

EVs in infrastructure systems perspective

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Consequences of electric mobility

- New routines for drivers
- Impact on infrastructure
 - Transport
 - Energy
- **Complex adaptive system**



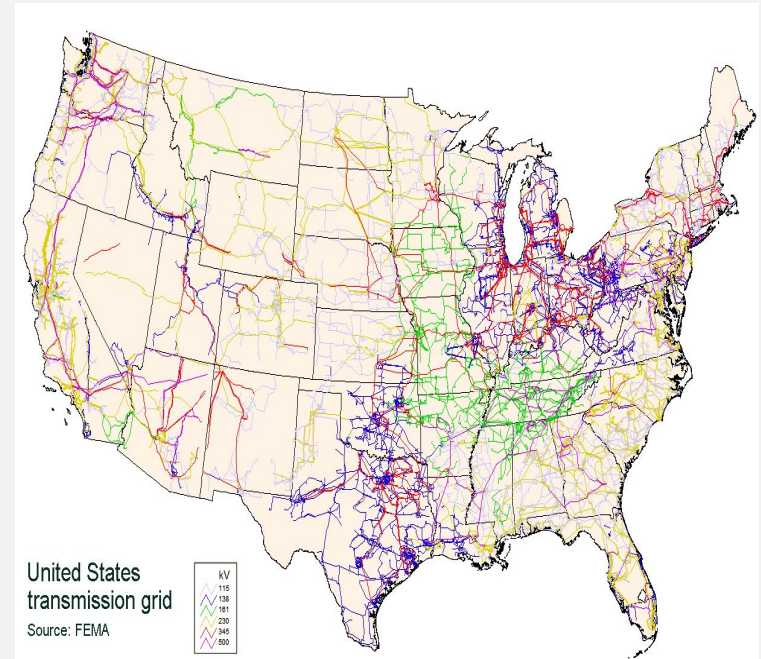
History of the energy infrastructure

- 1882 : First electricity infrastructure comes up in New York
- Single coal fired generator lights up 59 homes
- Soon similar systems in major cities around the world
- Entire urban areas linked with a multiplicity of simultaneously operating generators



History of the energy infrastructure

- Isolated grids linked up
- System extended to connect power facilities which were -:
 - Progressively larger
 - More remote
- Today : National and trans-national power systems



Current scenario of electricity infrastructure

- Fossil fuels dominance being eroded
- Renewable energy sources, mainly :
 - Hydropower
 - Biomass
 - Wind & solar
- Decentralized power generation



Energy infrastructure constantly evolving

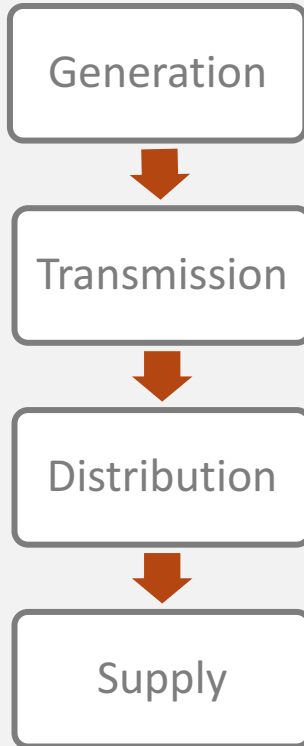
- Historically, **not designed** as an integrated system
- Rather, **evolved** into large-scale integrated system
- Constantly adapting to changing -:
 - Societal preferences
 - User needs
 - Economic conditions
 - Technological innovation

Socio –technical systems

Physical dimension &

Social dimension

Energy infrastructure constantly evolving



- **Vertically integrated** companies
- Often public or private **monopolies**
- **Regulation** to safeguard public values

Value chain disintegration

Vertical unbundling

- New players enter the scene

Competition in:

- Generation
- Supply

Monopolistic system operators:

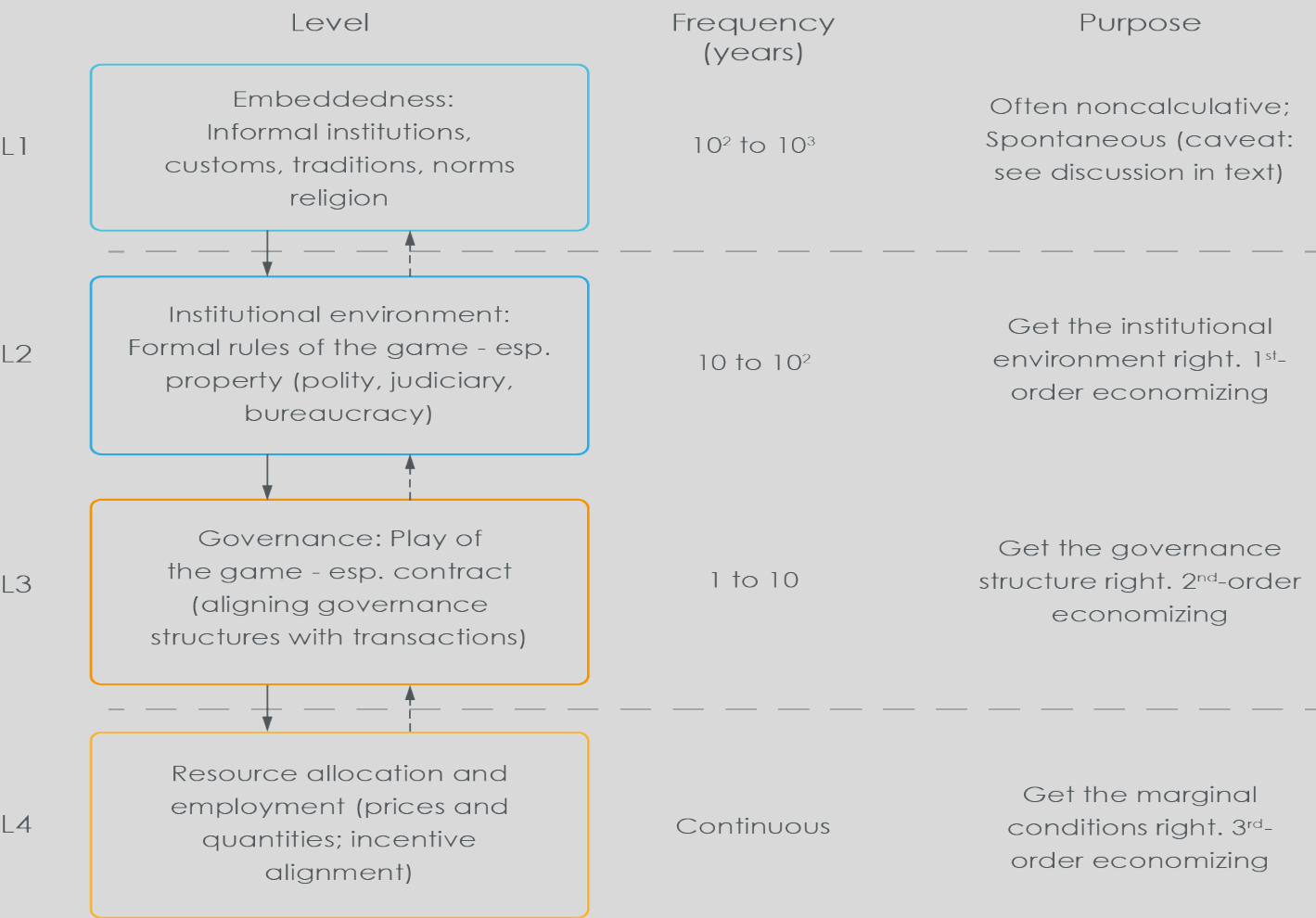
- TSO
- DSO

Need for institutional change

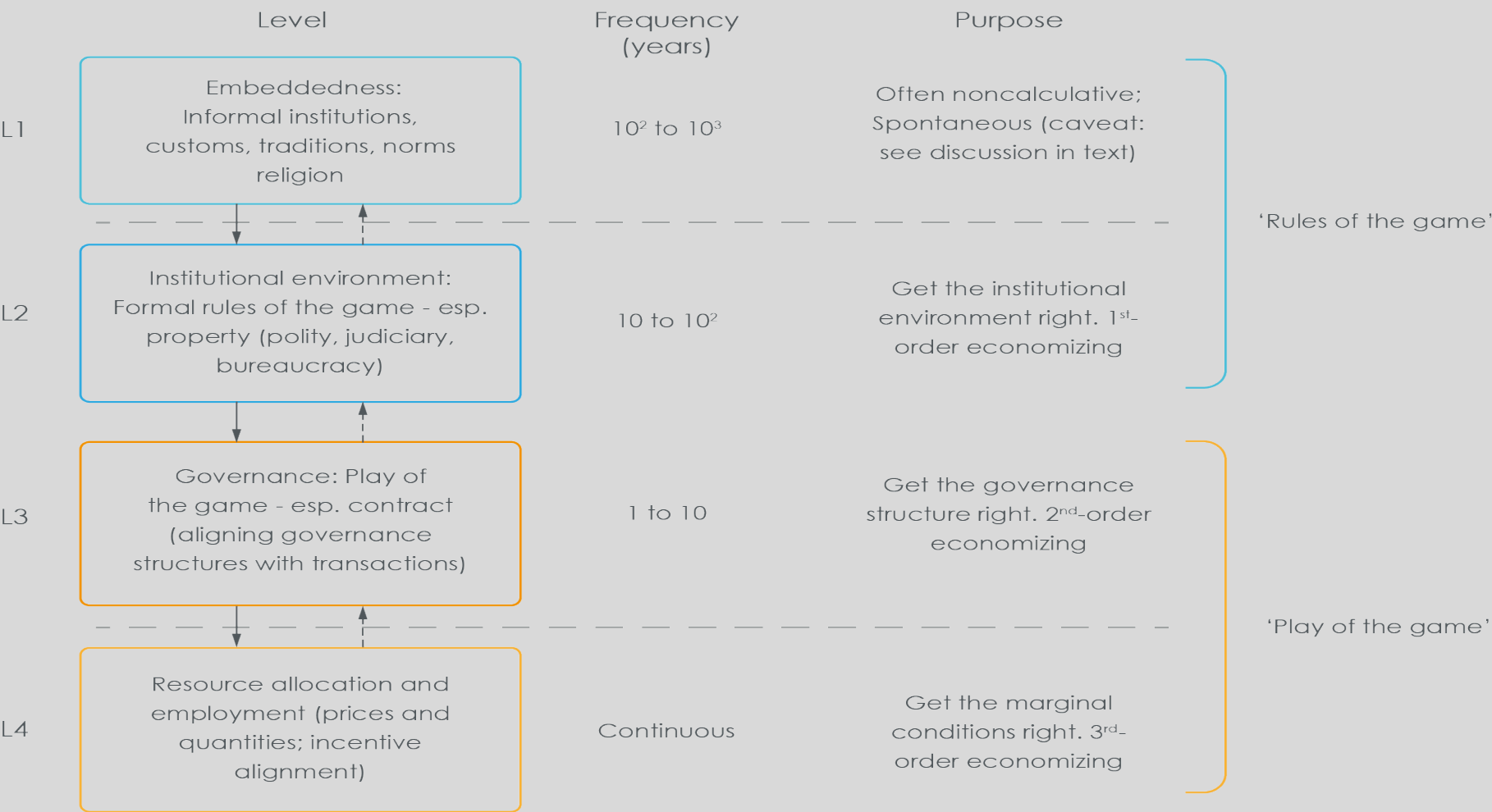
- New technologies change electricity system behavior – variability of renewable energy sources
- Changing roles of electricity consumers – prosumers, EV-bound services
- EVs can endanger stability of grid
- New practices and rules needed → institutions



Economics of Institutions



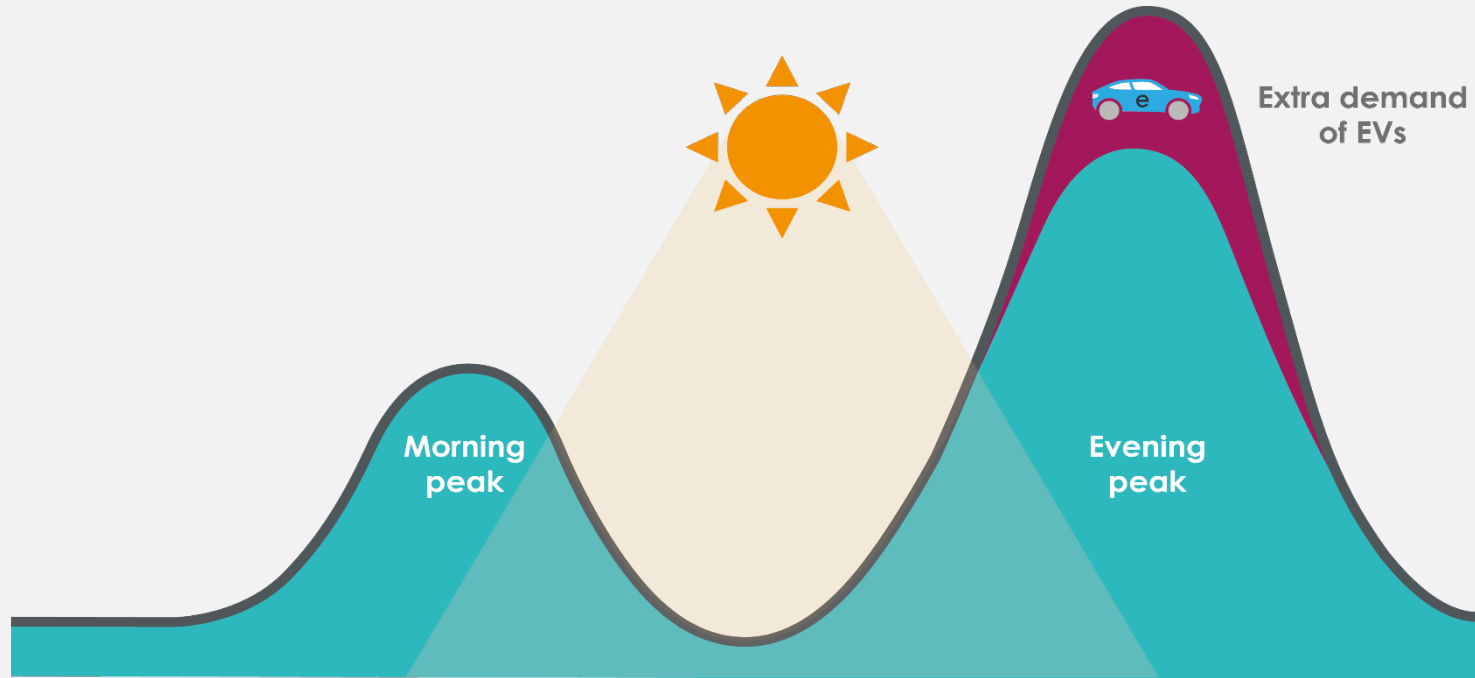
Economics of Institutions



Complex Adaptive Socio-Technical Systems

- **Co-evolution** of social and technical systems, in constant interaction
- **Institutions** shape interactions between social and technical systems
- **Path dependencies**
- **Emergent behavior**
- Government role → limited yet crucial

Impact of EVs on electricity infrastructure

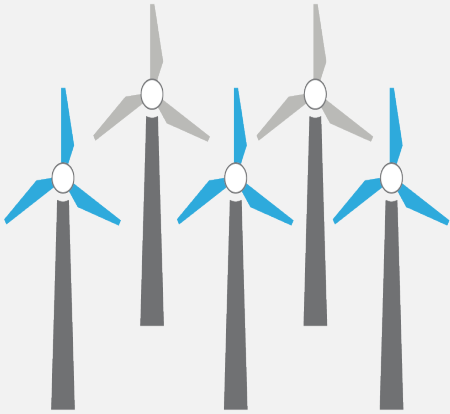


Possible solutions

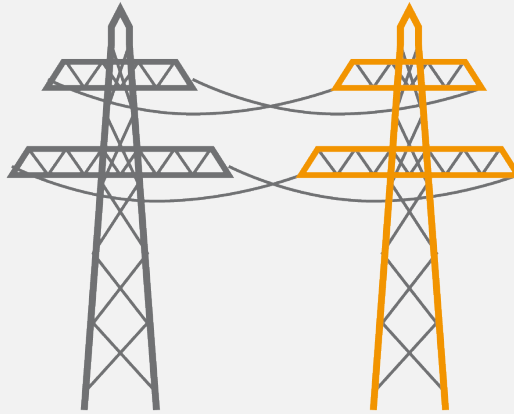


- Grid capacity expansion (expensive)
- Controlled battery charging = Smart charging
- Incentive to user
- Rewarded for flexible load pattern

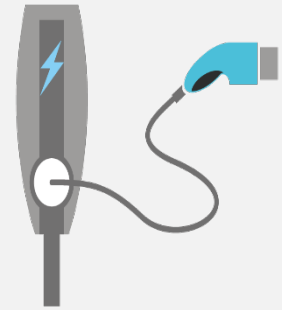
Roles & responsibilities



Energy supplier



Network operator



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Actions needed and fast

- Resolve who builds and operates charging infrastructure
- Demand flexibility → real time interaction with end-users
- **Smart grids** needed



Conclusions

- Large-scale adoption of electric mobility affects the physical infrastructure: both energy and transport infrastructure
- Intensive ICT-enabled interaction between transport & energy infrastructure
- Social (sub)system of the infrastructure undergoes major change
- New actors with new roles and interests
- Resistance from established actors - need to adapt
- Government → both established actor and agent of change at same time



Thank you for your attention !