UCLA Institute of the Environment & Sustainability

On the Role of Governance in California's Ongoing Energy Transition

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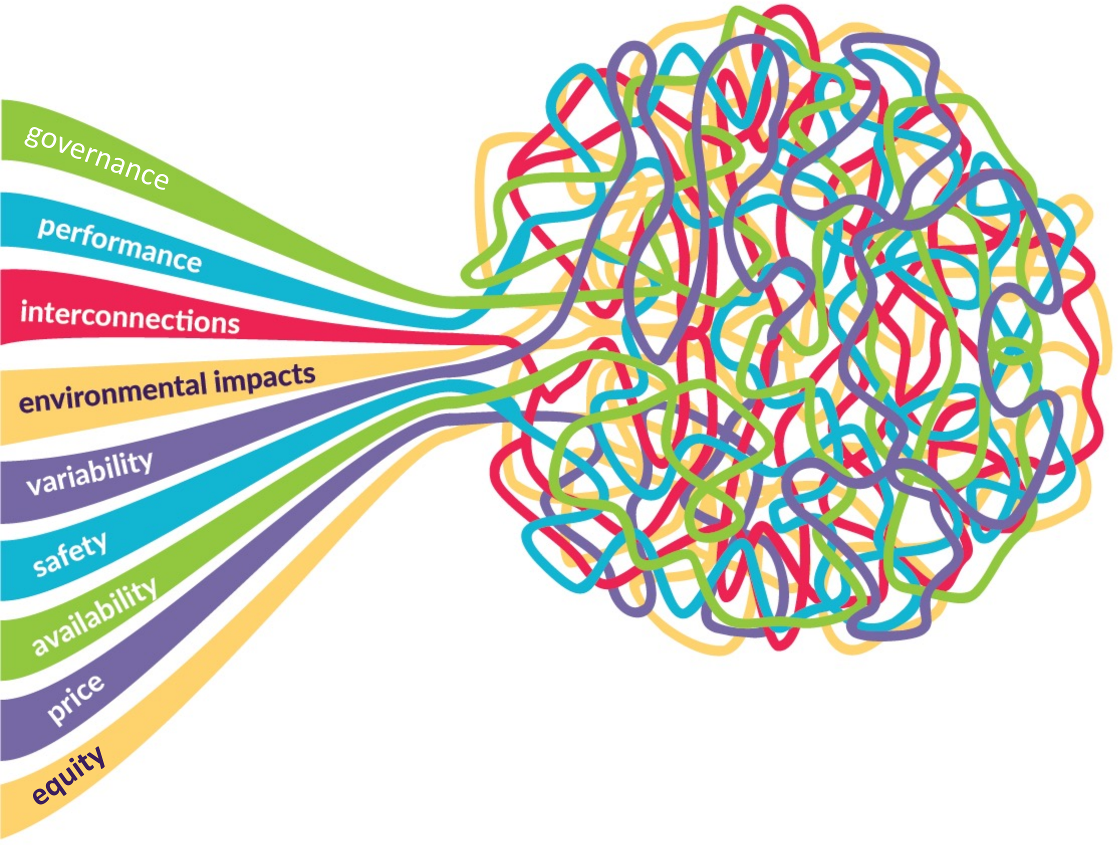
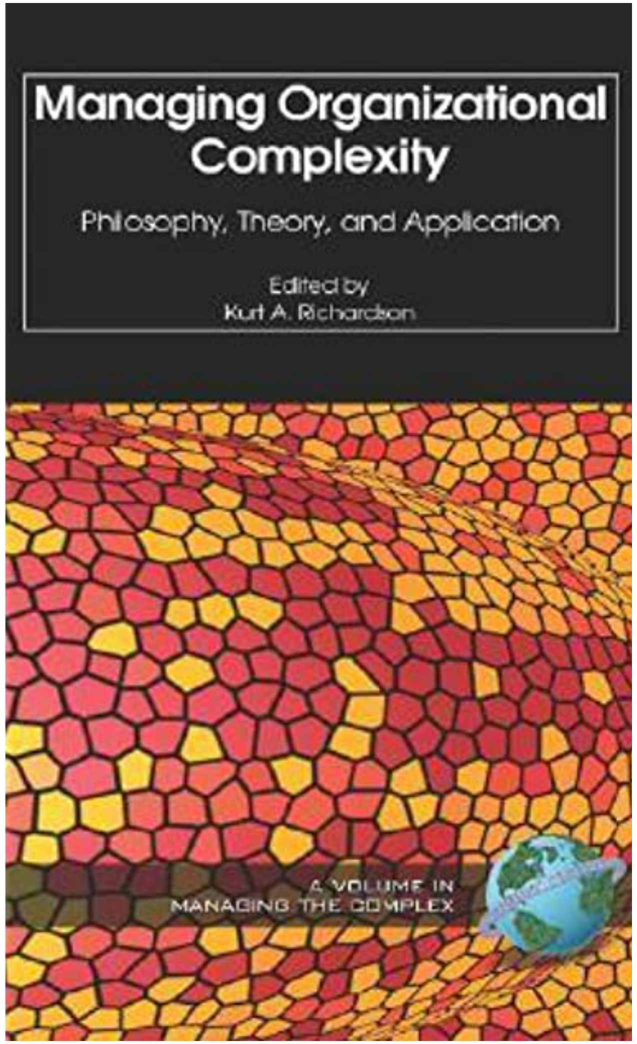
Energy Systems are Complex



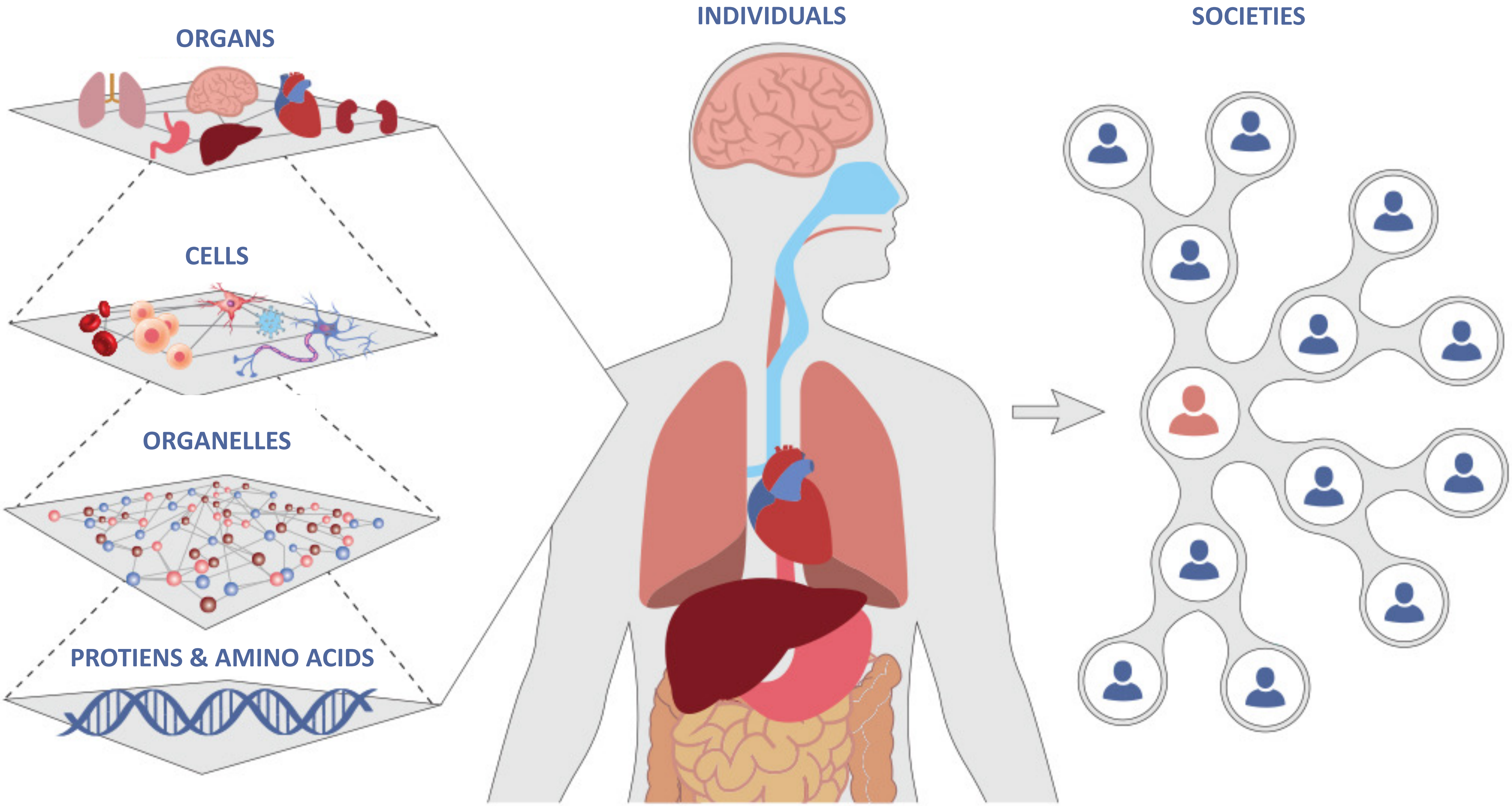
- As an energy system researcher, I am forced to think about and account for the many interacting elements which comprise the system's broader whole
- Governance structures, and in particular energy system regulatory authorities, play a pivotal role in guiding the dynamics of these systems
- I'd first like to quickly spend some time discussing properties which are common to complex systems
- Next, I will analogize the role of governance within California's energy system using, what is hopefully, a familiar example
- Then finally, I will briefly discuss an area that we are currently working in where regulators are actively deciding the trajectory of future events

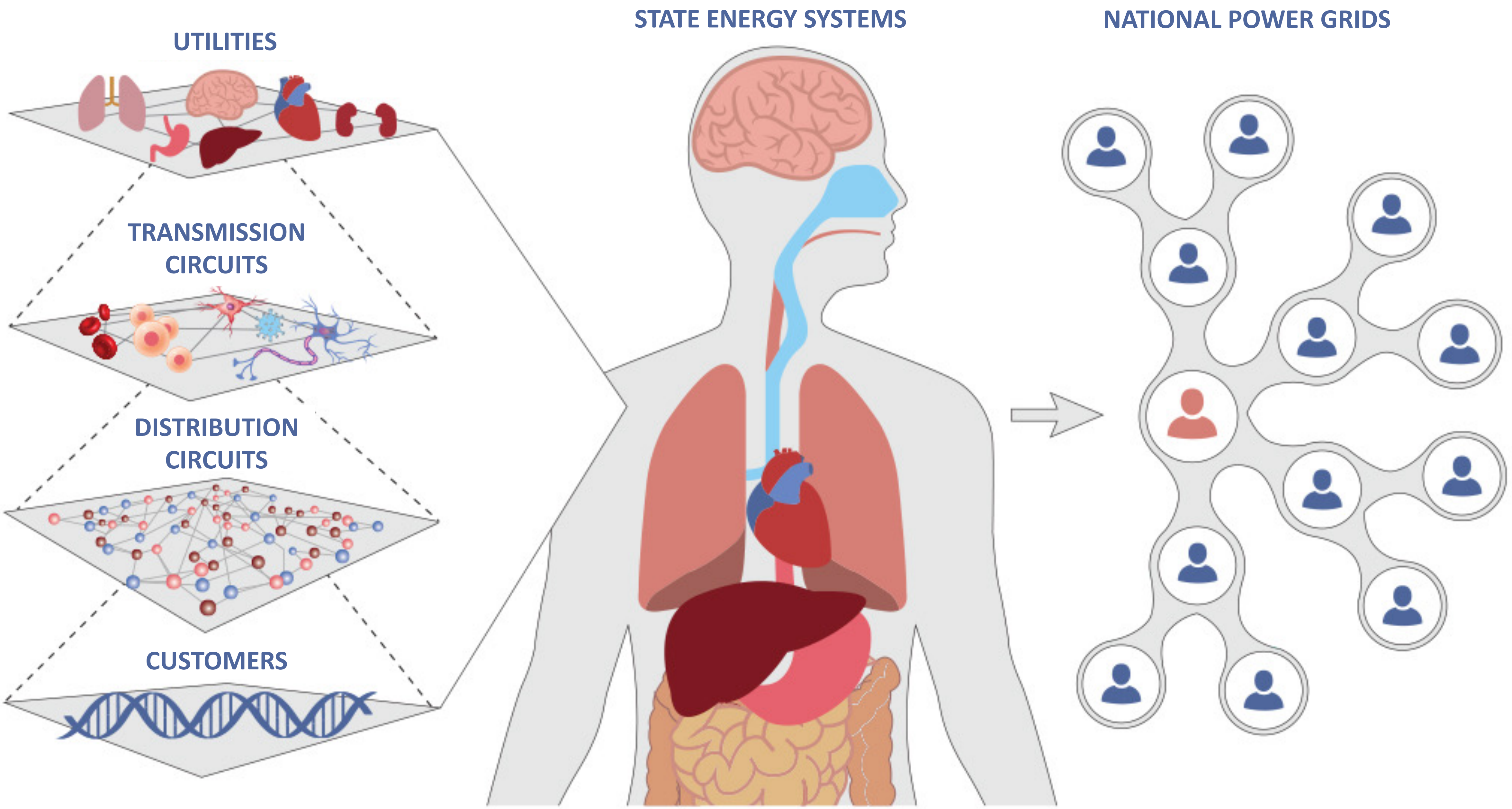
Complex systems have common properties

1. Complex systems are comprised of large numbers of elements which themselves are often quite simple.
2. These elements interact by exchanging energy or information. These interactions are rich and can propagate widely throughout the system.
3. These interactions are nonlinear.
4. There are many direct and indirect feedback loops.
5. Complex systems are open – meaning they exchange energy or information with the environment – and they operate at conditions which are far from equilibrium.
6. Complex systems have memory, not located in a specific place, but distributed throughout the elements of the system. The history of the system is therefore of cardinal importance to its behavior.
7. Finally, the behavior of a complex system is determined by the nature of the interactions between its elements. The richness and diversity of these interactions means that the behavior of the system cannot be predicted from an inspection of its components.



Richardson, Kurt A., ed. *Managing organizational complexity: Philosophy, theory and application*. IAP, 2005.


ORGANS
CELLS
ORGANELLES
PROTIENS & AMINO ACIDS
INDIVIDUALS
SOCIETIES


UTILITIES
TRANSMISSION CIRCUITS
DISTRIBUTION CIRCUITS
CUSTOMERS
STATE ENERGY SYSTEMS
NATIONAL POWER GRIDS

The CAISO Control Center

- This is more like the “nerve center”
- It’s responsible for coordinating immediate reactionary responses to events over the short term

The CPUC Voting Hall

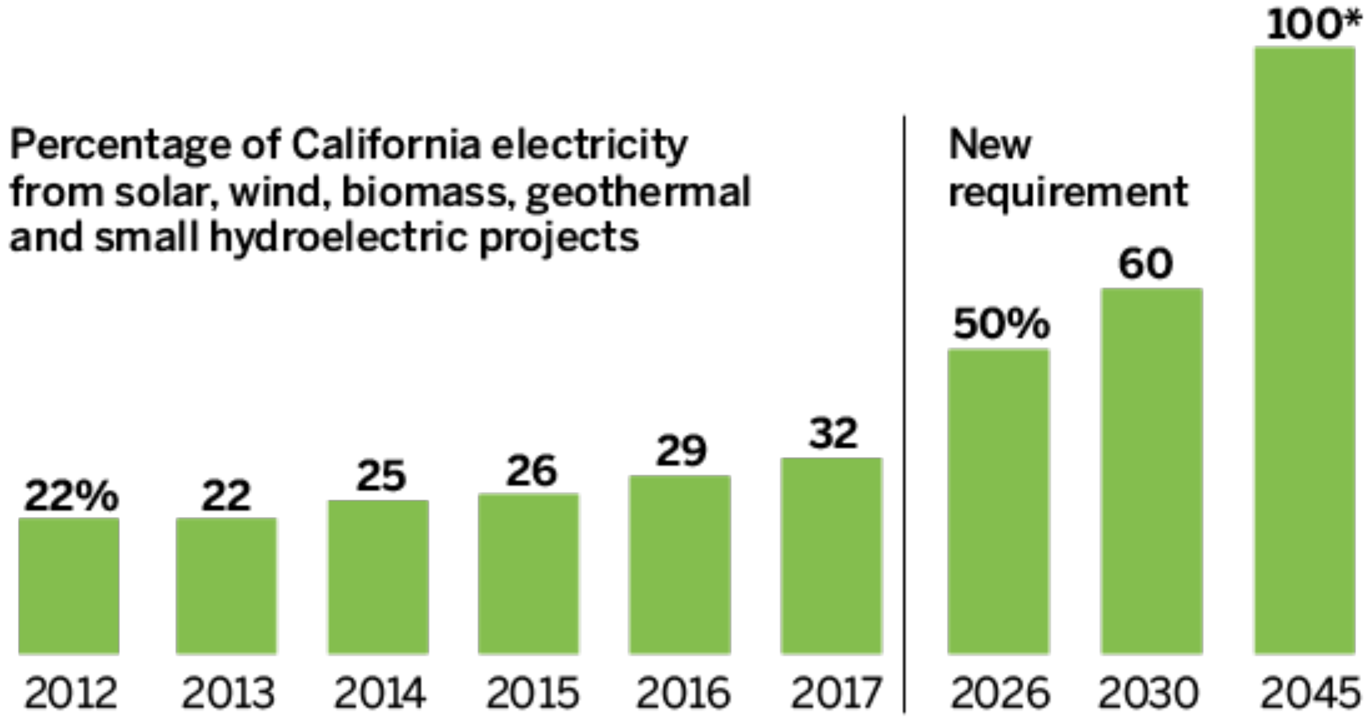
- This is, really, more like the “brain”
- It’s responsible for planning and strategic decisions which influence outcomes over the medium to long term

Energy regulators need to function like brains

- They must assimilate information about the system's dynamics
- This information comes both from above, from the federal entities, as well as from below, from local utilities, businesses, and ratepayer interest groups
- Their job is to ensure that the system's flows do not become untenable
- They are empowered with control over many of the system's most important "voluntary" faculties – these include setting rate tariffs, establishing rules, and developing timetables for achieving various goals and mandates
- The voluntary actions which they take interact with other ”involuntary” processes at work within the system (such as economic shocks, technological innovations, or changing consumer behaviors) in myriad ways. This creates the possibility for unintended consequences, despite well intentioned actions

So, you want to transform this complex system

- In California, we have passed laws which mandate this (SB 100) through the creation of a Renewable Portfolio Standard (RPS)



- An RPS dictates the "What" and the "When" but is agnostic as to the "How"
- There are always multiple potential pathways to achieve such a transformation

Historically, the energy system has been managed such that the following two objectives are met:

1) Minimize Cost
2) Maximize Reliability

Climate change is forcing us to consider a third, potentially competing, objective:

3) Minimize Climate Impacts

How should this new objective be weighed relative to the others? Where does climate mitigation rank relative to reducing energy costs and maintaining the system's reliability?

These are questions which can only be answered through processes of governance…

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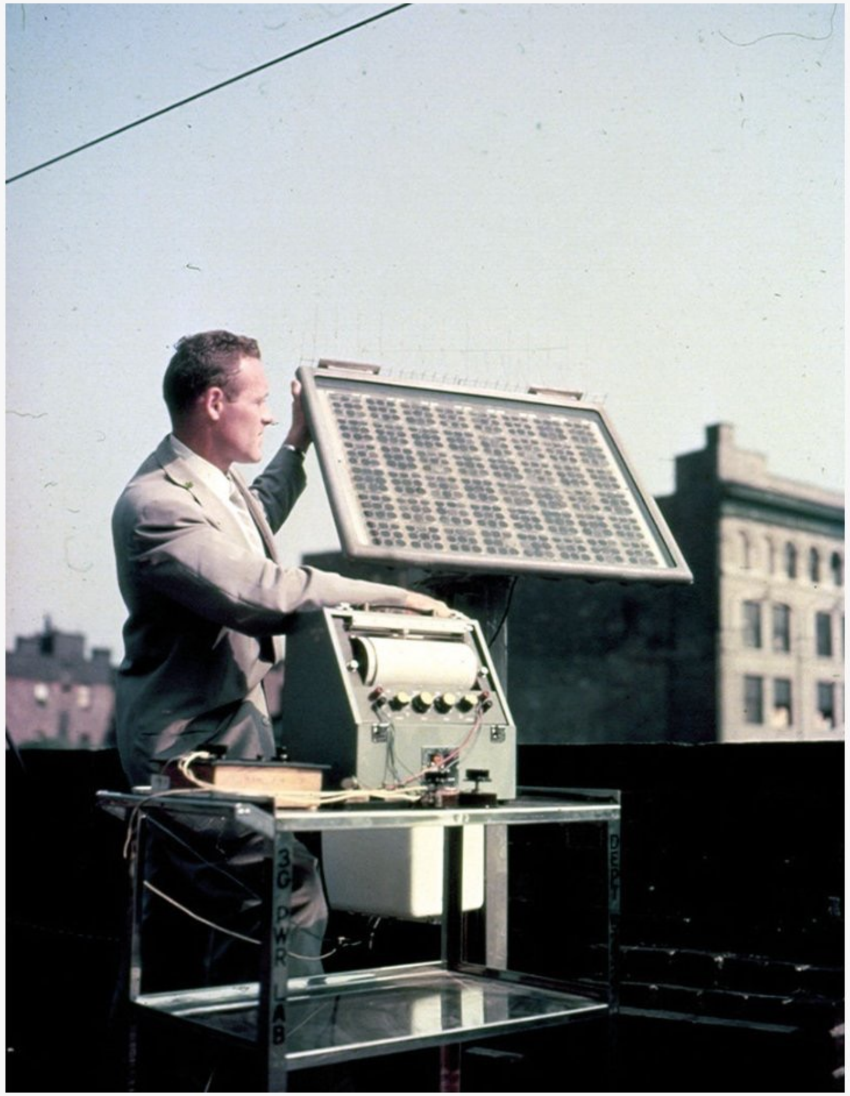
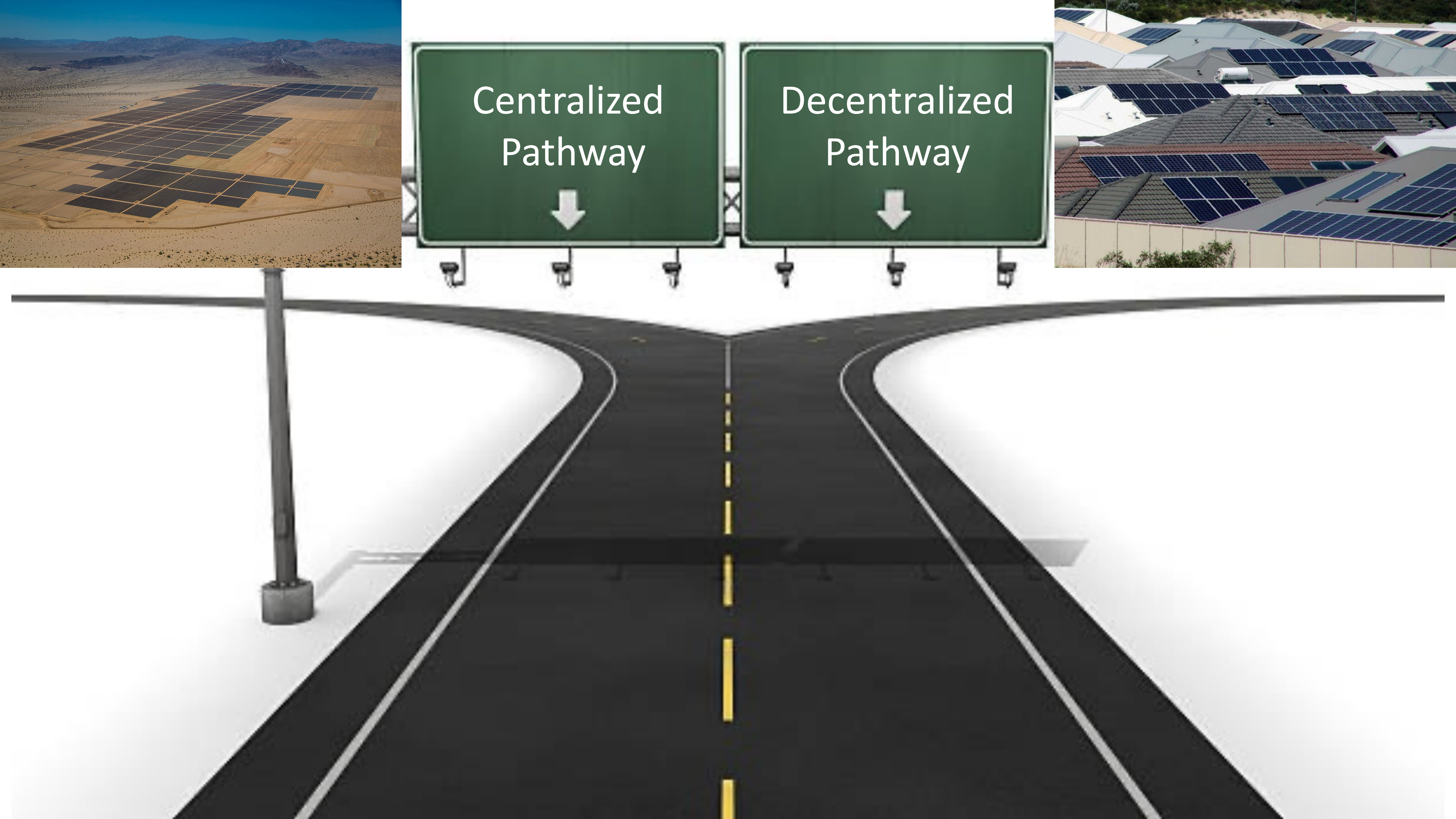
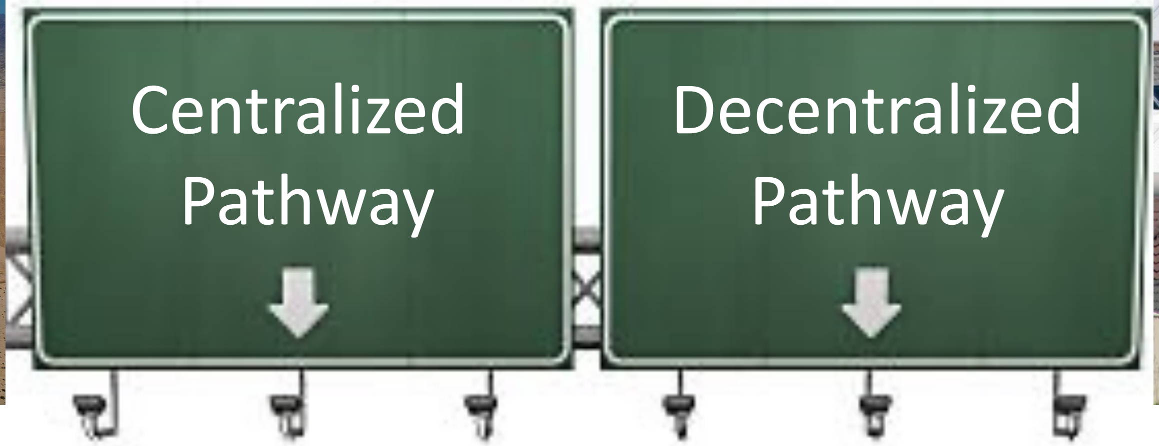


Bell Labs develops the first practical silicon photovoltaic cell, which produces electricity from sunlight. *The New York Times* says it may mark a new era in which we eventually harness the "almost limitless energy of the sun". Credit: Reused with permission of Nokia Corporation

Technologies tend to adapt faster than systems of governance

- Governments – and the regulators they appoint – establish the boundaries within which businesses must operate; this is especially true for publicly regulated monopolies like investor-owned energy utilities
- The arrival of a fundamentally new technology is frequently suggestive of new business models or at least changes in organizational structures/processes
- A prototypical example of this is presently unfolding with respect to the adoption of distributed energy resources (DERs) – these are things like rooftop solar and residential battery energy storage systems


Centralized
Pathway
Decentralized
Pathway



Requires:
- Development of renewable generation assets on virgin land, often in areas with sensitive ecosystems, without major structural modifications to the power system's architecture.

Implies:
- Continued development of a top-down system architecture with support only for unidirectional power flows. This prolongs our dependence upon high voltage transmission lines that are vulnerable to wildfire and extreme-heat related outages.

Requires:
- Deployment of renewable generation assets on existing structures with major required modifications to the power system's architecture including distribution hardware, software, and management systems.

Implies:
- Transition to a more decentralized system architecture with support for bi-directional power flows. This reduces the likelihood of major outages occurring and limits their scope and duration.

- This is perhaps a false dichotomy – as it is of course possible that a hybrid approach could be pursued.

- But the choice of which pathway is ***favored*** is likely to have profound impacts on the future cost, reliability, and availability energy services.

- ***When you vote for an elected official how much does a candidate's stance on various energy policies factor into your decision?***

- ***How long do you think you could live and work comfortably without reliable access to high quality energy services (light, heat, air-conditioning, electricity, internet, etc.)?***