EERA Center of Excellence on Energy Transition Modelling

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22-09-2022

Energy Ville

EERA
European Energy Research Alliance

Central question of today

What can the modelling research community do to facilitate an accelerated decrease in fossil fuel dependency in the context of Repower EU?

Additional input is welcome to Pieter.vingerhoets@vito.be and L.J.deVries@tudelft.nl

Center of Excellence – Energy Transition Modelling participating institutes

Founding members in 10 member states

LNEG (Pt), NTNU (No), ED (UK), DTU (DK), Tecnalia (Esp), Imperial College (UK)

KHAS (Tur), Sintef (No), RuG (Nl), ARU (UK), Ife (No),

DLR (De), Unipd (It), Ciemat (Esp), TNO (Nl), Ineg (Pt),

CBS (Dk)

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Topic	Description of model	Name of model	Geographical scope	Institute
Gas supply	The investments needed for diversifying the gas supply	NTNU model	EU	NTNU (Ruud)
	Complementing with North sea hydrogen	E3ME	North Sea	ARU (Aled Jones)
	Complementing with North sea hydrogen	BALMOREL	North Sea	DTU
	Power & Gas infrastructure model	PyPsa model	DE, (+EU)	DLR
	Location of hydrogen infrastructure	VTT and Udurham models	UK, Finland	University of Durham (Tom Roskilly), VTT
Circular economy	Circular economy measures		Belgium, Nl, EU	VITO, RUG
All sectors	TIMES scenarios for all sectors		Belgium, Netherlands, Spain	VITO, RUG, Ciemat
	OpenEntrance toolbox	OpenEntrance	EU	Sintef, others
	100% renewable, online toolbox	EnergyPlan	EU	UCD, Aalborg University
	How to consider transportation in energy system models, fleet development, flexible charging	DLR model, including aviation and shipping	EU	DLR
Residential sector	Local hydrogen generation in residential context, blending natural gas, hydrogen	Open Entrance,	Turkey, Denmark	DTU, Kadir Has
	Residential renovation and heat scenarios	DTU model, VITO model	Denmark, Belgium	DTU, Denmark
Renewables	Potential of biogas/biomass	GIS based models	Flanders, Germany	
Industry sector	Alternative pathways for industrial processes	GIS based models + TIMES	EU, Benelux + NRW	VITO, TNO
Market models	Electricity market models	Competes, Imperial college model	Diverse	TNO, Imperial College, VITO
Other models	Buildings, energy security, snenarios, decision support, agent based modeling, circular economy			Stavanger, DTU, U Bochum, CSEI, Croatia, Lithuania, UCD, UniPD, Lneg, CBS, Tecnalia etc.

RA
Research Alliance

We lack a European scenario to put national results into context
We lack the detail of the national scenarios in European models

- **Problem statement**: Up to now, few EU model sources and results to connect to.
- **Data** are at **national level** (Building data, industrial process data…) AND **expertise** at national level

Model	Results per member state	Open source	Gas supply detail	Comment
PRIMES	X	X	Y	No net zero 2050 per MS No power mix per MS
JRC-EU-TIMES	Y	Y	X	No EERA team in a ready-to-go state
OpenEntrance: GeneSySmod	Y	Y	Y	Scenarios ready in coming weeks
EnergyPlan	Y	Y	X	Flexible, more lightweight simulation model
ENTSO-E/G scenarios	Y	X	+/-	Scenarios not optimized Conservative results 2040
Other energy system models (non-exhaustive)				E3ME, Balmorel, SpineOpt, PyPsa, Calliope, Dispaset, Nemesis, Empire, Hypatia, IEA world/ETP…

Open source models are needed

To unlock the expertise of national research institutes in European scenarios!

European vs national scenario modelling

What we have

What we need

Example: how many hours is renewable energy abundantly available?

- Amount of hours per year with electricity generation cost <40EUR/MWh for electrolysis.

#hours of the year with cheap electricity<40€/MWh for electrolysis	2030	2033	2035	2040	2045-2050
TYNDP 2020 National Trends	1800			4300	
TYNDP 2018/2020, Distributed Generation			1500	4300	
TYNDP 2018 in Denmark (Energynet), GCA			1900	5700	
PBL KEV2021		4334*			
Agora Energiewende	1900*			1757*	1920*
Elia Adequacy and Flexibility**	400-1000				

TYNDP results are EnergyVille model based on TYNDP data

*, ** it is unclear how Agora and PBL results are calculated

The need for planning of ALL energy vectors

Example: how to determine the need and dimensioning of **ENERGY NETWORKS**?

Electricity

Natural gas

Hydrogen

Ammonia

CO2

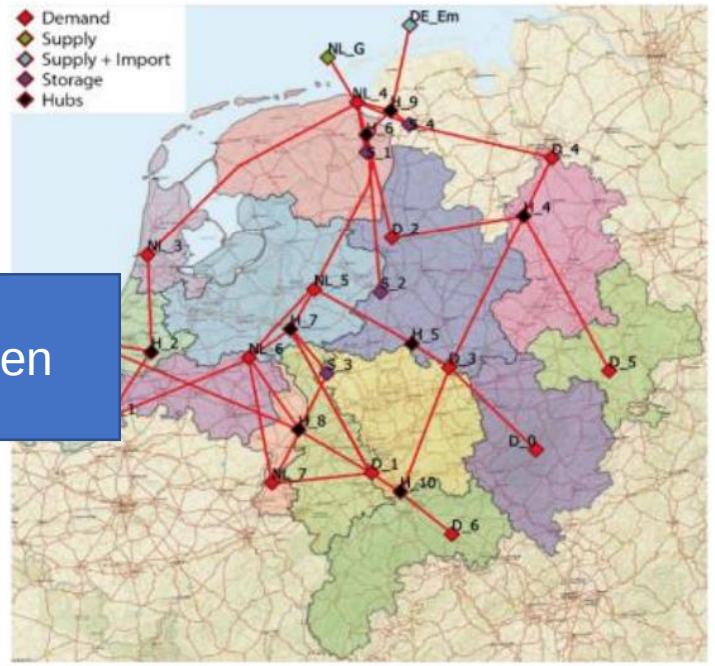
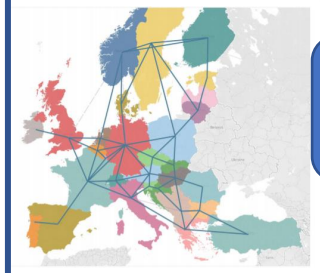


Figure 35: Envisioned hydrogen network for the Netherlands and North Rhine-Westphalia showing the demand, supply, import, storage and hub nodes modelled in transport analysis

Energy system

CETP TRI 1: Power planning tools

Open source energy system models: Connecting the dots



SINTEF · Technische Universität Berlin · vito · TU Delft

High-level EU scenarios

Dispatch model

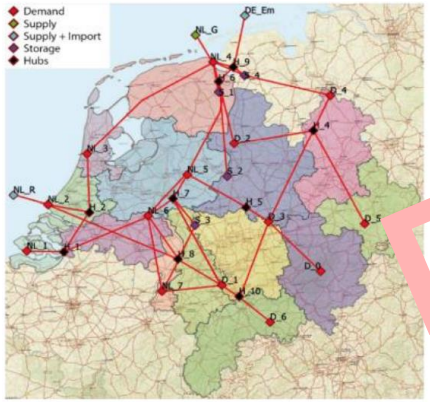
European – High coverage

National/regional High detail

Case 1

Hydrogen/CCS network infrastructure planning

TNO · vito



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Case 2

Hydrogen and renewable potential in the North Sea

Anglia Ruskin University · DTU

Cases 3 … n

National 2050 net-zero emission scenarios

Energy infrastructure planning: conclusions

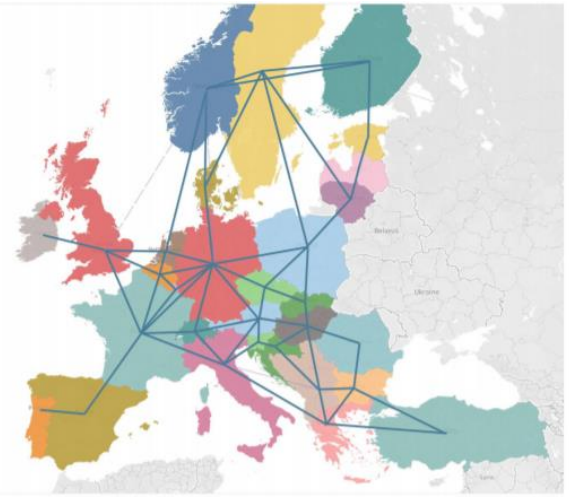
- We need European energy system scenarios which can exchange and learn from national studies
- We need future climate ambitions to be built on open source modelling with research communities
- We need to model the energy system as a whole, cross-border, cross - energy vectors, cross-sector

Thank you!

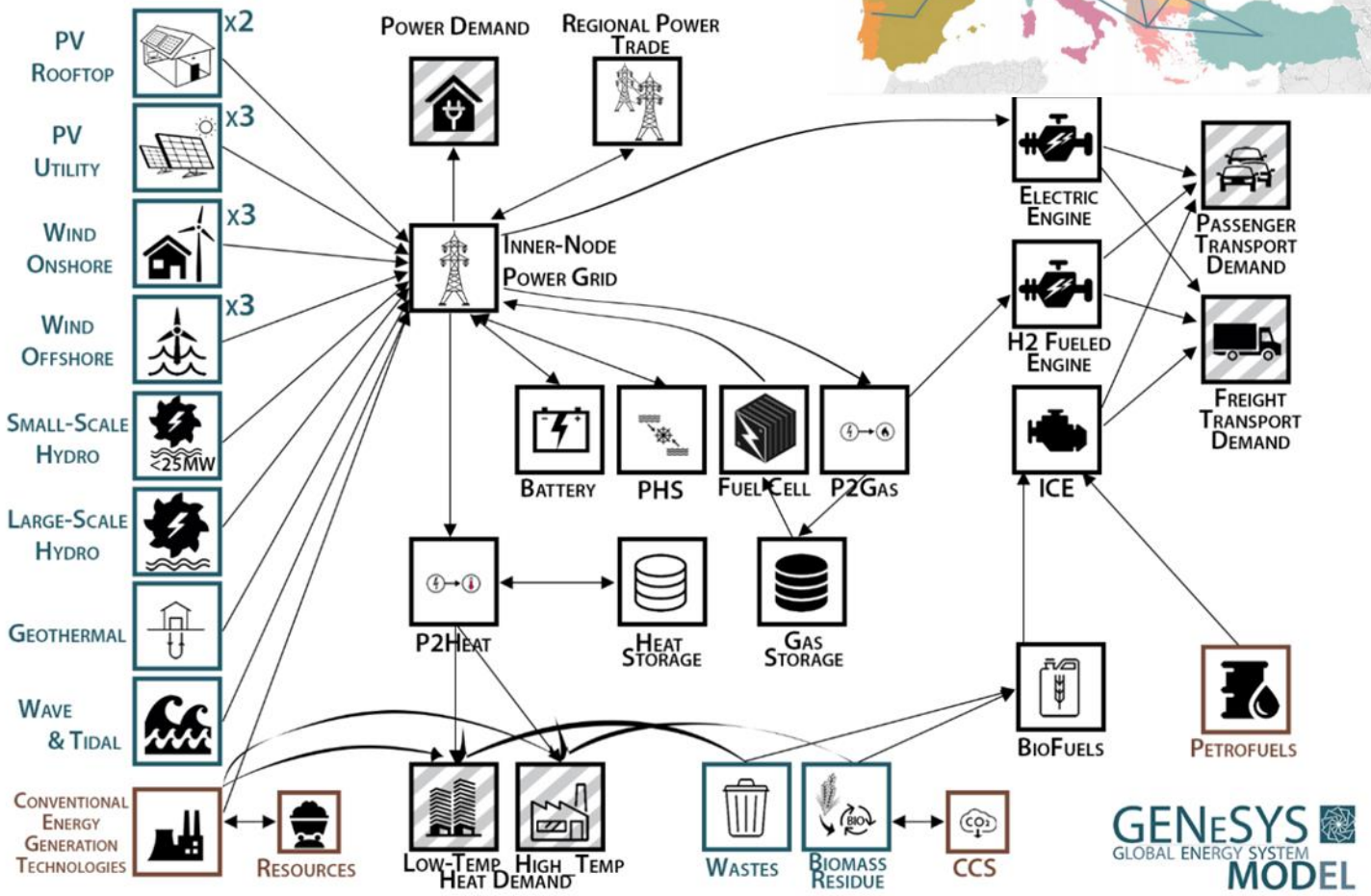
Contact: Pieter.vingerhoets@vito.be ; L.J.deVries@tudelft.nl

GeneSysmod

- TU Berlin
- Based on OSeMOSYS - family
- Linear program, minimizing total system cost
  - Exogenous demand; calculates the cheapest way to meet it
  - Constrains: max capacities (phys.,pol.), unrealistic development
  - Geographically flexible
  - Representative time steps or every xx hour
- 30 regions, 2015 to 2050 (5 year steps)
- Open source, GAMS, solver
- v3.0 developed for openENTRANCE

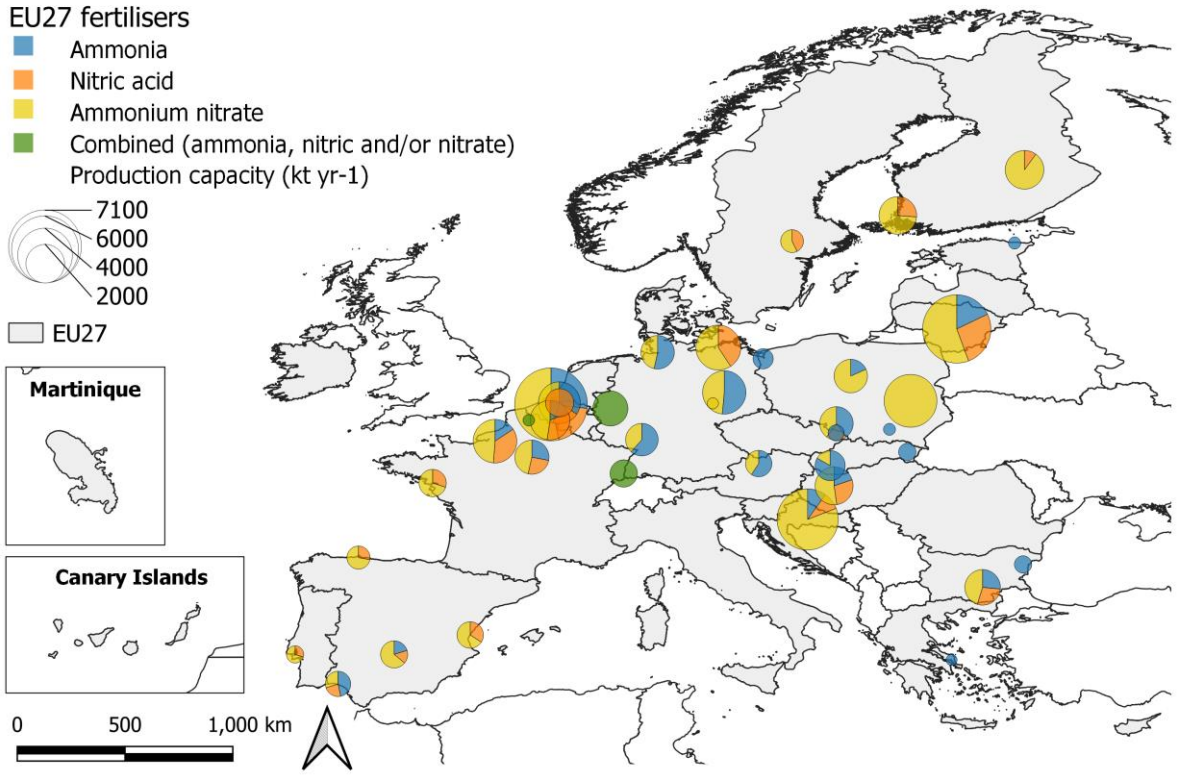


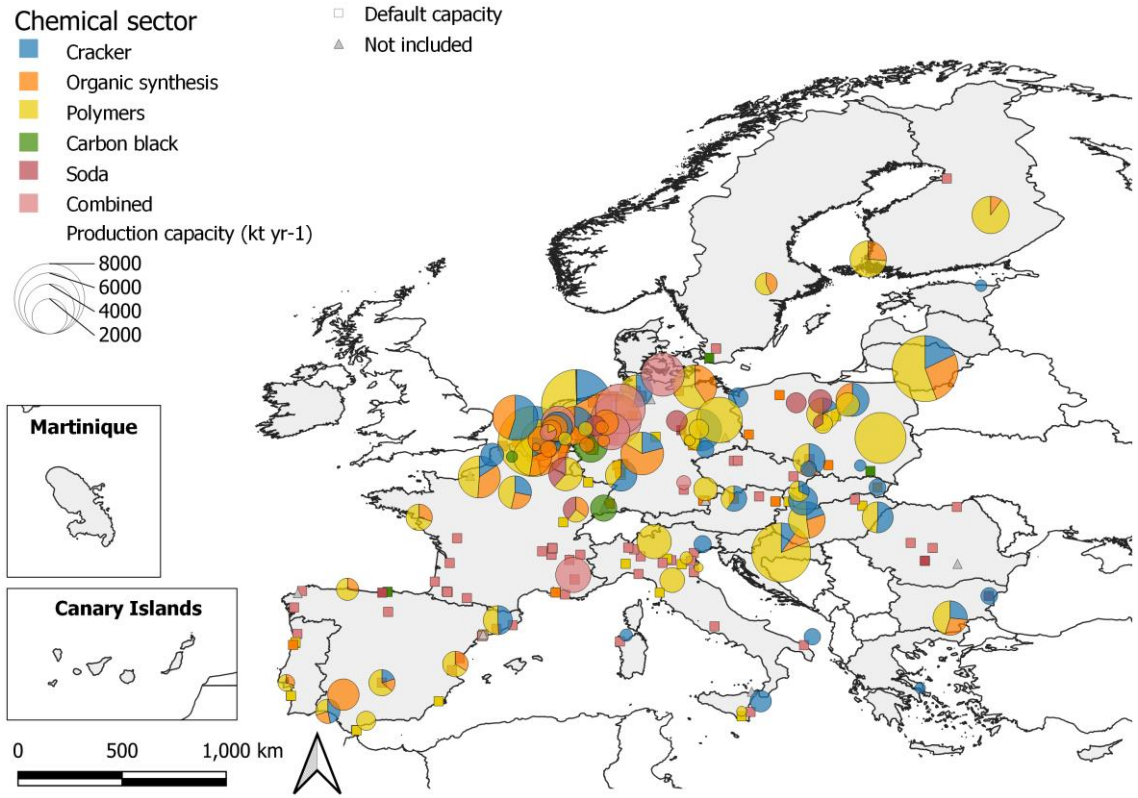
Abstracted overview of the model structure



Industrial clusters: Greening the hydrogen demand

Greening the hydrogen demand in industrial clusters





Source: VITO

Industrial clusters: Greening the hydrogen demand

- Connecting of the dots to green the hydrogen supply
- Source: The Hy3 project (TNO)

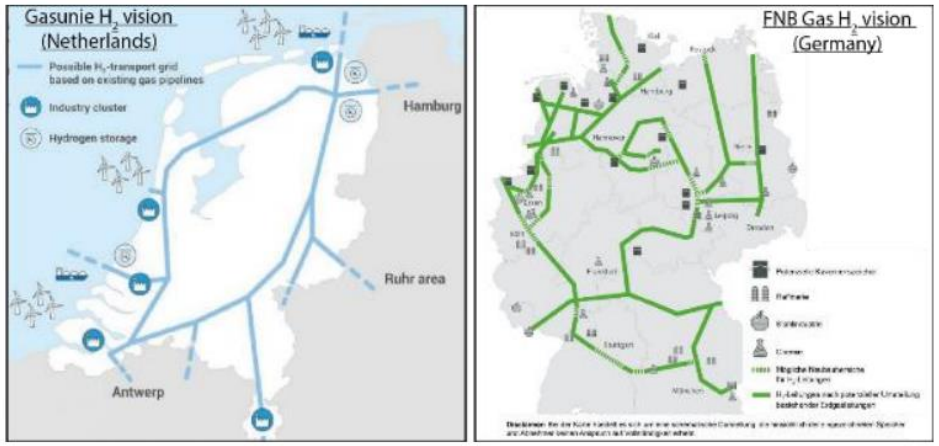
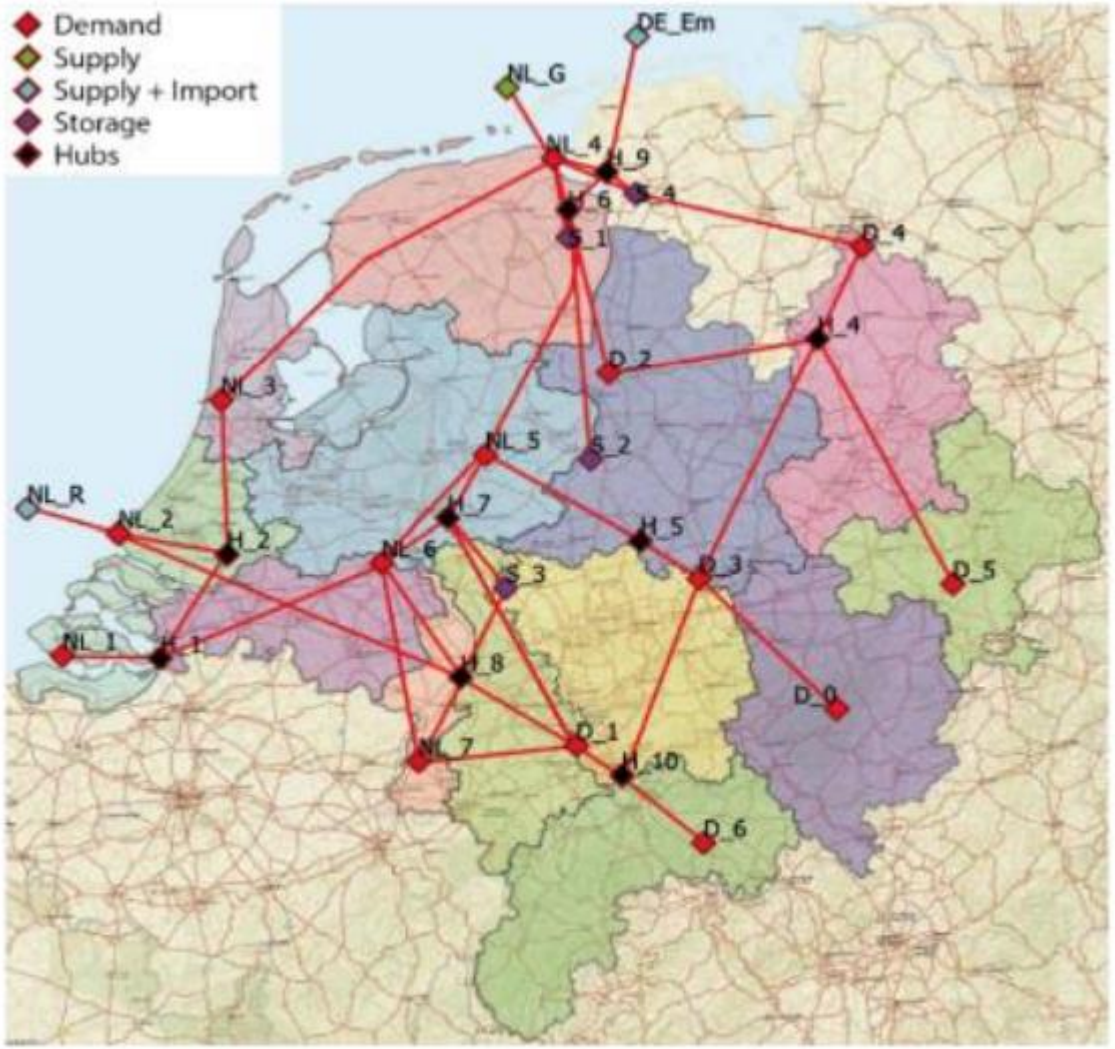


Figure 34: Envisioned hydrogen networks in the Netherlands (source: Gasunie) and Germany (source: FNB Gas)



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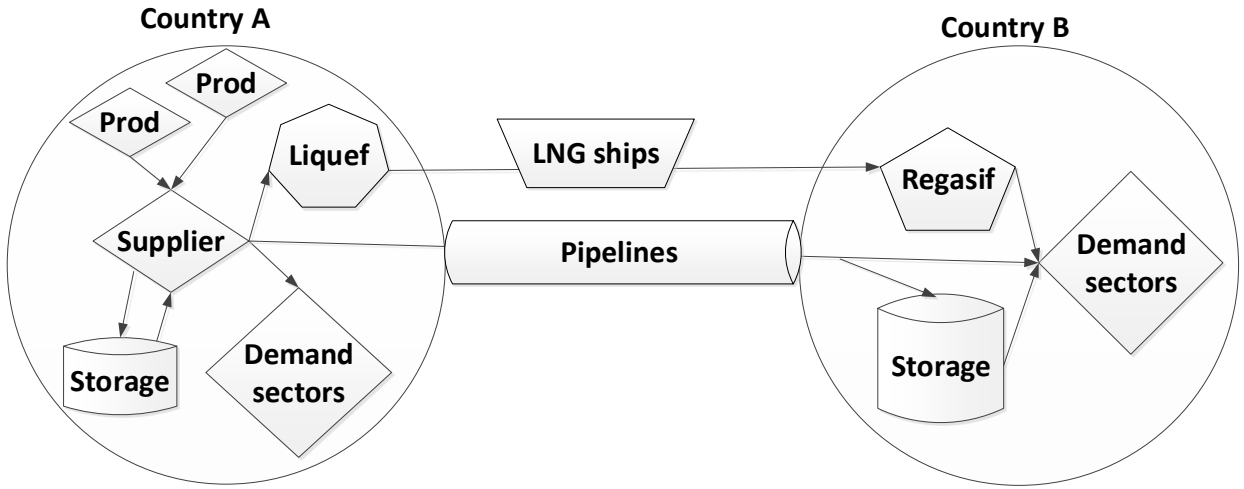
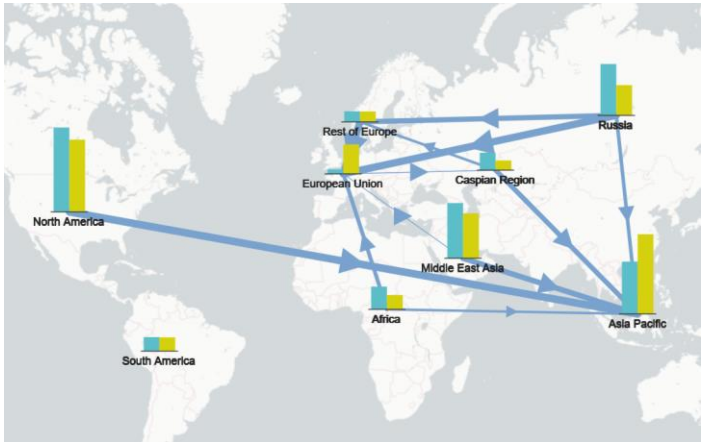
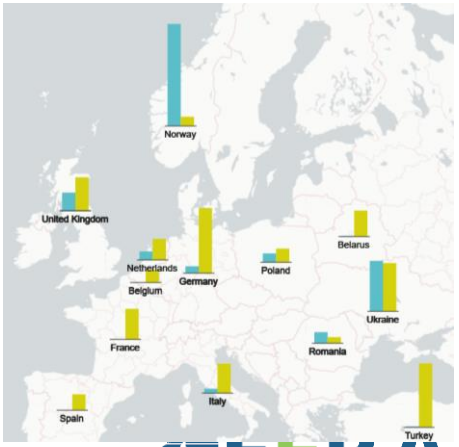
Global Gas Model

GGM	▪ multi-period partial equilibrium model for analyzing the world natural gas market. ▪ Country level; large countries split (USA, CAN, RUS, CHN, IND) ▪ Infrastructure investment and trade considering market power. ▪ Production, consumption, prices, pipelines, liquefaction, regasification
In	▪ Projections production, consumption, prices, market power, policies ▪ capacities, investment and operational costs, depreciation, loss rates, ▪ sector shares, demand elasticities.
Out	▪ pipeline, liquefaction, regasification, storage expansions and utilization, ▪ production, consumption, trade, prices; profits, costs, consumer surplus, social welfare impact

A carefully calibrated benchmark with global scope and country detail for counterfactual policy analysis.







NTNU DIW BERLIN

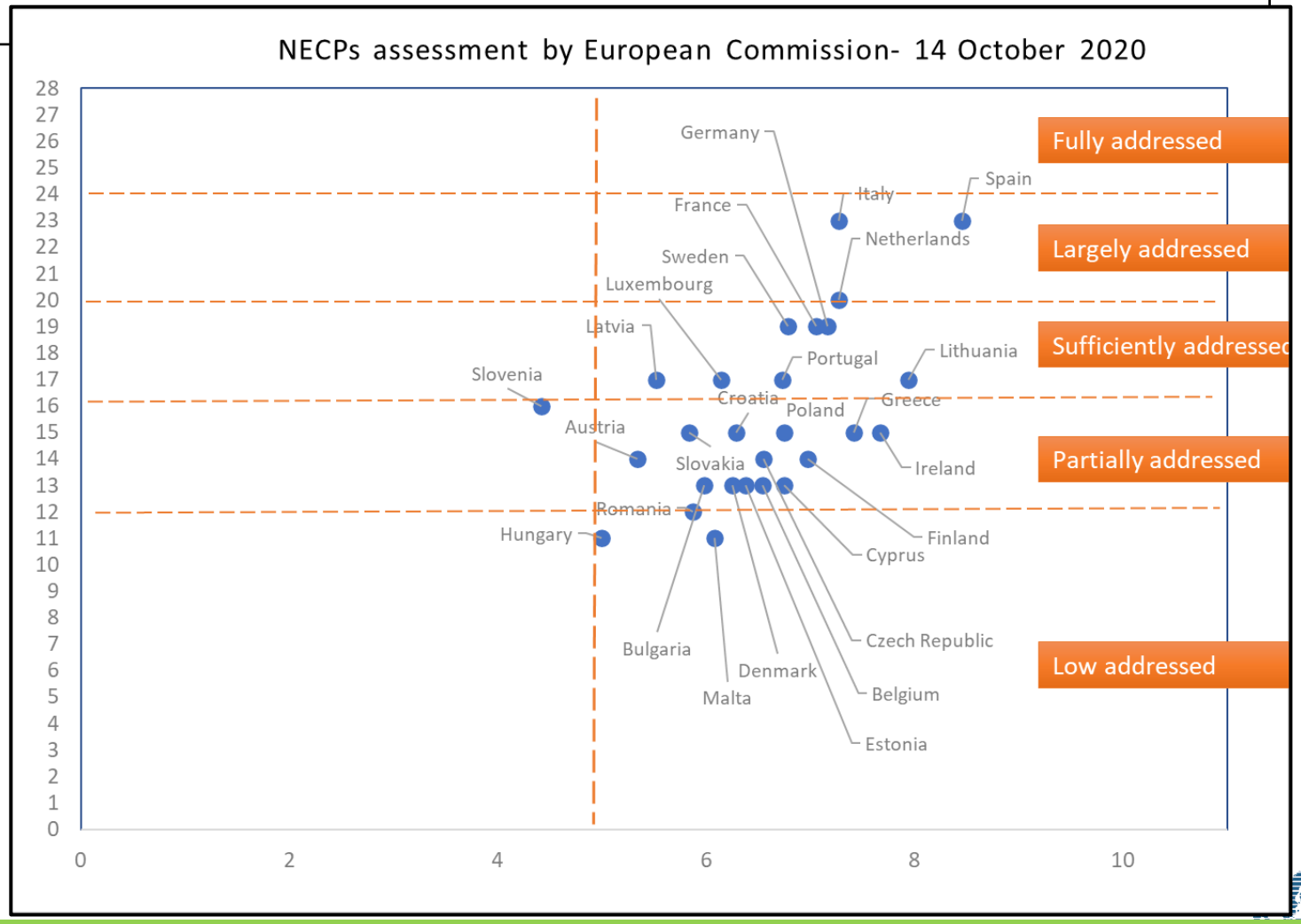
EERA European Energy Research Alliance

PLEDGES
PLEDGE LIMITS EVALUATION FOR DECARBONIZATION GOALS OF THE UE27 STRATEGY

EERA- Meeting on Fossil Fuel dependencies
5th May 2022

Anglia Ruskin University

Review paper on the National Energy and Climate Plans (NECPs) and Long Term Strategy plans (LTS) for EU27



Perissi, I.; Jones, A. Investigating European Union Decarbonization Strategies: Evaluating the Pathway to Carbon Neutrality by 2050. *Sustainability* **2022**, *14*, 4728. https://doi.org/10.3390/su14084728