

WISEE 2013 Solar Satellite Power Technological Innovation Process & Green Energy

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Technological Innovation Process: SSP for Green Energy

- ♦ Innovation
- ♦ Kondratiev Long Waves
- ♦ Technological Revolution
- ♦ Cross-Road SSP Green Energy Opportunity
- ♦ Energy Sample Facts & Figures
- ♦ SSP Innovation Feasibility
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Invention vs. Innovation

Everyone knows invention but not many understand innovation

- ♦ Invention is 'a novel idea' that has been transformed into reality or given a physical form (Latin root nova)
- ♦ Innovation defined as 'introducing something new' or 'applying a new idea' enabling us to meet our needs
- ♦ An invention introduces a new methodology where innovation adopted inventions with greater impacts
- ♦ **Three related terms:**
 - ♦ Radical innovation introduces discontinuity
 - ♦ Incremental innovation maintains the continuity.
 - ♦ Diffusion is the process causing an innovation to take off

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Two Views of Innovation

- ♦ "He who will not apply new remedies must expect new evils, for time is the great innovator"

Francis Bacon (1561-1626), Philosopher of Science




- ♦ "Many essential human *needs* can be met only through goods and services provided by industry, so Industry has the *power* to enhance or degrade the environment; invariably does both"


World Commission on Environment and Development, 1987

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Two Key Characters

- ♦ Leonardo da Vinci, called the *Father of Invention*, lived 300 years before first technological revolution (TR1), whose imaginary designs enabled TR1 to change Europe and then the world
- ♦ Thomas Edison's persistence and hard work produced the electric bulb, some call him the *Father of Innovation*

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Kondratiev Long Waves


- ♦ Studies show global economies change up and down periodically. Some cycle every 8-10 years and some every 15-25 but strongest is Kondratiev long waves (KLW) with a period between 45 to 60 years [1]


Clustering innovations	Key innovative technologies	Main geographical base
1 st long wave 1760s-70s	Steam engines Textiles, Chemistry Civil engineering	Britain France
2 nd long wave 1820s	Railways Mechanical engineering	Britain Europe
3 rd long wave 1870s-80s	Chemistry Electricity Internal combustion	Germany United States
4 th long wave 1930s-40s	Electronics Aerospace Chemical farming	United States
5 th long wave 1970s-80s	Microelectronics Biotechnology	Japan California
6 th long wave (2020s?)	?	?

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Technological Revolution


- In order to improve our 'quality of life' we solve common social problems adopting new methods called *technology paradigm*
- When the new bundles of innovation are significant we have a *technological development* and when many are synchronised we then have a *technological revolution (TR)* when technology brings significant improvements to the whole and in all dimensions of society
- A TR can be recognized by recorded social and economical enhancements created by adopting new *trustworthy technologies*
- A TR can be explained by a See-Saw Model when it swings by the force of new technologies feeding the growing *market dynamics* for a long-term stable balanced market-invention status!




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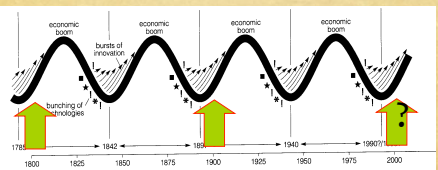
1st & 2nd Technological Revolutions


- The 1st technological revolution (TR1) occurred some 200 years ago with steam power as a result of Watt's observation of a kettle's heavy top moving by the boiling water steam, enabling the vision of the European Renaissance's clever Leonardo da Vinci (1452-1519) whose accurate designs gained the driving power from the steam to complete the cycle for a quantum leap for a great transformation
- The 2nd technological evolution (TR2) occurred around 100 years ago when chemistry offered new materials unknown to nature (plastic, fiber) and electricity enabled the essence of decentralization including: Electricity & electric light (Edison) and Signals to carry information in form of Data (Morse), Voice (Bell), Wireless (Marconi)


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KLW & Technological Revolutions

- The following waves show how R&D of innovative technologies integrate during a recession to create a new surge towards another economic boom.




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Cross-Road SSP Green Energy Opportunity

Ubiquitous SSP Green Energy

- A timely novel solution can enable SSP to provide a new large scale green energy solution
- New markets evolve for trusted professional companies
- Sustainable energy generates new economies




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Opportunity Components

- Crossing Roads:**
 - Overtly complex energy *technological* solution alternatives
 - Depressed *economical environment* for new energy alternatives
- SSP Superior Alternative Green Energy Provision**
 - Although we believe a timely SSP can provide a new long-term large-scale green energy solution (SWOT)
- SSP Energy Management Realities**
 - Market resistance in accepting new radical innovations (deployment)


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Energy Sample Facts & Figures

- Betting story**
 - How realistically does the Paul & Simon's "five commodity metals wager betting" puzzle apply? Should we trust human needs always to find a way? [2]
- Some Facts & Figures**
 - Sample market and technology points
- Some Energy Technological Notes**
 - What is SSP against?


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Energy Market Facts & Figures

The 'World energy demand and economic outlook 2013' [3]:

- The world energy consumption expected to increase by 56% in 30 years from 2010 to 2040
- The total estimated 820 quadrillion BTU in 2040 mostly due to non-OECD regions
- Main reasons are stronger economic growth and expanding populations where OECD member countries are mature energy consumers with slower economic growth and little or no population growth

Figure 12. World total energy consumption, 1990-2040
quadrillion Btu

OECD: Organization for Economic Cooperation and Development

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Energy Market Facts & Figures

The 'World energy demand and economic outlook 2013' [3]

Figure 13. Energy consumption in the United States, China, and India, 1990-2040
quadrillion Btu

Figure 14. World energy consumption, 2010-2040
quadrillion Btu

More detailed figures

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Energy Market Facts & Figures

The World energy world energy consumption by source:

The consumption from 2010 to 2040 increases at the following average annual rates:

- Total energy 1.5%
- Liquids at 0.9%
- Nuclear power and renewables both fastest at around 2.5%
- Others are around 1%

Figure 16. World energy consumption by fuel type, 1990-2040
quadrillion Btu

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Energy Market Facts & Figures

The World electricity generation by energy source:

- Coal provides the largest share declining from 40% of the total in 2010 to 36% in 2040
- Liquids' share also falls from 5% in 2010 to less than 2% in 2040
- The natural gas grows from 22% in 2010 to 24% in 2040 like the renewable from 21% to 25%
- Renewable generation is the fastest-growing source of electric power rising by 2.8% outpacing the natural gas (2.5%), nuclear power (2.5%), and coal (1.8 percent%).

Figure 18. World net electricity generation by energy source, 2010-2040
trillion kilowatt-hours

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Energy Market Facts & Figures

The World nuclear energy generation capacity by country:

- the 86% expansion in installed nuclear power capacity occurs in non-OECD countries, with China, India, and Russia having the largest increment from 2010 to 2040
- China adds 149 gigawatts between 2010 and 2040, India 47, and Russia 31
- OECD some increase, Germany and Switzerland and Japan (Fukushima Daiichi) might withdraw but Turkey and Poland, and France continues to use

Figure 20. World nuclear electricity generation capacity, 2010, 2020 and 2040
gigawatts

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Energy Market Competition

A typical example of SSP competitive forces:

- Many organizations for local, political or economical interests, under the flagship of green environment have established strong (competitive) cooperation to ensure they position themselves for a lion's share of the upcoming enormous energy market.
- To get a feeling we have to look at DESERTEC Foundation [4] and briefly look at their plans and a few of the developments of a complex (surface/panel) solar energy coverage in North Africa and the Middle East (MENA) to feed European Countries in the near future.
- The claim is based on 90% of world population living not further away than 3000 km distance from energy region.

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Energy Market Competition

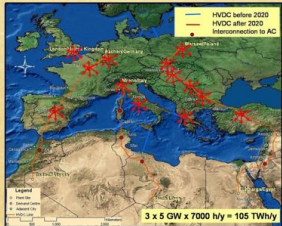
The following figure shows the area under consideration as the source for DESERTEC [4]:



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Energy Market Competition

Further images for this competitive source of energy



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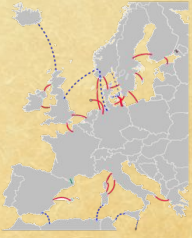
Energy Market Competition

Sample images for this competitive source of energy

- For distribution at the European end the transmission of renewable energy uses the High Voltage DC (HVDC) technology, which is proven to be the best option for multi-network transformation in both directions.

Legend

- Red indicates the existing links
- Green, under construction
- Blue, proposals for future expansions



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Energy Market Competition

Sample images for this competitive source of energy, (CSP) Concentrated Solar Power [5]



Stirling Dish: A parabolic solar dish concentrating the sun's rays on the heating element of a Stirling engine. The entire unit acts as a solar tracker.

Array style parabolic high-temperature collector

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SSP Innovation Feasibility

Sample images from Don M. Flounoy, Springer 2012 [6]

- The NASA Sun Tower Sunsat option, a conceptual design for providing a clean, abundant and instantly useful energy drawn down from strategically placed solar stations above Earth

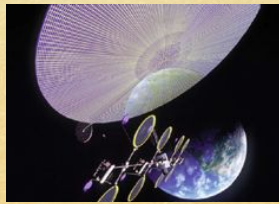


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SSP Innovation Feasibility

Sample images from Don M. Flounoy, Springer 2012

- A "Fresh Look" study, NASA's image of Solardisk, a solar power satellite to generate 5 gw of electricity in space at prices equal to or below ground alternatives

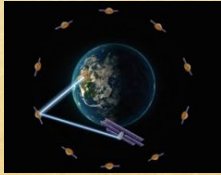



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SSP Innovation Feasibility

Sample images from Don M. Flounroy, Springer 2012

- Artistic form of a network of reflector satellites equatorial orbit, relaying energy from a power orbit representing the first-generation relay satellites for developing massive satellites needed to expand SSP to the 4 terawatt level of today's fossil-based primary power supply





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SSP Innovation Feasibility

Sample images from Don M. Flounroy, Springer 2012

- The Complexity of synchronization in space - the commercial communication satellites within the 360° geosynchronous equatorial orbit that is 36,000 km above Earth. Space objects in GEO is a prime move in sync with the turn of Earth






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SSP Innovation Feasibility

- I am certain the majority of other talks in this workshop provide significant up-to-date insight on the technical aspects and alternative solutions of SSP. We do not need to get involved any further, therefore I would like to view the market based innovation of the SSP to SWOT and its success as a alternative source of renewable energy
- Two methods are normally used to analyse a radical innovative SSP. One is classic *Marketing Mix*, which I find is too complex to be used for this case. Then there is a more suitable viability tool from Everett Rogers, called *Rogers Criteria*



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SSP Innovation Viability

Five components of Rogers Criteria

- Relative advantage
- Compatibility
- Complexity
- Observability
- Triability.




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TOSS

four basic measures for a cooperative developments

- Trust – without trust no proper use can be ensured
- Objectivity – overall effectiveness of an operation heavily depends on its fundamental goals
- Security – independent information security as control is an essential infrastructural procedure
- Stability – system intelligence inherits a natural factor of instability so control over critically important system's parameters is essential



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Conclusion

Supporting the bet I trust *human ingenuity* in finding the way to survive and improve its lifestyle. I therefore see some kind of SSP should emerge to provide/serve the world an ultimate trouble-free green energy solution.

However, the question is finding an optimum route to success, which does '*not cost us the earth*' and '*serves us all*', i.e., an important part of an integrated energy solution with its components placed all over the globe.

That is, when and how we should plan to make this happen?



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Thank You

Any Questions?



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References

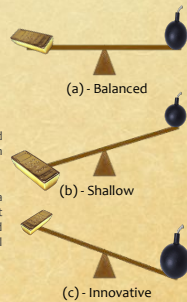
- [1] Classic Open University Course Materials for Innovation
- [2] Simon-Ehrlich wager - Wikipedia
- [3] US_EIA: <http://www.eia.gov/forecasts/ieo/world.cfm>
- [4] <http://en.wikipedia.org/wiki/Desertec>
- [5] Solar thermal energy - Wikipedia
- [6] Book: Don M. Flounoy, Springer 2012, ISBN: 978-1-4614-1999-0



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See-Saw Model

- See-Saw comes with 3 main states:
 - a) Balanced (diffusion)
 - b) Shallow
 - c) Rich & Innovative
- For a social impact we need a good balanced coupling of two main forces of innovation (tech & mar) is essential
- But as society cannot trust market forces a market-lead balance has limited impact therefore only technology-lead balanced innovations can bring a technological revolution (TR)

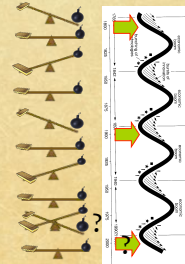


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See-Saw Model & TRs (state transitions)

- Technology-lead balance (TR)
- Market-lead balance (no TR)
- Technology-lead balance (TR)
- Market-lead balance (no TR)
- Technologies are not harmonized (??)



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