30th Annual INCOSE international symposium

Virtual Event
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Creating a Roadmap to Capture a Vision for a Sustainable Community in a Global Perspective;

Case Study in a Dutch town Best

www.incose.org/symp2020

Laura Elvebakk

Master student Industrial Economy with Systems Engineering
University of South-Eastern Norway, Kongsberg

Gerrit Muller

Professor Systems Engineering
University of South-Eastern Norway, Kongsberg

From Best

University of South-Eastern Norway

Best duurzaam

Gemeente Best

Dutch Town Best

30K inhabitants – 12K houses

Average income: 26K Euro/yr.

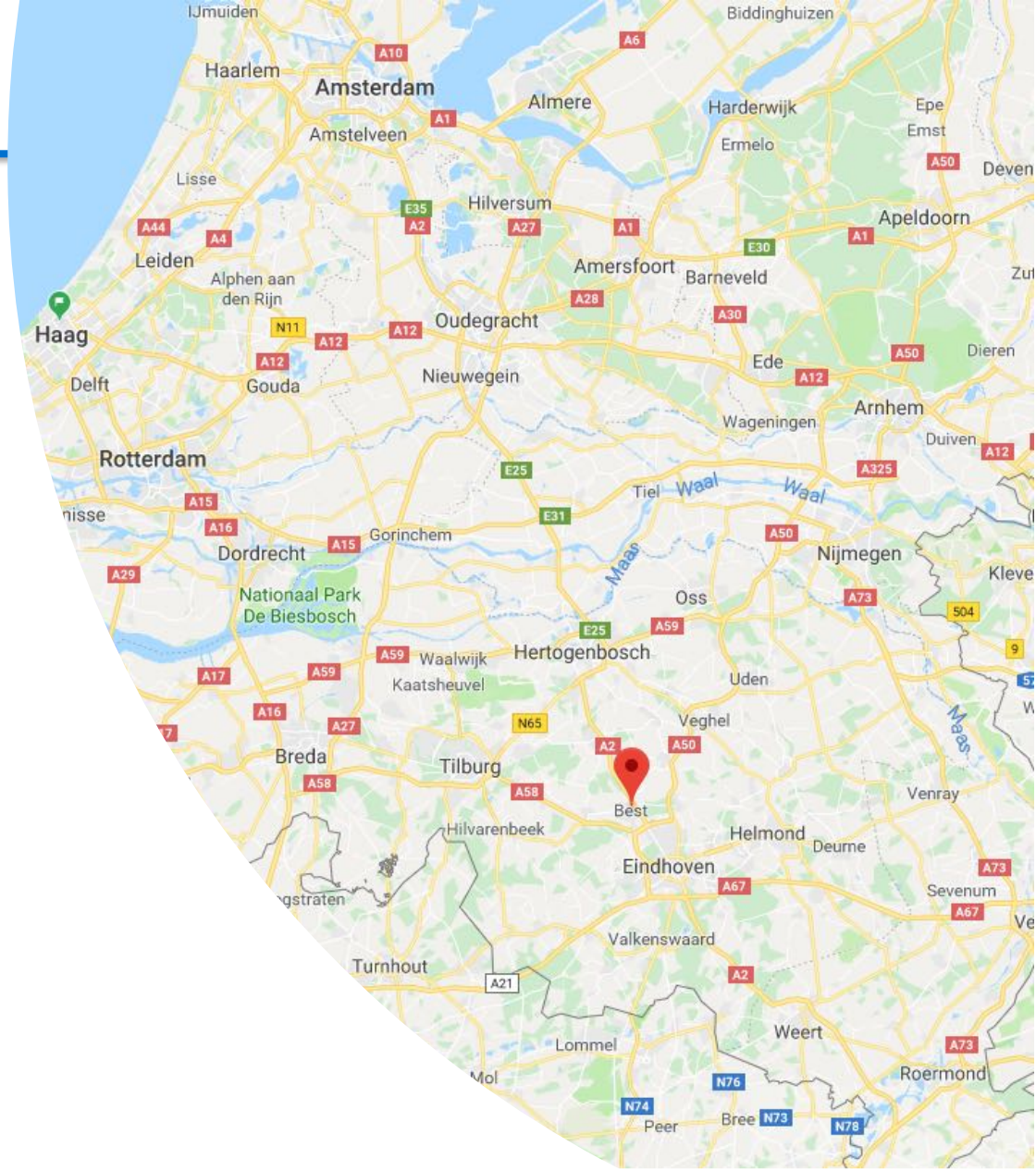
Cooperation Best Duurzaam

Mission:

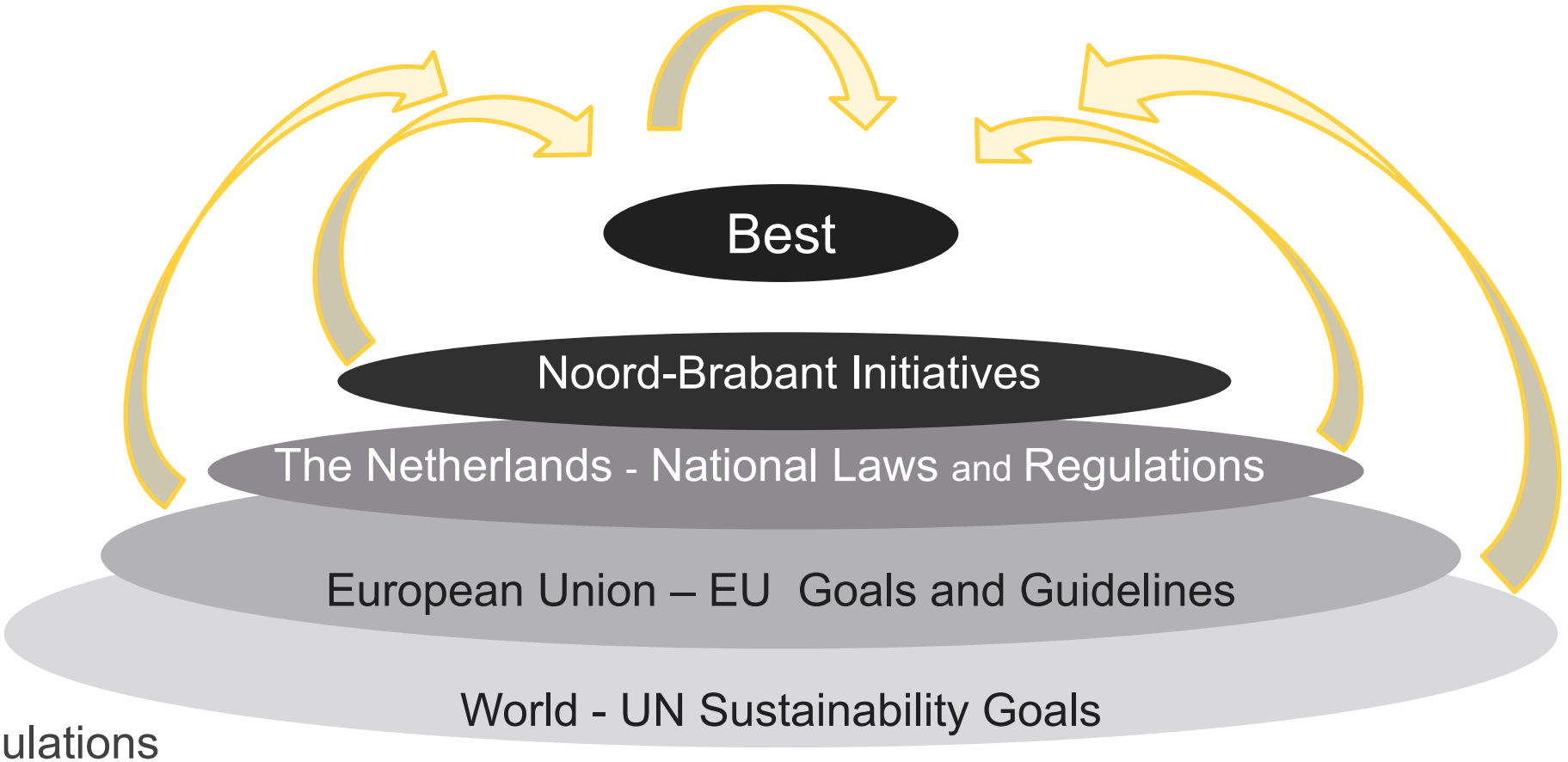
- Promote Sustainability
- Consultant
- Mediator

Organization:

- 360 members
- 40 active volunteers
- Working groups (Technology, Education)



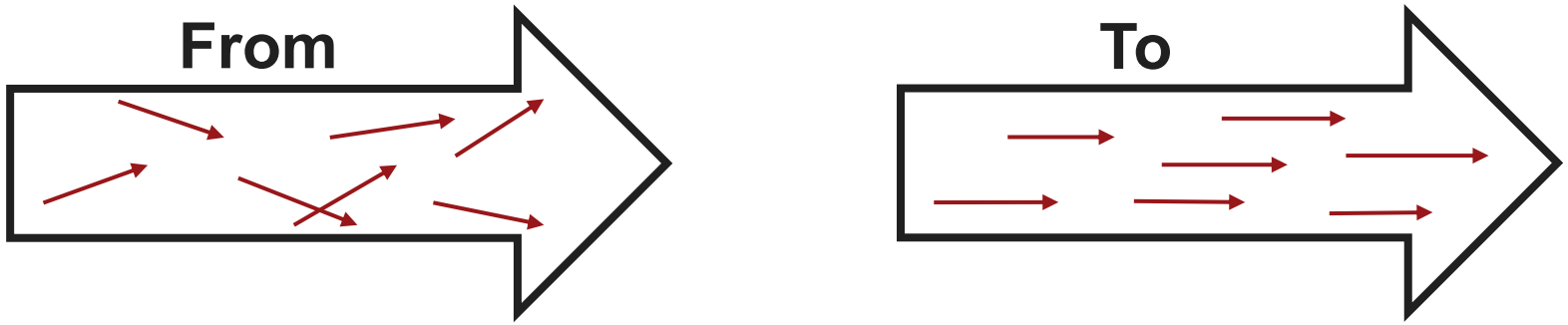
Town Best as a part of a System



- Governmental regulations
- Resident needs, wishes and possibilities
- Best Duurzaam vision and resourcefulness

Problem Statement

Best Duurzaam was missing an overall vision and a shared understanding for further direction and action.
In addition, the cooperation wanted to improve the communication with external stakeholders, especially municipal government.



Concept of creating a roadmap is to get all the involved stakeholders on the same page.
A roadmapping is an approach that supports a cross-disciplinary stakeholder communication and provides a context for projects and activities.

Research Questions

- How does creating a roadmap facilitate communication and sharing among stakeholders?
- How does creating a roadmap aid the local community to become more sustainable?
- How does a roadmap help in finding fitting solutions to sustainability goals?
- What factors do help in the creation of a roadmap?
- What factors can prevent the success of the creation of a roadmap?

Roadmap – What is it?

A roadmap is a structured framework that supports dialogue and communication

	Past - Now	Short-term	Medium-term	Long-term	**Vision**
Objectives Trends	What is happening? What do we need? /demographics, environmental, social, political, legal/				
Solutions Capabilities	How to get there? /renewable energy, circular economy, education, etc./				
Means	What means do we need/get? /hard and soft technology/				
Resources	What resources do we need? /human competences, education, production, supplies/				
Governance	What governance do we need? /standards, regulations, compliance, leadership/				

Drivers

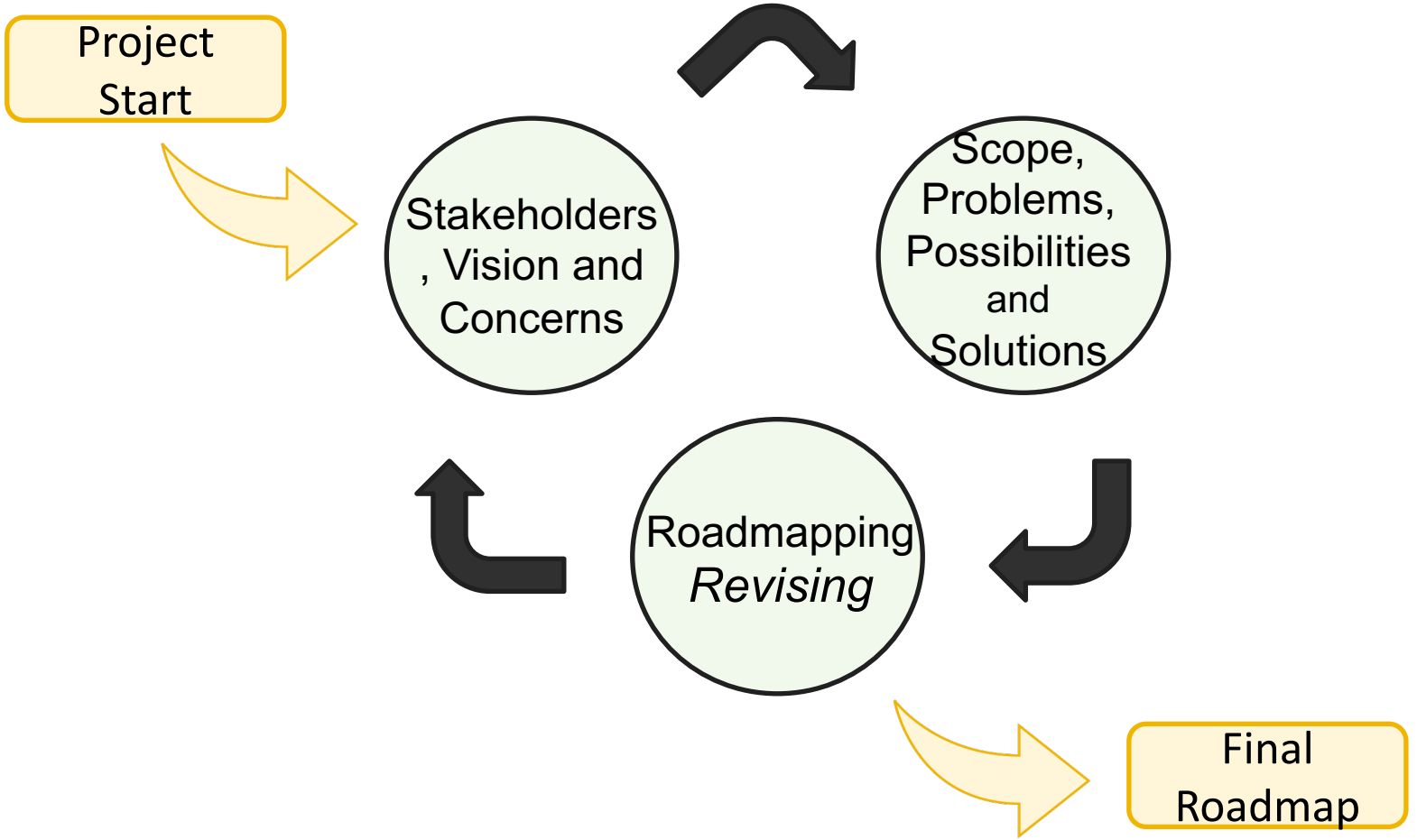
Enablers

Why ?

What ?

How ?

Process of Creating a Roadmap



Project Timeline

	Initializing	Researching			Developing		Completion	
	I1	R1	R2	R3	D1	D2	C1	C2
Weeks	n	n+1	n+2	n+3	n+4	n+5	n+6	n+7
Objectives Trends	What is happening? What do we need? /demographics, environmental, social, political, legal/							
Solutions Capabilities			How to get there? /renewable energy, circular economy, education, etc./					
Means		What means do we need/get? /hard and soft technology/						
Resources			What resources do we need? /human competences, education, production, supplies/					
Governance				What governance do we need? /standards, regulations, compliance, leadership/				

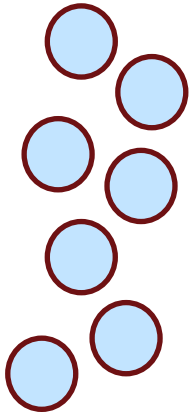
1. Workshop
Initial Roadmap

2. Workshop
Concept Roadmap

Project Presentation
Final Roadmap

Roadmapping Process – Interviews and Workshops

15 interviews – 6 interest groups – 18 representatives – 2 workshops – 1 roadmap



	Past - Now	Short-term 1-3 y 2019 - 2021	Medium-term 4-7 y 2022 - 2025	Long-term 8-11 y 2026 - 2030	Vision 2050
Objectives Trends		What is happening? What do we need? /demographics, environmental, social, political, legal/			
Solutions Capabilities		How to get there? /renewable energy, circular economy, education, etc./			
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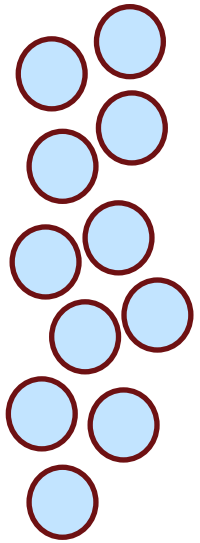

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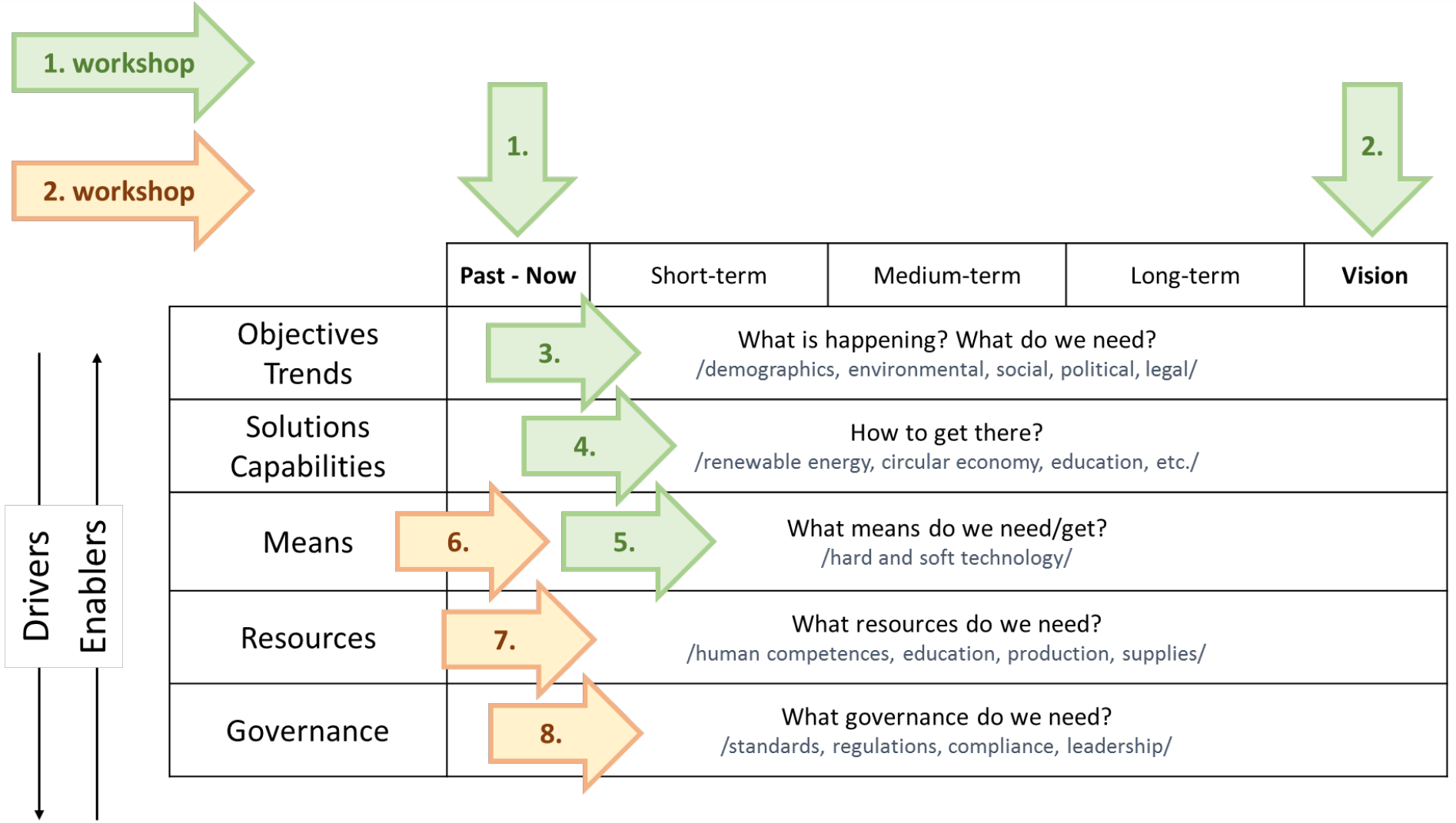
Two Workshops



The Findings

“Mindset” *“Educate”*

“Reduce. Reuse. Recycle.”

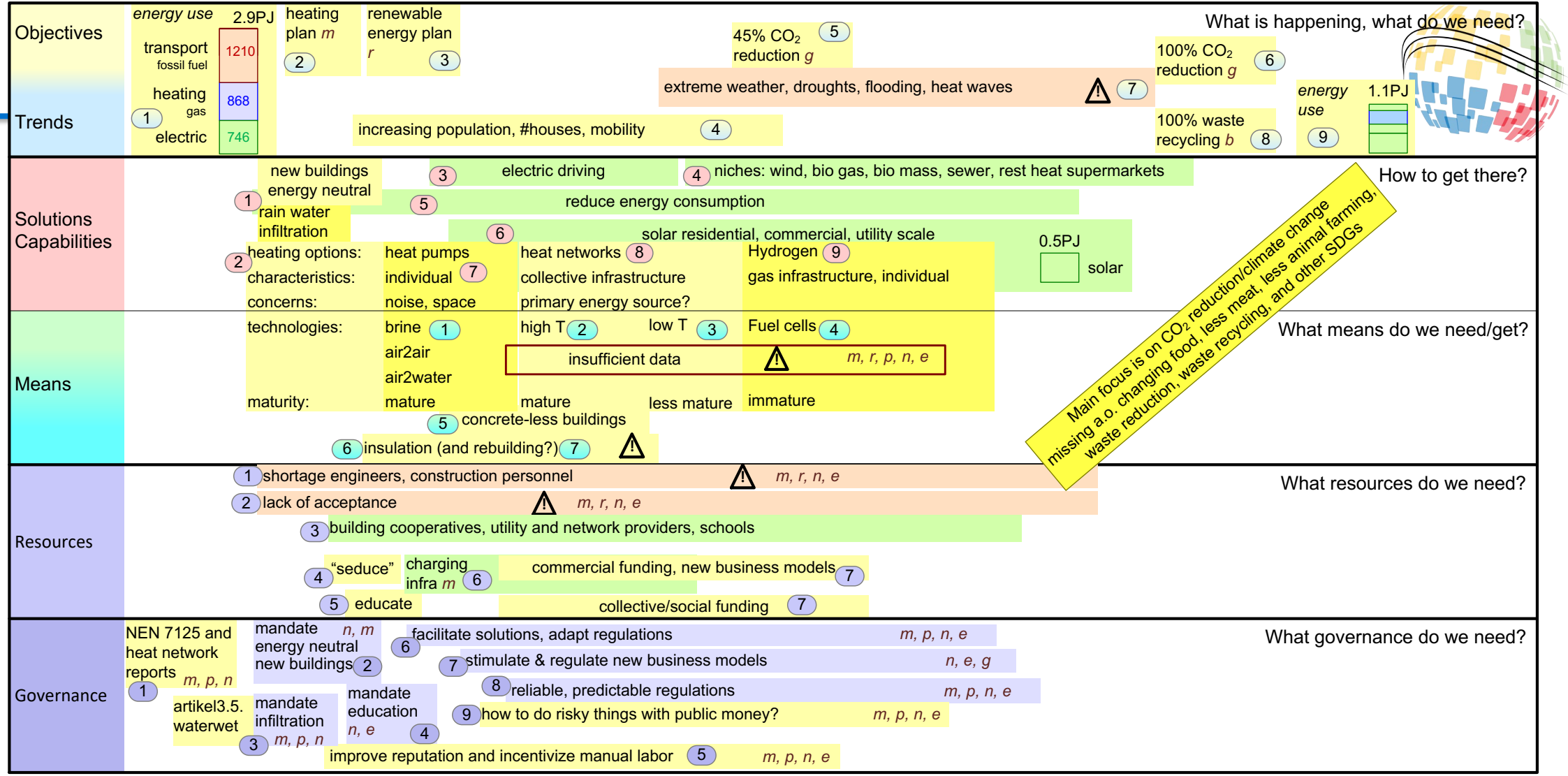
“Green Energy” *“Social Energy”*

“New Business Models”

“Seduce”

132 Post-It notes

The Roadmap



1 energy use 2017
2 mandatory 2020 heating plan per neighborhood
3 mandatory 2021 regional
4 small increase per year
5 IPCC 2018
6 IPCC 2018
7 may increase energy use
8
9 energy use after full electrification and some reduction

1 make all new developments sustainable
2 selection of options for heating plan
3 transport is major CO_2 producer
4 niche solutions in Best
5 reducing energy consumption is must
6 all forms of solar may result in 0.5 PJ/yr
7 mature; noise, space is concern
8 few rest heat sources; large collective infrastructure investment
9 long-term option; re-use gas infra

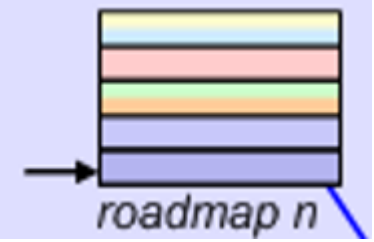
1 air2air for heating is efficient; how to get tap water?
2 compatible with older houses; challenge data is not public due to commercial interests
3 efficient allows re-use of any rest heat; storage is the big challenge
4 source to use little efficient; solves seasonal storage; production infrastructure expensive
5 concrete is major CO_2 producer
6 insulation is first step; external insulation needed?
7 when is rebuilding better (justified and acceptable)

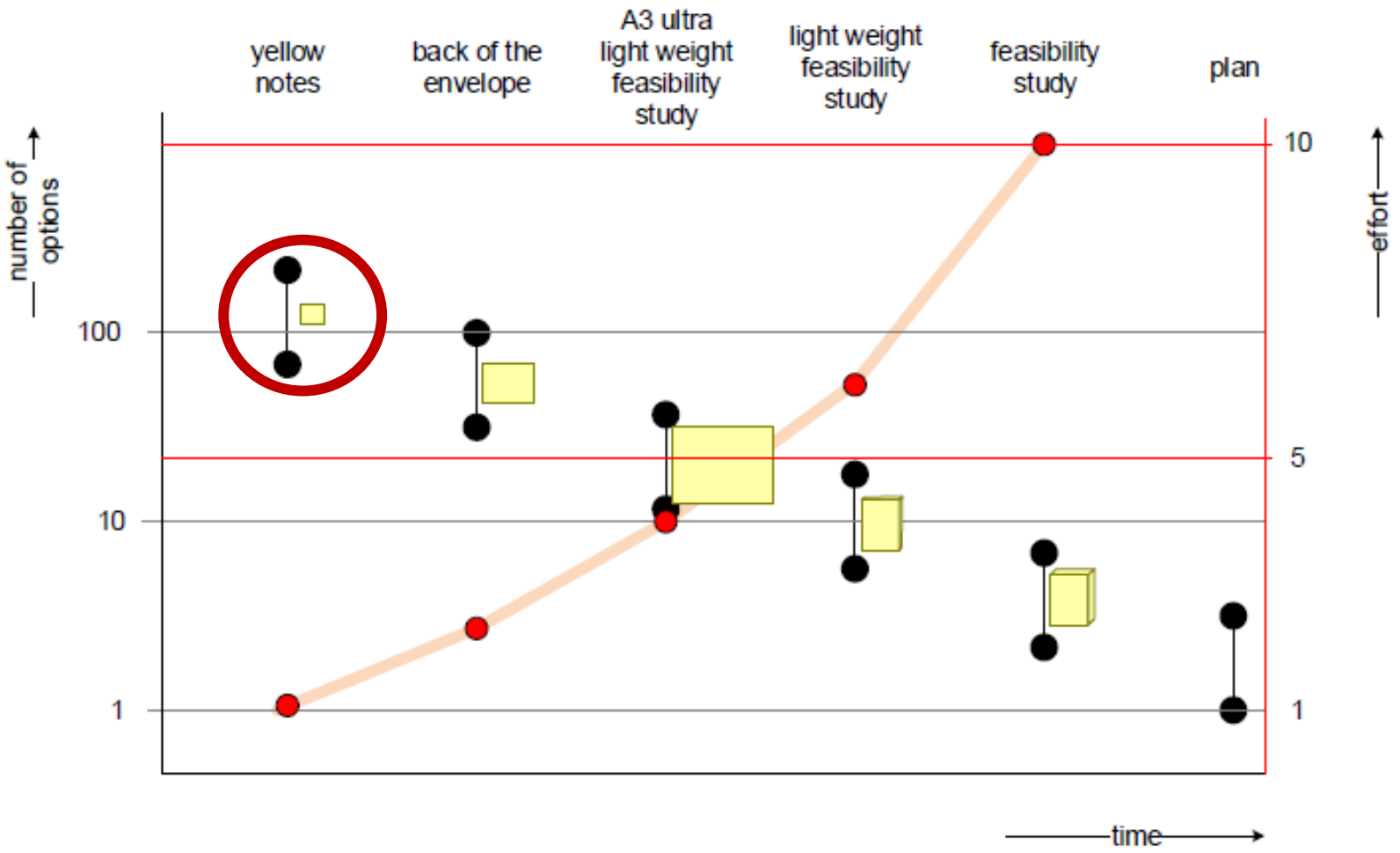
1 action plan to attract and educate
2 involve, engage, seduce, incentivize
3 roadmap and master plan to coordinate
4 more effective than enforcement
5 primary, secondary schools; avoid overload
6 enable electric driving
7 be creative to get economy and funding working

1 7125 and reports overrate sustainability of bio mass and rest heat sources; lack absolute data
2 ASAP! waiting increases problem
3 vng.nl/3-gemeentelijke-watertaken; should be standard operation when maintaining streets
4 how to do this effectively?
5 culturally ingrained
6 agile (fast response) governance
7 facilitate and regulate
8 past pitfall; blocks investments
9 major dilemma for 6, 7, and 8

legend
b Best Duurzaam
m municipality
r regional
p province
n national
e Europe
g global

Roadmap is Just a Start of a Process

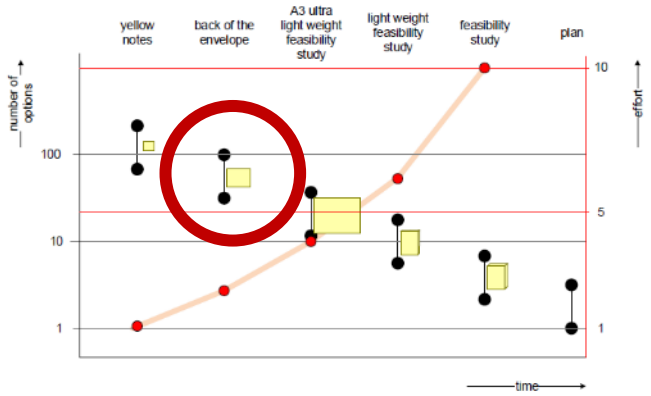




As the time goes:

- Fewer options
- More research effort

Back-of-the-Envelope



Back-of-the-envelope:

- To get a feel for the size of the problem
- A quick exploration of the solution option
- Estimate of the economic impact of potential solutions

Heat Pump

cost per house	in k€ incl. install incl VAT
heat pump in&out	11
mounting material	1
installation	6
16kW heat pump	18k€

average gas consumption per house in Best	electricity consumption to replace gas
1430 m^3/yr	(SCOP 3)
~13 MWh/yr	~4.3 MWh/yr

advantages:	disadvantages:
• energy efficiency	• installation effort
• independent of other houses	• initial cost
	• acoustic noise
	• space for equipment

cost/house	cost in k€ incl. install incl VAT
16kW heat pump	18
insulation	4
PV system with 16 solar panels, 5.4kWp	7
miscellaneous	1
total	30

heat pump in&out	11
mounting material	1
installation	6
total	18

16 panels 340kWp	3.7
optimizers	0.7
inverter	1.0
mounting material	1.0
installation	1.0
total	7.4
excl VAT	

cost for all houses in Best

12k houses
30 k€/house
360 M€

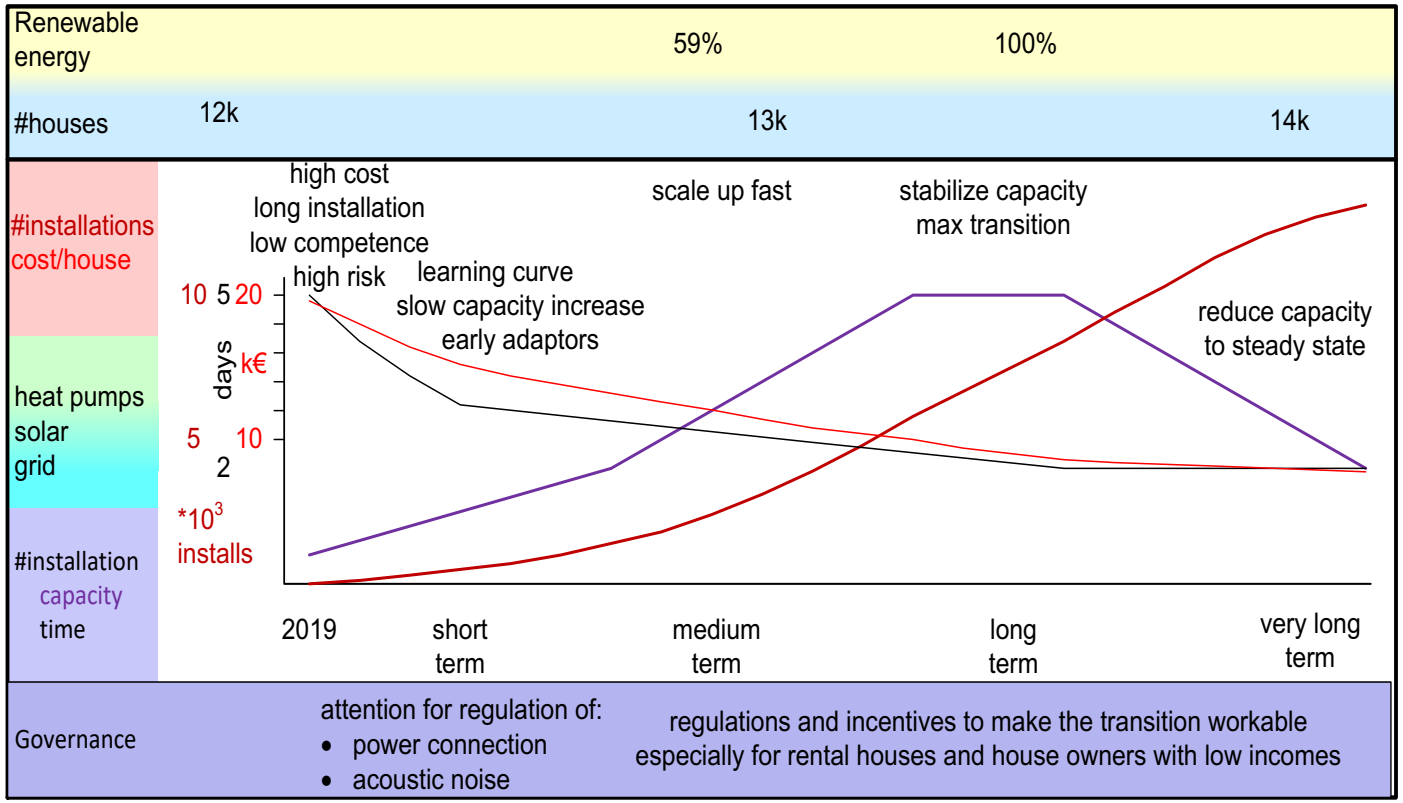
assumptions:
prices 2018
effort 2018
VAT return on solar
no infrastructure cost

this is a very coarse estimate, e.g. +/- 50%

Scenarios

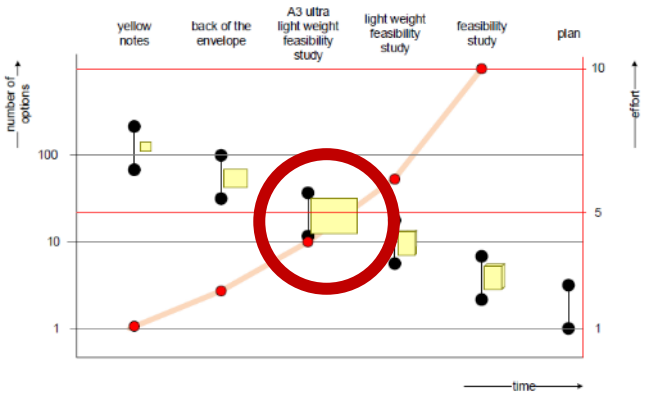
The main purpose of making the transition scenario is to discover:

- What questions to ask?
- What problems to explore?
- What relations to analyze?



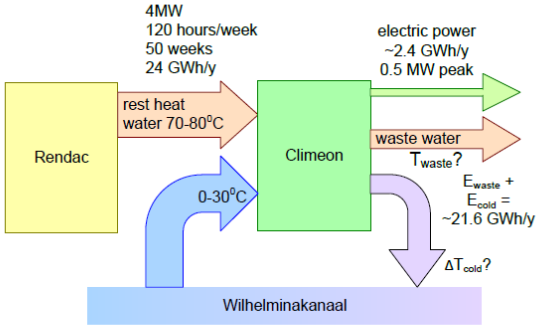
Many numbers in the scenario are assumptions.

A3 – Ultra Light Feasibility Study



A3 is a tool for knowledge sharing and effective communication. It provides a highly graphic process overview.

1 *System level block diagram*

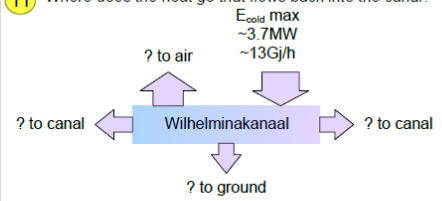


10 *Assumptions, limitations*

ignored:

- Operational cost
- effect of climate change (higher temperatures)
- warming up of Wilhelminakanaal
- energy use of auxillary systems
- potential subsidies

11 *Where does the heat go that flows back into the canal?*

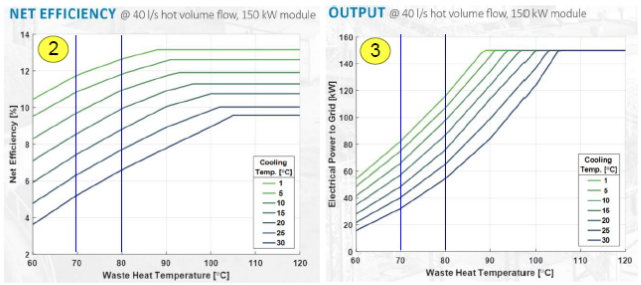


Explanations

This A3 explores how the Climeon system may transform rest heat into electricity at Rendac in Son. Purpose is to understand this option and to find out what questions we need to ask. Feedback is welcome. Blame Gerrit for mistakes.

1 provides a high level block diagram of the concept
How does the rest heat leave the system? How much is hot waste water, how much is the cold water warmed up?
2 the efficiency of the Climeon system depends on t_{hot} and t_{cold}
3 the P_{out} also depends on t_{hot} and t_{cold}
4 We need the efficiency and P_{out} @ t_{hot} = 70..80°C as function of t_{cold} between 0 and 30°C, we derived a linear relation from 2 and 3
5 KNMI.nl provides the temperature per month for the regio Eindhoven we assume that the water temperature follows the air temperature
6 Combining 4 and 5, with the data from 1 gives the energy per month
7 cumulating all months in 6 gives the produced electric energy per year
8 we use 4 to calculate the required #modules at worst case conditions, which is when t_{cold} = 30°C; it also shows E_{month} @ 30°C
9 cost = #modules * cost/module + installation cost
income per year = E_{year} * $price_{kWh}$
ROI = cost / income per year
10 we have simplified a lot, here are some limitations
11 warming up of the canal has a big impact on environment and efficiency of the solution. Where does all the remaining heat go?
12 to get a feel for the impact, we estimate how much a stretch of 100m of the canal gets warmer per hour or per day, if all rest heat stays in the that part of the canal.
13 shows the impact of canal water that is 3°C warmer than the average air temperature

Climeon data from https://climeon.com/wp-content/uploads/2017/04/Climeon-Tech-Product-Sheet.pdf



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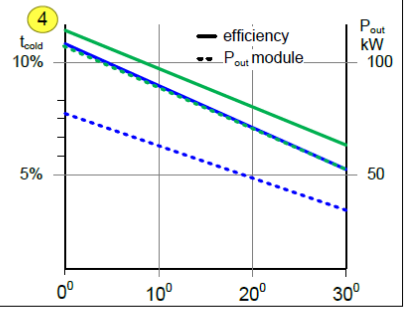
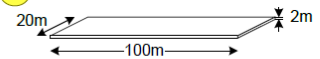


12 *Estimate of warming of canal water*



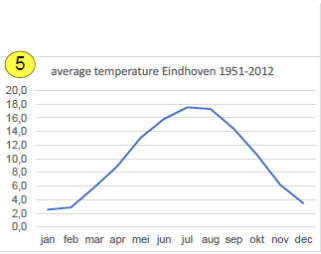
V_{water} = 100 * 20 * 2 = 4000 m^3
m_{water} = V_{water} * 1000 kg/m^3
c_{water} = 4.2 J/gK
E_{in} = 3.7 MW/h * 3600 = 13.3 GJ
$\Delta T = P_{in} / m_{water} * c_{water}$
= 13.3 * 10^9 / 4 * 10^9 * 4.2
~= 0.8 K

this stretch of the channel would heat
0.8 K /hour if no heat escape or 20°C/day

It is crucial to understand how the heat dissipates via the waste water, or from the canal to air, the rest of the canal, and the ground.

Electricity production in Eindhoven area

5



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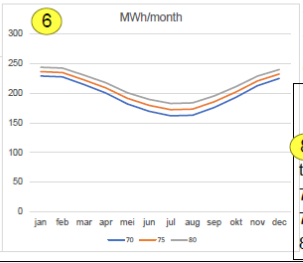


7

t_{hot}	MWh/y
70	2354
75	2460
80	2566

8 #modules, E_{month} @ worst case (t_{cold}=30°C)

t_{hot}	#mod	MWh/m
70	7	106
75	6	119
80	5	132

9 *Cost and Income*

Cost/module 350 k€
install cost (wild guess GM) 300 k€
electricity price 0.05€/kWh

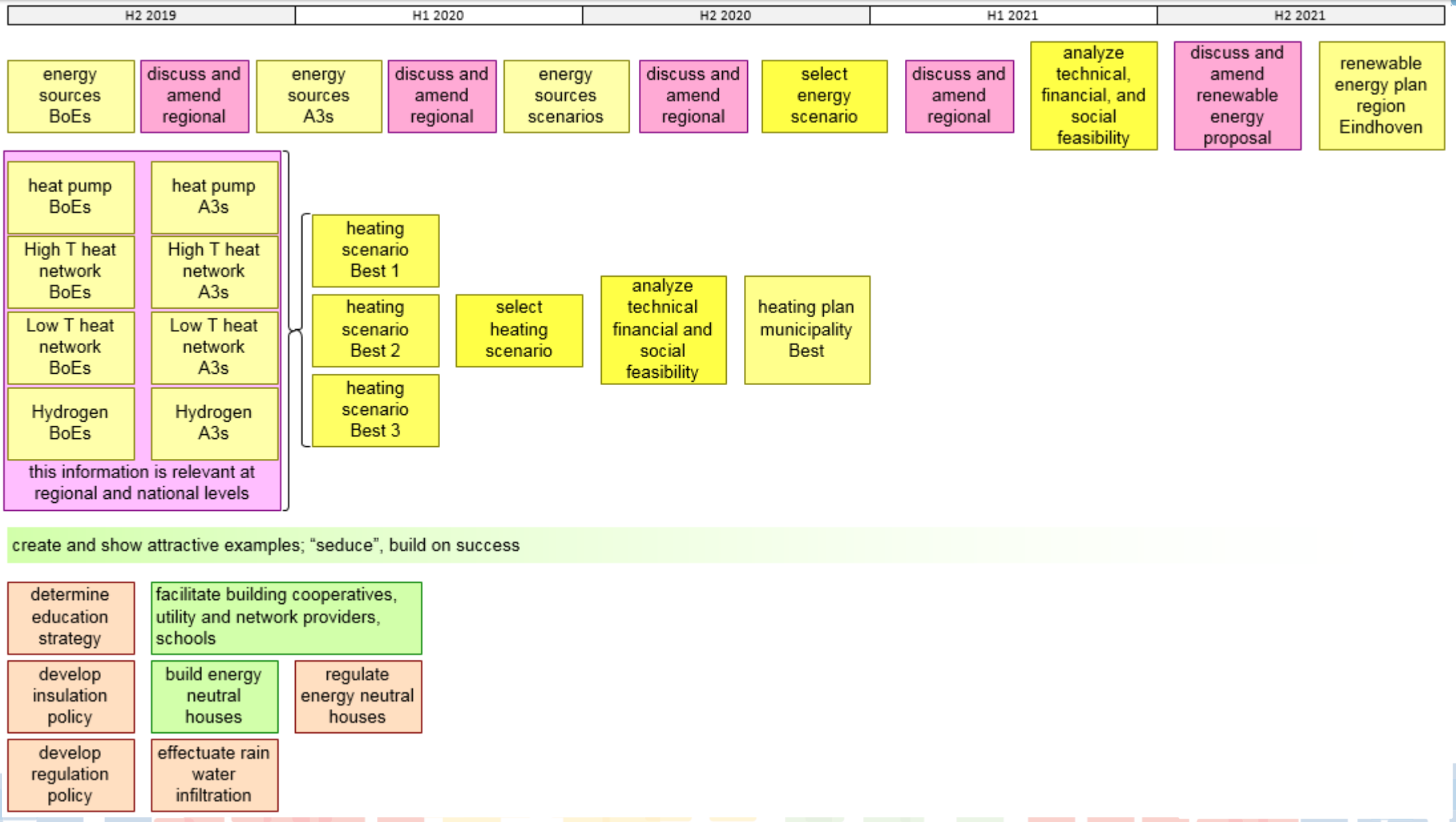
t_{hot}	#mod	cost k€	income k€/y	ROI years
70	7	2750	118	23.3
75	6	2400	123	19.5
80	5	2050	128	16.0

What if t_{cold} is 3 degrees warmer?

13

t_{hot}	MWh/y	income k€/y	ROI years
70	2193	109	25.2
75	2306	115	20,9
80	2402	120	17,1

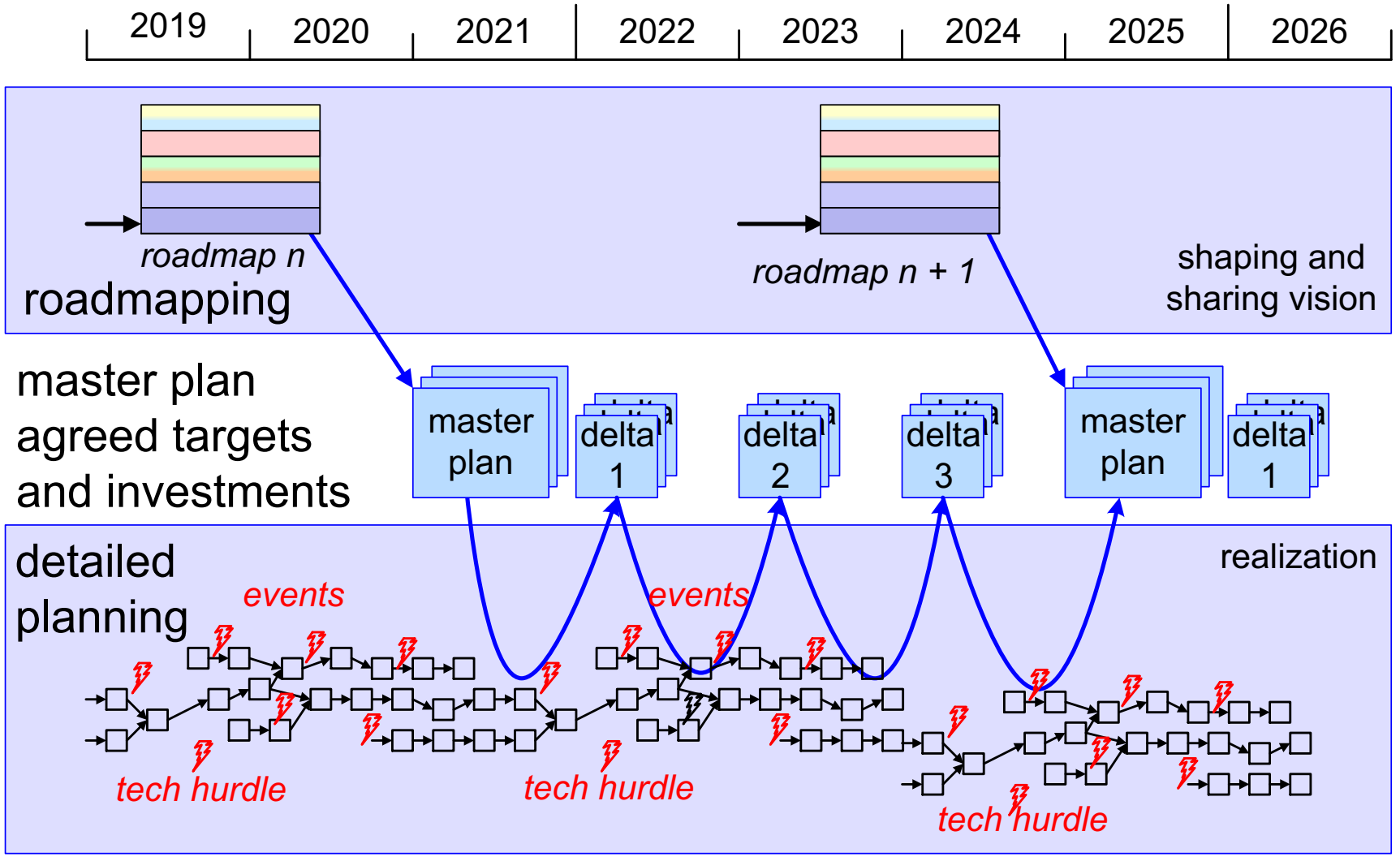
The Masterplan



How does this fit in a bigger picture?

A roadmap visualizes the strategy at a conceptual level. It is compact and provides an overview.

A Roadmap is a shared vision that serves as context for the masterplans.



Work is identified. But who's going to do it?

The value of the roadmap appear when the stakeholders start using it.

Steering group:

- Best Duurzaam members
- Politicians- municipal and regional
- Industry representatives
- Builders /Entrepreneurs
- Housing Corporation
- Grid provider
- Farming community representative

The Project Evaluation

The Impact Factors - to confirms the choice of the method

The Research Questions - to evaluate whether the roadmap achieves anticipated benefits

The evaluation of the case was based on:

- Stakeholder feedback
- Observations and assumptions of the researcher

The Impact Factors

- The interest of the stakeholders
- Engagement of stakeholders
- Recognizability of the roadmap
- Understandability of the time dimension
- Understanding the project relatability to the real world

The Discussion

The roadmap:

- does not provide, nor it suggests one specific solution for the transition process;
- it does support the exploration of different scenarios;
- it exposes key findings and ideas that could lead to feasible solutions;
- reveals the bottlenecks of the transition:
    - the shortage of human competencies
    - the mindset of people

The biggest challenge - the data allocation with respect to the time axis

A very social study – the research required a high level of people skills

The Conclusion

Feedback from the stakeholders was highly positive.

Roadmapping served as a great facilitator for communication among stakeholders.

The roadmap provided a much needed “helicopter view”.

The knowledge-sharing initiated by the roadmap is the contributor to efficient solution finding.

The Roadmap proved to be well suited for this project for the transition to a sustainable community

Questions

Thank you for your attention!