Planbureau voor de Leefomgeving

COST-EFFECTIVE HEAT-TRANSITION - VESTA MAIS MODEL

Folckert van der Molen

PBL - Netherlands Environmental Assessment Agency

Reducing natural gas use in the built environment

Multi-level approach	
National	Climate agreement 2030
Regional	RES - Regional Energy Strategy
Municipal	Transition vision heat 2021
District	Energy implementation plan

Energy Regions

National targets:

- Reducing CO2 emissions by 3,4 Mt in 2030
- Reducing natural gas demand in the built environment
- Up to 2 million homes to be disconnected from natural gas

Regional case study using the Vesta MAIS model

- The Heat Transition is taking shape on the municipality level with regional cooperation, applying localized solutions
- Insight into the interactions between national climate policy and the regional Energy Transition
- Preparation for the monitoring, analyzing and eventual adding-up of many Regional Energy Strategies

Drechtsteden region

Region characteristics
• 7 municipalities
• 270.000 inhabitants
• 144.000 buildings
• Currently using 7 petajoule of natural gas every year for heating
• Ambition: zero natural gas in 2035

Regional cooperation for the energy transition

Energy Strategy Drechtsteden - signed in September 2017

Guidelines for Cooperation – signed in March 2018

Further specified in working groups with municipal authorities and local stakeholders. For heat these include:

Strategy | Communication | Financing | Local planning

Parallel development of a two-component Heat Strategy

- Designing a process for implementation
- Detailed analysis of available options

Detailed analysis of available options

Looking for:

Ways to achieve 90% reduction of natural gas demand by 2035

Comparing these by:

Technical measures required, resulting energy use & total collective cost

To answer:

1. *How can the goal be achieved with the lowest total collective cost?*

2. *Which policies can create solid business cases for individual actors to make the required investments?*

3. *Which groups of actors will face the costs and the benefits?*

General overview of Vesta MAIS

Aimed at technical and economic analysis
to aid policy-makers concerned with
heating in the built environment

- Existing residential and commercial real estate
- *Optional* to include future construction
- *Optional* to include horticulture

Models energy flows, transactions and technical measures

Typically used as a simulation of a starting state, which can be subjected to diverse stimuli to create scenario's.

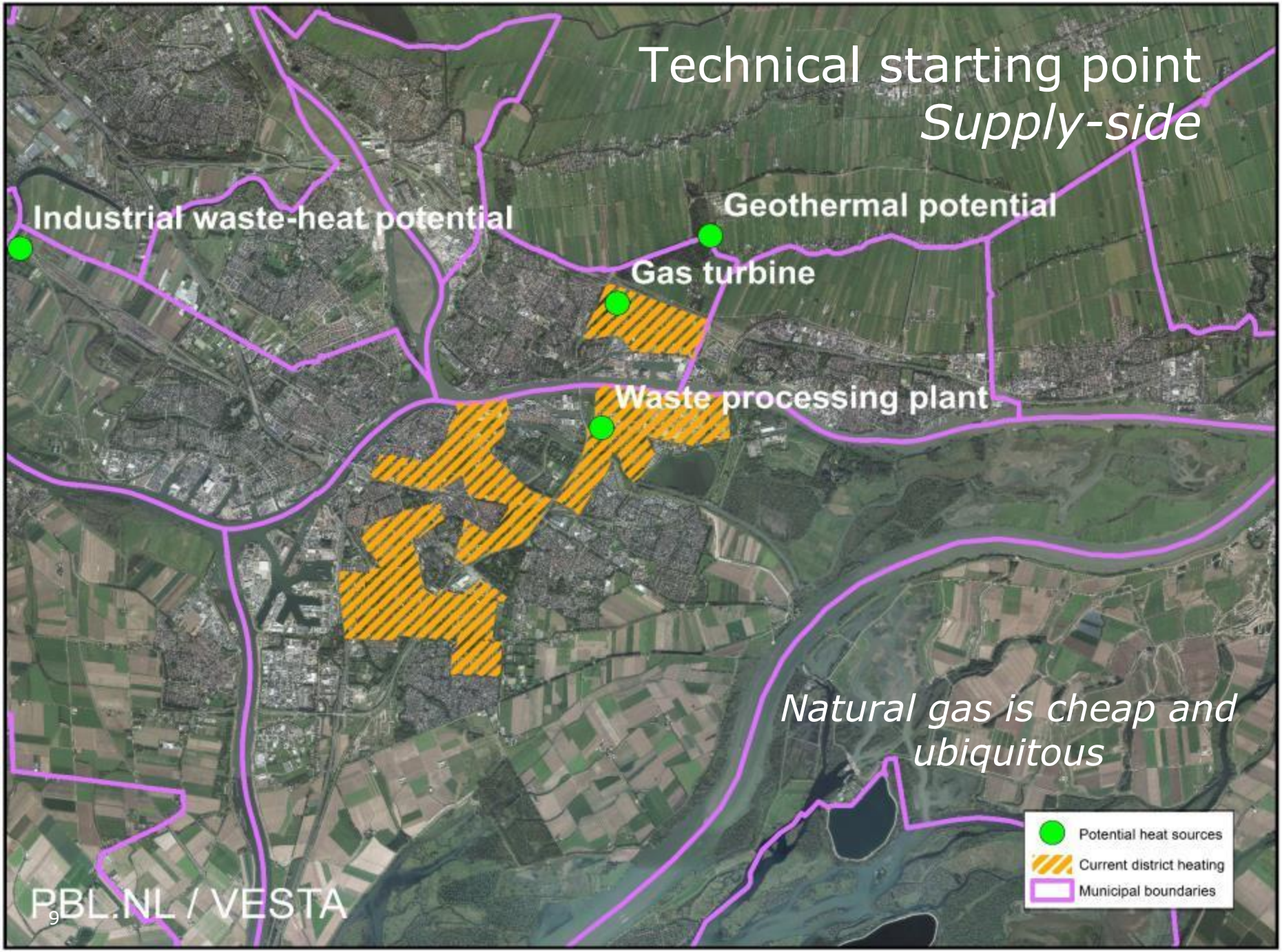
Starting state

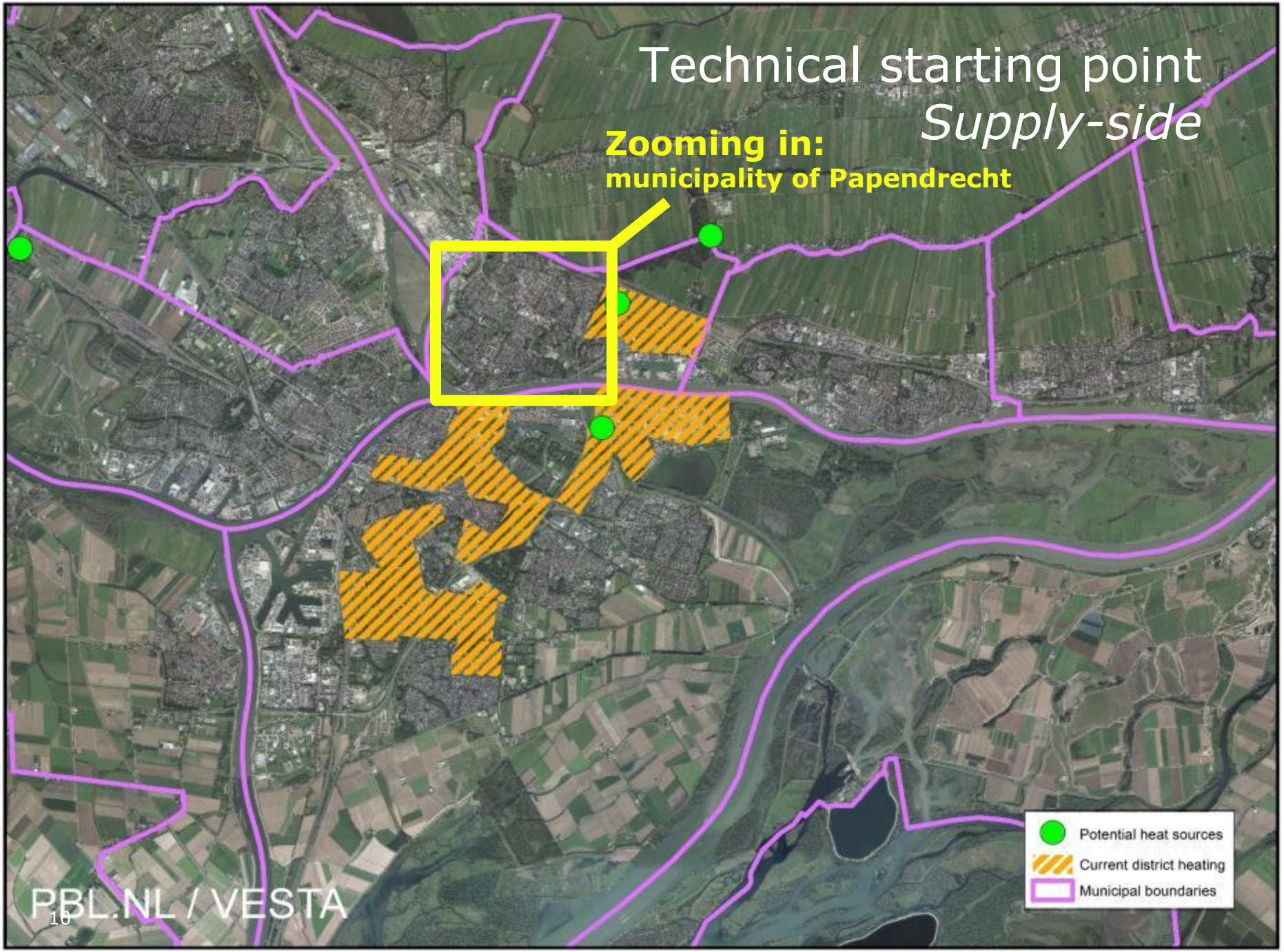
Existing building stock: demand side

- Input: Type of building
- Input: Construction period
- Input: Energy efficiency class (label)
- Calculated: Energy demand, including costs and emissions
  - Natural gas
  - Electricity (for heating and appliances)
  - Heat

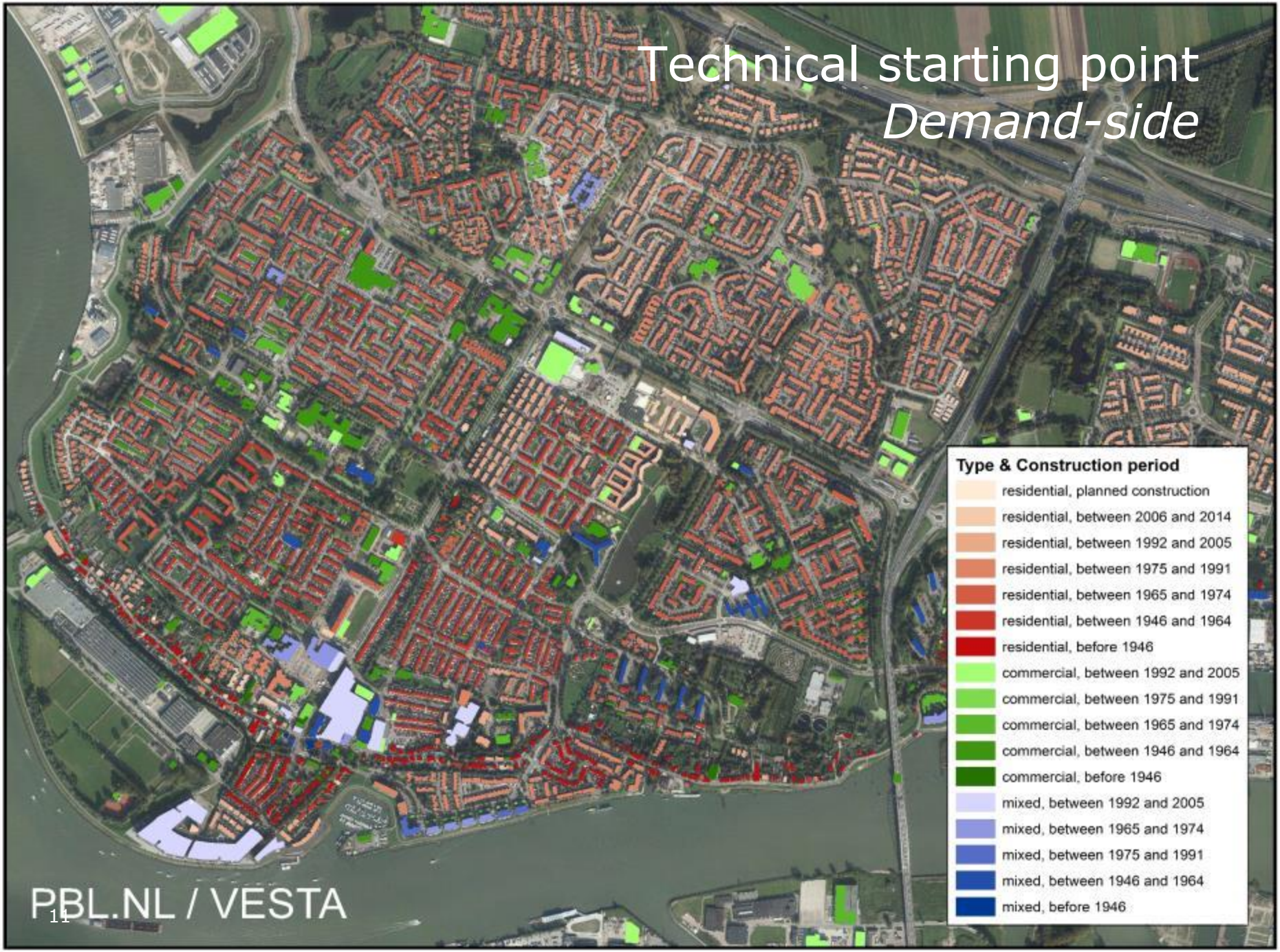
Existing and potential heat sources: supply side

- Input: Known heat sources, including emissions
- Input: Current use of heat sources, including costs
- Input: Potential areas for geothermal heat production
- Input: Potential areas for underground thermal storage

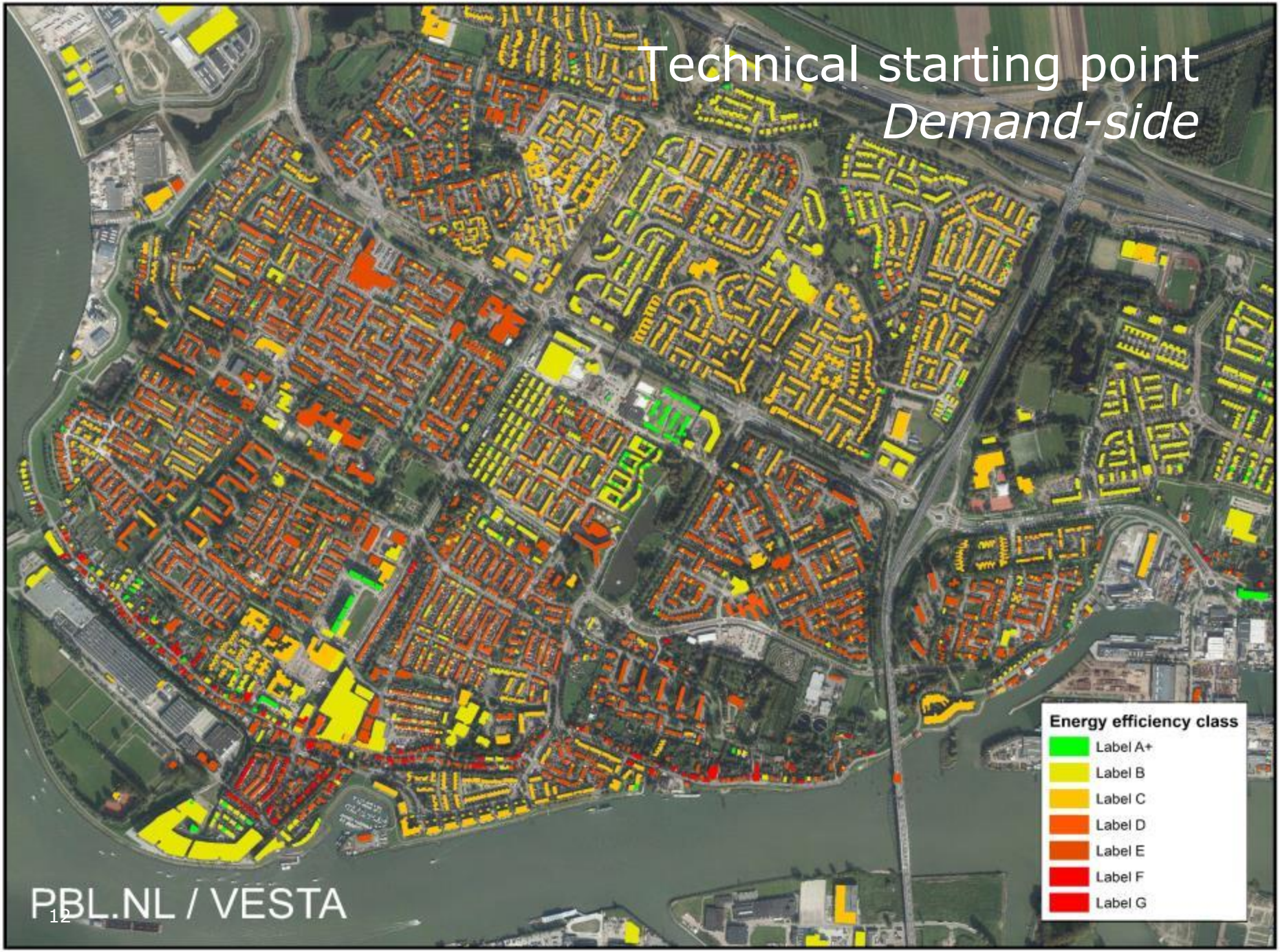

Technical starting point
Supply-side
Industrial waste-heat potential
Geothermal potential
Gas turbine
Waste processing plant
Natural gas is cheap and ubiquitous
Potential heat sources
Current district heating
Municipal boundaries
PBL.NL / VESTA


Technical starting point
Supply-side
Zooming in:
municipality of Papendrecht
Potential heat sources
Current district heating
Municipal boundaries
PBL.NL / VESTA

Technical starting point
Demand-side



Technical starting point
Demand-side



Modeling future developments

Autonomous influences up to 2050 (baseline)

- Input: new construction and redevelopment
- Input: climate impact on heat demand
- Input: curves for investment cost of technical measures
- Input: curves for future energy prices

Vesta MAIS determines business cases for a set of potential technical measures and applies them *according to user criteria*.

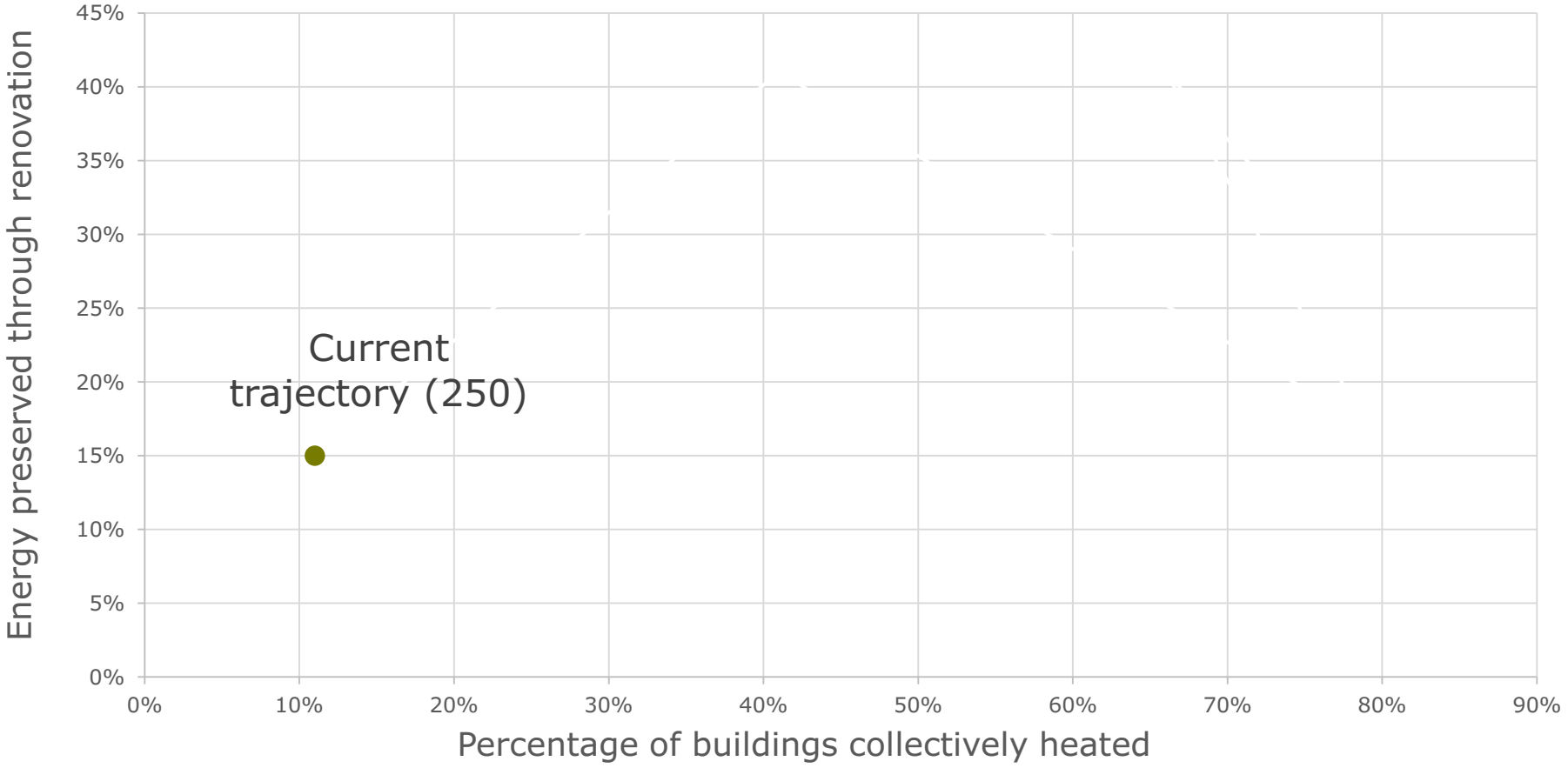
- Renovations of buildings
- Electrification of individual heating systems
- Heat networks over 70 °C (waste heat, geothermal or biomass)
- Heat networks under 60 °C (e.g. with thermal energy storage)

User criteria:

Which years? Collective cost or actor cost? Which order of operations?

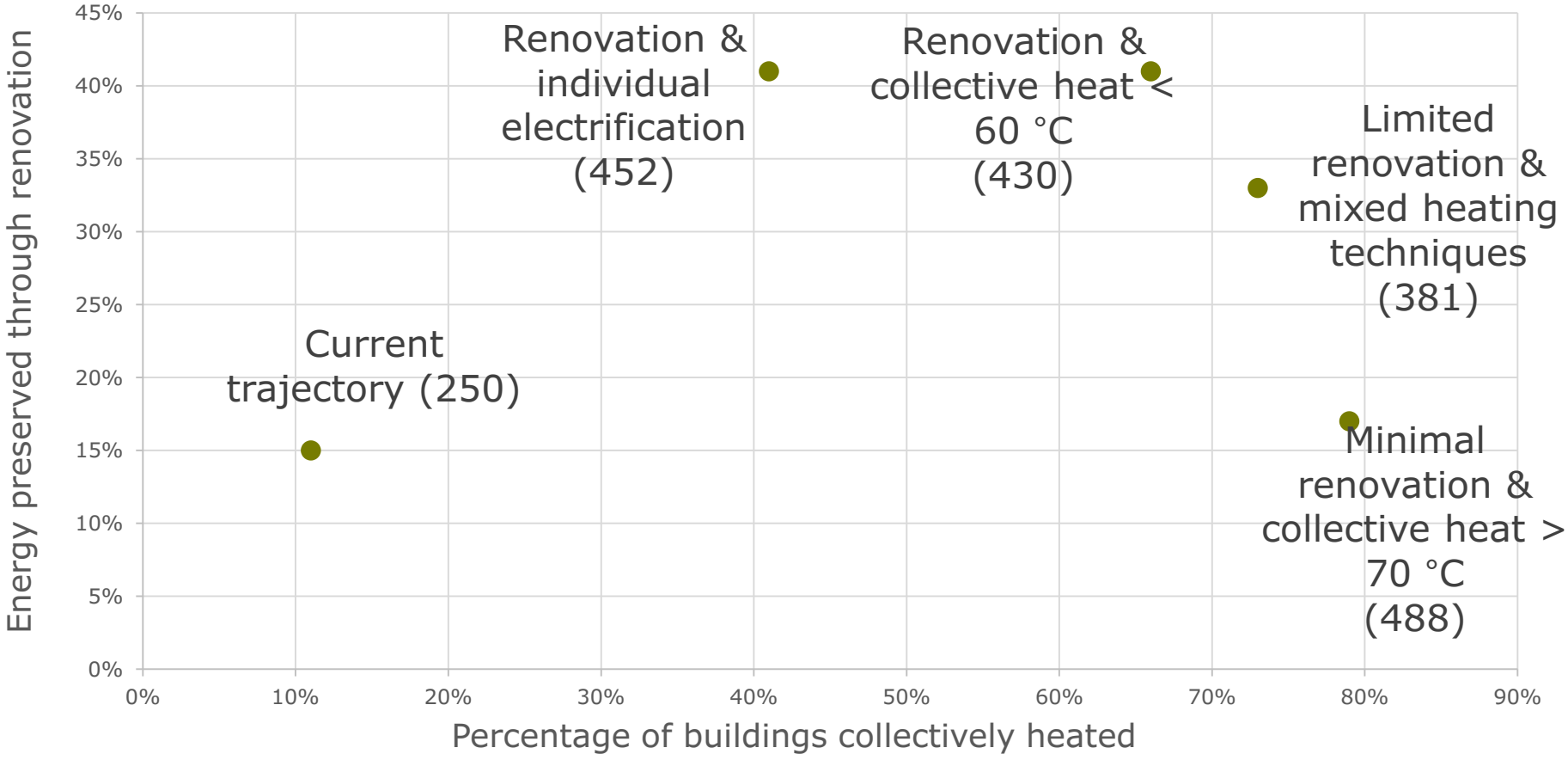
Four ways to achieve 90% reduction of natural gas demand in 2035

Current trajectory for reference. (total collective cost mln. € / year)



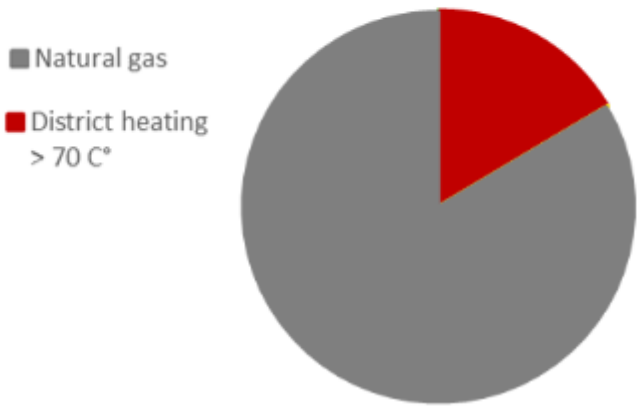
Four ways to achieve 90% reduction of natural gas demand in 2035

Current trajectory for reference. (total collective cost mln. € / year)

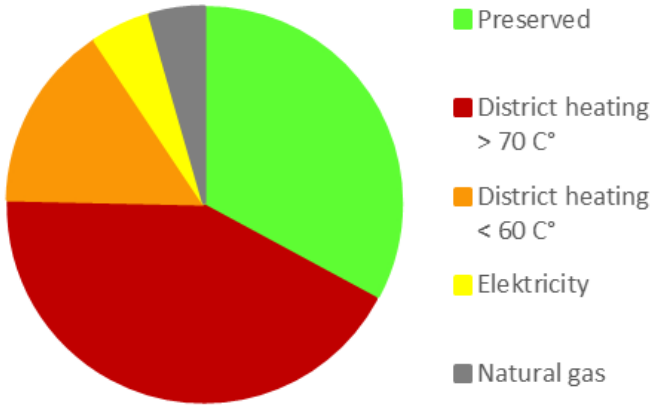


Limited renovation & mixed heating techniques

2015: Energy use before transition



2035: Energy use after transition

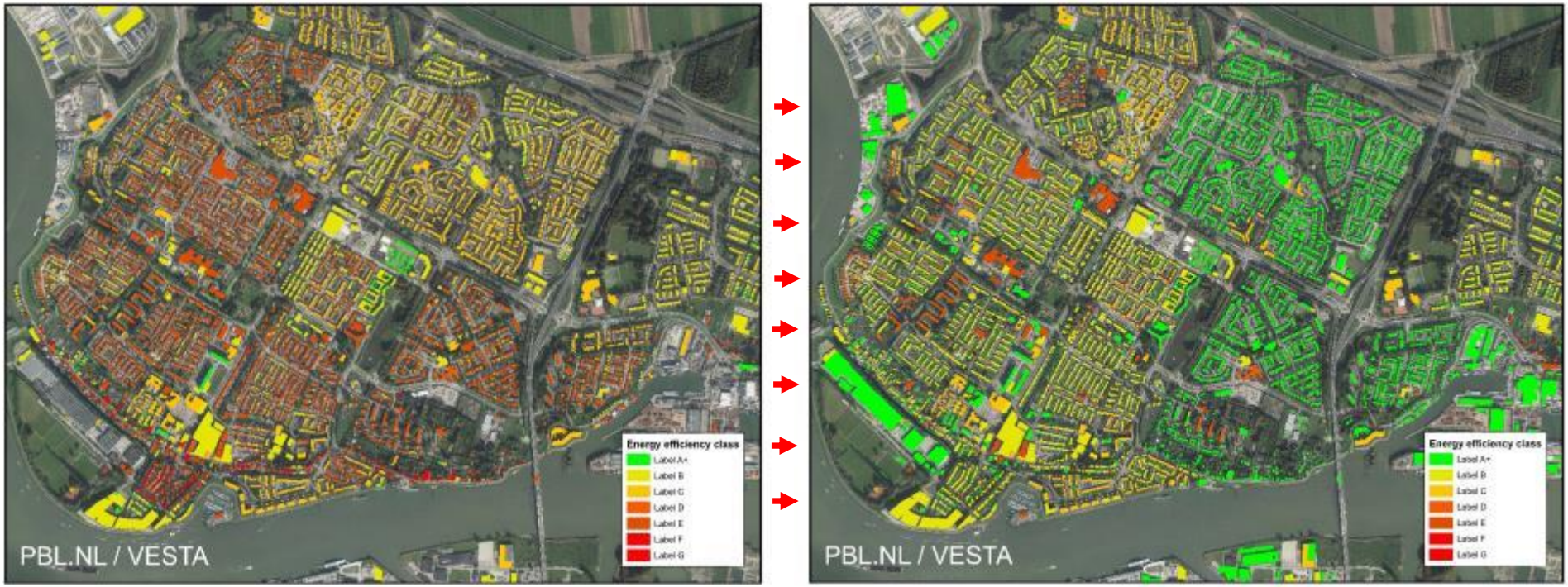


Priorities for technical measures

1. Renovation
2. Collective heat > 70 °C
3. Collective heat < 60 °C
4. Individual electrification

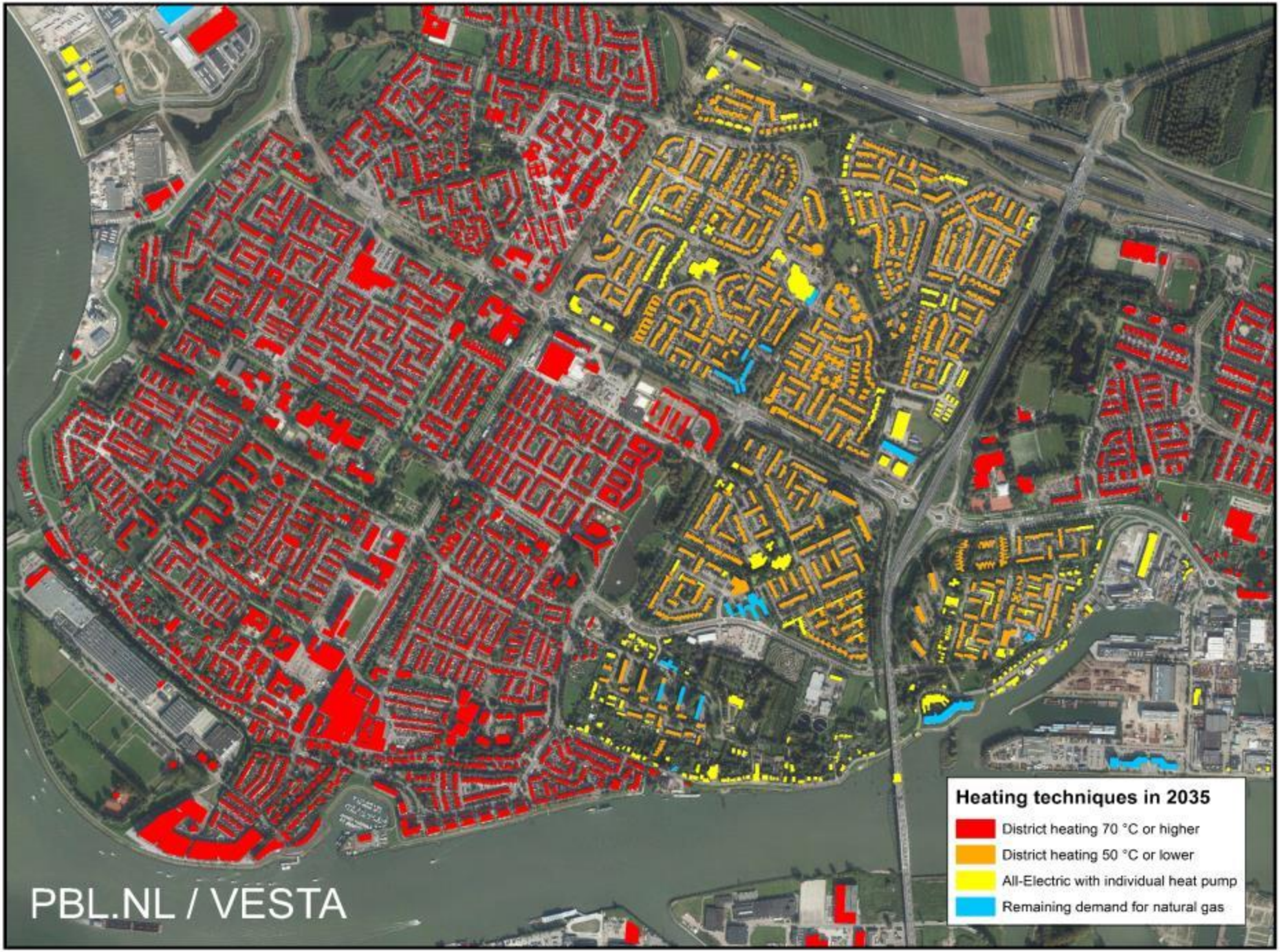
Energy Efficiency Class – all residential buildings	Before (2015)	After (2035)
A+	5.745	64.395
B / C	69.230	48.400
D / E / F / G	47.286	15.466

From now to 2035



Two types of neighborhoods in 2035:

1. Low capital investment: requires high temperature heating - high energy use
2. High capital investment: can suffice with low temperature heating - low energy use


Heating techniques in 2035
District heating 70 °C or higher
District heating 50 °C or lower
All-Electric with individual heat pump
Remaining demand for natural gas
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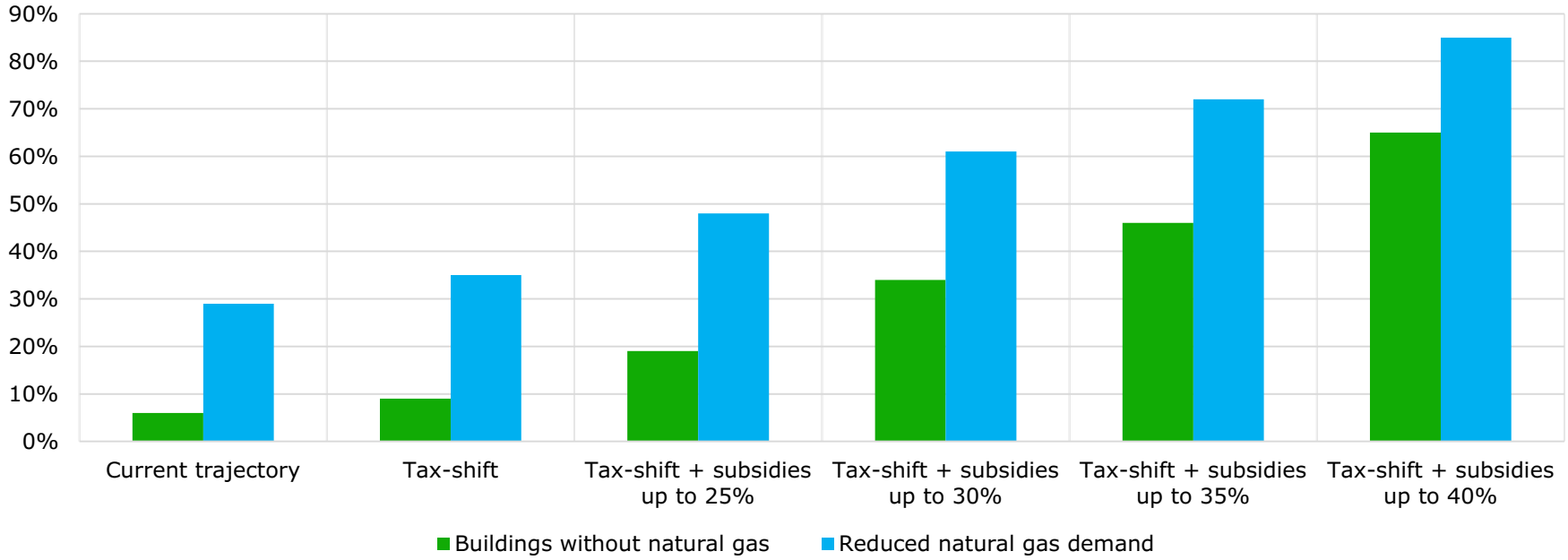
Creating feasible business cases for individual actors. Some policy options:

- Taxes on natural gas raised by € 0,20 / m^3 by 2035
- Taxes on electricity lowered by € 0,07 / kWh by 2035
- Subsidizing heat-infrastructure (collective)
- Subsidizing renovations and electric heat-pumps (individual)



Actor costs in million euros per year	Starting point (2015)	
	Energy companies	Real estate owners/users
Natural gas	3	81
Electricity		107
District heating	-29	29
Capital cost	16	
Taxes	5	86
Subsidies		
Total actor cost	**-5**	**302**

Actor costs in million euros per year	Starting point (2015)		2035, following current trajectory for reference	
	Energy companies	Real estate owners/users	Energy companies	Real estate owners/users
Natural gas	3	81	7	76
Electricity		107	1	113
District heating	-29	29	-56	56
Capital cost	16		28	22
Taxes	5	86	9	113
Subsidies				
Total actor cost	**-5**	**302**	**-11**	**375**

Actor costs in million euros per year	Starting point (2015)		2035, following current trajectory for reference		2035 with Heat Transition using policy-instruments (subsidizing up to 40%)	
	Energy companies	Real estate owners/users	Energy companies	Real estate owners/users	Energy companies	Real estate owners/users
Natural gas	3	81	7	76	10	15
Electricity		107	1	113	9	111
District heating	-29	29	-56	56	-108	108
Capital cost	16		28	22	61	48
Taxes	5	86	9	113	28	35
Subsidies					-8	-19
Total actor cost	**-5**	**302**	**-11**	**375**	**-6**	**298**

Conclusions

Local	National
• 28% reduction of natural gas demand is possible without additional policy.	• Additional policy on a national level is required to create viable business-cases for individual actors
• Rising cost of energy will lead to higher costs for actors in the future unless technical measures are taken.	• However, these measures require financial support: a national discussion is needed to allocate the costs
• It is essential to find the right technical solution for each particular neighborhood, based on local conditions and the technical starting point.	• If we can determine which type a neighborhood is, many technical decisions follow logically from that

Conclusions

Local	National
• Higher investment means lower future energy use and leads to lower long-term total collective cost. • Minimizing investments means higher future energy use and higher long-term total collective cost. • Both ways can realize the goal of decarbonization.	• Actors will optimize their preferred costs, unless incentive structures are aligned with the collective optimum
• For 90% reduction of natural gas demand in this region, costs for individual investors must fall by up to 40%.	• The national challenge for implementation is to either divide these costs, or realize cost-reduction up to 40%

Follow-up

Full publication on pbl.nl/vesta (Dutch)

Folckert van der Molen (2018), Technisch en economisch potentieel voor een aardgasvrije gebouwde omgeving in de regio Drechtsteden, Den Haag: PBL.

Link to Vesta MAIS model (open source, open data)

https://github.com/RuudvandenWijngaart/VestaDV

Contact us if you are interested in using the model, or other questions

folckert.vandermolen@pbl.nl