Sustainability Transitions from Local to Global Scales

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Outline

1. Some general comments on sustainability transitions

2. Transition to a low/zero-carbon economy

3. *Local level:* what contribution to global GHG emissions reduction should we expect from city policies?

4. *Global level:* which transition path might achieve effective climate policy worldwide?

Topic 1. Sustainability transition

- Fundamental societal changes to stay within planetary boundaries
  - *Alternative term:* 'System innovation', 'Industrial transformation' or 'Structural change'.
  - *Focused on basic activities:* energy provision, transport, water use and agriculture.
- Multidimensional: technologies, infrastructure, maintenance and distribution networks, user behaviours, norms and social values, institutions and regulations
- Multilevel: niche, regime and landscape (micro, meso, macro)
- Temporal phases: taken from life-cycle & multi-stage development theories:
  - conception, take-off, acceleration, stabilisation/standardisation, senescence.

Transition thinking: reasons and solutions

- **Different authors have distinct reasons**
  - We don't know which policy (mix) is needed – *local experiments*
  - Effective (regulatory) policies not implemented or weak – *political barriers*
  - Current technologies and life-styles are locked-in – *systemic barriers*
  - Complex system with uncertain long-term effects – *dynamic interaction of policies, social-networks & market mechanisms*
- **Debated solutions**
  - *Some downplay policy significance:* local experiments, communities, voluntarism
  - *Second-best policies:* trading-off effectiveness vs political feasibility.
  - *Many policies:* complementary/synergy, many small effects add up
  - *Transition to effective policy:* increase social-political support & effectiveness gradually or phase-wise

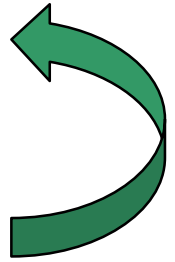
Main approaches to transitions research

Approach	Key concepts	Policy view	Analysis approach
Innovation systems	System failures, functions, national and sector systems, supply chain, industrial structure, learning networks, user-supplier networks and industry-academia networks.	Identify system failures and correct these with environmental regulation (correcting prices) and technology-specific policies.	Case based studies, systems dynamic models.
Multi-level perspective	Multiple (competing) technologies, structural change, multiple levels (niche, regime, landscape), multiple phases, coevolution, networks, user practices, vested interests, lobbying, infrastructure.	Align technologies and user practices. Strategic niche management (SNM) - reflexive management of real world experiments.	Historical analysis, case based studies, much descriptive. Discursive struggles about problem framing and solutions.
Complex systems	Attractors, nonlinearity, positive and negative feedback, subsystems, emergence, dissipative structures, multiple equilibria, bifurcation, chaos and self-organization.	Transition management (TM): transition experiments, focus on frontrunners, envisioning for sustainable futures.	System dynamic models, Agent-based models
Evolutionary systems	Population, diversity (variety, balance, disparity), cumulative change, recombinant innovation, multilevel selection, path-dependence, lock-in, coevolution, social networks.	Account for all selection forces, foster status-character of green products, optimal diversity, stimulate modular and deviant innovations.	Selection-innovation models, agent-based models, network models.
Environmental economics	Negative & positive externalities, public goods, welfare, cost-effectiveness, inter-firm/industry connections, market processes, income spending, use of tax revenues.	Correct market prices, protect innovation benefits, assure fair market competition, avoid collusion, subsidize highly risky and basic innovation research.	Partial and general equilibrium models, econometric models, input-output models, normative (optimization) models.

Transitions due to top-down and bottom-up: -

Downward + upward causation => global + local processes

- Total demand & supply determine price in each market
- Prices & groups (imitation, status, social norms) affect individual choices
- Public policies and institutions change behaviour & motivate collective action
- Technological knowledge that is publicly available influences all actors
- Macroeconomic conditions affect all consumers, producers and investors



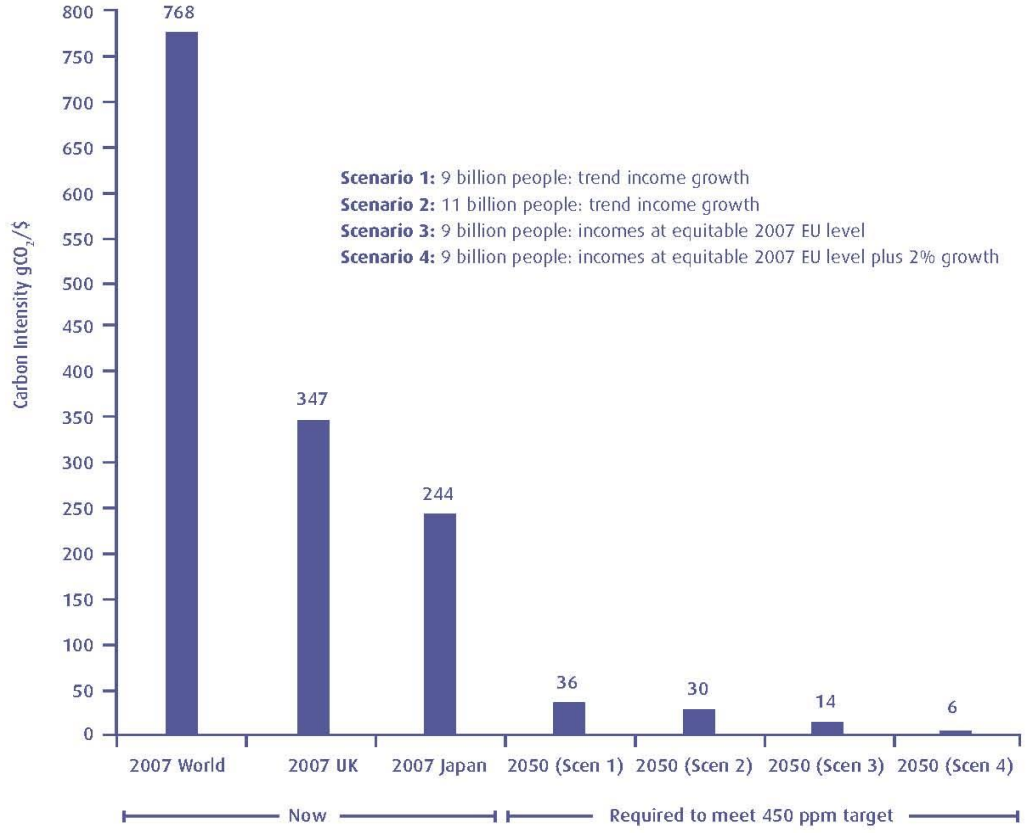
- Consumer actions add up to total demand
- Producer actions add up to total supply
- Individual behaviours change norm
- Group patterns are the aggregation of individual behaviours
- Local community initiatives (spontaneous collective action)
- Technological or behavioural innovations/novelties
- Market niche based on new service or good

Topic 2. A transition to a low/zero-carbon economy

Decarbonisation challenge (to avoid extreme climate change):

- Factor 20-100 reduction in carbon intensity of output needed.

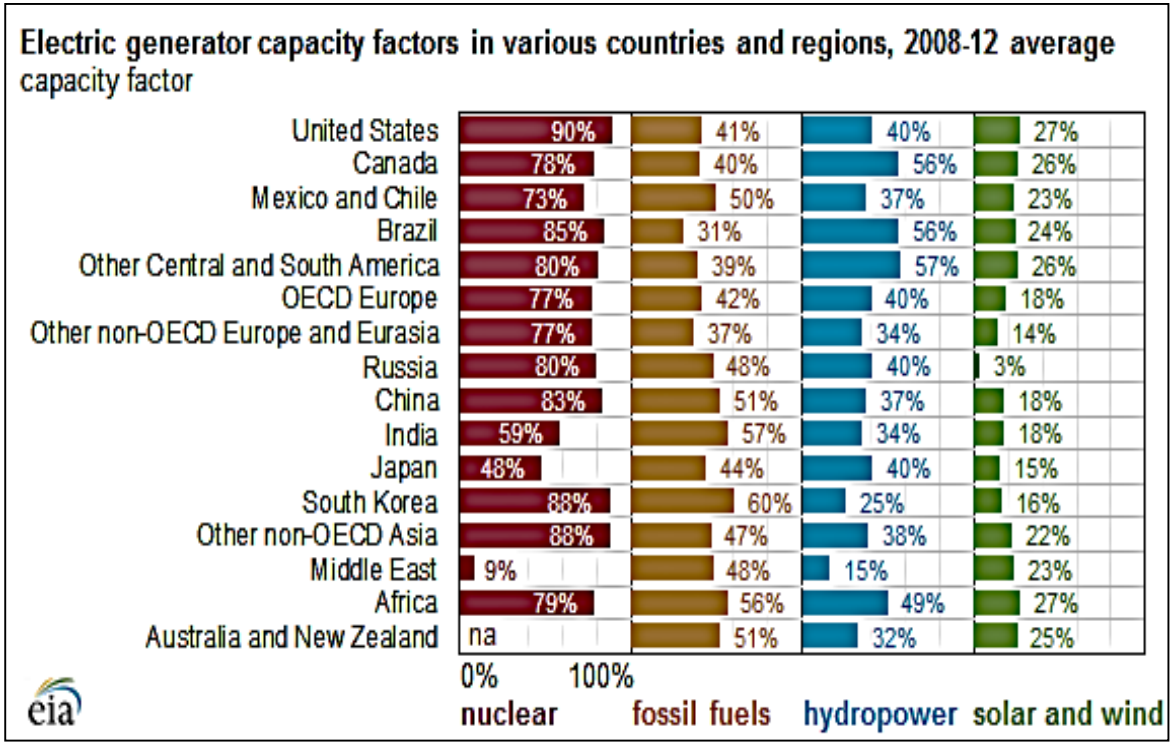
Figure 17 **Carbon Intensities Now and Required to Meet 450 ppm Target**[25]

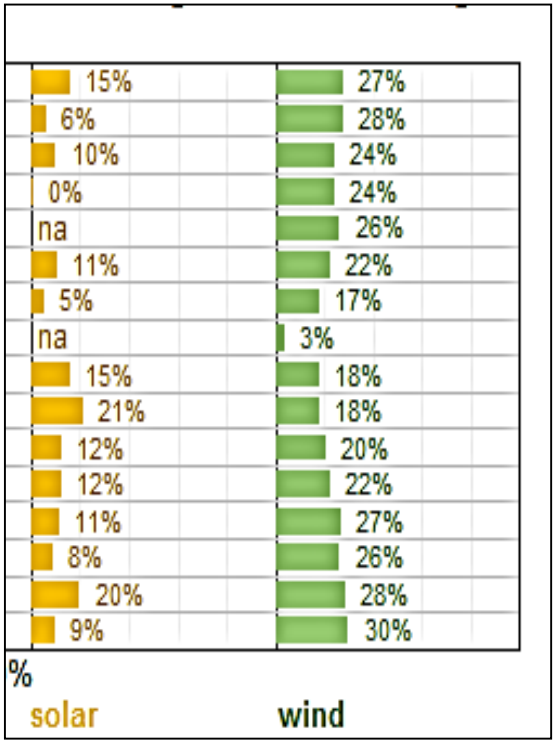


Source: Jackson (2009).

A renewable future involves many challenges

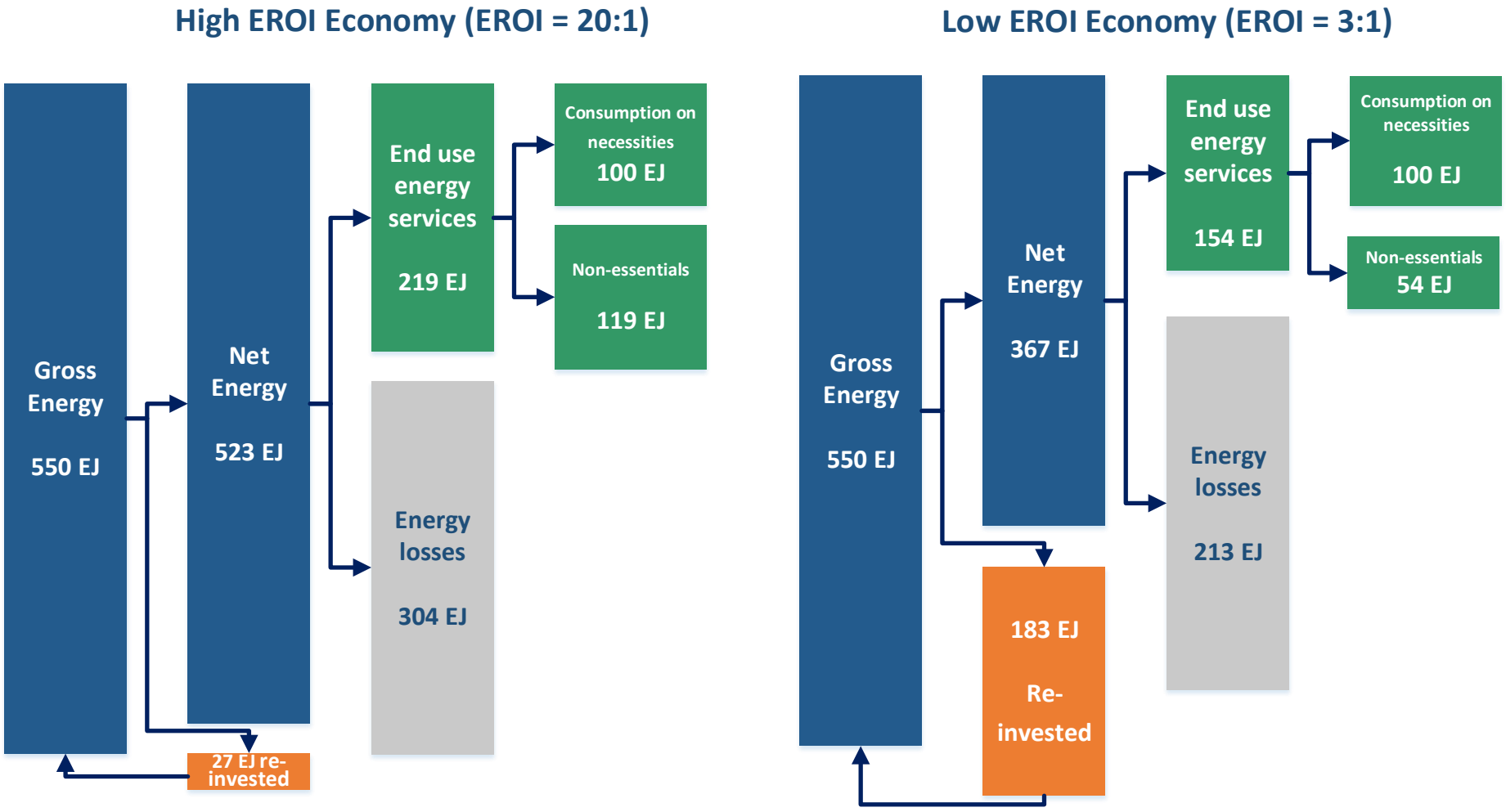
- Many (fossil fuel) energy and labor inputs needed indirectly
- Considerable energy storage if >1/3 of total electricity is renewable
- Night/day and seasonal cycles
- Recycling of equipment (if large-scale diffusion)
- Capacity unused => reduces EROI.





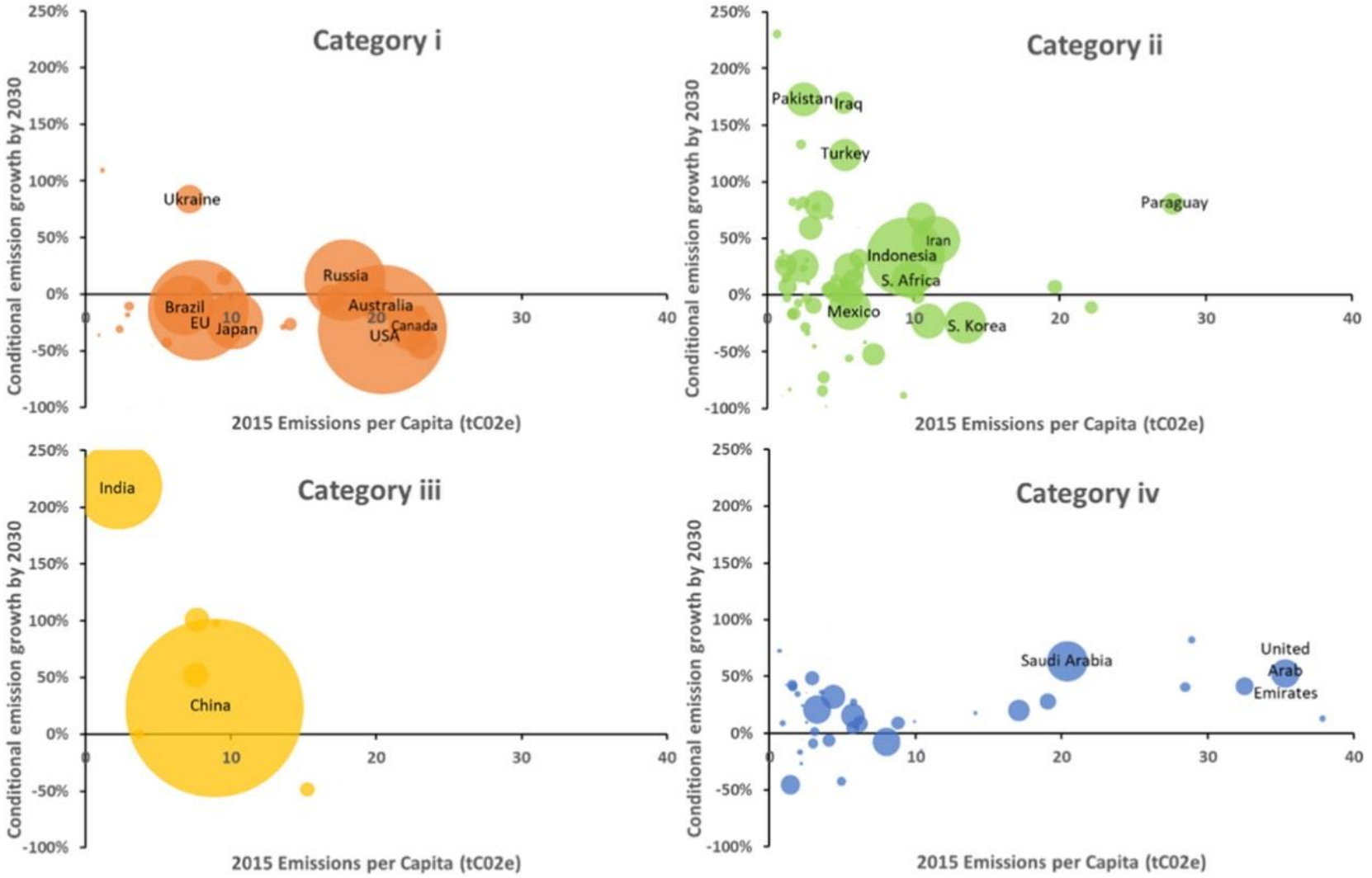
Source: U.S. Energy Information Administration, International Energy Statistics.

Illustrative comparison of economies with high- and low-EROI energy source



Source: King and van den Bergh (2018)

Low-carbon future – Paris agreement pledges/NDCs



Source: King & van den Bergh (2019)

Paris' pledges imply two systemic effects

1. Generally weak policies (subsidies, encouraging voluntary action) out of fear to harm *international competitive position (exports)* => **rebound, with intensity increasing from categories 1 to 4**
2. Very distinct policies => *trade effects and industry relocation* => **carbon leakage from categories 1 to 2, 3 and 4**

Global mean surface temperature may then go well beyond 3.5°C

Topic 3: The contribution of local policies by cities to curb climate change

- Role of cities gained attention in the slipstream of failed past climate COP (UNFCCC) negotiations
- Several networks of cities for climate arose, such as C40 Cities Climate Leadership Group, EU Covenant of Mayors and UN's Compact of Mayors
- Two "Assessment reports on climate change and cities" and IPCC's AR5 Ch. 12.
- Lots of nice jargon: "city intelligence", "reinventing cities", "transforming urban lifestyles", "new urban agenda" – greenwashing?

Experts express much hope & optimism

- According to articles in *Nature/Science*:
  - "Cities are crucial to global mitigation efforts. […] urban areas are responsible for 71% of global energy-related carbon emissions"
  - "Cities must address climate change. More than half of the world's population is urban, and cities emit 75% of all carbon dioxide from energy use"
  - "Cities are at the heart of the decarbonisation effort […] account for about two-thirds of primary energy demand and 70% of total energy-related carbon dioxide (CO2) emissions. […]."

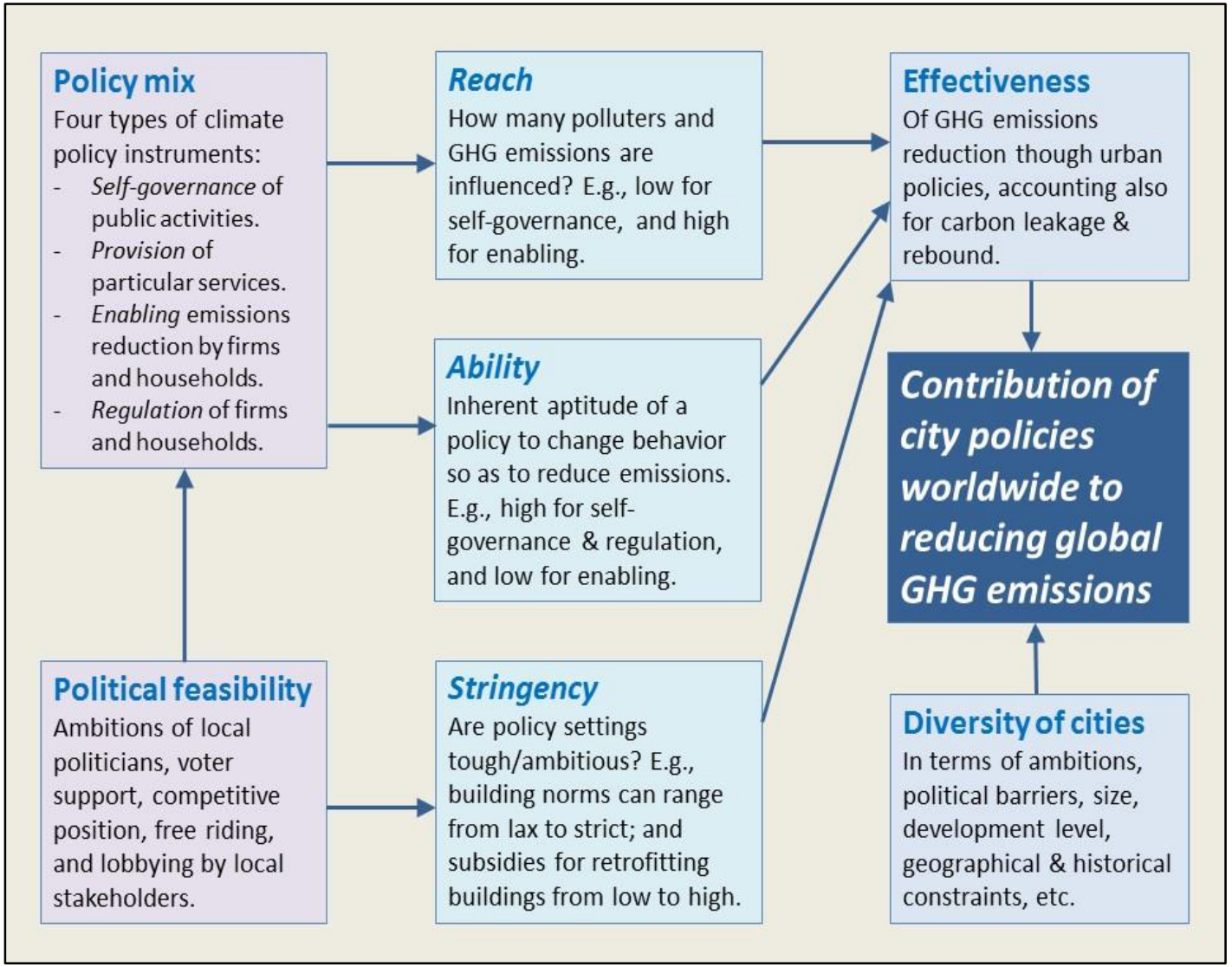
- But these figures bear no relation to urban policies. In particular, overestimate the "reach" (# decisions & emissions) of such policies.

Watts, M. (2017). Cities spearhead climate action. *Nature Climate Change* 7, 537-538.

Rosenzweig, C. et al. (2010). Cities lead the way in climate-change action. *Nature* 467: 909-911.

Bai et al. (2018). Six priorities for cities and climate change. *Nature* 555: 23-25.

Novel assessment framework



Qualitative assessment based on reviewing empirical literature (ex post policy assessments)

POLICY PERFORMANCE *(Current / Maximum)*	**URBAN GOVERNANCE MODES**			
	Self-governance	**Provision of services**	**Enabling**	**Regulation**
(1) Reach	Low / Low	Low / Moderate	Low / Moderate	Low / High
(2) Ability	High / High	Low / Low	Low / Low	High / High
(3) Stringency	Moderate / High	Moderate / High	Moderate / Moderate	Low / Low
*(4) **CURRENT** **EFFECTIVENESS OF EMISSIONS REDUCTION** (combines **blue** values in rows 1 to 3)*	MODERATE	LOW	LOW	LOW
(5) Political feasibility of 'maximum' governance mode implemented	High	Moderate	High	Moderate
*(6) **MAXIMUM** **EFFECTIVENESS OF EMISSIONS REDUCTION** (combines **green** values in rows 1-3 & 5)*	MODERATE	MODERATE	MODERATE	MODERATE

Maximum contribution quantified

Policy performance	Urban governance modes			
	Self-governance	Provision of particular services	Enabling	Regulation
(i) Reach	0.01	0.3	0.3	0.25
(ii) Ability	1	0.1	0.1	1
(iii) Stringency	1	1	1	0.5
(iv) Product of i-iii	0.01	0.03	0.03	0.125
(v) Maximum proportional contribution to emissions reduction by an ambitious city (=sum of elements in iv):	0.01+0.03+0.03+0.125 0.195 (=19.5%)			
(vi) Assuming one third of cities worldwide is ambitious and the remainder half as ambitious, gives an overall contribution:	(1/3)*0.195 + (2/3)*(0.195/2) 0.13 (= 13%)			

Relative contribution of regulation can be calculated from rows iv & v as 0.125/0.195= **64.1%**.

Illustrates that serious contribution of cities to climate mitigation depends essentially on whether they can implement instruments to effectively regulate emissions.

Recommendations for policy & politics

- **Don't let cities improvise and be caught in greenwashing.**

- **National governments should harmonize climate policies in cities** to allow for policy stringency and avoid carbon leakage
  - more use of *effective regulatory instruments* which are now lacking

- **Don't be too optimistic about role of cities**: major regulatory role for national governments
  - most direct and indirect emissions due to households in cities are not under the control of urban authorities

Topic 4: A transition path to global effective climate policy?

- Harmonized or uniform approach among countries to avoid (fear of) competitiveness losses
  - Unilateral policies are bound to remain weak for fear of negative trade effects
  - And if some, exceptionally, ambitious then carbon leakage

- Focus further climate negotiations around specific policy instrument to limit free-riding of countries
  - Country quota (voluntary) as in Paris Agreement invited for free-riding.

- Transition process from feasible start to ambitious end
  - Work at multiple levels: coalitions of countries, UNFCCC negotiations, sub-country states (USA).

Which policy instrument: Four main approaches

Instrument	*Performance criteria*			
	Effectiveness emissions reduction	*Distributional equity*	*Economic cost per unit of emission avoided*	*Global upscaling*
Carbon pricing	High *- full control, purchase + use, incentive for adoption + innovation*	High *- if revenues partly recycled to poor households*	Low / minimal	Feasible
Technical standards	Medium *- incompliance, rebound, too many tecnologies, country/sector lobby*	Medium *- no revenues raised to compensate poor households*	Medium to high *- does not select cheap options*	Difficult as there are many standards and distinct national interests
Adoption subsidy	Medium	Low *- poor housholds do not buy solar PV or electric cars*	High *- not select cheap options, people don't resist subsidies*	Difficult as it weighs heavily on national budgets
Information provision & nudges	Low	High	Low	Limited by cultural habits and norms

Resistance to carbon pricing in social sciences

- Many sociologists, political scientists and geographers do not show enthusiasm for, or even resist, carbon pricing – focus on *equity* & *spontaneous* bottom-up solutions; they do not always show much concern for *effectiveness of emissions reduction*.

- Hopeful alternative offered by such social scientists is voluntarism (bottom-up) but *without "sufficiency proof"*
  - Reviews of information provision: achieves less than < 10% emissions reduction
  - Overlooks rebound and negative psychological spillovers (Sorrell, 2018)

- If social scientists speak with many voices, politicians and voters will be confused.

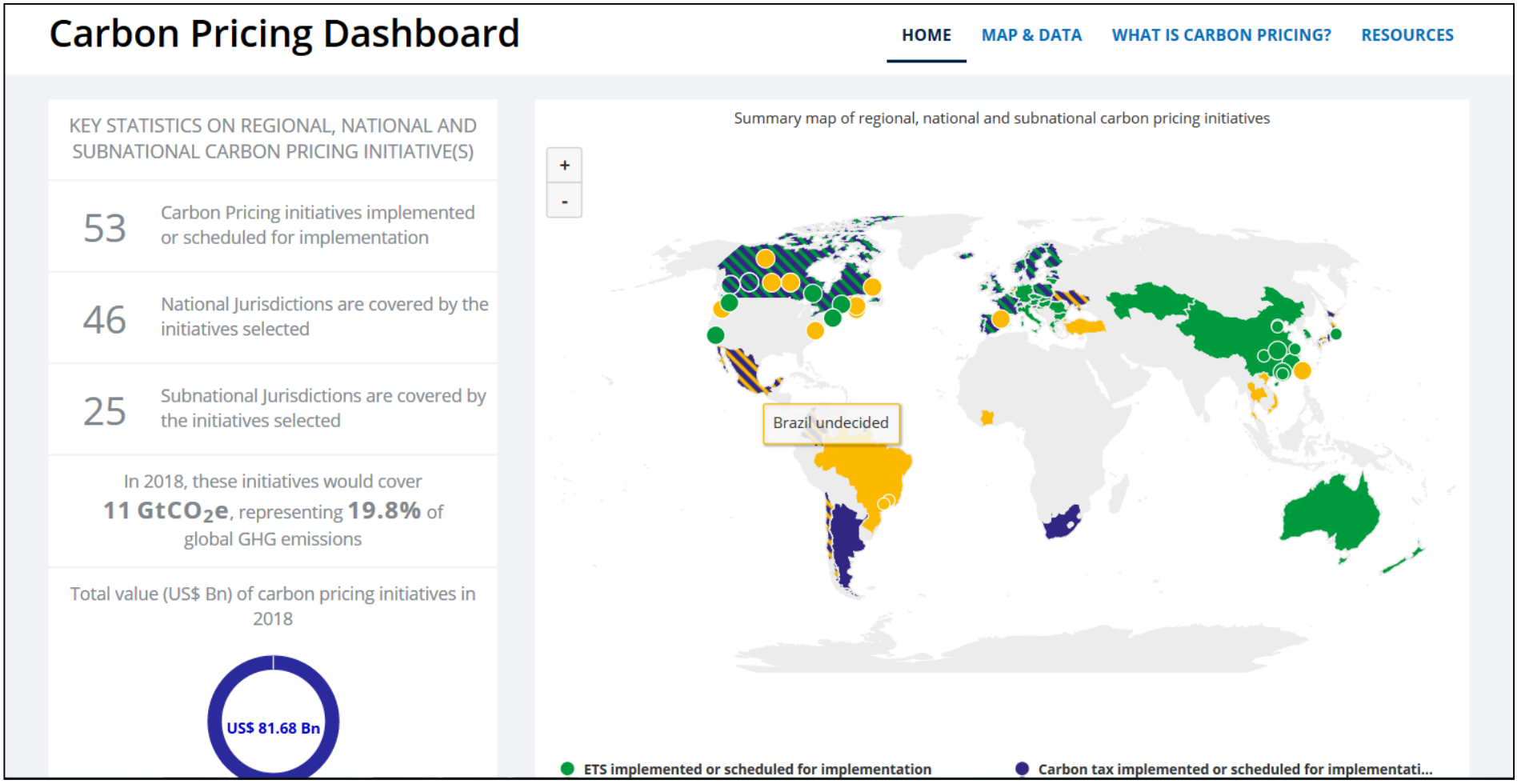
Of course: policy package; but CP essential

- **If only carbon pricing** => *early lock-in of non-optimal solutions, closes innovation trajectories of expensive options with much potential*

  => *innovation subsidies* to keep such options open

- **Policy for other emission sources:** e.g., land conversion, deforestation, land fills
- ***Nudges*** – bounded rationality of consumers
- ***Information provision*:** About climate change, need for internat. policy coordination, role of carbon pricing, consumer alternatives, etc.
- ***Technical standards:*** limits on car power, speed and acceleration – but won't reduce use, rather opposite (rebound).

Good starting point for upscaling



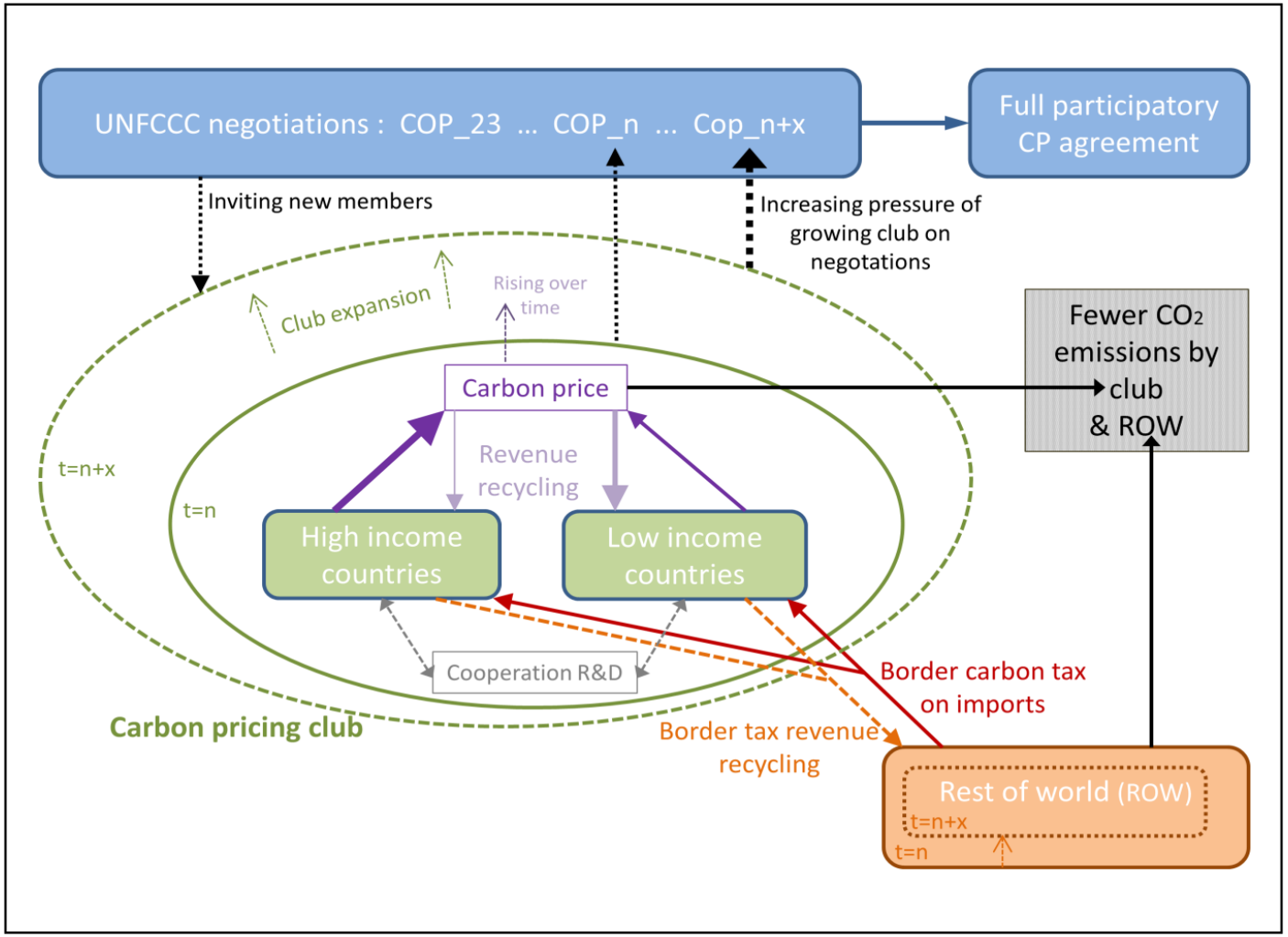
Source: World Bank (2018)

Post-Paris CP negotiations on policy harmonization through carbon price

- Untried: climate agreement on global carbon price/tax or on quota/standards: **1- vs n-dimensional problem**
- **Free rider behavior discouraged**: carbon price applies equally to all countries; start CP=0 & raise.
- **Redistribution** of revenues (already part of Paris Agr.) to assure support from poor nations.
- But some countries will resist, notably fossil-fuel exporters (Saudi Arabia, Russia, etc.), hence **insufficient approach**.

Transition path to uniform global carbon price

Two interactive tracks: coalition (club) and UNFCCC-COPs



Multiple phases in a transition to global CP

Phase	Track 1: coalition	Track 2: UNFCCC negotiations	Interaction between tracks
1	Climate coalition initiated by ambitious countries with low uniform carbon price and border tariff	Raising awareness in UNFCCC-COPs for relevance of coordinating national policies and potential role of carbon price	Coalition speaks with one voice at UNFCCC-COP meetings
2	Expansion of coalition; moral and economic pressure on countries outside the coalition	Frequent discussions and initial negotiations about carbon price among majority of UNFCCC countries	Coalition strongly lobbies for focus on carbon price during COP meetings
3	Higher carbon price and border tariff; further expansion	Negotiation of heterogeneous carbon prices adapted to income levels in UNFCCC countries with joint carbon price floor	Lessons learned in coalition about design and coordination of carbon price transferred to UNFCCC negotiations
4	Large coalition which includes major emitting countries	Converging carbon price in majority of UNFCCC countries; complemented by financial transfers from rich to poor countries	Large coalition creates critical mass in UNFCCC process
5	Remaining countries (notably fossil-fuel suppliers) come on board under large political and economic (trade) pressures; results in all countries having consistent, economy-wide and strong climate policy. After harmonization, gradual rise in carbon price; frequently revised in response to extent of global emissions reduction achieved and advances in climate sciences on required reduction.		Carbon pricing coalition and UNFCCC climate agreement integrate

Suitable large emitters to start coalition (>55% emissions)

Analysis based on data from opinion surveys, NDCs & participation in relevant coalitions

Nation	Effectiveness		Likelihood of involvement	
	% of total global CO_2 emissions	% of total global GDP	Net likelihood score	Net likelihood ranking
Australia	1.1	1.8	0.758	1
Brazil	1.6	2.4	0.746	2
Canada	1.6	2.1	0.721	3
South Korea	1.7	1.9	0.711	4
Mexico	1.4	1.6	0.661	5
Japan	3.6	5.9	0.585	6
EU	9.6	21.9	0.571	7
India	6.6	2.9	0.517	8
South Africa	1.4	0.4	0.515	9
Indonesia	1.4	1.2	0.438	10
US	15.5	24.5	0.383	11
China	30.4	15.0	0.366	12
Iran	1.9	0.5	0.326	13
Russia	5.0	1.9	0.284	14
Saudi Arabia	1.8	0.9	0.227	15

Source: Martin and van den Bergh (2019)

States in resistant country (USA)

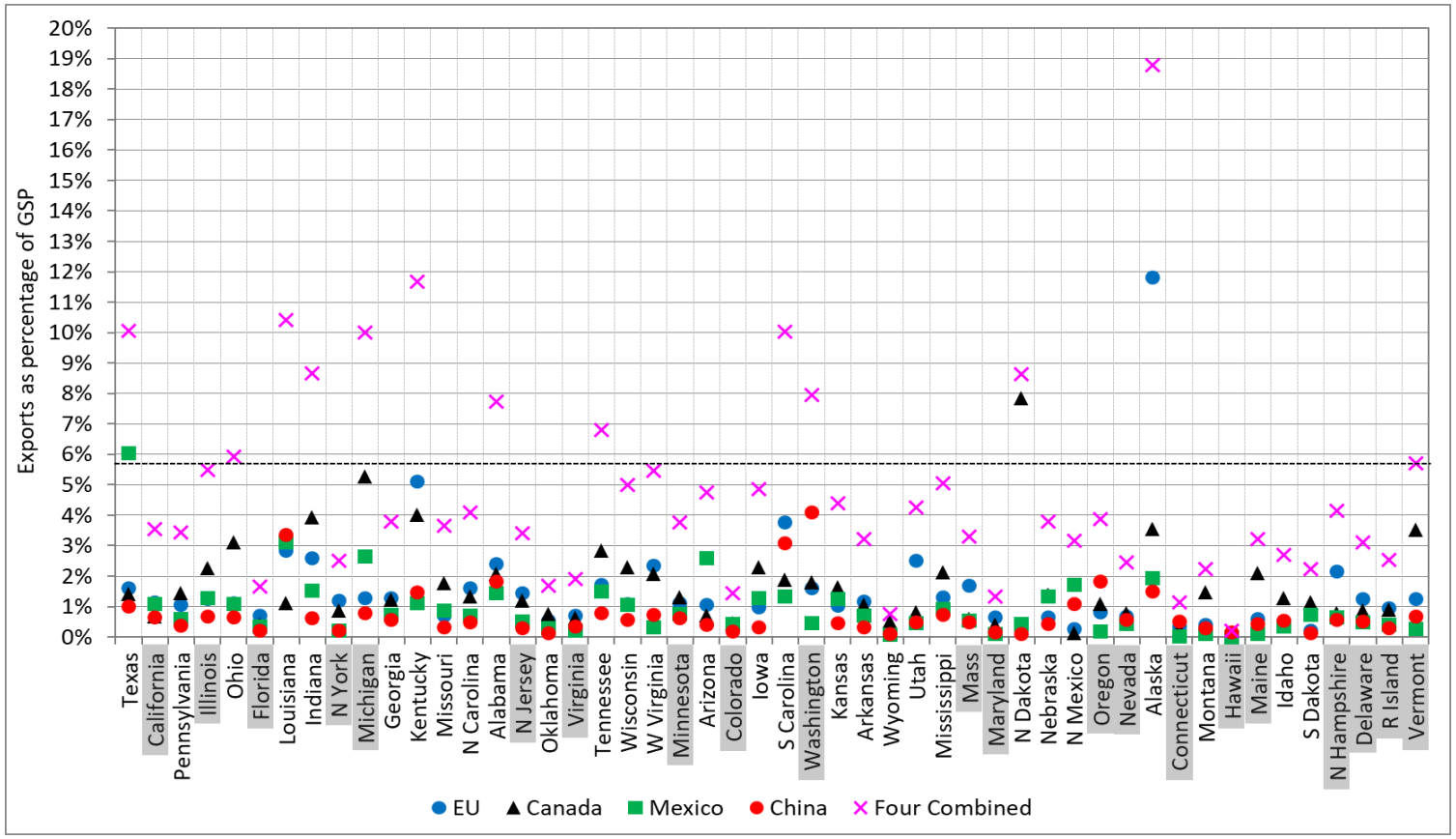
Analysis based on data from opinion surveys, NDCs & participation in relevant coalitions

State	% of total US CO_2 emissions	% of total US GDP	Likelihood-of-involvement		
			Score	Ranking	Rating
Mass	1.2	2.7	0.961	1	
N York	3.1	8.1	0.953	2	
Connecticut	0.6	1.4	0.924	3	
California	6.6	14.0	0.919	4	
Maryland	1.1	2.1	0.882	5	
R Island	0.2	0.3	0.876	6	Very Likely
Vermont	0.1	0.2	0.862	7	
Washington	1.4	2.5	0.859	8	
Oregon	0.7	1.2	0.858	9	
Delaware	0.2	0.4	0.850	10	
Hawaii	0.3	0.5	0.847	11	
N Jersey	2.1	3.2	0.838	12	
N Hampshire	0.3	0.4	0.803	13	
Virginia	1.9	2.7	0.786	14	
Maine	0.3	0.3	0.742	15	
Minnesota	1.8	1.8	0.735	16	
Illinois	4.3	4.3	0.725	17	Moderately Likely
Nevada	0.7	0.8	0.721	18	
Colorado	1.7	1.8	0.711	19	
Michigan	3.0	2.6	0.704	20	
Florida	4.2	5.0	0.699	21	

Source: Martin and van den Bergh (2019)

State-country trade as push force for additional members

About 70% of US emissions may be amenable to climate club involvement via a combination of both pathways (36% + 34%)



US state exports sold to four key countries and combined sum of all four as percentage of gross state product (GSP). Threshold line representing the 75th percentile of combined scores is also shown. States previously identified as "very likely" and "moderately likely" climate club members are highlighted in grey.

Source: Martin and van den Bergh (2019)

Environmental Innovation and Societal Transitions (EIST)

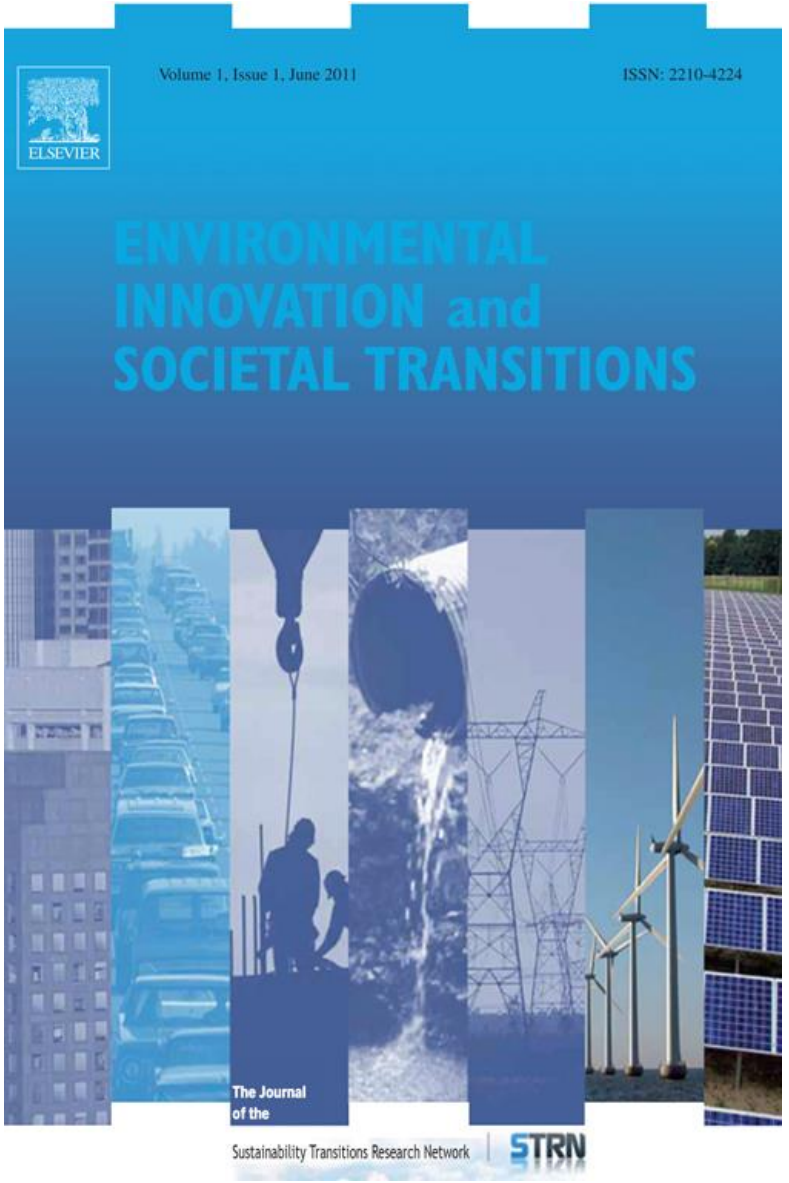
www.elsevier.com/locate/eist

Impact factor 7.514

Journal contains discussions of some of the previous topics.

Special issues on:

- Historical transitions and role policies
- Learning processes in transitions
- Geography of transitions
- Dealing with risks and uncertainties
- Self-organizing communities
- The sharing economy
- Low-carbon China
- Financial crises and transitions.



Lecture based on following publications

van den Bergh, J. (2011). Energy conservation more effective with rebound policy. *Environmental and Resource Economics* 48(1): 43-58.

van den Bergh, J. (2013). Policies to enhance economic feasibility of a sustainable energy transition. *PNAS* 110(7): 2436-2437.

van den Bergh, J., C. Folke, S. Polasky, M. Scheffer and W. Steffen (2015). What if solar energy becomes really cheap? A thought experiment on environmental problem shifting. *Current Opinion in Environmental Sustainability* 14: 170-179.

Baranzini, A., J. van den Bergh, S. Carattini, R. Howard, E. Padilla and J. Roca (2017). Carbon pricing in climate policy: Seven reasons, complementary instruments, and political-economy considerations, *WIREs Climate Change*, 8, 4, e462.

King, L.C., and J.C.J.M. van den Bergh (2018). Implications of net energy-return-on-investment for a low-carbon energy transition. *Nature Energy* 3(4): 334-340.

King, L., and J. van den Bergh (2019). Normalisation of Paris Agreement NDCs to enhance transparency and ambition. *Environmental Research Letters* 14 (2019) 084008.

Martin, N., and J. van den Bergh (2019). A multi-level climate club with sub-national members to create critical mass for policy harmonization. Revised submission.