A decentralized resilient mixed-energy infrastructure ($L^3$) model of America

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Outline

1. Goal
2. Motivation
3. Analysis of non-renewable energy
4. Analysis of renewable energy
5. Analysis of mixed-energy infrastructure
6. Analysis of solutions to the problems of $L^3$ model
7. The Model of the $L^3$ mixed-energy infrastructure
Propose a mixed-energy model to solve the problems in the current energy infrastructure of America.
### RPS

According to the RPS standards, the percentage of renewable energy in the total energy consumption should be more than 15% by 2015, 25% by 2025.

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## resilient

Make the current energy infrastructure more resilient (recover readily from extraordinary events such as natural disaster, system failure, political reasons).
The traditional non-renewable energy infrastructure is highly-centralized and heavily depends on the crude-oil, natural gas and coal.

Advantage
- Cheap
- Can be easily transported for demands in different places.

Disadvantages
- Pollution
- Dependence on the foreign countries with rich fossil energy.
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### renewable energy

- wind, biomass, biofuel, solar, geothermal, tidal, hydropower, methane, crop waste, sewage treatment facility.

### Advantage

- **Clean**
  - Diversified forms, which can reduce the risk of dependency on only few forms of non-renewable energy sources in the cases that they fail. (natural disasters: tornado, flooding, wild fire, mudslides, hurricane)
  - Improve energy security. Renewable energy can be used as backup energy in the case that major non-renewable energy can not work.
  - Domestic availability to reduce the dependency on foreign countries.

### Disadvantage

- Expensive
- Difficult to deliver in long-distance
- Regions without rich renewable energy sources may not get benefits.
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In order to take use of the advantages and remove disadvantages, we propose the decentralized resilient mixed-energy infrastructure.

- Distinct regions take full use of their own local renewable-energy sources.
- Develop the technology to generate electricity, heating and biofuel locally.
- Consume the renewable energy locally.
- Create new jobs for the local communities. Example: North Dakota has rich wind energy. Nevada has rich geothermal energy.
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- In near future (within 40 years), it is impossible to replace non-renewable energy with renewable energy completely.
- Make them be complementary with each other.
- In regions without rich renewable energy sources, the non-renewable energy has to be used under stricter standards (such as cleaner).

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The decentralized resilient mixed-energy infrastructure can be briefly summarized as $L^3$ principles.

- Generate renewable energy **Locally**;
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Advantage of $L^3$

- Diversified energy forms
  - reduce risks from natural disasters, system failure, political reasons
  - increase the resilience (self-recover, lower price perturbation) of the overall energy infrastructure.
- Avoid the cost from long-distance transmission and transportation systems.
- Local new jobs can reduce the transportation fuel consumption.
- Each region is self-reliant.
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- Local protectionism in the regions with rich renewable energy sources.
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Solutions to the Disadvantages

Exercise

Small-scale trials in some regions with rich renewable energy sources. The experiences and lessons can be helpful to correct the overall plan and policy.

Part of the profit made from the renewable energy is used to

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**cap-and-trade**

the buyer is paying a charge for polluting and the seller is rewarded for having reduced emissions by more than was needed.

- The states(regions) with rich renewable-energy can reduce pollution at the low cost.
- The high cost for the states or regions without rich renewable energy may reduce the energy supply.
- Cause higher price of non-renewable energy.
- This can stimulate the surrounding areas to provide them with low-price renewable-energy.
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The Model of the $L^3$ mixed-energy infrastructure

**the $L^3$ model**

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& \text{max} \quad \text{Economic benefits + Social benefits} \\
& s.t. \quad \text{RPS policy} \\
& \quad \text{Stimulus package budget}
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**Decision variables**
- Decision variables: investment (nation-level, state-level, region-level).

**Economic benefits**
- Increase profits, reduce cost (investment, operation).

**Social benefits**
- Protect natural environment, create new jobs.
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Subject to:
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Economic benefits: revenue and cost

Revenue
the amount charged for delivery of goods or services in the ordinary activities of a business over a stated period.

Opportunity cost
is the return that a business entity’s resources could have earned elsewhere in next most valuable use.

Explicit cost
observable, measurable expenses such as the money cost of production inputs and the interest cost of renting (borrowing) capital.
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revenue of $L^3$ model

Sales of electricity, heating and transportation fuel generated by renewable and non-renewable energy.

Total Explicit Cost of $L^3$ model

- Equipment, plant building, transmission/control software.
- Electricity, heating, transportation fuel.
- Employee salary paid.
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- Forgone salary.
- Forgone interest.
- Economic depreciation on building or equipment.
- Normal profit (the opportunity cost of owners’ entrepreneurial expertise.)
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Clean natural environment

Resolve economic recession

- New jobs that can increase consumers’ demand for services and goods.
- This increase can help resolve economic recession, in which the short-run equilibrium real GDP is less than the full employment GDP.
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  - This increase can help resolve economic recession, in which the short-run equilibrium real GDP is less than the full employment GDP.
The Model of the $L^3$ mixed-energy infrastructure

Question and comments.
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