Energy Efficiency and Energy Conservation Practices

Rangan Banerjee
Forbes Marshall Chair Professor
Department of Energy Science and Engineering
Indian Institute of Technology Bombay

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R$_x$ for Energy Sector

- Paradigm shift – focus on energy services
- ‘Shortage of supply’ to ‘longage of demand’
- Present energy systems unsustainable resources, climate change, environmental impact
- Transition to renewables, clean coal, nuclear, efficiency
India Abatement Curve

Why bother about energy efficiency?

- Control costs
- Reduce carbon footprint
- Competitive advantage
- Reliability of supply
- Good corporate citizen
- Sustainability
Electricity Cost Control

Elect Bill = Average Elect Price × Electricity Consumed

- Energy Efficiency Options to reduce electricity consumption
- Reduce the average electricity price
  - by opting for cogeneration, PV
  - by analysing tariff structure and modifying usage pattern.

Strategies for the company

- Dematerialisation/ Product Design/ Substitution – Analysis of life cycle of product – Design challenge
- Benchmarking – Specific Energy Consumption – Statistical, Thermodynamic – Reduce and reuse wastes
- From “Best Practices” to “Next Practices”
Steel Plant Optimal Response to TOU tariff

Generalized approach for model based benchmarking

Survey of existing models of process
Understanding basics
- Defining system boundary
- Writing fundamental equations governing process
- Decide assumptions identifying empirical correlations for process

Model development
- Divide process into sub-models
- Identify input / output parameters for sub-models
- Identification of design and operating variables
- Developing linkage between process parameters and energy consumption

Experimentation
- Validation of model
- Refinement of model

Source: Banerjee and Vishal, 2007
Barriers to Energy Efficiency

- Risk
- Imperfect Information
- Hidden Costs
- Access to Capital
- Split Incentives
- Bounded Rationality
## Split Incentives

I found a way to save a million dollars by spending only $10,000.

The $10,000 would come out of my budget but the savings would go into someone else's budget. It's not feasible.

Our stockholders might disagree. That's why they aren't invited to meetings.

www.dilbert.com

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### Comparison of initial cost and life cycle cost

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Equipment</th>
<th>Rating</th>
<th>Initial cost (Rs)</th>
<th>Annual Electricity Cost (Rs)</th>
<th>ALCC (Rs)</th>
<th>Cost of electricity as % of ALCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor</td>
<td>20 hp</td>
<td>45,000</td>
<td>600,000</td>
<td>605,720</td>
<td>99.0</td>
</tr>
<tr>
<td>2</td>
<td>EE Motor</td>
<td>20 hp</td>
<td>60,000</td>
<td>502,600</td>
<td>512,700</td>
<td>98.0</td>
</tr>
<tr>
<td>3</td>
<td>Incandescent Lamp</td>
<td>100 W</td>
<td>10</td>
<td>1168</td>
<td>1198</td>
<td>97.5</td>
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<tr>
<td>4</td>
<td>CFL</td>
<td>11 W</td>
<td>350</td>
<td>128</td>
<td>240</td>
<td>53.6</td>
</tr>
</tbody>
</table>

EE: Energy Efficient, CFL: Compact fluorescent lamp, ALCC: Annualised life cycle cost
Standard Fan vs Efficient Fan

<table>
<thead>
<tr>
<th></th>
<th>Standard Fan</th>
<th>Efficient Fan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>70 W</td>
<td>35 W</td>
</tr>
<tr>
<td>Price</td>
<td>Rs 1300</td>
<td>Rs 2600</td>
</tr>
<tr>
<td>BLDC motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life</td>
<td>10 years</td>
<td></td>
</tr>
<tr>
<td>Sweep</td>
<td>1200 mm</td>
<td></td>
</tr>
<tr>
<td>RPM</td>
<td>350-400</td>
<td></td>
</tr>
<tr>
<td>Similar air delivery</td>
<td>230 m³/min</td>
<td></td>
</tr>
</tbody>
</table>

Cost Of Saved Energy – Efficient Fan

![Graph showing the cost of saved energy over different discount rates and hours.]

Discount Rate

- 1000 hours
- 2000 hours
- 3000 hours
- 4000 hours

C$E$ Rate/kWh

- 0
- 2
- 4
- 6
- 8
- 10
- 12
- 14
- 16
- 18

0 0.1 0.2 0.3 0.4 0.5
Team Shunya
Building a sustainable future
SOLAR DECATHLON EUROPE 2014

House in Versailles – 26th June, 2014

Team Shunya
70 students   13 disciplines   12 faculty
House Architecture

- Integration of traditional knowledge with modern simulations
- 2 bedrooms with modular furniture
- Steel based prefab construction
- Insulated wall panels for thermal comfort
- Extensive daylighting provision

<table>
<thead>
<tr>
<th>Position</th>
<th>1st pref.</th>
<th>2nd pref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing and Dining Room</td>
<td>E</td>
<td>N</td>
</tr>
<tr>
<td>Kitchen</td>
<td>SE</td>
<td>NW</td>
</tr>
<tr>
<td>Master Bedroom</td>
<td>SW</td>
<td>S</td>
</tr>
<tr>
<td>Kids Bedroom</td>
<td>NW</td>
<td>SW</td>
</tr>
<tr>
<td>Main Entrance</td>
<td>NE</td>
<td>E</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>NW</td>
<td>W</td>
</tr>
</tbody>
</table>

Synergy of Vastu Shastra and Passive Solar Architecture

House assembly process
References

- GEA, 2012: Global Energy Assessment - Toward a Sustainable Future, Cambridge University
- www.dilbert.com
- Team Shunya (first Indian team selected for Solar Decathlon 2014) international student competition held in Paris-Versailles, June, 2014 (http://teamshunya.in/).