The crucial role of infrastructure design in the German Energiewende: An analysis of possible branching points

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POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

Motivation

- Germany‘s energy system is in a state of transition [Energiewende]

  → Towards what future???

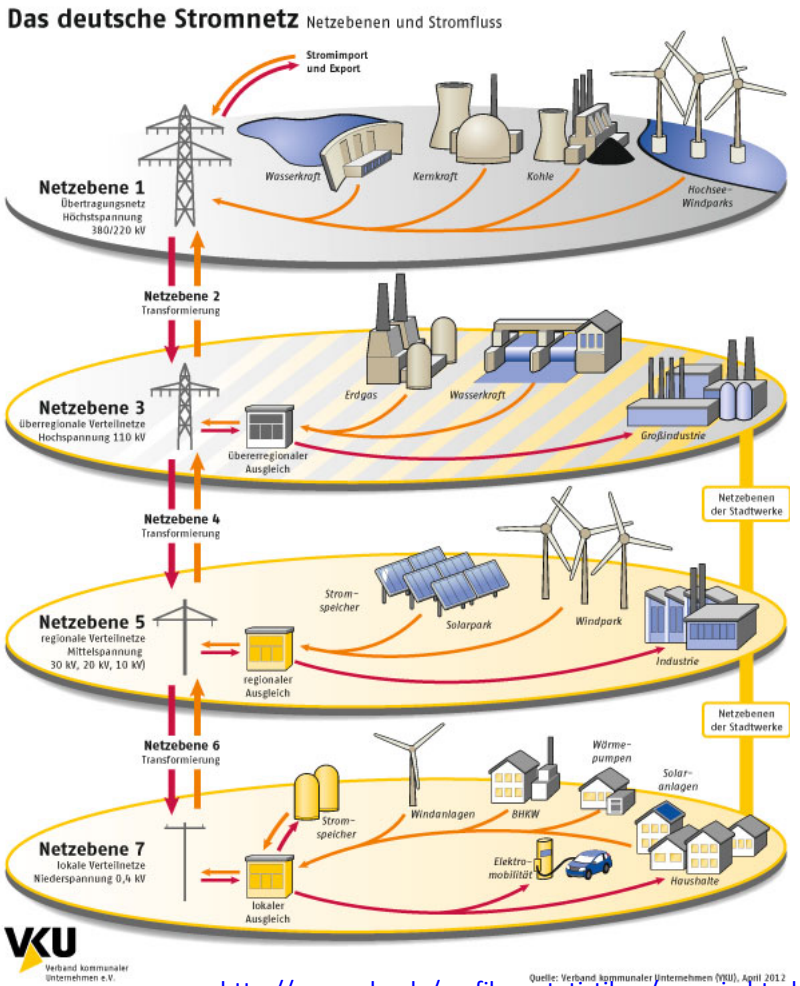
- Model-based scenario analyses focus on establishing technical feasibility „in an optimal world“, … disregarding
  - Actors, institutions and decision making (protective vs. proactive)
  - Infrastructure technologies with very long lead times (grid, IT/smart solutions)

- Leads to neglectance of many „transition-relevant“ aspects , particularly with respect to the integration of variable renewables!

Premises

- **Postulation 1:** Infrastructure design determines „what is possible“ / sets technical boundaries, e.g.
  - DSM requires smart grids
  - Pan-European balancing requires transmission grid capacities

- **Postulation 2:** Different infrastructure configurations are consistent with different visions of the future system logic
  - „Decentralized paradigm“
  - „Centralized paradigm“



http://www.vku.de/grafiken-statistiken/energie.html

Problem Statement & Method

- Which infrastructure-related branching points are possibly ahead in the German Energiewende and what are strategic implications?

- Time-frame of analysis: Three foci
  - Near-tearm (~2020), mid-term(~2030) and long-term(~2050)

- Method: Qualitative scenario analysis drawing on (quantitative/model-based) literature and applying three theoretical concepts:
  - Branching point analysis (Foxon et al, 2013)
  - Field anomaly relexation (FAR) (Rhyne, 1995; Coyle, 2001)
  - Feedback effects in the context of regime shifts (Strunz, 2014)

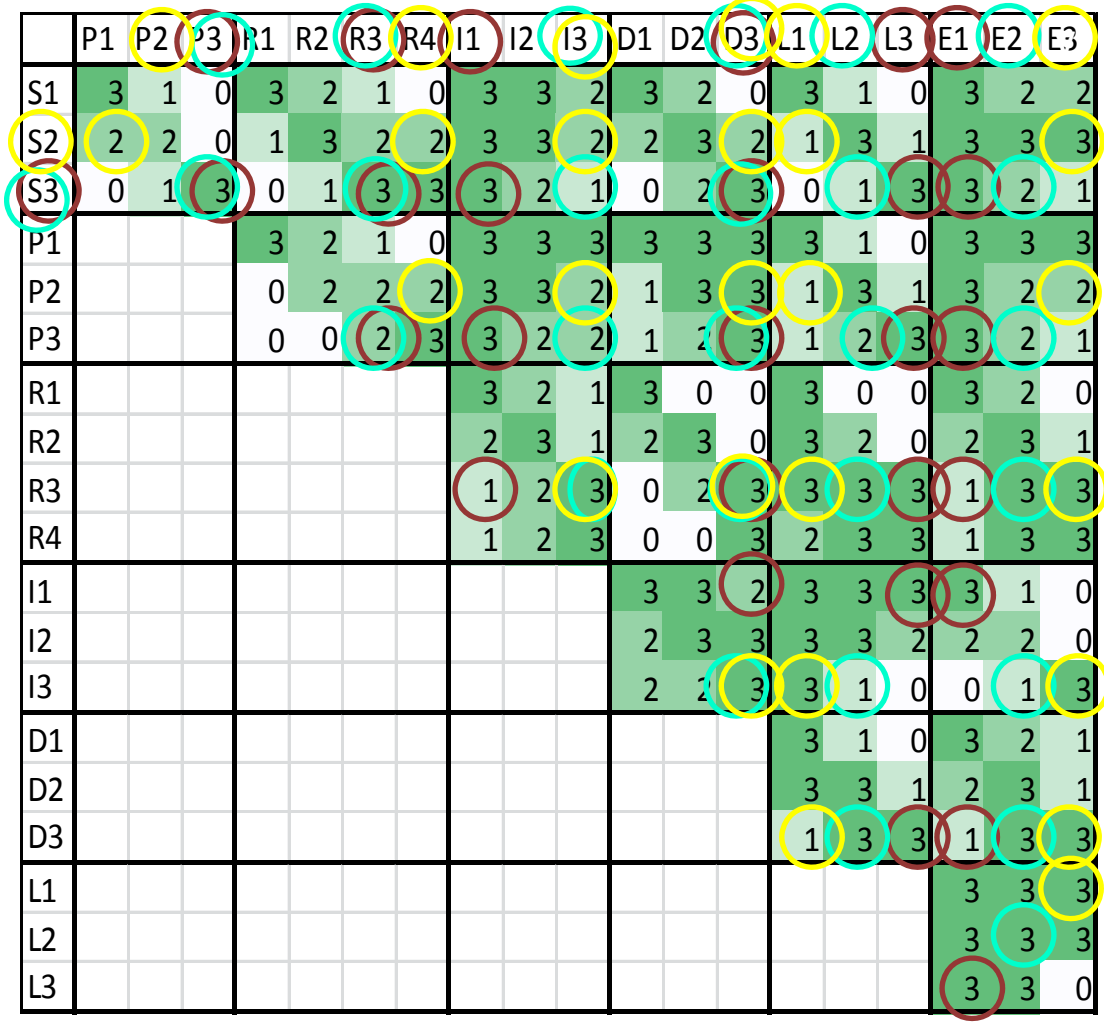
Branching point analysis

- Starting point: Transition pathway narratives that are subject to different „logics“ with corresponding dominant actors
- E.g. in http://www.lowcarbonpathways.org.uk :
  Market Rules, Central Co-ordination, Thousand Flowers
- Branching point: „Key decision point in a pathway at which actors‘ choices, made in response to internal or external pressures, determine whether and in what ways the pathway is followed“ (Foxon et al., p. 147)
- Branching point analysis intends to offer strategic insights on proactive vs protective decision making possibilities (cp. Hughes et al. 2010, Hughes 2013)

Applying FAR: A sector/factor array for the problem „The future of the German energy system“

Storage Deployment (in GER)	DSM **P**enetration (in GER)	Domestic **R**ES-share, mainly fluctuating	European Grid **I**ntegration	Dominant **D**ispatchable PP Philosophy (in GER)	Institutional Coordination **L**ocal (in GER)	Institutional Coordination pan-**E**uropean
S	**P**	**R**	**I**	**D**	**L**	**E**
S1: Hardly any	**P1**: Small (only industry)	**R1:** Low (0-20%)	**I1:** Slow	**D1:** Baseload-Band necessary for refinancing	**L1:** Not Important	**E1:** Not Important
S2: Some strategic increase	**P2:** Moderate	**R2:** Moderate (20-40%)	**I2:** Picking Up	**D2:** Rather flexible, many FLH needed for refinancing	**L2:** Some emphasis	**E2:** Some emphasis
S3: Strong increase of all kinds	**P3**: High (Mainstream)	**R3:** High (40-60%)	**I3:** Real Momentum	**D3:** residual system designed to complement f-RES	**L3:** Dominant strategy	**E3:** Dominant strategy
		R4: Very high (60-80%)				

A sector/factor matrix for the problem: „The future of the German energy system“



	P1	P2	P3	R1	R2	R3	R4	I1	I2	I3	D1	D2	D3	L1	L2	L3	E1	E2	E3
S1	3	1	0	3	2	1	0	3	3	2	3	2	0	3	1	0	3	2	2
S2	2	2	0	1	3	2	2	3	3	2	2	3	2	1	3	1	3	3	3
S3	0	1	3	0	1	3	3	3	2	1	0	2	3	0	1	3	3	2	1
P1				3	2	1	0	3	3	3	3	3	3	3	1	0	3	3	3
P2				0	2	2	2	3	3	2	1	3	3	1	3	1	3	2	2
P3				0	0	2	3	3	2	2	1	2	3	1	2	3	3	2	1
R1								3	2	1	3	0	0	3	0	0	3	2	0
R2								2	3	1	2	3	0	3	2	0	2	3	1
R3								1	2	3	0	2	3	3	3	3	1	3	3
R4								1	2	3	0	0	3	2	3	3	1	3	3
I1											3	3	2	3	3	3	3	1	0
I2											2	3	3	3	3	2	2	2	0
I3											2	2	3	3	1	0	0	1	3
D1														3	1	0	3	2	1
D2														3	3	1	2	3	1
D3														1	3	3	1	3	3
L1																	3	3	3
L2																	3	3	3
L3																	3	3	0

0 = manifestly inconsistent
1 = probably inconsistent
2 = probably consistent
3= certainly consistent

Select combinations based on

- gestalt criterion: „Could I imagine a world like that?“
- score, e.g.

55 $S_3P_3R_3I_1D_3L_3E_1$
50 $S_2P_2R_4I_3D_3L_1E_3$
53 $S_3P_3R_3I_3D_3L_2E_2$

Pathways – Applying the FAR method

$S_2P_2R_4I_3D_3L_1E_3$ = Truly European $S_3P_3R_3I_1D_3L_3E_1$ = Local Smart Solutions

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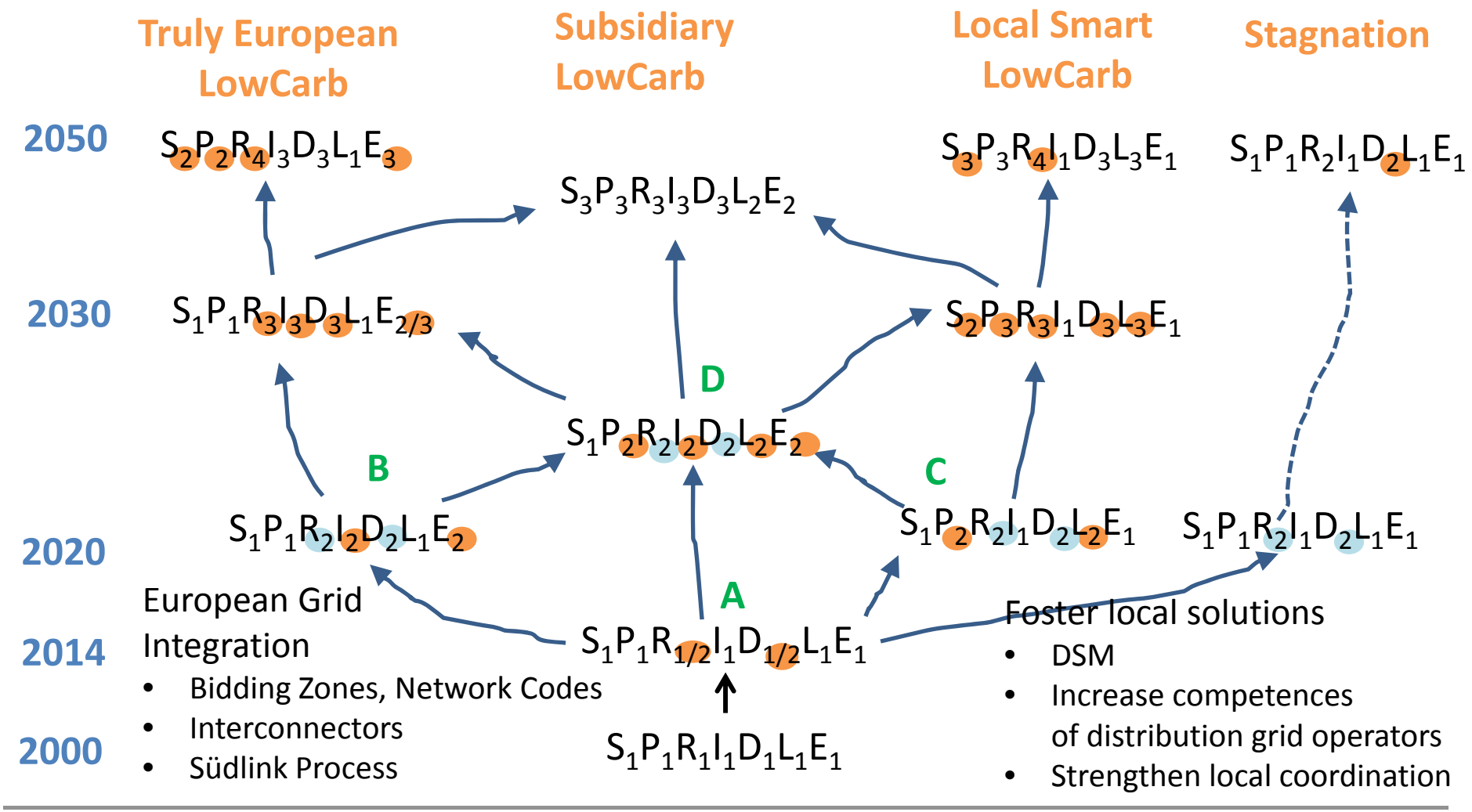
Pathway tree and possible branching points



For each infrastructure-related branching point…. ask:

- What are the possible decisions?
- Which pathway would they lead to?

- Which actors have which interests?
- Which interest-coalitions are likely to be successful?

- Which branches are unlikely/likely?
- Which exogenous events could influence decisisons?

Characterization of branching points

Branching Point	Issue	Theme	Required Infrastructure
A: „Decisions, decisions“	Currently no clear committments to either pathway	Keep all options available?	„A bit of everything“
B: „European Gridlock“	European efforts have picked up but no *real* momentum	Can the full integration be achieved?	Pan-European (Institutional, IT, physical)
C: „Local smart can‘t make it all the way“	Full potential of DSM not accessible (legal/institutional barriers)	Is the retreat to local solutions really the desired way to go?	Local / Regional (Institutional, IT, physical) [transformative change]
D: „Decisions, decisions a decade later“	Still no clear committment to either pathway – but more knowledge	Is mingling through successfull or will it lead to serious delay in mitigation?	„A bit more of everything“

Conclusions

- Preliminary strategic implications of analysis
  - Infrastructure design matters and influences which pathways will be viable in the future – and *differs*!
  - If renewable deployment shall increase as projected then either European or local solutions are necessary – or both
  - Proactive decision making

- What does this mean for energy system modeling?
  - Model-based scenarios/pathways that „switch“ at some point
  - Analyse results more dedicatedly with respect to infrastructure
  - Conceptual work: How to bridge the scales (local vs European)?

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