No smooth energy transition in sight

– experiences from the turbulent history of renewable energy

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Wind and biogas today …

- technically working and economically feasible
- high growth and penetration rates
- potential as dominant forms of renewable energy
- though still questions to size, scalability, and system integration
- but … not always so!
- judged useless and without a future several times

Why such a turbulent history and conflicting assessments?

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The bigger picture

- technical, environmental, and economic qualities are associated with energy technologies
- often in situations identified as inherent properties of the technologies – while they are temporary, not stable
- associations results of actor engagements and mediations
- represents institutional and material politics
- e.g. are the roles of substances as carriers or sources dependent of the technologies of utilization and context
- the two cases illustrate these material dimensions
- a sociology of energy systems is about actors giving meaning to materials and politics

Energy systems – transitions

- new energy technologies have to fight to get a place in the existing energy systems
- technological regimes dominate and are built on existing technical infrastructures and established institution
- not only in economic and technical priorities, but in the conceptual framing of ‘good solutions’
- finding a places and roles for new energy technologies implies a larger transition
- or at least defining niches and spaces for the new innovations to develop, be tested, and implemented

Storylines – authoring visions

- established institutions and stakes/shares are important in defining the sense making ‘stories’ to be told
- stories set the stage for e.g. ‘security’, ‘climate’, and ‘efficiency’
- science/knowledge disciplines are involved as well
- storylines are an important part of constructing the bigger picture of interests and perspectives
- mapping the present relations and powers and defining / pre-occupying the future
- dominant institutions and companies frame policy and define the basis for models

Longer history: electrifying the rural

experimental wind turbines at Askov Højskole 1903

- producing electricity and using hydrogen to store energy

Backdrop: coal, gas, efficiency

- back-bone in Denmark: coal and oil fuelled electricity plants and co-generation of power and heat
- heavy CO_2-emissions
- centralised and non-profit, public owned utilities
- energy crisis short term response: natural gas plants
- building codes and support programs improved heating efficiency of buildings
- planning and efficiency improvements lead to decoupling of energy consumption and growth in Denmark
- utilities are now centralized and semi-privatized

Wind and biogas – alternatives

- oil crisis in the early 1970ies created a social and political urgency
- controversy on nuclear power risks and fossil fuel shortages / dependencies grew during 1960ies
- controversy on the societal impact of centralized energy systems and institutions versus local supplies
- among others wind turbines and biogas were identified as alternatives
- not only to fossil fuels and nuclear, being renewable
- but also to the concentrations of 'power' in society, being outside the energy system and local / self-organized

Wind turbine entrepreneurs

- environment movement based ‘grassroots’ and wind energy entrepreneurs broke the barriers
- inspired by ideas of a local and independent energy technology
- bottom up (experiments and scaling) versus top down (research and design) strategies
- complexity of wind aerodynamics and structural dynamics underestimated making large, designed turbines fail
- technology and research support schemes were not very important
- annual wind meetings and the Risø test station crucial

Creation of a new industry

- wind turbines taken up by machine industries in crisis
- soon crossing national borders as markets in Germany and California grew
- government support schemes for energy installations, but owned by cooperatives or local communities
- most important were forced grid connections and fixed prices, changing wind turbines to small energy utilities
- entry barriers and the importance of experience protected the industry in its ‘infant’ period
- integration in the grid based on rebuilt system control strategies pushing from 15 to 25 % (and more)

Priorities and properties

- important to master connections and systems management
- Kyoto and emissions trading schemes created new mechanisms favouring the polluters
- CO_2 market emerge as separate new way of short term optimisations and few experiments with renewable energy
- market construction favours utilities and conventional, proven technologies
- major shift from local investors and entrepreneurs to financial markets and large investors changes the priorities
- while wind turbines today is considered an important contribution the context for innovation has changed

Local biogas experiments

- farmers important in the first experiments with biogas producing heat at farms in the 1970ies
- engineering firms involved in the development and diffusion and a test facility was created in Horsens
- many practical, technical problems in making these small facilities function efficiently
- improvements were made in biogas yields, especially by using supplementary organic waste in the process
- but … the problems made a generation of young farmers skeptical about the usefulness of biogas technologies

Common biogas facilities

- following the local farm based biogas installations common facilities were taken up in the 1980ies
- based on the lessons from the small facilities and due to the larger scale these installations were more successful
- economic support from the ministry of energy helped the diffusion
- based in the action plans for water quality improvement focusing on pollution from farms with e.g. fertilizers
- less focus on biogas as producer of energy, though still part of the equation
- changes in the support schemes ended the experiments

Biogas as integrated technology

- in the 1990ies biogas serves as an integrated technology solving a several problems within conventional agriculture
- policies also are linked to a larger aim in handling biomass as an energy source
- status: 19 common and 60 farm facilities handling 1.6 mill. tons of biomass – compared to Germany with >3000
- now envisaged to reduce nitrogen dilution, a renewable energy in Energy Plan 21, and handling household waste
- growing sizes of pig farms may improve scale and add smell pollution to the associated properties
- complexity in combining waste handling and energy

Economics – mantras and masters

- framing of knowledge by disciplines are crucial for the types of advice they produce
- association of properties important for the assessment of energy technologies
- EU liberalisation created an opening for competition in mergers and strategic ownership of utilities and grid
- models used in energy planning dependent on rather stable assumptions not responding to technical change
- conclusions from a series of scenarios: least complex models are the most useful as they are more transparent and open for discussion

Innovation contexts

- the specific societal and political context for innovation important for the outcome
- defining visions for energy technologies and their combination framing the innovative behavior
- defines configuration of actors involved in experimentation, learning, and diffusion
- innovative role and engagement of people and NGO's
- research has produced rather few results so far, as have laboratory experiments
- practical experimentation and scaling seem to be very crucial for success

Big and small disasters

3 MW turbine in Germany

and

small Danish backyard turbine crash

Policy – an interaction approach

- policy models often imply a centre of strong control and standards setting
- policy should be as much be considered a facilitator of interaction and experimentation
- continuous adjustment of policy measures needed to support the transformation from niche to main stream
- contemporary climate policies are top-down and dominated by rhetorical maneuvering
- Innovation policy is dominated by research and generic technology hype

Conflicts and institutional change

- top-down policies dangerous for a sustainable transition
- these policies are dependent on including strong actors from existing regimes
- tend to envisage consumer and citizens as a problem
- bottom-up initiatives are crucial
- conflicts unavoidable and an intrinsic part of the transition process
- without, alternatives including changes in values and institutions will not be developed