Sustainability Research Institute
FACULTY OF ENVIRONMENT

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Towards resource-efficient integrated infrastructure services; The role of end-users and policy

Katy Roelich and Christof Knoeri

ARCC network assembly 2014

Urban areas as systems: adapting for the future

EPSRC
Engineering and Physical Sciences Research Council

Adapting [infrastructure business models] to climate change

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- We need drastic change in energy and water provision and demand; especially in our urban areas
- Current business models are resistant to this change
- We need systemic action to encourage business model change; including from end-users and policy makers

- Plan for today
  - The role of end-users
  - The role of policy

Service-performance provision

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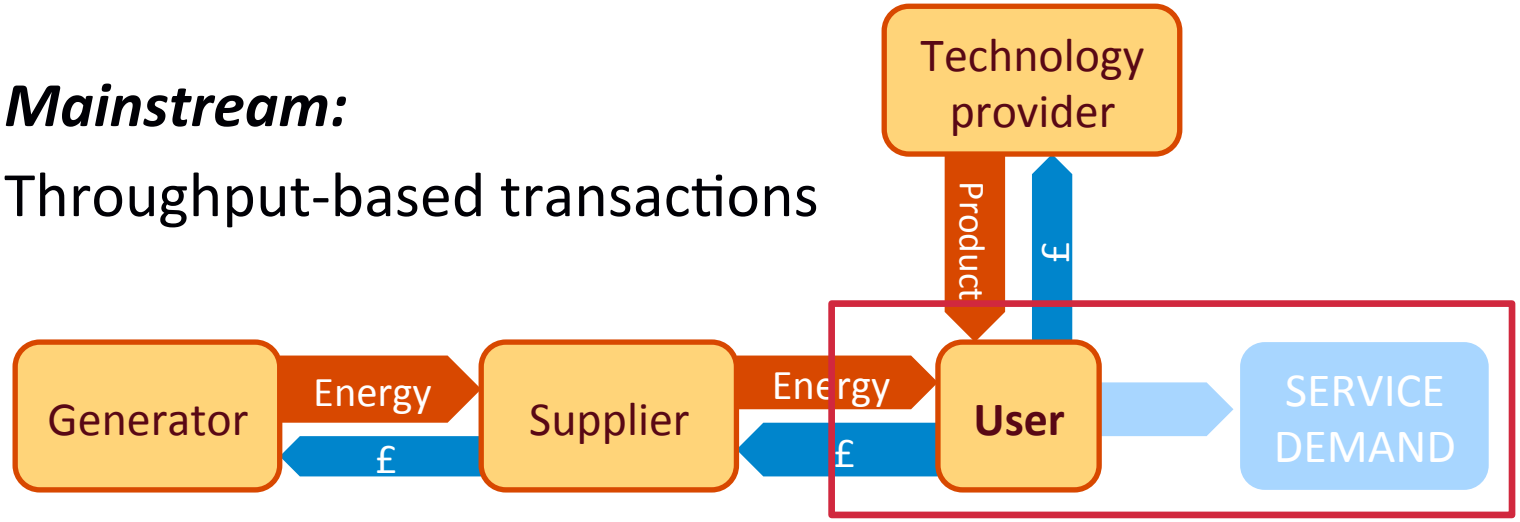
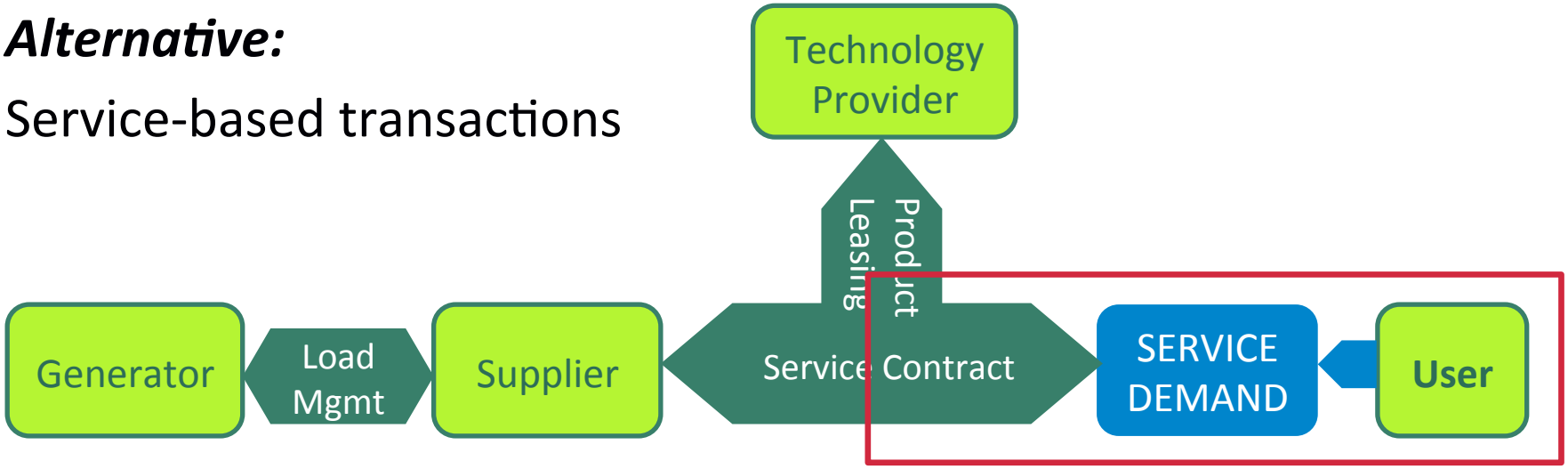
Mainstream:

Throughput-based transactions



Alternative:

Service-based transactions



Adapted from: Steinberger, Van Niel & Bourg 2009

"Ultimate service demand" or What do end-users really want?

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Services categories	Service metrics
thermal comfort	**usable floor area (UFA) at an average temperature**
illumination	**lumen per UFA perceived by the user**
hygiene	**textile cleaning:** number of washing cycles/loads **personal hygiene:** number of showers, baths & tap uses **human waste disposal:** number of full & reduced toilet flushes
sustenance	**food conservation:** refrigerator and freezer volume **cooking:** number of meals; times of hob, oven, microwave & kettle use; water volume for nutrition **food cleaning:** number of dish washing cycles, sink use volume **gardening**: tap uses & water volume for irrigation
communication	**entertainment:** hours of equipment use **home computing:** hours of equipment use
passenger transport	**commuting, business & education** trips **shopping, escort & personal** trips **leisure** & other trips

Source: Knoeri, et al. forthcoming

Infrastructure integration at the end-user level

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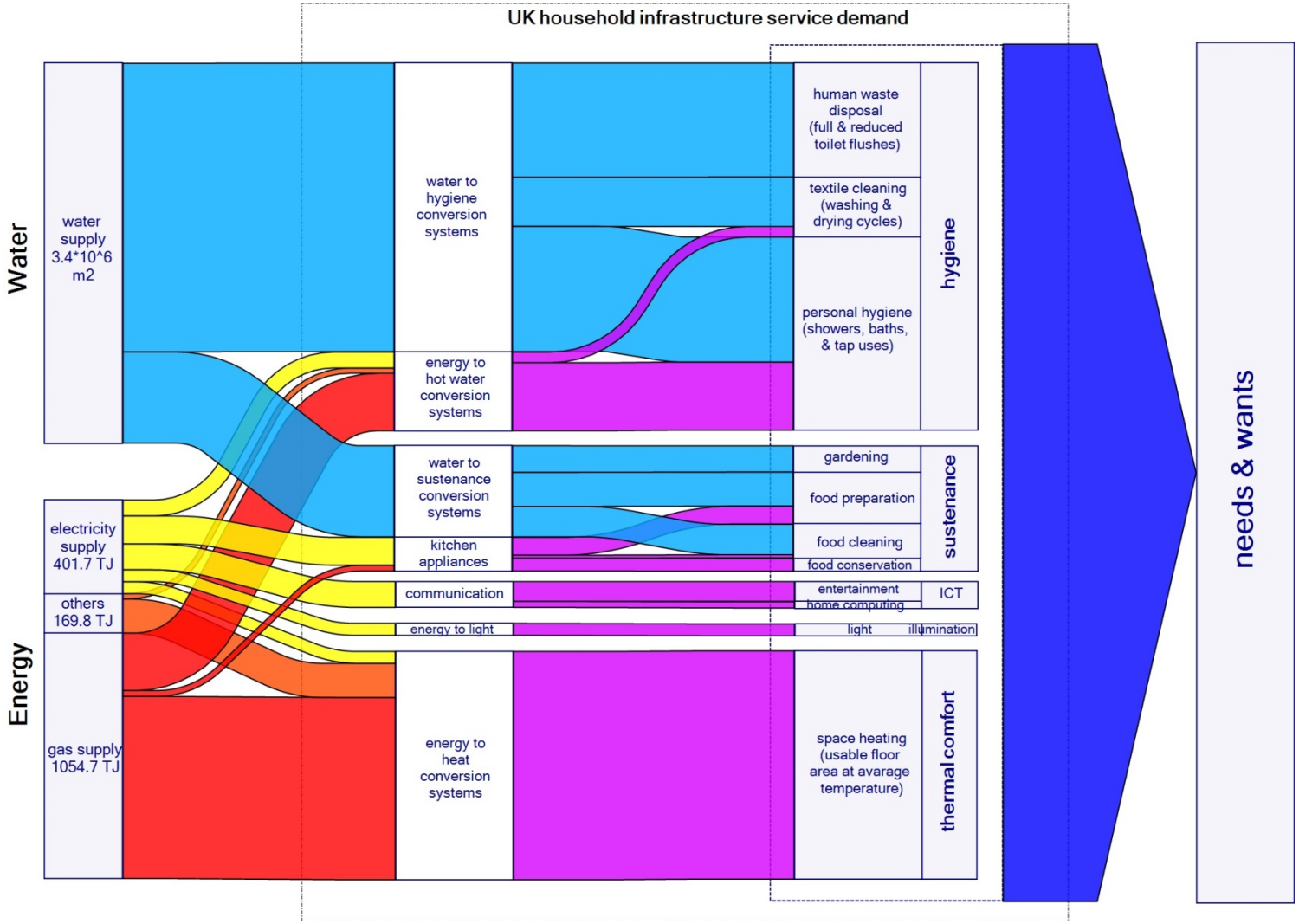

Source: data: decc (2011), defra (2012), waterwise (2012), illustration: Knoeri, et al. forthcoming

Supply chain socio-technical interaction

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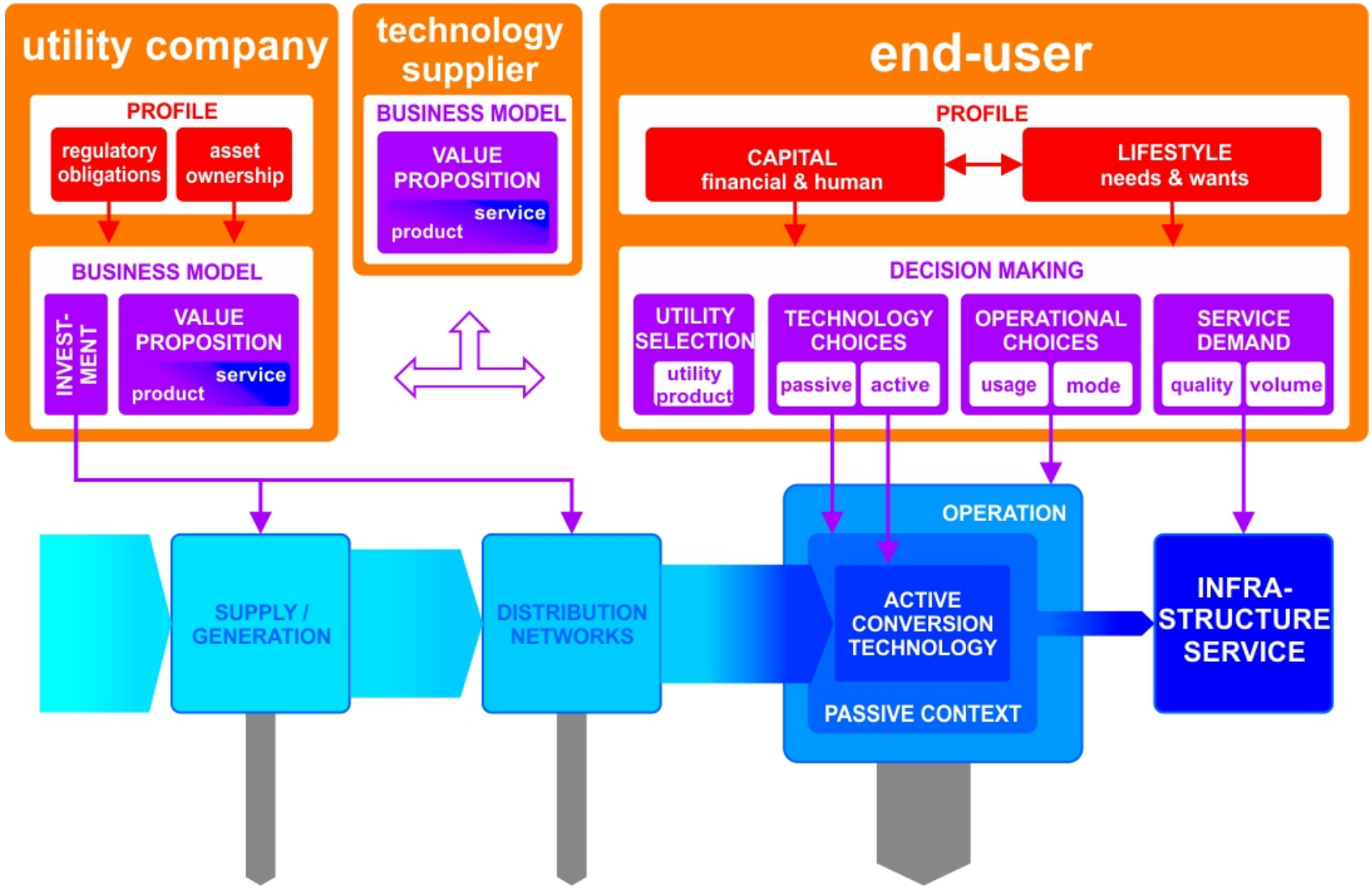

Source: Knoeri, et al. forthcoming

Results – constraints from policy paradigm

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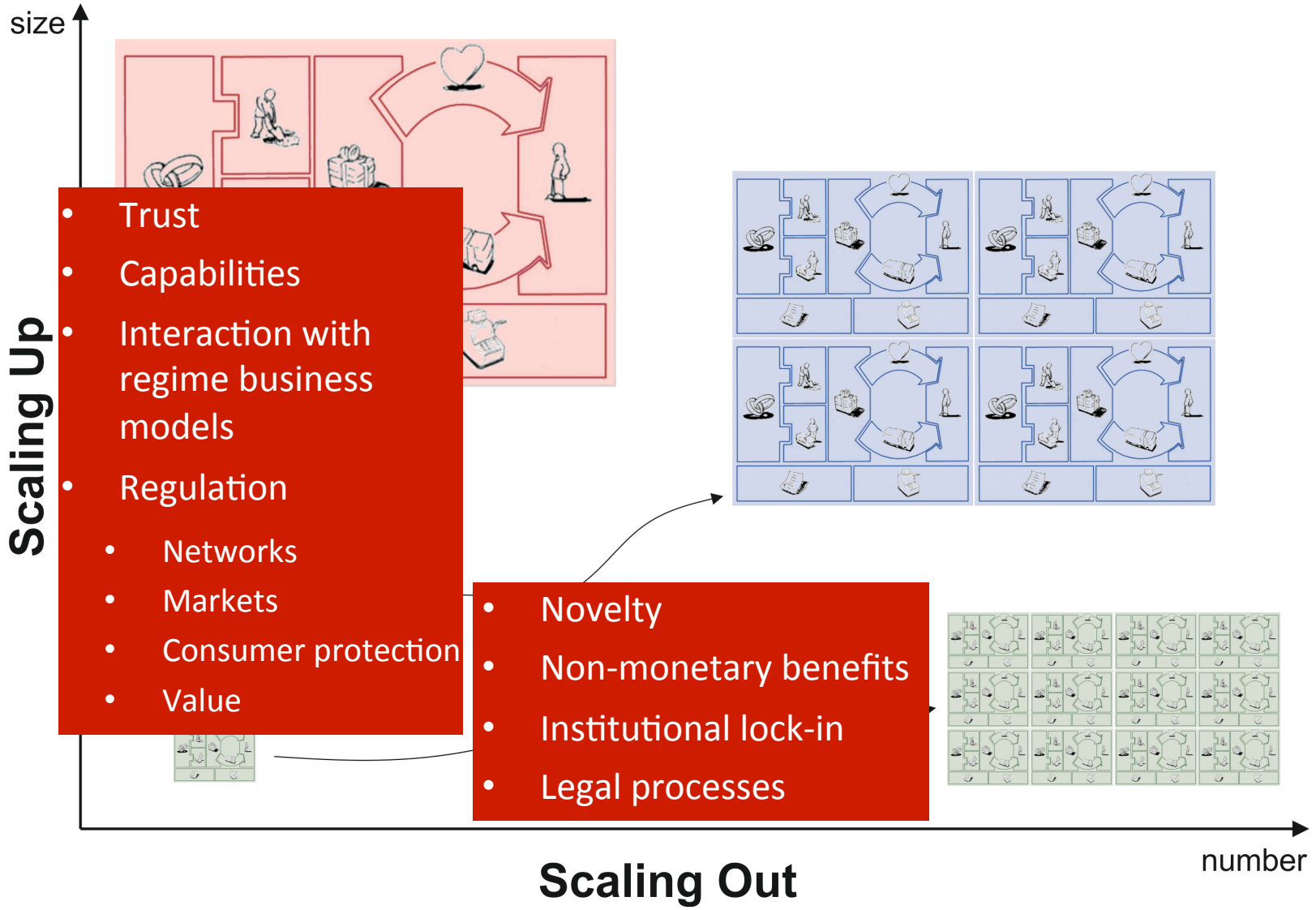

Results – constraints from policy and regulation

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Translating: to another sector or setting

Responses to constraints

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Policy

- Reduce **financial risk** and uncertainty
- Widen **scope and purpose** of funding
- Increase **intermediary support** to increase capabilities and learning
- Provide **best practice guidance and templates** for contracts and technologies
- Improve **integration between policy** areas

Regulation

- Make **access to electricity networks** easier
- Make **electricity markets more accessible** to small scale providers
- Create **market for energy saving** as well as energy generation
- Create a functional approach to **regulating smaller** suppliers
- Allow **longer contracts** with regulated suppliers
- Incorporate **social & environmental factors** into cost benefit analysis

Conclusion

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- Service-performance perspective offers potential to accelerate transition in energy and water provision from a throughput based economy to one based on demand management.
- Infrastructure services are integrated, diverse (multiple technologies), difficult to measure, and not yet well understood.
- Infrastructure services are embedded in a socio-technical system (or socio-ecological infrastructure system)
- Change requires engagement of end users and policy makers
- Barriers to scaling up service-based companies from regulation, capabilities and exclusion of non-monetary benefits

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Thank you for your attention!

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Traditional view of infrastructure service supply chain

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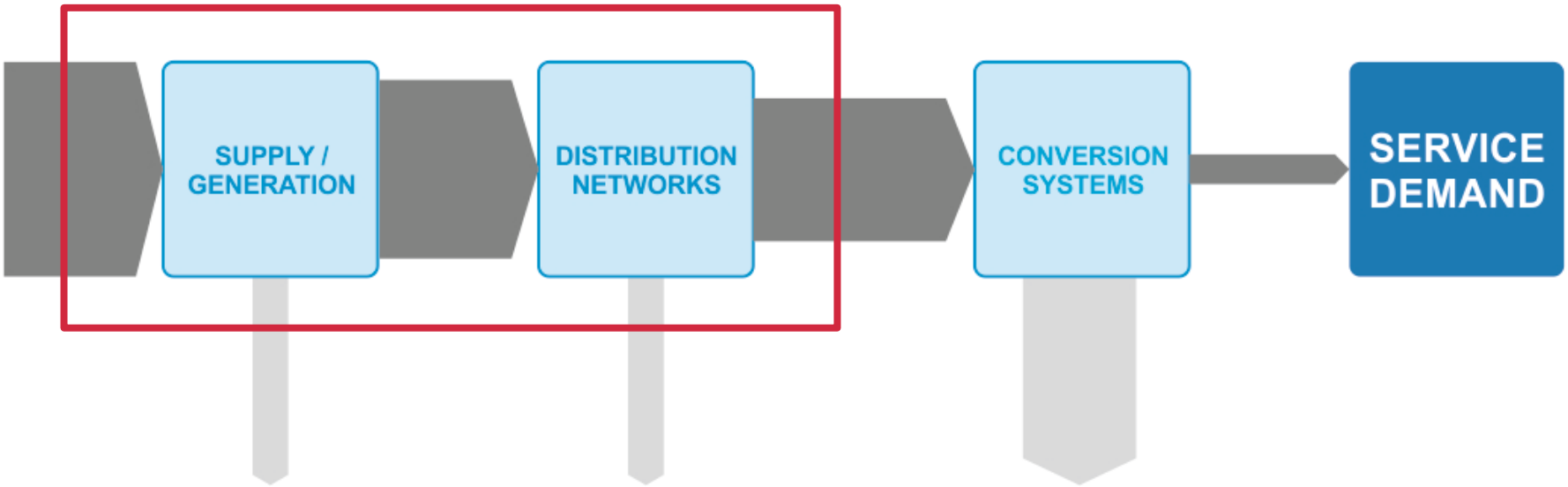

Active conversion technologies, passive context, and technology operation

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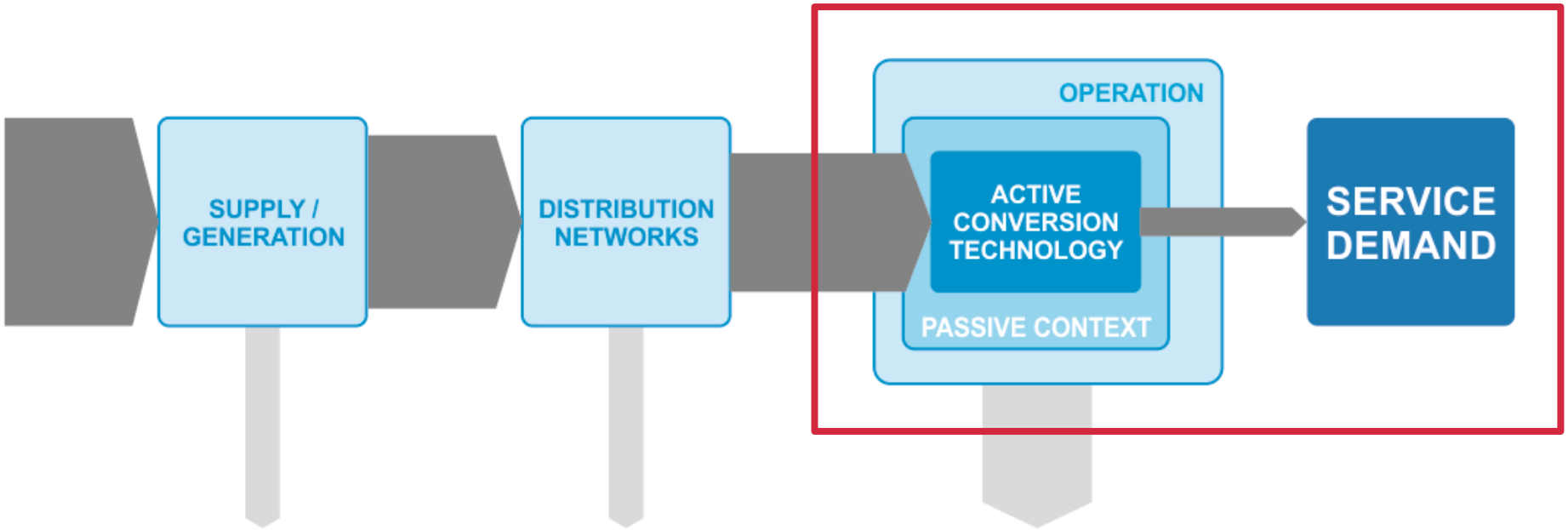

Conversion devices and passive systems

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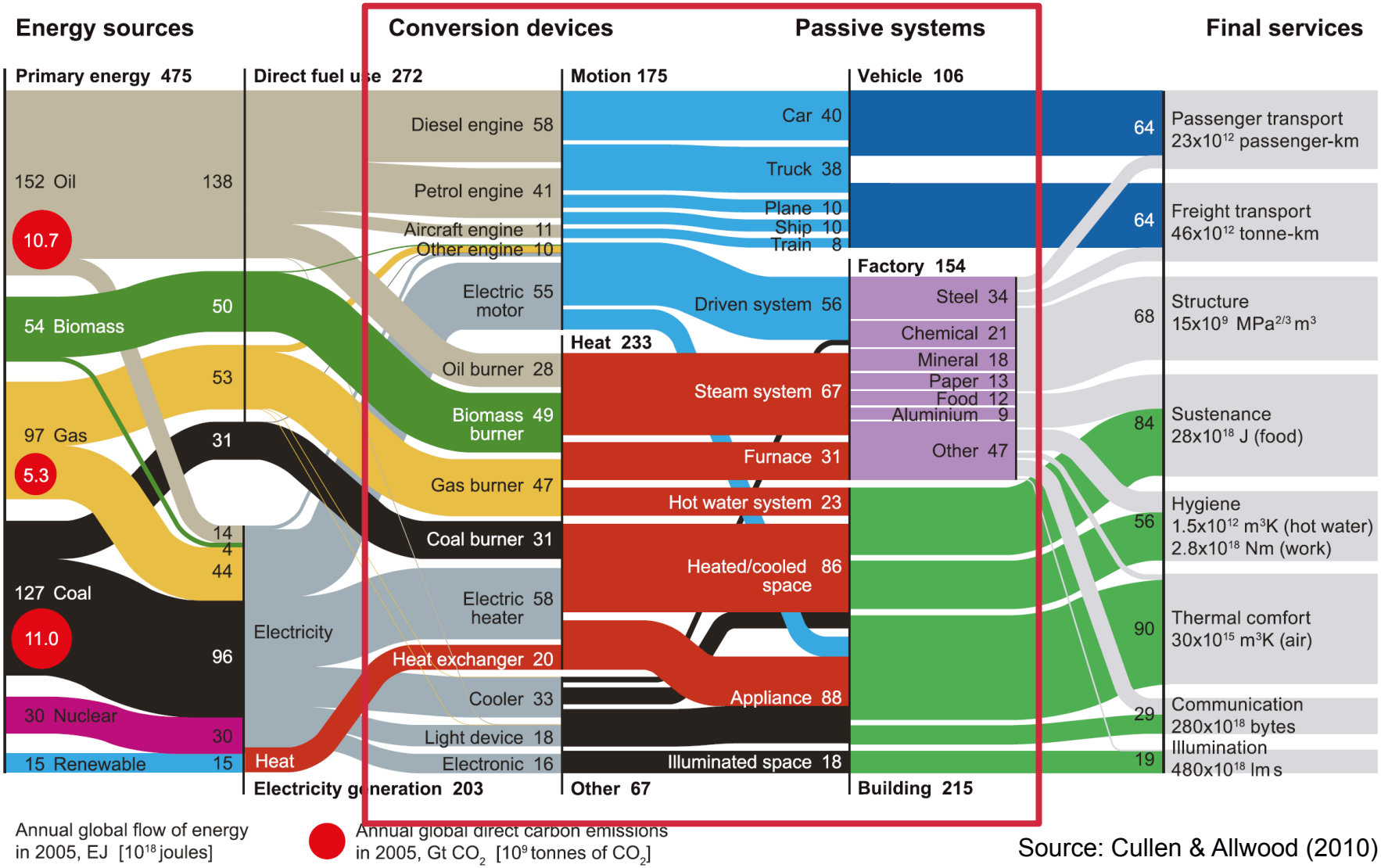

Annual global flow of energy in 2005, EJ [10^{18} joules]

Annual global direct carbon emissions in 2005, Gt CO_2 [10^9 tonnes of CO_2]

Source: Cullen & Allwood (2010)

"Service heterogeneity" or do we all want the same?

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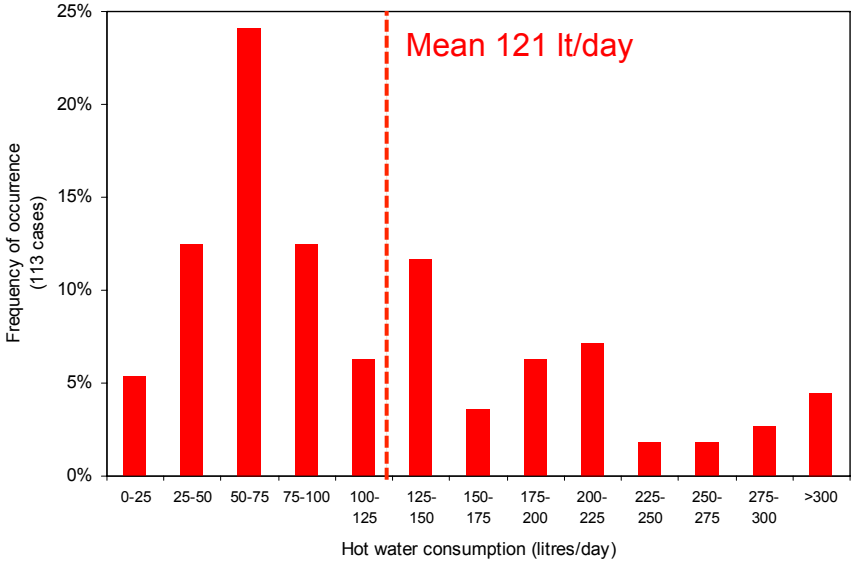
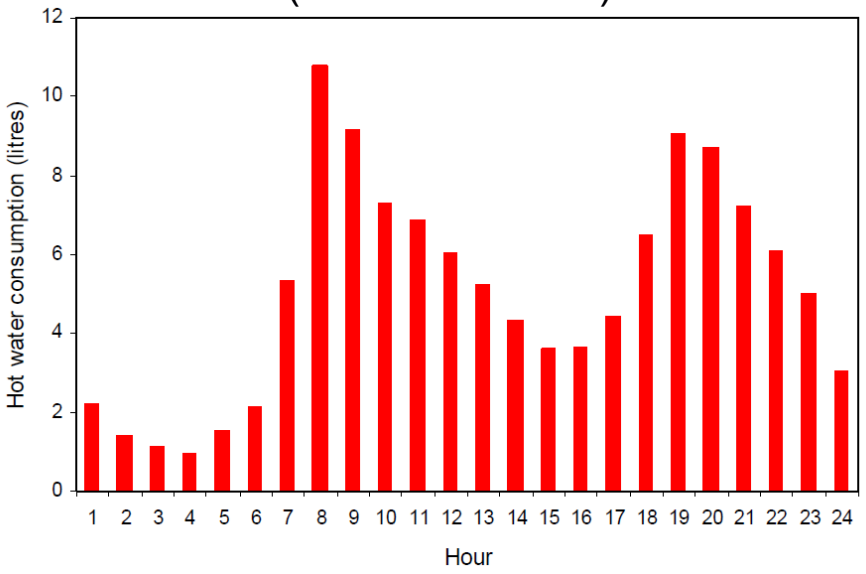
Domestic daily hot water consumption

(113 households, litres/day, 12 month)

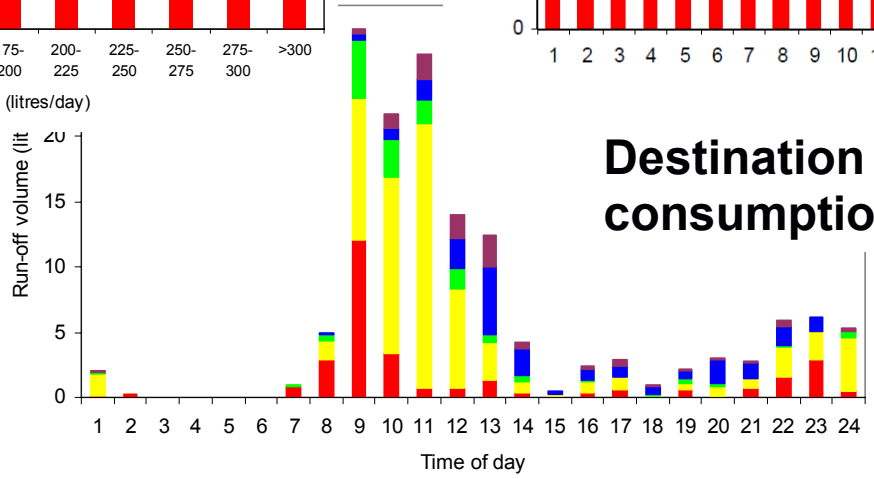


Daily run off profile

(113 households)



Destination of hot water consumption (1 households)



Source: DEFRA (2008)
Measurement of Domestic Hot Water Consumption in Dwellings

Bespoke quality delivery

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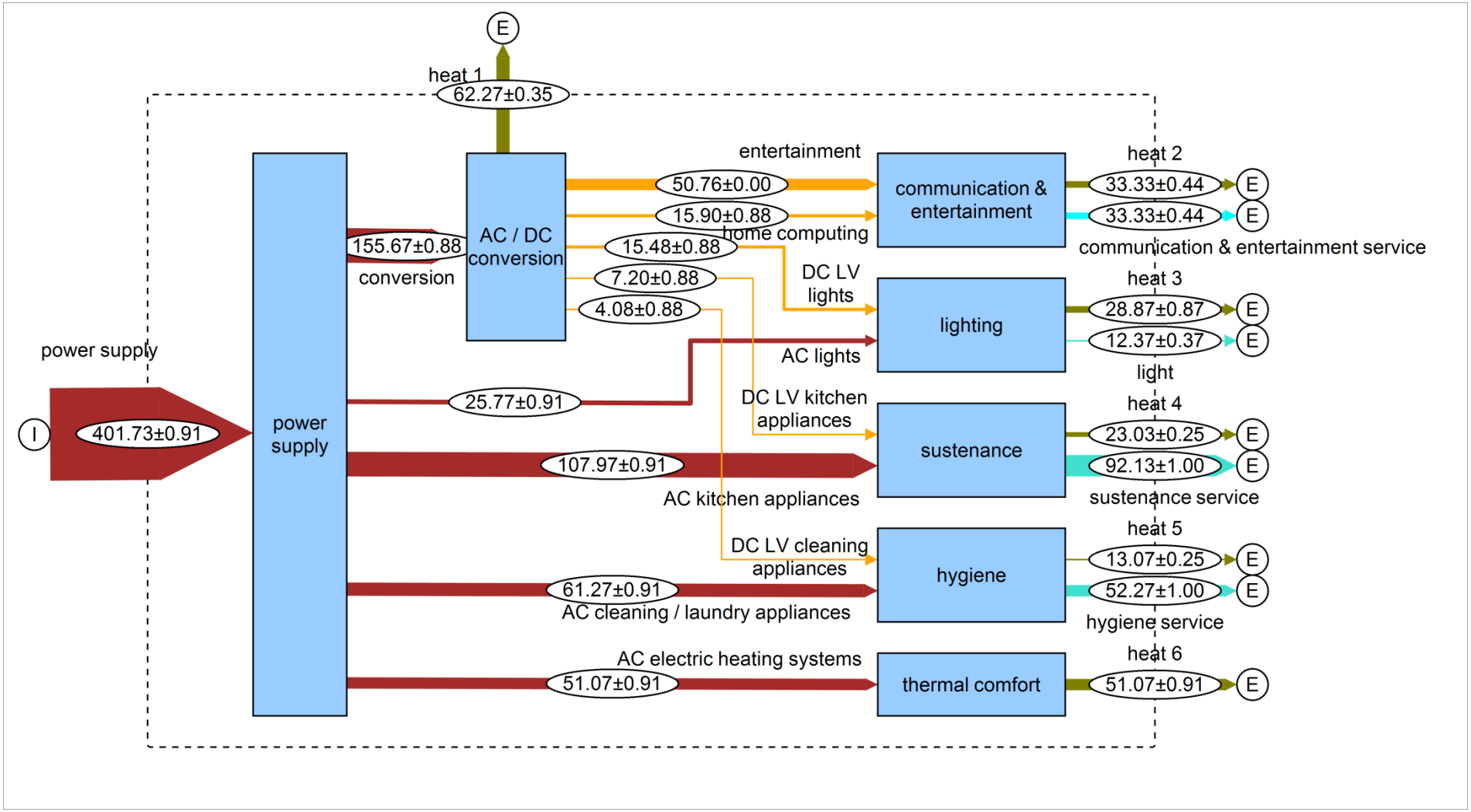

Source: Roelich, et al. forthcoming

End-users barriers for rapid adoption of efficient technologies

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Knowledge gap

- lack of information about own demand levels, potential savings through efficient technologies and changes in usage behaviour

Adherence to habits and routines

- service consumption is embedded in routine activity determined by many factors, leading to lock-in of specific patterns of consumption

Inappropriate operation of technology

- individual behaviour has a strong influence on the operation of end-use technologies, and can limit their real-life performance

How supportive is current governance?

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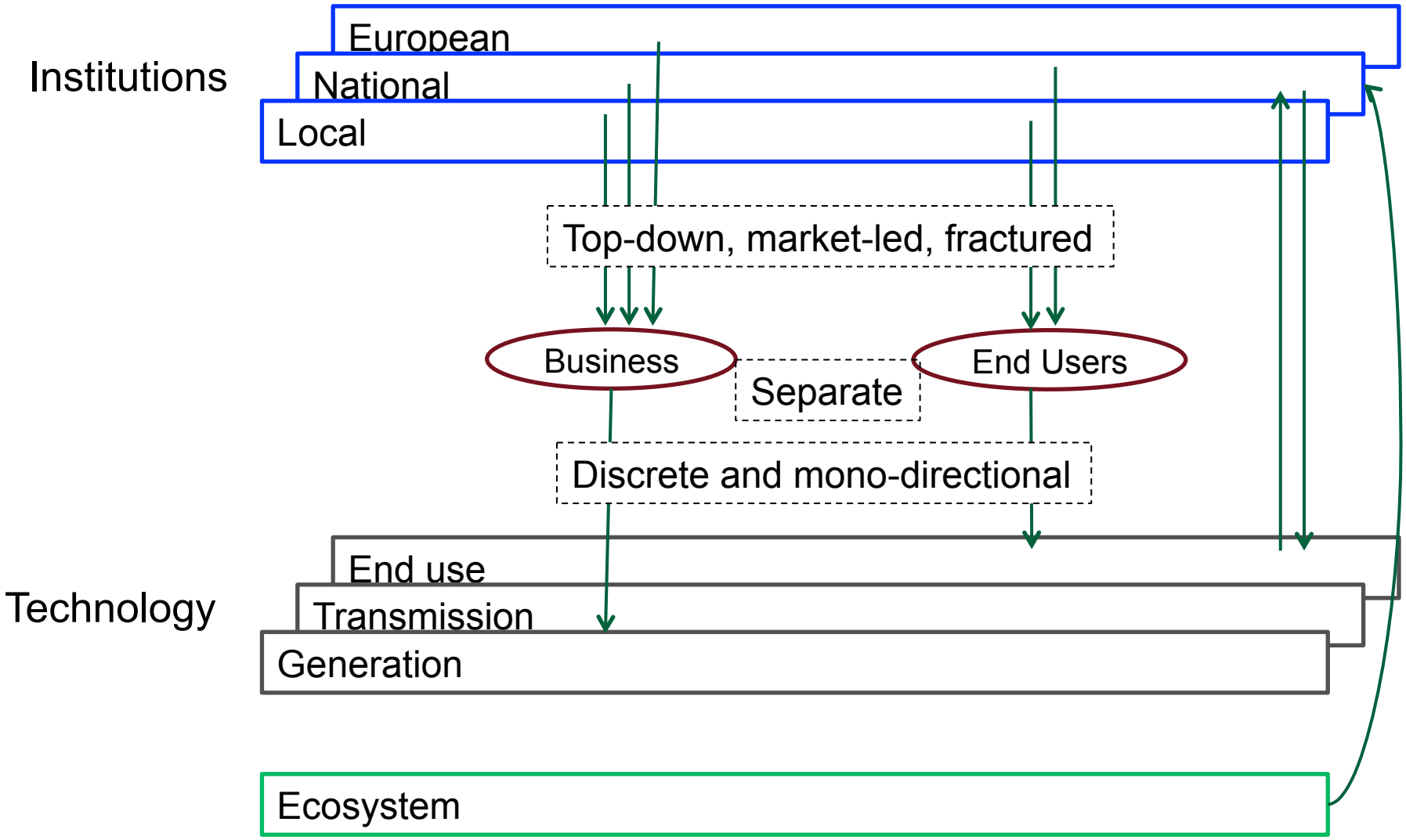

Result – governance analysis framework

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