Participation as co-production — inevitable community involvement in Distributed Generation in Micro-Grids

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Some state-of-the-art fundamentals
inconsistent with common sense

- *Social* Acceptance ≠ *Public* Acceptance
- Acceptance *energy source* ≠ Acceptance *projects*
- Barriers to deployment **NOT** primarily local opposition (community acceptance)
- Social Acceptance is about institutions
  → accepting institutional changes
- Innovation: new patterns of thinking and behaviour (=institutions) organizing and regulating energy

Fundamental question
summarizing 30 years of social acceptance RES research

- How do we change *energy systems*, energy *conversion*, as well as energy *consumption,* into a power supply system applying renewable *sources* and clean energy *carriers*?

- Answer: it requires *institutional change*, an entirely different system, not simply the same system in which current generation is replaced by other forms of energy conversion Wolsink 1990
- Escape from the *institutional lock-in* '**carbon lock-in**' Unruh, 2000

Institutitions

- Definition:
  ... behavioural patterns as determined by societal rules; "the rules of the game in society"
  North D, 1991. *Instit, Inst Change and Econ Perform.* Cambridge University Press.
- Contrary to common-sense 'knowledge' (including beliefs among many policy makers)

PV/ Wind/ RE$_{\textbf{whatever}}$ innovation:

institutional constraints mainly at the level of **socio-political acceptance**

Innovation theory

- Institutional “lock-in” Unruh, 2000; Lehmann ea 2012
- Institutions function in a pattern of social self-organization
- Existing configuration energy sector and in land use emerged in history to serve certain objectives (“path dependency”)
- → does not serve new objectives, hence it creates barriers/inertia

Sources of institutional lock-in

Unruh, 2002. Escaping carbon lock-in. *Energy Pol* 30, 317–325

- Technological: Dominant design, standard technological architectures and components, compatibility
- Organizational Routines: training, departmentalization, customer-supplier relations
- Industrial Industry standards: technological inter-relatedness, co-specialized assets
- Societal System: socialization, adaptation of preferences and expectations
- **Institutional Government: policy intervention, legal frameworks, departments/ ministries**

Institutional lock-in: existing patterns of thinking and behaviour

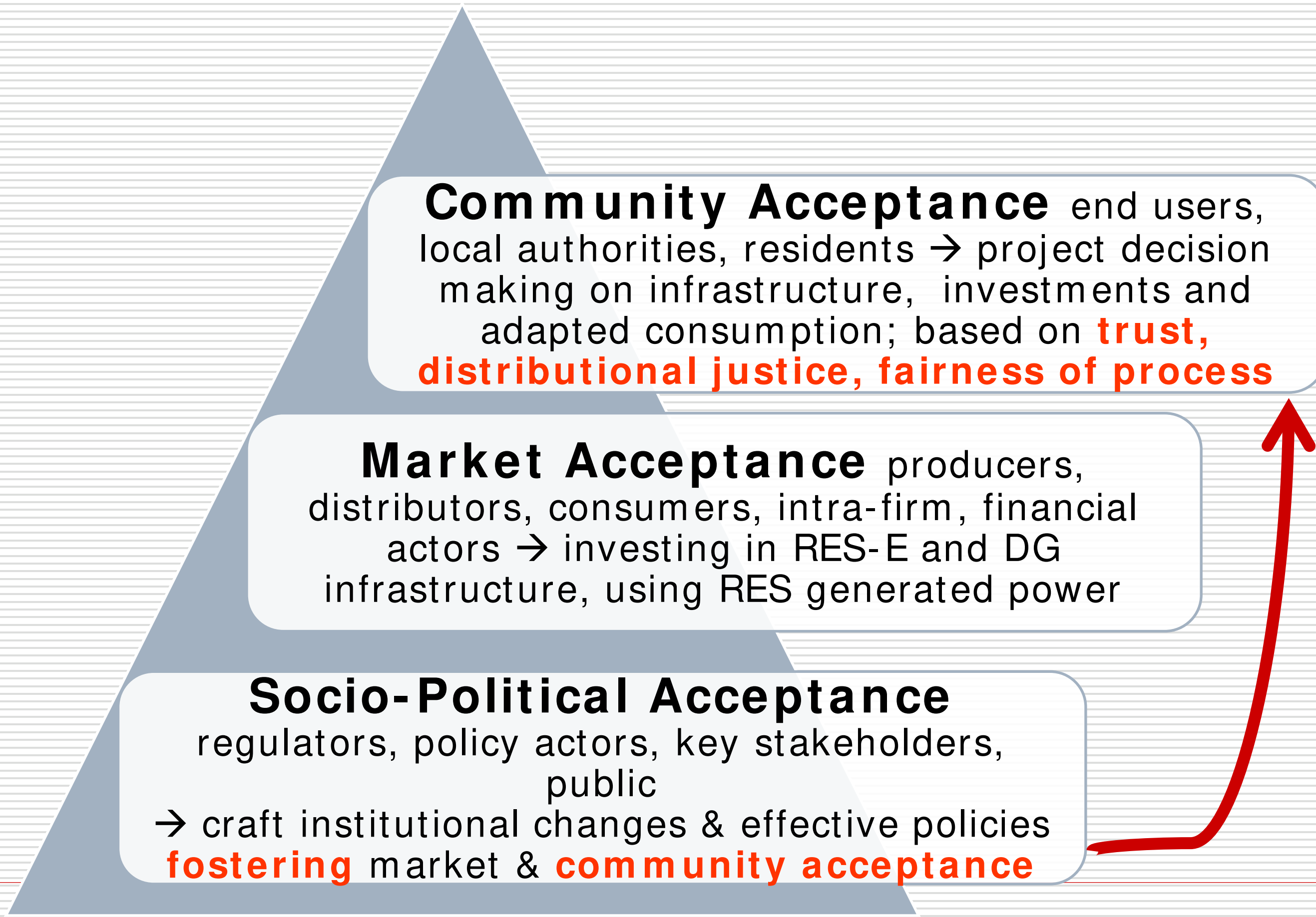
"Alternatives representing radical technological change have to come from outside organisations representing the existing technologies, whereas the existing incumbents even make efforts to eliminate alternatives from decision-making processes."

Lund (2010) Energy 35: 4003-4009.

Comparison of 12 decision-making processes in RES projects in 1st country successful in RES implementation

Social acceptance in energy innovation primarily issue with an institutional character

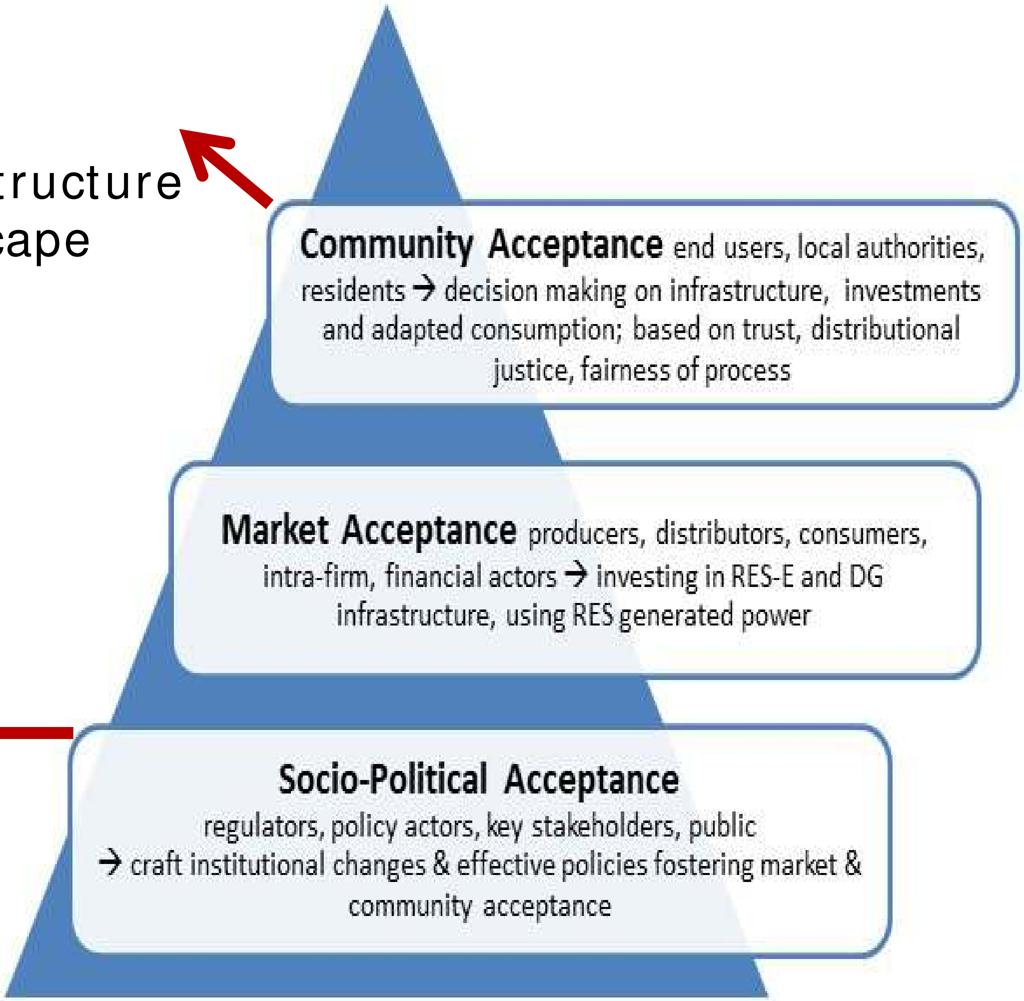
adapted from Wüstenhagen et al 2007, p.2386



Social Acceptance in innovation examples (among many others) *Wolsink 2012 Encyclopedia*

Elements such as (among many others)
- sustainable community agenda
- involvement (ownership) infrastructure
- communities' land use + landscape

Elements such as (among many others)
- fully restructured power supply system (STS)
- intitutional change in planning systems (redefining decision making on land use) opening acceptable options for RES and DG/microgrid infrastructure



Acceptance of 'Intelligent' grid
(buzzword: 'smart grid')

- Definition:
  "Power grid consisting of a *network of integrated micro-grids* that can monitor and heal itself" *Marris E (2008) Upgrading the grid. Nature 454: 570-573*

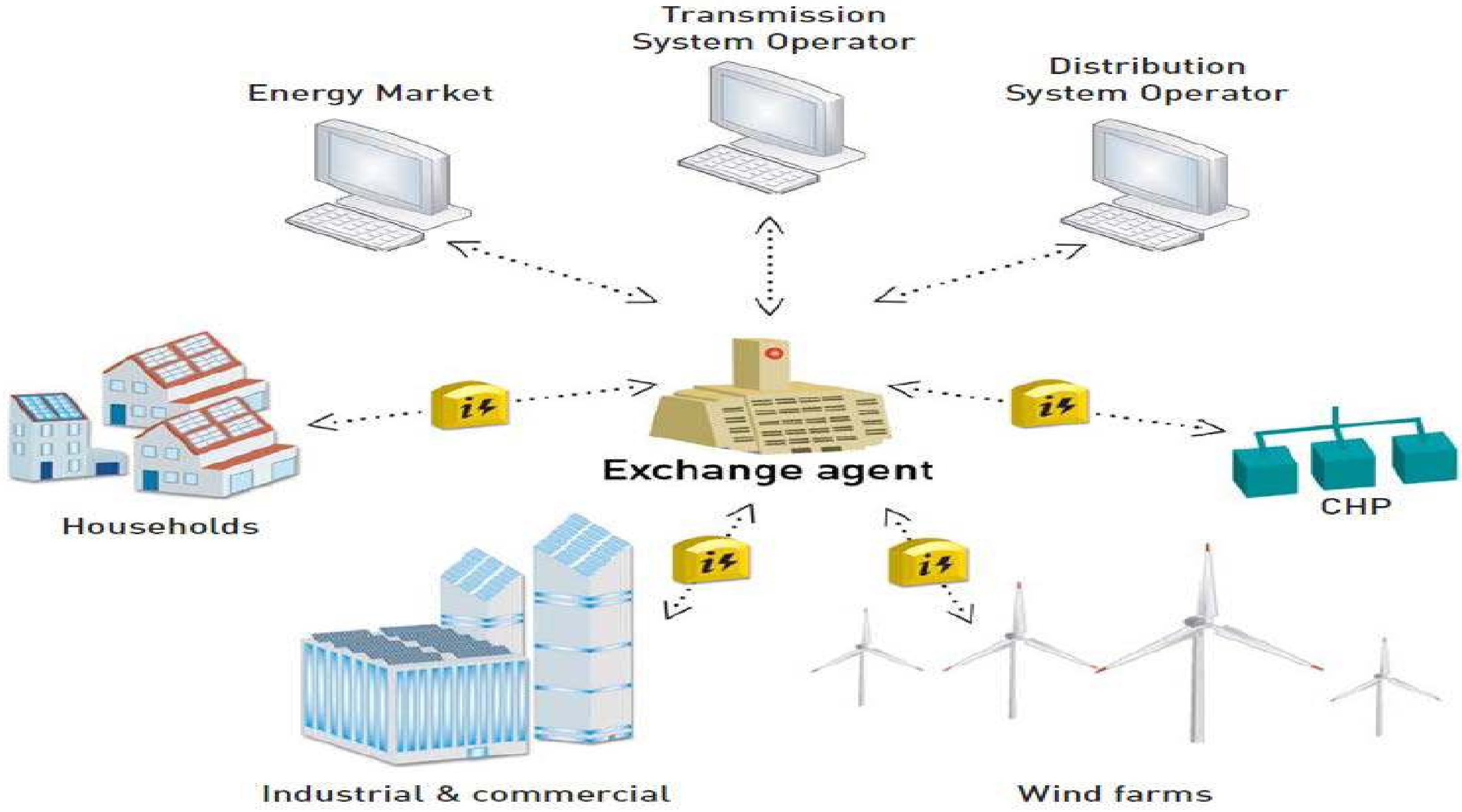
examples of recognized relevance in policy:

- "Experts predict that the U.S. energy system will include more than 150 million interacting elements…need ever more sophisticated and powerful computer models to track the flow of energy, and better batteries to support computing and store energy"
  US Department of Energy: Quadrennial Technology Review, Sept. 2015

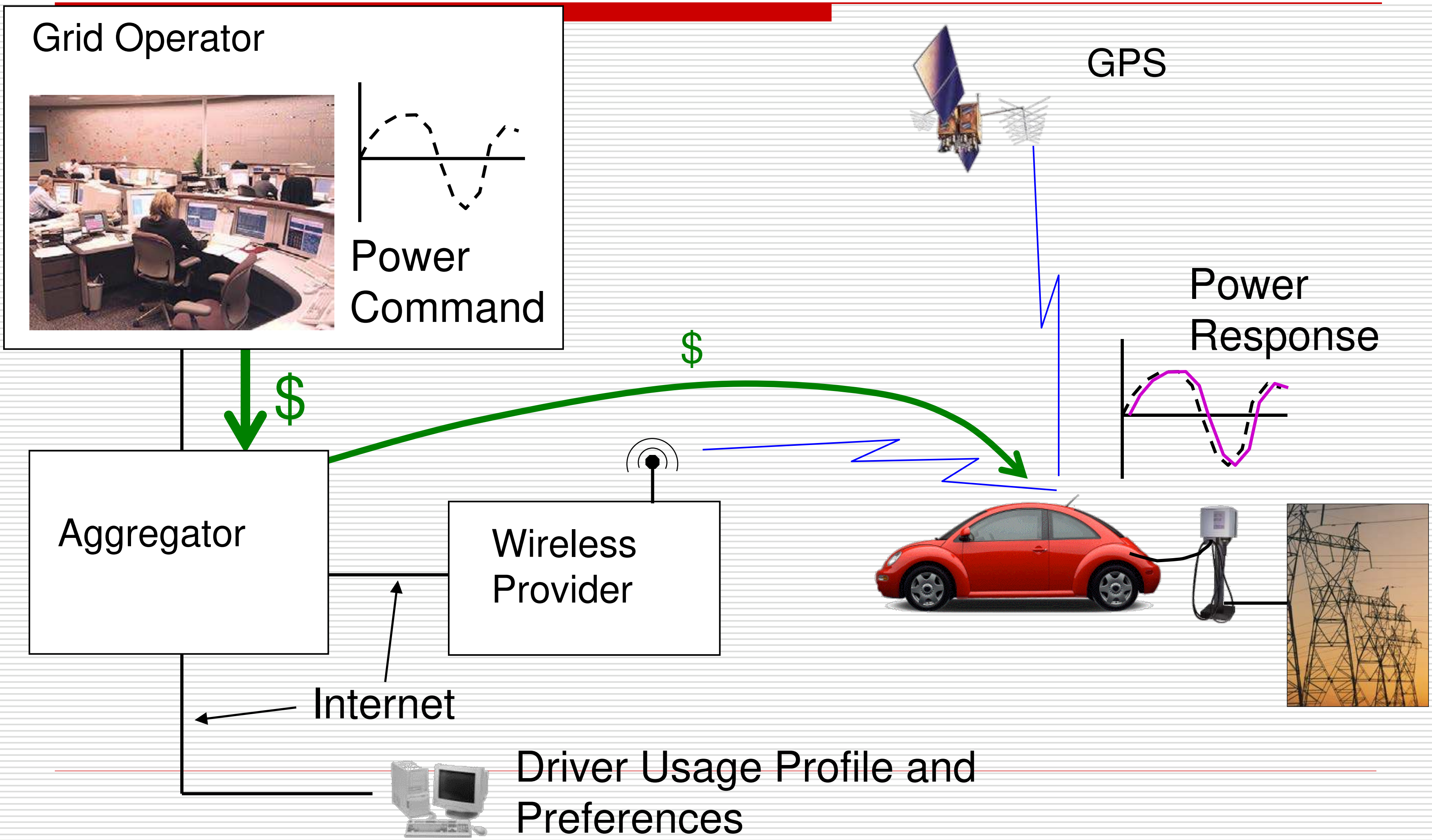
More examples of recognized relevance in policy: EU 'vision' on the 'smart' grid

Mengoli ea 2013

EU vision still ‘locked-in’ in centralized thinking whereas DG is by definition not centralized



Example SmartGrid V2G Regulation. Centralized vision → low acceptance



Renewable Energy (prime reason for establishing intelligent grids): *“Distributed Generation”*

- Micro/decentralized generation
- Smaller scale (than current units)
- Spatially very dispersed
- **Spatial claims renewables: "huge"**
  MacKay 2008
- Integrate variable sources and demand
- Power grid applied as 'storage' capacity

Charles 2009 Science 324: 172-175 "Renewables test IQ of the grid"

Distributed Generation

Ackermann, Andersson, Söder 2001; with several additions

Combined cycle gas T.	35–400 MW
Internal combustion engines	5 kW–10 MW
Combustion turbine	1–250 MW
Micro-Turbines	35 kW–1 MW
Renewable (favourable, but ≠ 'sustainable')	
Biomass, e.g. gasification	100 kW–20 MW
Small hydro	1–100 MW
Micro hydro	25 kW–1 MW
Wind turbine	200 Watt–3 MW
Photovoltaic arrays	20 Watt–100 kW
Solar thermal, central receiver	1–10 MW
Solar thermal, Lutz system	10–80 MW
Fuel cells, phosacid	200 kW–2 MW
Fuel cells, molten carbonate	250 kW–2 MW
Fuel cells, proton exchange	1 kW–250 kW
Fuel cells, solid oxide	250 kW–5 MW
Geothermal	5–100 MW
Stirling engine (micro CHP)	2–10 kW

DG, continued

❖ Ocean energy	
Waves, Tidal	100 kW–1 MW
Saline/Fresh (osmotic) pressure	100 kW-50 MW
❖ *Distributed Storage and Transmission (of Renewable generated energy)*	
❖ Heat storage (electric boilers)	1-10 kW
❖ Heat storage in buildings (solar, electr. heat pumps)	10-500 kW
❖ 'Cold' storage (cooling systems)	1-100 kW
❖ Battery storage	500 kW–5 MW
❖ Electric vehicles (batteries)	10-100 kW
❖ V2G (Vehicle-to-grid; uploading)	10-100 kW
❖ MicroGrid (balancing supply-demand within)	1kW-100MW
❖ SuperCondiuting Transmission lines	100-1000 kV
❖ *Storage in 'non-heat' consumption (of Renewable generated energy)*	
❖ Water Supply systems	10kW-1000 kW
❖ Desalinization reservoirs	10kW-500 kW
❖ Storage in CO_2 based fuels	10kW-1MW (??)

❖ And many more emerging……

Solar power plants: mirrors reflecting on towers
Wind-centralized power plants – e.g. off-shore
Drawbacks: far away from consumption; expensive, problematic transmission, energy losses

Why are we trying to transform energy system?

Centralized, large scale; high infrastructure cost; continued dependance non-domestic sources. large scape generation deserts ('Desertec' initiative) example DESERTEC

More Centralized ideas for RES in current existing power supply: Les Mées, Durance valley (F)

DG

more integrated in community

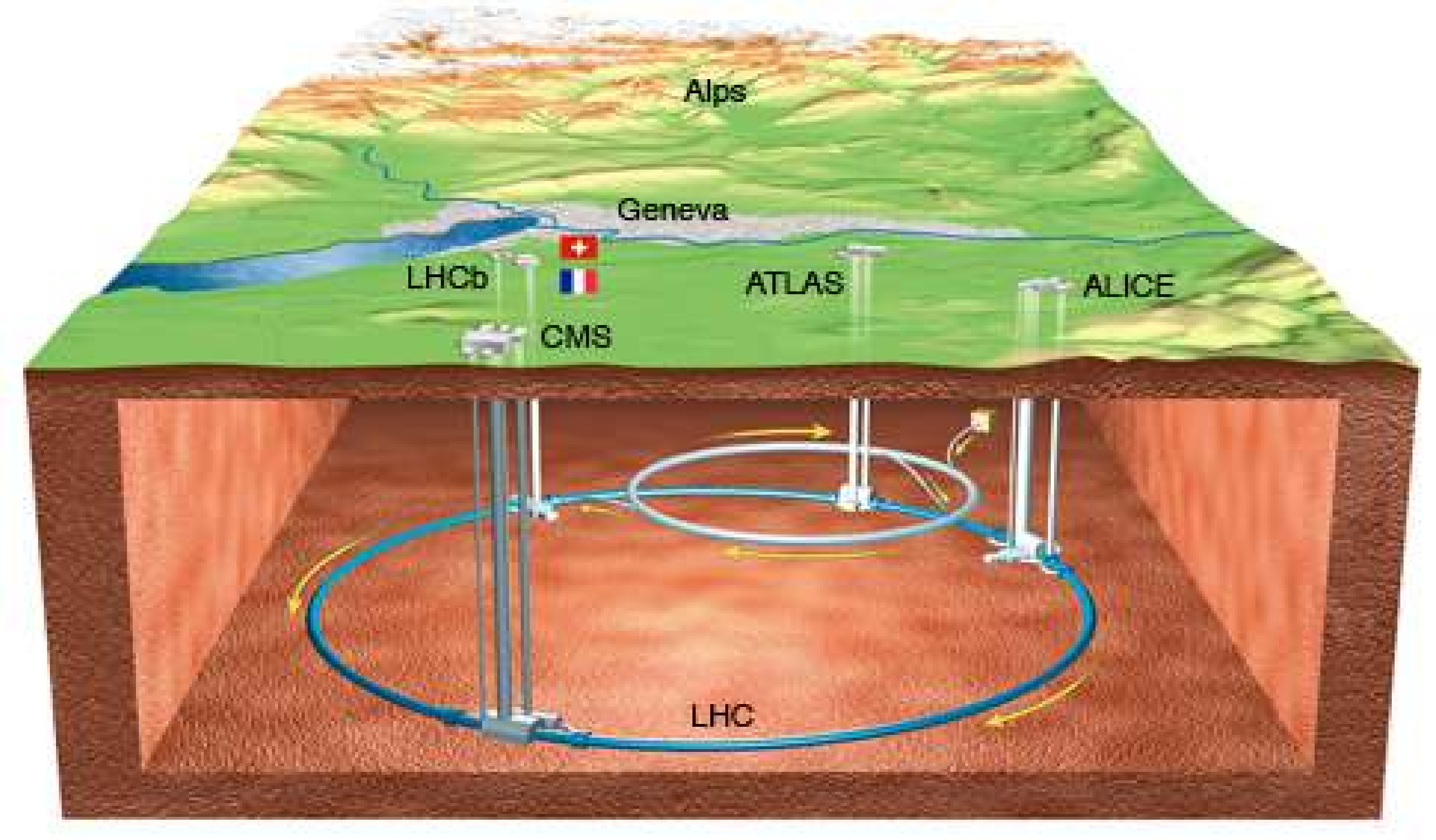
Prosumer's communities (Germany)

New inventions for the Future
Saline/fresh water encounters. Artist impression Afsluitdijk (NL) separating Sea/Lake

Drawback: fresh water scarcity; fresh/salt encounters mainly estuaries, large biodiversity; similar drawback for tidal power

Large Hadron Collider

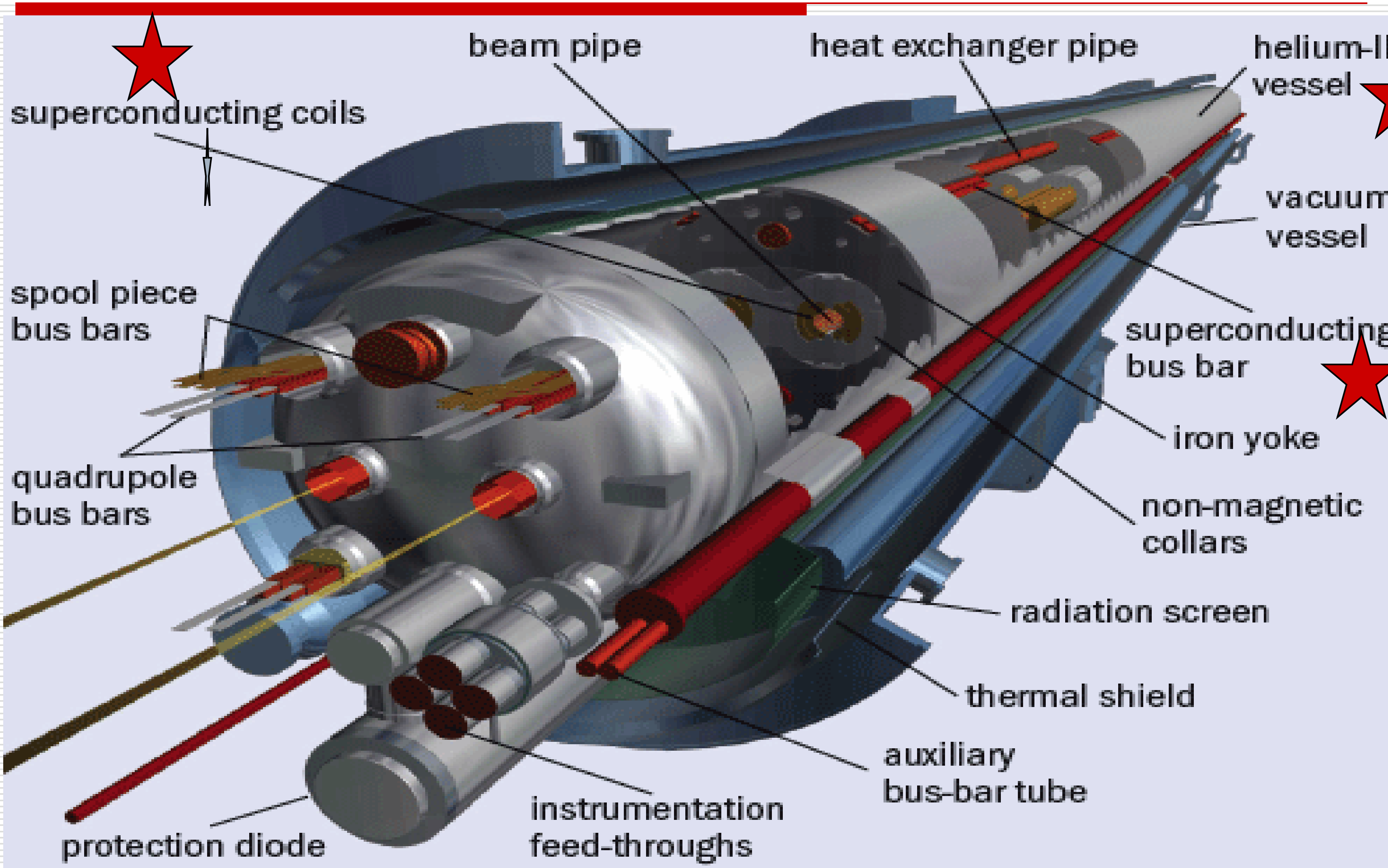
F, CH close to Geneva



Application SuperConducting HV transmission

Cooling: He, possibly N_2 (MgB_2 at 39K); bi-polar coax DC-HV → no magnetic field; experimental application in transmission lines, underground, narrow tracks, no magnetic fields

possibly replacing current HV Transmission Lines Thomas et al, RSER in press



Example ‘Landscape integration’ by central direction; solar on roof of tunnel, without community integration

Leiderdorp, NL, local opposition

Or DG, which implies 'landscape integration', including community integration

Bellwald, Upper Rhône valley, CH Michel et al 2015

Definition

- **Distributed Generation**

  is an electric power source

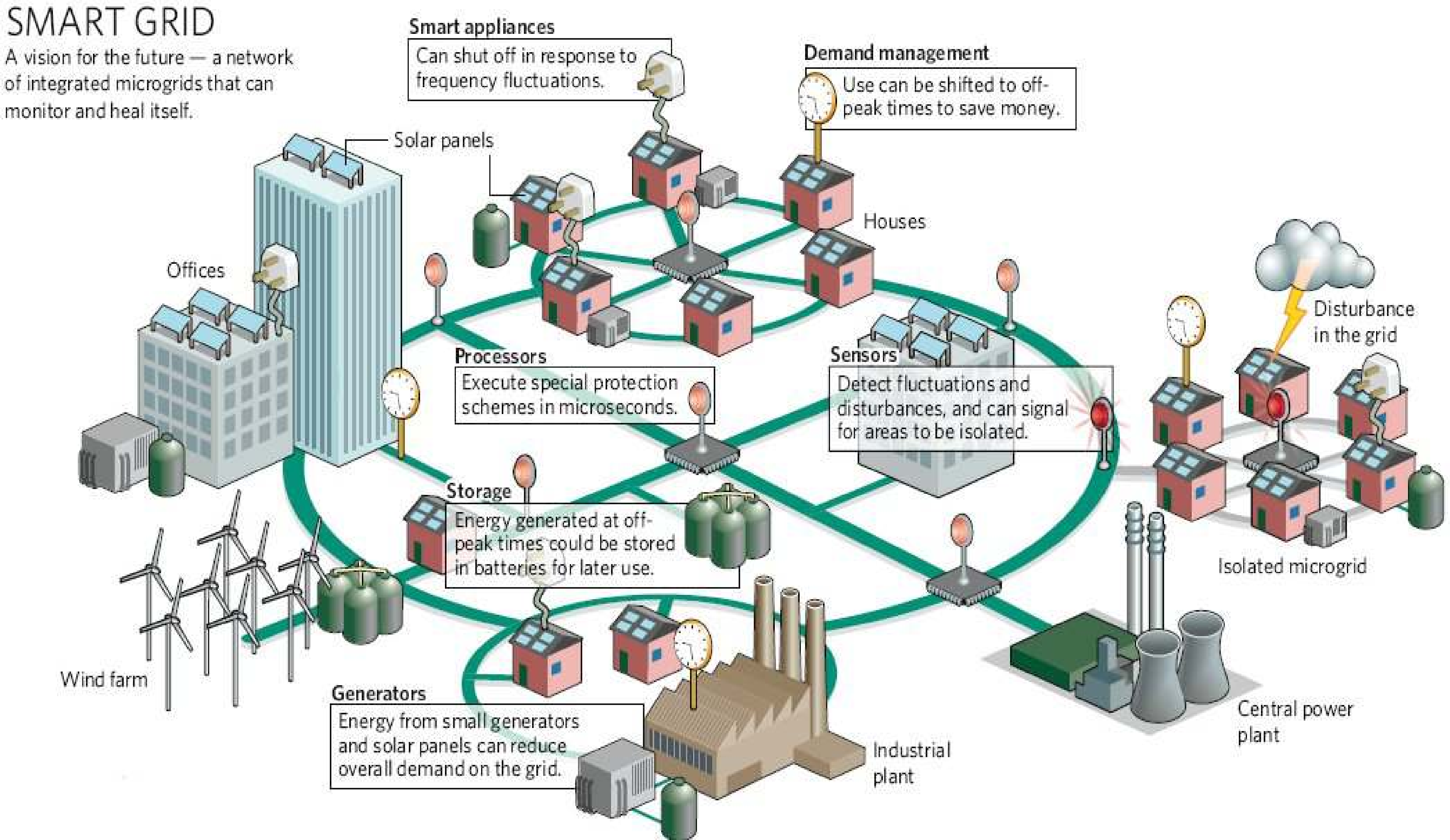
  - connected directly to the distribution network

  - or on the customer side of the meter.

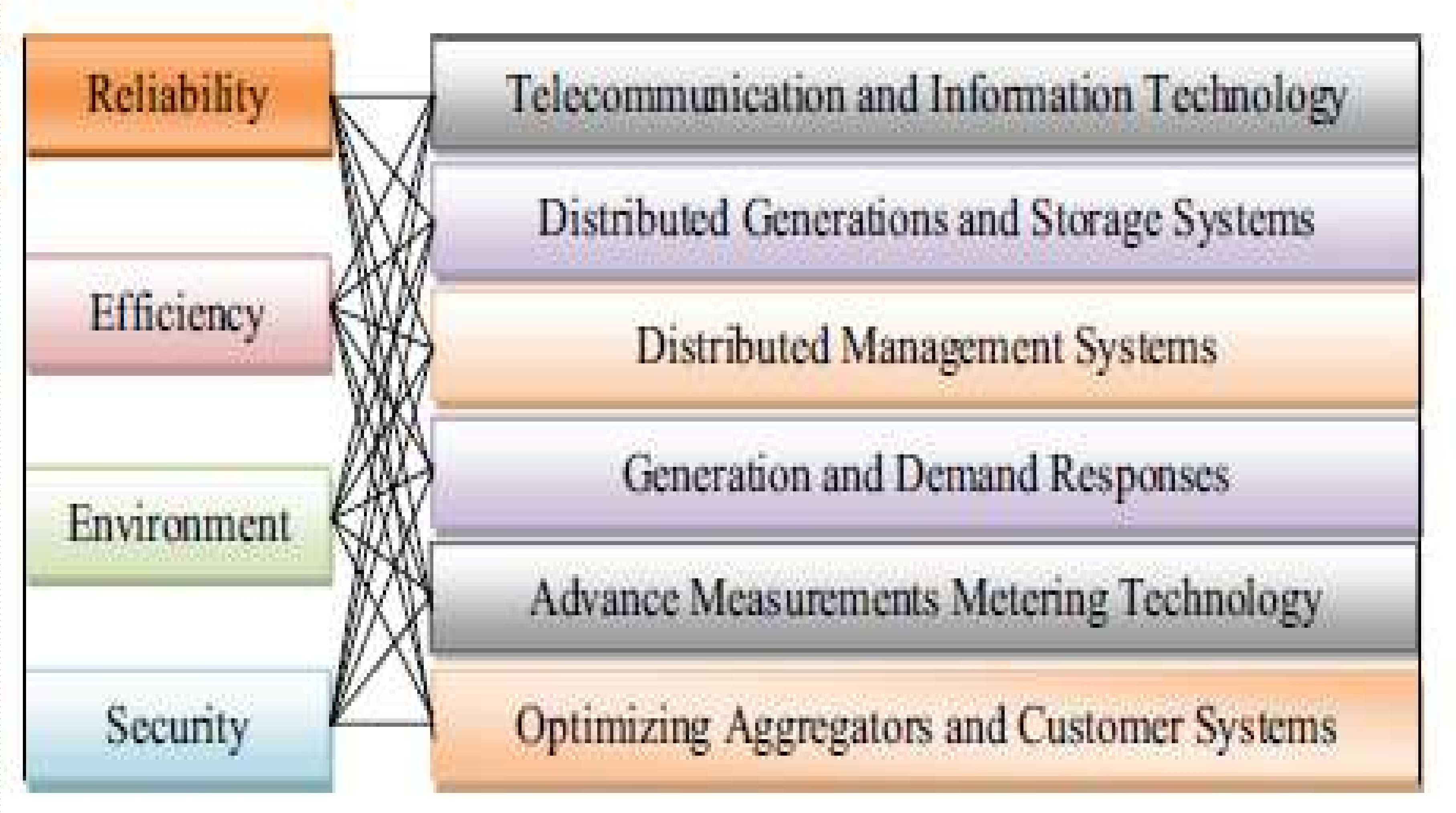
Ackermann et al 2001

‘Smart grid’: “…rescaling and distributed generation” …“integrated micro-grids that can monitor and heal itself”

Marris 2008, *Nature* 454, 570



Again: why? 4 kinds of 'merit' (not guaranteed, depending upon institutional frame !!) related to 6 smart microgrid elements



Haidar et al *Ren Sust En Rev* 2015

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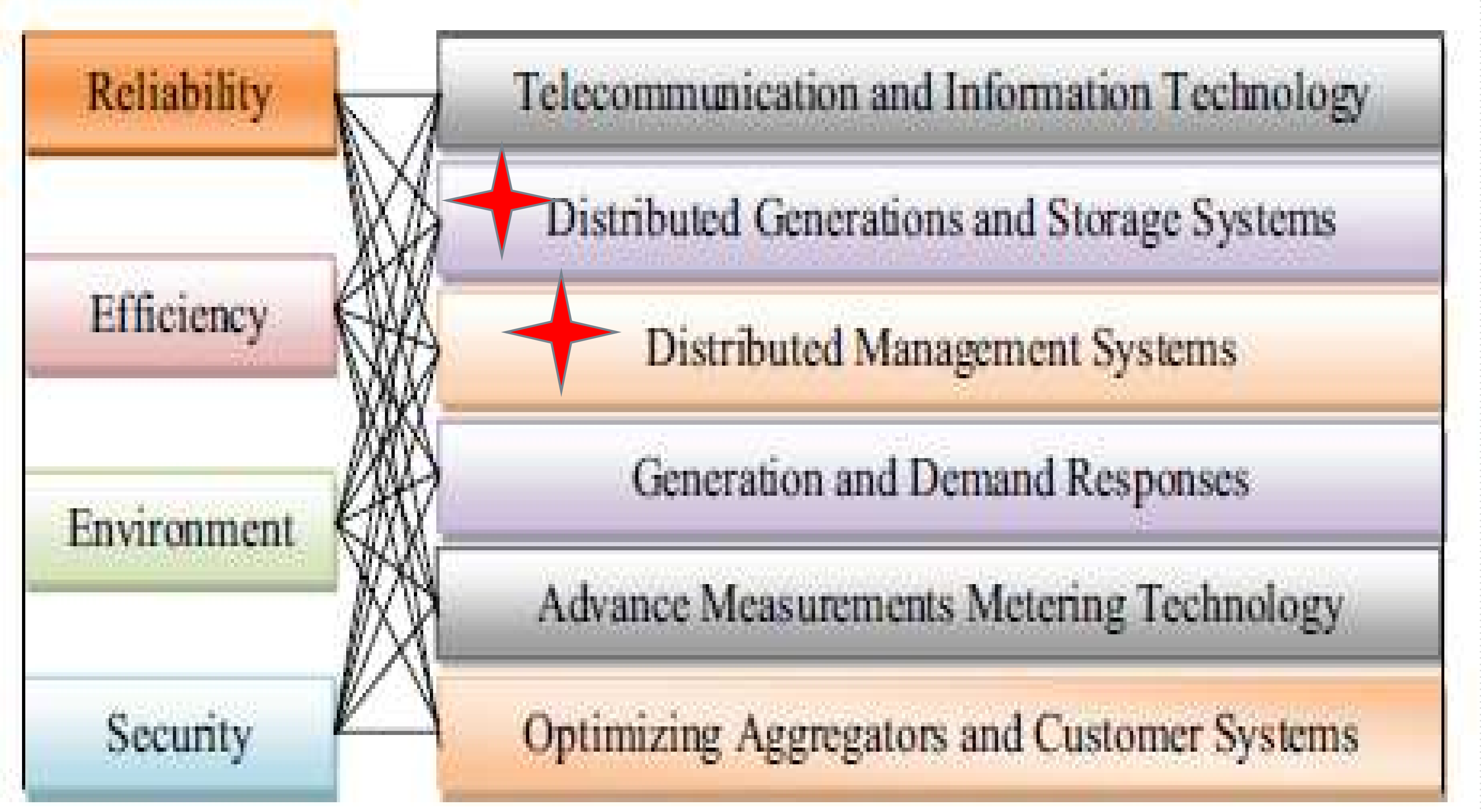
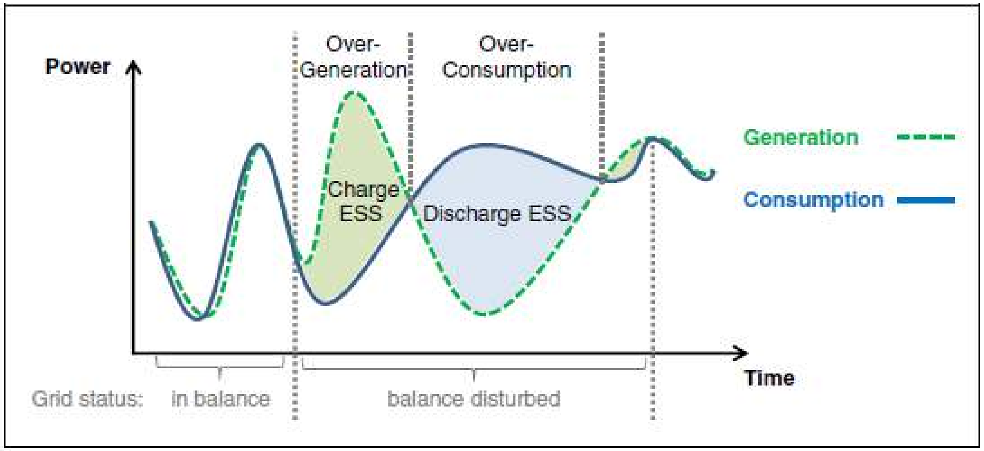


Haidar et al Ren Sust En Rev 2015

Feasibility RES requires integration in

- Of Different patterns of variable supply
- Optimization supply and demand: needs (micro-)optimization



- Development of community micro-grids,
  - co-operation of co-producers ('prosumers')
  - load-control *(supporting DG, **not** central capacity)*
  - storage within community (e.g. electric vehicles)
  - Intelligent regulation/metering within community
  - *supporting 'micro-grid'*
  - instead of central power plants

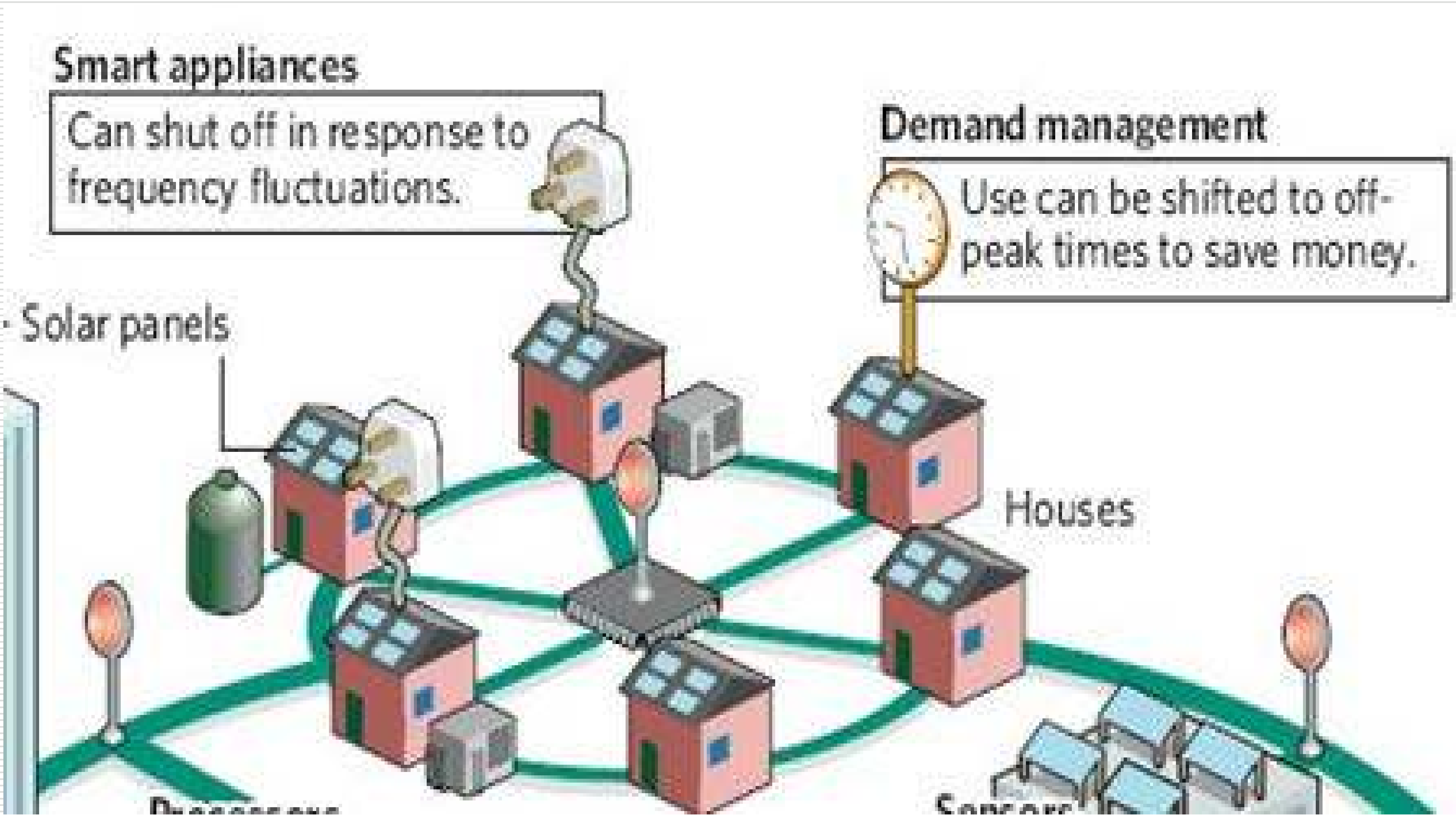
“Planning”? Why stakeholder involvement needed?

- “targets only achievable …broad stakeholder involvement and a social movement …towards energy transformation … in order to overcome transformation barriers” Oßenbrügge, this conference

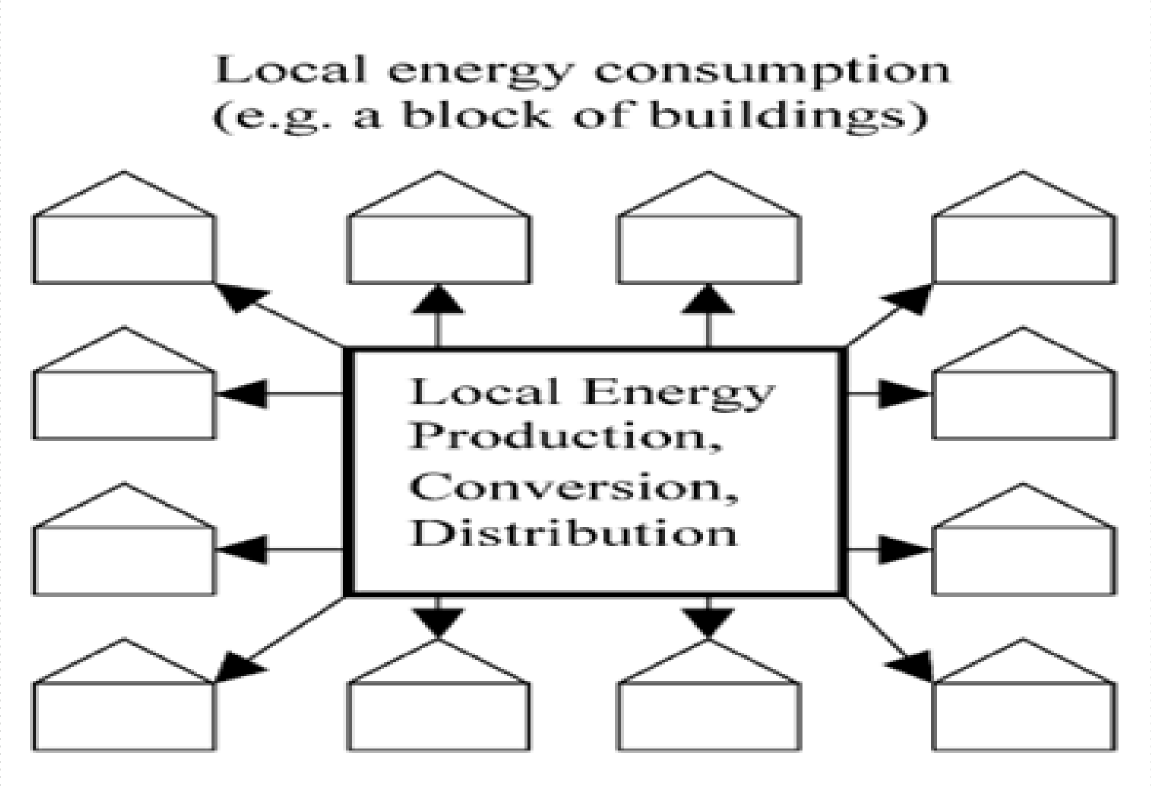
OR

- Abolish central control to break down barriers … to promote co-production and participation to achieve acceptable land use planning for energy infrastructure

Micro Grid (example of only houses) internal integration of generation and demand (minimizing exchange with public grid)



Micro Grid: Co-operating prosumers form a **community** harvesting, applying and **governing a natural resource**



All units (generation, transmission, regulation, consumption) connected in 1 STS

Innovation theory

Energy system is collection of STS's

- Socio-Technical Systems (STS)
  because of DG: huge geographical variety
  all STSs consist of 5 subsystems

- \- resource system: conversion technology; transmission & regulation infrastructure
- \- natural system: climate, ecology, landscape
- \- governance system (≠ government): investment, management, property, land use
- \- users, consumers involved in production
- \- consumption patterns, adaptation to variable resources, storage

CPR approach to RES: definition (Lin Ostrom, 1999; 1990) and application

- **Common Pool Resources** are
  - natural or man-made resources
  - where one actors's use of the commons
  - subtracts from its use by others
  - but there is difficulty in excluding access

  Dietz et al. *Science*, 2002; Ostrom, 1990, 2000

▪Energy Application to Socio-Ecological Systems SES

Hodbod, Adger *EnResSocSci* 2015

▪Application to Socio-Technical Systems, STS including landscape Wolsink *RenSustEnRev* 2012

Substractability; Excludability

- 1) Exploitation by one results in less availability for others *(subtractability)* → Resource NOT scarce, scarcity is space required for generation and distribution (McKay 2008) (landscape, resource rights)

- 2) Difficulties to exclude potential users *(excludability)*. Source is free, current barriers only man made (= institutional)

Ostrom, 1999. *Coping with tragedies of the commons.* Annual Review Political Science 2, p493

"Contemporary policy analysis of the governance of common-pool resources is based on three core assumptions:

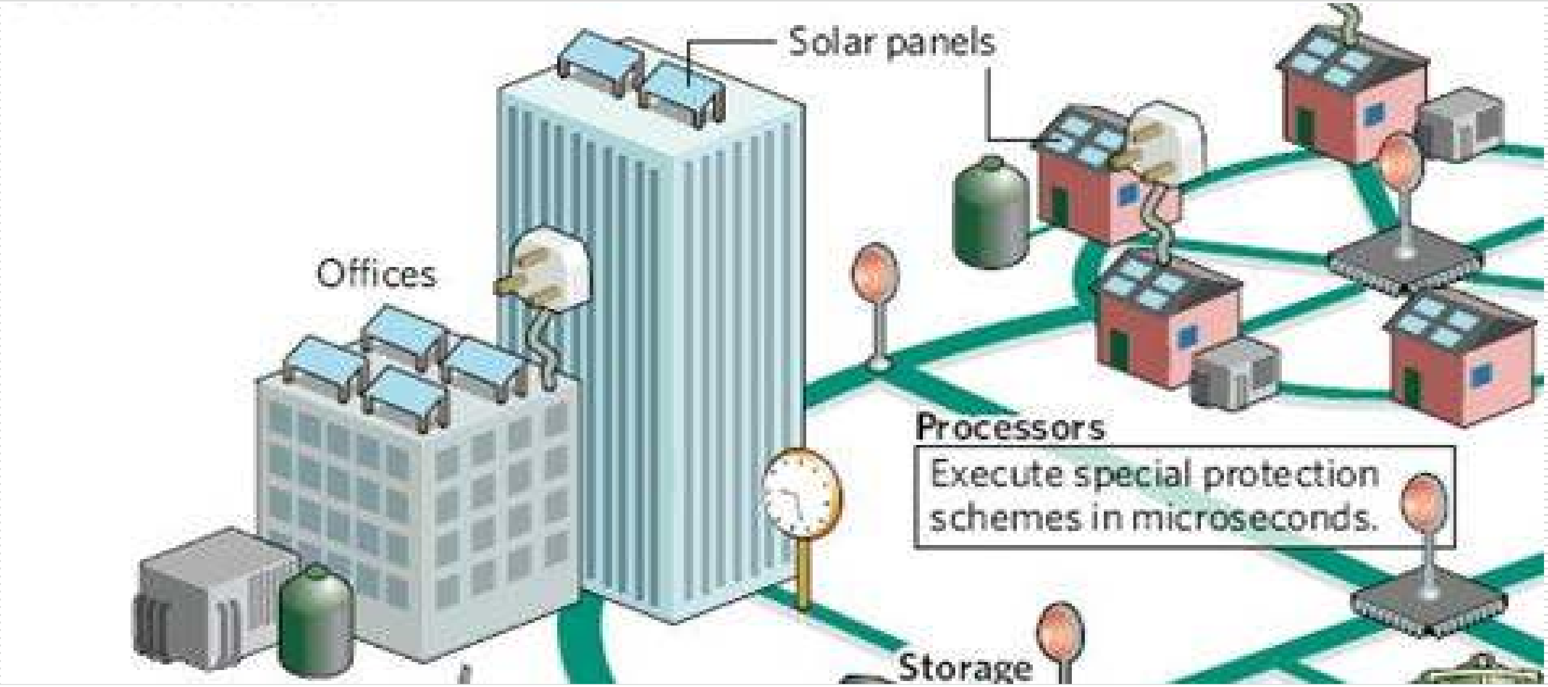
(*a*) resource users are norm-free maximizers of immediate gains, ……

(*b*) designing rules to change incentives of participants is a relatively simple analytical task

(*c*) organization itself requires central direction"

"……… all three assumptions are a poor foundation for policy analysis."

land use issues related to DG *example:* in CPR management: resource rights, to be settled within community

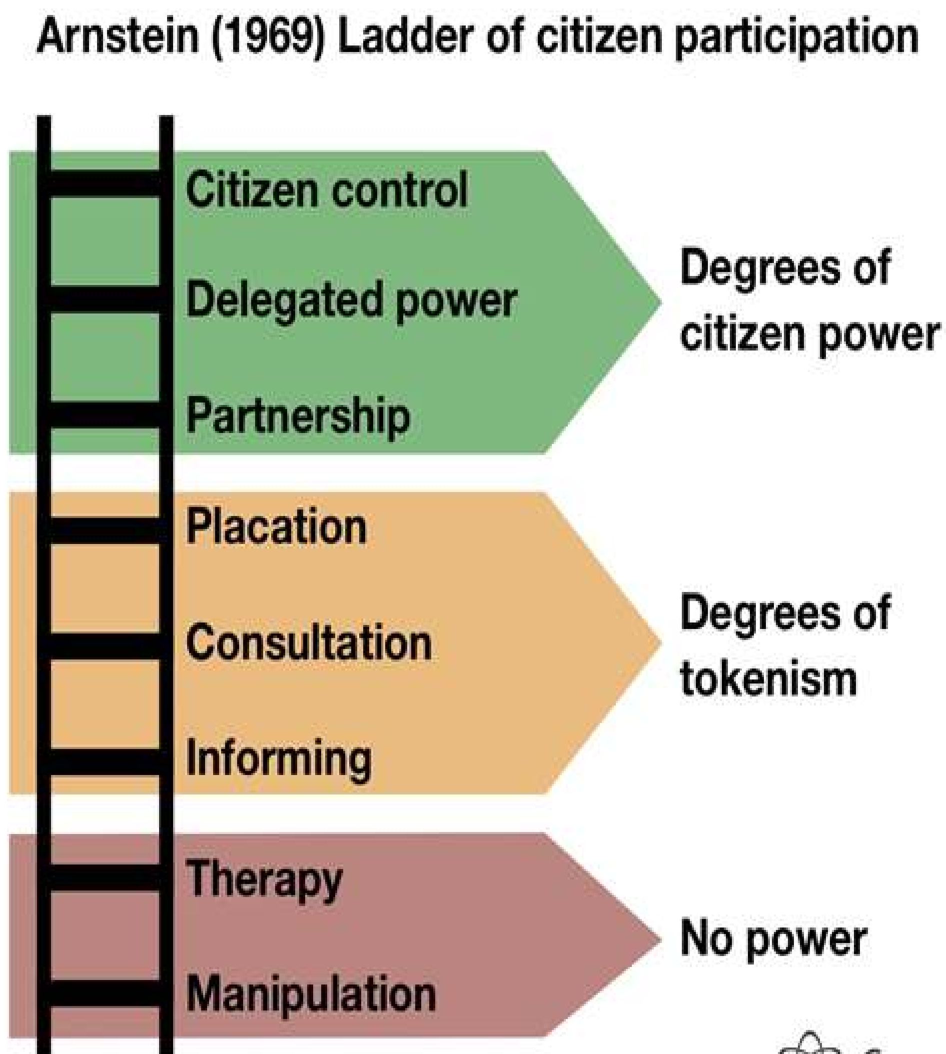


Changed meaning of ‘space’ and property of land.
- Integratating land use with generating power
- fully depending on local ecology, culture, and social-technical system (Schlager & Ostrom, 1992).

→ **Self/ Polycentric governance** for all land use issues related to DG Dietz ea 2003; Ostrom 1999, Ostrom ea 2007 *example:* landscape values & perceptions

- Required infrastructure units, huge numbers, affecting more people, more landscapes (Nadaï & van der Horst, 2010; Wolsink, 2012)
- Infrastructure developments may threaten citizens' subjective connections to the landscape (Bell et al 2013; Devine-Wright, 2009; Wolsink, 2007).
- Landscape implications of community outsider's energy infra results in opposition continuing to arise (Pasqualetti, 2011; Walker, et al, 2014)
- Energy landscapes represent innovation, sustainability and environmental health; good fit to local values of landscape fosters cultural acceptability (McLachlan, 2010)
- Acceptance of RES requires fit to local identity (sense of place, place attachment Devine-Wright; Stedman)

Lock-in also (among others) in Planning System and in centralized, hierarchical energy planning



→ inclination towards tokenism and 'therapy'

Current trend: enhanced reliance on tokenism

Steps *down* the ladder:

- commodification RES projects (e.g. tenders) neoliberal agenda
- 'streamlining' planning hierarchical agenda Cowell Owens 2006

conclusions

- RES: higher social (community) acceptance → DG
- Central as backup *only* (resistant incumbents)
- Huge variety among, and within Socio-Technical Systems (STS)
- Microgrid an DG relate to co-operation: community
- Like SES → variety and complexity
- Hierarchy creates complications (e.g. landscape values) and destroys trust
- Co-operation requires Self Governance in systems,
- Polycentric and adaptive governance:
- Participation in co-production is inevitable precondition

Thank you.

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