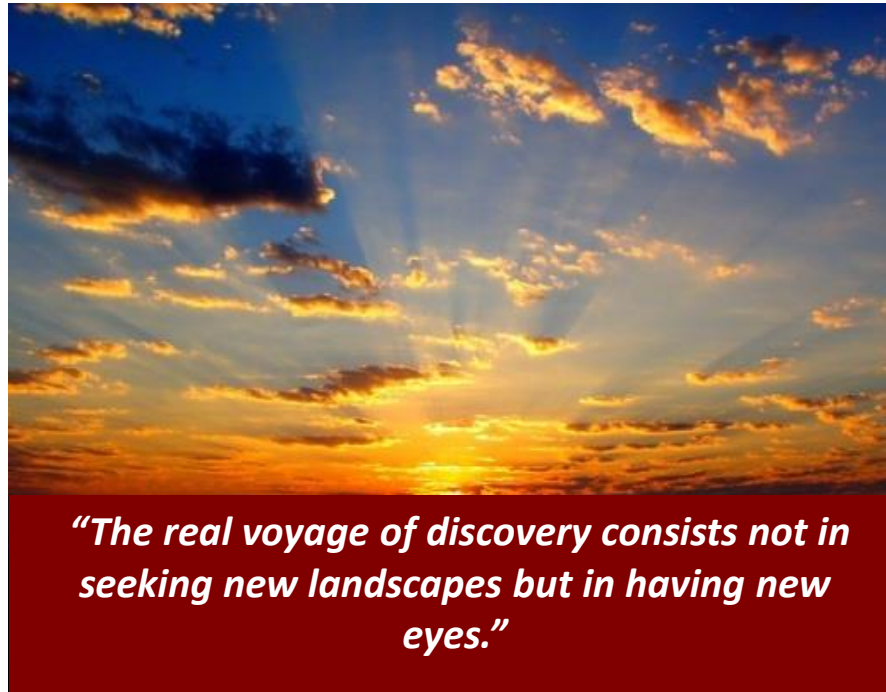


# Tomorrow's Water

Martin Mayfield, Rizwan Nawaz and Vanessa  
Speight

University of Sheffield, April 2017



**“Who wants to hear actors talk”**

Harry M. Warner, Warner Bros.

1927

**“I think there’s a world market for about 5 computers”**

Thomas J. Watson, Chairman, IBM

c1948

**“There is no reason for any individual to have a computer in their home”**

Ken Olsen

President, Chairman, Founder, DEC

1977

## TWENTY65 Theme 8: Foresight & Integration Vision

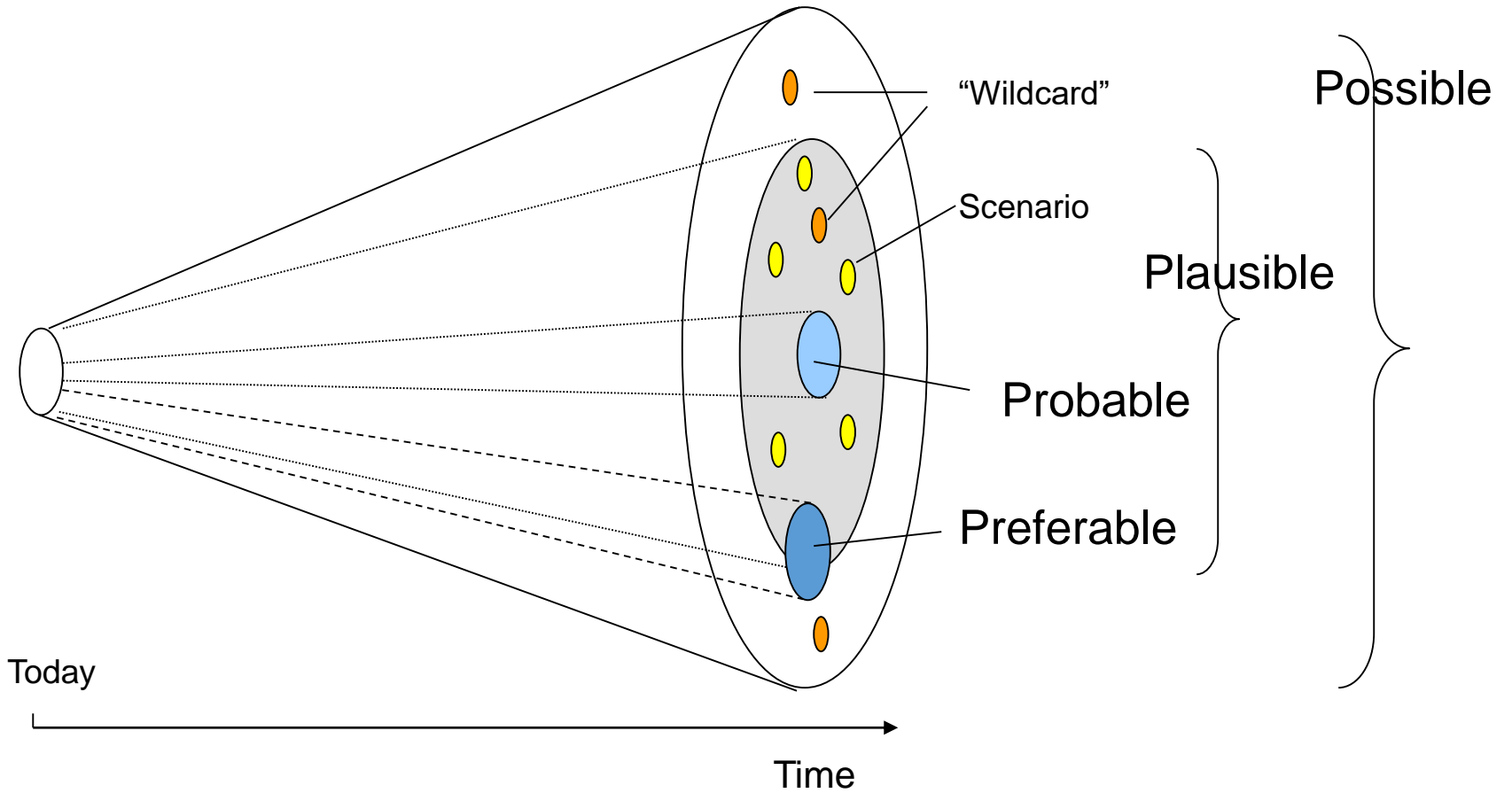
“Deliver a next generation toolkit able to align with the ***most pressing long term problems*** affecting integrated water systems”

An exploratory tool (with sustainability metrics) will enable the ***exploration and testing*** of which technologies/innovations a ‘silver basket’ requires to achieve ***particular water futures***.

Tools will be adapted to enable consideration of ***emerging new technologies*** and approaches.

Adapted modelling approaches will be applied within the context of water futures to ***stress test*** ‘silver baskets’ of ***solutions***

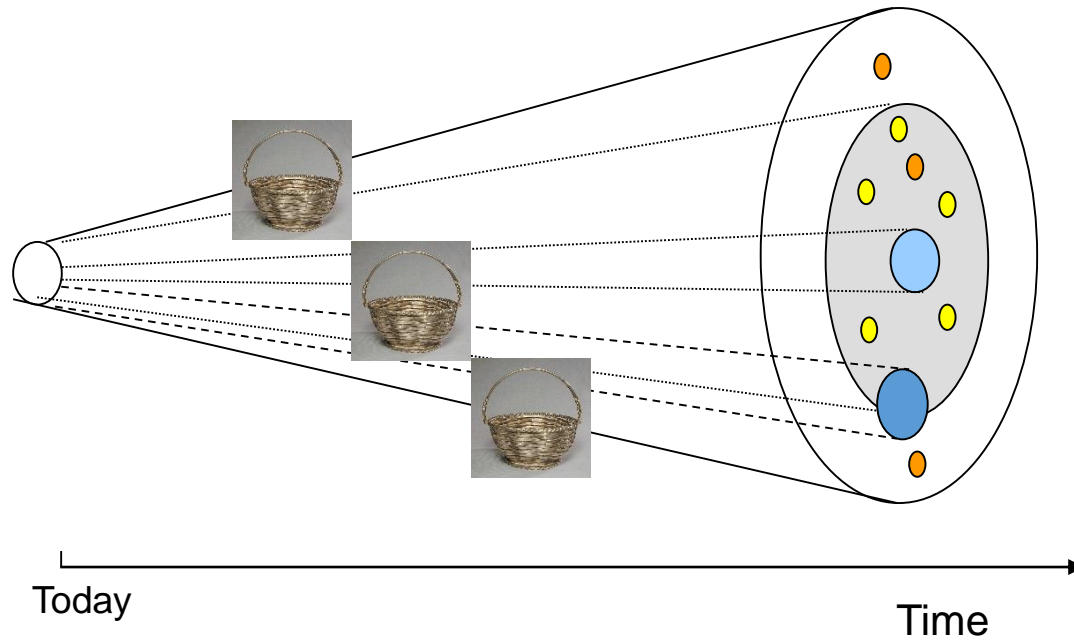
# Vision



Source: Hancock and Bezold (1994).

Hancock, T. and Bezold, C. (1994). Possible futures, preferable futures, *Healthcare Forum Journal*, 37(2), 23-29.

# Vision



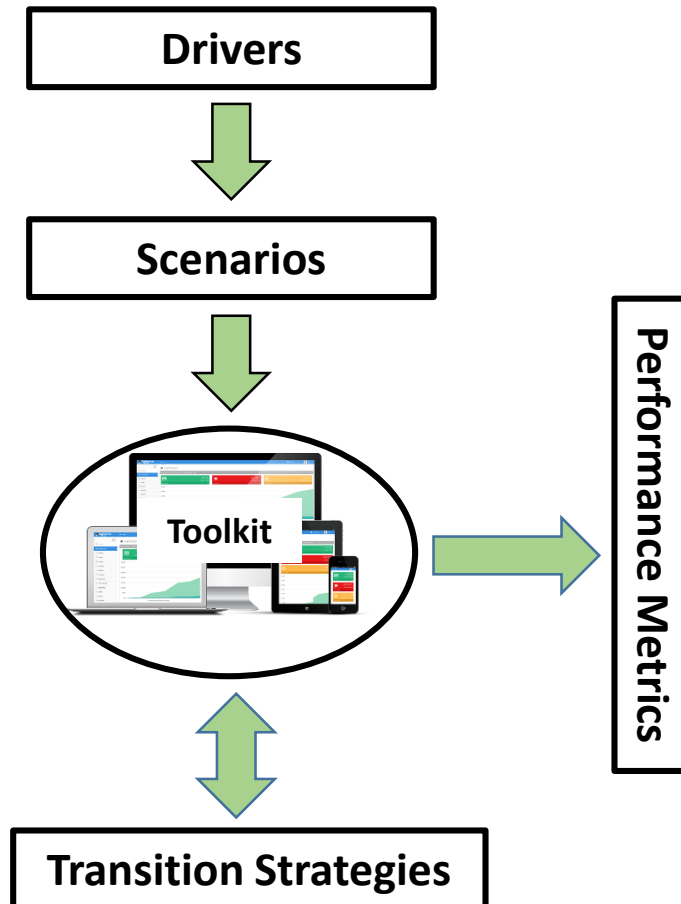
# Approach

## Three Key Steps:

Step	Description	Product
Scanning	Collecting information – the system, history and context of the issue and how to scan for information regarding the future of the issue.	Information
Forecasting	Describing baseline and alternative futures: drivers and uncertainties, implications and outcomes.	Baseline and Alternative Futures (Scenarios)
Visioning	Choosing a preferred future: envisioning the best outcomes, goal-setting, performance measures.	Preferred Future and Strategies

*Adapted from Bishop and Hines (2007)*

# Approach



# Futures Thinking

Rizwan Nawaz



# Futures Thinking

Nobody knows the world (and the future) until we actually observe the world (and future). If there is no observer there is no world (and future).

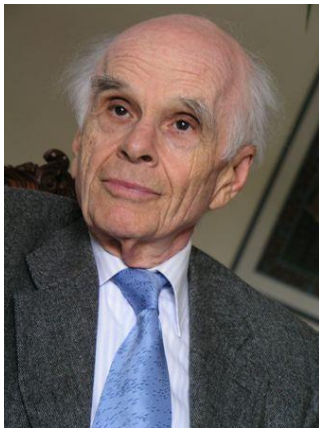
Humans can forecast a vision of the future.

Whatever future is in store for us, its realization will be brought about only by human will.

## Laszlo's Changing Worldview in the Age of Bifurcation

	The Modern View	The Emerging Worldview
Physical world	Atomistic; fragmented. Objects are independent and free standing. People are individuated and discrete.	Holistic; interconnected.  Objects and people are interwoven into a community
Physical processes	Materialistic; deterministic, mechanistic.	Organic; interactive, holistic.
Organic function	Discrete and separable; parts are exchangeable.	Interwoven; interdependent.
Social ethos	Technology oriented; interventionist; goods-based.	Communication oriented; service-based.
Social progress	Consumption dependent; resource conversion.	Adaptation oriented; balance of resources.
Economics	Competition and profit driven; exploitative.	Cooperative and information driven.
Humankind	Mastery over nature. Anthropocentric.	Integrated into nature. Gaia-centric.
Cultures	Euro-centric; colonial.	Pluralistic.
Politics	Hierarchical; power-based.	Holarchic; harmony-based.

Source: Laszlo (1991, p. 79).



**Ervin Laszlo**  
Systems Theorist

Laszlo, E. (1991). *The Age of Bifurcation: Understanding the changing world*. Philadelphia: Gordon and Breach.

# Ervin Laszlo on Forecasting (Laszlo, 1991)

## Non-equilibrium Crystal Ball

is the tool of the new science of complex systems—systems that evolve both in nature and in the human sphere in conditions far from equilibrium. In these non-equilibrium conditions, systems are dynamic: they balance their unstable structure through many self-regulating and self-organizing processes. Being unstable, they are frequently unpredictable. Thus the non equilibrium crystal ball does not foretell a ready-made future. *It tells only of what one can predict*—which is important, even if it is not everything. (p. 37)

# Futures Thinking

*“If futures studies use the distinction of probable, preferable and probable futures, future generations research is concerned with creating the preferable and not specifically with exploring the full range of alternative futures (Inayatullah, 1997)”*

The future is uncertain; the only way to forecast the uncertain future is to forecast multiple futures. The more humanity knows and imagines, the better humanity’s future will be.

## Six Pillars of Futures Studies (MATDCT)

---

1. Mapping	Where have we come from, where are we going?
2. Anticipating	Emerging issues, The futures wheel to develop the consequences of today’s issue.
3. Timing	The grand patterns of history, the identification of each one.
4. Deepening	CLA, Four quadrant mapping (inner, outer, self, collective).
5. Creating Alternatives	Four images, Scenarios, Nuts and bolts (a structural analysis, finding different ways).
6. Transforming	Questioning, Backcasting, the transcend method.

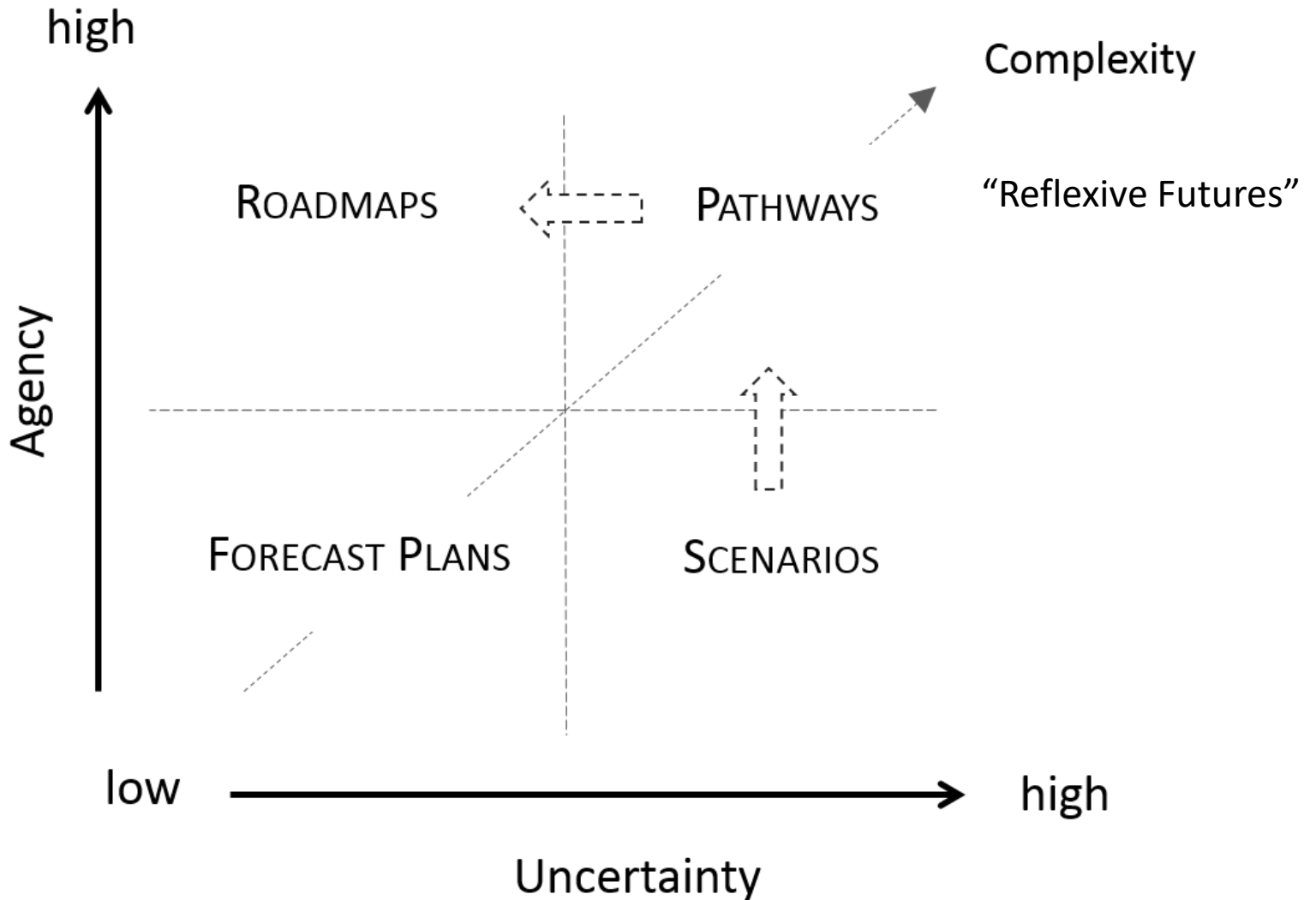
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**Sohail Inayatullah**

Cultural/spiritual Theorist

# Futures Thinking



# Scenarios

*Sustainability* **2012**, *4*, 740-772; doi:10.3390/su4040740

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*sustainability*

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Article

## Scenario Archetypes: Converging Rather than Diverging Themes

Dexter V. L. Hunt <sup>1,\*</sup>, D. Rachel Lombardi <sup>1</sup>, Stuart Atkinson <sup>2</sup>, Austin R. G. Barber <sup>3</sup>,  
Matthew Barnes <sup>4</sup>, Christopher T. Boyko <sup>5</sup>, Julie Brown <sup>3</sup>, John Bryson <sup>6</sup>, David Butler <sup>2</sup>,  
Silvio Caputo <sup>7</sup>, Maria Caserio <sup>8</sup>, Richard Coles <sup>8</sup>, Rachel F. D. Cooper <sup>5</sup>, Raziye Farmani <sup>2</sup>,  
Mark Gaterell <sup>7</sup>, James Hale <sup>6</sup>, Chantal Hales <sup>6</sup>, C. Nicholas Hewitt <sup>4</sup>, Lubo Jankovic <sup>8</sup>,  
I. Jefferson <sup>1</sup>, J. Leach <sup>5</sup>, A. Rob MacKenzie <sup>6</sup>, Fayyaz Ali Memon <sup>2</sup>, Jon P. Sadler <sup>6</sup>,  
Carina Weingaertner <sup>3</sup>, J. Duncan Whyatt <sup>4</sup> and Christopher D. F. Rogers <sup>1</sup>

<sup>1</sup> Civil Engineering/College of Engineering and Physical Sciences, University of Birmingham, Birmingham, B152TT, UK; E-Mails: d.r.lombardi@bham.ac.uk (D.R.L.); I.Jefferson@bham.ac.uk (I.J.); C.D.F.Rogers@bham.ac.uk (C.D.F.R.)

<sup>2</sup> Center for Water Systems/College of Engineering and Physical Sciences, University of Exeter, Exeter, EX4 4QF, UK; E-Mails: swa201@ex.ac.uk (S.A.); D.Butler@exeter.ac.uk (D.B.); r.farmani@exeter.ac.uk (R.F.); f.a.memon@exeter.ac.uk (F.A.M.)

May 2016

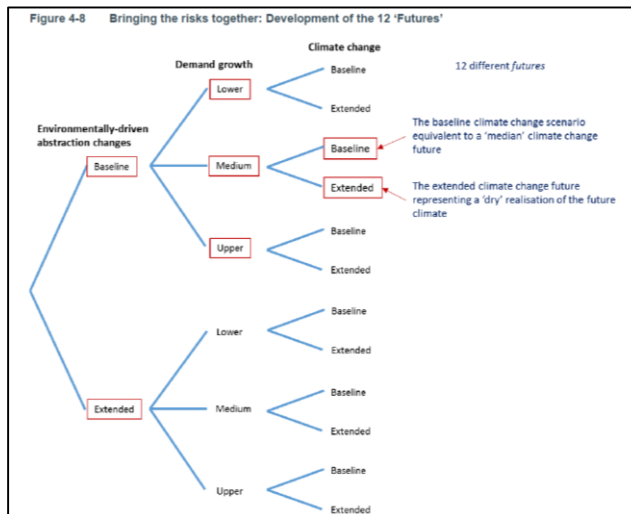
## The water and wastewater sectors

The long view



pwc

YorkshireWater

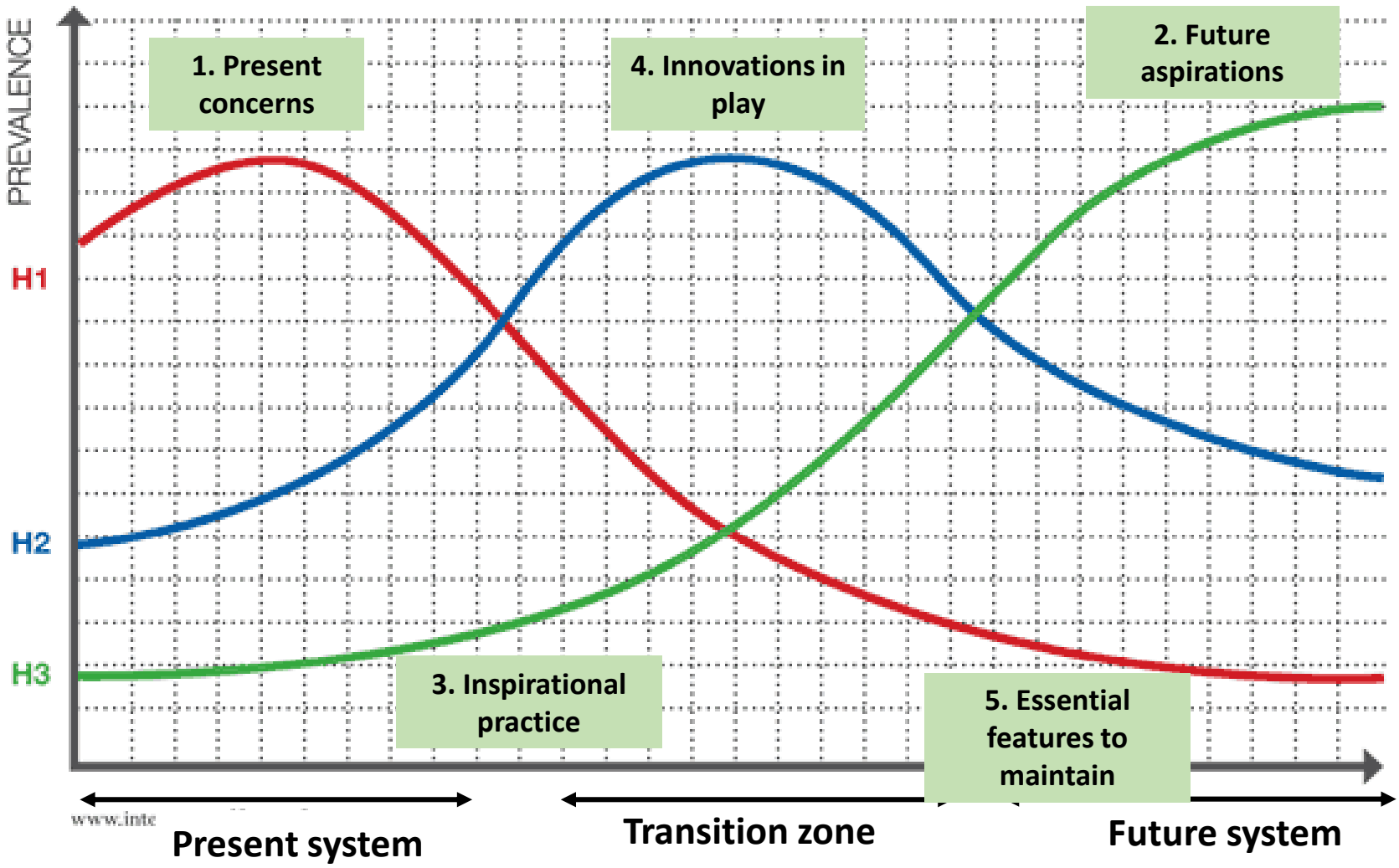


# Roadmaps

- Concerned with coordinating social complexity
- Most useful where there is greater certainty – where they provide clearer directions for change
- Usually involve bringing together expertise to assemble paths towards the future in relation to intermediate goals, and aligning intent among many parties to direct resources and activity toward shared goals (Saritas and Aylene, 2010).
- **Limitations:** usually a single roadmap – provides agency but does not allow space for emergence of new and uncertain future conditions that may require going down new paths.

**Prevalence:** ways of doing things; use of a particular technology, a set of values

# Three Horizons: a pathways practice for transformation



# TWENTY65 Roadmap

Vanessa Speight



# What we want to achieve with the roadmap

- Lay out a vision for the water systems of the future and how to get there
  - Spark innovation in the water sector
  - Launch disruptive research into the water solutions of the future
  - Bring together stakeholders to be more collaborative
  - Raise the profile of UK water research on the global stage

# Roadmap

- A variety of roadmaps already exist
  - Many with a very specific purpose and geographic focus



HM Government

Future Water

The Government's water strategy for England

Water for Life

Looking ahead

The challenges that affect your water service

Creating a great place for living

Enabling resilience in the water sector

March 2016

Our Blueprint for Yorkshire  
The next 25 years

FUTURE HORIZONS 2040

Roadmap to reform of the water sector

High and Dry

Climate Change, Water, and the Economy

# Roadmap Process

- Develop a set of scenarios
  - Based on drivers of key importance (today)
- Identify our desired future system performance criteria
  - Thought Leadership Club workshop, 20 June 2017
- Test how well different silver baskets meet the performance criteria
  - Using expert input since no comprehensive model exists (Autumn 2017)
- Determine pathways based on results of performance testing (End of 2017)

# Interactive Exercise

# SCANNING

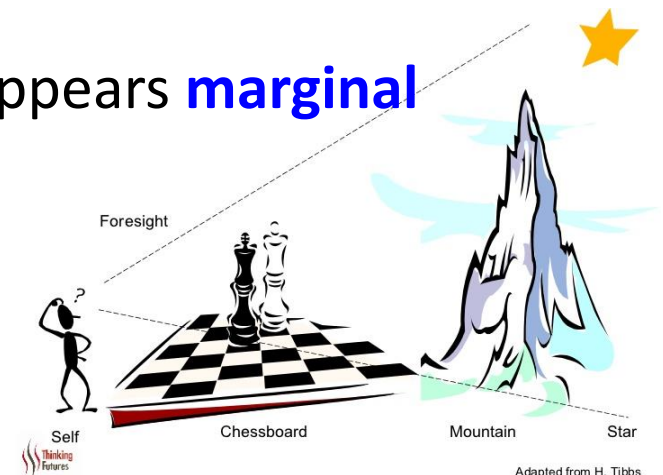
## *Foresight*

Some references in the *systems literature* to *futures thinking*

## *Integration (systems thinking)*

Some references in the *futures studies material* to *systems thinking*.

Work on **connections** between the two appears **marginal**



# Activity: Cross Impact Analysis

		1	2	3	4	5	6	7	8	9	10	Score
		Advances in technology	Energy cost	Cost/value of chemicals	Regulation	Climate change	Water treatability	Investment levels	Planning changes	Public awareness	Industrial skills/expertise	
1	Advances in technology											
2	Energy cost											
3	Cost/value of chemicals											
4	Regulation											
5	Climate change											
6	Water treatability											
7	Investment levels											
8	Planning changes											
9	Public awareness											
10	Industrial skills/expertise											
0: Independent		1: Low Impact										
2: Medium Impact		3: Strong Impact										

**Instructions:** Consider *one* of three components of the water system:

- Water Distribution
- Water/wastewater treatment
- Urban drainage

Individually, on the A4 sheet, complete the impact matrix, remember to include on the sheet which one of the water system components you considered

# Activity: Cross Impact Analysis

		1	2	3	4	5	6	7	8	9	10	Score
		Advances in technology	Energy cost	Cost/value of chemicals	Regulation	Climate change	Water treatability	Investment levels	Planning changes	Public awareness	Industrial skills/expertise	
1	Advances in technology											
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5	Climate change											
6	Water treatability											
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10	Industrial skills/expertise											
0: Independent		1: Low Impact										
2: Medium Impact		3: Strong Impact										

**Instructions:** Consider *one* of three components of the water system:

- Water Distribution
- Water/wastewater treatment
- Urban drainage

Next, divide into three groups and repeat the exercise to develop a master list on the A3 sheet

**The trend(s) which have the strongest impact on the other trends can be considered as the powerful drivers for scenario development**

**Thank you for your participation**

**Questions, comments, further participation:**

**[n.r.nawaz@sheffield.ac.uk](mailto:n.r.nawaz@sheffield.ac.uk)**

**[v.speight@sheffield.ac.uk](mailto:v.speight@sheffield.ac.uk)**

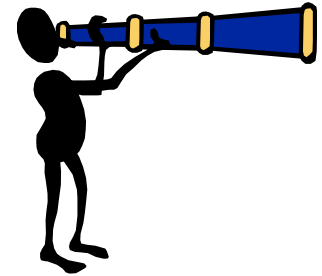
**[martin.mayfield@sheffield.ac.uk](mailto:martin.mayfield@sheffield.ac.uk)**



# Notes

# Futures Vocabulary: Types of Futures

- Possible - “might” happen (future knowledge)
- Plausible – “could” happen (current knowledge)
- Probable - “likely to” happen (current trends)
- Preferable - “want to” happen (value judgements)



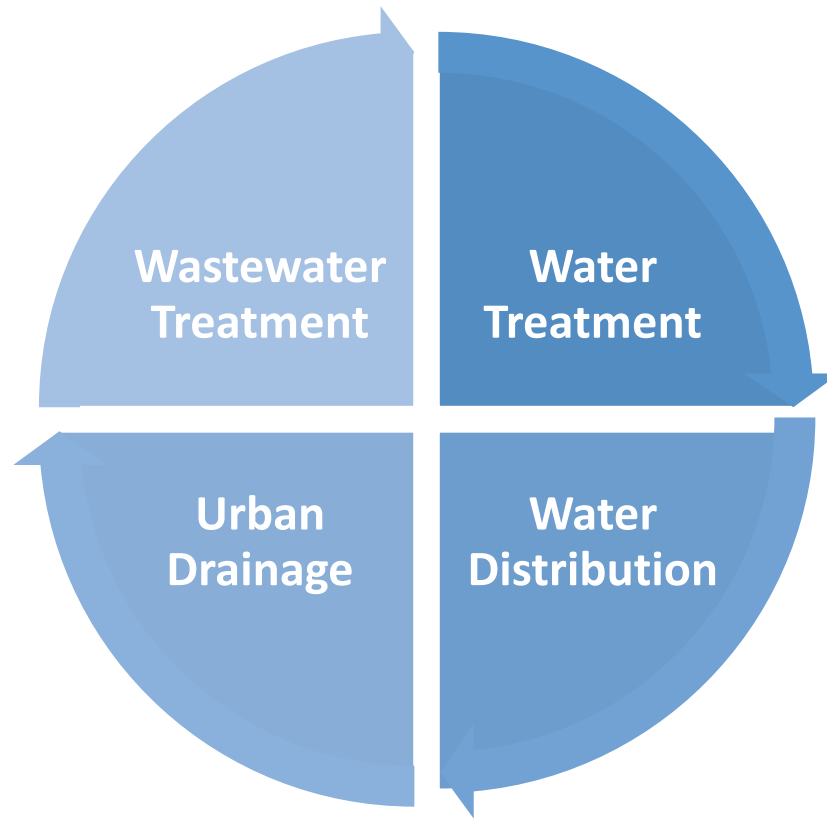
# ENGAGEMENT

Three levels:

- 1) Causal Mapping – 40 participants
- 2) Three Horizons– 20 participants
- 3) T65 Theme Leaders - 10 participants

## **TLC Feedback – 40 participants**

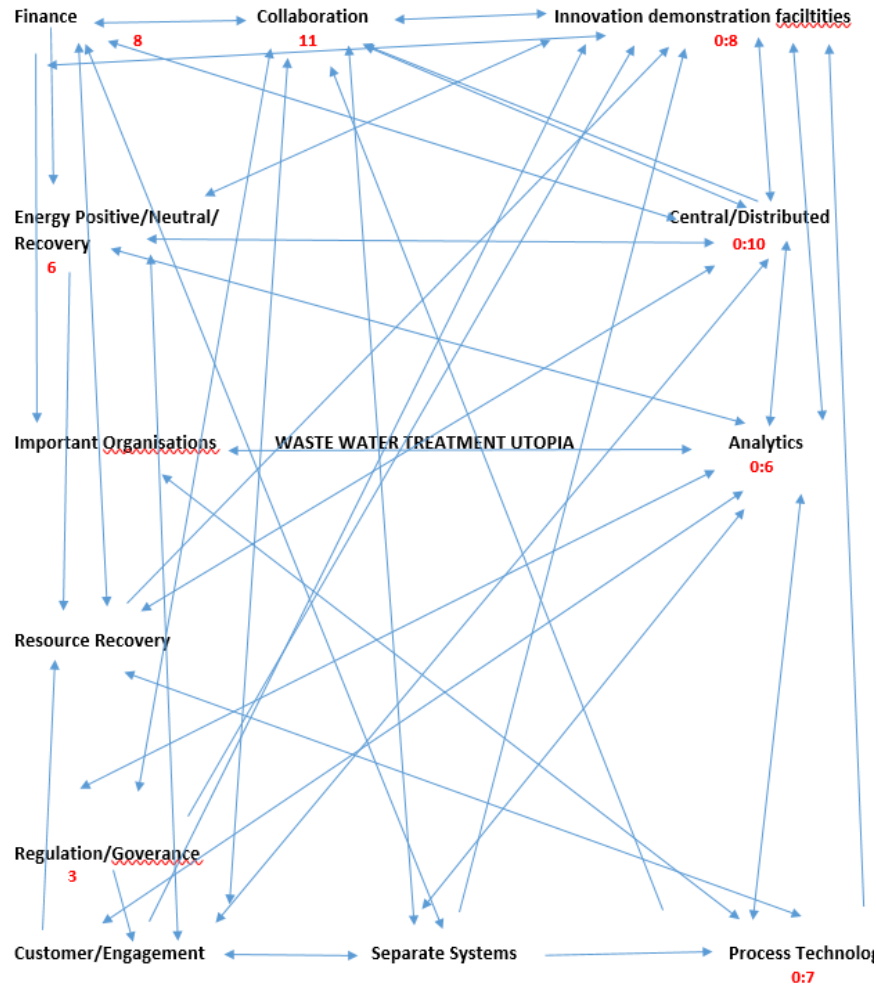
# Water System Components



# Exploring Future Aspirations

Based on Causal Mapping July 2016

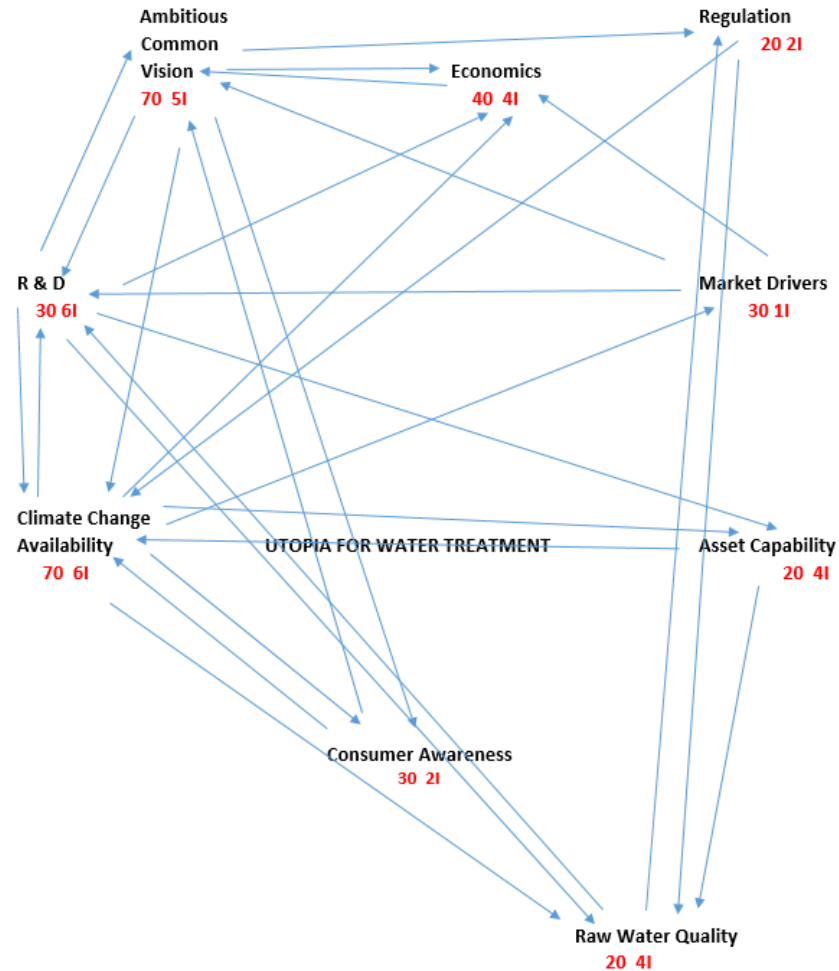
## Waste Water Treatment:



# Exploring Future Aspirations

Based on Causal Mapping July 2016

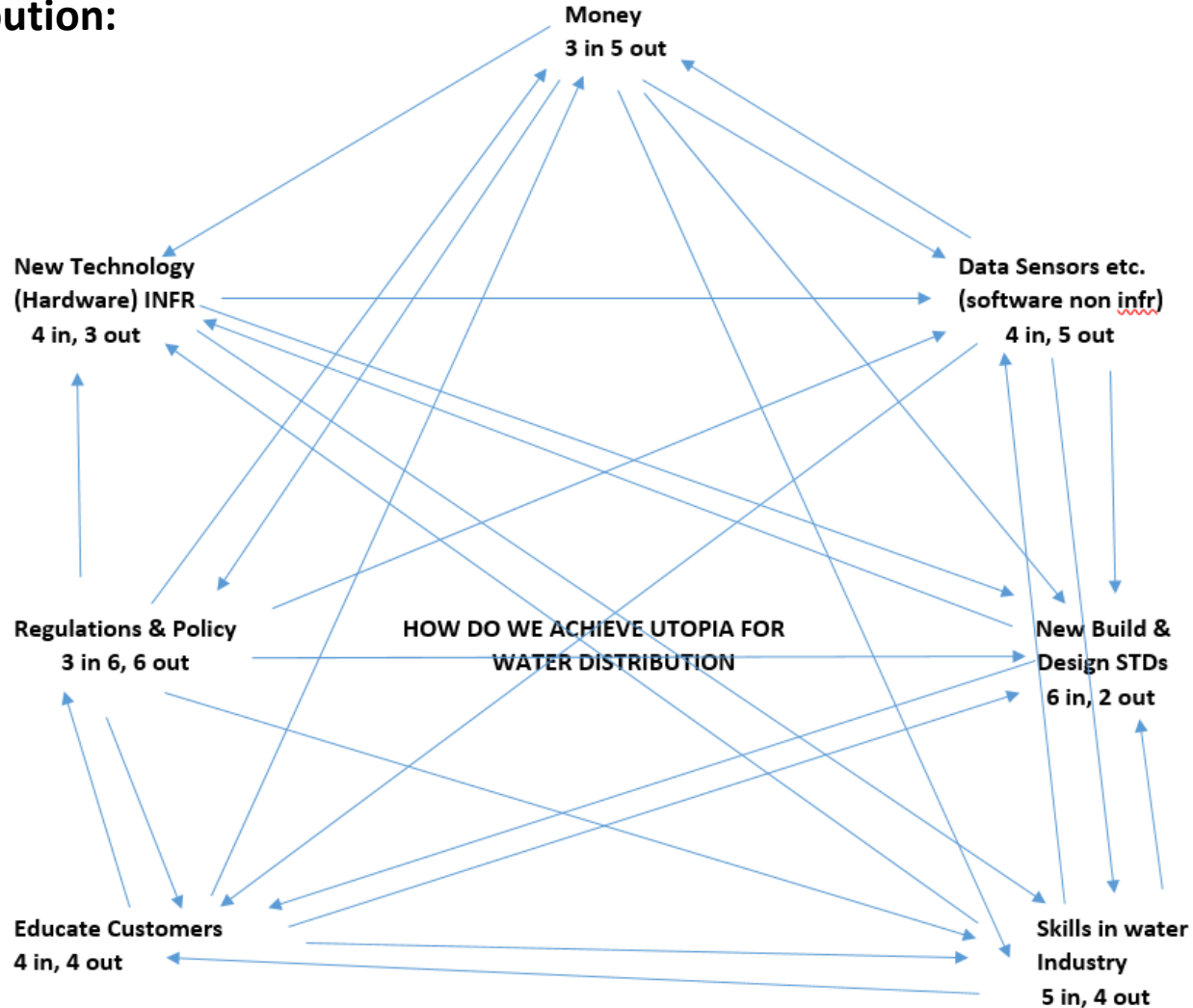
Water Treatment:



# Innovations in Play

Based on Causal Mapping July 2016

## Water Distribution:

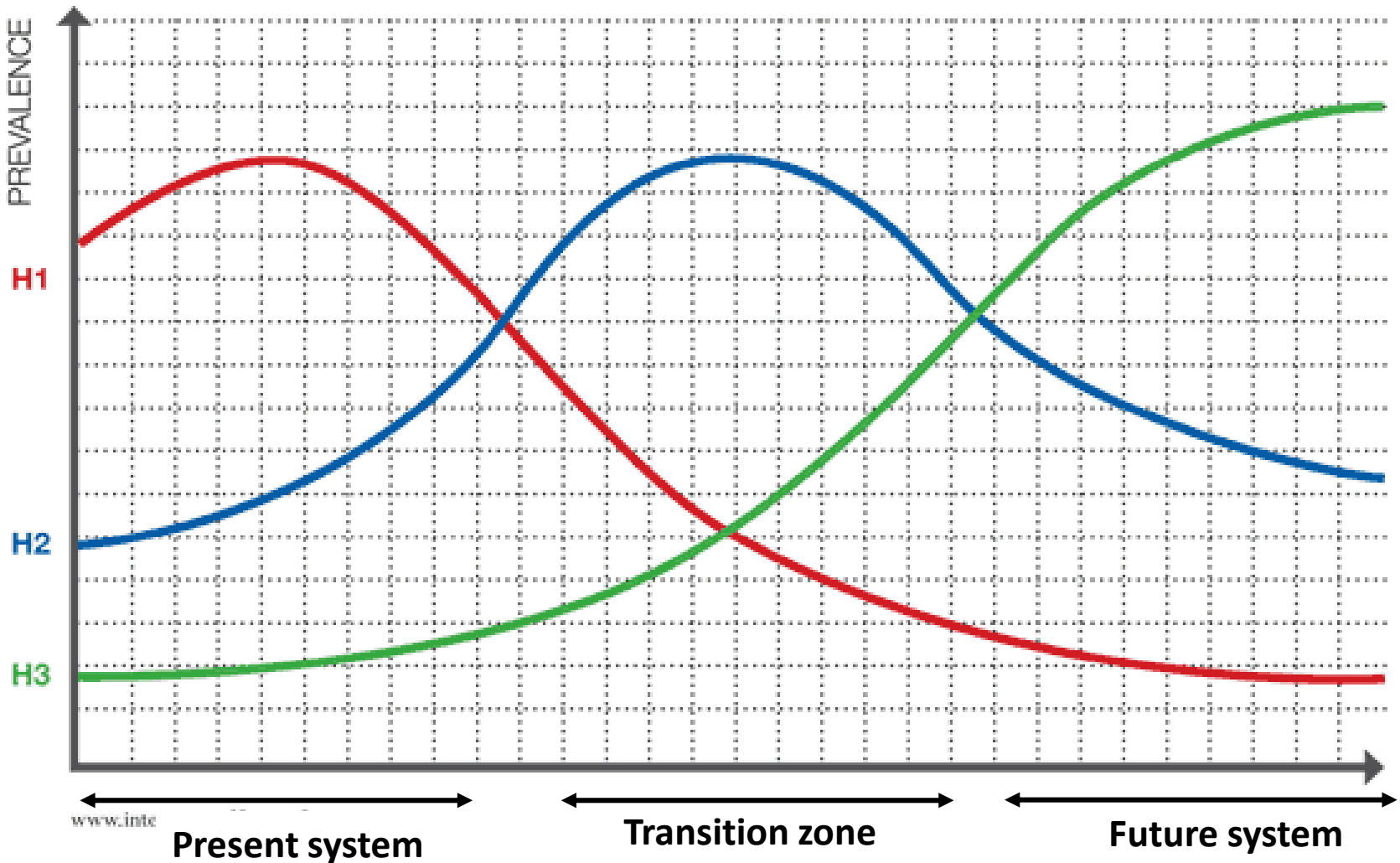




# Leadership Board – Three Horizons

**Prevalence:** ways of doing things; use of a particular technology, a set of values

# Three Horizons: a pathways practice for transformation



## **1) Examining Present Concerns**

Which current ways of doing things are losing fit with the emerging conditions?

Lessons from past successes and failures – looking back, what would you identify as the significant events which have produced the current situation?

## **2) Exploring Future Aspirations**

Third Horizon – What are your visions, aspirations, and possibilities for the reality that may emerge over time, as a replacement to the first horizon? What do you think the future will be like? What future are you afraid of? Do you think you can transform the future to a desired future? Why or Why not? What are possible disruptors?

What are the hidden assumptions about your predicted future?

What are some alternatives to your predicted or feared future?

Which future do you wish to become reality for T65

## **3) Exploring Inspirational Practice in the Present**

Can you identify “pockets of the future in the present”

## **4) Innovations in Play**

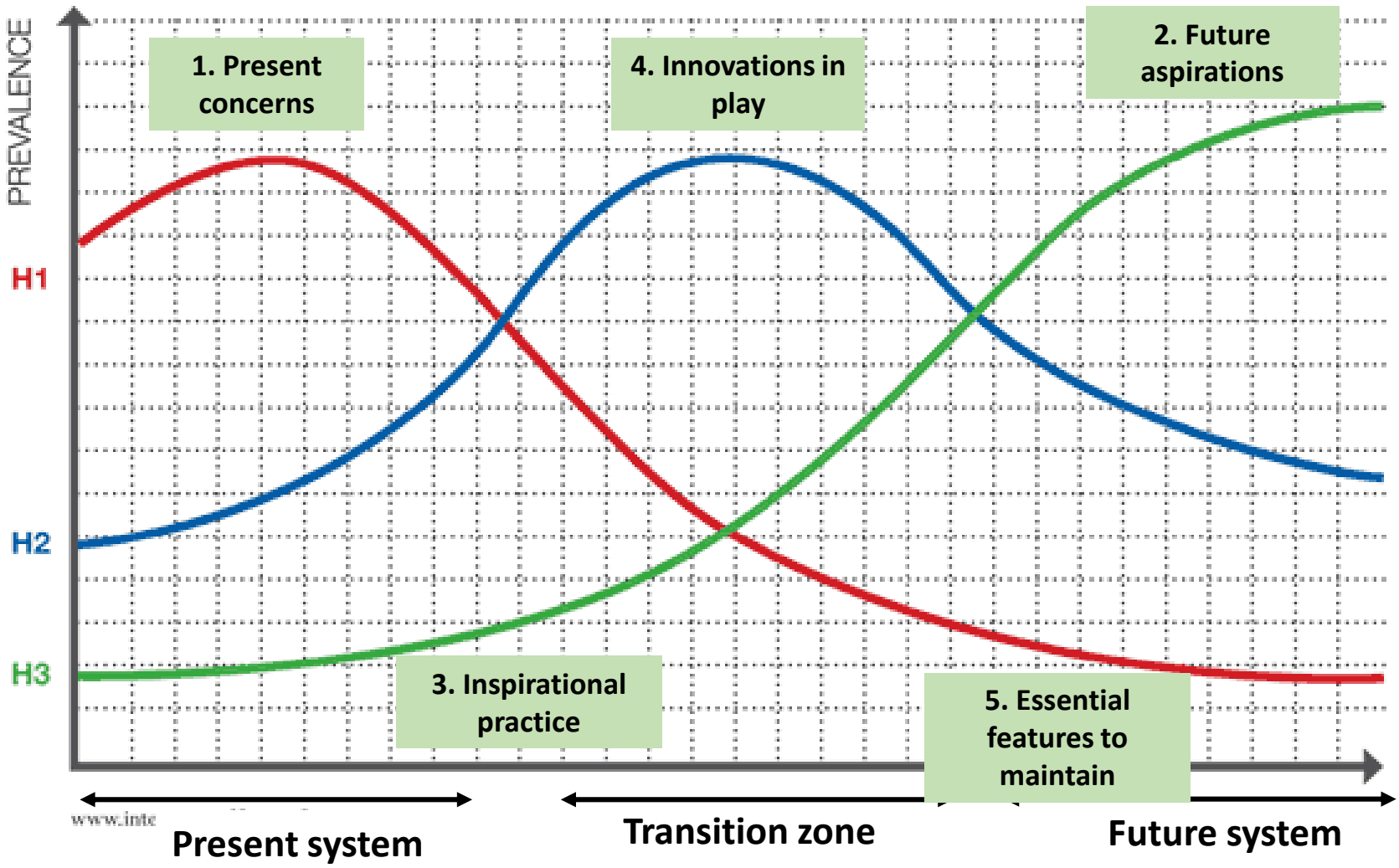
Consider the second Horizon, the realm of transition between the first and third horizons. Identify the innovations that can be seen to be going in response to the failings of the first horizon and the possibilities of the third. How do we consider the diffusion of innovation?

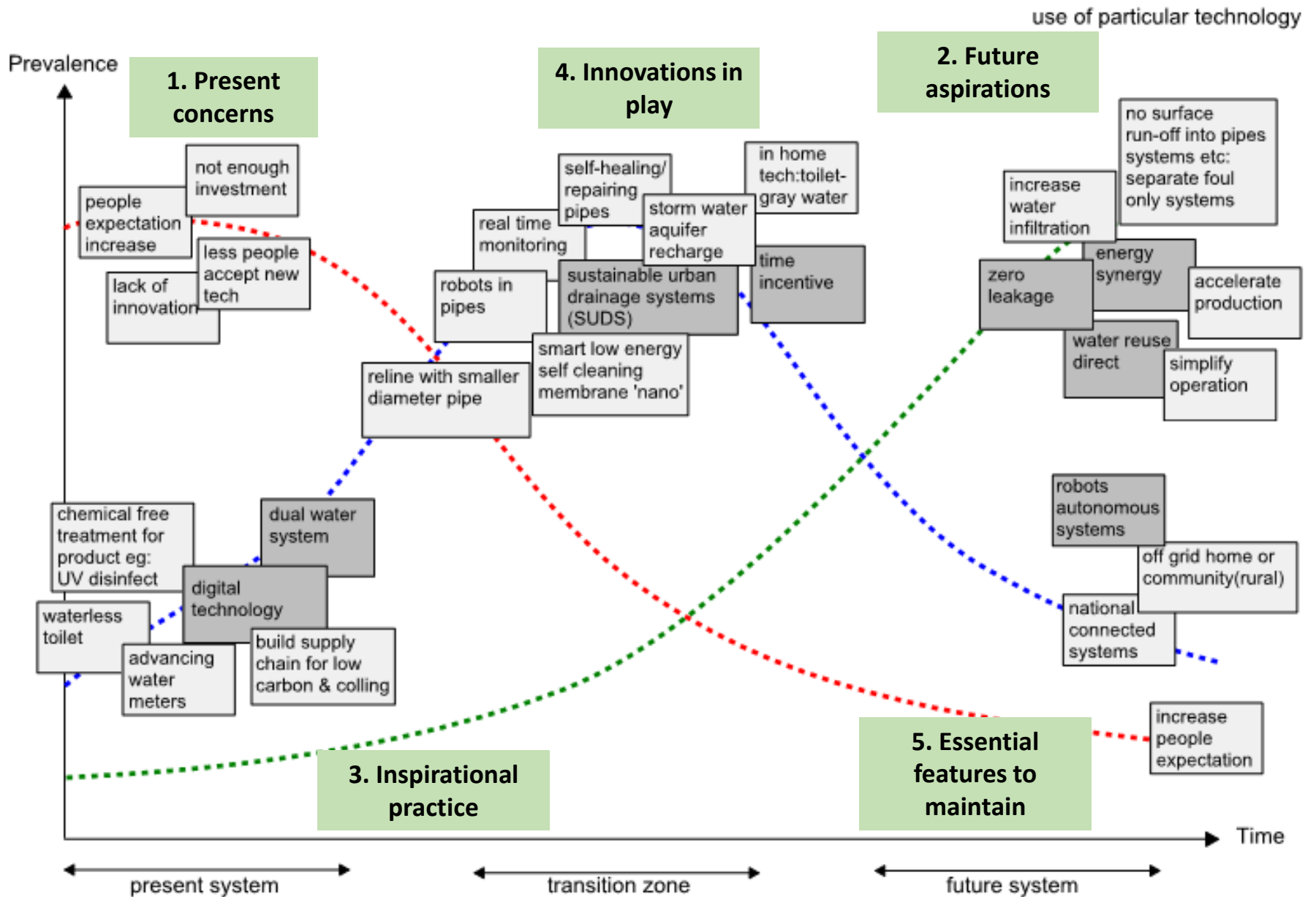
## **5) Essential Features to Maintain**

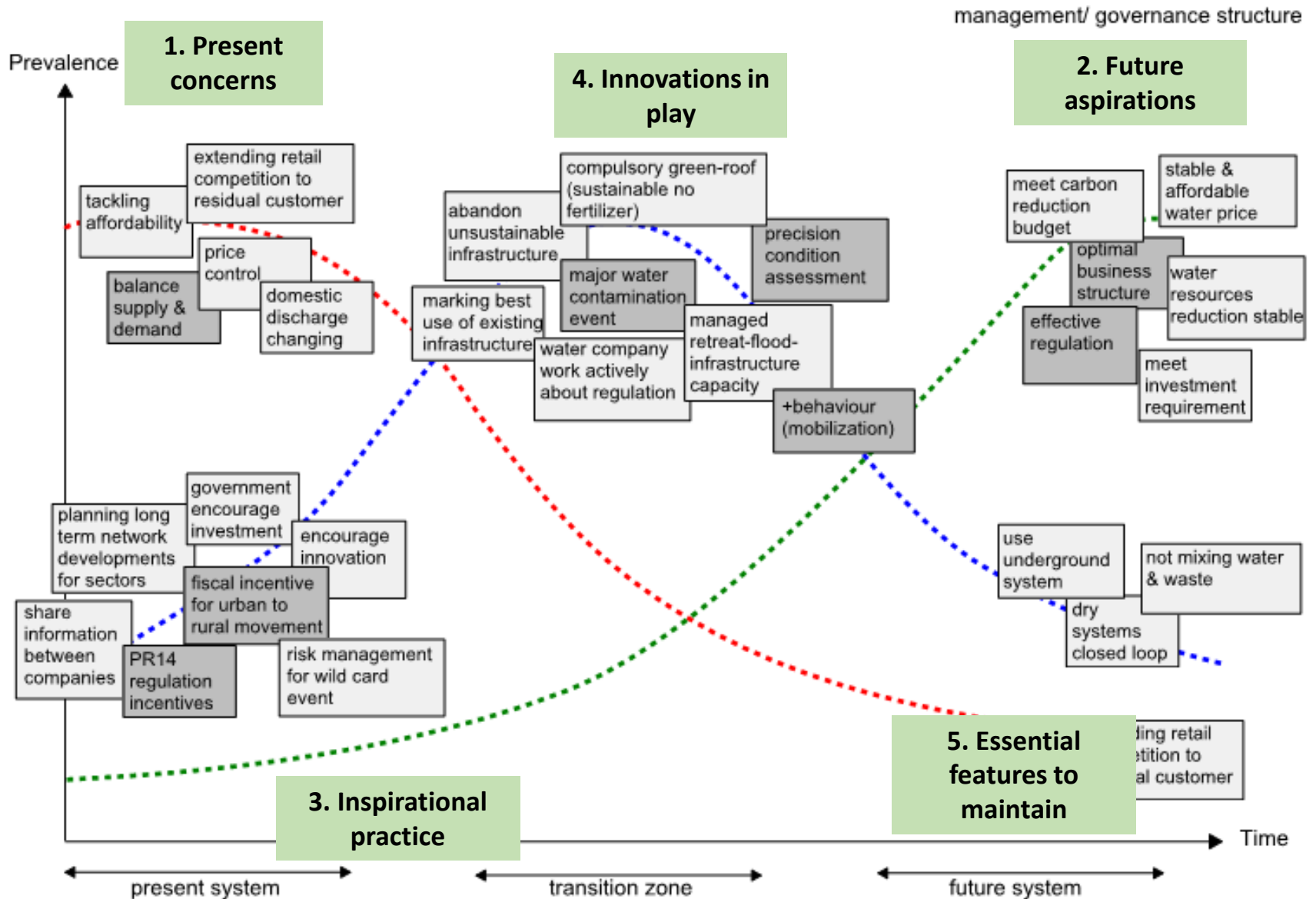
Can you draw attention to those aspects of the old system that are likely to persist into the future within the context of the new dominant system.

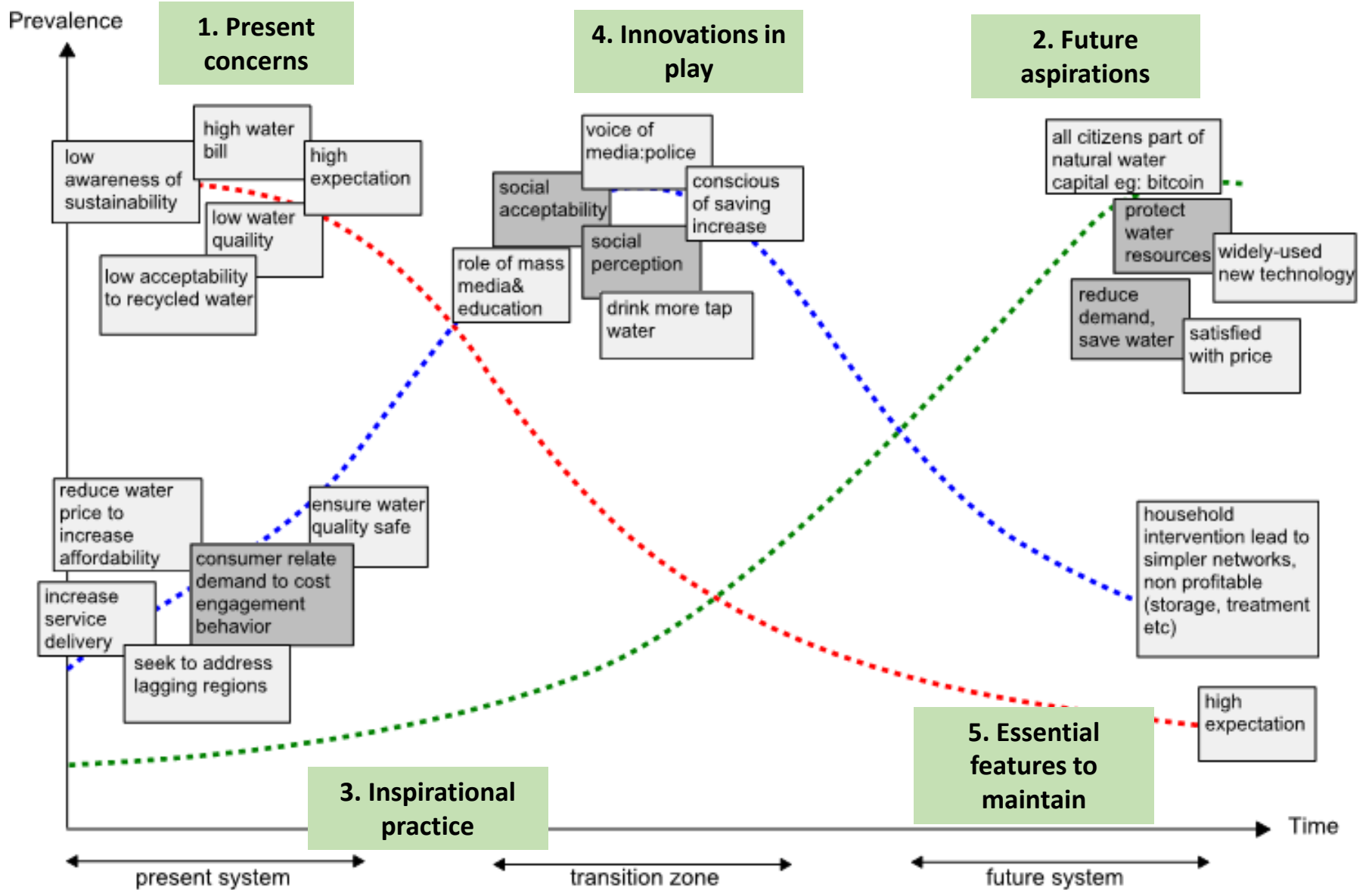
**Prevalence:** ways of doing things; use of a particular technology, a set of values

# Three Horizons: a pathways practice for transformation



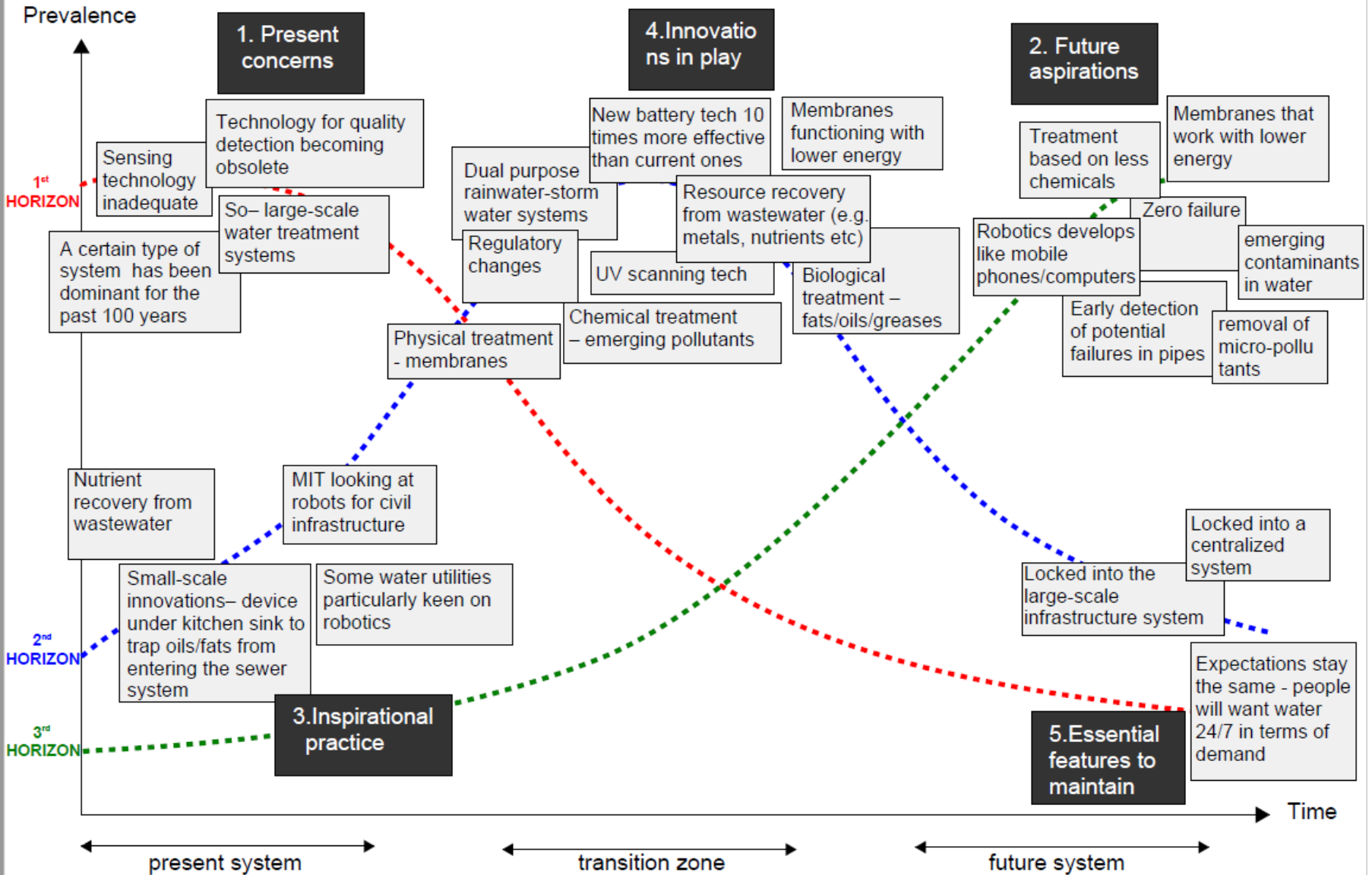




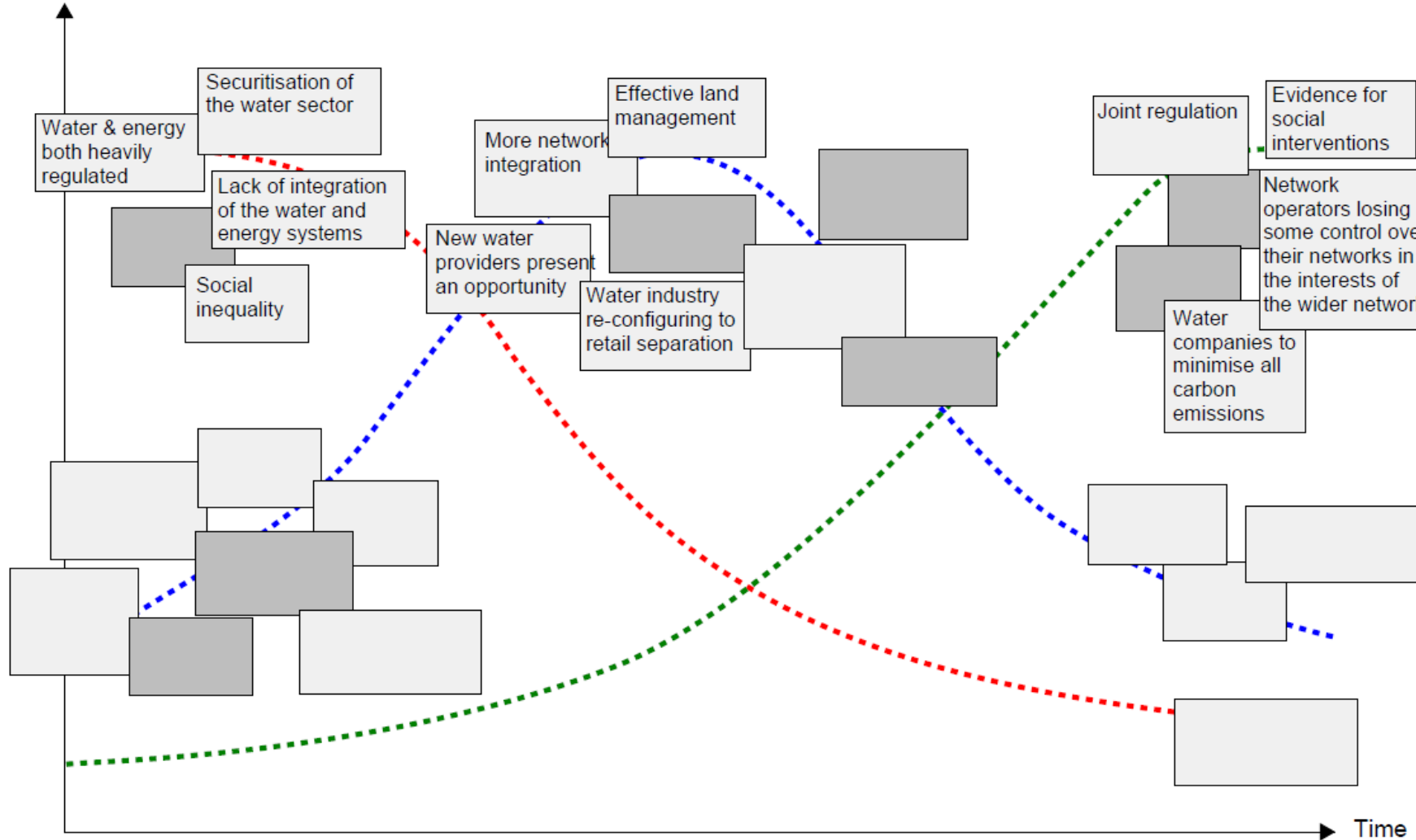


# Theme Leaders





Prevalence



Water & energy both heavily regulated

Securitisation of the water sector

Lack of integration of the water and energy systems

Social inequality

New water providers present an opportunity

More network integration

Effective land management

Water industry re-configuring to retail separation

Joint regulation

Evidence for social interventions

Network operators losing some control over their networks in the interests of the wider network

Water companies to minimise all carbon emissions

present system

transition zone

future system

Time

# FINDINGS

# Drivers

## July TLC

- Strong regulatory drivers ('stick')
- Legislation to enable innovation
- Supporting regulation across planning/local councils, related sectors
- Short-term vs long-term thinking
- Climate change, intensity of rainfall and unpredictability
- Financial constraints of current water companies – cost to ratepayers
- Access and availability of data from a wide range of parties
- Public education
- Uncertainty in data quality and related models/predictions
- Expertise across the entire supply chain
- Take up of innovation (e.g. SUDS)
- Role of professional bodies (e.g. UKWIR, CIWEM)
- Resilience

# Future Aspirations (Performance Criteria part 1)

- Leadership Board 3 Horizons Exercise: Technology
  - No surface runoff into pipes (separate systems)
  - Increase water infiltration (aquifer recharge)
  - Energy synergy
  - Water reuse/direct water reuse
  - Accelerate production (treatment)
  - Simplify operation
  - Off grid homes or communities
  - Zero leakage
- Theme interviews
  - Integration of different infrastructures and regulation (water & energy)
  - Equitable access to water/water quality
  - Carbon-water footprint minimisation at city scale

# Essential Features to Maintain (Performance Criteria part 2)

- Leadership Board 3 Horizons Exercise: Technology
  - National connected systems
  - Increased expectations of people
- July TLC
  - Harvesting energy
  - Lower power requirements
  - Biodegradable products
  - Reduce water waste (including rainwater) and related materials waste
- Theme interviews
  - Customer expectations on continuous supply and quality (does this lock us into current centralised paradigm?)

# Inspirational Practice (Technology baskets)

- Leadership Board 3 Horizons Exercise: Technology
  - Chemical free treatment (e.g. UV disinfection)
  - Waterless toilets
  - Advancing water meters
  - Build supply chain for low carbon
  - Treat water contamination
  - Assets not adaptable
- July TLCs
  - Making space for water through policy
  - Operational intelligence from data
  - Land use regulations to promote SUDS, etc. (e.g. no more paved gardens, sprawl)
  - Innovative mindset in industry
  - Customer engagement (and understanding people to do this effectively)
  - Strong leadership in the water industry (including clarity of ownership, accountability)
  - Understand rates of deterioration, serviceability, condition of assets

# Inspirational Practice (Technology baskets)

- Theme interviews
  - Nutrient recovery from wastewater
  - FOG removal at under-sink level
  - Smart machines/fixtures in the home controlling usage



# Innovations in Play (Technology baskets)

- Leadership Board 3 Horizons Exercise: Technology
  - Self-healing pipes
  - Storm water aquifer recharge
  - In-home tech (e.g. gray water)
  - Time incentive
  - Smart, low energy, self-cleaning membrane (nano)
  - Real time monitoring
  - Robotic autonomous systems
  - Pipe rehabilitation
- July TLC
  - No vehicles so no pollution runoff
- Theme interviews
  - Dual purpose rainwater-storm water systems

# Drivers emerging from Theme interviews

- Advances in technology
- Energy cost (including environmental impact)
- Cost / value of chemicals (including environmental impact and potential markets for recycling)
- Regulation (including more stringent water quality standards)
- Climate change
- Water treatability (raw water quality degradation – from climate or pollution or both)
- Investment levels (including R&D and infrastructure)
- Changes in planning/local councils/land use/developer community
- Public awareness/education
- Skills / capacity / expertise in the industry