Who can put the German Energiewende into practice? An analysis of actors and their demands for future electricity infrastructures

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Potsdam Institute for Climate Impact Research
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openmod open energy modelling initiative

- A grassroots initiative of 50+ modellers across Europe
- We want to promote the idea of open-source and open-data modelling in energy research and energy policy advice
- Power market models, grid models, energy system models, fuel market models
- Workshops in Sep 2014, Apr 2015, Nov 2015
- www.openmod-initiative.org

Join us!

Motivation

Official Energiewende-Targets

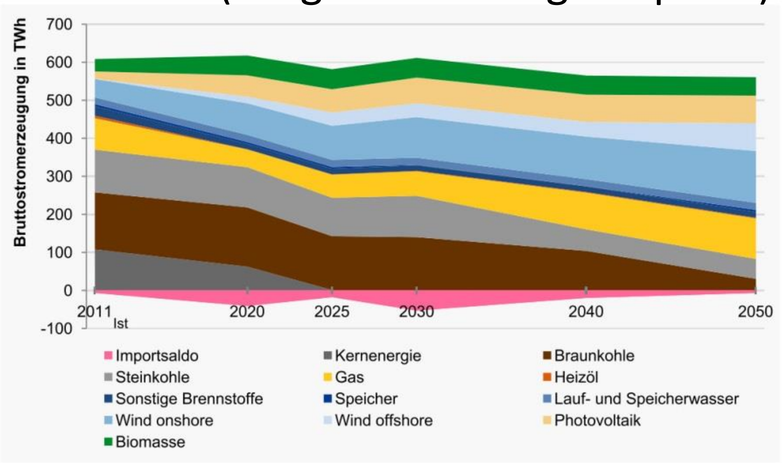
- 80-95% recuction in CO_2 emissions
- Nuclear phase-out
- Competitiveness
- Security of supply

Official Energiewende Strategies

- Renewables
- Efficiency

Model-based scenarios, e.g.

(Exogenous change impulse)



Quelle Prognos/EWI/GWS 2014

- Authors doubt “whether politics and society possess the required will and consistency for implementing all changes necessary for target attainment today and in the future“ (Schlesinger et al. p. 378)
- How to put technological change in the German society into practice?
- Combine insights from social sciences and techno-economic modeling

Aim & Scope of the paper

- **Hypothesis:** Electricity Infrastructure required for decentralized vs centralized vision differ substantially

- **Reseach questions**
  - Who are the actors that can put the changes necessary for decarbonizing the German electricity system into practice?
  - What are their main motives?
  - What kind of electricity-related infrastructures are likely demanded by the different actors in the future?

- **Method:** Literature Review (analytical framework)

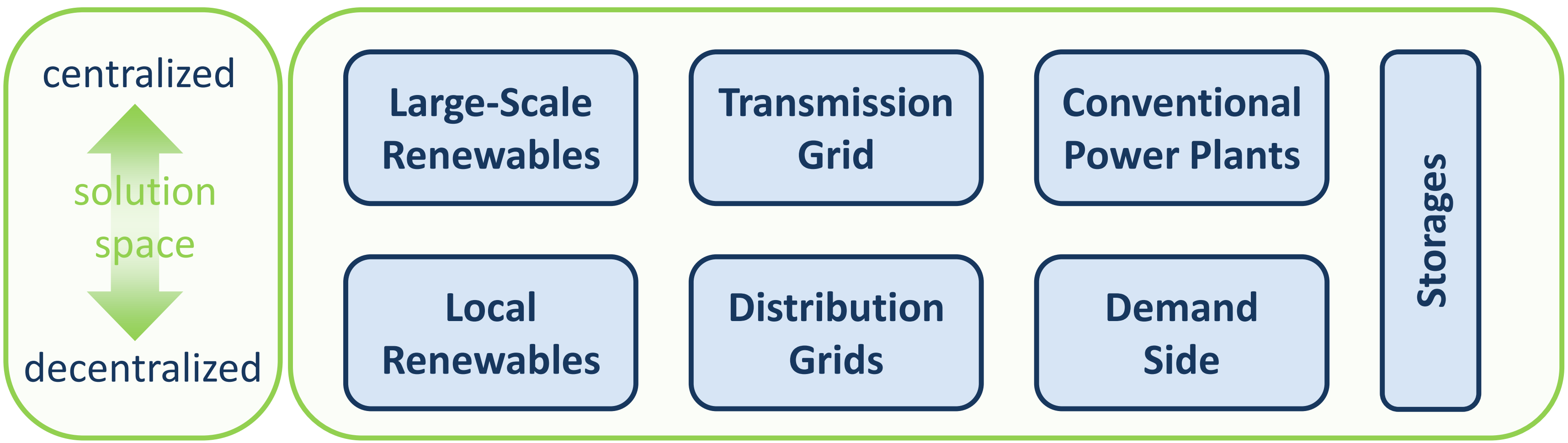
Applied analytical framework (1/2)

- Backbone: Strategic action fields (Fligstein & Mc Adam, 2011)
  - Fundamental units of collective action in society
  - Actors have common understanding of purposes of field, (power) relationships & rules
  - Russian dolls, sub-fields
  - Incumbents, challengers, state-actors
  - Transformative change: Fundamental restructuring of power relationships within a field
  - Social skill

- Additions:
  - Advocacy coalition framework (Sabatier, 1987):
    - Competing Coalitions form based on underlying normative & causal beliefs (policy core)
  - Discourse coalition approach (Hajer, 1993)
    - Competing Coalitions are held together by narrative storylines, language!
  - Resilience framework / shift to renewables regime (Strunz, 2014)
    - non-hierarchical level connection – panarchy – lower level resilience contributes to transformability of higher levels

Applied analytical framework (2/2)

- German electricity system is one SAF
- Delineate sub-fields based on insights from energy-system modeling



Who? does **What?** and **Why?**

Characterization of sub-fields (1/7)

Local Renewables

- In 2012 owned by citizens and farmeres (25%), cooperatives (9%), minority participation models (12%), public utilities (4%)[1]
- Local conflict arenas, many regional sub-fields

- *If trend continues, implications for infrastructures*
  i. Owned by active/organized citizens & local energy service providers
  ii. Small/medium modular units, installed in geographical proximity to owner
  iii. Guided by motivations that exceed profit, local benefits, societal values

- *Necessary enabling conditions*
  a. Remuneration schemes simple, manageable risk
  b. Increasing share of local actors engage financially
  c. Security of supply locally high
  d. Sufficient sites approved by communes
  e. Societal values credibly maintained
  f. Local benefits accrue as promised

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Characterization of sub-fields (2/7)

Large-Scale Renewables

- In 2012 owned by institutional and strategic investors (41%), and private utilities (9%)[1]
- European focus / Desertec idea

- *If trend continues, implications for infrastructures*
  i. Owned by corporate utilities, institutional or strategic investors from Germany or abroad
  ii. Large units, installed where resource potential is most favorable
  iii. Guided by motivations to maximize return on investment

- *Necessary enabling conditions*
  a. E(Return)>Cost of Capital
  b. No local protest
  c. Sufficient transmission capacity
  d. Coordination of support strategies across Europe
  e. aggregate economic efficiency accrues

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Characterization of sub-fields (3/7)

Distribution Grids

- 884 Distribution System Operators (DSOs) [2]
- 10(20) DSOs own 60%(80%) of total distribution grid capacity [3]

- *If rising local renewable capacities need to be integrated, distribution grids will…*
  i. Be structurally refurbished distribution system configuration
  ii. Play a central role in future energy system management
  iii. Connect multitude of producers, prosumers and consumers
  iv. Be owned by DSOs that actively manage regional grid stability

- *Necessary enabling conditions*
  a. Incentive regulation reformed
  b. Sound legal frameworks for intelligent & smart grids
  c. Suitable protocols for data exchange

Characterization of sub-fields (4/7)

Transmission Grid

- 4 Transmission System Operators (TSOs)
- "Netzentwicklungsplan" / Public consultation: 26,000 commentaries, majority to Corridor D[4]
- ENTSO-E / Projects of common interest (PCIs)

- *If rising large-scale renewable capacities need to be integrated, the transmission grid will…*
  i. need to be expanded significantly
  ii. Remain the focal level for system stability
  iii. Serve as a means for the system and market integration of renewables

- *Necessary enabling conditions*
  a. Mode for planning and deployment procedures a the European, national and local levels that is perceived as sufficiently fair for local abutters to refrain from protest
  b. Investment opportunities are worthwhile for TSOs
  c. Welfare and efficiency gains accrue as promised

Characterization of sub-fields (5/7)

Demand Side

- Industry 43%), households (27%), commercial sector (15%), public institutions (9%), transport (3%), agriculture (2%) [5]
- 2 major trends: effiziency / sufficiency & DSM

- *If these trends continue / establish themselves, implications are that…*
  - i. Less electricity needs to be supplied cp. to counterfactual
  - ii. Demand-side infrastructure will be shared or leased, owned privately to a lesser extent
  - iii. Electricity demand becomes flexible / manageable by smart grid

- *Necessary enabling conditions*
  - a. Legal & behavioral barriers to energy efficiency are overcome
  - b. Dynamic market for provision of energy services evolves
  - c. Institutional modes for unleashing DSM potentials develop

Characterization of sub-fields (6/7)

Conventional Power Plants

- "Big 4" and (larger) public utilities
- Conventional business case phases out, needs to be adapted when renewables become dominant

- *If the German Energiewende targets are being attained over time, conventional generation capacities will…*
  i. Provide flexible generation
  ii. Earn income either during high scarcity prices (EOM) or balancing market or capacity mechanisms
  iii. Are driven by the motivation to maximize return on investment

- *Necessary enabling conditions*
  a. Future market design is adapted to create sensible business cases
  b. Sufficient investors find these attractive
  c. Self-perception of actors changes from representing the integral mode of electricity generation towards providing residual load

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Characterization of sub-fields (7/7)

Storages

- Currently, only significant storage is pumped hydro
- Daily Storages vs storages for dark, calm periods
- Today only few business cases, barriers to deployment
- Prospectively variety of actors

- *If storages become techno-economically feasible, implications are that … for modular (centralized, large-scale) storages*
  i. More local (large-scale) renewable electricity can be integrated
  ii. Enable provision of local/regional (centralized) frequency control and ancillary services
  iii. Less (more) transmission grid capacities are required

- *Necessary enabling conditions*
  a. Technology development leads to enhanced techno-economic performance
  b. Expectations on business cases make upfront investments attractive

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Discussion

- Large variety of diverse actors, particularly in decentralized solutions

1. To what degree can decentralized and centralized solutions coexist?

Actor types (Who?)	Motives (Why?)	Conceivable roles in sub-fields, current and prospective (What?)						
		Local RES	Distribution Grid	Demand Side	Storages	Large-Scale RES	Transmiss. Grid	Convent'l Power Plants
Citizens (Households)	*Energy services & other individual*	Abutter Owner Operator Opponent	Customer Supplier	Consumer Manager	Owner (S)	Abutter Opponent	Abutter Opponent	Opponent
Farmers	*Max. income & other individual*	Abutter Owner Operator Opponent	Customer Supplier	Consumer Manager	Owner (S-M)	Abutter Opponent	Abutter Opponent	
Cooperatives	*Provide quasi-public good*	Owner Operator	Supplier Owner	Supplier Service provider	Owner (S-M)			Opponent
Public Utility	*Max. local value added*	Owner Operator	Supplier Owner	Supplier Service provider	Owner (S-M)			Owner (gas) Operator
Industry firms	*Max. profit/SV*	Owner Operator	Customer Supplier	Consumer Manager	Owner (S-M)			
Service Firms	*Max. profit/SV*	Owner Operator	Customer Supplier	Consumer Manager	Owner (S-M)			
Communes/ Municipalities	*Max. local welfare*	Tax rev. Approval	Concession (20 years)	Consumer Manager	Tax rev. Approval	Tax rev. Approval	Abutter Opponent	Tax rev. Approval
Virtual Power plant	*Max. profit/SV*	Operator	User	Operator	Operator	Operator	User	
German Government	*Diverse set of motives*	Support Scheme		R&D funding	R&D funding	Support Scheme		
ICT firms	*Max. profit/SV*	New smart solutions				Refine existing technologies		
DSOs	*Provide secure grid*	Customer	Owner Operator	Supplier & service provider	Owner (S-M)		Sub-ordinate	
TSOs	*Provide secure grid*		Ordinate			Customer	Owner	
Federal Network Agency	*Max. federal welfare (regulator)*		Determine revenues				Determine revenues	
ENTSO-E	*Coordinate regulators*						European interests	
Institutional investors	*Max. profit/SV*				Owner (M-L)	Owner Operator	Supplier	
Strategic investors	*Max. profit/SV*				Owner (M-L)	Owner Operator	Supplier	
Project developers	*Max. profit/SV*					Planner Developer		
Private Utilities	*Max. profit/SV*		Owner	Supplier & service provider	Owner (M-L)	Owner Operator	Supplier	Owner Operator

Discussion

2. What are the determining factors that influence the development in either direction (decentral / central)?

- Key factors will be decided in political arenas
- Specific design of regulatory frameworks determines which actors and technologies are viable
- Social skill of coalitions will ultimately determine success in the implemetation of policy objectives
  - Storyline decentral energy system – Value: “democratization”
  - Storyline central energy system – Value: “efficiency”
- Elite-technocratic worldview vs. representative democracy vs. pluralistic democracy -> Input / Output legitimacy

Conclusion

- Energiewende has increasing amount of diverse actors
  – Differ with respects to worldviews & values

- Discourse coalitions form around storylines that have deep implications for future infrastructure demands

- Adapt model of scientific policy advice?
  – Pragmatic-enlightened model (input&output legitimacy)
  – Participative scenario development appropriate under thse conditions

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Referenzen (Alphabetisch / Fußnoten)

- N. Fligstein and D. McAdam, "Toward a General Theory of Strategic Action Fields*," *Sociol. Theory*, vol. 29, no. 1, pp. 1–26, Mar. 2011.
- M. Hård, "Beyond Harmony and Consensus: A Social Conflict Approach to Technology," *Sci. Technol. Human Values*, vol. 18, no. 4, pp. 408–432, Oct. 1993.
- D. Loorbach, "Transition Management: new mode of governance for sustainable development," 2007.
- V. Luoma-aho and M. Vos, "Towards a more dynamic stakeholder model: acknowledging multiple issue arenas," *Corp. Commun. An Int. J.*, vol. 15, no. 3, pp. 351–331, Apr. 2010.
- J. Rotmans, "Societal Innovation: between dream and reality lies complexity," Erasmus Research Institute of Management (ERIM), Jun. 2005.
- S. Strunz, "The German energy transition as a regime shift," *Ecol. Econ.*, vol. 100, pp. 150–158, Apr. 2014.
- W. Weimer-Jehle, W. „Cross-impact balances: A system-theoretical approach to cross-impact analysis," Technological Forecasting and Social Change, 73(4), 334–361, 2006.

1. trend research and Leuphana Universität, "Definition und Marktanalyse von Bürgerenergie in Deutschland," 2013.
2. Bundesnetzagentur and Bundeskartellamt, "Monitoringbericht 2014," 2014.
3. Bundesnetzagentur, "Evaluierungsbericht nach §33 Anreizregulierungsverordnung ARegV," 2015.
4. 50Hertz Transmission GmbH, Amprion GmbH, TenneT TSO GmbH, and TransnetBW GmbH, "Netzentwicklungsplan Strom 2014," 2014.
5. BMWi, "Energiedaten: Gesamtausgabe." 2014.

Literature on technological/policy change in societies (selection)

- Large technical systems (LTS)
  - Seminal theory by Hughes (1987), Change through scientfic (&technial) closure (Pinch&Biker, 1987)
  - Technocratic, consensus-oriented social constructivism inappropriate, rather conflict perspective (Hård, 1993)
- Strategic Action Fields (SAF)
  - Theory of social change and stability, rooting in social movement studies & organizational theory
  - Fields = meso-level social order, power struggle & coalitions (Fligstein & McAdam, 2011)
- Theories of the policy process / public policy analysis
  - Advocacy coalition framework (Sabatier, 1987)
  - Discourse coalition approach (Hajer, 1993)
- Transition management framework (Loorbach, 2007)
- Resilience framework, Energiewende as a regime shift (Strunz, 2014)
  - „Centralized, supply-side oriented engineering future“ vs.
  - „Decentralized, demand-side oriented new society“

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