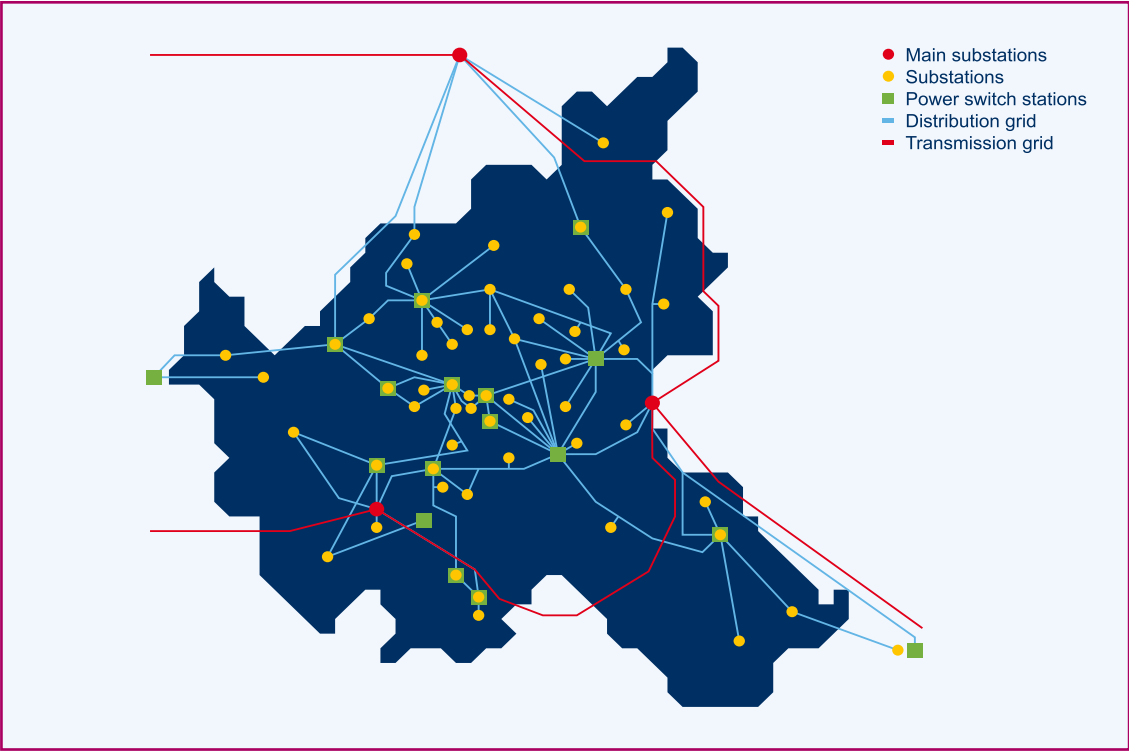# Sector coupling and essential data exchange

Dr. Davood Babazadeh

16.05.2024 Stockholm

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Wir machen Hamburg möglich.

Our Grid

Legend (Hamburg grid map):
- Main substations
- Substations
- Power switch stations
- Distribution grid
- Transmission grid

Legend (Germany map):
- Substations
- Transmission Grid

Logos: Amprion, 50hertz, TRANSNET BW, Tennet

1,189,272 Electricity meters	**30,006 km** Entire grid length	**1,440** Charging points for electric vehicles (SNH)
1,258 MW Installed decentralised generation	**55** Substations	**1,607 MW** Maximum grid load (high voltage)
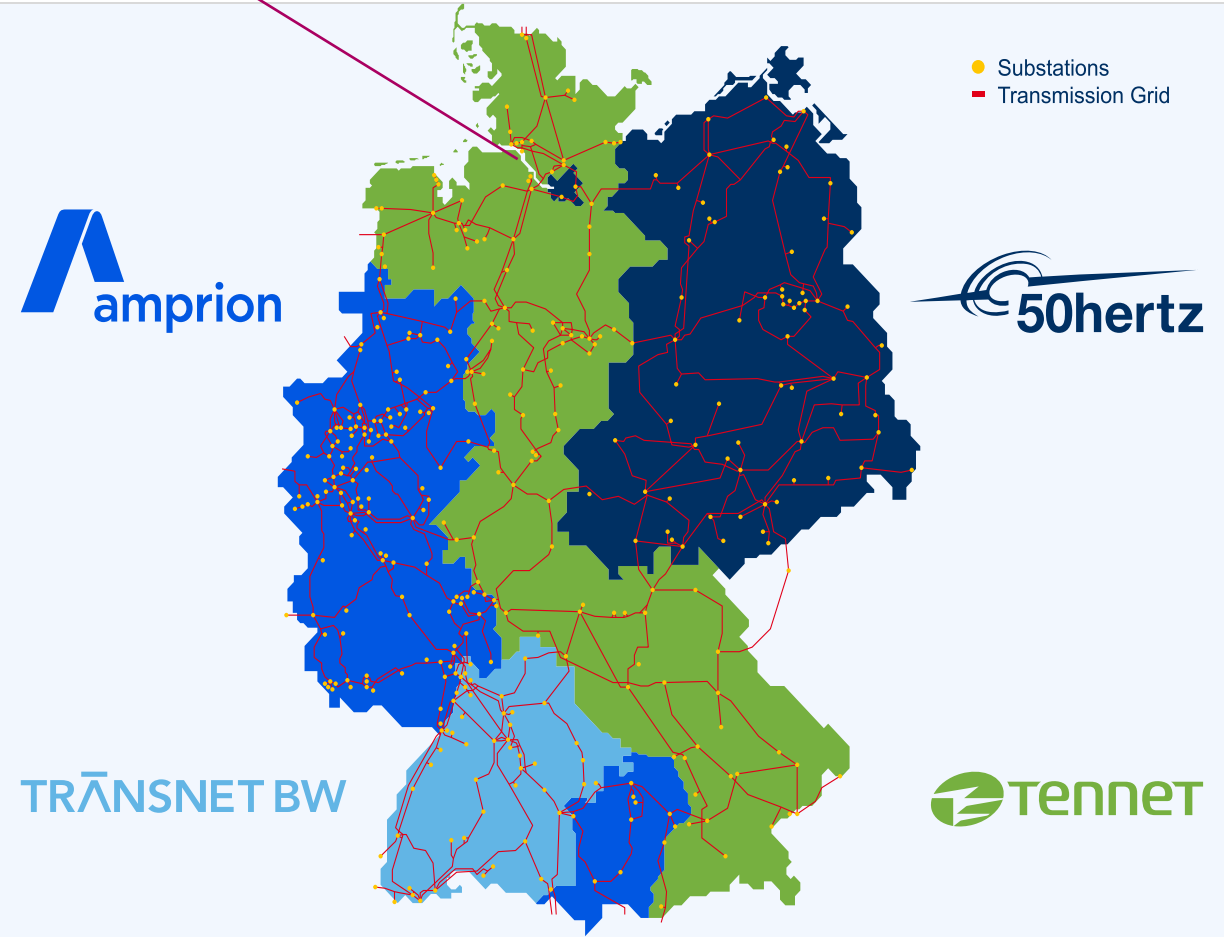
Demand Developments in Hamburg

Stromnetz Hamburg

electricity demand per sector

Legend:
- Private Houshold
- Industry
- District heating
- Heat Pumps
- Transport
- Trade, services
- H2 / eFuel

TWh

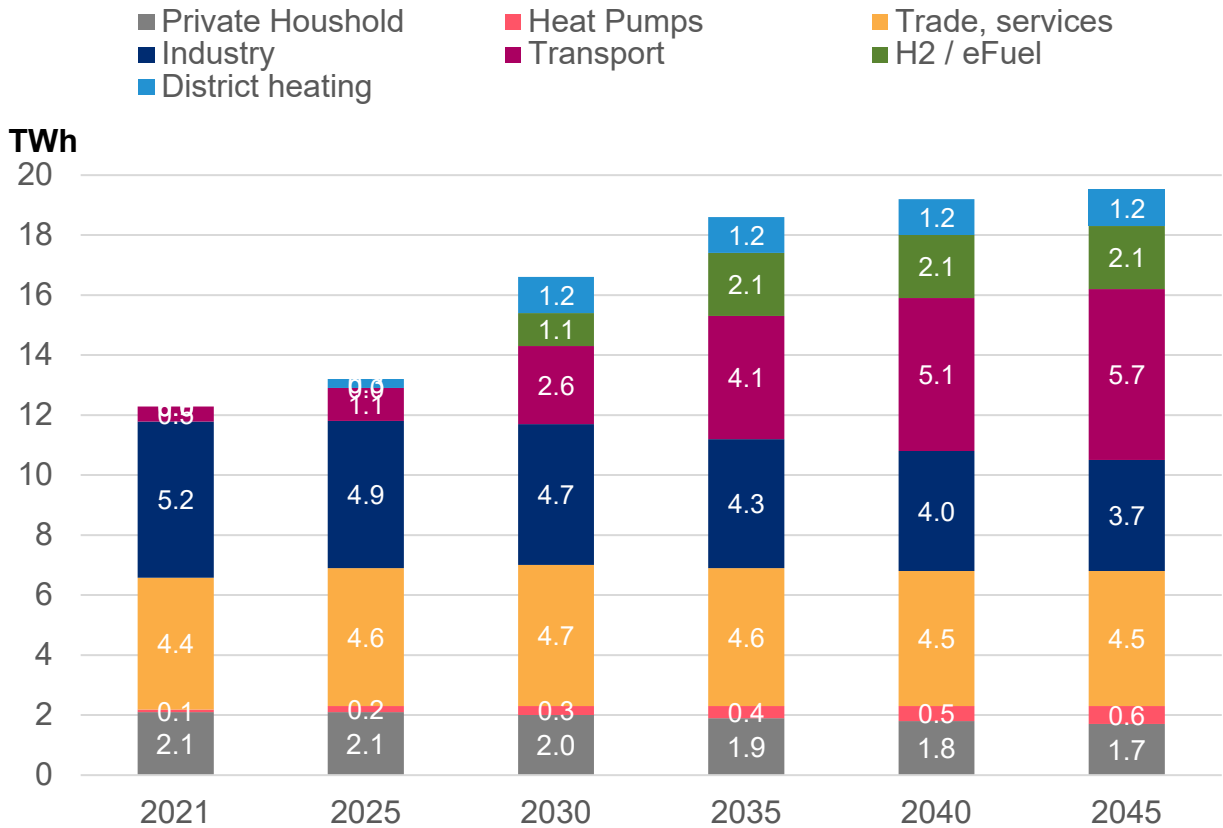| Sector	2021	2025	2030	2035	2040	2045
District heating	—	0.9	1.2	1.2	1.2	1.2
H2 / eFuel	—	—	1.1	2.1	2.1	2.1
Transport	0.5	1.1	2.6	4.1	5.1	5.7
Industry	5.2	4.9	4.7	4.3	4.0	3.7
Trade, services	4.4	4.6	4.7	4.6	4.5	4.5
Heat Pumps	0.1	0.2	0.3	0.4	0.5	0.6
Private Houshold	2.1	2.1	2.0	1.9	1.8	1.7

maximum grid load

MW

Year	2021	2025	2030	2035	2040	2045
Max grid load	1,721	2,061	2,763	3,255	3,473	3,606

Electricity demand will increase to 19.5 TWh by 2045; the maximum grid load to >3,600 MW. The strongest drivers are the forecast growth in **eMobility**, **heat pumps** and the production of **hydrogen / eFuels**.

Challenges in Grid Development

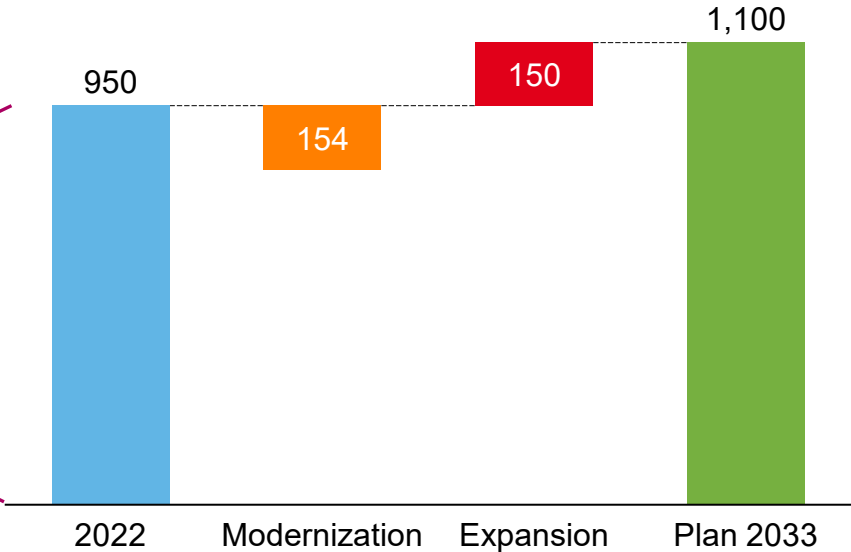| Resources	2022	construction output per year	Annual construction work for renovation and expansion until 2033	Plan 2033
Feed-in node (in units)	3		2 in 10 Jahren	3
Transformer stations	55	2	>4	55
Switchgear	22	1	1,5	22
110-kV Transformator	110	9	>5	123
HV-Grid (km)	**950**	**4**	**30 [2]**	**1.100**
MV-Substations	5.700	121	185	6.400
MV-Grid (km)	5.570	180	196	6.500
LV-Grid[1] (km)	13.500	125	177	14.000

[1] without house connections
[2] without HV-customer connections

In order to achieve the climate protection targets in Hamburg, a significant expansion of the high-voltage grid is particularly necessary

Challenges in Grid Development

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https://haspa-marathon-hamburg.de/

https://trstriathlon.com/

Public events require a great deal of planning

In order to achieve the climate protection targets in Hamburg, a significant expansion of the high-voltage grid is particularly necessary

Solution: The Intelligent Integrated Planning & Operation

Load Management & Flexibility

Visualisation

Integration of other sectors

Digitalisation & security
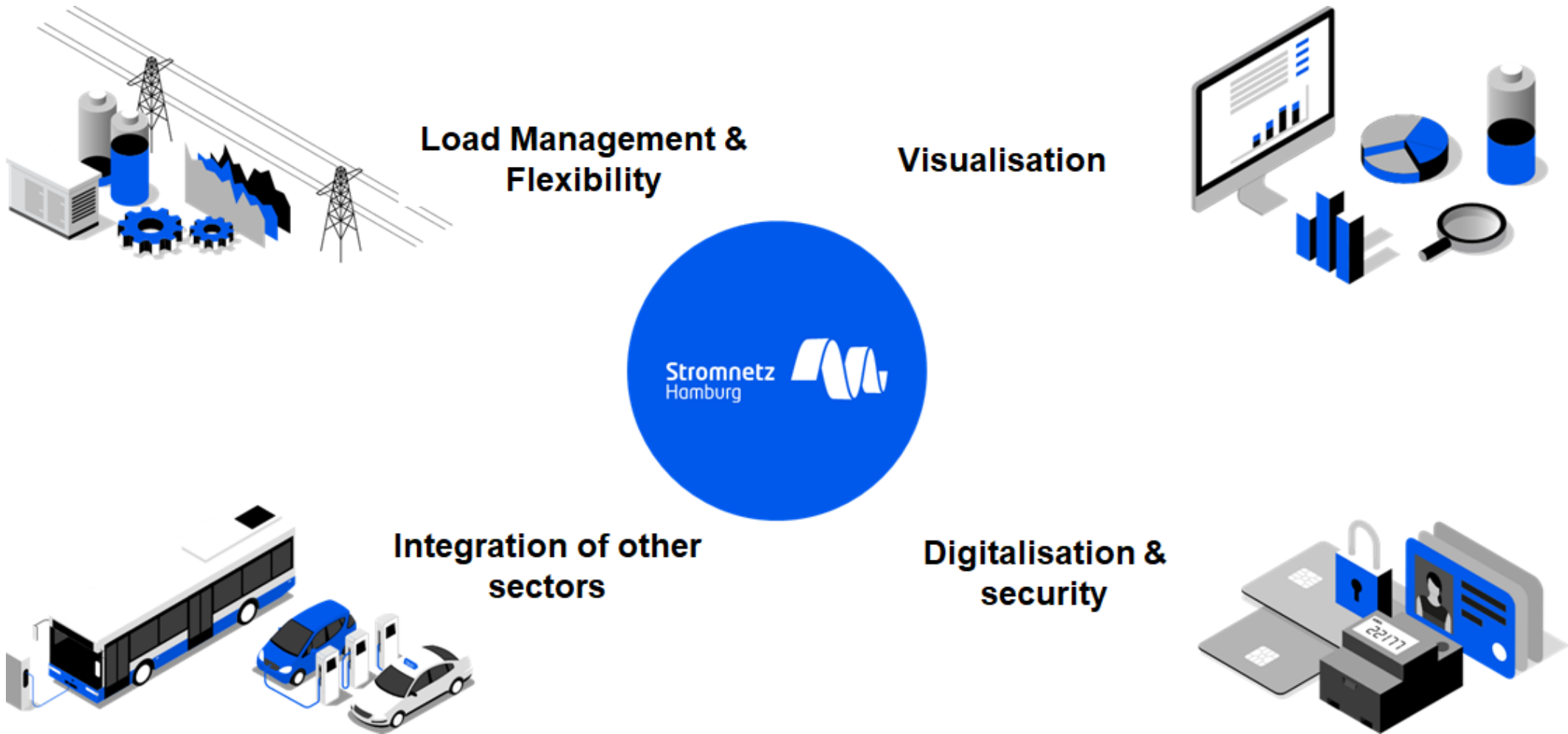
Integrated Grid Planning

iNeP
integrierte Netzplanung

Supported by:

Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision
by the German Bundestag
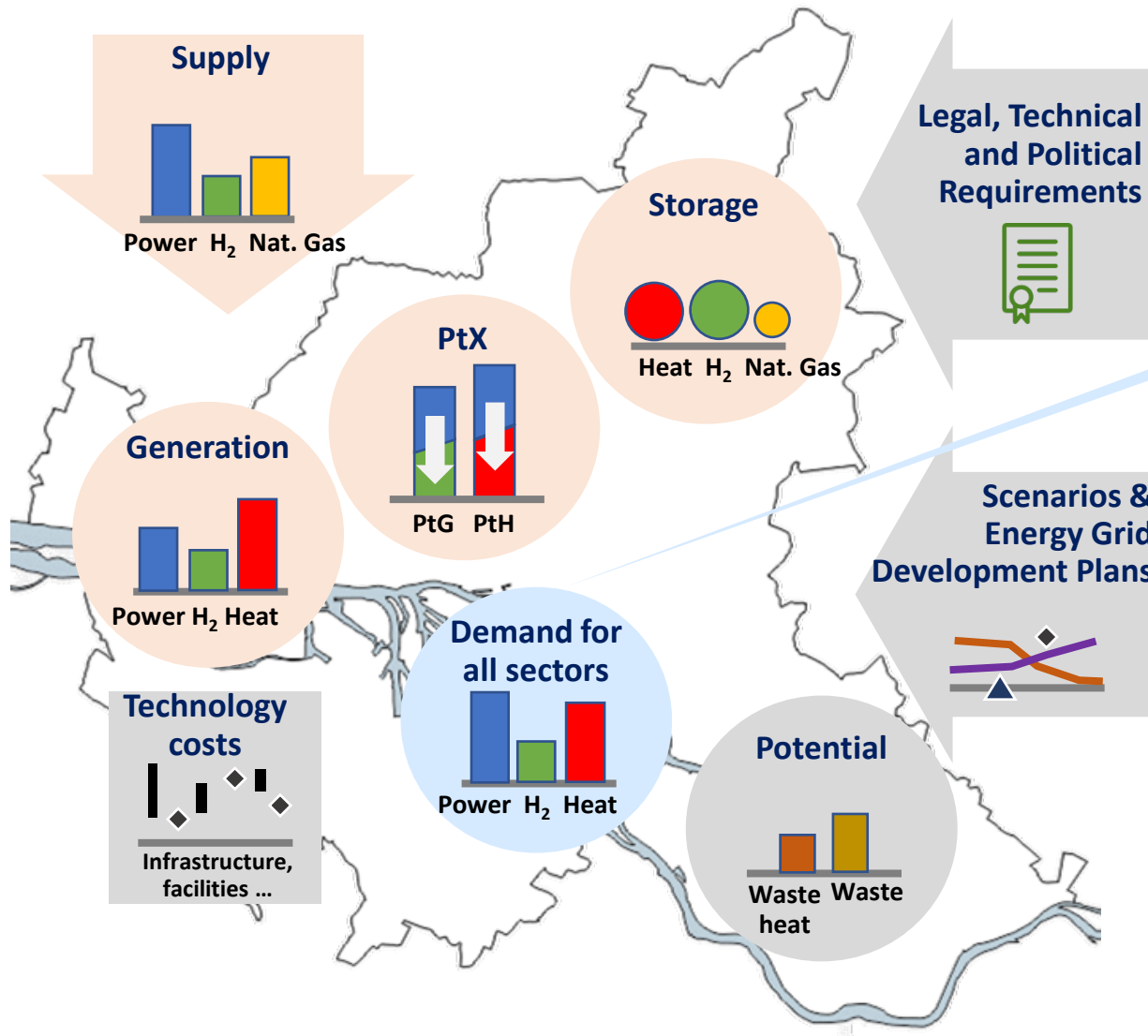
NRL
Norddeutsches
RealLabor

GASNETZ HAMBURG

Stromnetz Hamburg

Hamburger Energiewerke

unterstützt durch:

TUHH
Technische Universität Hamburg

HELMUT SCHMIDT UNIVERSITÄT
Universität der Bundeswehr Hamburg

TECHNISCHE HOCHSCHULE LÜBECK

iNEP: Demand-driven Planning

Supply
Power H₂ Nat. Gas

Generation
Power H₂ Heat

PtX
PtG PtH

Storage
Heat H₂ Nat. Gas

Technology costs
Infrastructure, facilities ...

Demand for all sectors
Power H₂ Heat

Potential
Waste heat Waste

Legal, Technical and Political Requirements

Scenarios & Energy Grid Development Plans

Sectors are:
- **Industry**
- **Mobility**
- **Households**

"Sector-coupled Energy Systems"?

▶ iNeP defines "sectors" by different sectors of energy consumers with dedicated demand of energy sources

▶ coupling of different and/or demanded energy sources (power, gases, heat) will not only occur on energy grid level, but also at customers site / consumers

GASNETZ HAMBURG   Stromnetz Hamburg   Hamburger Energiewerke

Requirements in iNEP
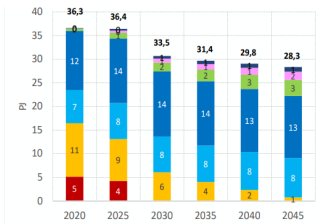
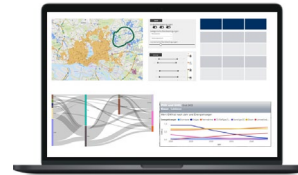| Scenarios	Regionalization	Interactive	Energy Balance	Nodes' requirements
➢ The respective energy requirements in the area anticipated for 2023 and 2045	➢ Defining areas relevant for integrated energy planning	➢ interaction with the platform ➢ graphical display of areas	➢ Energy balance of different coverage scenarios	➢ Individual requirements for consumers and producers and coupling points
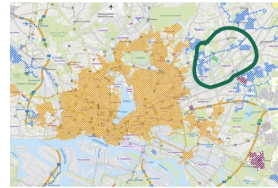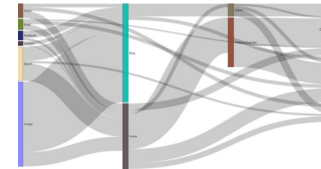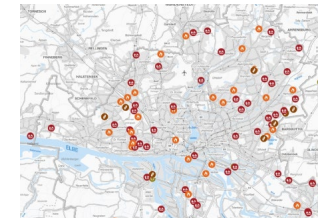
DiP Data-supported Interactive Platform
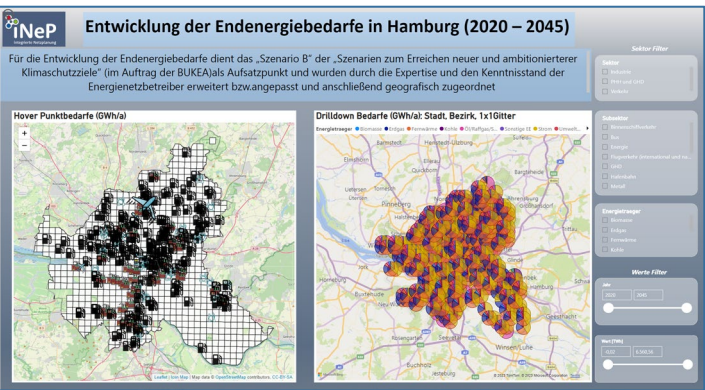
iNeP V1.0	iNeP V2.0
Show	Process, design, manage and export
Universally valid	Customizable
Static demand determination scenario	Adjustable scenarios for demand determination, demand coverage and planning scenarios
demands	demands and demand coverage
GIS data for the distribution	GIS data for the derivation of scenarios (→ bottom-up)
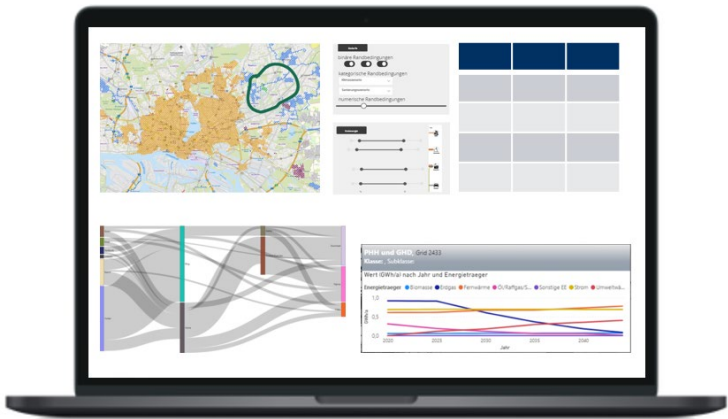
D Data-supported
I Interaction
P Platform

The DIP enables grid developers/planners to:
➤ enter, coordinate, retrieve and track planning-relevant information and boundary conditions
➤ Design alternative solutions and coordinate them with the other companies.
(External) Stakeholders can be involved in the planning process and the discourse with the DIP

Screenshot: DIP

Coverage requirement

means representation of demand at all levels

- ➢ Space heating from public data "heat register"

- ➢ Photovoltaic potential as

- ➢ General electricity demand of households

- ➢ Electricity demand for electromobility in private households

- ➢ Hydrogen demand at filling stations and in industry

as well as possible supply potentials of feeders (CHP, industrial potentials, heating plants...)

Deckungsanforderung ⓘ

	2023		2045	
	Arbeit [kWh/a]	Leistung [kW]	Arbeit [kWh/a]	Leistung [kW]
Nutzenergie Massenobjekte				
Massenbedarf: Max. PV Potential	0	0	0	0
Massenbedarf: Raumwärme	808.006.744	417.381	506.230.681	232.883
Massenbedarf: Strom 04	140.491.197	24.904	113.615.123	14.346
Massenbedarf: Strom MOB	5.231.040	2.047	29.865.292	11.724
Nutzenergie Individualobjekte (exkl. Wandler)				
H2 stofflich	9.807.083	8.177	46.878.027	46.516
Strom 04	0	0	0	0
Strom 10	143.280.775	58.423	345.847.599	77.411
Wärme HT	2.362.763	516	2.835.316	619
Wärme MT	206.356.562	44.023	210.867.292	44.985
Bereitstellungsvorgabe Wandler				
Bereitstellungsstrom 04	0	0	0	0
Bereitstellungsstrom 10	10.500.000	1.500	0	0
Bereitstellungswasserstoff	0	0	0	0
Bereitstellungswärme	106.195.000	30.760	0	0

Flexibility/Load Management as Key Measure till Grid Expansion

Gefördert durch:

Bundesministerium für Wirtschaft und Technologie

aufgrund eines Beschlusses des Deutschen Bundestages

OpenADR (IEC 62746-10-1 ED1)

Ladepunktbetreiber (CPO)

Datenerfassung und Netzüberwachung

- *Attraktive Lösungen*
- *Große Skalierung*

weitere

Grid connection request (HS/MS) exceeds available reserves

Not served power

Available planning reserves

Temporary operational reserves

Grid capacity

Project goal,
to develop a concept to be able to offer a short-term grid connection product for controllable flexible loads until the necessary grid reinforcement to realize the full required grid connection capacity has been implemented.
Temporary operational reserves are used for this purpose.

Required grid expansion

Today — *FlexOption* → *Future*

LV-Grid
ELBE, DISEGO
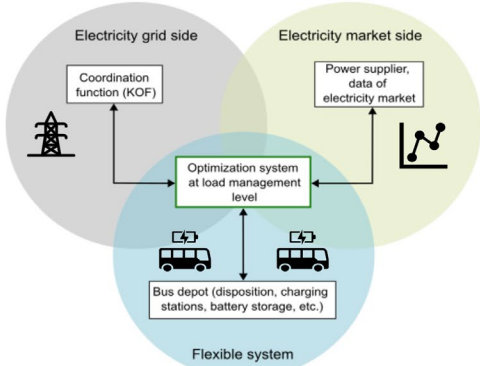
MV-Grid
KOLA, FlexOption

HV-Grid
FlexOption
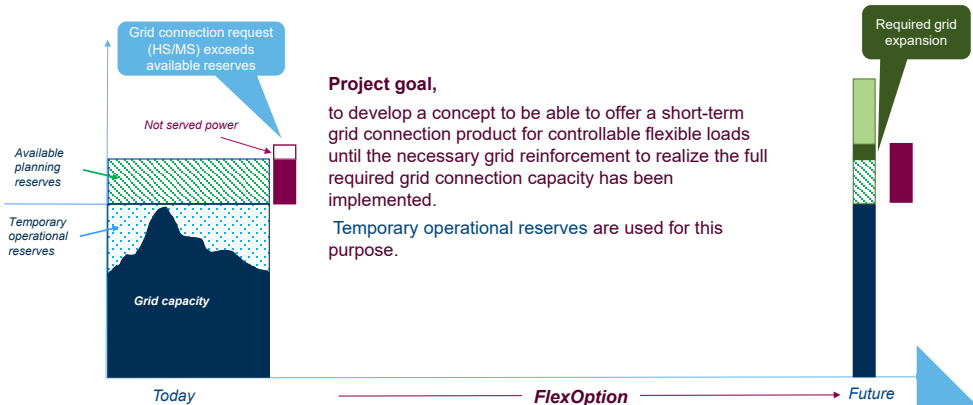
KoLa – Flexibility Coordination btw. Energy and Transport
Electrified Public Transport Use-case

2022-2026

- **Objectives**
  - Development of a „coordination function" to ensure grid stability while offering flexibilities
  - Optimal charging and **flexibility management** of electrified bus depot
  - Validation of overall system in **distributed laboratory setup** and in **field test**

Electricity grid side

Electricity market side

Coordination function (KOF)

Power supplier, data of electricity market

Optimization system at load management level

Bus depot (disposition, charging stations, battery storage, etc.)

Flexible system

Supported by:

Federal Ministry for Economic Affairs and Climate Action

HELMUT SCHMIDT UNIVERSITÄT
Universität der Bundeswehr Hamburg

ieet
INSTITUTE OF ELECTRICAL POWER AND ENERGY TECHNOLOGY

Stromnetz Hamburg

HOCHBAHN

ieet • 20/04/2023

Thank you for the attention

Stromnetz Hamburg

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