

PAUL SCHERRER INSTITUT



WIR SCHAFFEN WISSEN – HEUTE FÜR MORGEN

Evangelos Panos

:: Paul Scherrer Institut

Antti Lehtilä

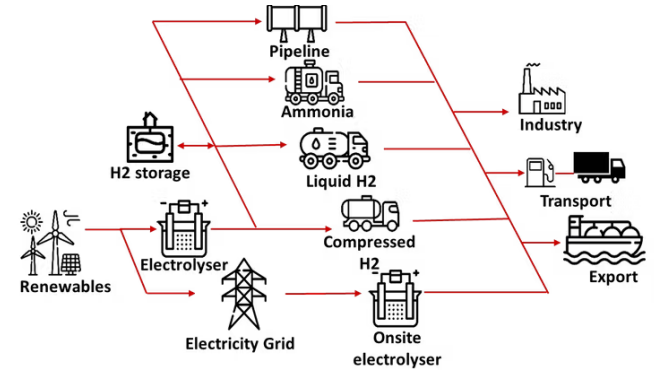
:: VTT Technical Research Centre of Finland Ltd

TIMES extension for electricity, gas, hydrogen and CO₂ transport infrastructures

New energy infrastructures need to be developed in the next decades to support the energy transition



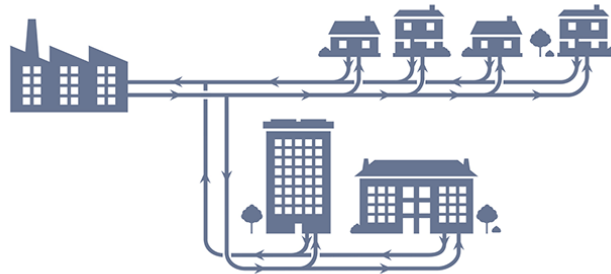
- Electricity grids



- Hydrogen grids



- Gas and CO₂ grids



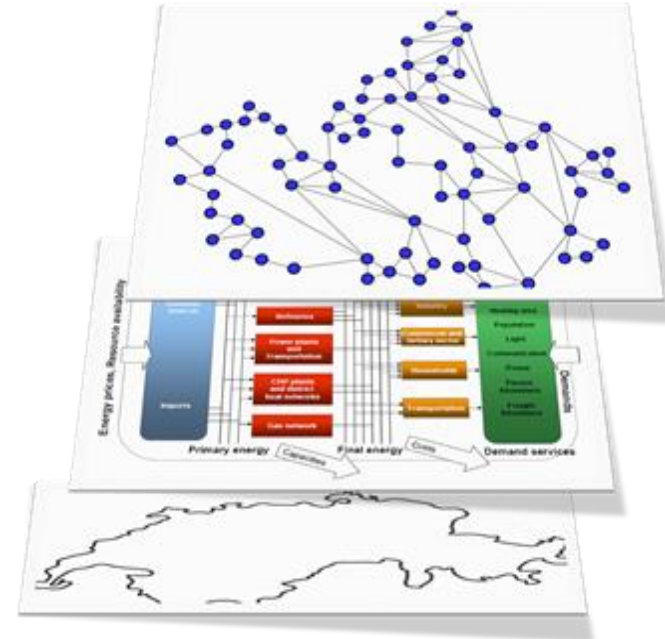
- District heating grids

But in TIMES we largely neglect their properties

- Many infrastructure operational constraints arising from their physical properties are missed in TIMES
- Infrastructures become increasingly interconnected via sector coupling accounting, and their physical properties matter
- Modelling infrastructure with simple processes in TIMES questions the technical **feasibility** of the derived optimal energy system configurations
- To tackle this issue, TIMES community couples energy system and network models – but this raises **consistency** questions

Taking the current TIMES GRID extension further

- In 2013, the GRID extension of TIMES implemented as an add-on for DC Power Flow approximation
- The extension imposed a number of infrastructure constraints on top of the current structure of the model
- Flexibility in the number of lines and nodes representing the electricity transmission need without increasing the spatial resolution of the underlying TIMES model
- This idea can be used to model other infrastructures in the TIMES framework



The proposed extension will offer the following features:

- Electricity grids:
 - besides DC power flow also Power Transfer Distribution Matrix formulation: $-\mathbf{b} \leq \mathbf{P}x \leq \mathbf{b}$
- Pipeline grids for gas, hydrogen, CO₂ and district heating:
 - Linear approximation of pipeline physical properties
 - Introduction of constraints of the same logic as the PTDF matrix formulation , e.g., “gas flow distribution factors” encapsulating the properties of the pipelines
- Non-pipeline infrastructure, e.g. deliveries via trucks or ships
 - Definition of routes between generation and demand nodes
 - Properties like length of the route, trips per route, costs and efficiency per trip, etc

Project deliverables

- A new extension of TIMES enabling the modelling of:
 - electricity grids,
 - pipeline grids for gas, hydrogen, CO₂, heat, etc.,
 - other means of delivery for energy carriers
- Documentation of the extension and demo model
- Webinar demonstrating the extension

Benefits to the ETSAP

- The new extension would enable studies on **energy security and reliability of supply and demand**
- A state-of-the-art TIMES framework by **tackling an important critique** on the technical feasibility of the obtained solutions
 - enhances the capabilities of current the energy systems analyses
 - facilitates and even reduce the need for coupling TIMES with network models
- TIMES framework stays ahead of competition, attracts new users and become suitable for a range of new applications
- The project is relevant to the objectives of ANNEX XVI:
 - “Tools Maintenance, Improving and Capacity Building”
 - “Research and Development”

Budget and schedule

Work package	Partner	Person days	Personnel cost (EUR)
WP1: Mathematical design of the extension	PSI	20	20000
	VTT	2	2000
WP2: Prototype and implementation in TIMES	PSI	5	5000
	VTT	13	13000
WP3: Documentation, demo model and webinar	PSI	5	5000
	VTT	3	3000
Total requested from ETSAP		48	48000

- Time schedule: 18 months after the signing of the contract

Thank you for your attention!

