“Nueva generación de modelos de simulación de sistemas de infraestructura y herramientas para informar sobre el análisis, planificación y diseño de las infraestructuras a nivel nacional en el Reino Unido”

“New generation of infrastructure system simulation models and tools to inform the analysis, planning and design of National Infrastructure (NI) in UK".

Dr Matthew Ives

Investigador en Environmental Change Institute, Universidad de Oxford

Senior Researcher, Environmental Change Institute. University of Oxford

The UK Infrastructure Transitions Research Consortium (ITRC)

El ITRC es un consorcio de siete universidades líderes del Reino Unido:

Objetivo:
Desarrollar y demostrar una nueva generación de modelos y herramientas de simulación para el análisis, planificación y diseño de la infraestructura nacional

Colaboradores de investigación colaborativa del Gobierno y la Industria:

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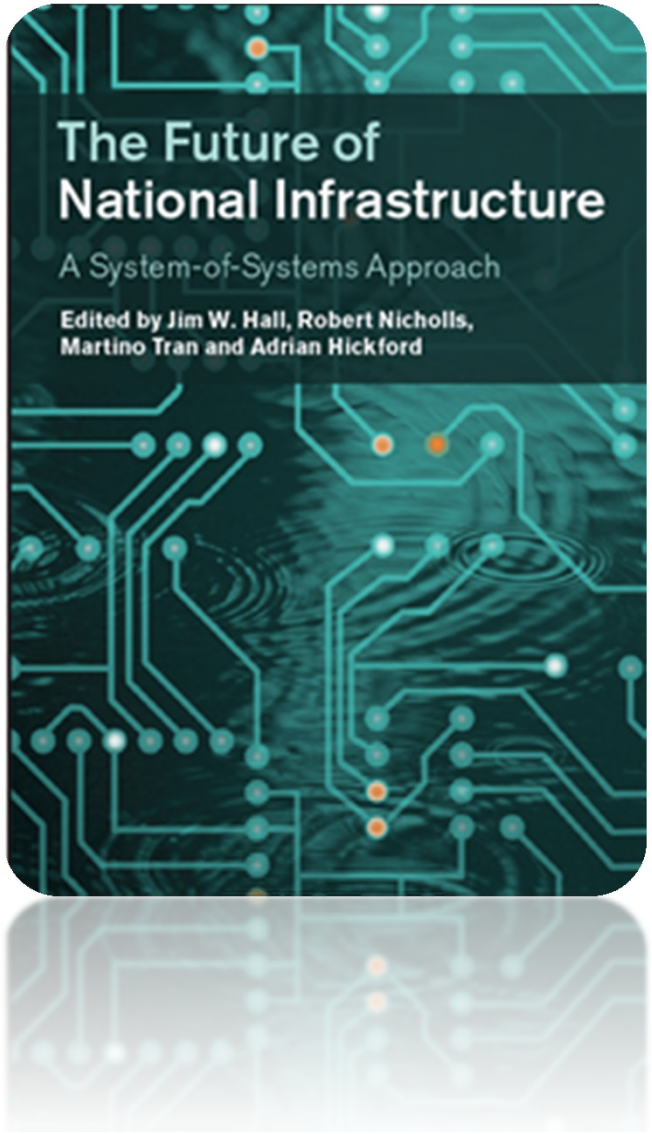
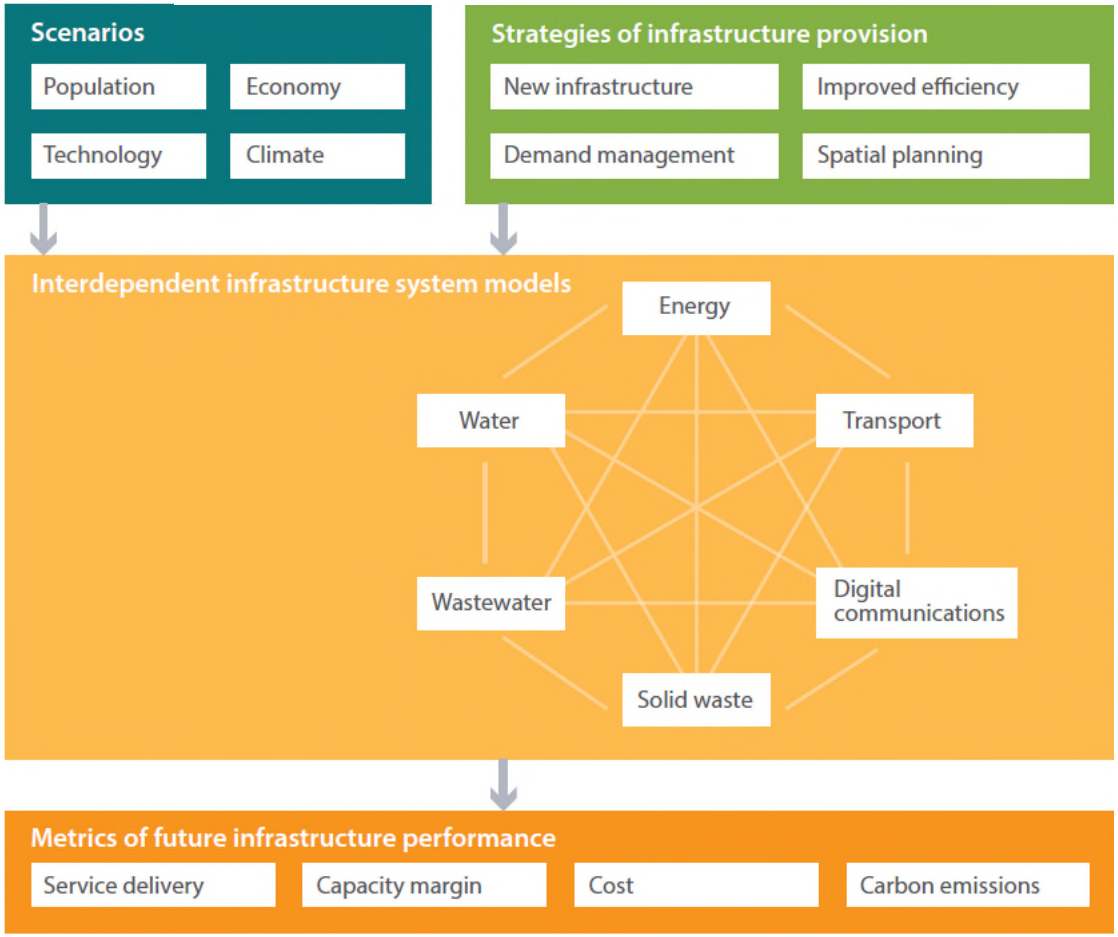
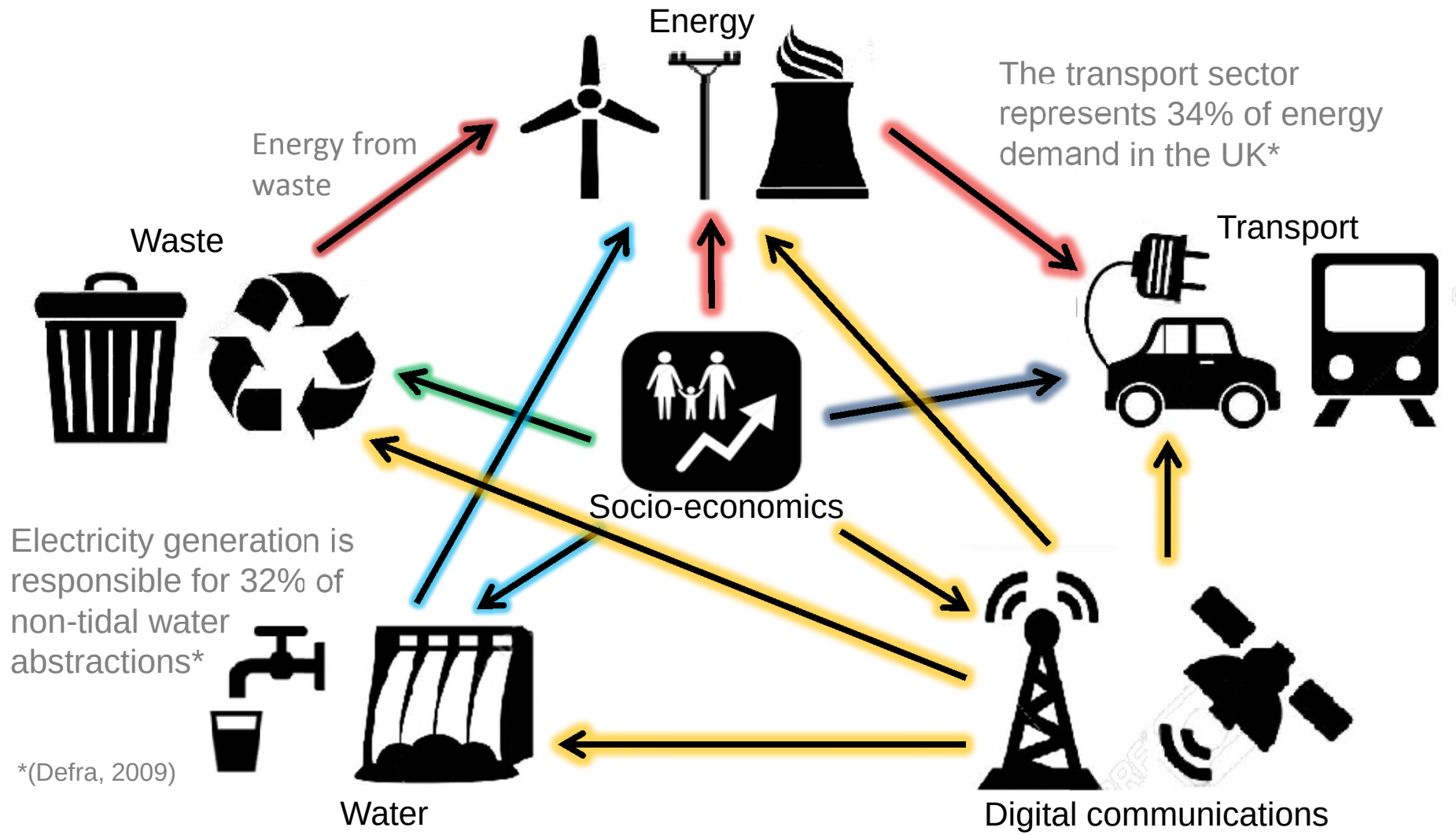
Published outputs of ITRC



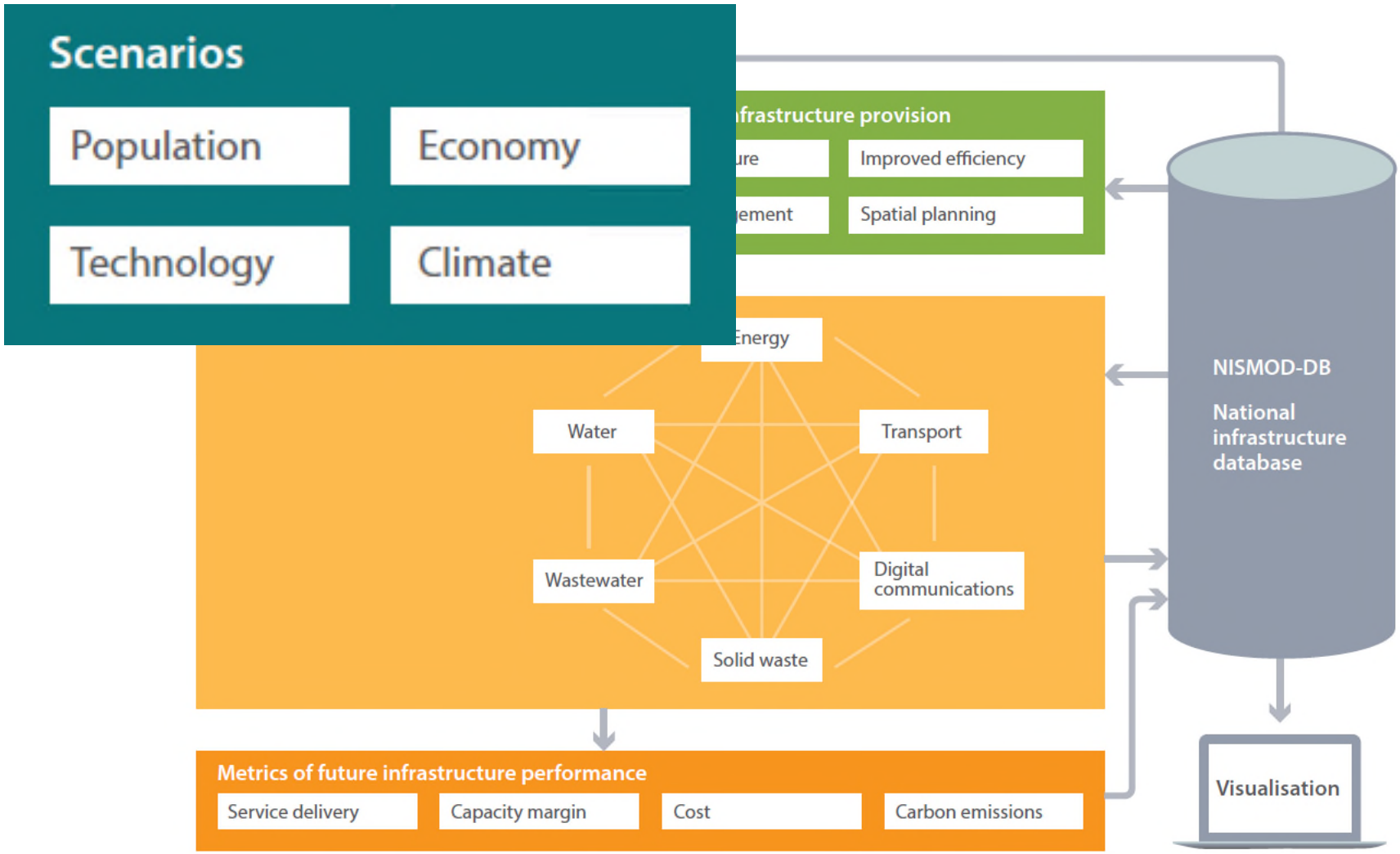
NISMOD-LP: Long term planning and decision analysis



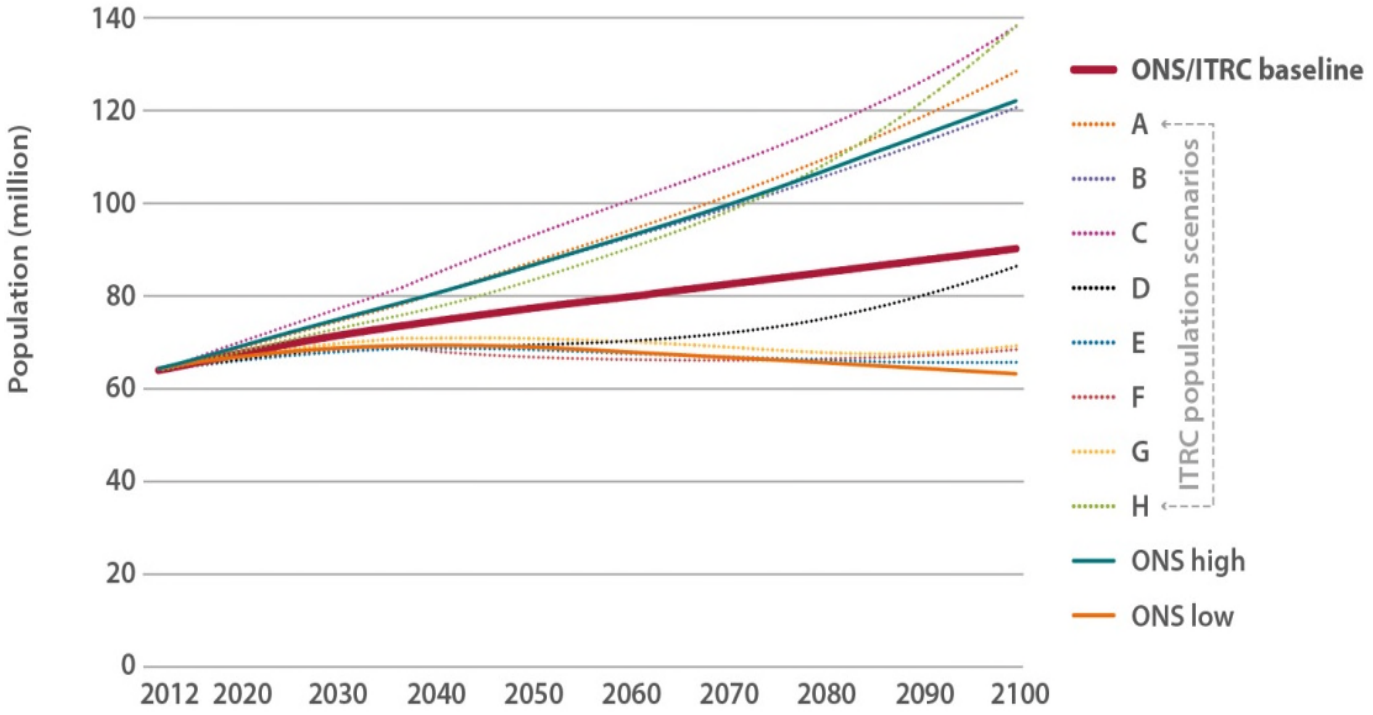
NISMOD-LP: Long term planning and decision analysis



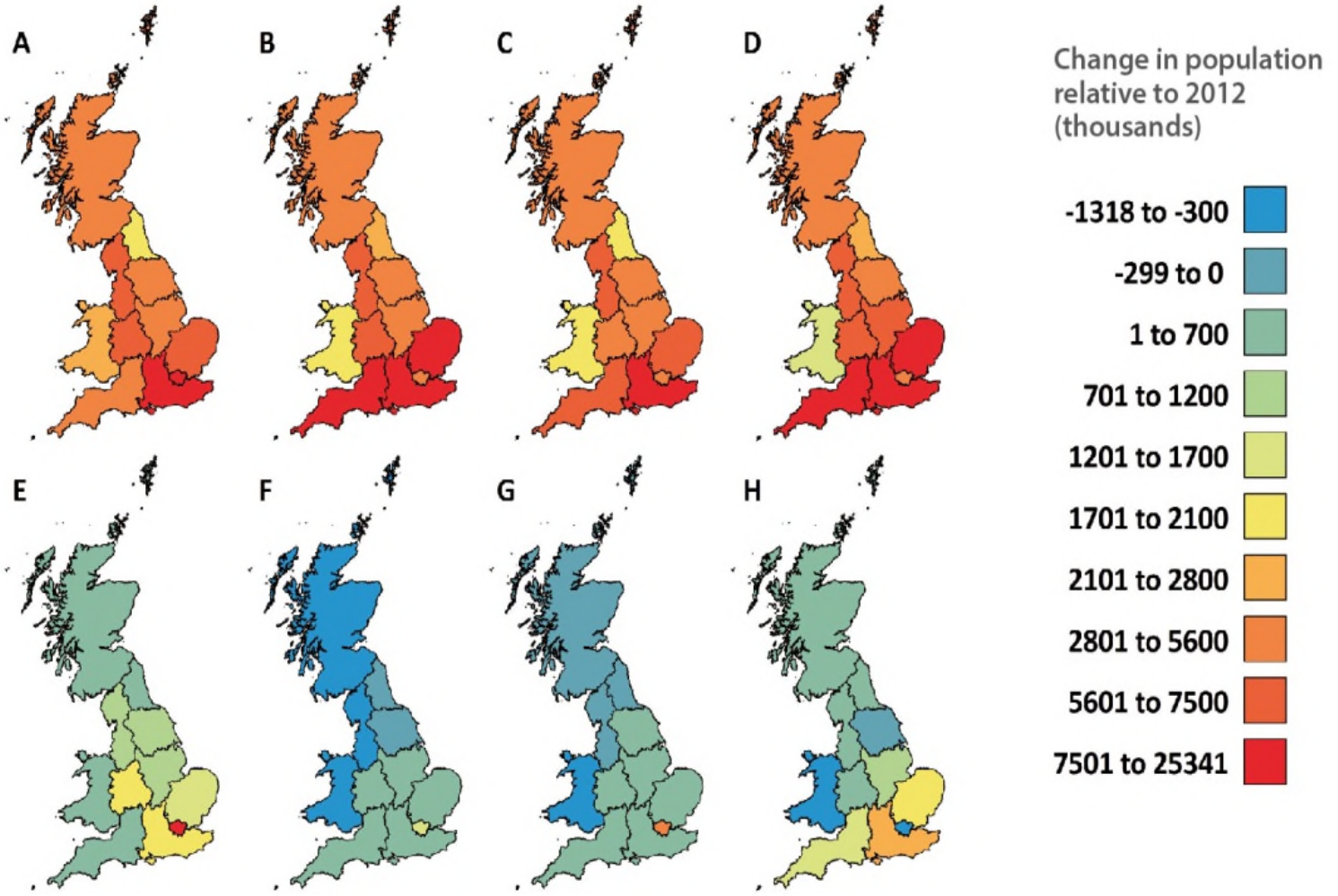
Exogenous scenarios



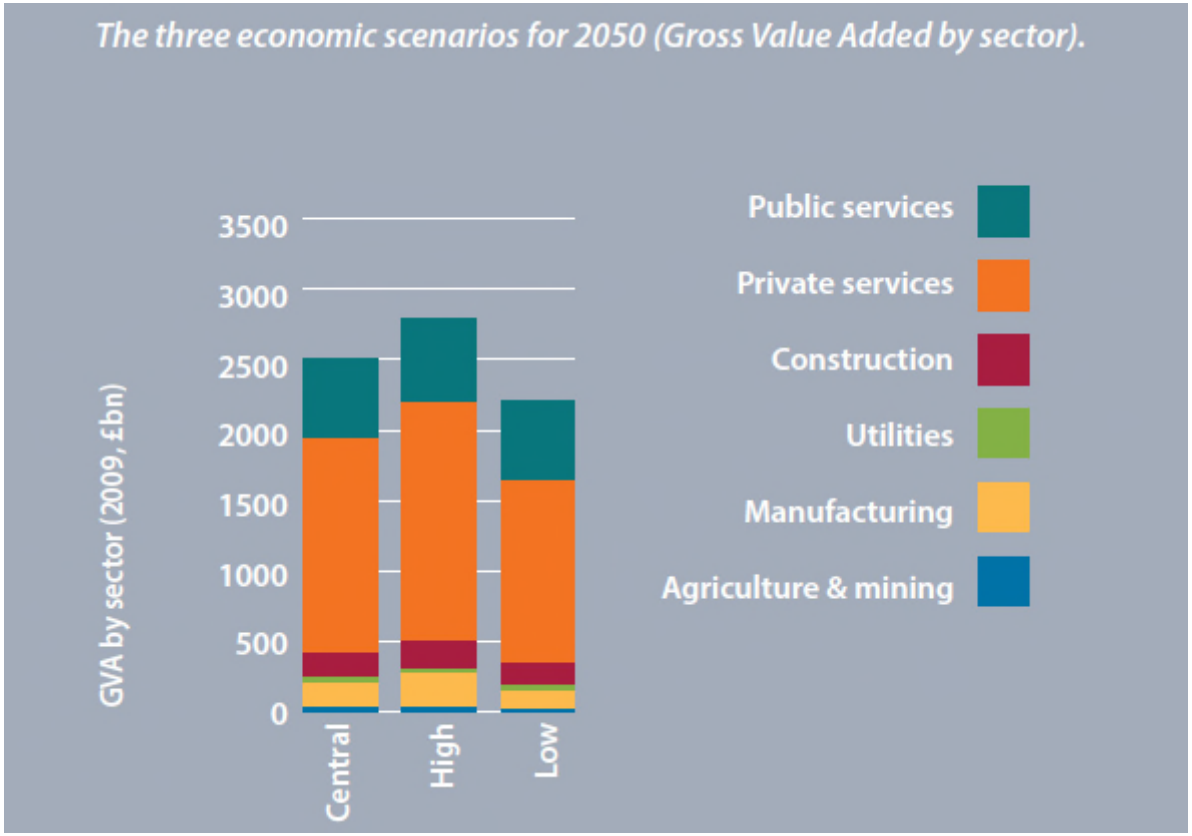
Drivers of future need: population



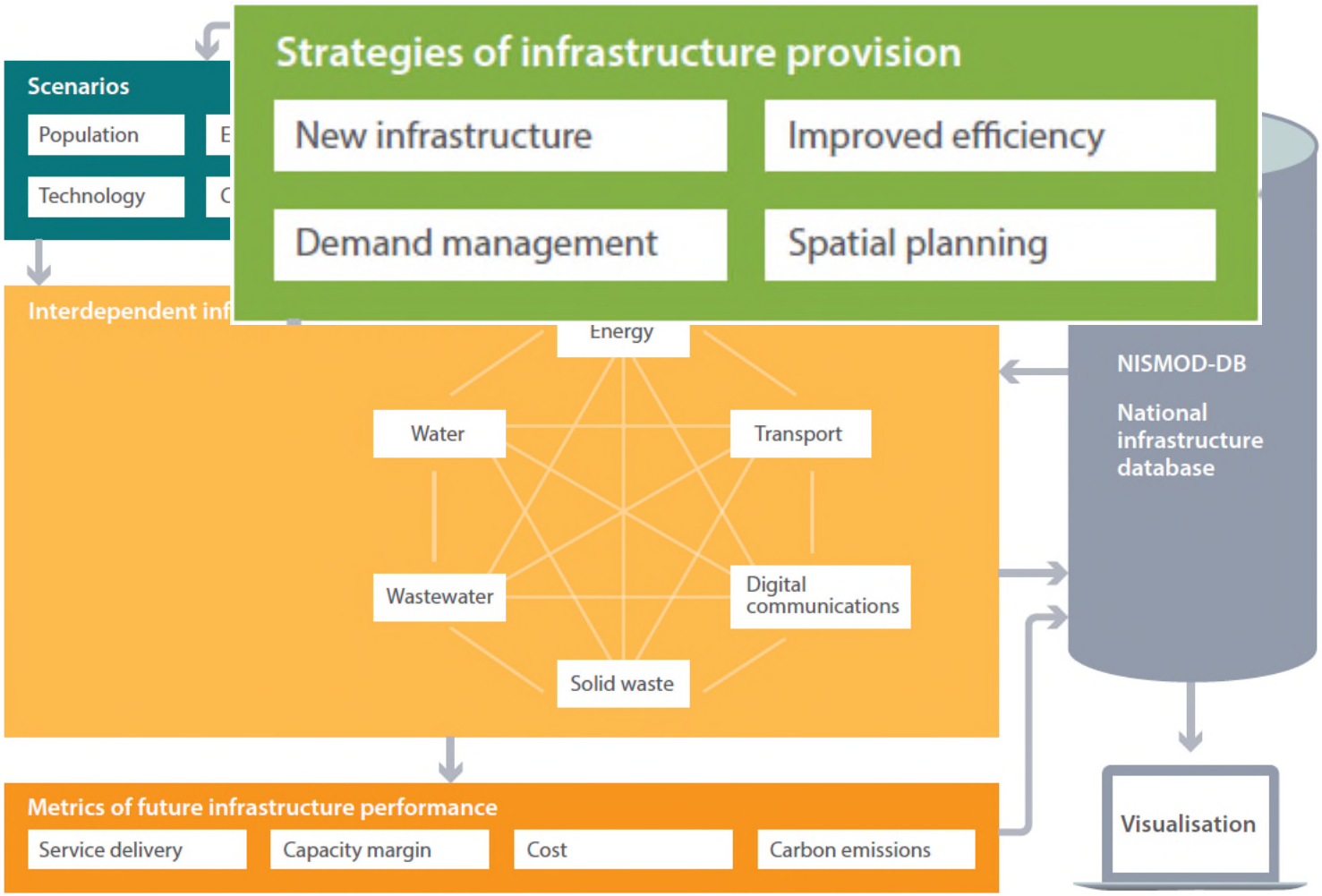
Drivers of future need: Regional growth



Drivers of future need: Economic growth



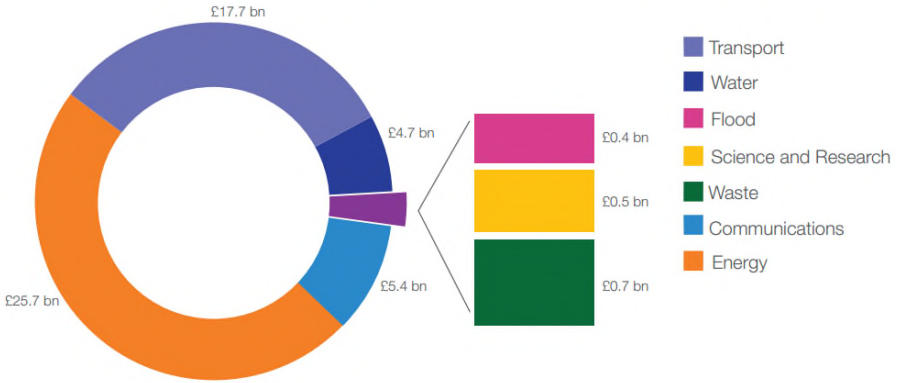
Infrastructure strategies



National Infrastructure Pipeline (NIP) investments analysed in NISMOD

Sector	Pipeline value (£bn)	Number of projects/ programmes	Number in priority list
Communications	7.0	6	4
Energy	244.9	158	65
Flood	3.5	27	27
Science and Research	1.4	26	6
Transport	127.4	302	88
Waste	1.0	16	0
Water	25.7	29	29
Total	**411.0**	**564**	**219**

Chart ES.1: 2014 infrastructure pipeline, by sector, spend in 2015-16



Source: HM Treasury, Major Infrastructure Tracking Unit
Note: Spend on energy in 2015-16 includes oil and gas of £12 billion

Infrastructure UK

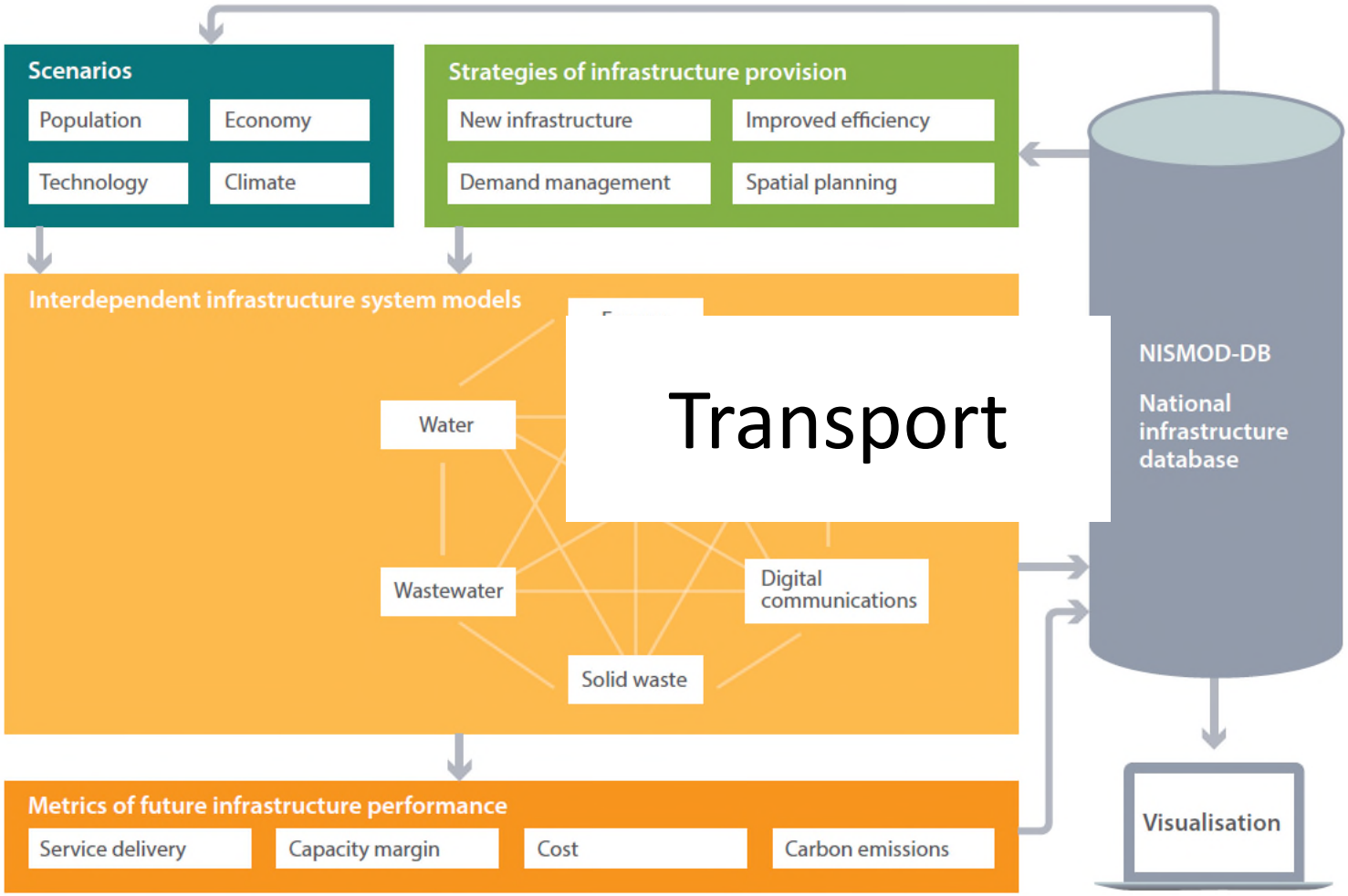
The NNA national infrastructure strategy in summary

- A recognition of the need to respond to drivers of future demand
- Provision of new infrastructure capacity to unlock growth and provide sustainable services
- Willingness to manage demand, with the help of smart technologies
- Commitment to carbon targets, with major implications for all sectors, especially energy
- Investment in resilience to future shocks and changes
- Informing the agenda for timely policy, regulation and investment

ice Institution of Civil Engineers

National Infrastructure Commission

Transport system



Transport demand projections

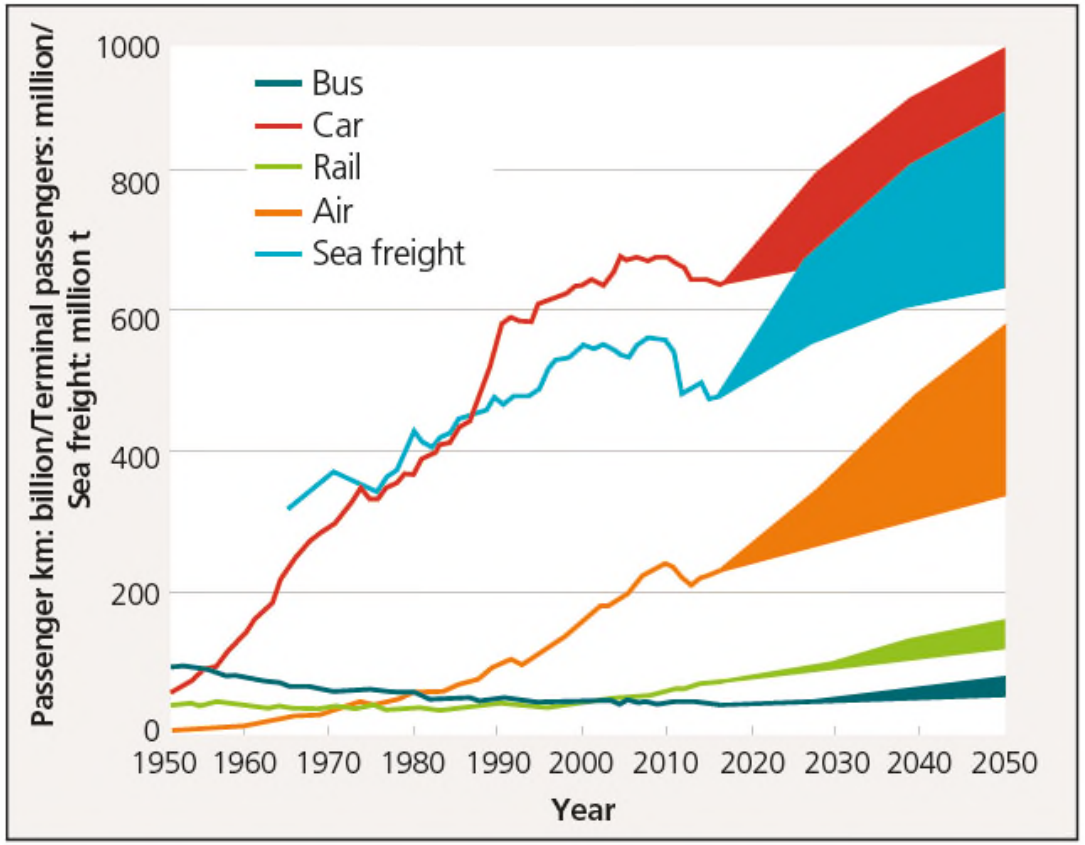


Figure 9. Historic trends and projections of transport usage for *National Needs Assessment* transport strategy and central population/economic scenario. Car and air projections are based on Department for Transport forecasts (DfT, 2013, 2015), but with more aggressive demand management and strong 'peak car' assumptions associated with the lower bound projections for cars

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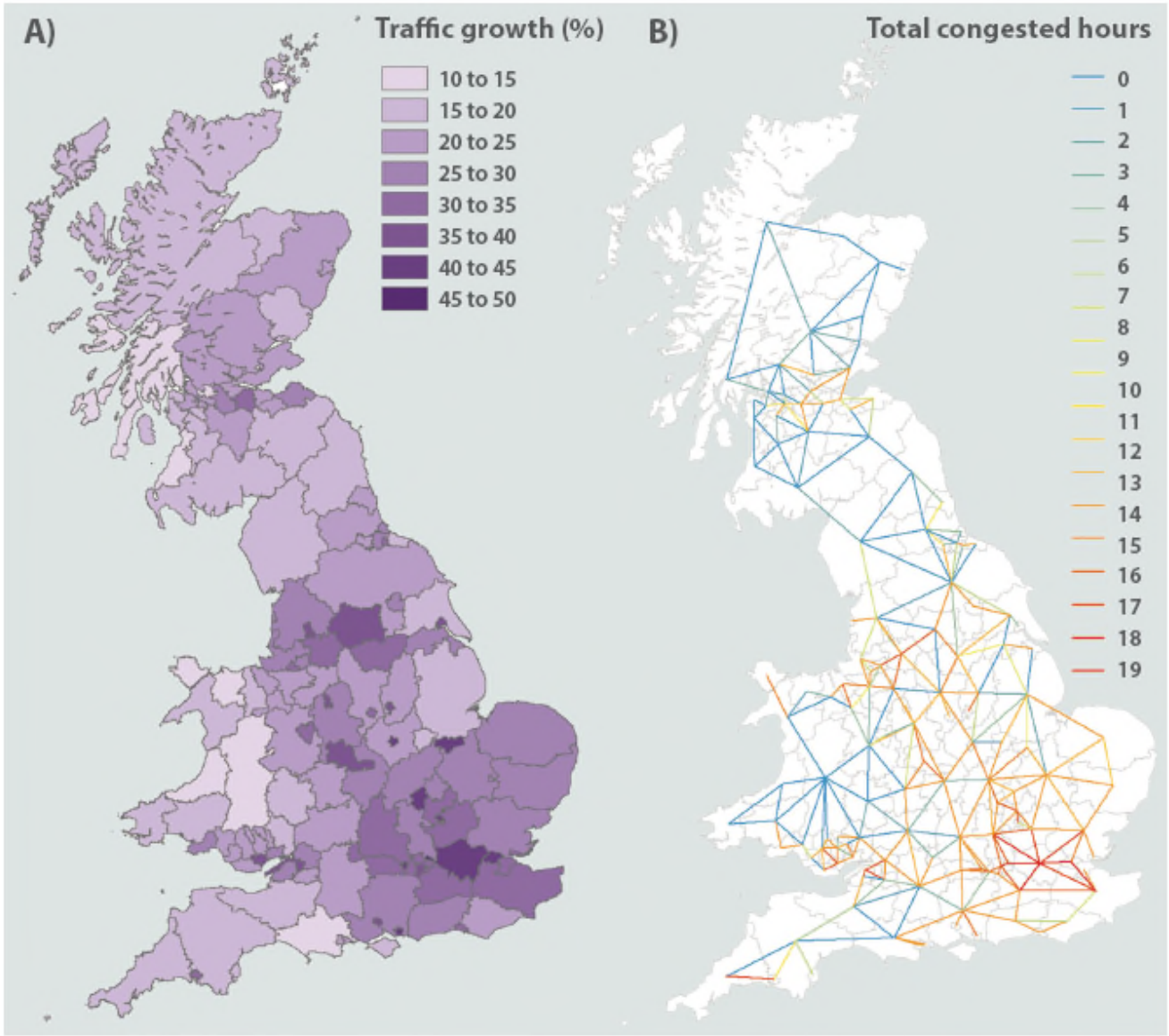
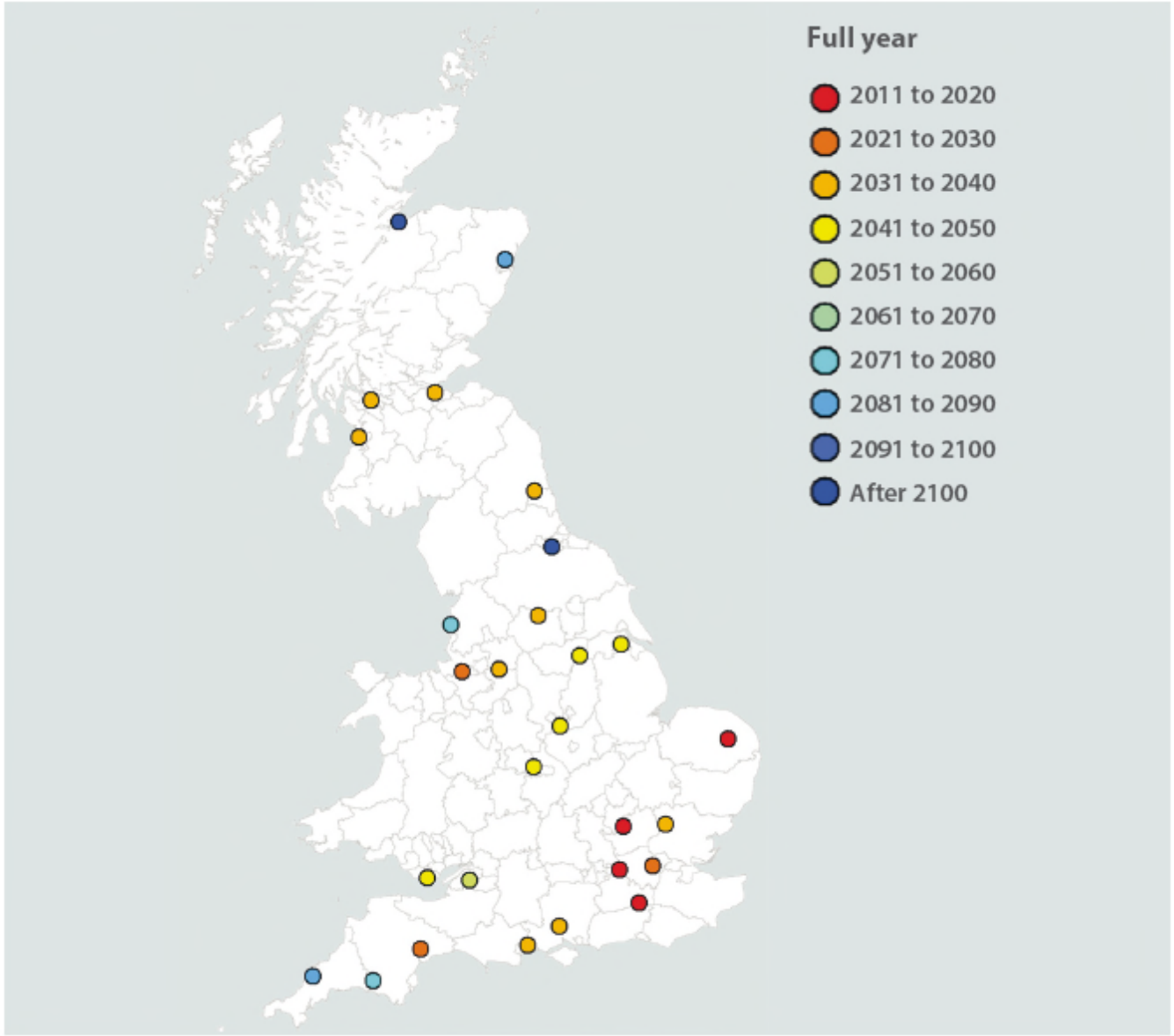
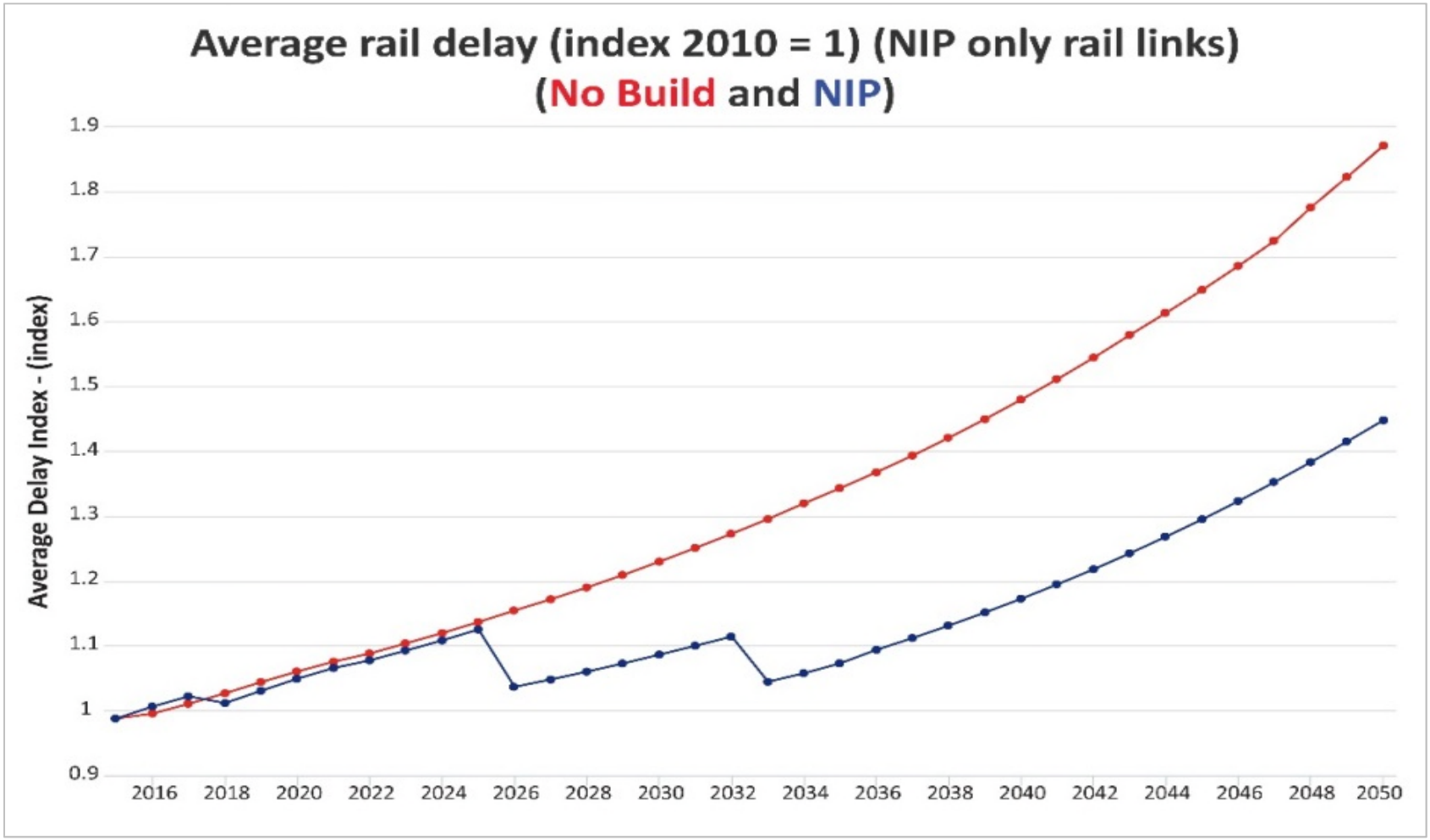
Transport congestion



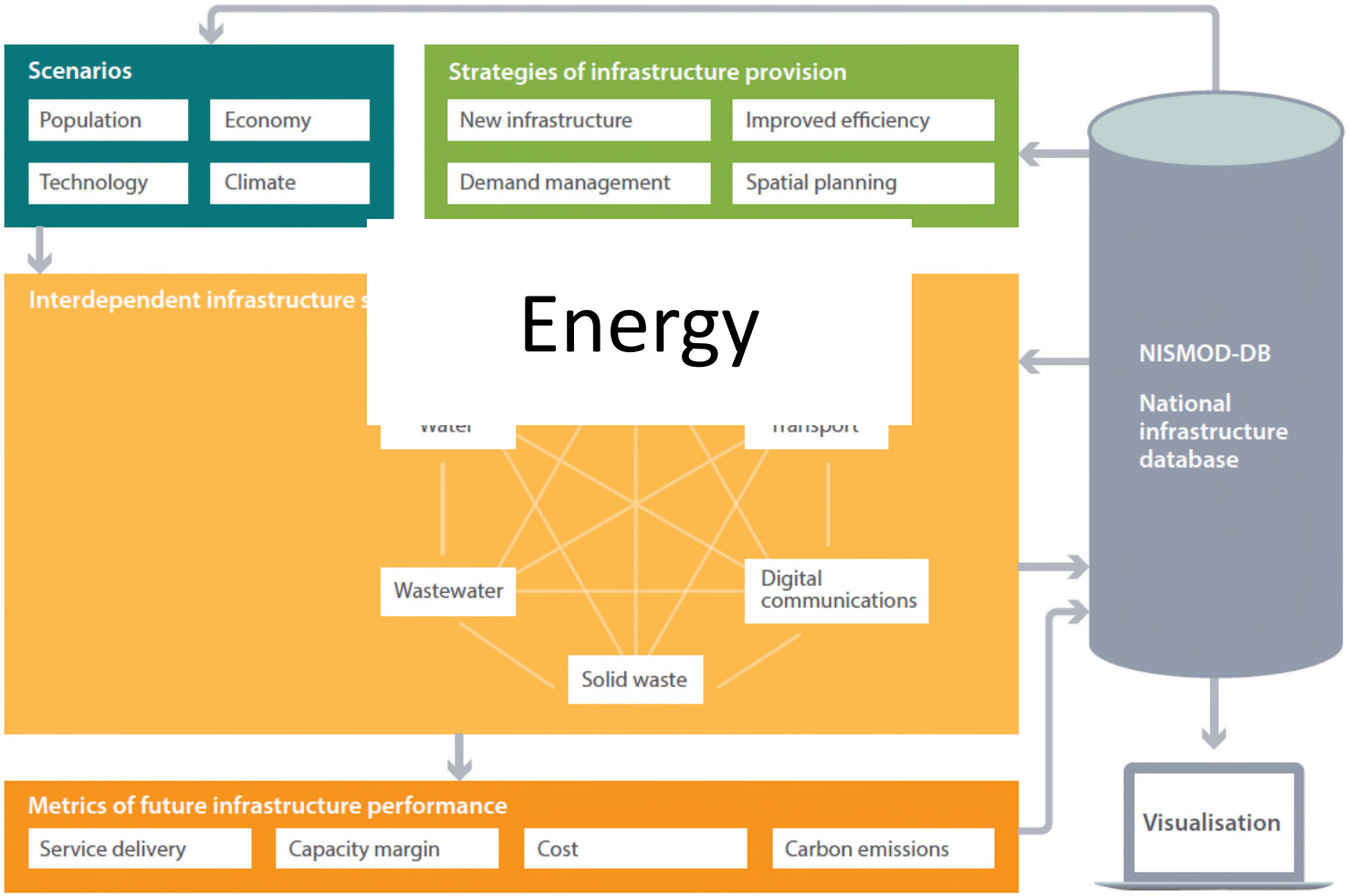
Airport capacity



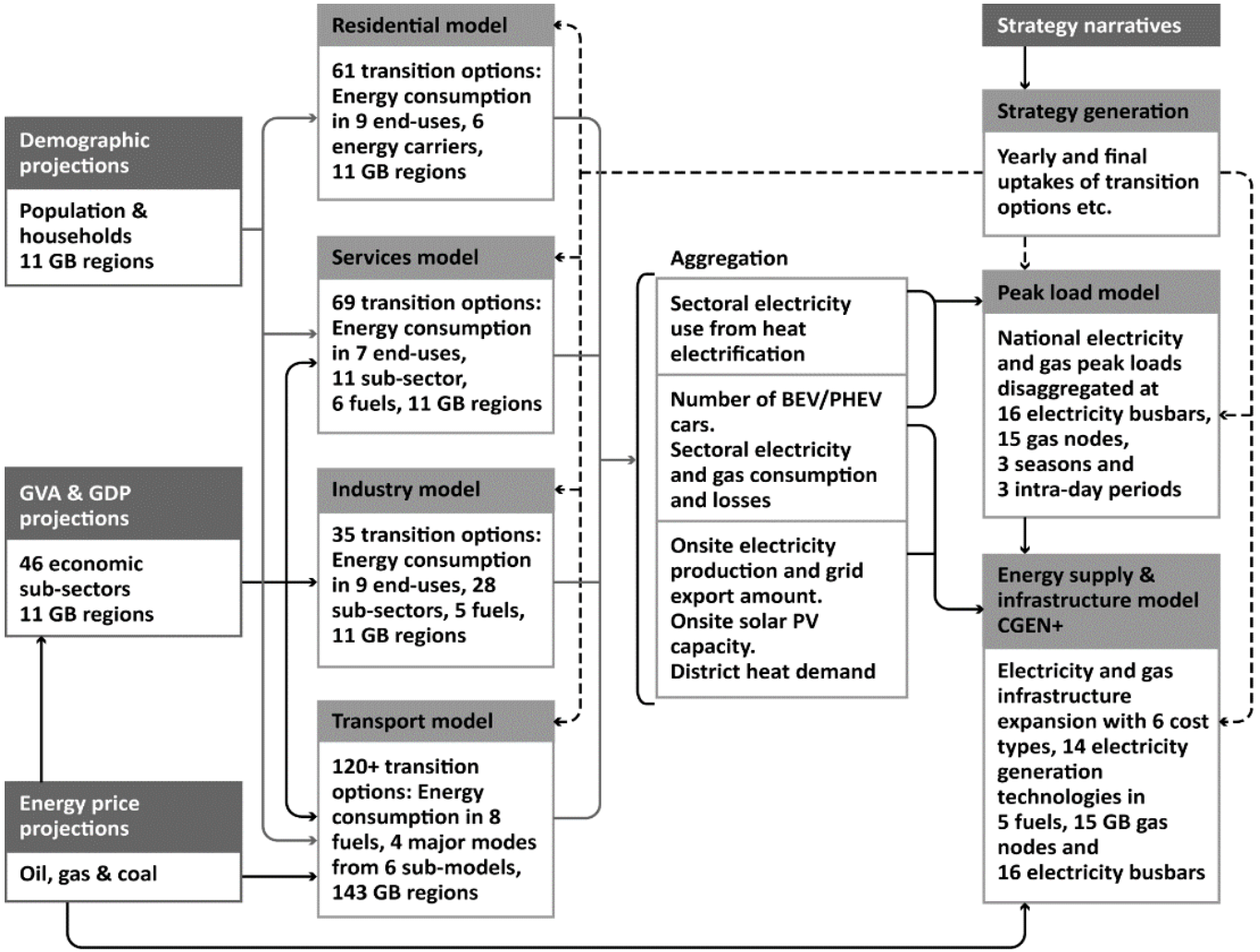
NIP rail investments – HS2



Energy system



Energy modelling



Testing specific energy investments

Example: Hinckley Point C

MinP = minimum power output (MW)
MaxP = maximum power output (MW)

BusNum (15) = SW England and Wales
(16 busbars overall see ES_LU_BusData)

AddCapex = user-defined project

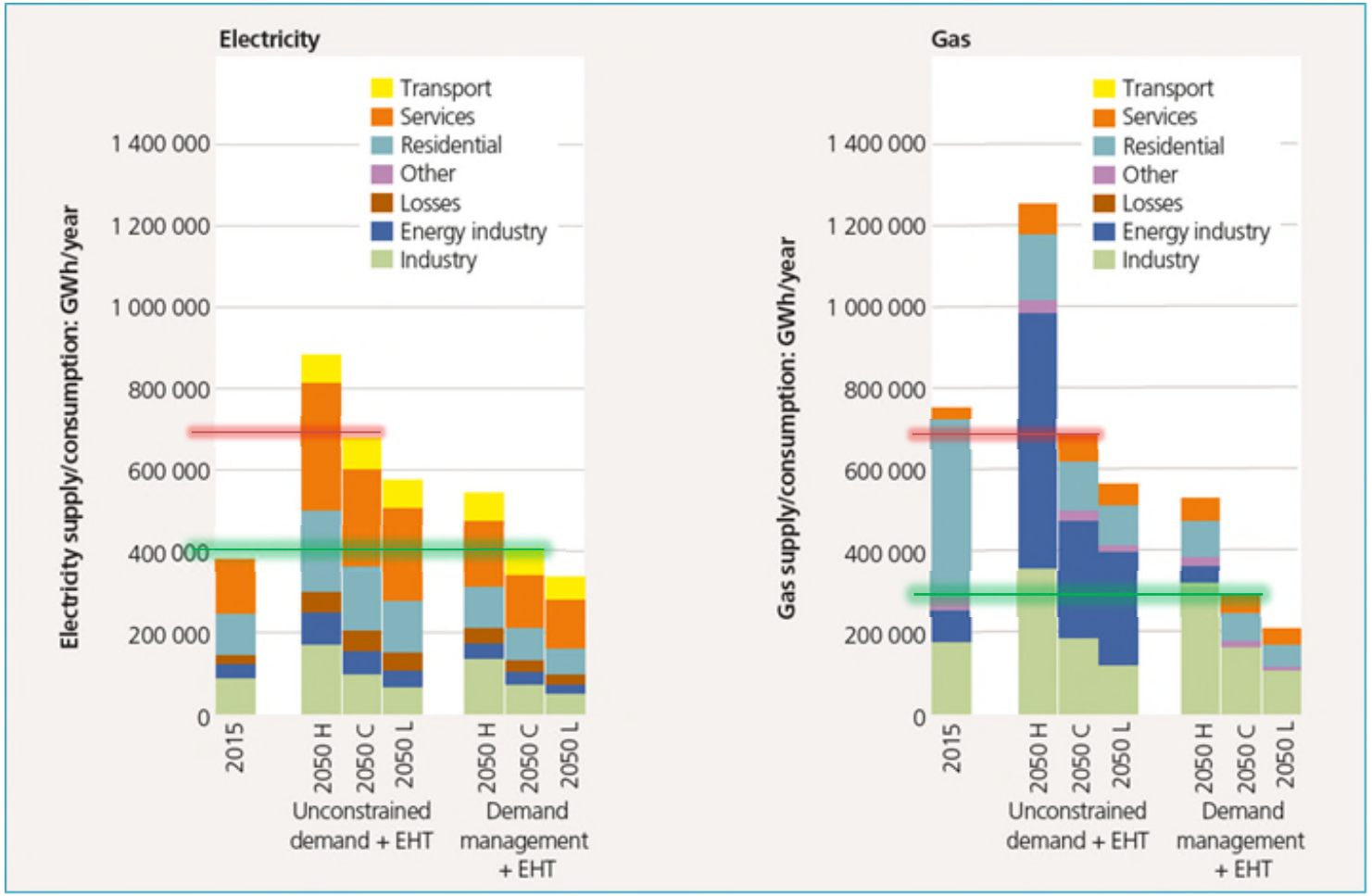
GenID	GenNum	GenName	GenType	Type	BusNum	MinP	MaxP	Year	Retire	Connect	AddCapex	Residual
....	500	Hinkley Point C	Nuclear EPR	4	15	0	3200	2023	2083	0	1	0

Type (4) = Nuclear European Pressurised Reactor
(20 types overall – see ES_LU_GenType)

Year = year connected to grid
Retire = year of asset retirement
(fixed lifetime 60 yrs – see ES_I_NewGen_Base)

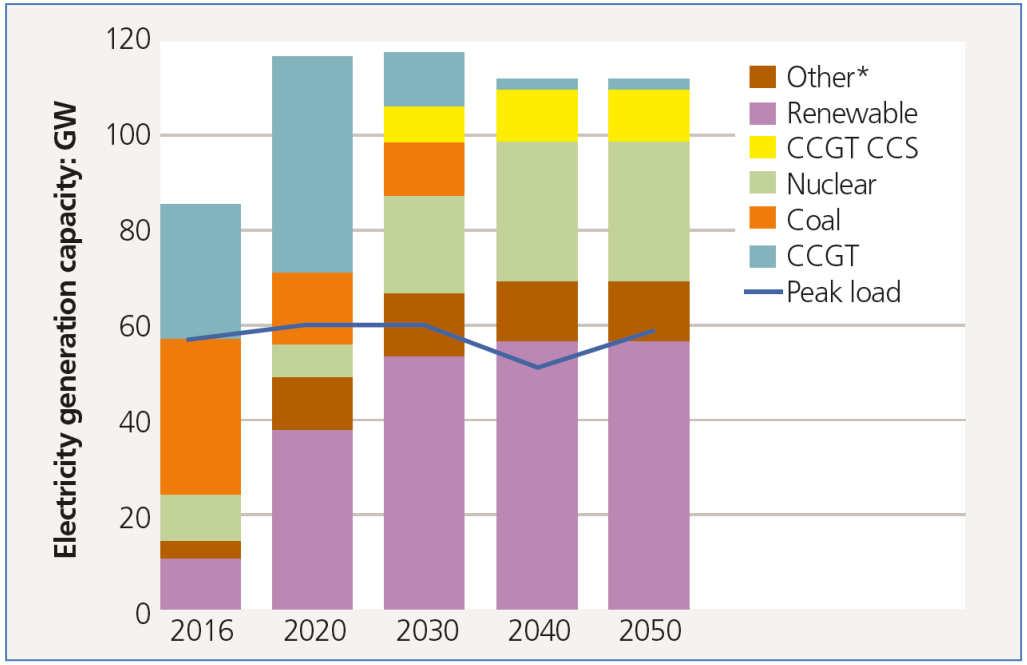
Image and logo taken from *"Hinkley Point C An Opportunity to Power the Future", February 2013.* Available at: https://www.edfenergy.com/sites/default/files/edf-energy-hinkley-point-c.pdf. Copyright

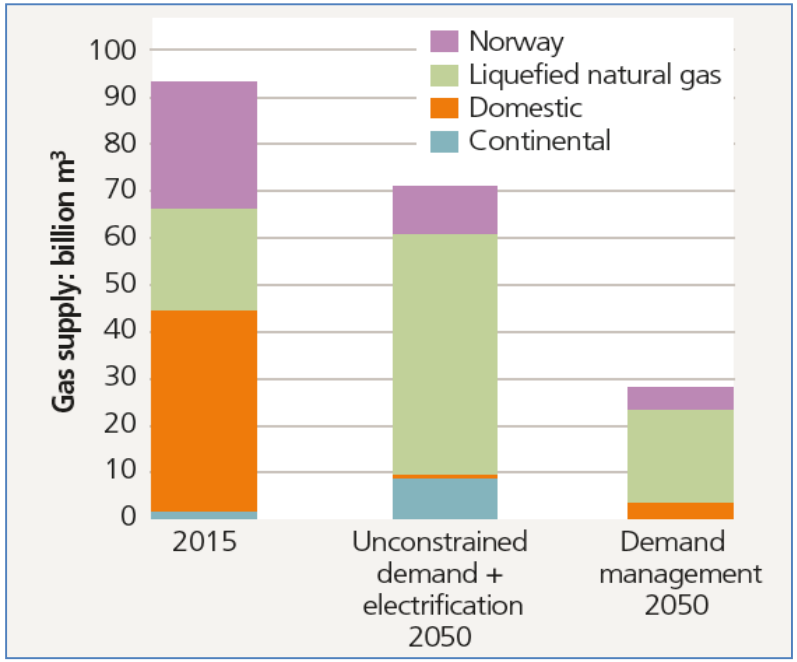
Electricity demand projections

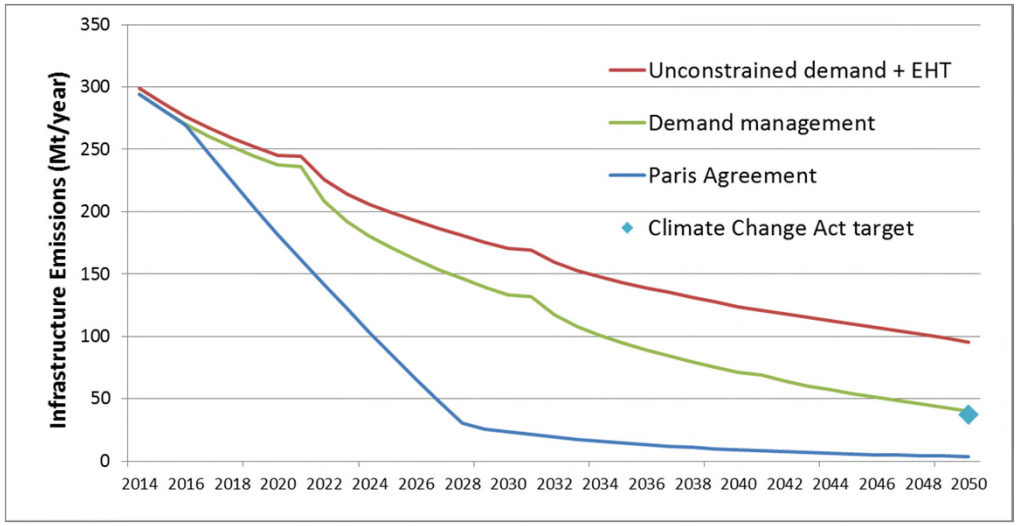


NISMOD projections of energy demand, for high (H), central (C) and low (L) population and economic growth scenarios. EHT is electrification of heat and transport

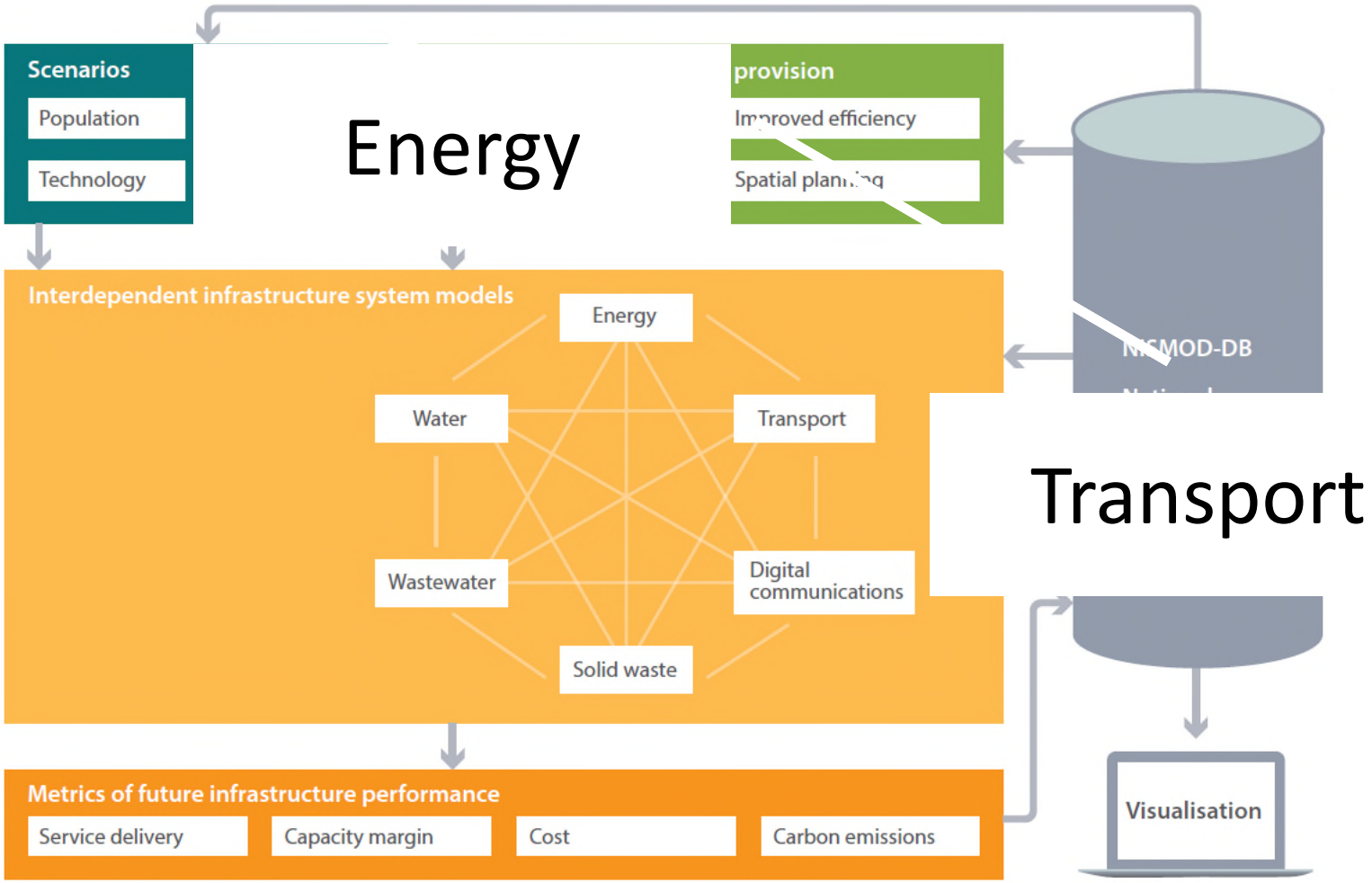
Electricity supply portfolios



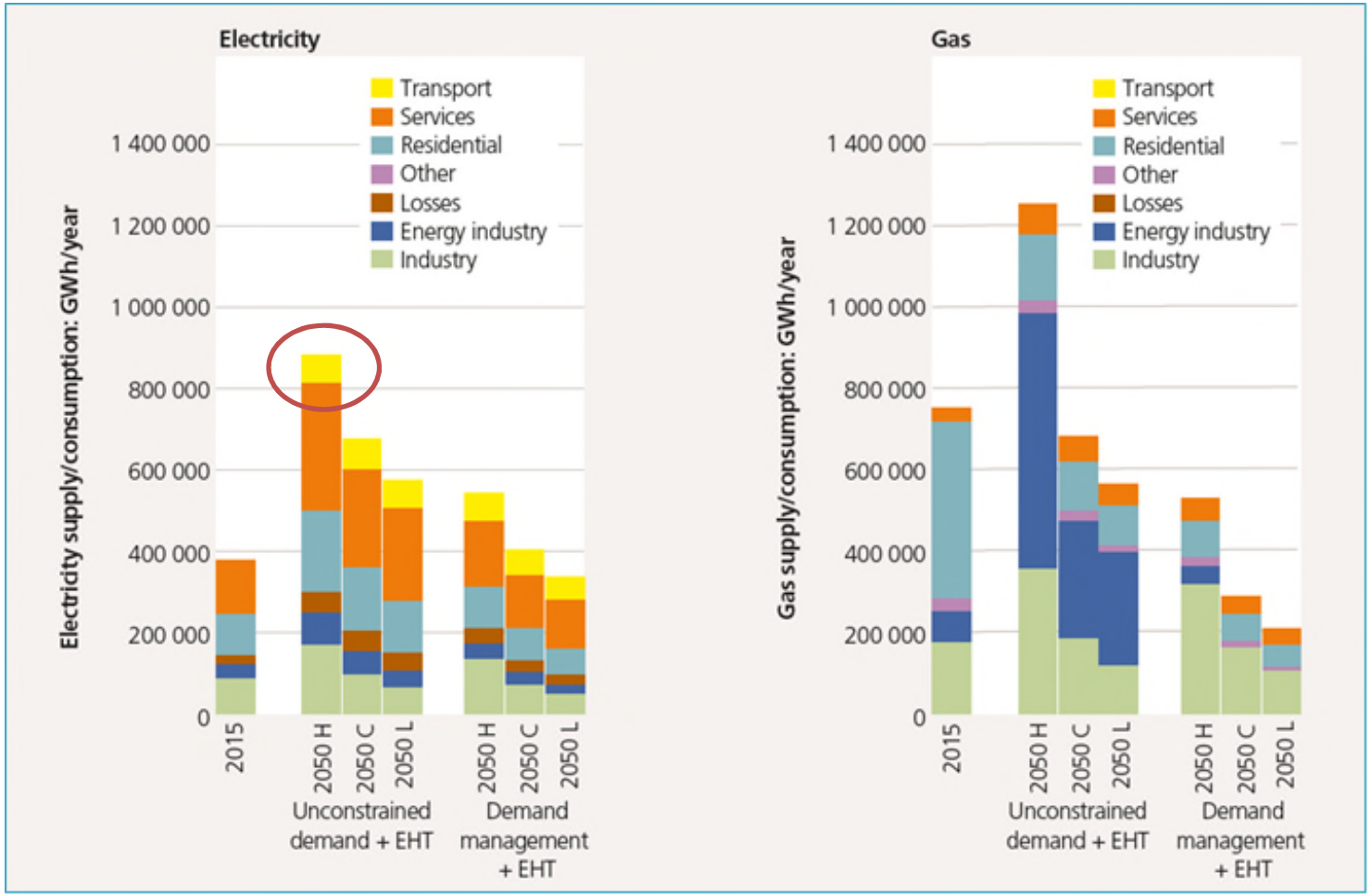




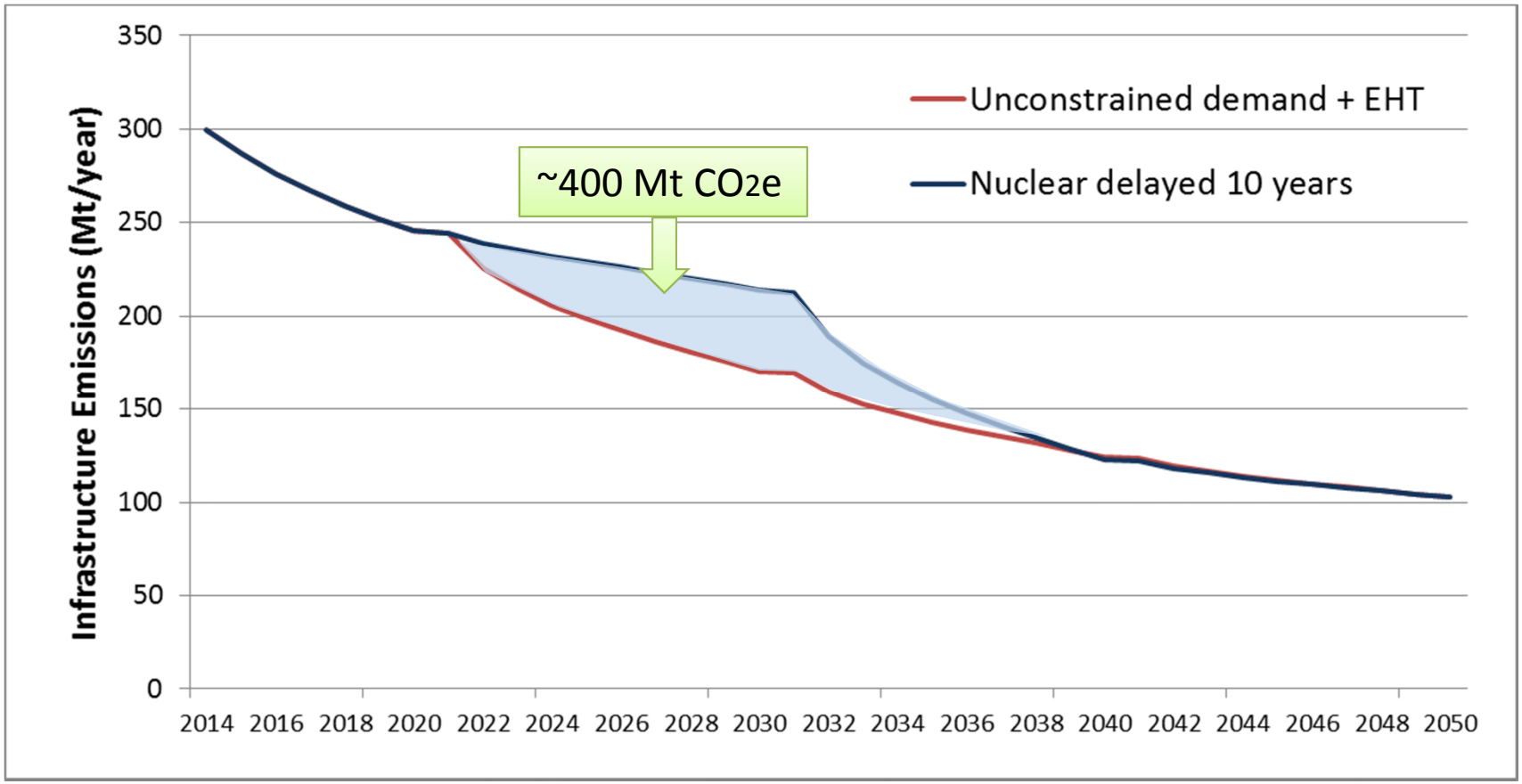
Energy-Transport interdependencies



Electricity demand projections

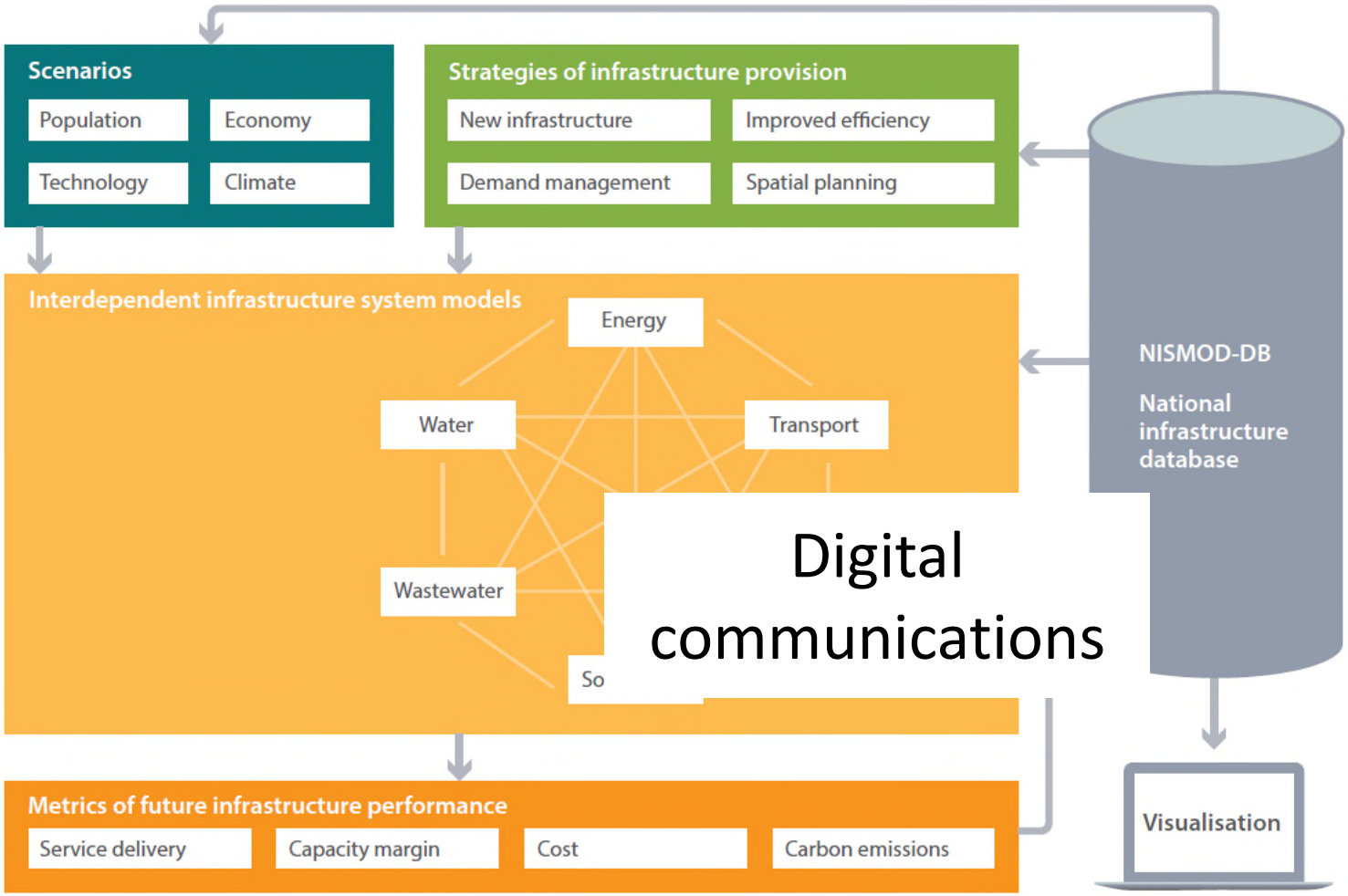


Coordinated pathways

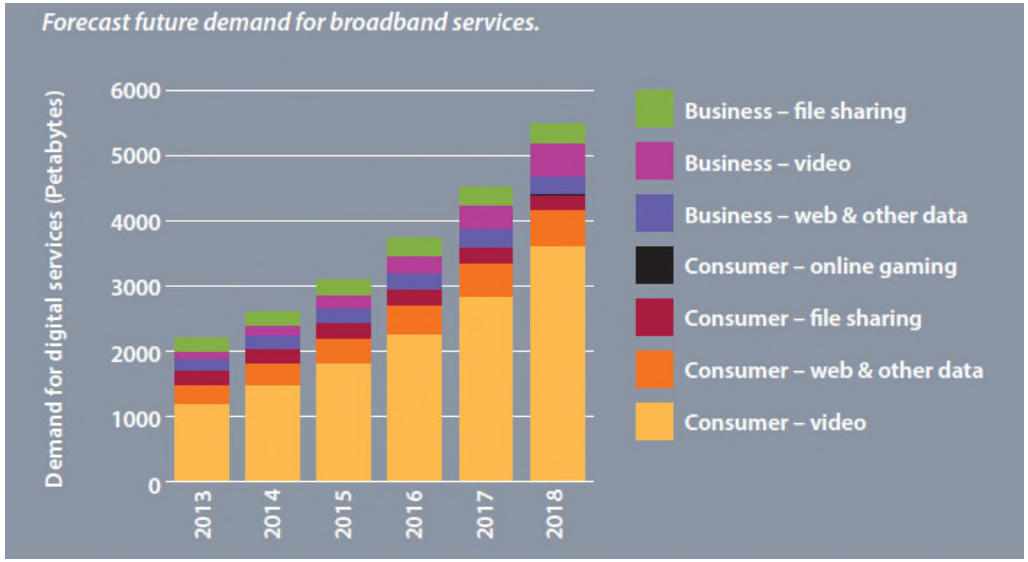


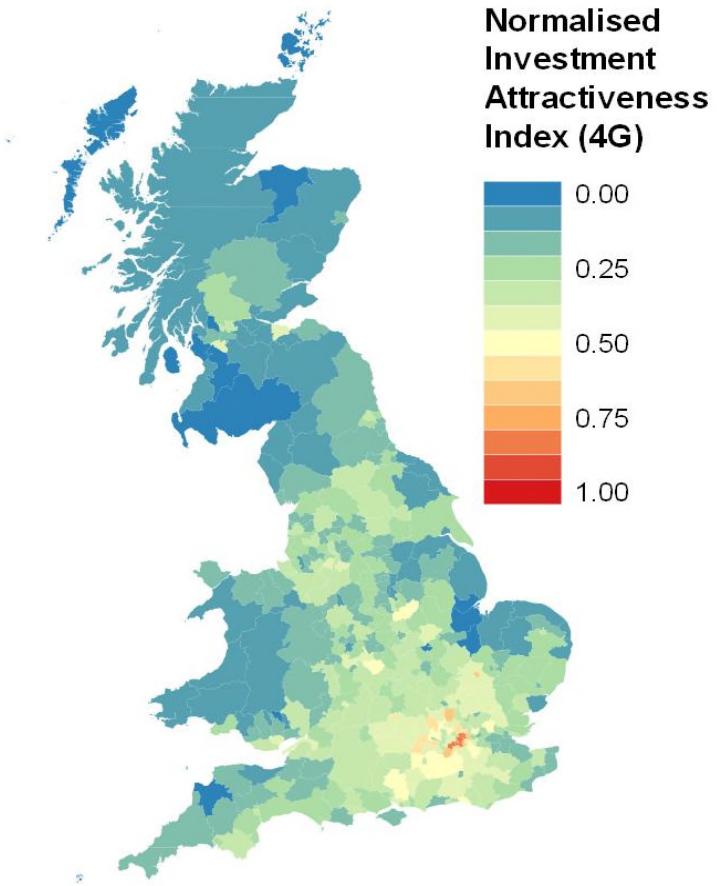
NISMOD projections on the cost of delaying all three planned nuclear generation projects in the 2020's by 10 years under the central (C) population and economic growth scenarios for the unconstrained demand management with electrification of heat and transport strategy [7]

Digital communications

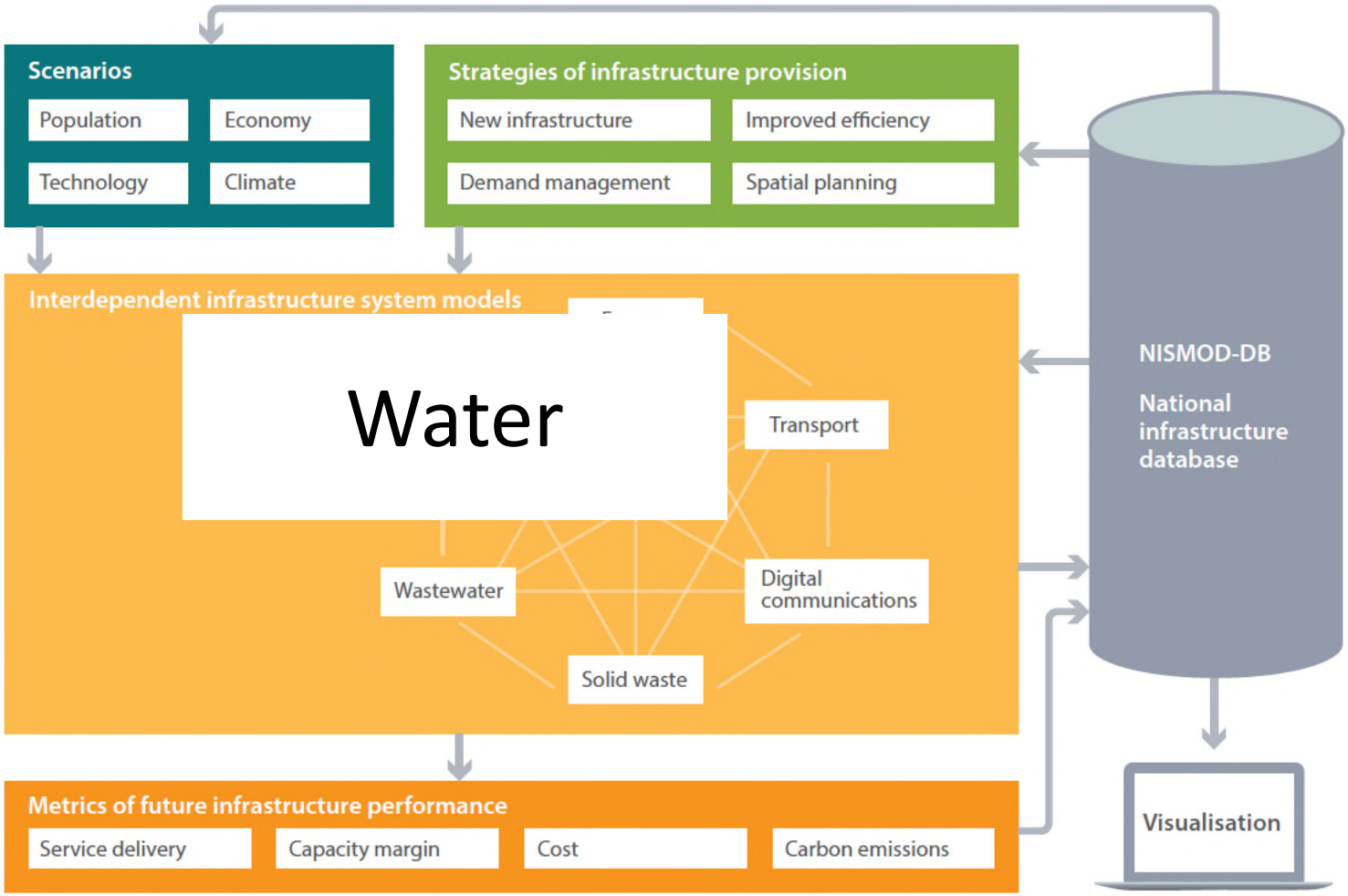


Digital connectivity





Water


Scenarios
Population
Economy
Technology
Climate
Strategies of infrastructure provision
New infrastructure
Improved efficiency
Demand management
Spatial planning
Interdependent infrastructure system models
Water
Transport
Wastewater
Digital communications
Solid waste
Metrics of future infrastructure performance
Service delivery
Capacity margin
Cost
Carbon emissions
NISMOD-DB
National infrastructure database
Visualisation

Water demand

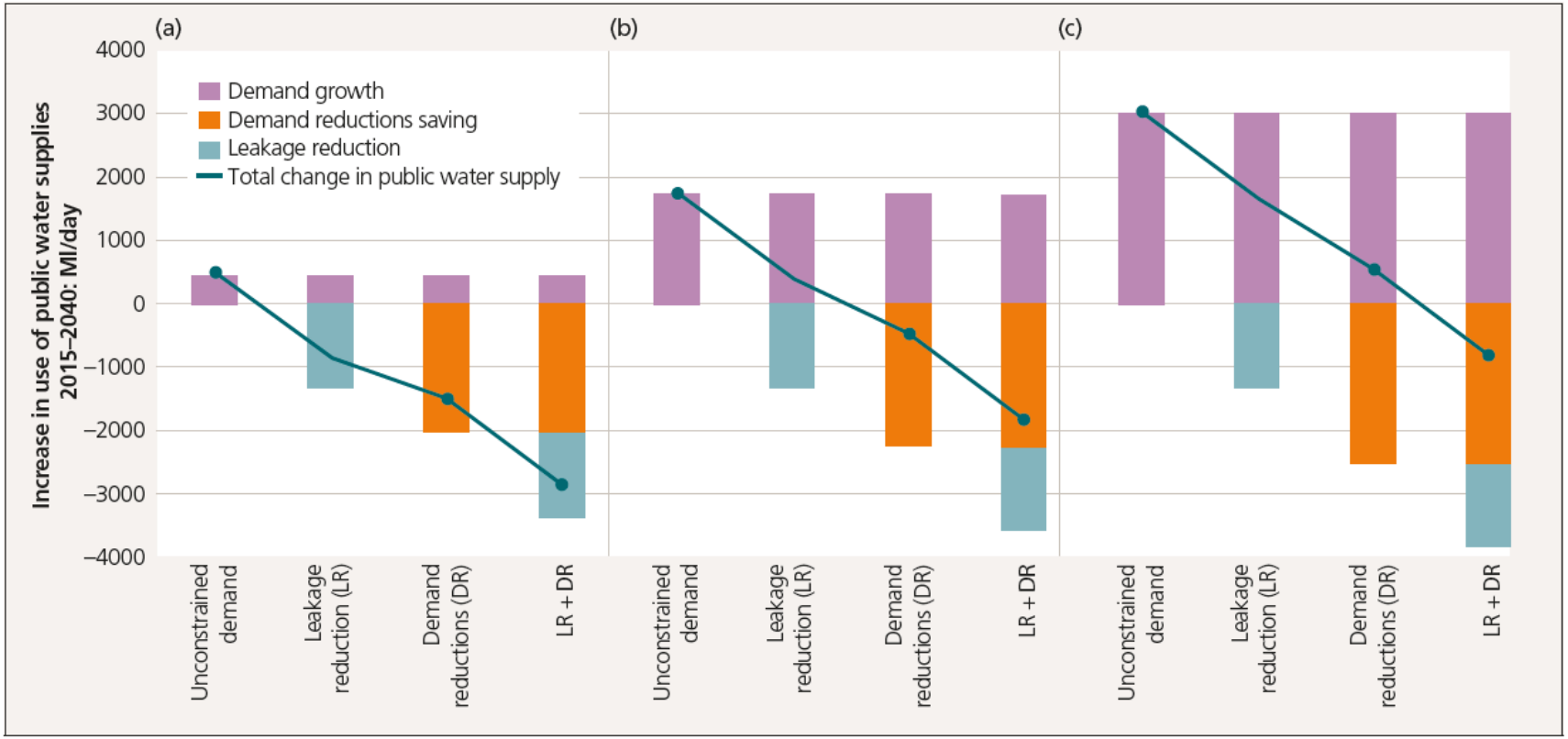
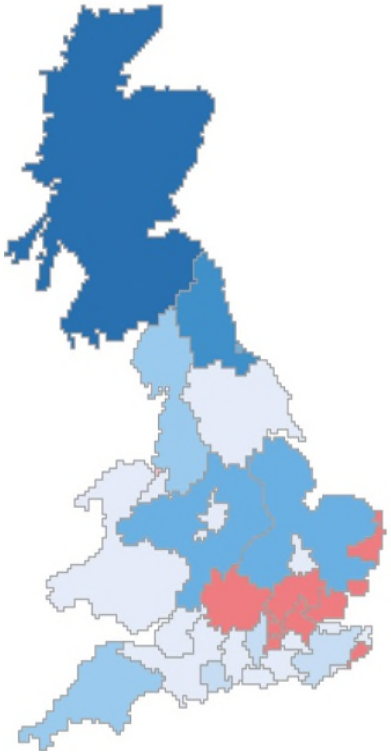


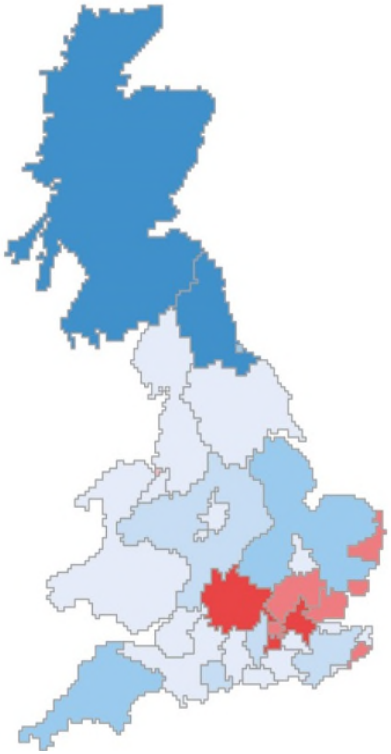
Figure 11. Projections of changing use of public water supply and the effect of the *National Needs Assessment* strategy for water demand management and leakage reduction: (a) low, (b) central and (c) high population growth

Water supply

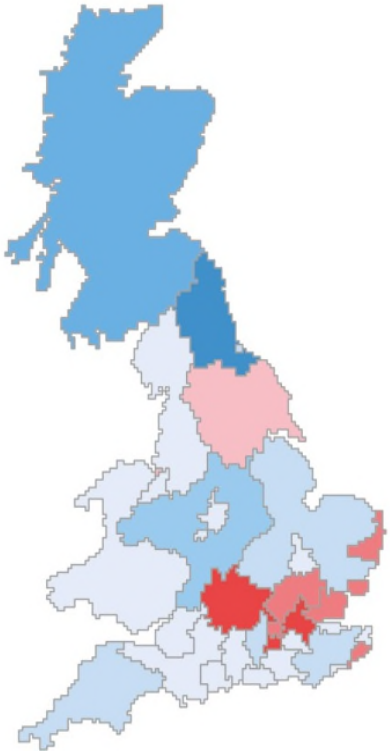
Low population growth
High flow climate scenario



Central growth
Central flow climate scenario

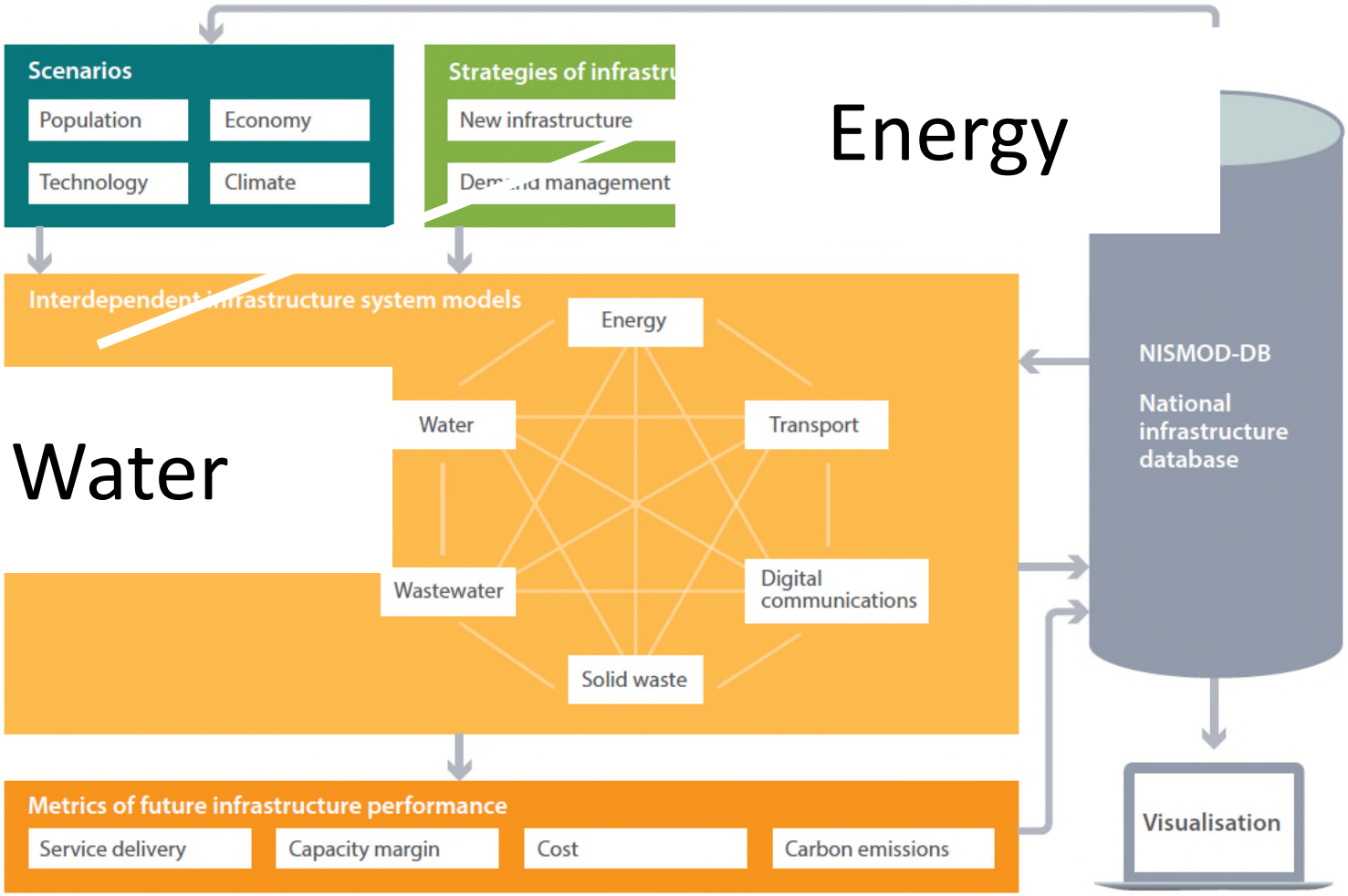


High population growth
Low flow climate scenario

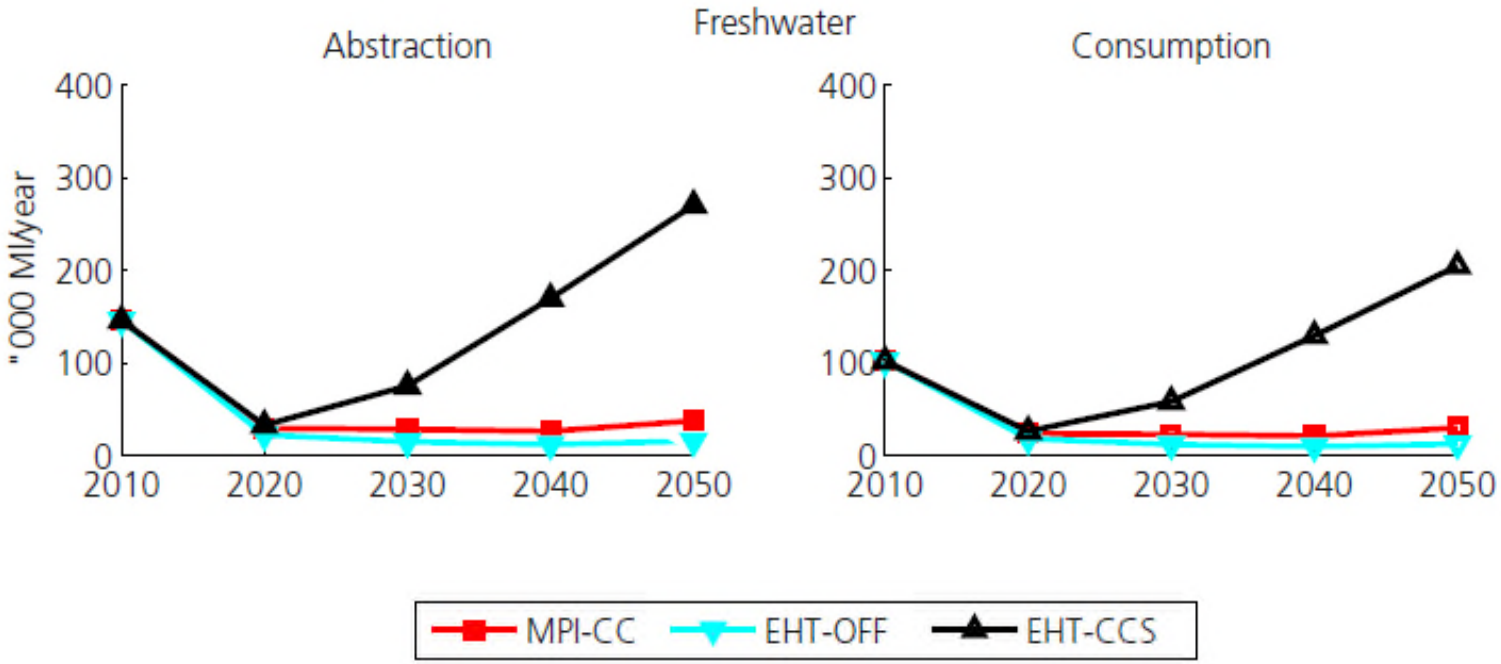


Supply–demand balance (ML/d)

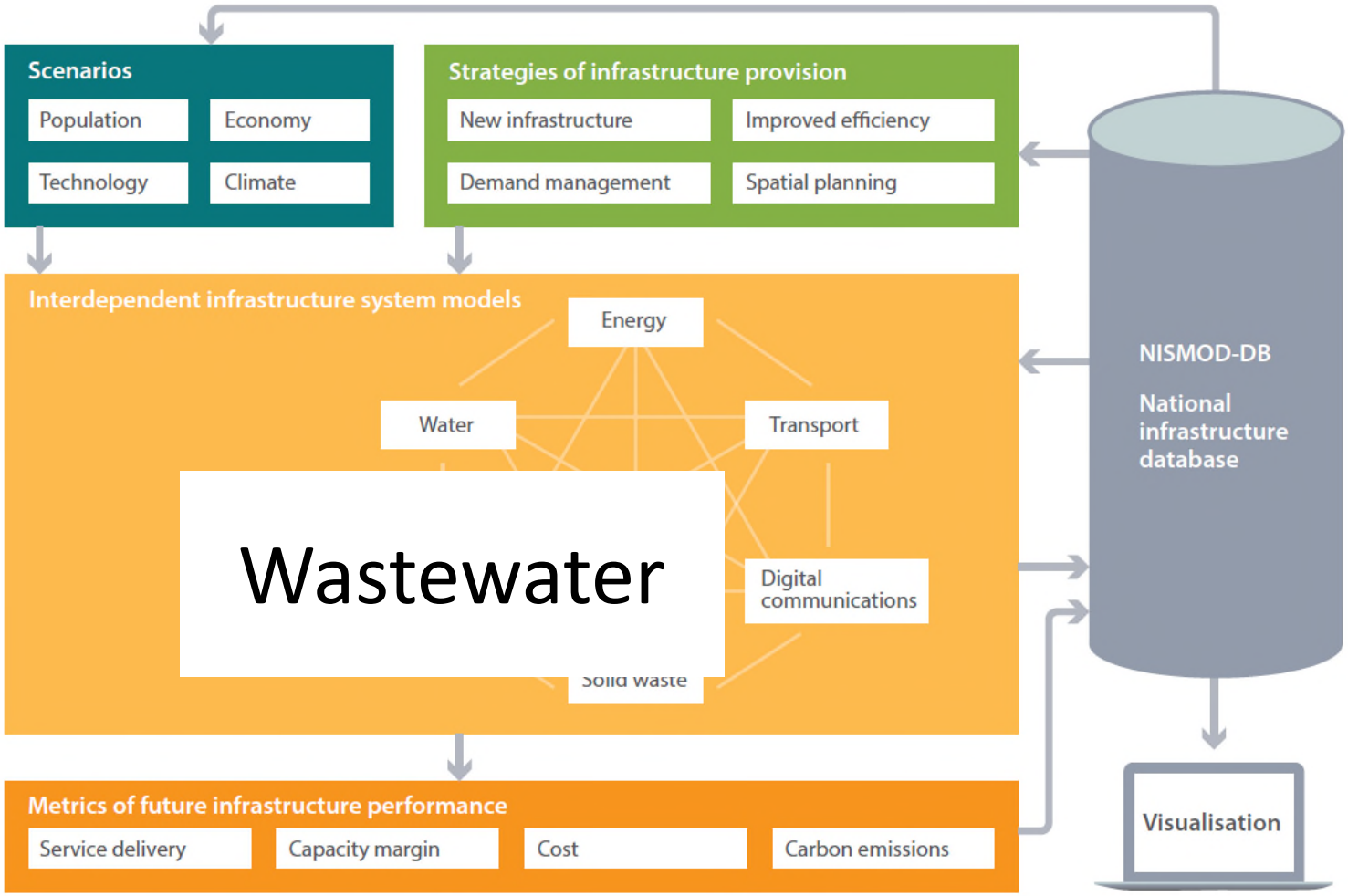
Energy-water interdependency



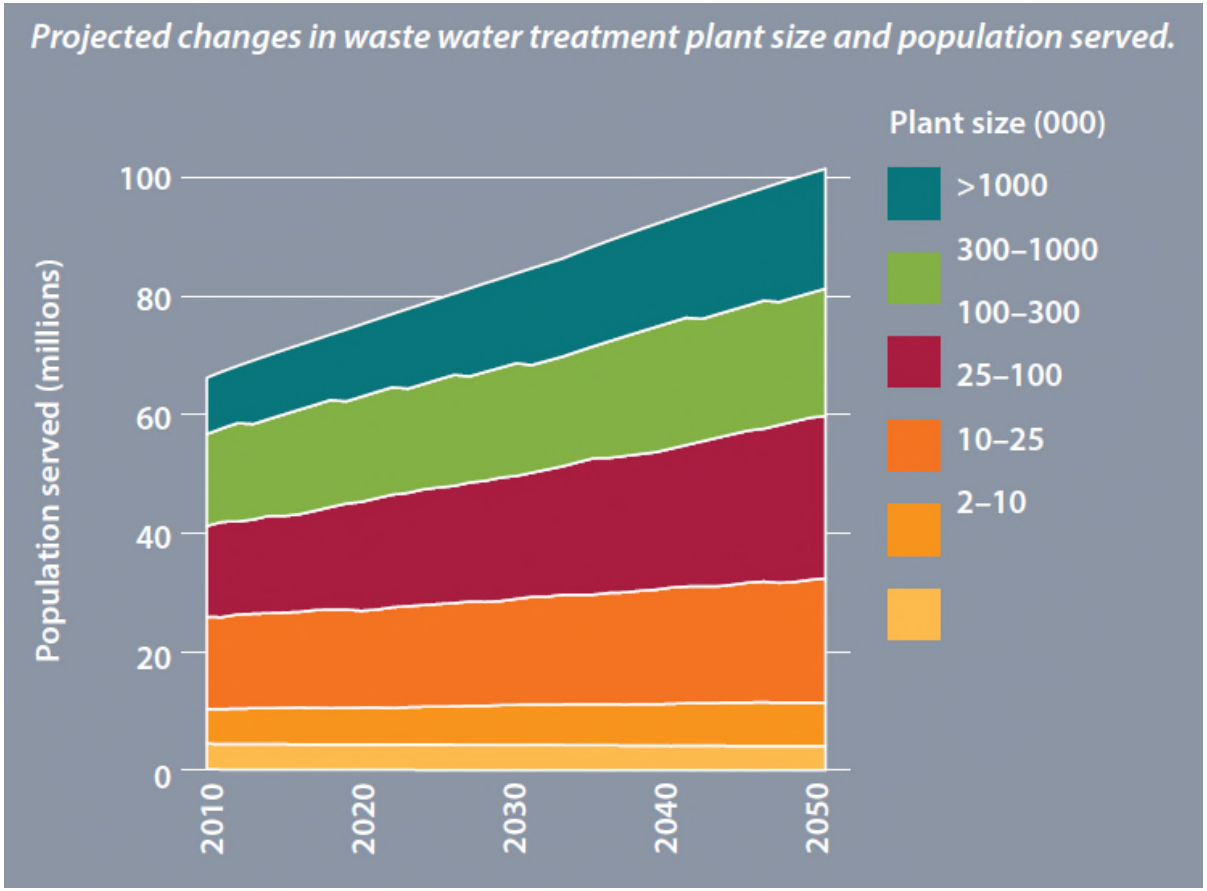
Interdependencies: cooling water demand for thermo-electric plants



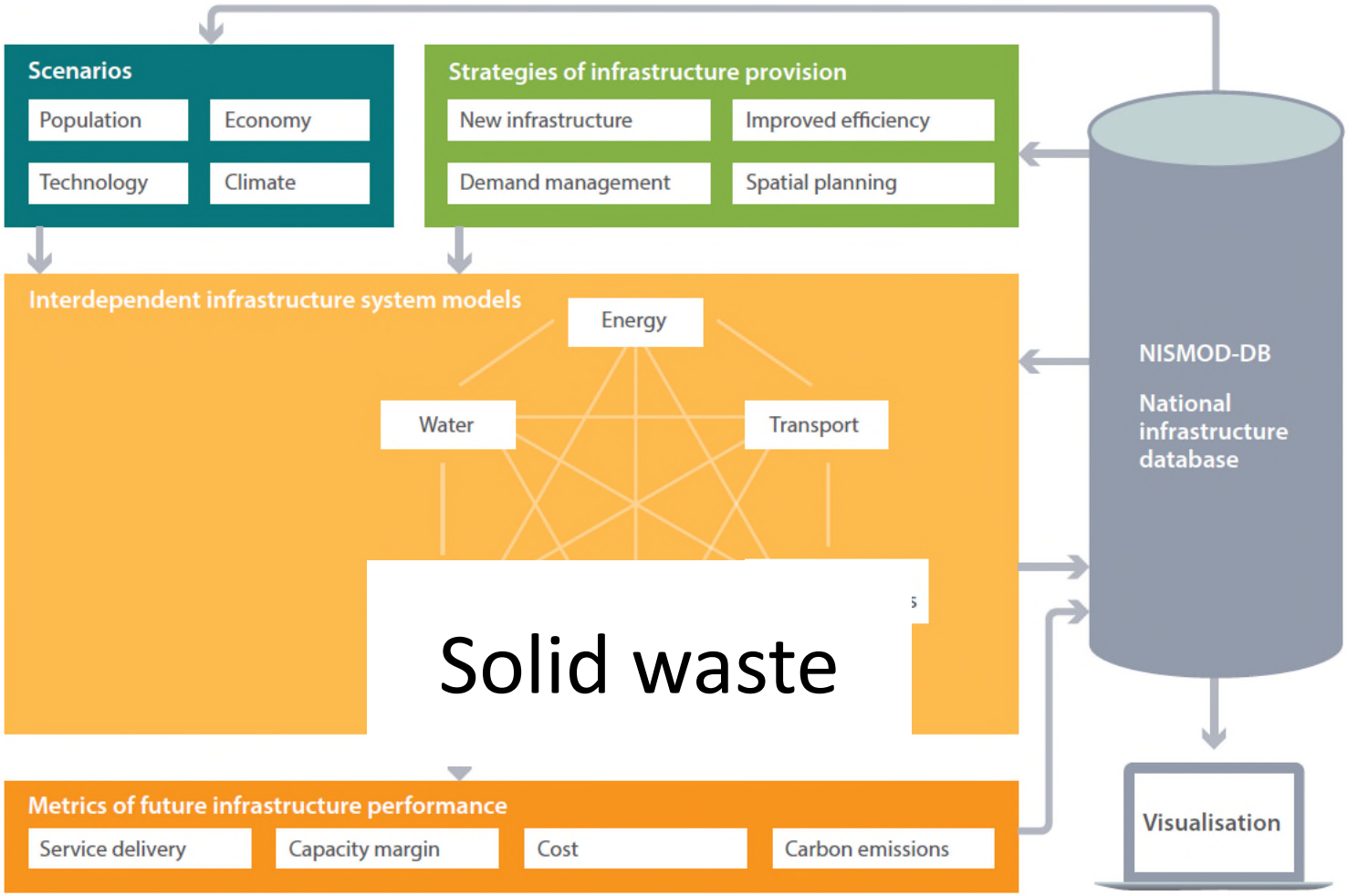
Waste water


Scenarios
Population
Economy
Technology
Climate
Strategies of infrastructure provision
New infrastructure
Improved efficiency
Demand management
Spatial planning
Interdependent infrastructure system models
Energy
Water
Transport
Wastewater
Digital communications
Solid waste
NISMOD-DB
National infrastructure database
Visualisation
Metrics of future infrastructure performance
Service delivery
Capacity margin
Cost
Carbon emissions

Waste water treatment plant requirements



Solid waste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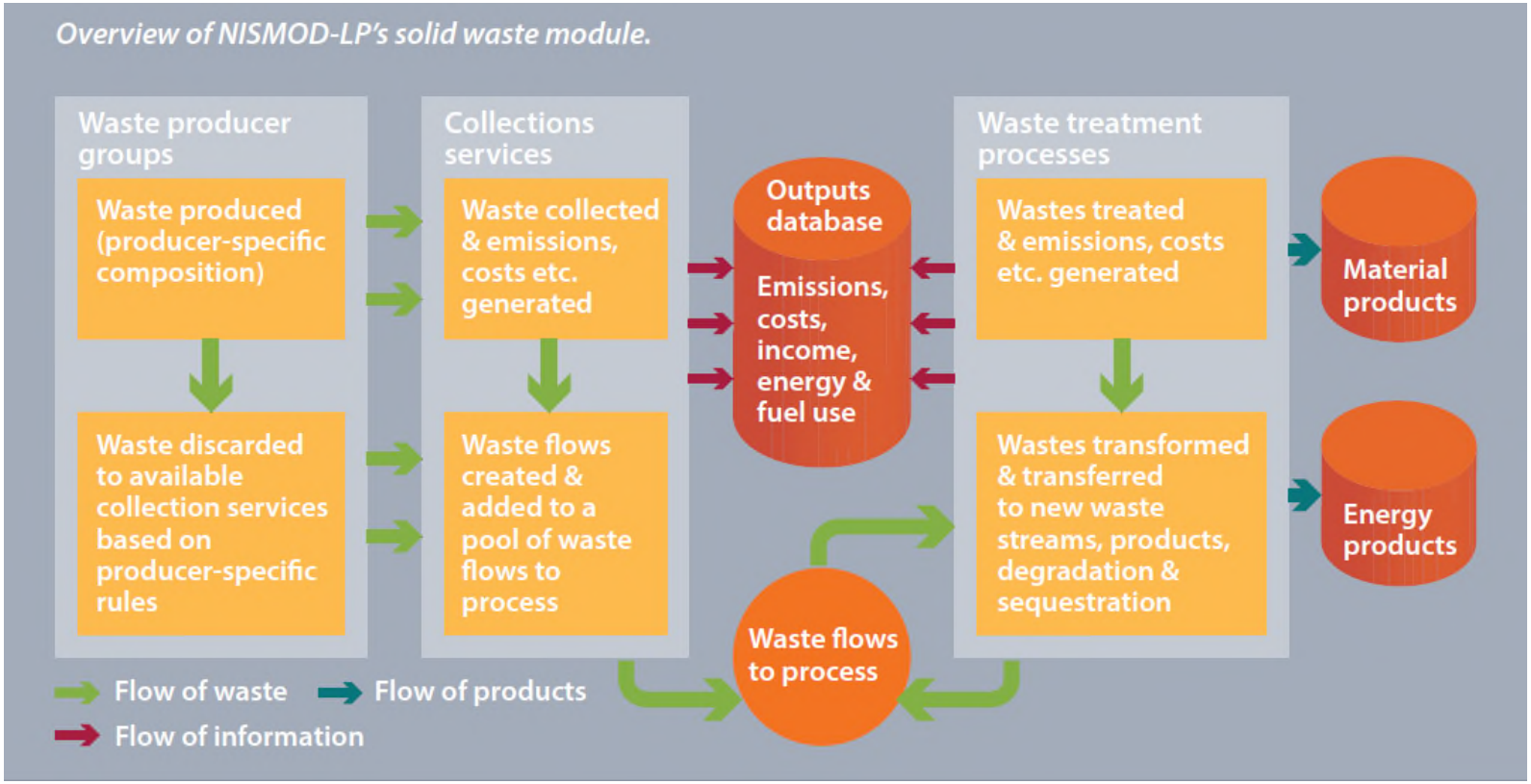
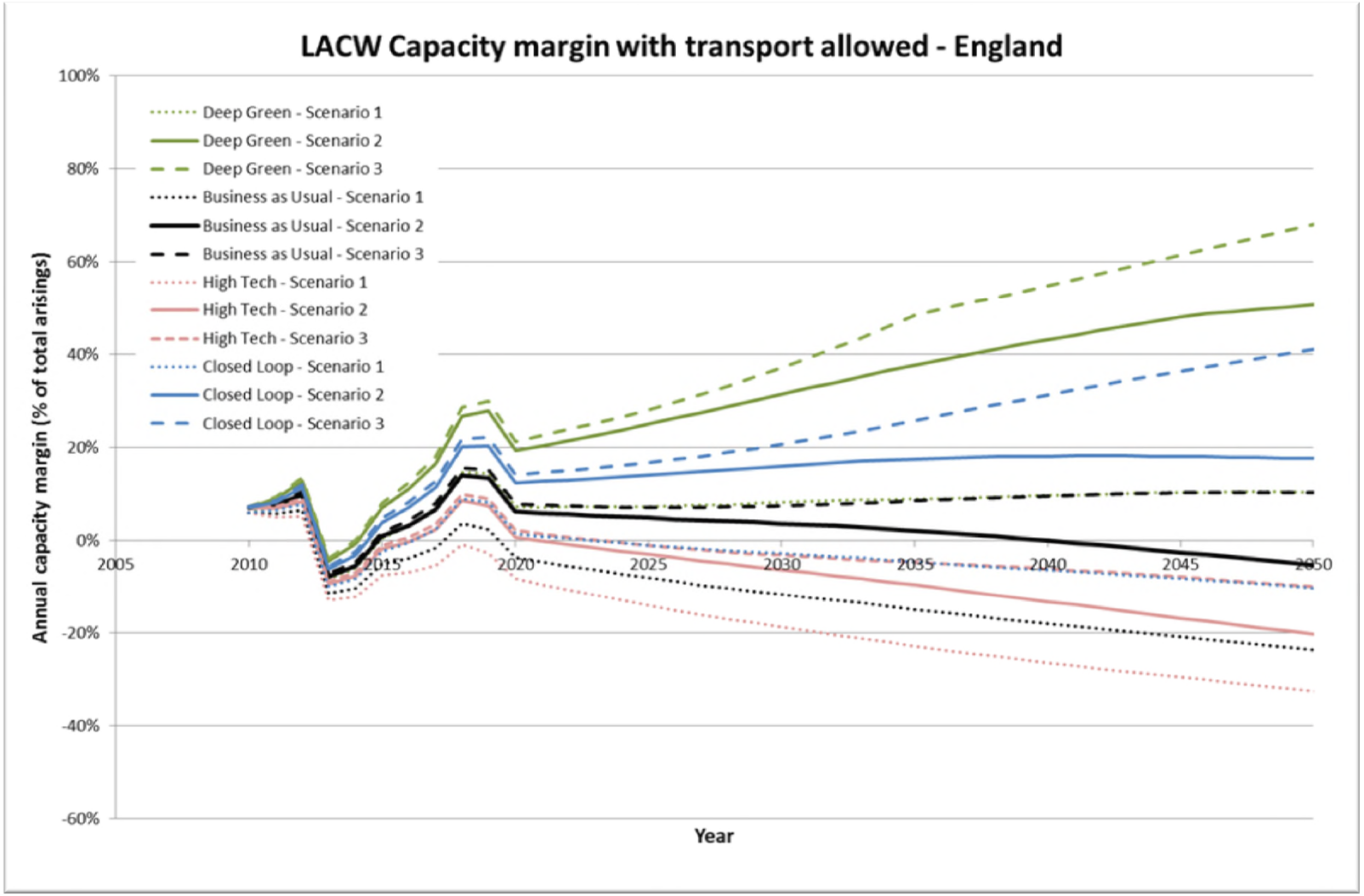
Visualisation

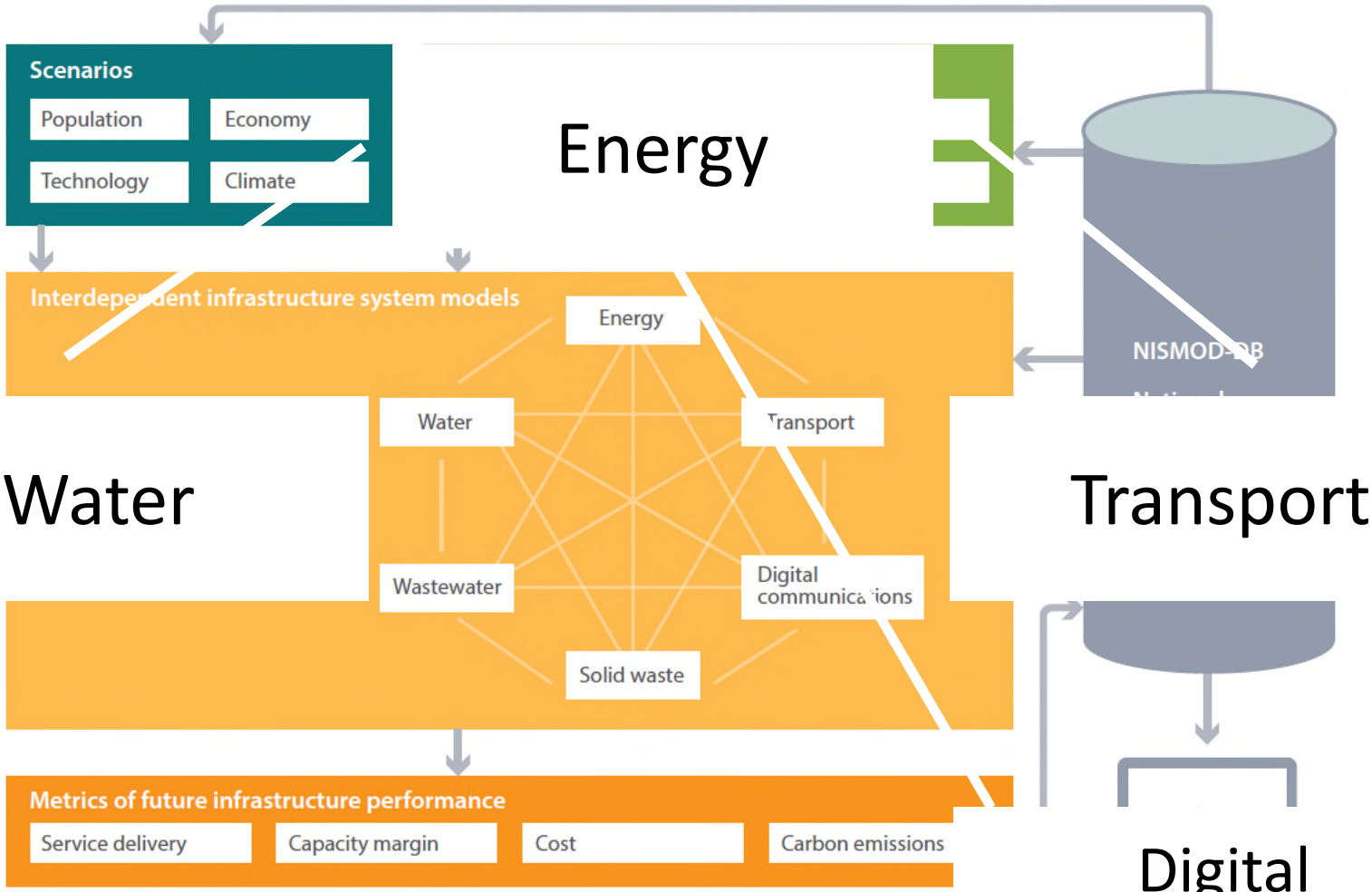
Solid Waste


Overview of NISMOD-LP's solid waste module.
Waste producer groups
Waste produced (producer-specific composition)
Waste discarded to available collection services based on producer-specific rules
Collections services
Waste collected & emissions, costs etc. generated
Waste flows created & added to a pool of waste flows to process
Outputs database
Emissions, costs, income, energy & fuel use
Waste flows to process
Waste treatment processes
Wastes treated & emissions, costs etc. generated
Wastes transformed & transferred to new waste streams, products, degradation & sequestration
Material products
Energy products
Flow of waste
Flow of products
Flow of information

Solid Waste


LACW Capacity margin with transport allowed - England
Annual capacity margin (% of total arisings)
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Year
Deep Green - Scenario 1
Deep Green - Scenario 2
Deep Green - Scenario 3
Business as Usual - Scenario 1
Business as Usual - Scenario 2
Business as Usual - Scenario 3
High Tech - Scenario 1
High Tech - Scenario 2
High Tech - Scenario 3
Closed Loop - Scenario 1
Closed Loop - Scenario 2
Closed Loop - Scenario 3

Multiple energy interdependencies

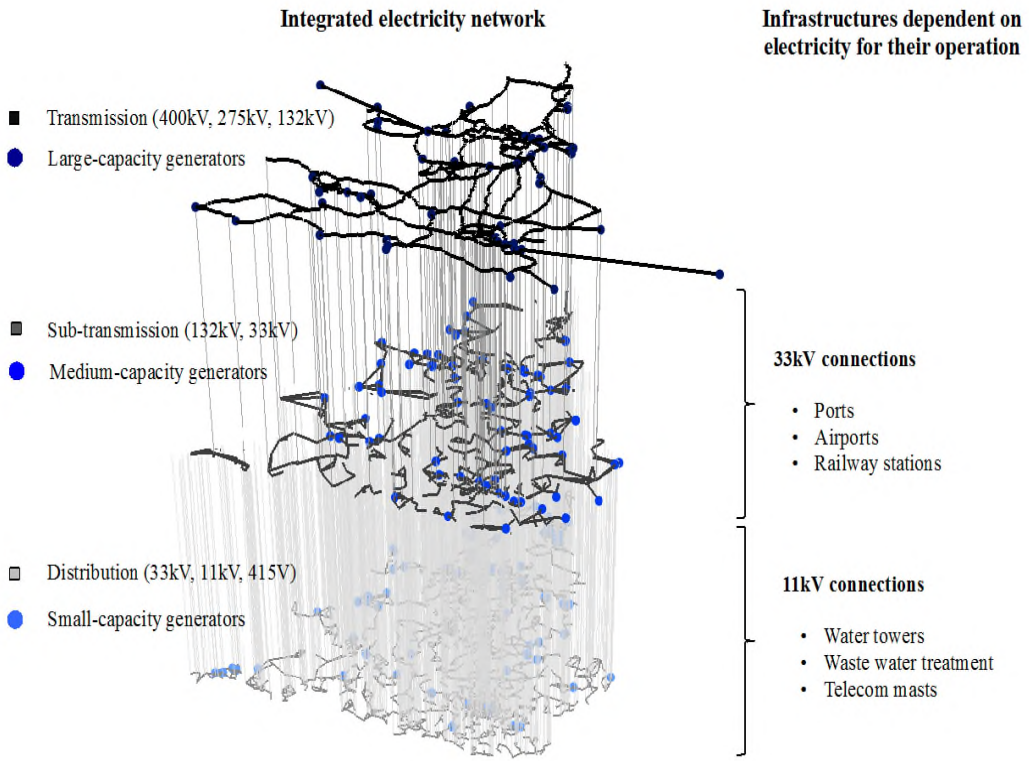


Water

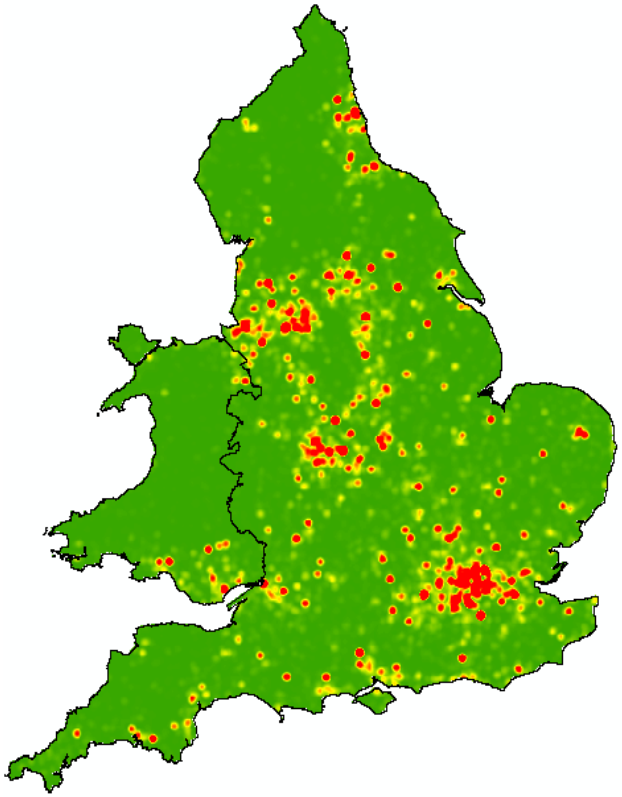
Transport

Digital communications

NISMOD-RV: Risk and Vulnerability in interdependent networks

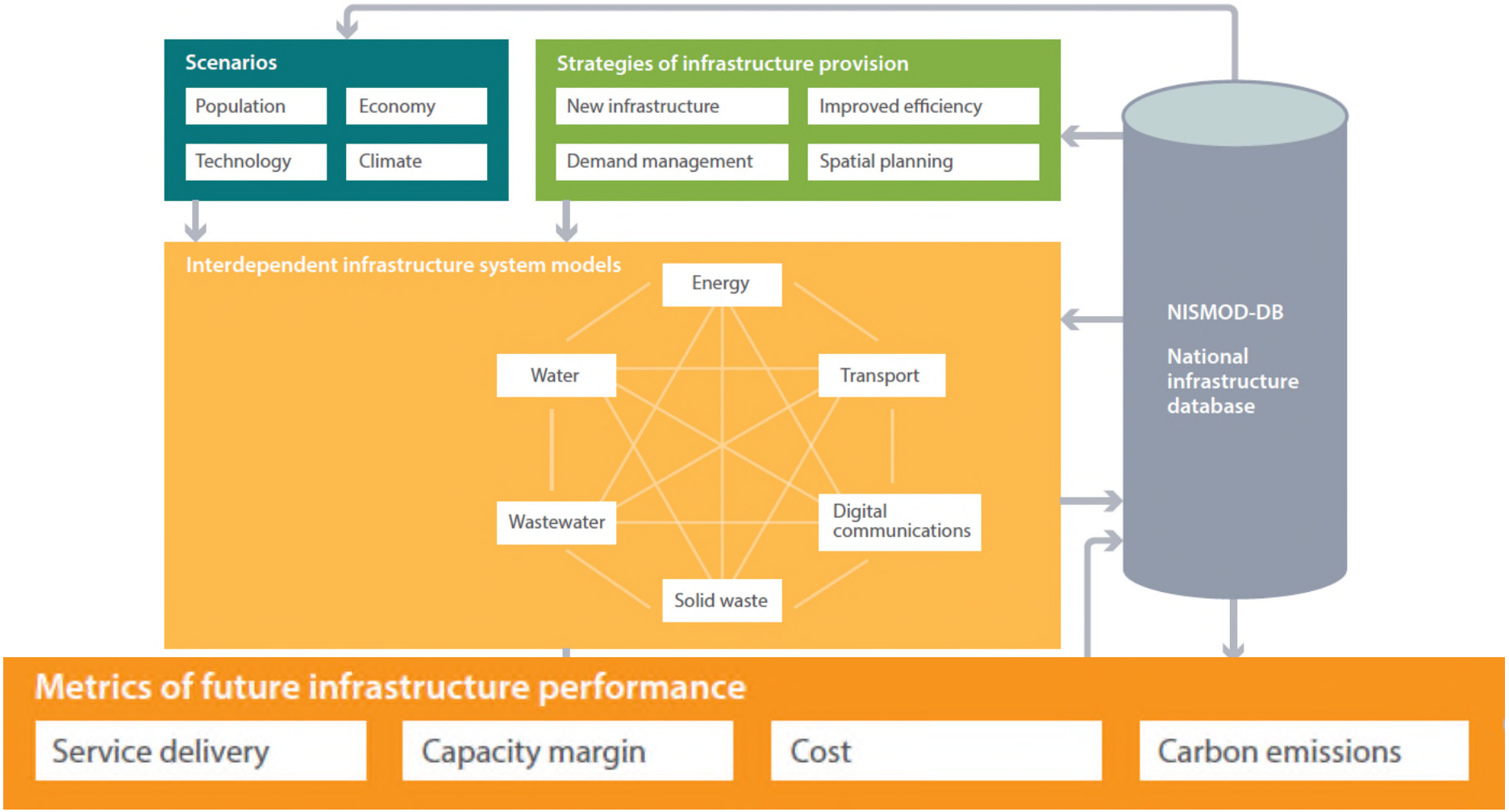


Hierarchical electricity network with infrastructure interdependence

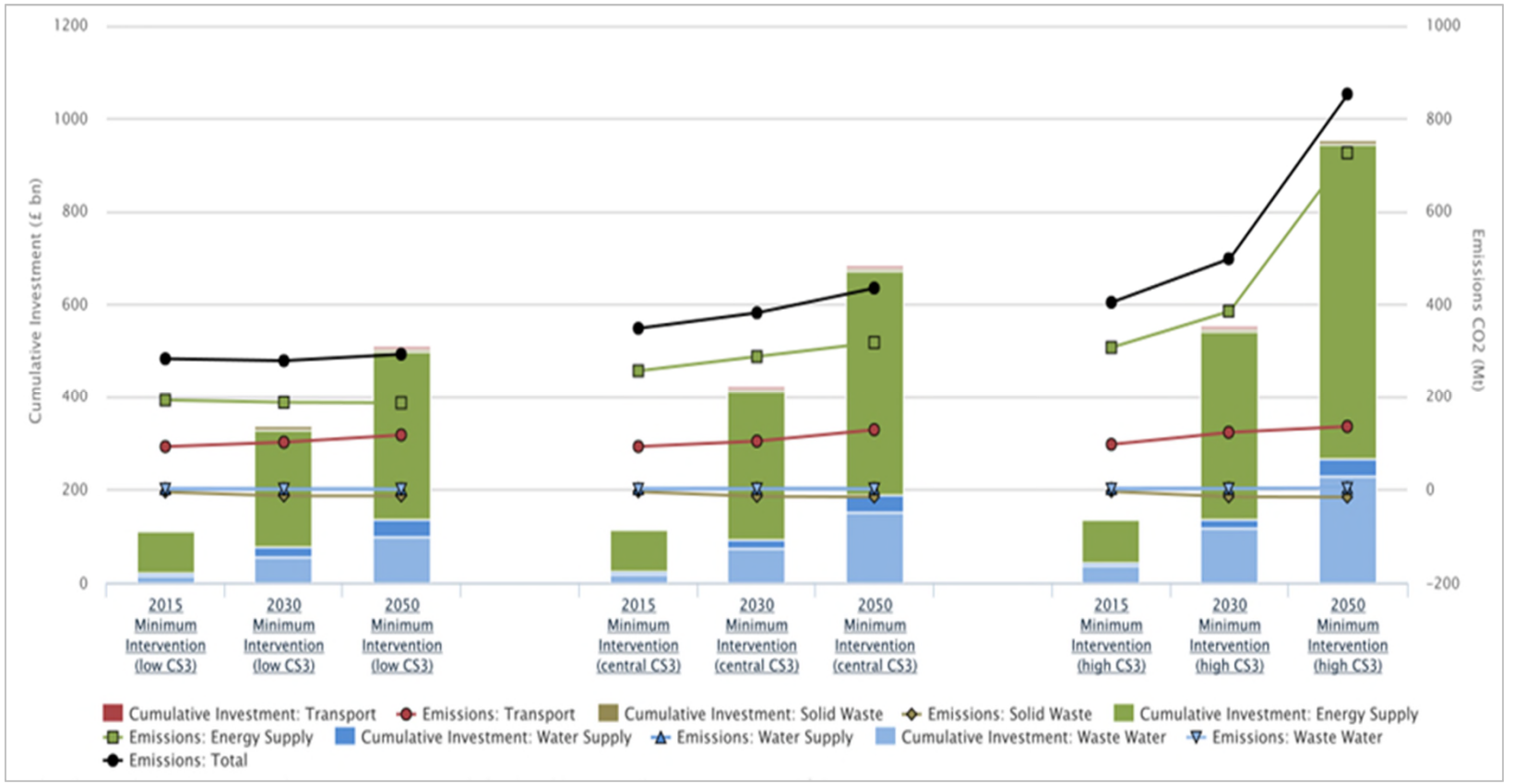


Critical infrastructure 'hotspots' analysis

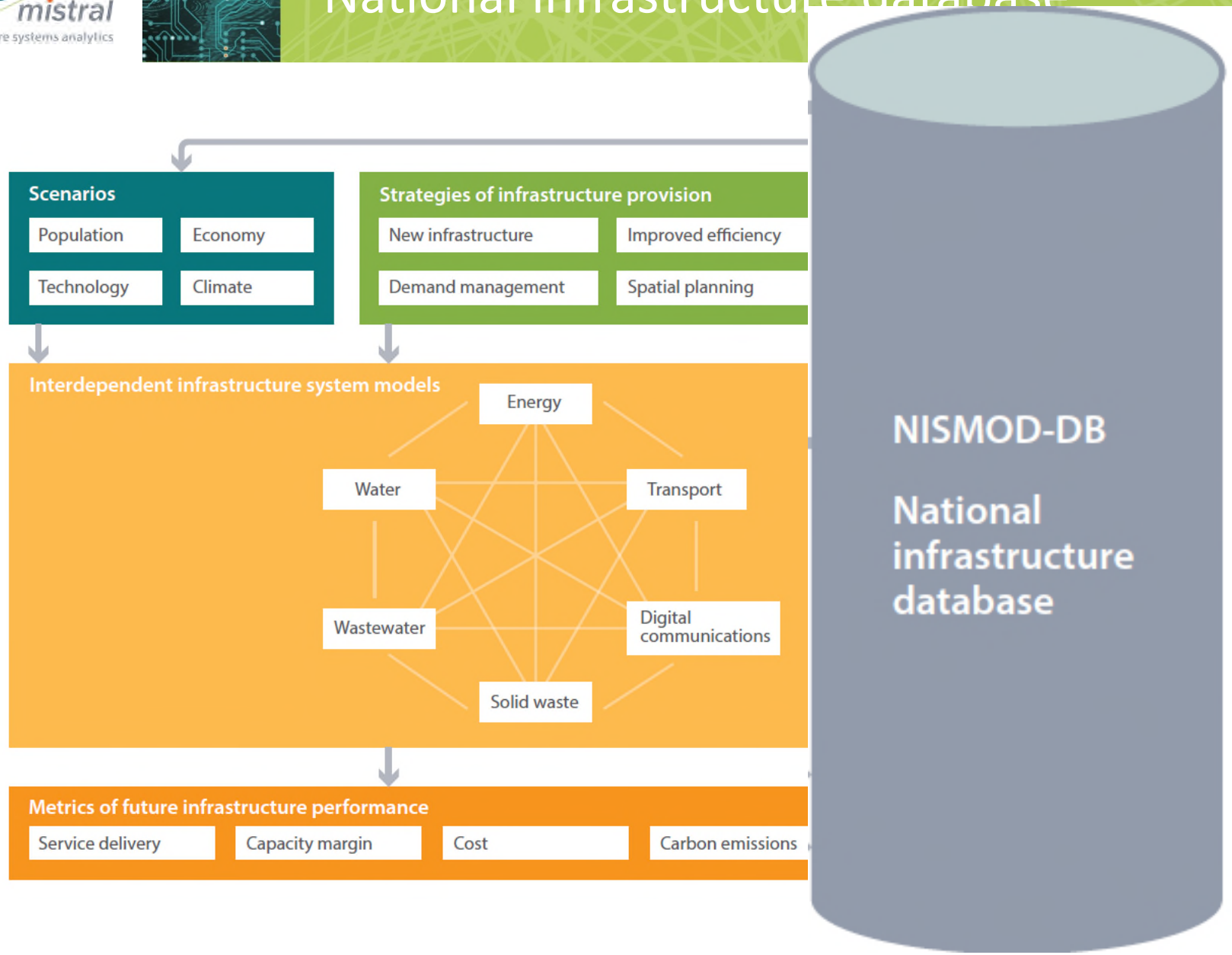
Projecting infrastructure performance metrics



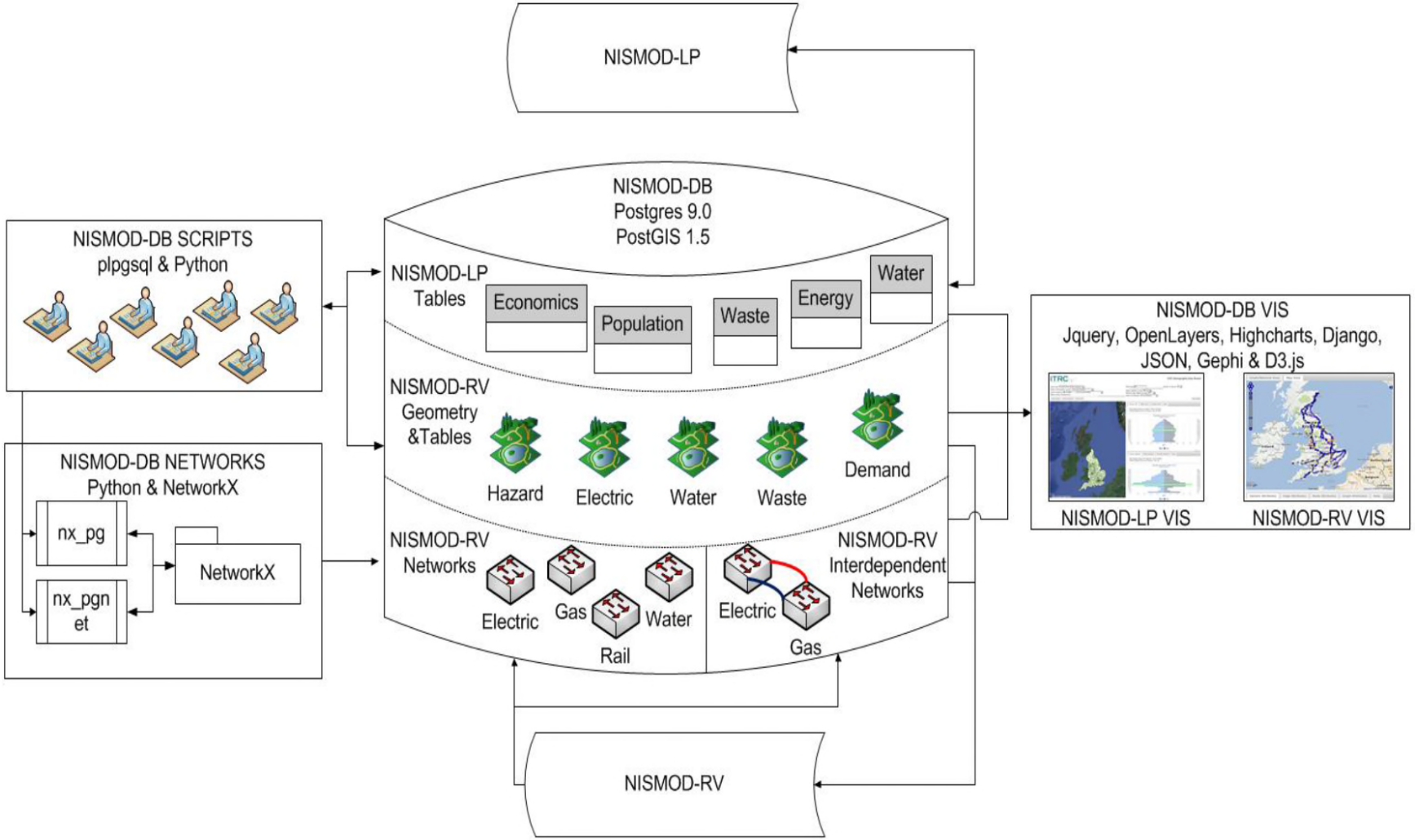
Costs and carbon emissions



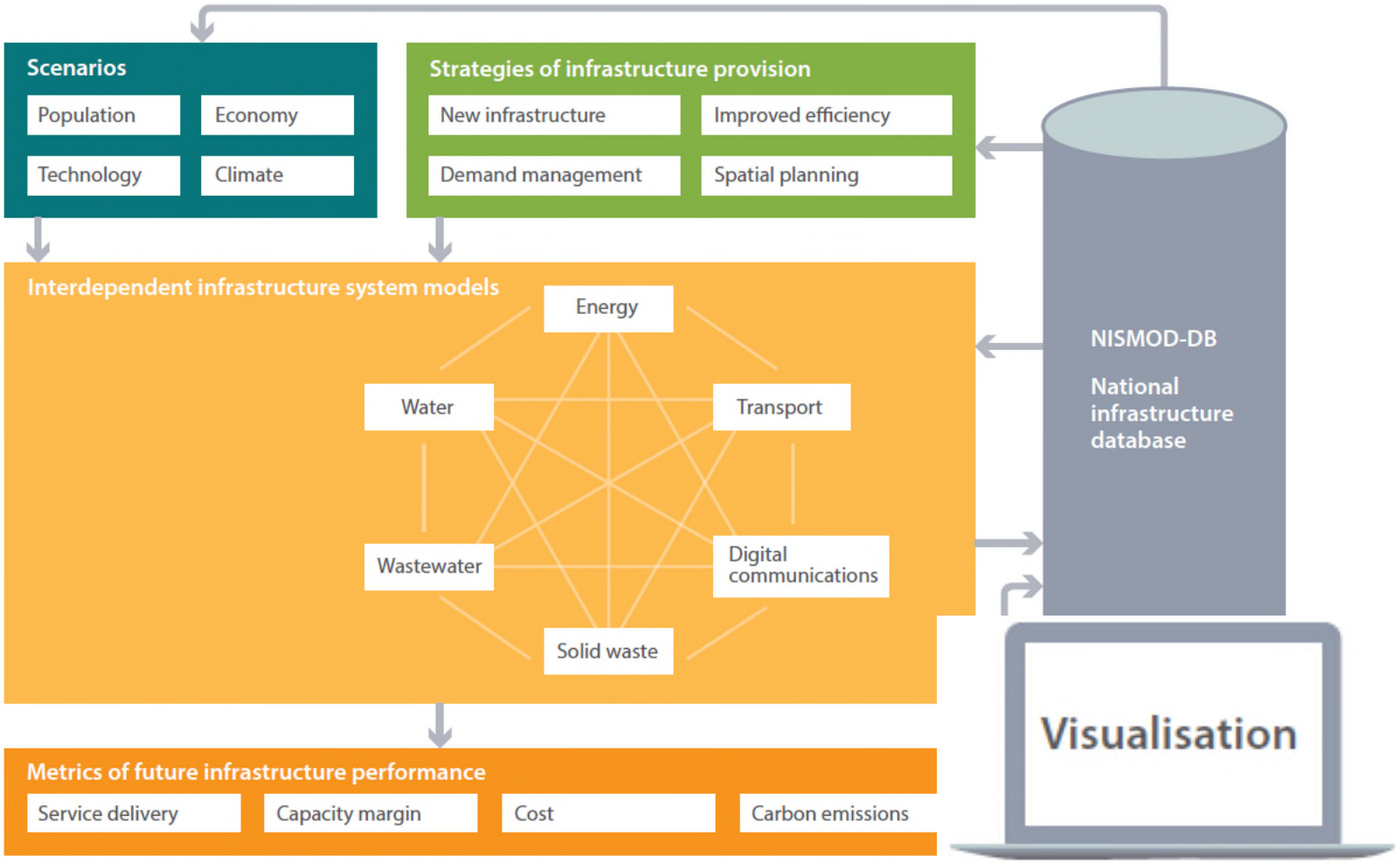
National infrastructure database



NISMOD-DB: National infrastructure database



Visualisation



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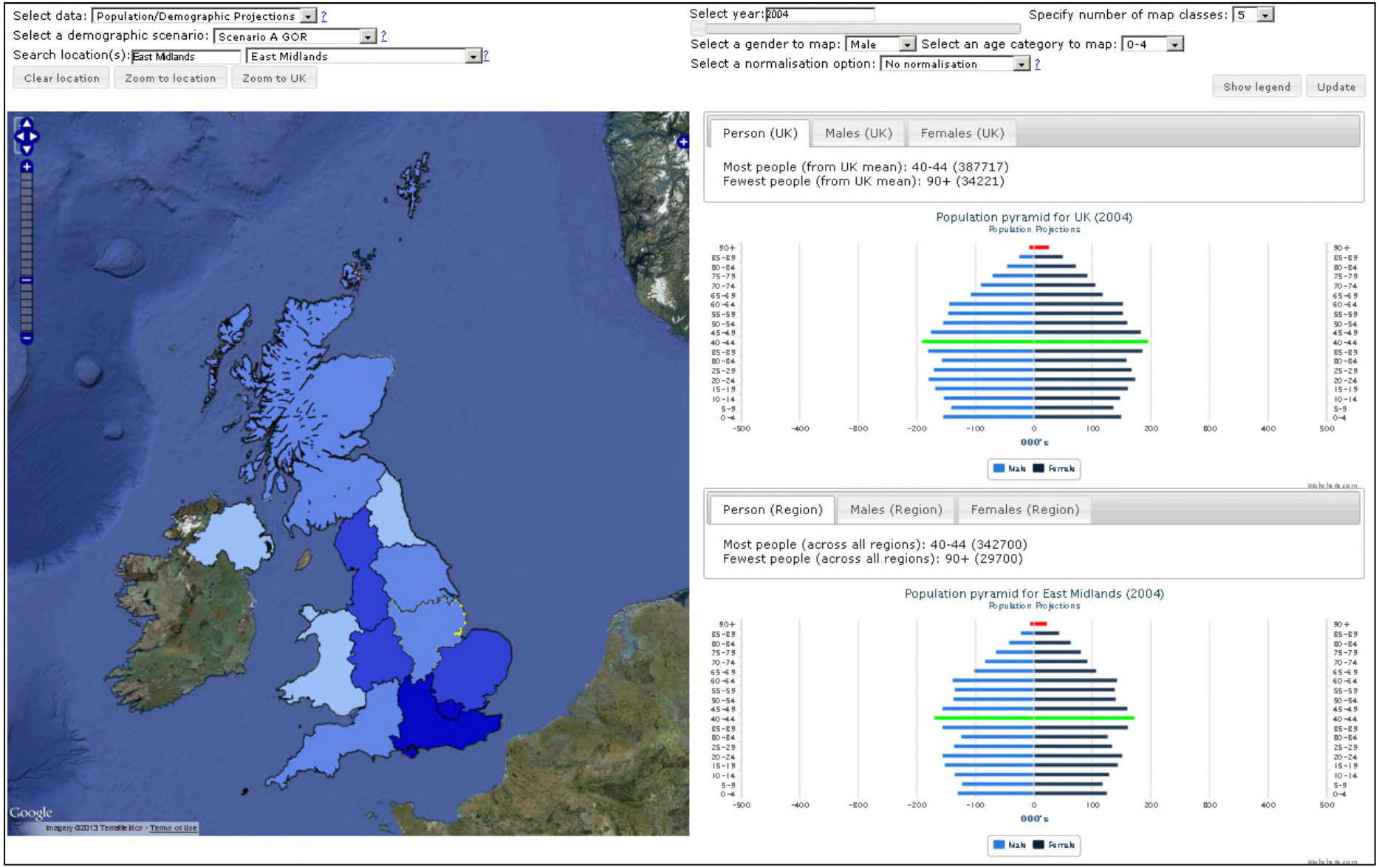
Database Driven Visualisation Tools



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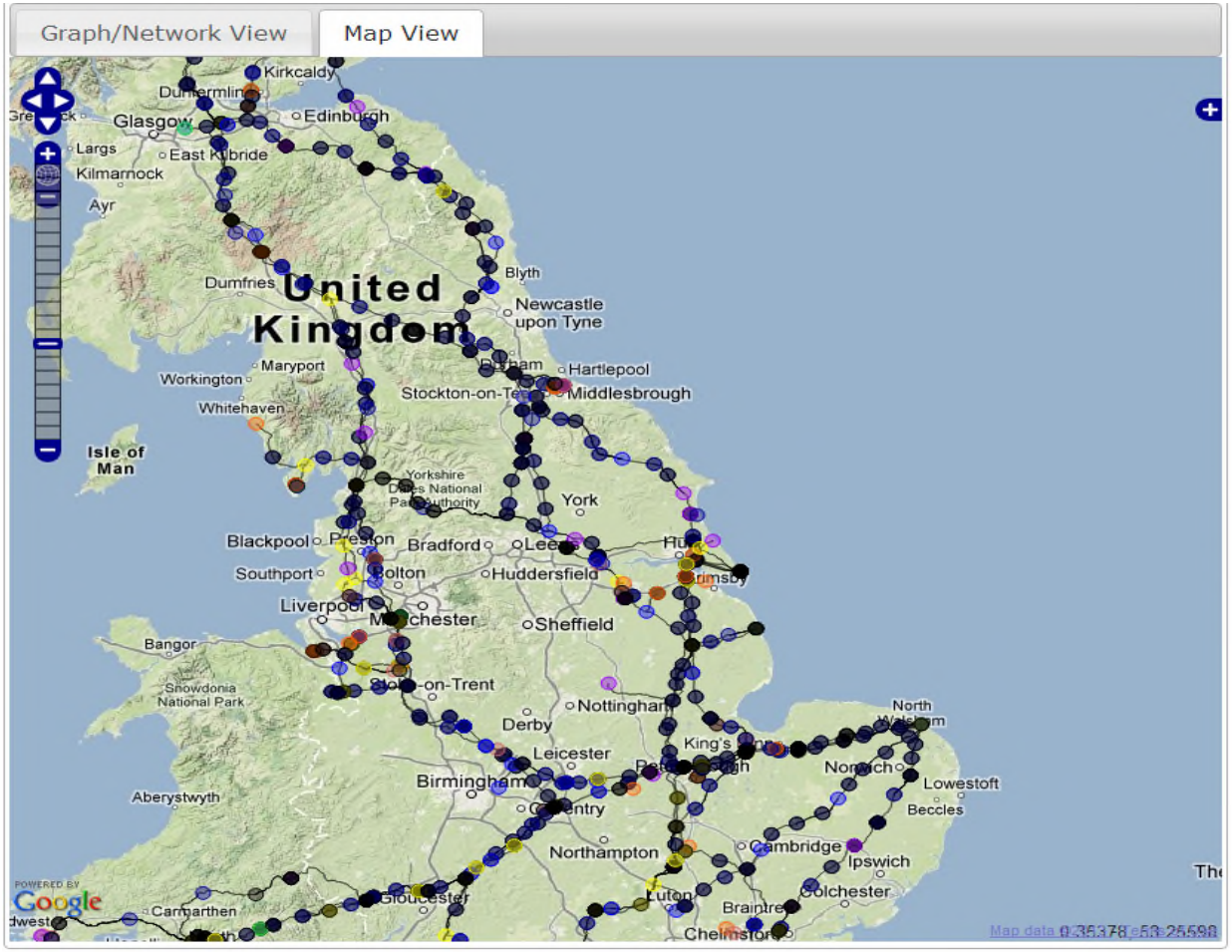
multi-scale infrastructure systems analytics

Infrastructure Network Dashboard



Networks

Spatial Data

National Grid Gas Transmission

Map Visualisation Controls

Node Vector Style:

National Grid Gas Transmission Nodes (By function)

Node Label:

Display Node Labels (black text on white)

NodeID

Edge Vector Style:

Default (all equal)

Edge Label:

Display Edge Labels (white text on black)

EdgeID

Graph Visualisation Controls (disabled)

Update Map

Generic Attributes | Edge Attributes | Node Attributes | Graph Attributes | Help

- Miscellaneous
- Connected
- Strongly Connected

Graph Legend (disabled) | Map Legend

Node(s):

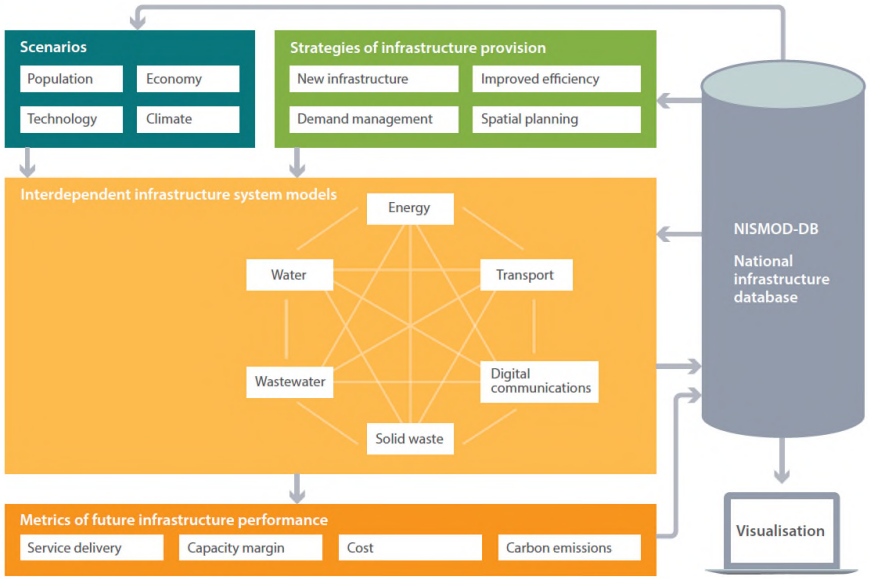
function = BV
function = CC
function = LNG
function = MJ
function = MO

Edge(s):

Default =
Stroke Width: 1

Summary

Thanks to EPSRC funding, ITRC has been able to develop unique national capability for infrastructure system-of systems analysis:



- Common economic, demographic, climate scenarios
- Interdependent system-of-systems models
- Efficient models that can be used for scenario and uncertainty analysis
- Designed to test and compare alternative national infrastructure strategies
- Database with full traceability of results and visualisation

Muchas gracias

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