

Governance of Science and Technology

New Roles for Technology Assessment?

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Assumptions

1. Governance structures influence how technology can be implemented, how benefits are utilized and how risks are generated.
 2. Technology assessment should not only focus on technology, but also on governance structures.
 3. Governance structures includes not only the state but a multitude of actors. Thus, technology assessment has to take such a multitude into consideration.
- Example 'E-Energy' infrastructure: emerging and converging technology fields, converging governance spheres, elements of tentative governance

Overview

1. Snapshot of technology assessment
2. Governance of technology and the role of TA
3. Governance of future E-Energy infrastructure
4. Risks of the envisaged energy infrastructure
5. Implications for technology assessment

Snapshot of Technology Assessment

- Technology assessment: Concepts and methods used to scientifically investigate the conditions for and the consequences of technologies and to contribute to their societal evaluation (e.g., Grunwald 2009)
- Many concepts, two common features:
 - TA is a prospective approach
 - TA considers positive and negative impacts of science and technology, especially their unintended consequences (Bechmann et al. 2007)
- TA provides knowledge, orientation and procedures to contribute to future-oriented problem-solving related to science and technology

Snapshot of Technology Assessment

Feature	Abstract distinctions				
Degree of participation:	Experts ('classic' TA)		Affected parties, laymen (participatory TA)		
Area of intended changes and knowledge supply:	Research, innovation and design process (constructive TA)	Legislation (parliamentary TA)	TA advice for ministries and agencies	TA advice for the general public	Internal managerial TA
Type of involvement:	Advice by publications	Accompanying R&D and innovation		Platforms for societal debate and conflict resolution	
Time horizon, recognition of uncertainties:	Analyses and future-oriented interpretations of empirical facts	Calculations on existent figures, scientific forecasts	Prospective estimations by experts or laymen (foresight)		Analysis of visions (vision assessment)

Understanding of Governance

Governance from an analytical perspective :

- Policy situations and structures without monocratic actor
- Involvement of multiple actors at multiple levels of decision-making, coordination and implementation (e.g., Mayntz 2008; Schuppert 2008)
- Modes of governance: self-regulation, co-operation, regulatory activities; central: negotiations in multi-actor arenas
- Since 'liberalization' and privatization: energy industry as example of governance structure (Mayntz 2009)

Governance of Technology and the Role of TA

- Number of addressees of TA research multiplied
- Expertise relevant for promoting, shaping and controlling technologies is diffused among a greater number of actors
 - TA has to cope with expertise and counter-expertise: critically analyse such knowledge, identify unconsidered issues, initiate or conduct research, analyse the normative backgrounds, make it possible to communicate about it in political and public debate
- TA should also consider governance structures
 - ⇒ should be demonstrated in the following

Governance of Future E-Energy Infrastructure

- E-Energy infrastructure: ‘intelligent’ generation, distribution (smart grid), consumption and storage of energy
- Intensively promoted and funded: promises to increase energy efficiency and climate protection
- Main elements:
 - ‘Smart’ meters: consumers should gain transparency in energy consumption, temporal price differentiation
 - ‘Virtual power plants’: collections of decentralized power sources, especially renewable energy; adaptation to volatile supply with intelligent control systems
 - ‘Electric vehicles’: decentralised energy storage

Governance of Future E-Energy Infrastructure

- ‘Emergent’ technology field with paradigm shift: ‘Decentralization’ and ‘virtualisation’
 - Realization only with automation of the myriads of transactions and embedding transaction control in software systems
 - For ‘real time’ adaptivity envisaged automated, self-organised online communication among components
- Tentative approach: six model regions in Germany
 - ‘Real life’ implementation with accompanying research
 - From a TA perspective: *initial explorative risk research*

TA of Technological and Governance Developments

1. Governing by software?

- Large portions of institutional arrangements to govern transactions and interactions have to be programmed into software systems
 - With collective binding decisions questions of legitimacy emerge (see compulsory smart meters)
 - Open question of how public values can be embedded in software (universal service criteria, privacy)
 - First instances of smart meters suggest adaptation of privacy protection regulation (Raabe et al. 2010)

TA of Technological and Governance Developments

2. Governance structures as sources of risks

- Governance structures provide incentives and sanctions to handle risks
- Public and private actors have diverging interests in security
 - Low incentive for investments in ICT security for for-profit entities: optimization strategy between investment and operation costs and security improvements and comparative advantage
 - Most IT systems in infrastructures by private actors
- Institutional ‘counter-measures’, such as security certification considered inadequate (e.g., Jackson 2009)

TA of Technological and Governance Developments

3. Complexity of future energy infrastructure

- ‘Real-time’ functionality requires large number of couplings with tight interconnections and interdependencies: sources of risks
- Software-based automation may help to exclude occasional human error versus
- Potential of un-controlled chain-reactions and non-linear processes
 - Negative experiences with computer trading with securities (e.g., Goldin & Vogel 2010)
 - ‘Emergent behaviour’ of self-organising IT systems

TA of Technological and Governance Developments

4. Interdependencies between infrastructures (1)

- Convergence of infrastructures; ‘system of systems’ with heterogeneous interests in security
- Interdependencies between infrastructures allow failures to propagate; interdependencies and systemic risk rarely observed by risk research
- Couplings of interdependent networks prone to iterative cascading of failures:
 - Blackout in 2003: shutdown of power stations led to failures in Internet communication, in turn led to breakdowns of further power stations (Buldyrev et al. 2010)

TA of Technological and Governance Developments

4. Interdependencies between infrastructures (2)

- Couplings follow economic interests: e.g., increased interconnectivity of control/SCADA systems with Internet:
 - More functionality and cost savings, but increased vulnerability (Christiansson & Luijff 2008)
- Unresolved governance issues: liability of power generation and network operators for software failures:
 - Challenges for software quality, quality certification, insurance, and adjustments of legal framework

TA of Technological and Governance Developments

5. Incoherence of technical and institutional practices

- ‘Liberalization’ and privatisation in energy generation, trade, metering, and sales
- Governance of networks still organised as integrated system with centralised planning, control and operation (Künneke 2008)
- Better integration of renewable energy requires decentralized approach with ‘intelligent’ control systems and corresponding adjustment of governance structures (Künneke 2008; Rohracher 2007)

Implications for Technology Assessment

- Coherence of technological and governance developments: Mismatch hamper realisation of infrastructure advancements, can be source of unacceptable risks
- TA should analyse, besides technology, also governance structures to understand handling with risks ('governance assessment')
- Governing institutions are programmed in software: analyse interrelations and repercussions of different types of institutions (informal values, formal laws and contracts, 'software institutions')
- Insight into co-evolution of technology and institutions: reconsidered regarding converging technology and converging governance structures

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Thank you for your attention

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