Deep Transitions: Mapping Long-Term Changes in Industrial Modernity

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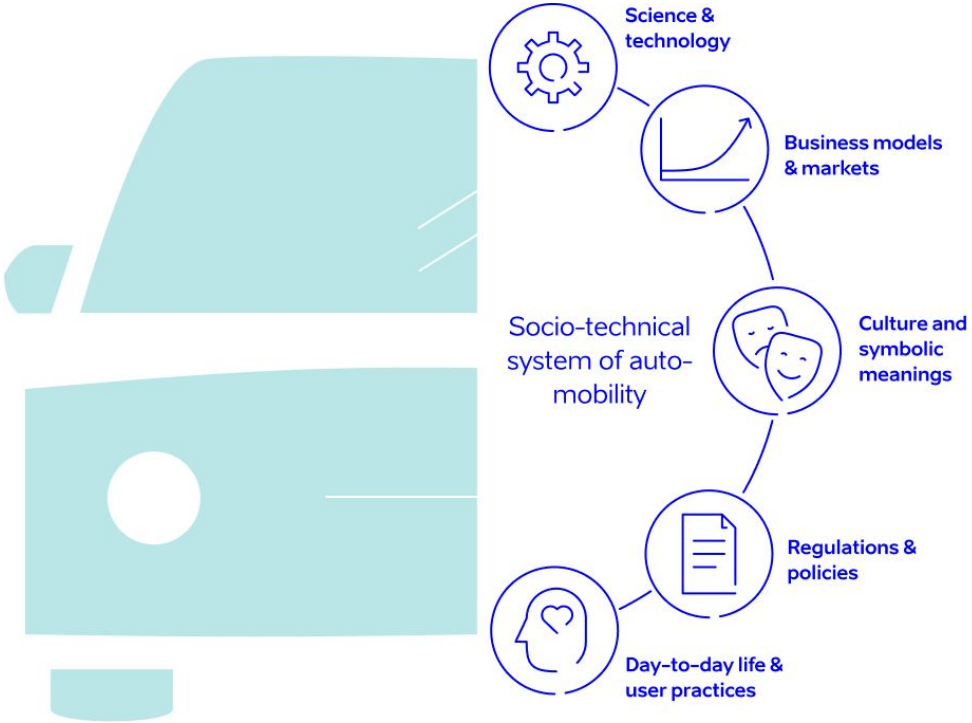
A sociotechnical system

Society + Technology

Auto-mobility system:

- Car
- Roads + gas stations
- Traffic regulations
- Daily commute & kids to school
- Driving a Porsche
- BMW factories & employees

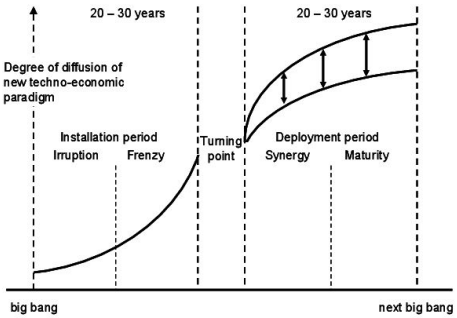


Based on Geels et al (2004)

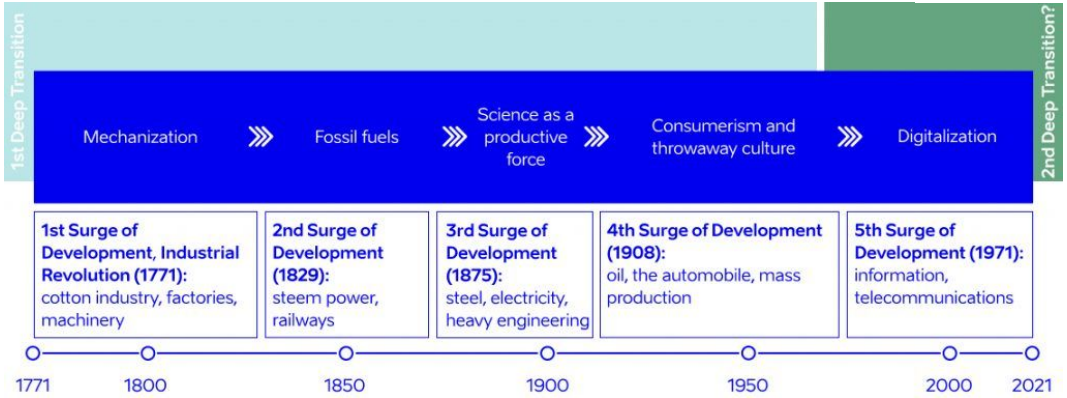
Evolution of socio-technical systems

5 great surges of development (Perez 2002)

- Technological revolution propagates across the economy, leading to structural changes in production, distribution, communication, consumption & society.



Source: based on Perez 2002, p.74



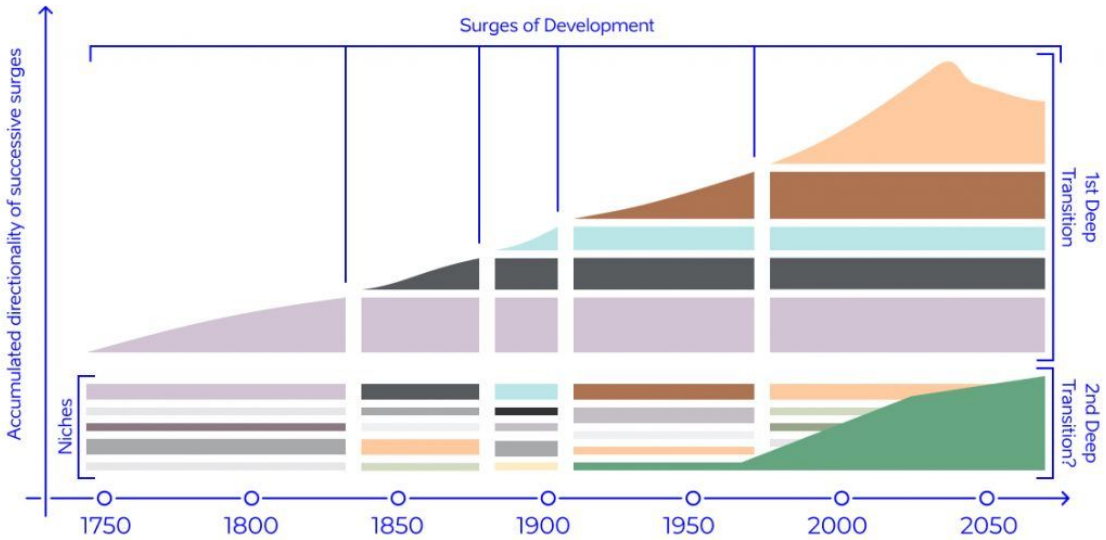
Based on Perez (2010)

Deep Transitions

Claim: All surges were in the same direction and accumulated and intensified features (Schot & Kanger 2018)

1st Deep Transition (Industrial Modernity)

- increased labour productivity,
- mechanization, increasing complexity
- reliance on fossil fuels,
- resource-intensity,
- energy-intensity,
- reliance on global value chains



Based on Schot & Kanger (2018)

Some features of Industrial Modernity

Ideas

- Limitless supply or substitutability of resources
- Societal problems, however deep and complex, can be solved through technological innovation
- Any human task can and should be substituted with technologies, whenever possible, to increase productivity and efficiency

Institutions

- Prioritization of societal over environmental concerns in institutional design
- Largely reactive approach to regulating innovation
- Normalization of temporary unemployment due to technological displacement - constant pressure towards the upgrading skills

Practices

- Specific socio-metabolic profile: ‘mineral’, fossil fuel based and linear economy
- Techno-fixes: solve problems created by current technologies and infrastructures with new and more complex technologies
- Increasing dependence on energy- & resource-intensive sociotechnical systems for everyday life

The challenge for Industrial Modernity

Unprecedented prosperity but also

Recurrent problems

- climate change (caused by the use of fossil fuels),
- pollution and an enormous waste of resources (caused by the assumptions of limitless supply of resources and limitless capacity to absorb waste),
- inequality (caused by system innovation mainly aimed at the richer markets) and
- persistent unemployment (caused by a relentless emphasis on productivity growth).

Schot & Kanger (2018) skeptical if can be solved within the same deep transition.

Operationalizing Industrial Modernity

The concept, very simplified

- Neglect of the environment
- No caution in approach to science and innovation

The approach

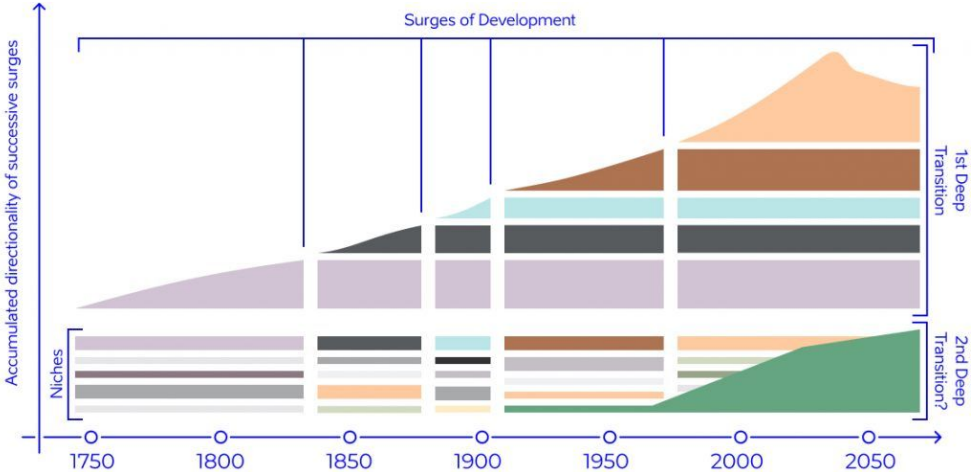
- Ideas, institutions, practices in noticing environmental effects
- Ideas, institutions, practices with caution in science & innovation

	Environment	Science	Technology and innovation
IDEAS	Separation of nature and society, placing primary emphasis on the latter in public discourse	Belief in limitless progress through the application of science	Belief in limitless progress through the application of technology
INSTITUTIONS	Prioritization of societal over environmental concerns in institutional frameworks	Dominance of technocratic reasoning and decision-making in policy circles	Reactive policies: institutions are mainly directed to regulating the consequences of technological innovation
PRACTICES	Specific socio-metabolic profile: 'mineral', fossil fuel based and linear economy	Sporadic and unsystematic application of precautionary principles to prevent the ethical, social and environmental risks involved in basic scientific research	The overall directionality of innovative activities and the actual use of technology is largely indifferent to environmental concerns
Underlying themes	Environment as a blind spot Overconfidence in science and technology		

Trying to measure Deep Transitions

Controversies have existed throughout. But how much influence do they have?

Is there continuity in Deep Transition 1, is there a change towards Deep Transition 2?



Data sources

Historical data 1900-2020 is not easy, many relevant measurements from 1980s onwards.

Canvassed datasets and collections that could have info for 1900-2020 on some countries

- Newspapers collections: various sources (Canberra Times, Pravda, Spiegel, NYT etc, combined for 1900-2020 coverage)
- ECOLEX - database of environmental law
- MS Academic Graph - database of scientific publications
- PATSTAT - database of patents
- The Shift - resource use database

Five countries

Based on data availability & profiles

- Australia
- Germany
- India
- USSR/Russia
- United States

But mostly data availability

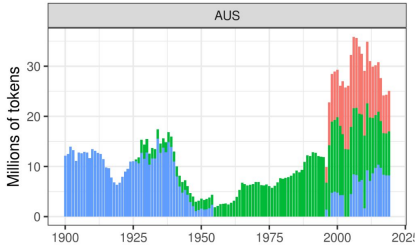
	Australia	Germany	India	USA	USSR/Russia
Total population in thousands (% share of global population)[1]	25,500 (0.33)	83,784 (1.07)	1,380,004 (17.7)	331,003 (4.25)	145,934 (1.87)
GDP in trillion current US$ (% share of global GDP)[2]	1.33 (1.57)	3.85 (4.55)	2.62 (3.1)	20.94 (24.75)	1.48 (1.75)
Total primary energy production in EJ (% of global production)[3]	9.11 (2.95)	4.8 (0.74)	18.09 (2.79)	107.48 (16.6)	68.14 (10.52)
Economy[4]	Liberal market economy	Coordinated market economy	Statist market economy	Liberal market economy	Planned economy shifting to patrimonial market economy
Polity[5]	Liberal democracy	Liberal democracy	Liberal democracy	Liberal democracy	Communist ideocracy shifting to electoral autocracy
Culture[6]	Secular/ self-expression	Secular/ self-expression	Traditional/ survival	Secular/ self-expression	Secular/survival
Time of industrialization[7]	Second phase	First phase	Third phase	First phase	Second phase

Capturing env-sci-tech in ideas-institutions-practices

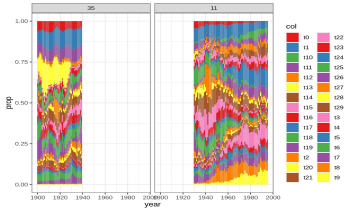
	Sources	Environment	Science	Technology & Innovation
Ideas	Newspapers	- Presence of environment vs science & technology in public interest **(NEWS)**	- Sentiments on science (predict increased worry on each) **(NEWS)**	- Sentiments on technology (predict increased worry on each) **(NEWS)**
Institutions	Databases, Newspapers	- Emergence of international laws on environment **(ECOLEX)**	Technocratic keywords in texts on government **(NEWS)**	- Cautionary approach in environmental law **(ECOLEX)**
Practices	Databases	- Renewable energy production **(Shift)**	- Engineering, Environment, Sustainability in Publications **(MS Academic)**	- “Green” patents vs all patents. **(PATSTAT)**

Methods, text

Lemmatized corpus
AUS: 1,361M tokens

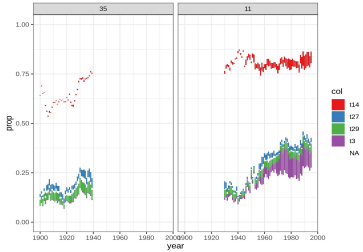


Keyword sets for each lang
e.g. nature, discover*, technolog*

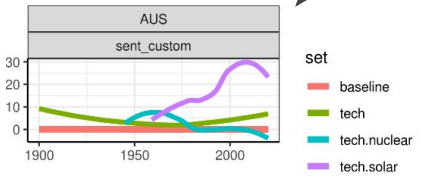


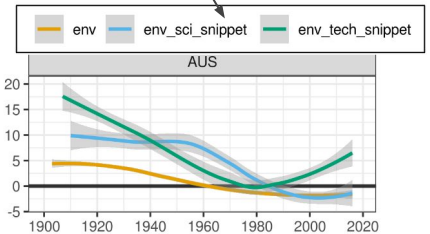
Query disambiguation
Vs ‘human nature’, ‘police discovered’

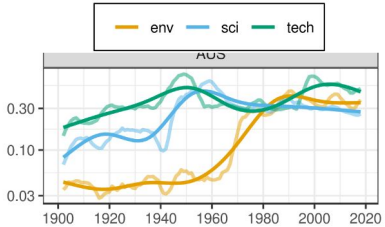
14		12	0.05955	school child education student year university work teacher v
15		13	0.07571	tho aro havo moro ono wero tbo nnd thoy wear boen thero th
16	T	14	0.04493	system research science year energy computer scientist wor
17		15	0.05379	health hospital medical disease doctor people patient drug ye
18		16	0.04416	film art work play music theatre artist year exhibition miss pic
19		17	0.11109	australia australian government service public people canber
20		18	0.05072	government bill party state minister member labour house pa
21		19	0.07269	book life story write author man year woman work world time
22		20	0.02721	play team game match player win club ball score good sport
23		21	0.1092	act union board state work public committee report commissi
24		22	0.05654	british britain war london germany german government cour
25		23	0.05338	court police case justice charge evidence act defendant law p
26		24	0.02889	church god man life christian world christ people day bishop
27		25	0.08724	nbsp sydney day year sir hold miss meeting member night ye
28		26	0.06861	foi hie und mid tin tho tile lie fiom nnd aie ind tint ill iii ihe natu
29	T	27	0.04011	plant tree bird grow soil flower garden good fruit year water f
30		28	0.0181	race horse win club handicap run time year good day event c
31	T	29	0.0736	water river island south sea day land year north fish mile find



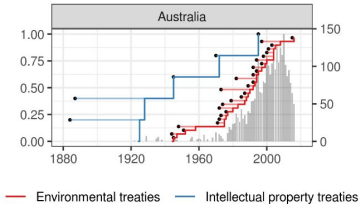
Sentiment analysis (custom adjectives)
successful, substantial, effective, efficient
alarming, severe, disastrous

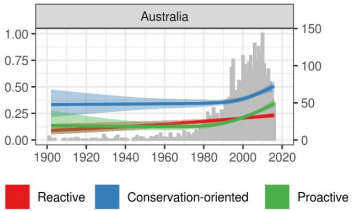






Methods, datasets



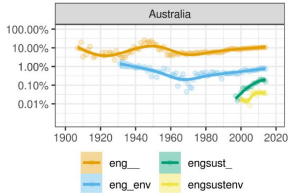


ECOLEX:

- Compare large international environmental treaties with large international intellectual property rights (IP) treaties
- Manual classification - conservationist, reactive, proactive policies in tags.

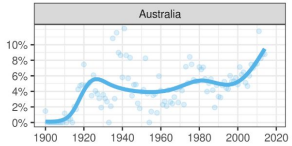
MS Academic:

- Articles with engineering, environment or sustainability tags



PATSTAT

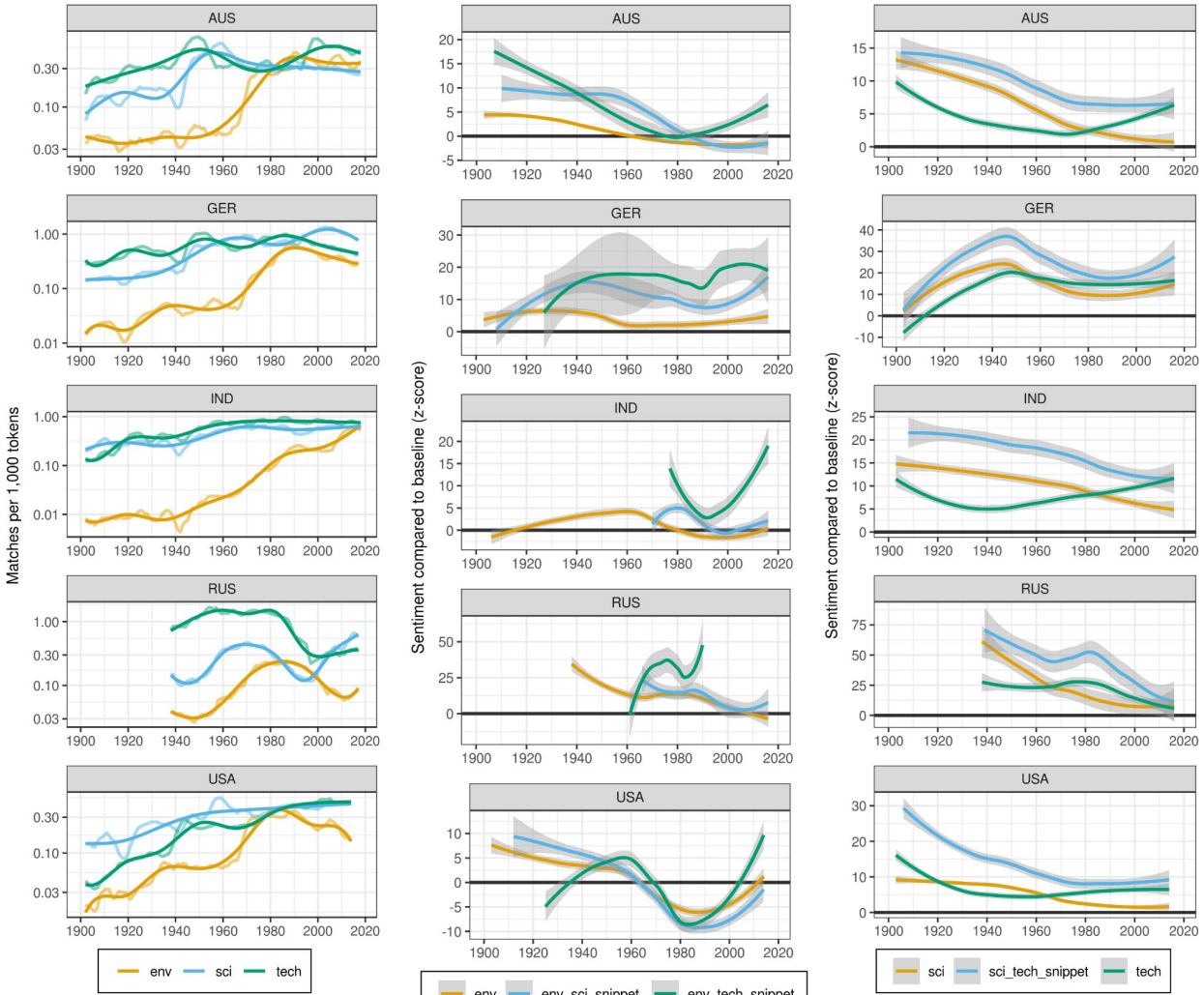
- Green patents vs all patents



Ideas

Some results

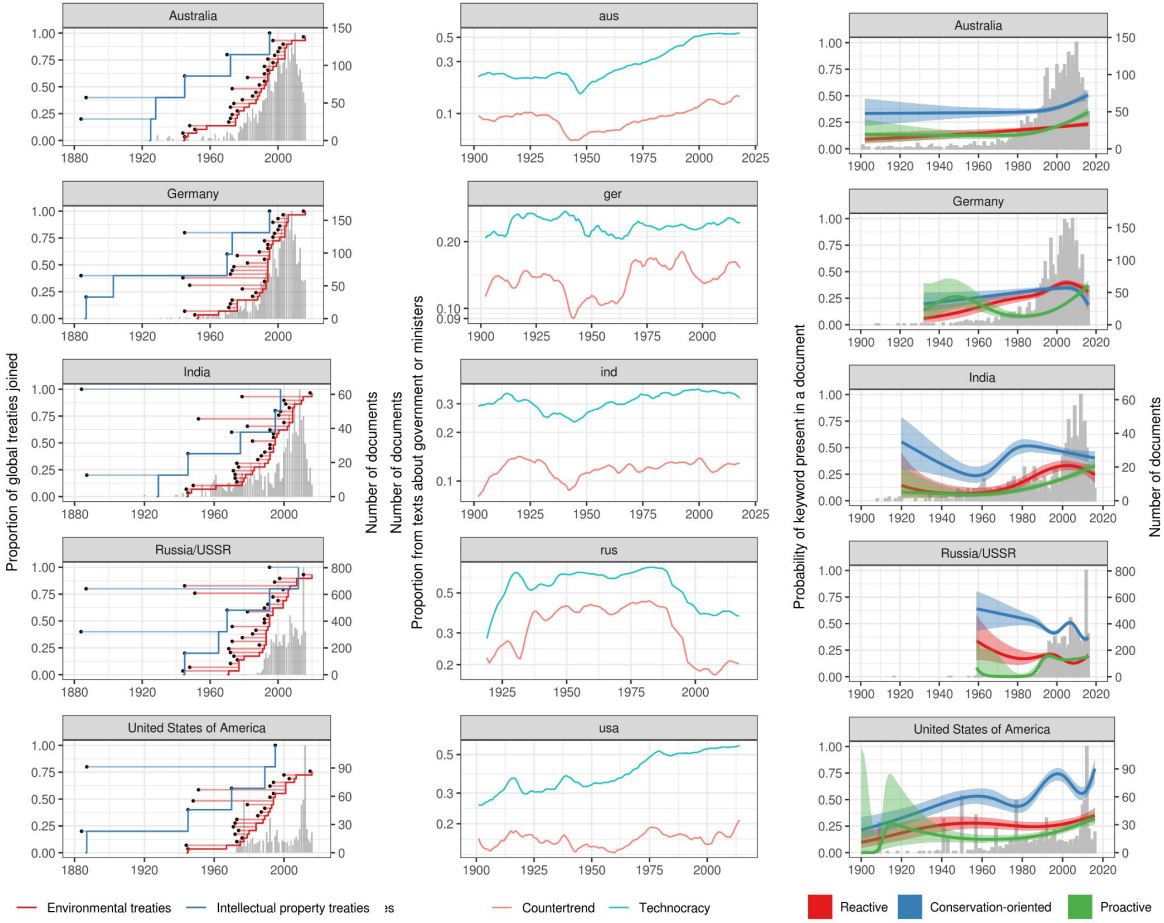
- Environment emerging in 1960-70s in all countries (neg attitudes often)
- Sentiments on technology stay positive, science a bit more cautious



Institutions

Some results

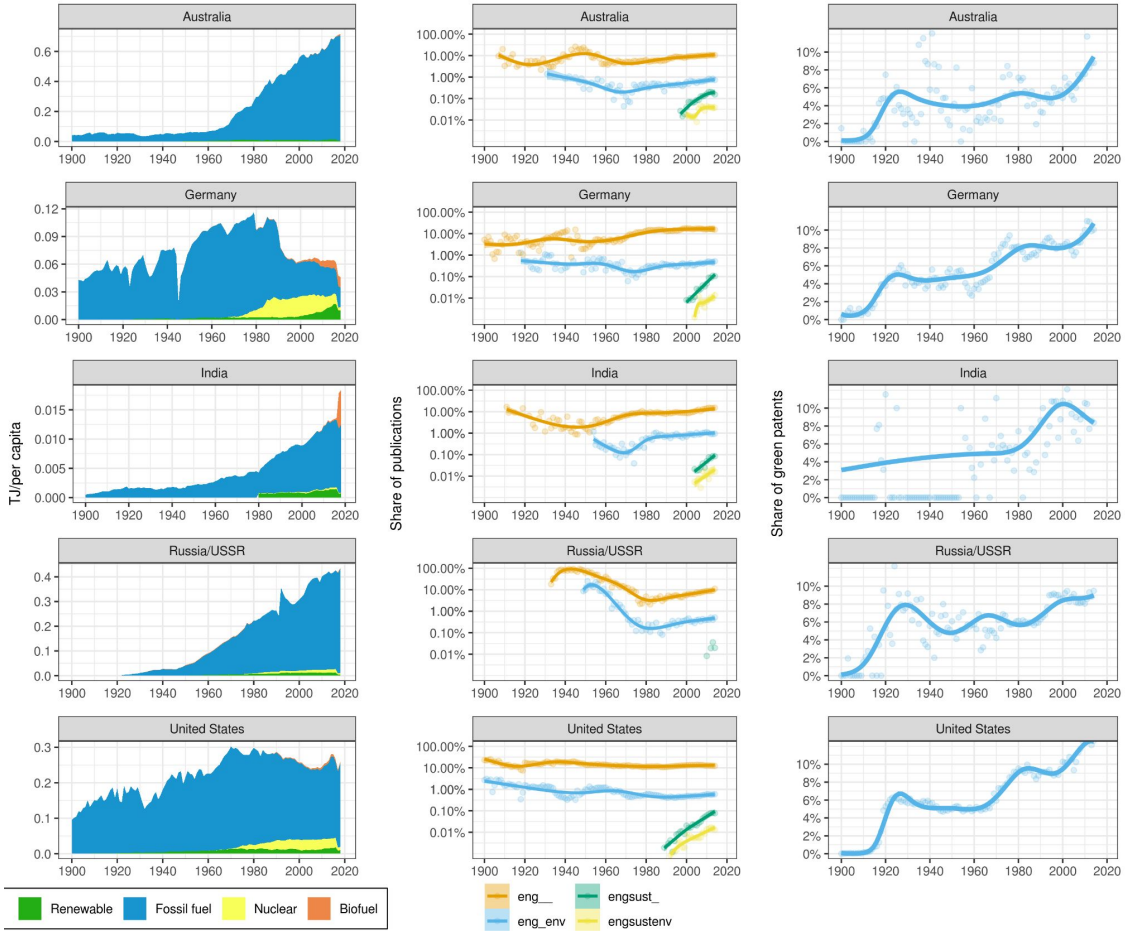
- IP treaties precede env. ones - growth in 190s
- Proactive legislation gaining momentum in 2000s



Practices

Some results

- Fossil fuels dominate (some hope in Germany)
- Sustainability emerging in engineering papers in 2000s
- Many early green patents (some classification issues too), new wave of green patents in 2000s

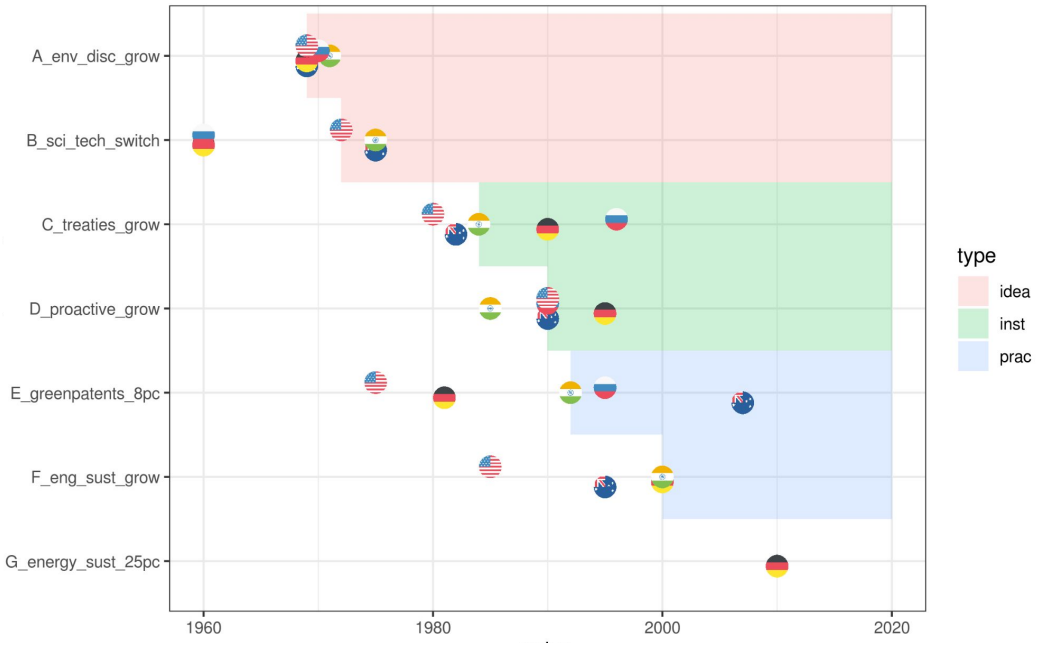


Notable transitions

Some results

- Ideas: environmental discourse grows in 1960-70s
- Institutions: growth in laws/treaties 1980-90s
- Practices: sustainability in research and patents 1990s
- Ideas -> institutions -> practices ?

Not much caution on technology, fossil fuels going strong



Discussion

Methods

- Social science theory -> historical text & data analysis
- Simple tools can show the trends

Results

- Concern for environment has grown since 1960s
- Less so for impact of science & technology
- Observed sequence: Ideas -> Institutions -> Practices

Thank you

TARTU ÜLIKOOL
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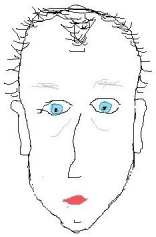
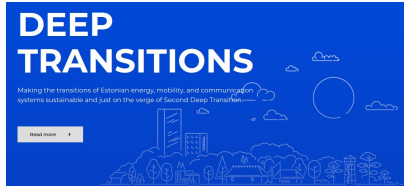


Done as part of a larger project with a team:

with Laur Kanger, Anna-Kati Pahker, Kati Orru, Amaresh Kumar Tiwari, Silver Sillak, Artjoms Šeļa, Kristiina Vaik



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“Reshaping Estonian energy, mobility and telecommunications systems on the verge of the Second Deep Transition” (2019-2023) University of Tartu, Estonia.