

Digitalisation, domestication, and impacts on climate change

Charlie Wilson
Oxford Energy Day
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European
Research
Council

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Environmental Change Institute
SCHOOL OF GEOGRAPHY AND THE ENVIRONMENT

“Of the energy-using sectors, buildings are expected to be the most transformed by digitalisation in the near-term ...”



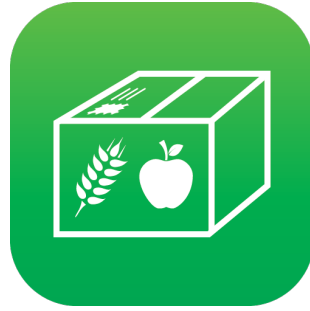
- smart building controls to manage energy use
- smart heating and lighting systems to reduce energy use by 10% through sensors or learning algorithms
- increasing electricity consumption by appliances and small plug loads
- opportunities for smart demand response (curtailment or time-shifting)
- new opportunities for energy-service providers to manage energy use

Digitalisation in homes creates opportunities for decarbonisation



Manage, control, learn about energy
e.g., smart home technologies

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Substitute for physical activity
e.g., commuting, shopping trips

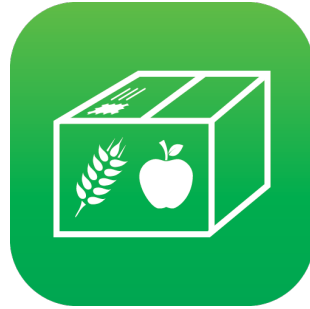


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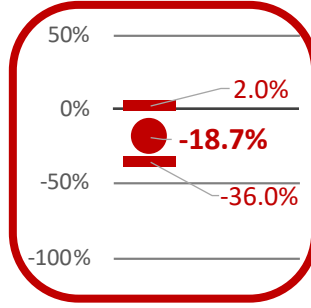


Integrate homes into renewable grids
e.g., smart EV charging, demand response, time-of-use tariffs

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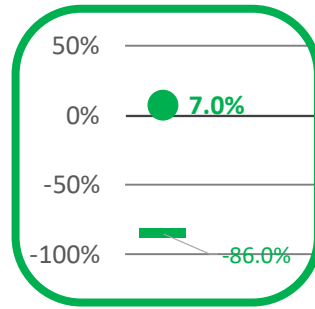
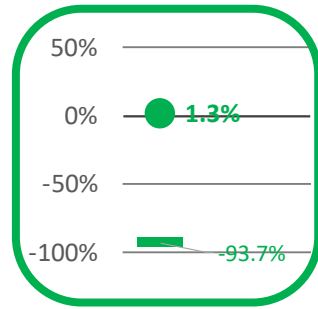
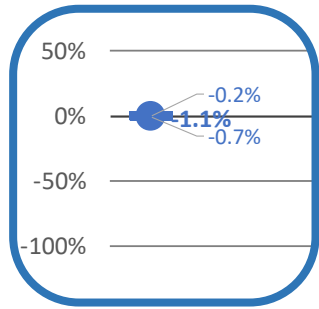


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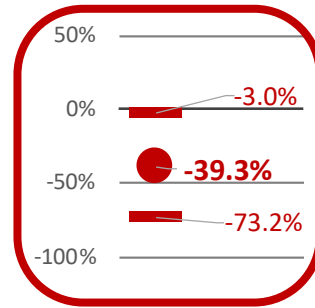
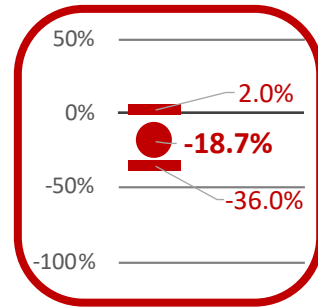
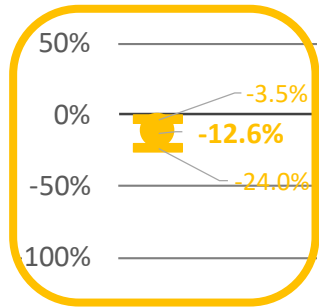


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Digitalisation has direct, indirect, and systemic impacts on energy

technology
perspective

direct impacts

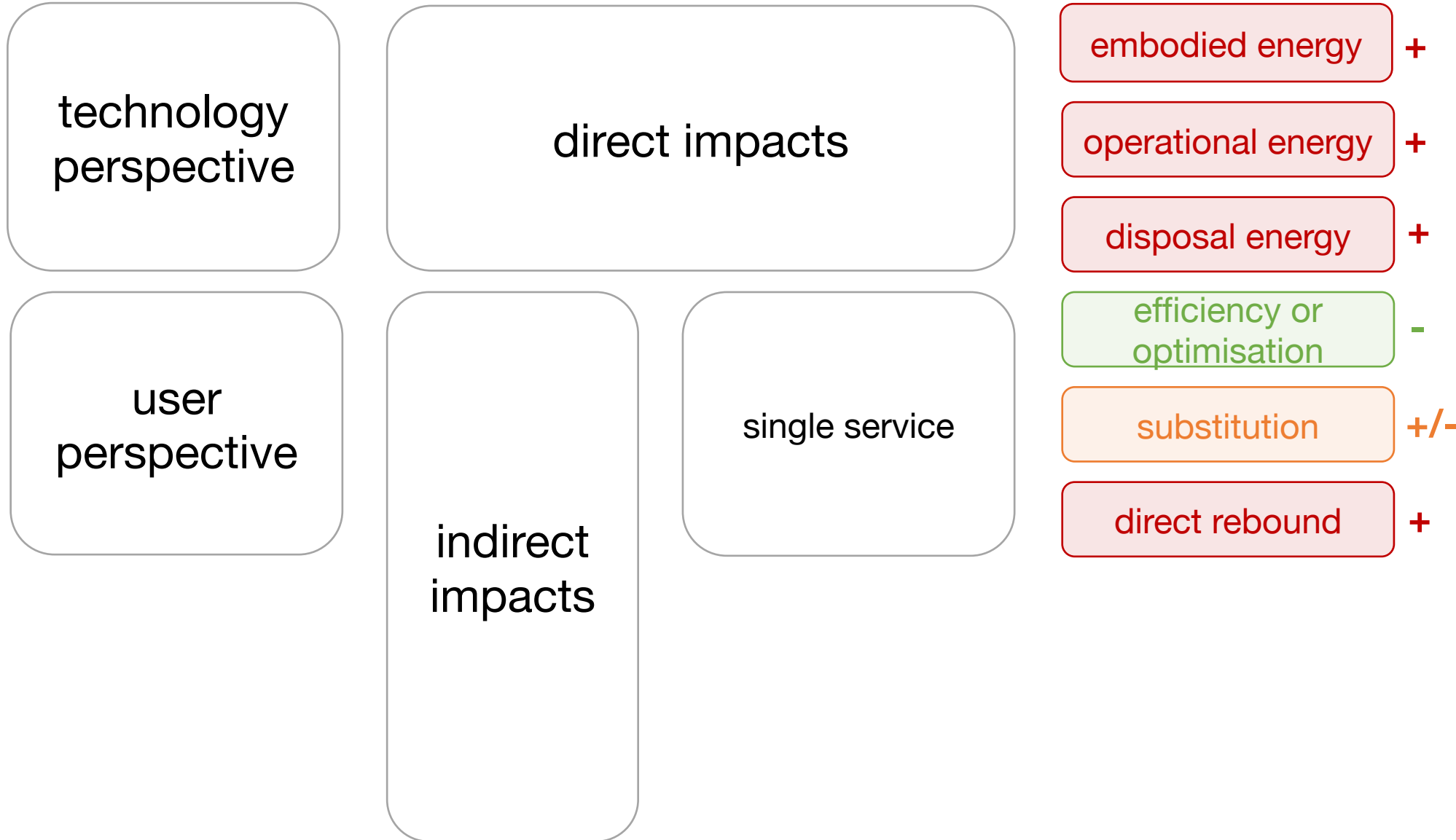
embodied energy +

operational energy +

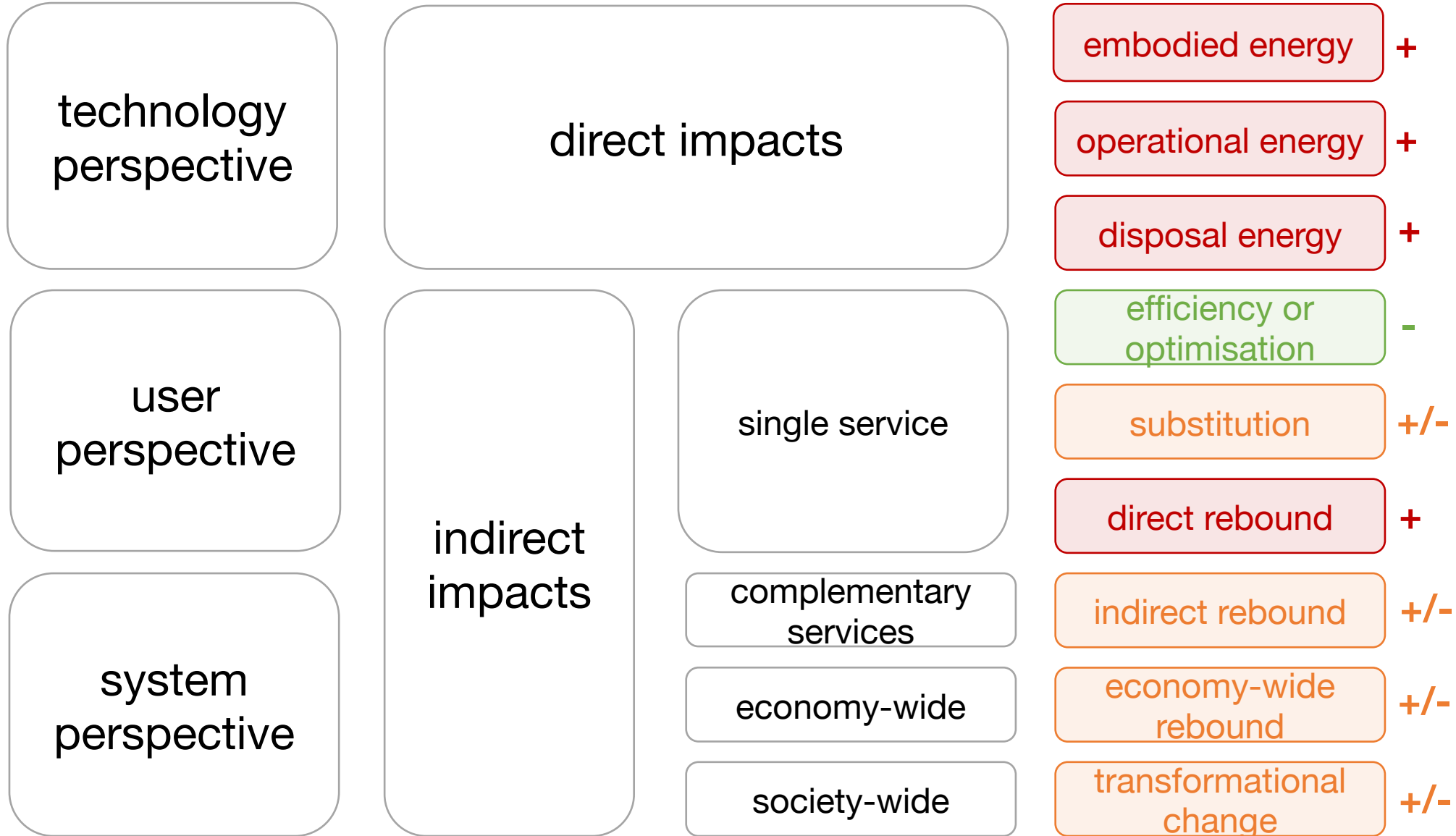
disposal energy +



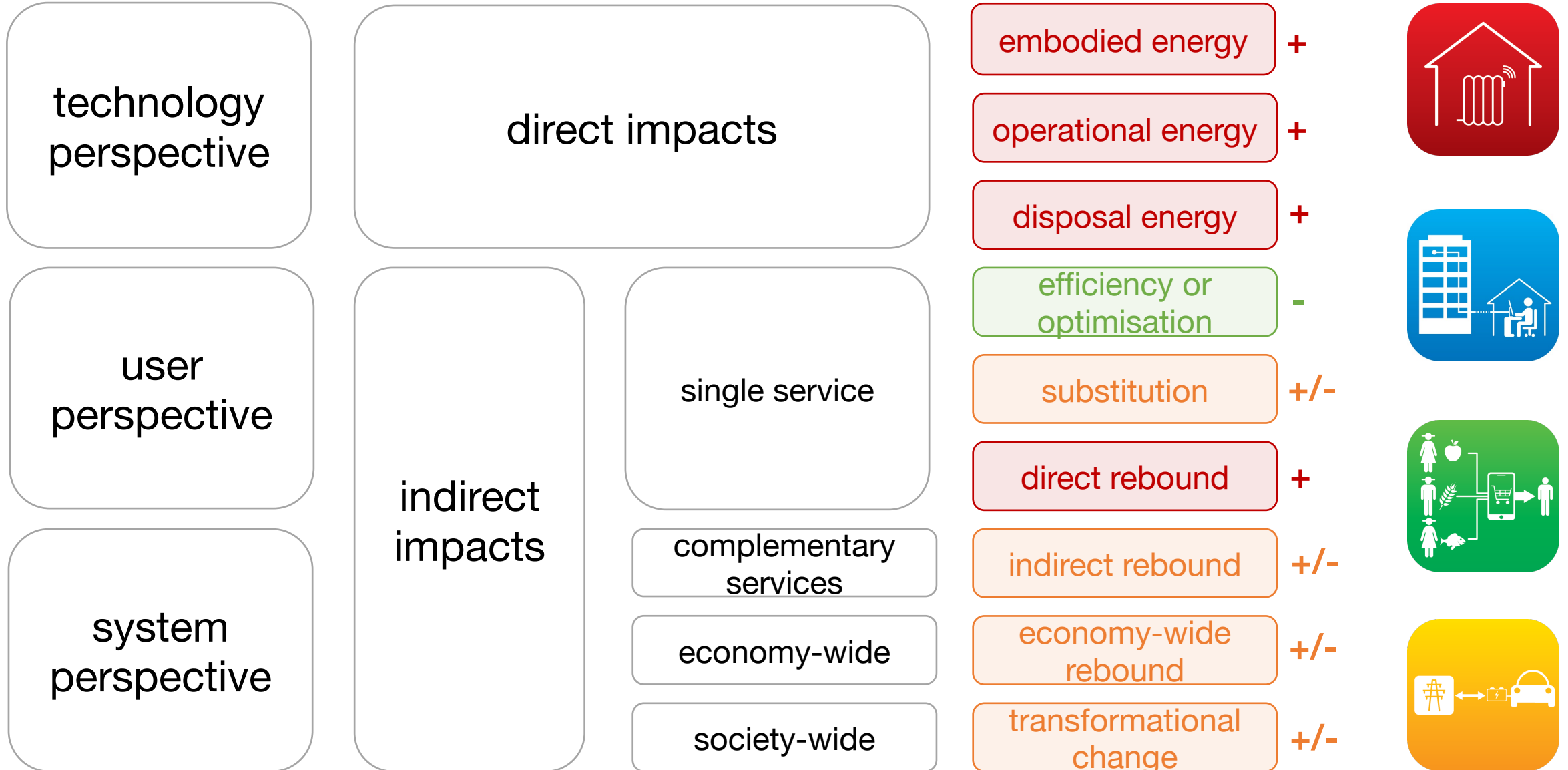
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Global low energy demand scenario 'assumes' important enabling role for digitalisation in homes

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changing thermal comfort 2020-2050 in global LED scenario	decomposition factor (+/- impact on energy demand)	<i>link to digitalisation ...</i>		
		dependent on	enabled by	possible without
main measures				
heat pumps, fuel cells, micro-cogeneration systems	Structure (-)		improved controls	
stringent thermal efficiency standards for new builds and retrofits	Structure (-) * Intensity (-) *			historical trend
doubling of retrofit rates	Structure (-) Intensity (-)		targeting & learning	

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floor area converges on 30m ² per capita (with urban shift to multi-family dwellings)	Activity (+)			urbanisation trend
smart home systems manage and reduce demand (°C.DD/m ²)	Activity (-)	sensing, learning		
demand response with time-of-use (ToU) pricing and automation	Activity (-)	real-time price signals		
retrofit standardisation (Energiesprung)	Intensity (-)		3d scanning & design	
enforcement of efficiency standards	Intensity (-)		smart meter monitoring	

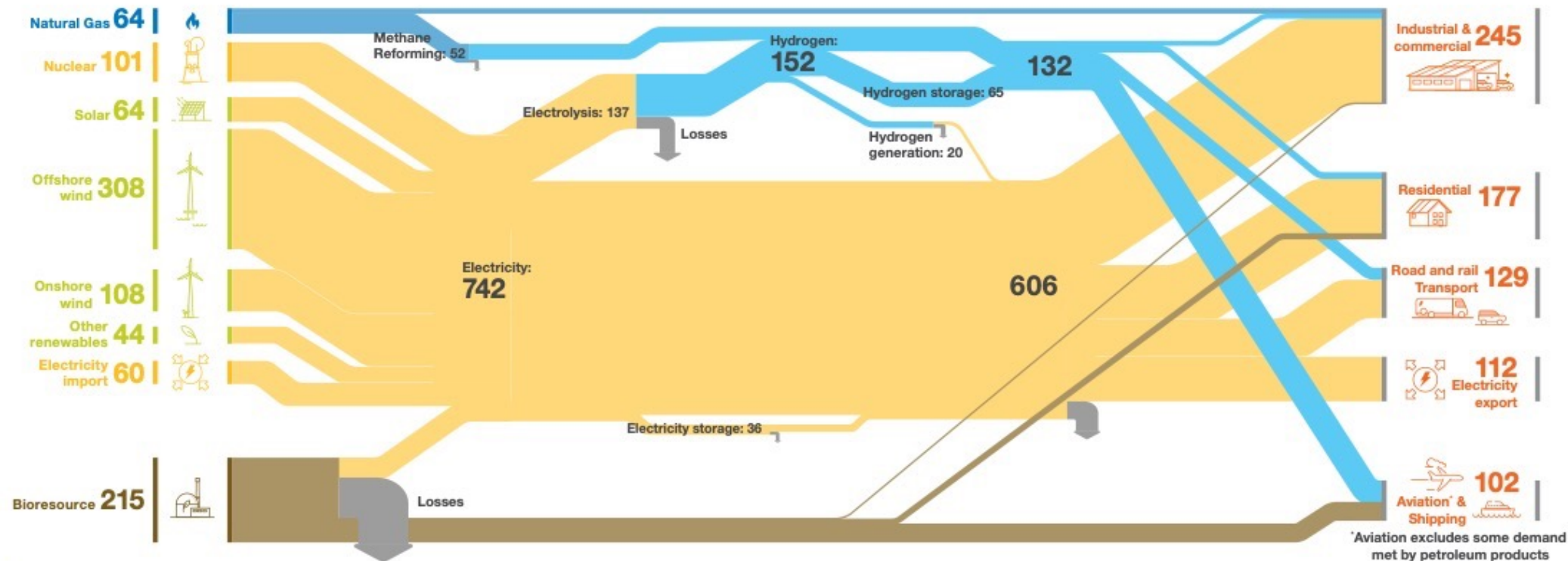
Scenario studies on the impact of digitalisation for energy and carbon emissions have a tendency towards optimism

2050 energy flows

Consumer Transformation

2050 energy flows in Consumer Transformation (TWh)

- Home heating, transport and industry largely electrified
- Hydrogen produced in the UK, primarily through electrolysis
- Electricity generation capacity is highest in this scenario
- Substantial increase in energy efficiency measures, lowest end-user energy demand
- Small amounts of natural gas used with CCUS to decarbonise industry, due to lower availability of hydrogen



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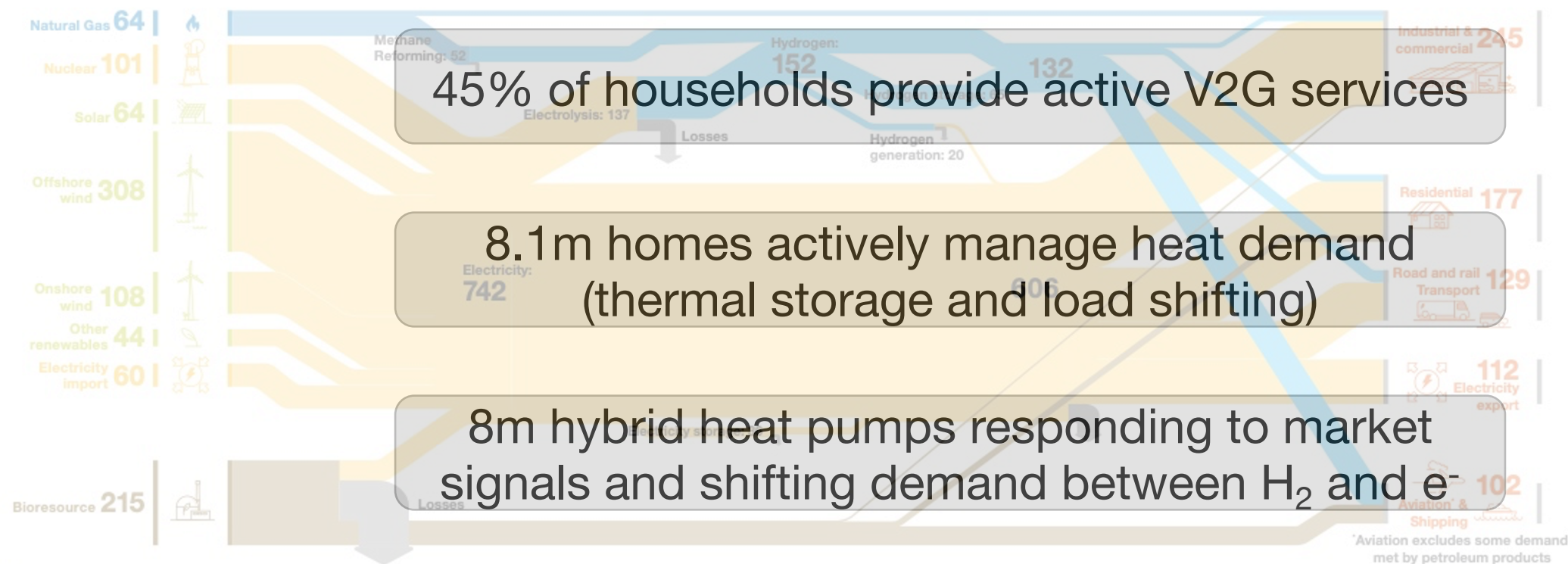
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80% of households smart charge EVs

45% of households provide active V2G services

8.1m homes actively manage heat demand (thermal storage and load shifting)

8m hybrid heat pumps responding to market signals and shifting demand between H₂ and e-



*Aviation excludes some demand met by petroleum products

Scenario studies vary in how they represent agency, control, and users ... but all make coarse, simplifying assumptions.

business
models, users,
and data



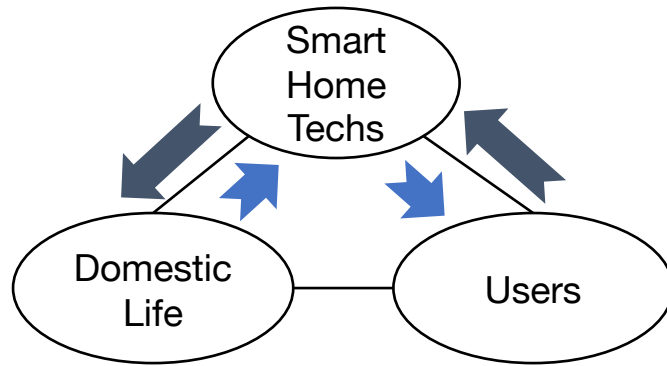
control,
automation,
user behaviour



Domestication involves three types of learning and control about technologies, about users, and about domestic life.



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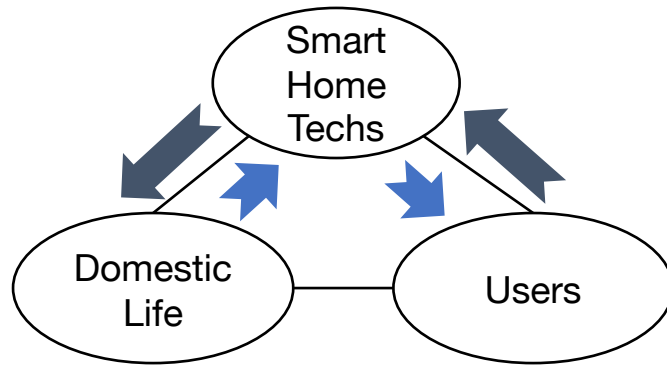


Artefactual Control

Smart home technologies are used to enable or support certain household functions.

Experiences feed back to shape how smart home is configured and used.

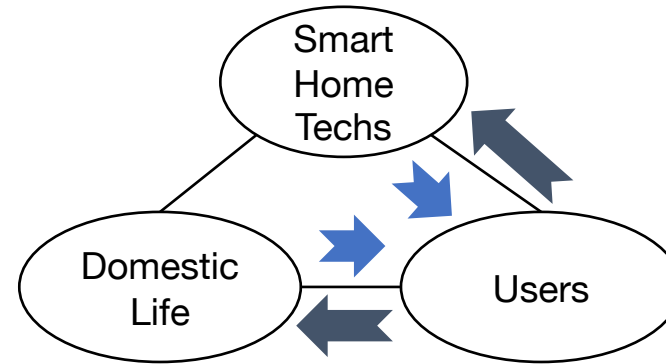
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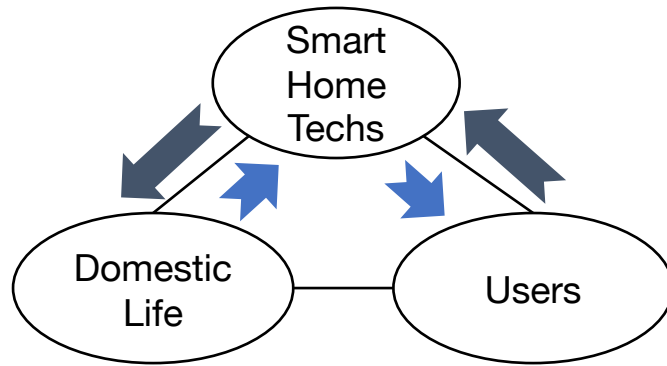


Perceptual Control

Users learn through trying out smart home technologies as a novel way of helping (or hindering) domestic life.

Experiences feed back to shape users' feelings of being more in (or out of) control.

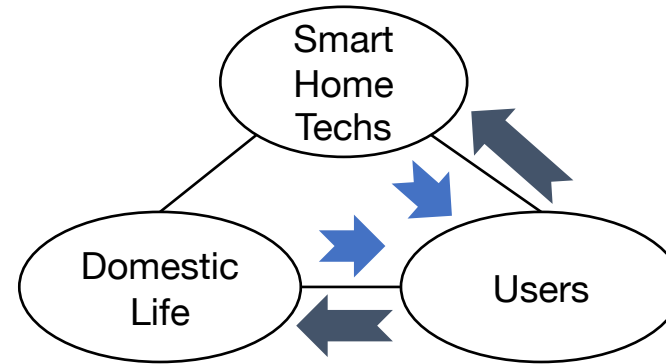
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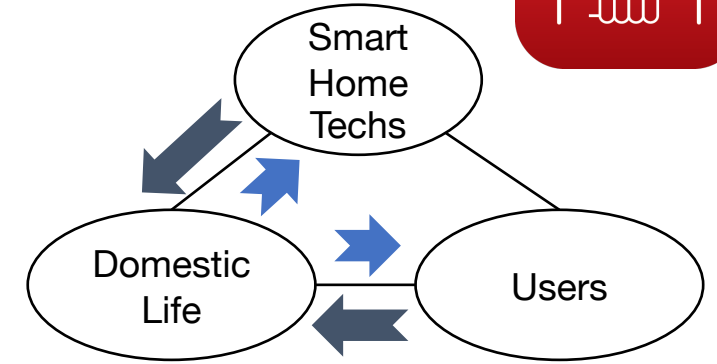
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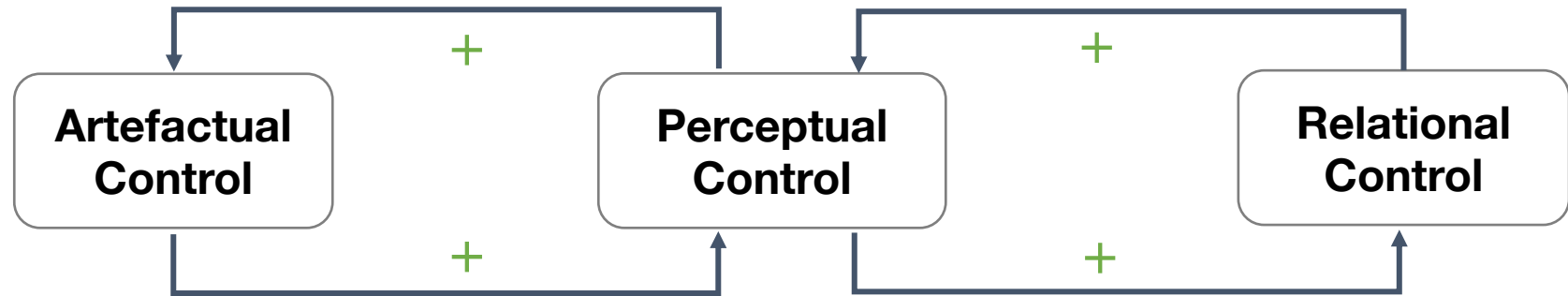
Relational Control

Smart home technologies may affect relationships between household members and between activities.

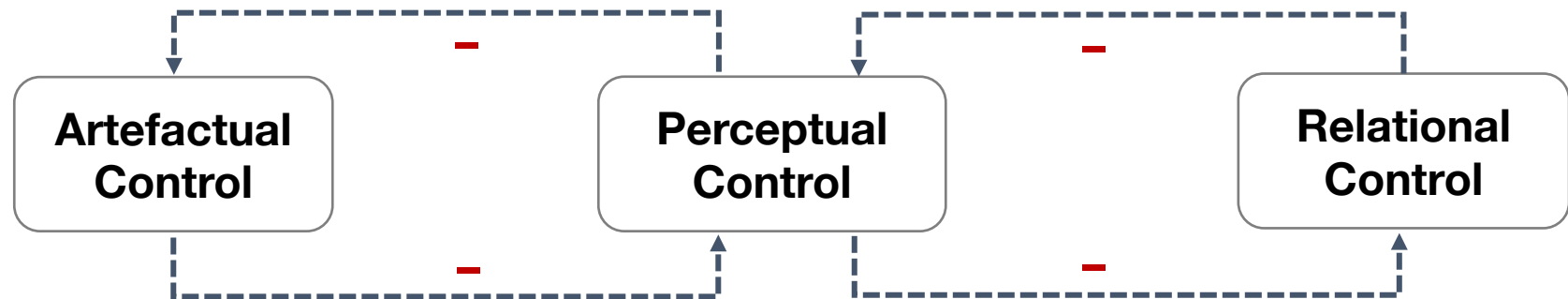
Experiences feed back to reinforce or undermine the use of smart tech for organising & scheduling at home.

Positive and negative feedback loops between different forms of control shape domestication or rejection.

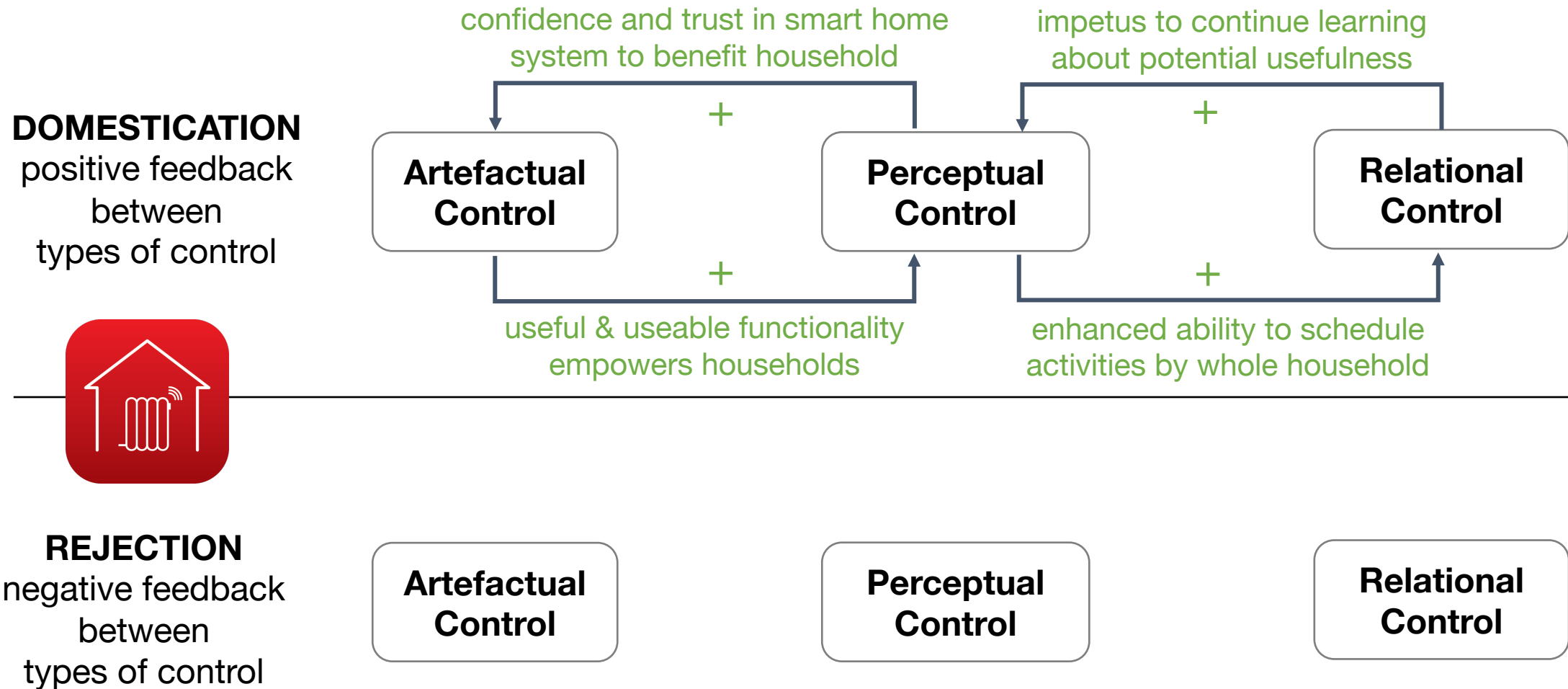
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positive feedback
between
types of control



REJECTION
negative feedback
between
types of control

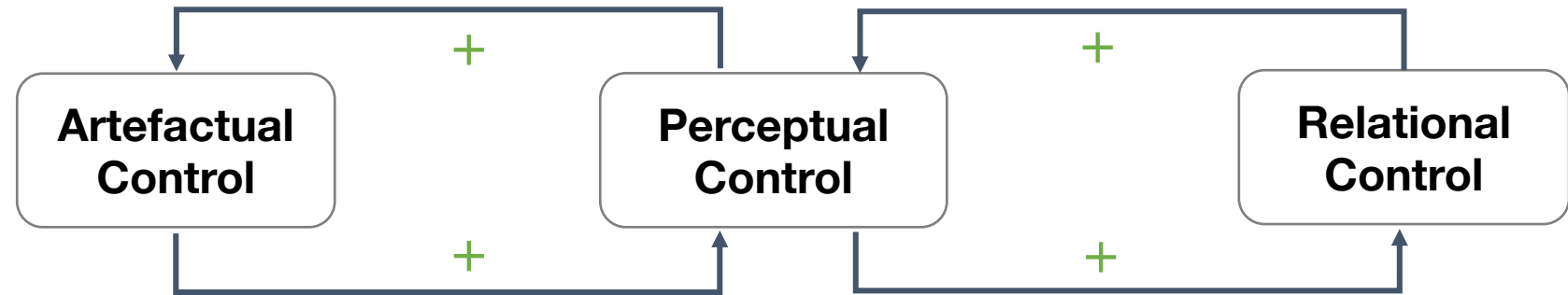


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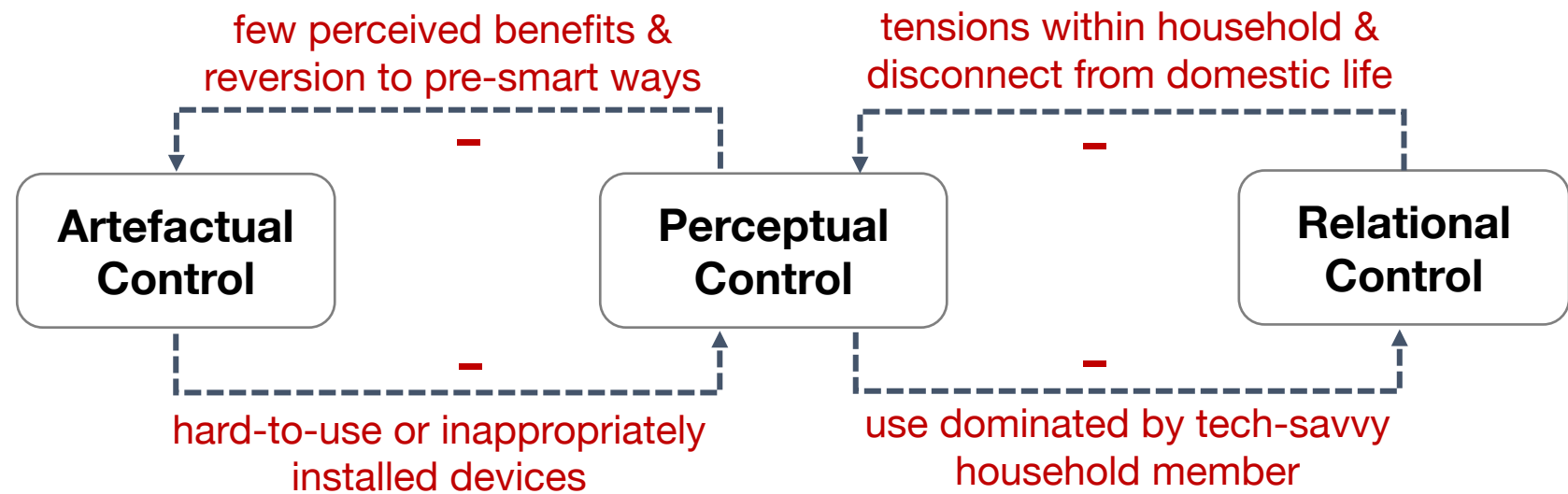


Positive and negative feedback loops between different forms of control shape domestication or rejection.

DOMESTICATION
positive feedback
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How will agency and control play out for system benefits (public purpose) as opposed to private functional benefits?



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