Closing remarks:
Launching a research career focused on 100%

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Tuesday, March 26, 2019
Imperial College London
2nd International Conference on Energy Systems Integration

Presentation Outline

- Key themes
- Lessons: Launching a 100% research program
  - Problem orientation
  - Collaboration
  - Flexible Frameworks
  - Two-pronged approach
  - Asking the right research questions

ESI Interactions: key conference themes

The physical system

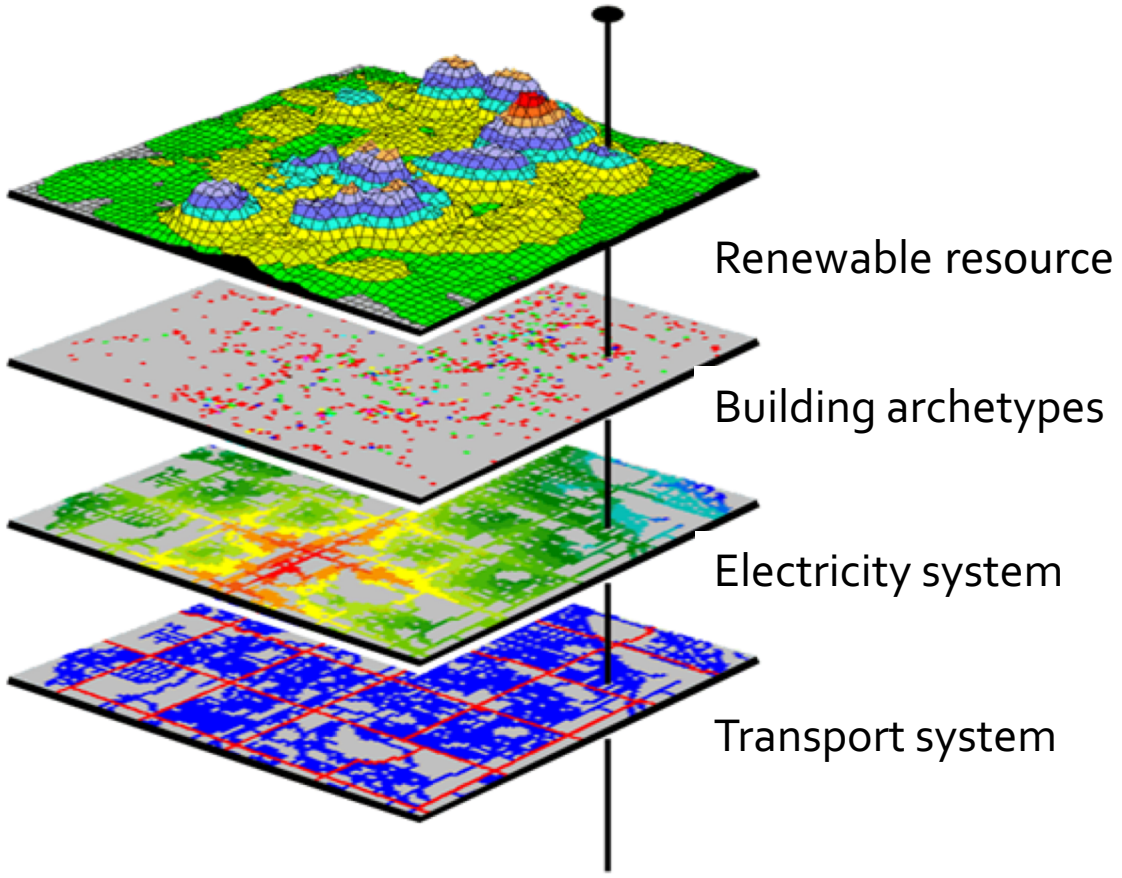
Co-optimization of the electricity and gas networks

Emerging area

Opportunity to build resilience

Lots of questions (intent);

Lots of room for answers (studies)



The physical system

Limited scope of all studies

Moving beyond narrow study scopes -> ESI driver

Mechanisms to pick up where others left off (open data & models)

Pathways vs. targets; near-term solutions vs. long-terms solutions

Holistic thinking

-> central planning vs. markets

-> optimization vs. agent-based

Big drivers: price signals (markets) -> consumer behavior (including non-price drivers – ego, altruism, hedonism)

-> demand and storage setting marginal prices

-> not an engineering or technical solutions!

The societal dimension

Energy system transitions have driven larger, more systemic societal shifts

Framing the transition within its historical context

- Remind us of the enormity of the societal shift
- Underscores the link between the technical and human shifts

What tools and strategies do we have at our disposal to navigate the human transition?

The institutional systems

Expansion of geographic scales

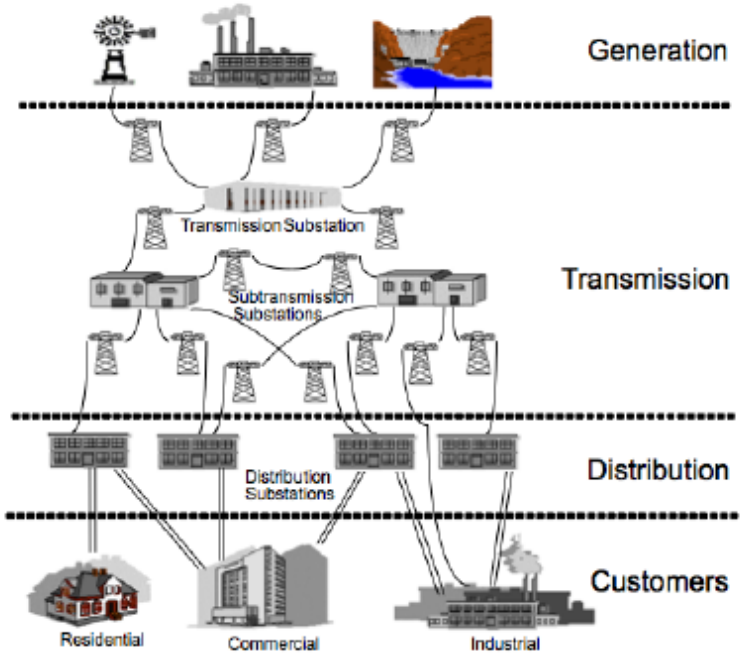
- Interconnected grids sharing resources over large areas
- One of the key ideas coming out of grid integration studies

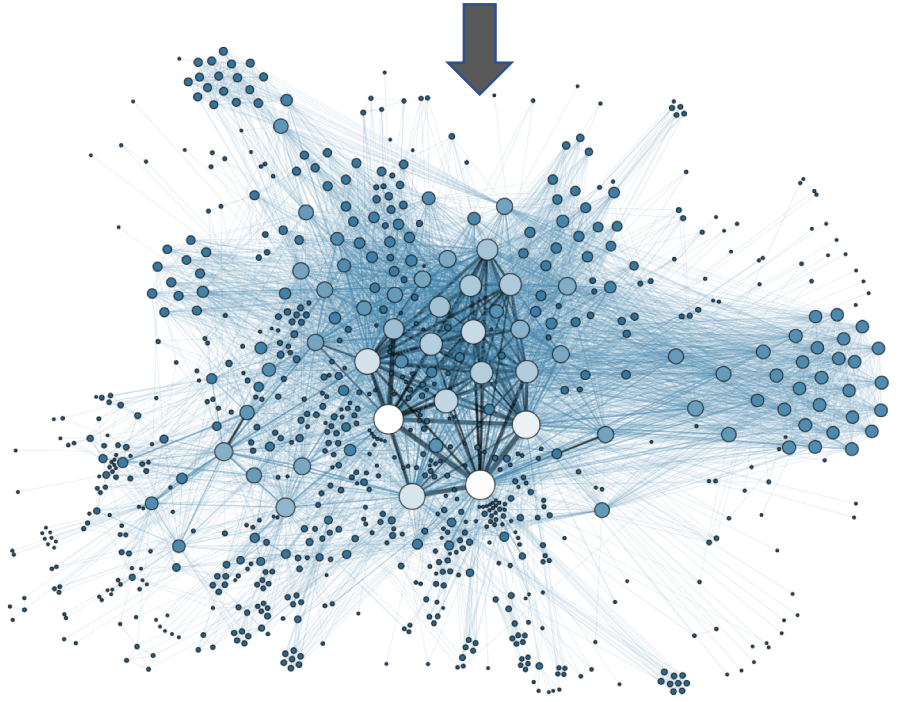
- Smaller and more local resources on that large grid
  - The 'uberization of electricity'
  - Self generation & storage
  - Peer-to-peer sharing with blockchain

Integration of zero marginal cost resources

Chicken and egg – develop solutions in current regulatory framework vs. explore revised regulatory framework and their impact on solutions

How can institutional systems, such as ownership or market frameworks, facilitate (or hinder) a speedy transition?





Navigating in this vast ESI space

Five lessons

Lesson: From discipline orientation to problem orientation

Universities' departmental orientation is a bad fit for ESI

ESI doesn't fit into engineering faculty let alone civil, electrical, or mechanical

Role for theme-focused centers to complement discipline structure

…but center impact can be marginalized by university structure

- Evaluation is at department level
- Service is at department level
- Funding (e.g. NSERC in Canada) is focus on evaluation groups (disciplines)

Look to places like NREL, IIASA for inspiration

Lesson: From individual research to collaboration

The focus is now (as it should be) is on integration

- …of systems, of ideas, of disciplines, of models, of data, etc.

By definition: synthesis across a network rather than individual research

- 'Deep' collaboration / beyond collaboration

But our institutional design is deeply siloed

- Discipline orientation
- Evaluation metrics
- Bureaucratic issues with co-supervision
- Funding – feasibility based on individual's merits rather than collaboration plan

Lesson: From 'pet' models to a flexible framework

Many attempts at a panacea model

Major lift gathering expertise, developing model, collecting data, …

Leads to a tendency to commit to a particular model

-> commitment to research paradigm

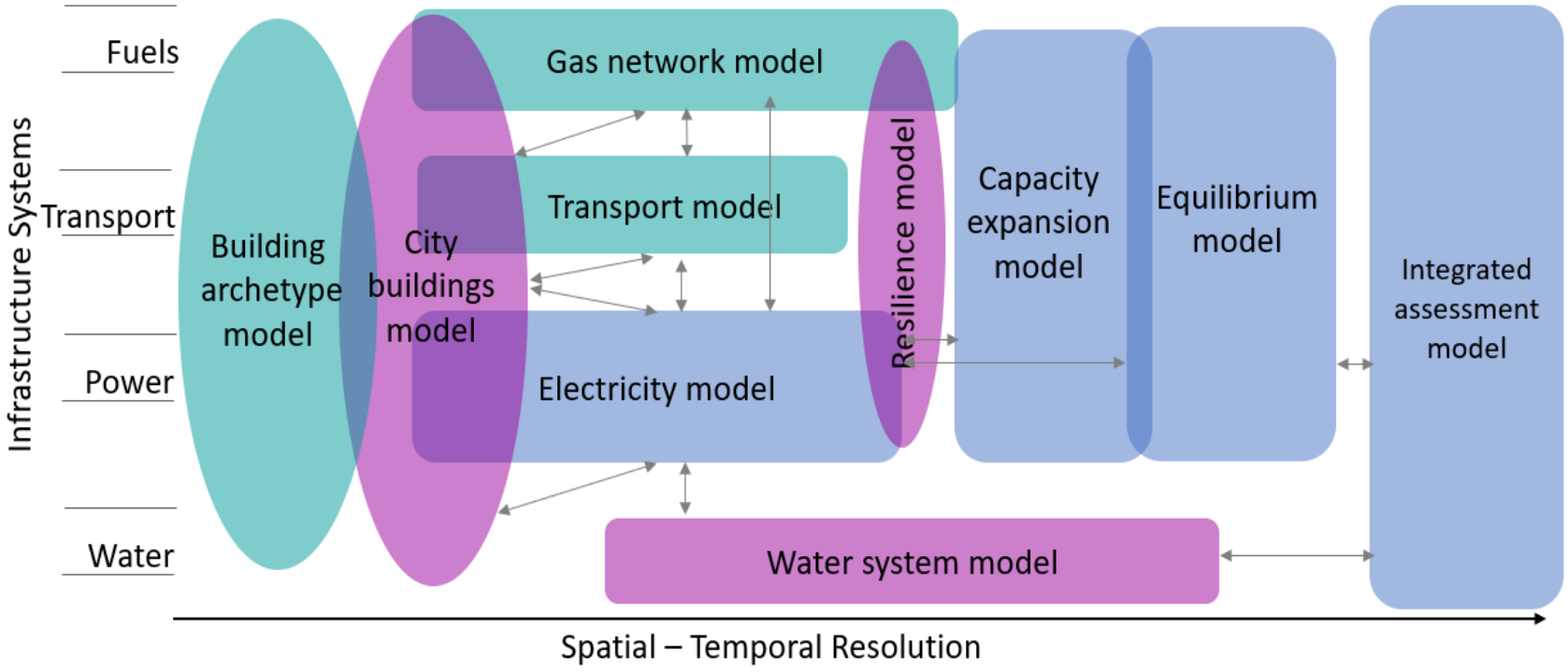
-> limited to a certain scope of insight …

…but then every research question is unique

Problematic: digging into silos that will stunt the energy system transition

Shift to frameworks that prioritizes adaptability and flexible

Flexible and open access data and models

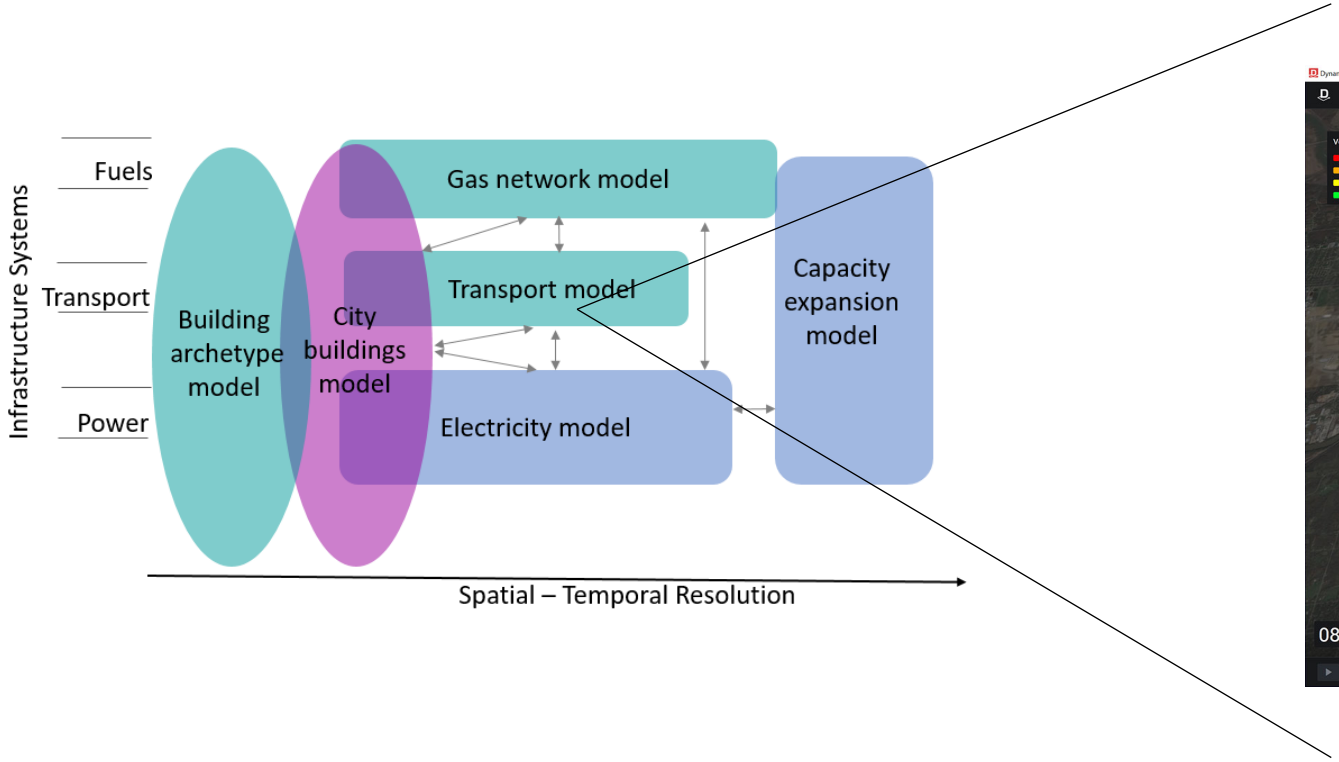


Proposed research platform

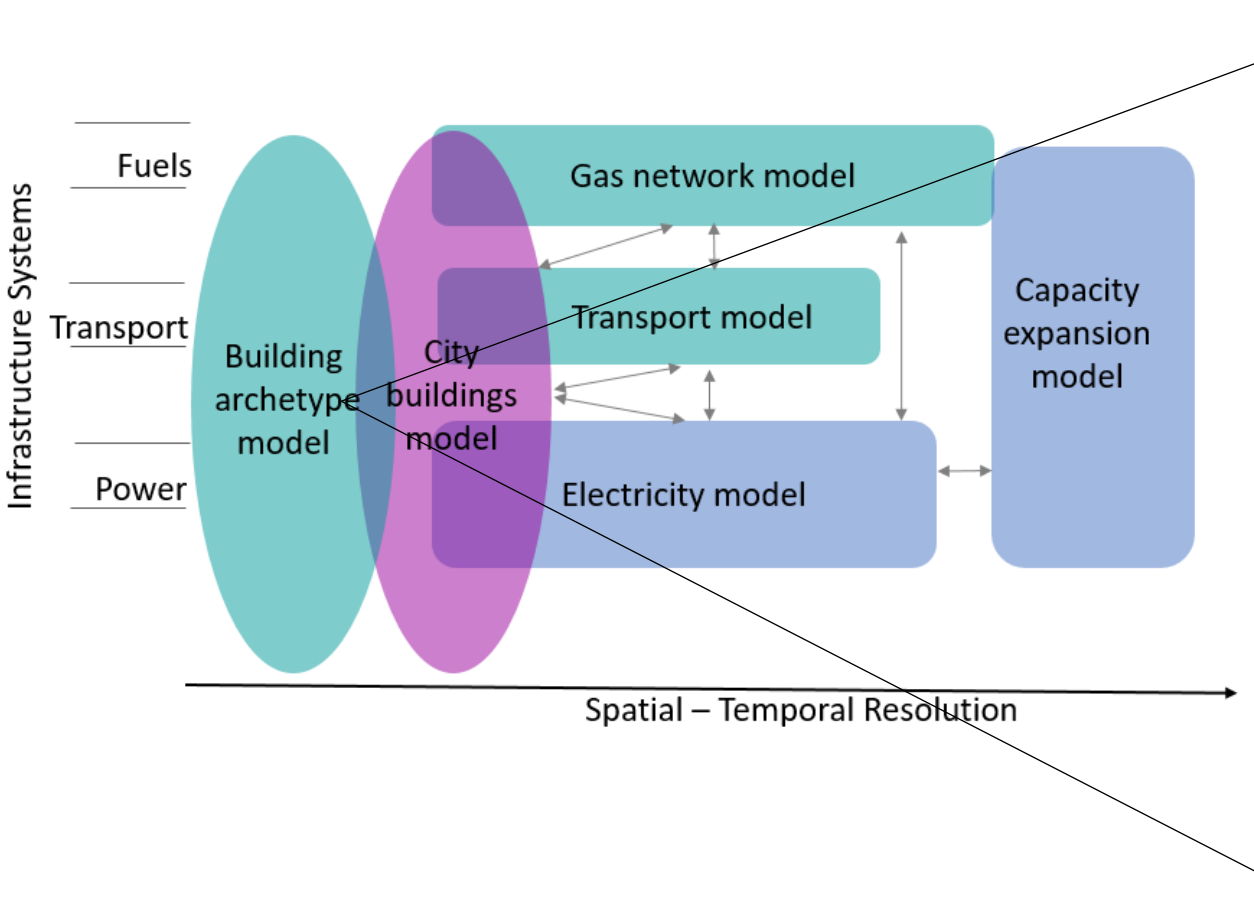
Spans scales, vectors, systems >> integration

Modular design >> adaptable

Transport sector model



Building model



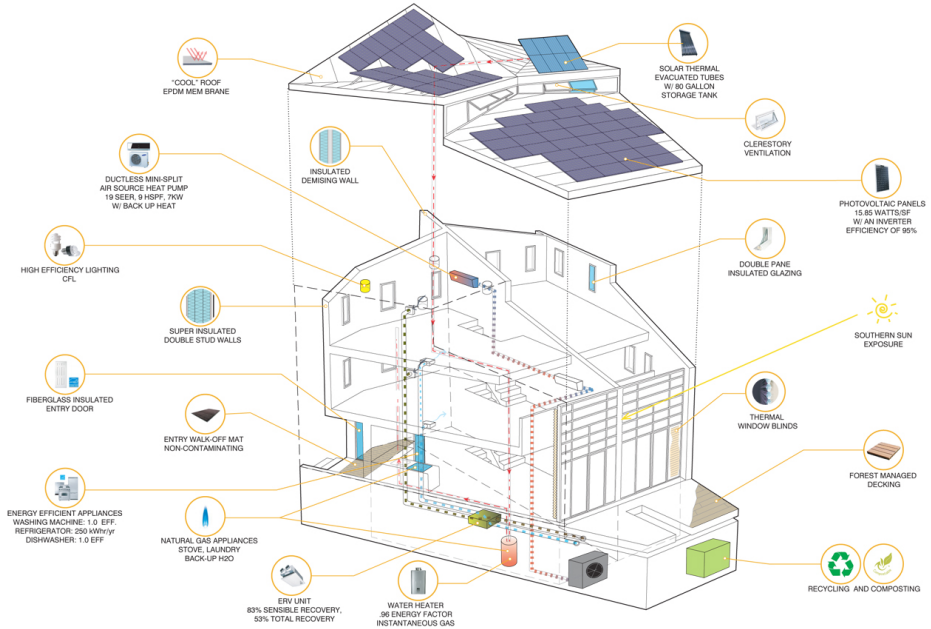


Image source: http://blog.studioluz.net/2011/09/e-green-building-housing/

Lesson: Two-pronged approach

Combining research with ready policy analysis

- Novel research endeavours
  - Identify and frame upcoming and impactful issues several years out

- Repository of robust and ready platforms
  - Quick turnaround deployment to engage when policy windows open

Approach: Policy harmonization across jurisdictions

Jurisdiction specific policy recommendations

- Targeted policies per jurisdiction
  - Municipal: land-use & transportation
  - Provincial: electricity system
  - Federal: fuel standards

Consistent targets

- Do the summation of municipal targets & actions meet provincial targets?
- Do provincial targets & actions meet federal targets?

Lesson: Asking the right research questions

Models are just models… how do we generate practical results?

Wide open research space

- Easy to come up with research questions

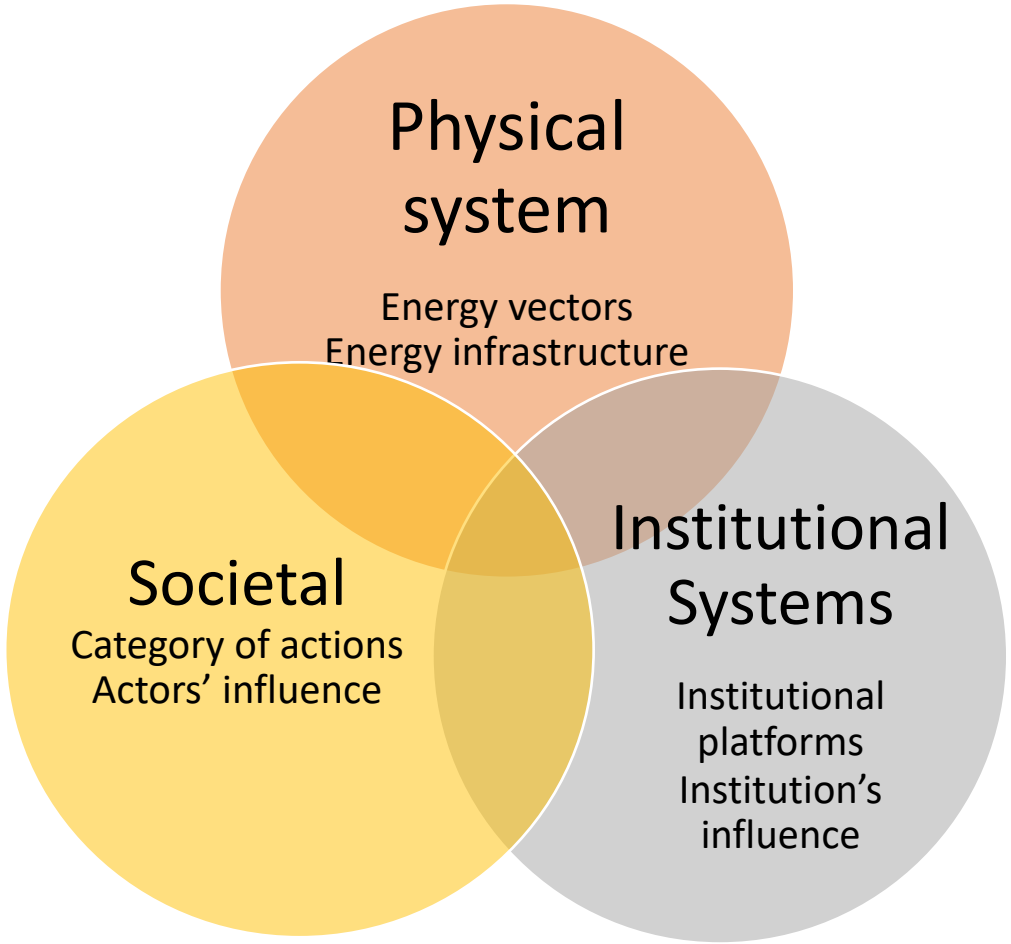
But asking the right research questions is difficult

- Particularly for modellers (myself included) bound by our own modelling framework
- What can my model answer instead of what needs to be answered

Need a collaborative approach to coming up with the research questions

Enter: roadmap

Mapping the space: ESI Interactions

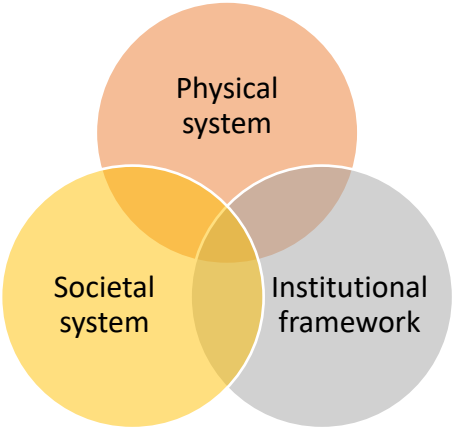


Physical system: the machines and wires that make the energy system work

Institutional framework: the platforms which engage and the govern energy system actors and infrastructure

Societal system: the stakeholders that make decisions within the energy system

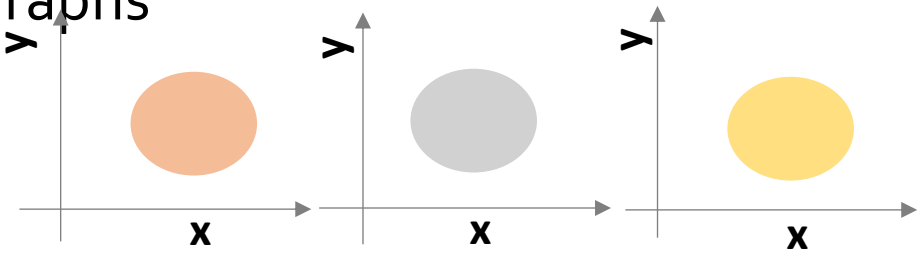
Proposed Framework / Methodology



Three parts:

(1) Mapping the space via interacting systems

(2) Illustrating systems' components via cartesian graphs



(3) Developing a Roadmap progress matrix

Cartesian plots	Bubbles in our cartesian plots	Present	2020	2030	2040	…

Proposed Framework / Methodology

Three parts:

(1) Mapping the space via interacting systems

Outline the key systems that constitute ESI

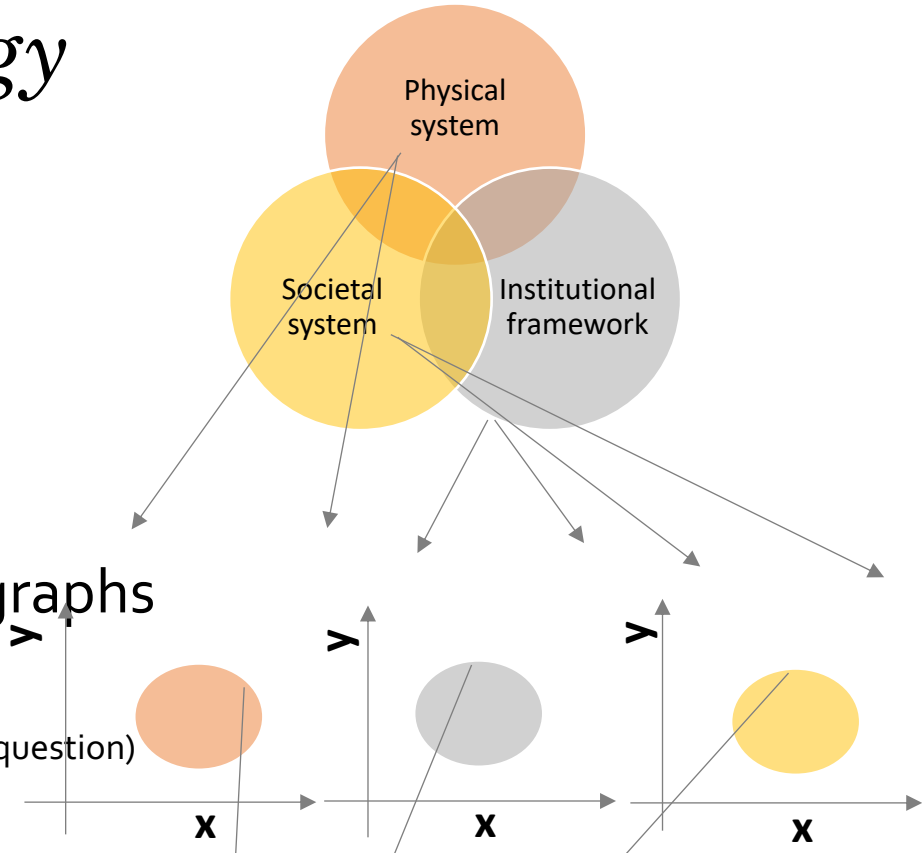
(2) Illustrating systems' components via cartesian graphs

Describe each system from (1) in terms of components

Populate the graphs with areas of research (e.g. technology or question)

(3) Developing a Roadmap progress matrix

Chart the progress of each area of research



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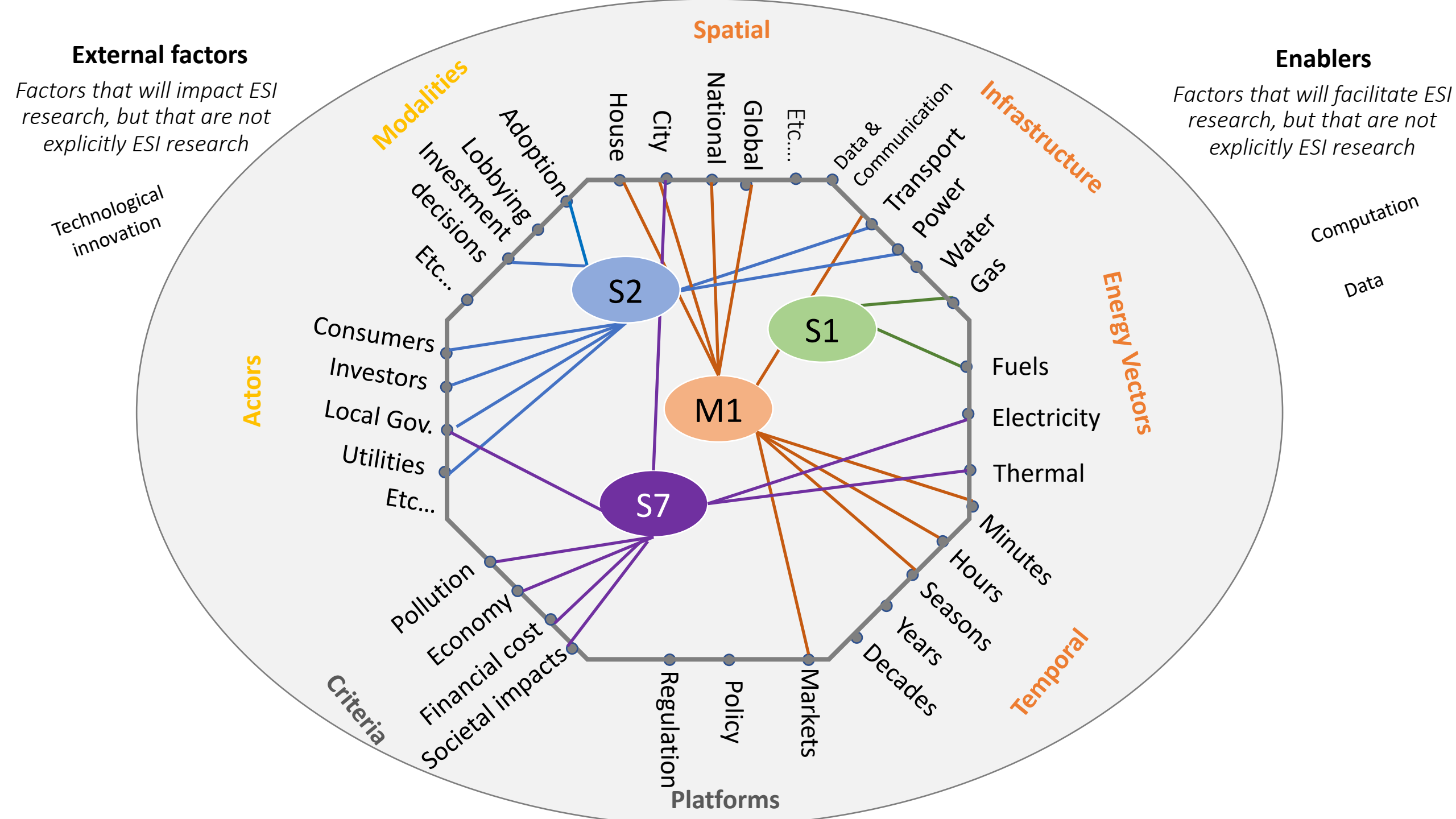
External factors
Factors that will impact ESI research, but that are not explicitly ESI research
Technological innovation
Enablers
Factors that will facilitate ESI research, but that are not explicitly ESI research
Computation
Data
Spatial
House
City
National
Global
Etc....
Infrastructure
Data & Communication
Transport
Power
Water
Gas
Energy Vectors
Fuels
Electricity
Thermal
Temporal
Minutes
Hours
Seasons
Years
Decades
Platforms
Markets
Policy
Regulation
Criteria
Societal impacts
Financial cost
Economy
Pollution
Actors
Consumers
Investors
Local Gov.
Utilities
Etc...
Modalities
Adoption
Lobbying
Investment decisions
Etc...
S1
S2
S7
M1

Thank you

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