



United States Sustainable Energy

United States Department of Energy

Roadmap

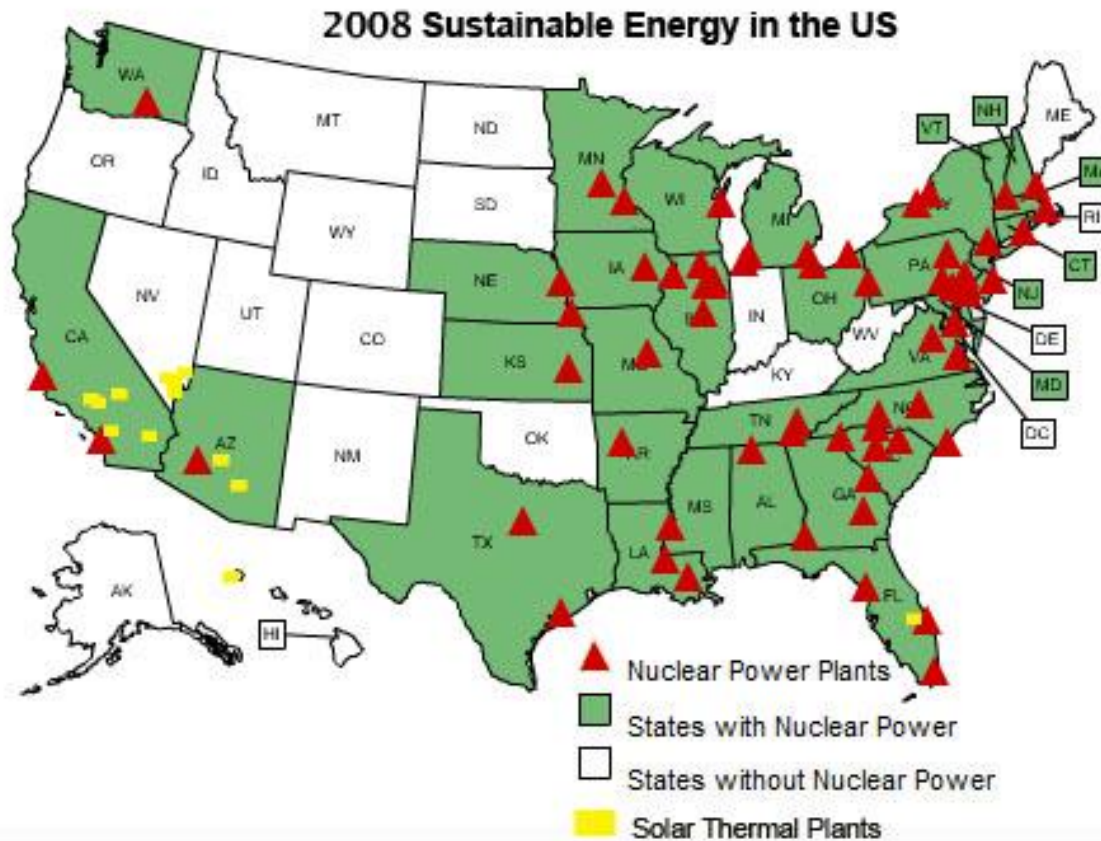
- Energy Assessment
- Solution
 - Phase I: Nuclear Energy
 - Phase II: Solar Thermal Energy
 - General Implementation
 - Economics
- Conclusion

Energy Assessment

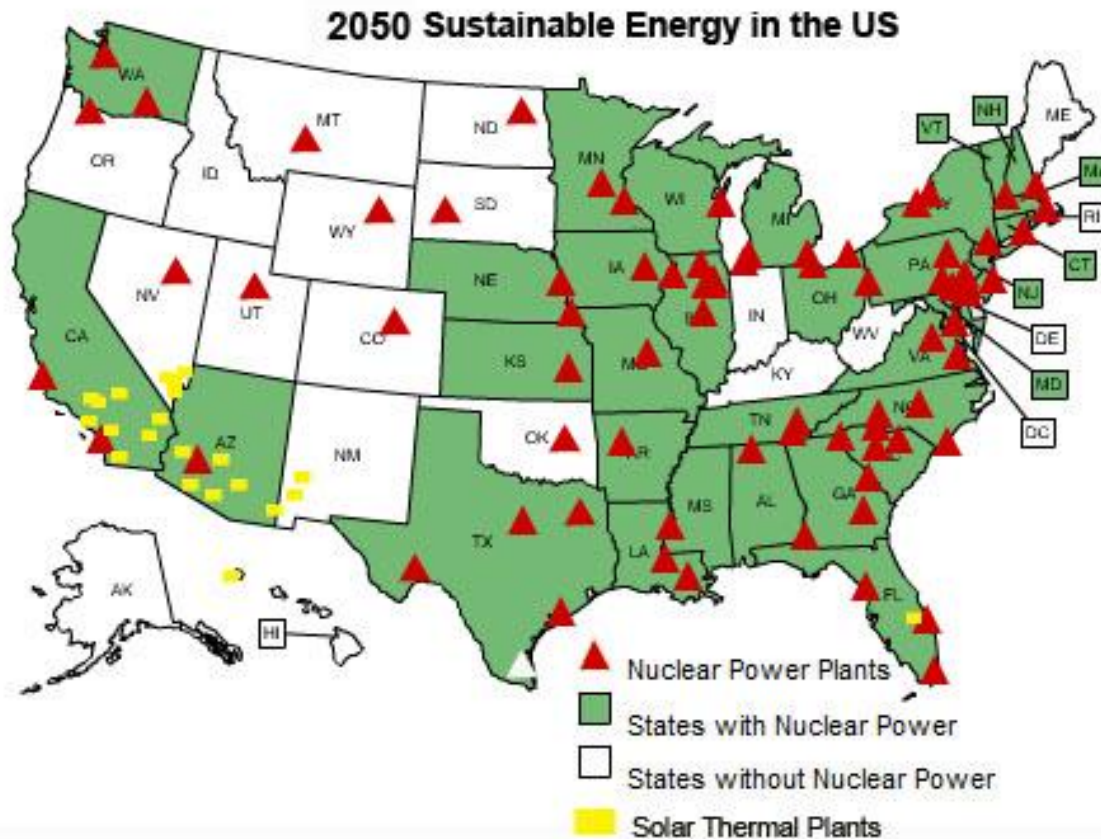
- Decommissioning Nuclear Energy Plants from 1970's
 - Loss of supply, increase of demand
- Coal plants number decreasing and cost increasing
- Heavily dependent on fossil fuels
 - Carbon emissions
 - Fluctuating prices



Current Energy (2008)



Solution (2050)



U.S. Energy Future

- Reducing carbon footprint
- Less dependent on fossil fuels
- Stable economy
- Set examples for other countries with new technologies

Nuclear Energy

- One of the cleanest forms of energy
- Very cost-efficient
- Unit cost: \$6-9 billion per reactor
- Implementation – 2015
 - 210 nuclear reactors
- Completion – 2050
 - 400 nuclear reactors



Generation III+

- Westinghouse AP1000
- 100 times safer than normal nuclear reactors
- Numerous innovative safety features
- 1154 MW output

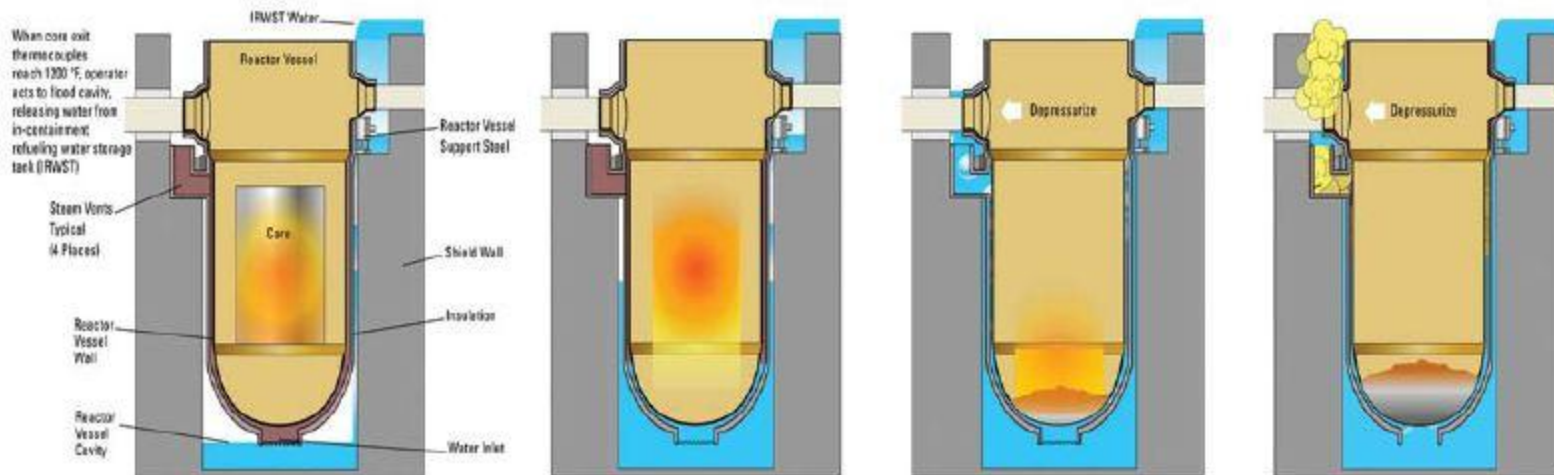


Advantages

- More powerful reactors
- Passive Containment Cooling Systems
- Cost competitive with coal plants
- Creates total of 250,000 jobs
- AP 1000 is inherently safer than older designs

Disadvantages

- Public hesitant about nuclear energy
- Potential radiation damage
 - Product from Cleveland Biolabs



Solar Thermal Energy

- Cost: \$6 billion
- Output: over 900 MW
- Phase II—2035
 - 45 plants
- Locations: Southwest
- Parabolic Trough Design



Advantages

- Cheap energy
- Electricity 50-70% more efficient than solar PV cells
- Able to heat to very high temperatures
- Hybridization

Disadvantages

- High costs
- Unable to focus diffused light
- Weather dependent



General Implementation

- 2015—Nuclear
- 2035—Solar Thermal and Nuclear
- 2050—Plan finishes
- Natural gas as transition from coal
- Satisfies both parties in Congress

Economics

- Energy Policy Act of 2005
- Government funds up to 80% loan guarantees
- 15 percent tax break for nuclear
- 30 percent tax break for solar
- 77 billion dollars per year
- Cost competitive with Coal

Cost Comparison

Nuclear vs. Coal		
	Nuclear	Coal
With Capital	4.3c/kWh	3.8c/kWh
Without Capital	1.87c/kWh	3.3c/kWh
Capital costs	\$3382/kW	\$2750/kW

Conclusion

- Sustainable energy is the future
- Nuclear and solar thermal security
- Role model for developing countries

Questions?

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BACKUP SLIDES
NUCLEAR

Nuclear Energy is Safe

- Impossible to meltdown
- Radiation is contained in multiple layers
- Coal plants reduce more radiation

How to Store Nuclear Waste

- Before: stored in barrels inside building
- Fukushima: leakage problem
- AP1000: underwater at the base of the reactor

What happens if the AP1000 is not approved?

- Letter from Advisory Committee on Reactor Safeguards
 - “We conclude that there is reasonable assurance that the revised design can be built and operated without undue risk to the health and safety of the public.”
- Easily replaceable
- Areva

The Westinghouse Monopoly

- Not true
 - AP1000- example on any Generation III+ plant.
- GE and Babcock & Wilcox no Generation III+ designs
- Reevaluating the energy situation in 2035
 - Assess and potentially invest in new technology

Environmental Impact of Nuclear Energy

- Releases hot water vapor only
- No radiation

Importing Uranium

- 1 lb. of Uranium = 20,000 lbs. of coal.
- Canada and Australia,
 - good diplomatic relations
- The price does not fluctuate as much as fossil fuels.
- Enough uranium to easily outlive the plants built in 2050

Nuclear Proliferation

- It is impossible to build a nuclear weapon out of the uranium in a pressurized water reactor.
- New reactors have top security measures.

Safety Features of the AP1000

- Passive Core Cooling System
- Containment Isolation
- Passive Containment Cooling System
- Main Control Room Emergency Habitability System
- In-Vessel Retention of Core Damage

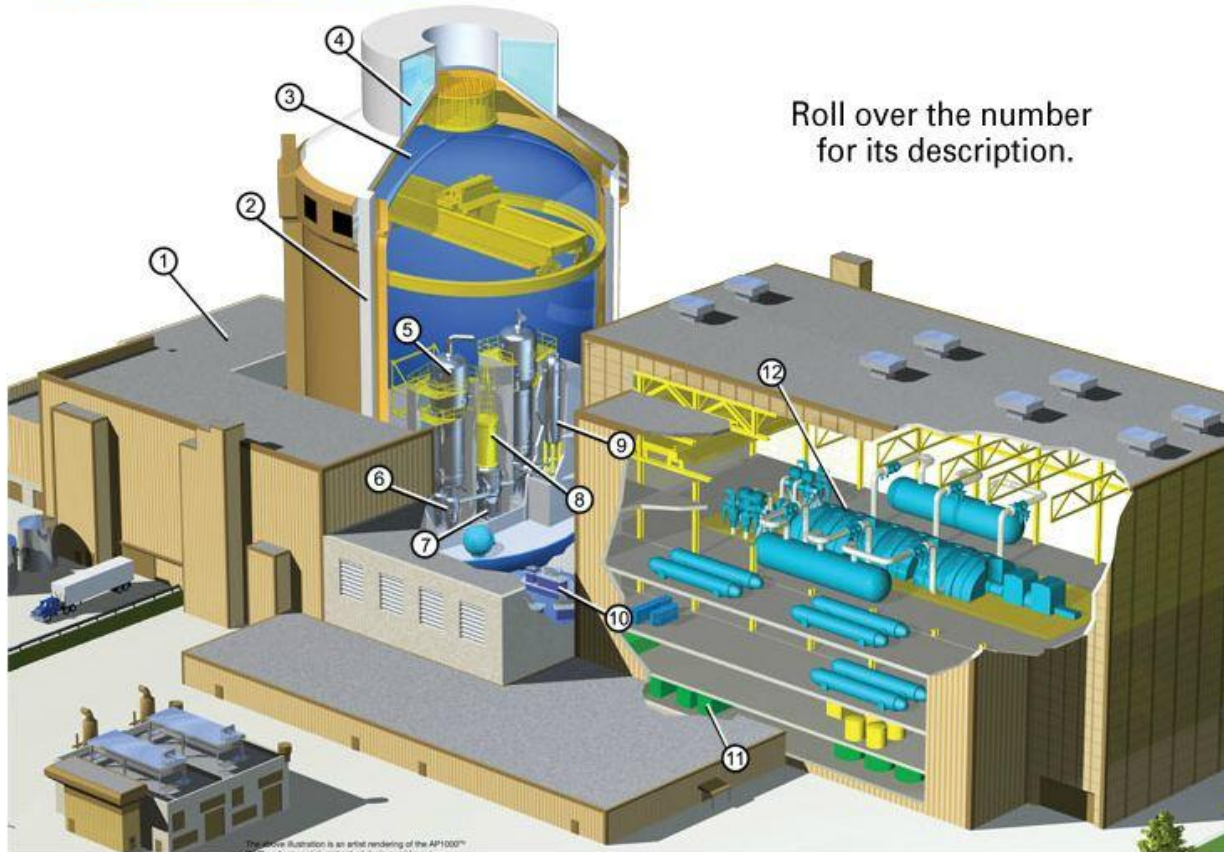
AP1000 Reactor Diagram



The Nuclear Renaissance Starts Here.™



Westinghouse Electric Company LLC



Roll over the number
for its description.

Aftermath of Fukushima

- Obama Administration still supports nuclear
 - Still wants \$54.5 billion into nuclear (triple Bush)
- Agreed to monitor while Fukushima investigation occurred
- US is continuously upgrading safety requirements
- Japan Department of International Affairs: over 50% support increase/status quo as of June, 2011

Other Generation III+ Reactors

- Economic Simplified Boiling Water Reactor (ESBWR) by GE Hitachi Nuclear Energy: 1575 MW
- Advanced CANDU Reactor (ACR) by Atomic Energy of Canada Limited: 1200 MW
- European Pressurized Reactor (EPR) by Areva: 1650 MW

BACKUP SLIDES SOLAR THERMAL

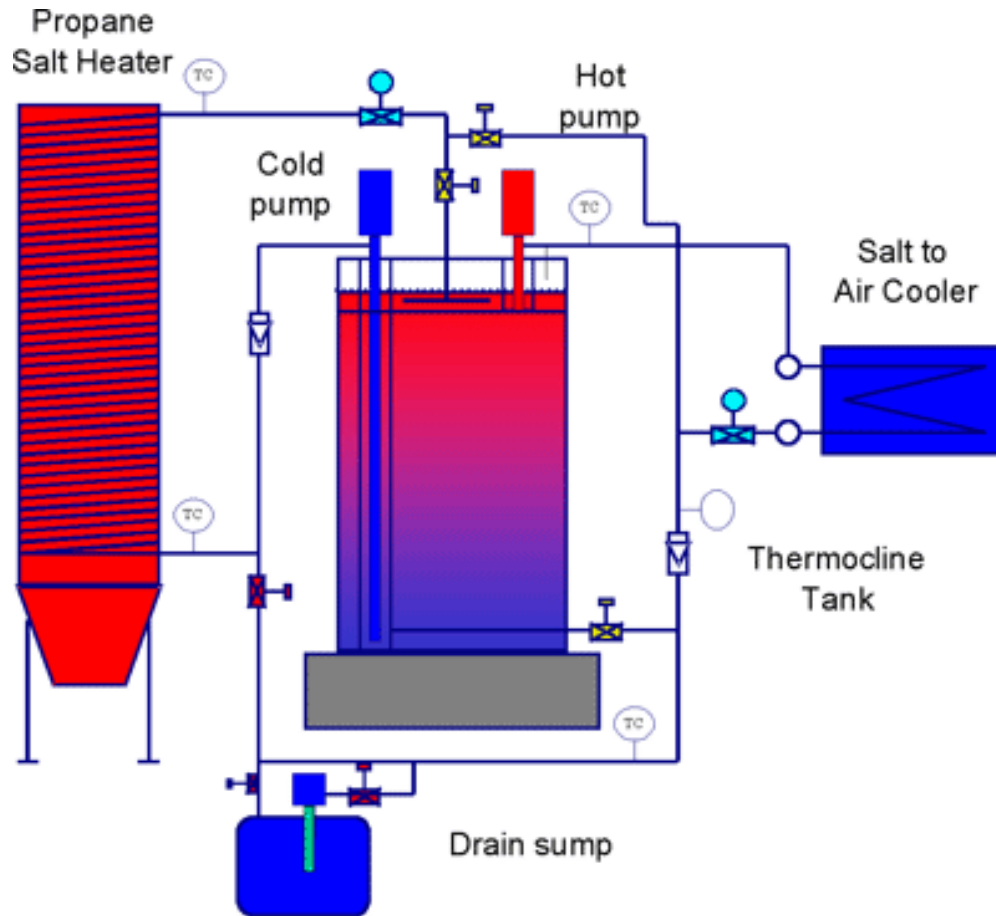
Errors in Current Policies

- PV cells unable to develop in large scale
- Inadequate funding
- Majority of technology was too expensive at the time of development

Parabolic Trough Plant



Storage: Thermocline System



Solar Thermal Prices

- Decrease 15% in the next decade with 50% loan guarantee from the government (World Bank)
- Definite cost reduction (NREL)
- Large-scale production is cheaper
- Become competitive with current energies by 2015

Potentials of Solar Thermal

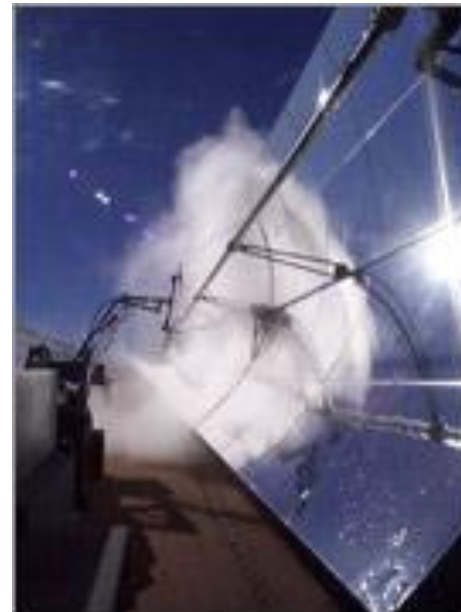
- With 100% government loans
 - 2015: 4 GW of electricity, 10% of US energy
 - Energy production doubles several times over
 - Avoids current nature preserves

Solar Thermal or Agriculture?

- Land competes with agriculture in the desert
- Solar Thermal generates larger profit: Imperial Valley Case Study
 - Alfalfa: \$750/year/acre
 - Solar Thermal: \$45,000/year/acre
 - Used less water
 - Other benefits: jobs, district revenues

Operation and Maintenance

- Operate and maintain 24 hours a day
- Initially lots of engineer/mechanic requirements
 - Initial additional cost: \$7,000
- Annual O&M Cost: \$14,000



Electricity of Solar Thermal

- Currently: \$0.11 / kWh
- By 2020: (without government subsidies) \$0.03 / kWh

Why has our government not implemented solar thermal yet?

- Decline in federal and state incentives
- No longer competitive with cheaper energy

Success Stories

- SEGS I-IX (Solar Energy Generating Systems)
- Around 800 MWs



BACKUP SLIDES ECONOMICS

Methodology

- Existing Capacity: 1025.4 GW
- Increasing demand at 0.07 percent per year
- Necessary Demand 2050: 1364.9 GW
- Nuclear power retirements: 101.216 GW
- Coal power retirements: 72.03 GW
- Total Need: 512.7 GW
- At 1154 MW, we need 445 plants.
- 400 nuclear reactors and 45 solar thermal plants

Loan Guarantees

- Definition: An agreement that a government will pay an amount of money if a private company defaults on their engagements.

Tax Breaks

- 15 percent tax breaks for nuclear
- 30 percent tax break for solar thermal
- Only for time of construction, max 10 years

Funding

- Congress allocated \$6 billion fund for sustainable energy
- No concrete plan proposed—fund unused
- 2010: DOE used \$2 billion, 22 plants
 - (ABC News)

BACKUP SLIDES
MISCELLANEOUS

Coal

- Will be more expensive
- Is actually more radioactive than nuclear energy
- Pollutes the atmosphere
- Clean coal increases the cost exponentially