ENERGY as Socio-technical Problem

Infrastructures as Interdisciplinary Research Topic

Christian Büscher | 14.03.2016
### Integration of research

**Purpose**  PROVIDING SERVICE: ENERGY sustainment of operations

**Label**  SOCIO-TECHNICAL SYSTEMS

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<thead>
<tr>
<th>Norms/Values</th>
<th>RELIABLE</th>
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**Definitions**  Heterogeneous technical and social elements
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”’The overall system can be fruitfully described as posing a linked series of sociotechnical problems.’’ (Paul Edwards)

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The overall system can be fruitfully described as posing a linked series of sociotechnical problems.

(Paul Edwards)
Dimensions of the energy complex
1. Dimension

Structure

Institution

Energy

Operation
Complexity/ Control

Heuristic for “Large Technical Systems”
(Source: derived from Hughes, Mayntz, etc.)

<table>
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<tr>
<th>System</th>
<th>Environment</th>
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<tbody>
<tr>
<td>Technical Processes</td>
<td>(3) Operational Couplings to ext. infrastructures</td>
</tr>
<tr>
<td>(1) Determination of Production</td>
<td></td>
</tr>
<tr>
<td>Social Processes</td>
<td>(4) Regulation/ Governance</td>
</tr>
<tr>
<td>(2) Organization of Production</td>
<td></td>
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2. Dimension

Structure

Institution

Energy

Operation
## Redundancy/ Variety

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<th>Variety</th>
<th>Redundancy</th>
<th>high</th>
<th>low</th>
</tr>
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<tr>
<td>high</td>
<td>A. learning organization; regime/ niche-constellation</td>
<td>B. experimental settings; emerging technology fields</td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>C. dominant regimes path dependency lock-ins</td>
<td>D. low degree of organization</td>
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3. Dimension

Structure

Institution

Energy

Operation
## Socio-technical Time

Actions and operations within the power grid, with a time-scale variance from microseconds to years

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<th>Action or Operation</th>
<th>Timeframe</th>
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<tr>
<td>Wave effects (fast dynamics, such as lightning causing surges or overvoltages)</td>
<td>Microseconds to milliseconds</td>
</tr>
<tr>
<td>Switching overvoltages</td>
<td>Milliseconds</td>
</tr>
<tr>
<td>Fault protection</td>
<td>100 milliseconds or a few cycles</td>
</tr>
<tr>
<td>Electromagnetic effects in machine windings</td>
<td>Milliseconds to seconds</td>
</tr>
<tr>
<td>Tie-line load frequency control</td>
<td>1 to 10 seconds; ongoing</td>
</tr>
<tr>
<td>Economic load dispatch</td>
<td>10 seconds to 1 hour; ongoing</td>
</tr>
<tr>
<td>System structure monitoring</td>
<td>Steady state; on-going</td>
</tr>
<tr>
<td>System state measurement and estimation</td>
<td>Steady state; on-going</td>
</tr>
<tr>
<td>System security monitoring</td>
<td>Steady state; on-going</td>
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<tr>
<td>Load management, load forecasting, and generation scheduling</td>
<td>1 hour to 1 day or more, ongoing</td>
</tr>
<tr>
<td>Maintenance scheduling</td>
<td>Months to 1 year, ongoing</td>
</tr>
<tr>
<td>Expansion planning</td>
<td>Years, ongoing</td>
</tr>
<tr>
<td>Power plant site selection, design, construction, environmental impact, etc.</td>
<td>10 years or longer</td>
</tr>
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Technical and Social Operation

Orthogonal Relation

- ‘simple’ interface: signs and symbols
- ‘complicated’ complex: physical and social structures, institutions

social

Organization

technical

Control

Production

Regulation
Outlook

- Strategy Action: Innovation Research
- Discourse of Change
- "Real-World" Experiments
- Trust and Confidence in Systems
- Capability in Complex Systems
- Structure
- Exogenous Threats: Hazard Research
- Social Organisation: Critical Transactions
- Technical Operation: Resilience
- Energy Complex

"Real-World" Experiments

Discourse of Change

Trust and Confidence in Systems

Capability in Complex Systems

Institution

Operation