PUMP, BOILER, CELL OR TURBINE?
SIX IMAGES FOR ENERGY FUTURES IN AGRICULTURE

Petri Tapio, Heidi Rintamäki, Pasi Rikkonen, Juho Ruotsalainen

aFinland Futures Research Centre, University of Turku
bLUKE, Natural Resources Institute Finland
Scenarios – why?
Material and methods
Scenarios of energy use in farms
Discussion
SCENARIOS – WHY?

- Preparing for several futures simultaneously
- Enabling strategic discussions and decisions
- Preventing ’business-as-usual’ to come true
Global CO$_2$ emissions from fossil fuel burning
1860-2013

Business as usual?
RENEWABLE ENERGY IN FARMS: POTENTIAL BENEFITS

- Reduces purchase of oil and electricity
- May be sold and provide additional income
- May keep rural areas lively
  - Installations, service, retail, image...
- Reduces greenhouse gas emissions
EXPERT VIEWS UP TO 2030

- Data gathering: Hybrid Delphi (see Landeta et al. 2011)
  - 1. round questionnaire + interview (N=28)
  - 2. round questionnaire (N=23)
  - 3. round stakeholder workshop (N=25)
- Data analysis:
  - Numeric responses grouped with cluster analysis
  - Complemented with qualitative material from interviews
- How probably /preferably will each energy form be used in Finnish farms up to 2030?
# Expertise Matrix

## Social expertise - host organization

<table>
<thead>
<tr>
<th>Cognitive expertise</th>
<th>R&amp;D&amp;I</th>
<th>Farm</th>
<th>Administration</th>
<th>NGOs</th>
<th>Interest groups</th>
<th>Advisory services</th>
<th>Industry</th>
<th>Media</th>
<th>Trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>13(9)</td>
<td>8(6)</td>
<td>9(6)</td>
<td>0(2)</td>
<td>6(7)</td>
<td>2(2)</td>
<td>6(3)</td>
<td>3(2)</td>
<td>2(1)</td>
</tr>
<tr>
<td>Renewable energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Society</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural sciences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Numbers in parentheses indicate the number of experts in each category.
Energy sources considered

- Renewable, not based on combustion
  - Solar
  - Wind
  - Hydropower
  - Heat pumps

- Biofuels
  - Biogas
  - Firewood (incl. wood chips)
  - Liquid biofuels
  - Other biomass burning

- Mainstream (fully or partially fossil fuels)
  - Oil
  - Natural gas
  - Bulk electricity
Cluster analysis

- Process of grouping individual answers (N=41)
## Six clusters

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Mainstream technology</th>
<th>Biofuels</th>
<th>Other renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oil</td>
<td>Natural gas</td>
<td>Bulk electricity</td>
</tr>
<tr>
<td>Boiler and Pump</td>
<td>2,00</td>
<td>1,50</td>
<td>5,00</td>
</tr>
<tr>
<td>Incremental Change</td>
<td>4,60</td>
<td>3,40</td>
<td>6,00</td>
</tr>
<tr>
<td>Energy Boost +</td>
<td>3,88</td>
<td>4,38</td>
<td>5,38</td>
</tr>
<tr>
<td>Energy Boost -</td>
<td>4,75</td>
<td>2,38</td>
<td>5,38</td>
</tr>
<tr>
<td>Renewable Prosperity</td>
<td>1,63</td>
<td>3,38</td>
<td>2,75</td>
</tr>
<tr>
<td>Energy Save</td>
<td>2,17</td>
<td>1,83</td>
<td>2,67</td>
</tr>
</tbody>
</table>

1=very unlikely, very much non-preferred

... 4=middle alternative.

... 7=very likely, very much preferred
## Six Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Idea</th>
<th>Strength</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler and Pump</td>
<td>Focuses on combustion processes, complemented with heat pumps</td>
<td>Competence available</td>
<td>Food production?</td>
</tr>
<tr>
<td>Incremental Change</td>
<td>Small cautious steps</td>
<td>No pain</td>
<td>No gain?</td>
</tr>
<tr>
<td>Energy Boost +</td>
<td>Use of all energy forms increase</td>
<td>New business opportunities</td>
<td>Emissions will increase?</td>
</tr>
<tr>
<td>Energy Boost -</td>
<td>As above, but no wind, water or gas</td>
<td>Focusing on the essentials</td>
<td>Winners picked too early?</td>
</tr>
<tr>
<td>Renewable prosperity</td>
<td>All renewables up, fossil fuels down</td>
<td>Emissions down</td>
<td>Is there willingness to change?</td>
</tr>
<tr>
<td>Energy Save</td>
<td>Energy consumption should be reduced</td>
<td>Emissions and costs down</td>
<td>No renewable market?</td>
</tr>
</tbody>
</table>
ENERGY USE IN FINNISH FARMS UP TO 2030
SIX SCENARIOS

Relative change of the energy forms in each scenario

Deviation from mid-scale
ANOTHER ROUND: STAKEHOLDER SEMINAR (N=25)
VOTING FOR SCENARIOS’ PROBABILITY

- Energy Save
- Renewable Prosperity
- Energy Boost -
- Energy Boost +
- Incremental Change
- Boiler & Pump

Very unlikely | Unlikely | Rather unlikely | "Fifty-fifty" | Rather likely | Likely | Very likely
STAKEHOLDER SEMINAR (N=25)
VOTING FOR SCENARIOS’ DESIRABILITY

![Bar chart showing voting results for various scenarios](chart.png)
Discussion

- All scenarios include firewood and heat pumps
- Key strategic question: Towards renewables with
  - Current subsidies
  - Increased subsidies
  - Reduced subsidies
  - Reallocation of subsidies
- Small scale production access to the grid needs to be made easier
- Collaboration between agricultural, forestry, energy and environmental stakeholders is essential