ????? ????????? 7.5 ????????? ???????? ?????????? ????????? ??????????,” ????? ???? ?????? ?????????? ????????? ??????? ???? ????? ?????? (Jan Vande Putte) ????????. “??? ????????? ??????? ?????? ????? ??????? ???????????? ?????????? ???????????? ????????????, ??? ????????? ????????? ???????? ????????? ???????, 2080 ??? ??????? ???????? ????????? “???? ??????? ????????????” (Renewable Energy) ?????????????? ??????? ????????? ???????? ??????? ????????????.

From left : IAEA's Werner Burkart, China's Guanhua Xu, EU's Janez Potochnik, Russia's Alexander Rumyantsev, Japan's Nariaki Nakayama, Korea's Seok-Sik Choi, American Raymond Orbach after signing an agreement at Moscow's President Hotel, Tuesday, June 28, 2005. A six-party consortium chose France as the site for an experimental nuclear fusion reactor (ITER), opening the way for development of a potential source of clean, inexhaustible energy.

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Picture Credits: NASA, JPL; National Geographic; Time Magazine, Astronomy Magazine.

1. Our Universe – National Geographic Picture Atlas By: Roy A. Gallant (1986)
2. 50 Greatest Mysteries of the Universe – How Did the Solar System form ? (Aug 21, 2007)
3. Astronomy Facts File Dictionary (1986)
4. The Practical Astronomer By Brian Jones & Stephen Edberg (1990)
5. Sky & Telescope – Why Did Venus Lose Water ? [April 2008]
6. Cosmos By Carl Sagan (1980)
7. Dictionary of Science – Webster's New world [1998]
8. The Universe Story By : Brian Swimme & Thomas Berry (1992)
9. Atlas of the Skies – An Astronomy Reference Book (2005)
10 Hyperspace By : Michio kaku (1994)
11 Universe Sixth Edition By: Roger Freedman & William Kaufmann III (2002)
12 Physics for the Rest of Us By : Roger Jones (1992)
13 National Geographic – Frontiers of Scince – The Family of the Sun (1982)
14 National Geographic – Living with a Stormy Star – The Sun (July 2004)
15 The World Book of Atlas : Anatomy of Earth & Atmosphere (1984)
16 Earth Science & Environment By : Dr. Graham Thompson & Dr. Jonathan Turk (1993)
17 The Geographical Atlas of the World, University of London (1993).
18 Hutchinson Encyclopedia of Earth Edited By : Peter Smith (1985)
19 The Origin of Earth (www.moorlandschool.co.uk/earth/earthorigin.htm)
20 IAEA Report – France to Host ITER International Nuclear Fusion Project (June 28, 2005)
21 IAEA Report Focus on Fusion By : IAEA Staff
22 IAEA Report – Fusion : Energy of the Future By : Ursula Schneider IAEA Physics Section World Atom Staff Report.
23 BBC News : France Gets Nuclear Fusion (Experimental) Plant.
24 World : France Chosen to Host Experimental Fusion Reactor Project By : Breffni O'Rourke(June 28, 2005).
25 http://www.thinnai.com/?module=displaystory&story_id=40203101&format=html(??????????? ????? ???????? ???????? ?????????)
26 http://www.thinnai.com/?module=displaystory&story_id=40303172&format=html(?????? ?????????? ????????????? ????? ?????????? ????????)
27 http://www.thinnai.com/?module=displaystory&story_id=40508052&format=html (21 ???? ???????????? ????????????? ????? ?????????? ????? ????????)
28

http://www.thinnai.com/?module=displaystory&story_id=40709271&format=html(???????????? ?????? ???????? ???????????? ????????? ???????)
29. http://www.popularmechanics.com/science/energy/next-generation/is-fusion-power-finally-for-real [June 21, 2011]
30. http://world-nuclear.org/info/Current-and-Future-Generation/Nuclear-Fusion-Power/#.UkceJNNza9I [August, 2013]
31. http://www.opli.net/opli_magazine/eo/2013/laser-fusion-experiment-yields-record-energy-at-llnl.aspx [August 26, 2013]
32. http://en.wikipedia.org/wiki/National_Ignition_Facility [September 17, 2013]
33. http://en.wikipedia.org/wiki/Fusion_power [September 27, 2013]
34. http://www.cbc.ca/news/technology/nuclear-fusion-hits-energy-milestone-1.2534140 [February 12, 2014]
35. http://www.world-nuclear-news.org/C-Progress-in-controlling-fusion-heat-bursts-18031501.html [March 18, 2015]
36 https://www.forbes.com/sites/ethansiegel/2015/08/27/how-close-are-we-to-nuclear-fusion/#25a93ab916ec [August 27, 2015]
36 (a). https://gizmodo.com/the-real-problem-with-fusion-energy-1777994830 [May 27, 2016]
37. https://www.theguardian.com/environment/2016/dec/02/after-60-years-is-nuclear-fusion-finally-poised-to-deliver [December 2, 2016]
38. https://www.livescience.com/61298-new-fusion-reactor-uses-boron-and-hydrogen.html [December 28, 2017]
39. https://en.wikipedia.org/wiki/Fusion_power [January 10, 2018]
40. https://www.iter.org/sci/beyonditer
41 https://physics.stackexchange.com/questions/178671/hydrogen-boron-fusion
42. http://world-nuclear.org/information-library/current-and-future-generation/nuclear-fusion-power.aspx [November, 2017]
43.https://commons.wikimedia.org/wiki/File:EAST_Tokamak_vacuum_vessel_2015.jpg
44. http://news.mit.edu/2018/nas-report-right-path-fusion-energy-1221 [December 21, 2018]
45.https://en.wikipedia.org/wiki/Experimental_Advanced_Superconducting_Tokamak [April 14, 2019]
46. https://en.wikipedia.org/wiki/Fusion_power [May 3, 2019]
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