A Sustainable Energy Future through Research and Education

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Sustainable access to energy for a growing population

Population

<table>
<thead>
<tr>
<th>World average</th>
<th>2008</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.7 billion</td>
<td>10 billion</td>
</tr>
<tr>
<td></td>
<td>2.4 kW</td>
<td>3.0 kW</td>
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Power consumption:

<table>
<thead>
<tr>
<th></th>
<th>1990</th>
<th>2008</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>TW</td>
<td>11.7</td>
<td>16.1</td>
<td>30.0</td>
</tr>
</tbody>
</table>

≈ 14 TW is needed in 40 years

14000 GW/40 years = 350 GW/year = 1 GW/day

Good news: The massive investments can drive the economy
Fossil fuels dominate today

World energy production & consumption is dominated by fossil fuels.

Change takes time

It takes around 30 years for a new technology to deliver 1% of the energy mix!
What can we do?

• Important
  • to follow several parallel routes!
  • to continuously build the human potential via research and education.

• Development of a wide range of energy sources is essential
  • various sources are suited to be used in different circumstances,
  • no chance to accelerate the change in energy system by only a few techniques
  • smart balance of energy sources can solve the intermittency problem that renewable energy sources suffer from.

• We also need basic research!
Energy science: we can all contribute

Energy science is truly interdisciplinary.
Energy science: we can all contribute

Energy science is truly interdisciplinary.

Naturally it relates to physics through the fundamental concept of energy, isotopes, fission, fusion, flows, and energy conversion.
Energy science is truly interdisciplinary.

To chemistry through the understanding of burning of fossil fuels and production of renewable energy.
Energy science is truly interdisciplinary.

To mathematics through the mathematical methods needed for theoretical modelling.
Energy science: we can all contribute

Energy science is truly interdisciplinary.

It relates to computer science via the need for simulations, data analysis, visualisation, control systems, etc.
Energy science is truly interdisciplinary.

It also relates to geography through the location of energy resources.
Energy science is truly interdisciplinary. To economics through energy pricing and policies,
Energy science is truly interdisciplinary.

- Economics
- Political Science
- Geography
- Computer Science
- Energy Science
- Mathematics
- Chemistry
- Physics

To political science for the need of international agreements.
Energy science: we can all contribute

Energy science is truly interdisciplinary.

and to history for examples of earlier global challenges and transitions.
Education and research serve a strategic role

- Do we have a historical precedent for developed societies choosing to abandon an economic advantage?

Yes! The abolition of slavery.

Why?

- Moral convictions
- Technology made it unnecessary

How can we repeat this success?

Research and education is the key to both!
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- How can we repeat this success?
  - Research and education is the key to both!
Conclusions and discussion questions

1. Realise the sheer magnitude of the transition
2. Need to join forces: we can all contribute
3. Research and education is the key

Main question:
How can You contribute?
Sweden
Gothenburg
... situated on the beautiful west coast of Sweden