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Supporting legislation

Risk Assessment Regional approach – *Involvement of the Contracting Parties*

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Content

1. Reg. (EU) No 994/2010 and the regional approach;
2. Ongoing revision of Reg. (EU) No 994/2010
3. A tool for regional analysis: EUGas – A hydraulic model of the European Gas Transmission System;
4. Selected examples of regional approach like the South-East corridor and the Baltic Region;
5. Conclusions

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C3: our pipeline

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Customers

- DG-ENER
- DG-HOME
- MS (FI, LV, LT, EE, EL, BG)
- Other Countries (UA)

Activities

- Modelling
- Assessment
- Review
- (Research)

Tools

- EUGas
- GEMFLOW
- ProGasNet
- “Experience”
- Techno-Economic

Policy

- Reg. 994/2010
- Reg. 347/2013
- Directive 2008/114/EC
- LNG & UGS strategy
- Energy Union

Reg. (EU) No 994/2010 - Regional approach

- The current Regulation foresees the possibility to adopt a regional approach and prepare regional Plans (on a voluntary basis).
  - *UK & IR (IR not satisfying N-1 at national level)*
  - *DK and SE or ES and PT (very strong coordination)*
  - *FI and Baltic Region (jRA, but not jPAP or jEP)*

- Art. 11 “Union and regional emergency responses”

Revision of Reg. (EU) No 994/2010

- *Risk Groups and Common Risk Assessment;*
- *Templates for common RA and national RA;*
- *Regional dimension in PAP and EP;*
- *Art. 12 "Solidarity" principle, "Solidarity protected customers" and compensation mechanisms;*
- *Art. 15 Cooperation with the Energy Community Contracting Parties*

What is EUGas?

EUGas is an ongoing effort to develop a country scale steady state hydraulic model of national gas transmission systems.

EUGas is a unique tool and no comparable projects exist in Europe (i.e., only few countries use hydraulic models like in the NDP of Germany or the RA of Ireland).

Each Transmission System Operator has at least (i) a steady state hydraulic model for network development and capacity planning and (ii) a transient hydraulic model for network management (coupled with SCADA).

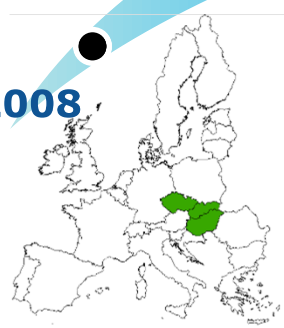
Competent Authorities (Reg. (EU) No 994/2010) don't have such tools for they activities (the exception is Germany).

EUGas History

Phase 1

- Hydraulic Module
- Pilot Study

2008



Phase 2

- GIS Module
- Hydraulic Module
- Estimated values for demand
- Simplified Network Topology

2010

Phase 3

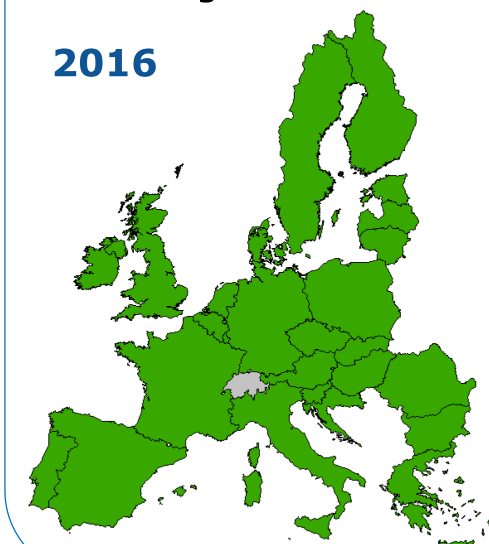
- GIS Module
- Hydraulic Module
- Real/Estimated demand
- Complex Network Topology
- Scenarios

2013

Phase 4

- Scenario module
- Templates
- Allocation procedure
- Networking with TSOs and MSs for data exchange

2016



What EUGas models:

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Infrastructure

Pipelines

Compressor Stations

Underground Gas Storages

LNG Terminals

Production Sites

Regulators

Blending Stations

Nodes

Cross-border points

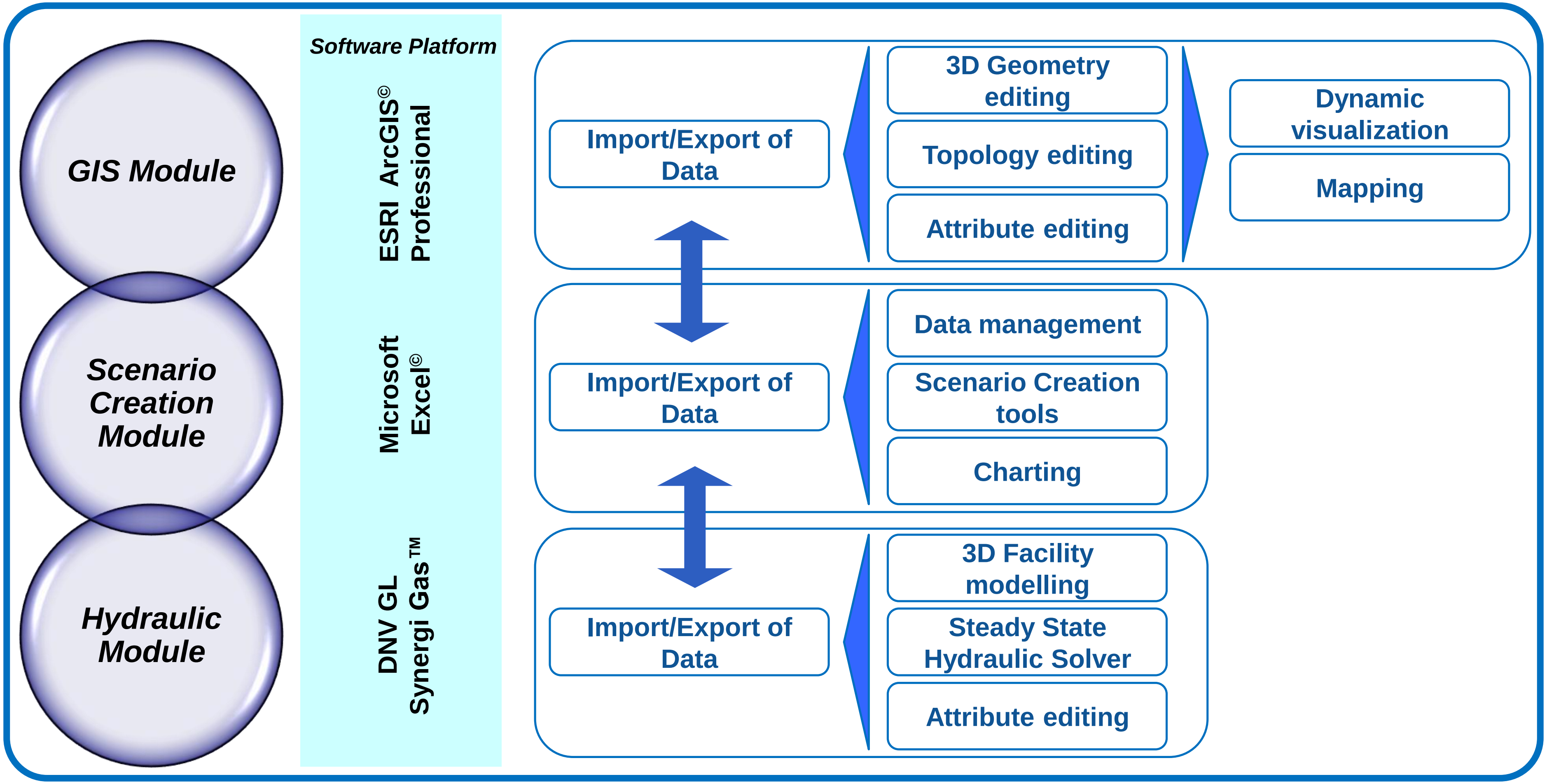
Domestic / Commerce off-take

Industry off-take

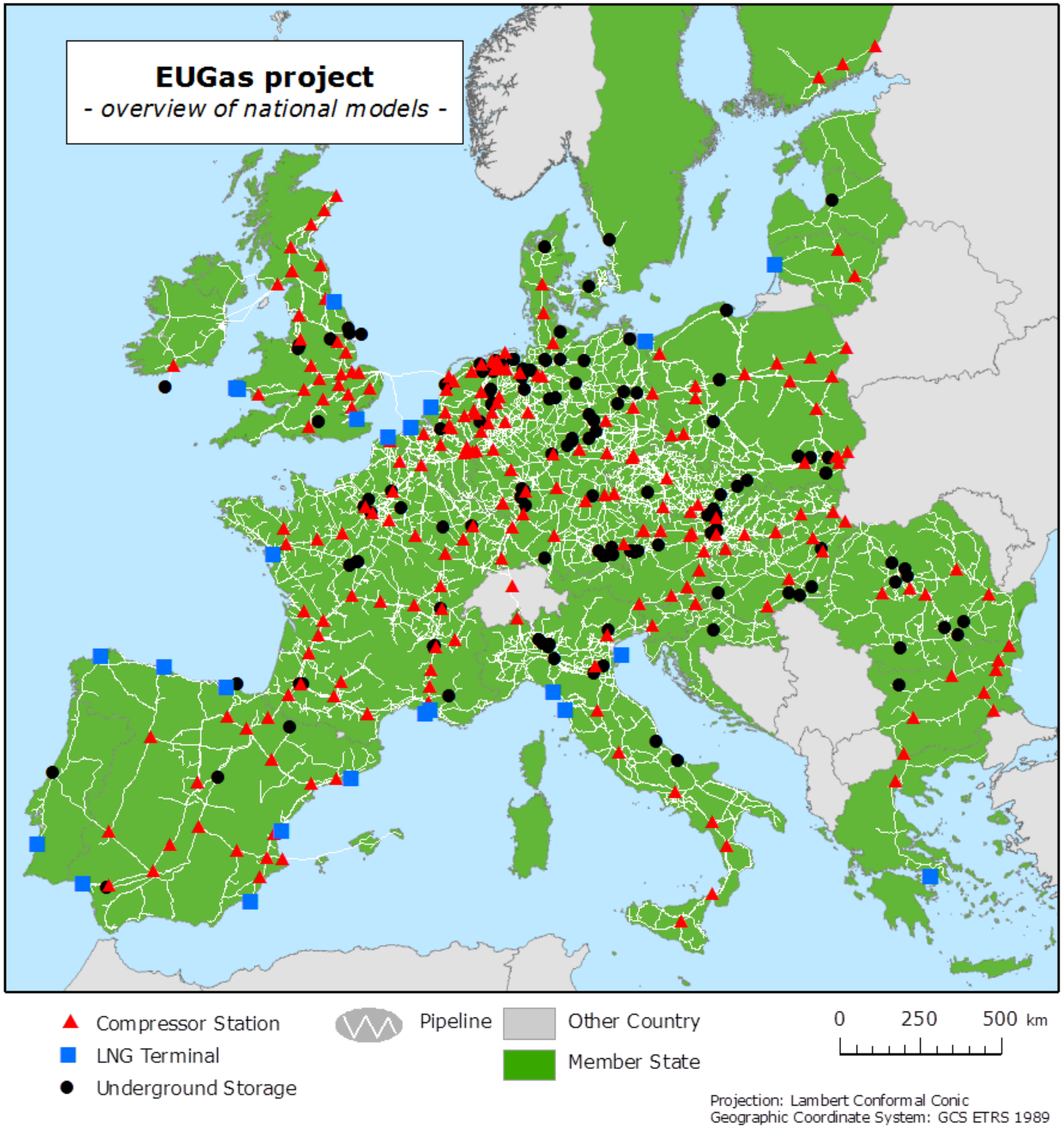
District Heating off-take

Electricity Production off-take

EUGas History



EUGas extent



146 UGS
217 Compressor Stations
22 (+2) LNG
~16.500 Pipeline segments
~180.000 km of pipelines

Recent extension

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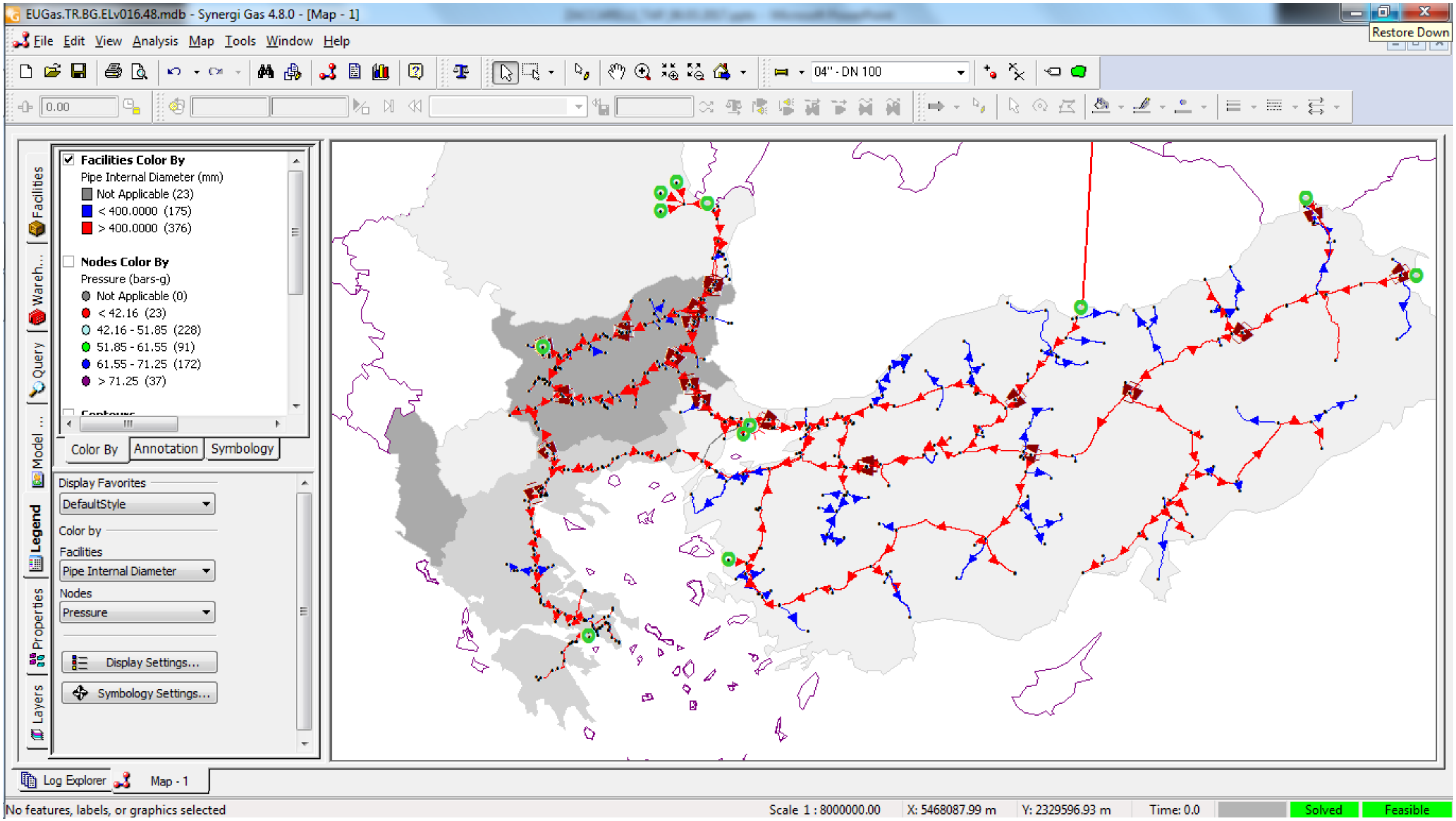
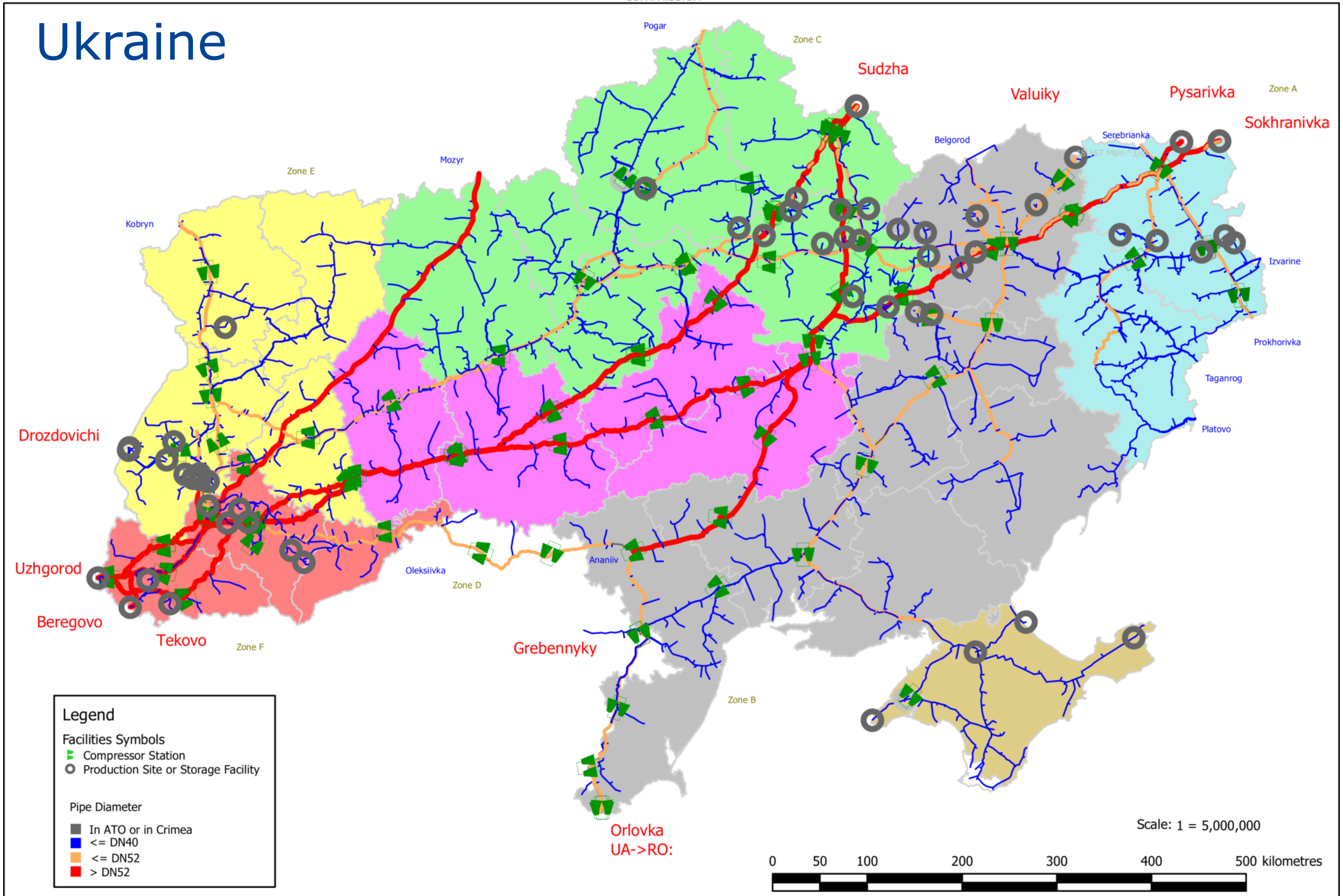
Turkey



Recent extension



Hydraulic model *is defined by mathematical set of equations that gather all the variables that govern the behavior of gas in a network.*

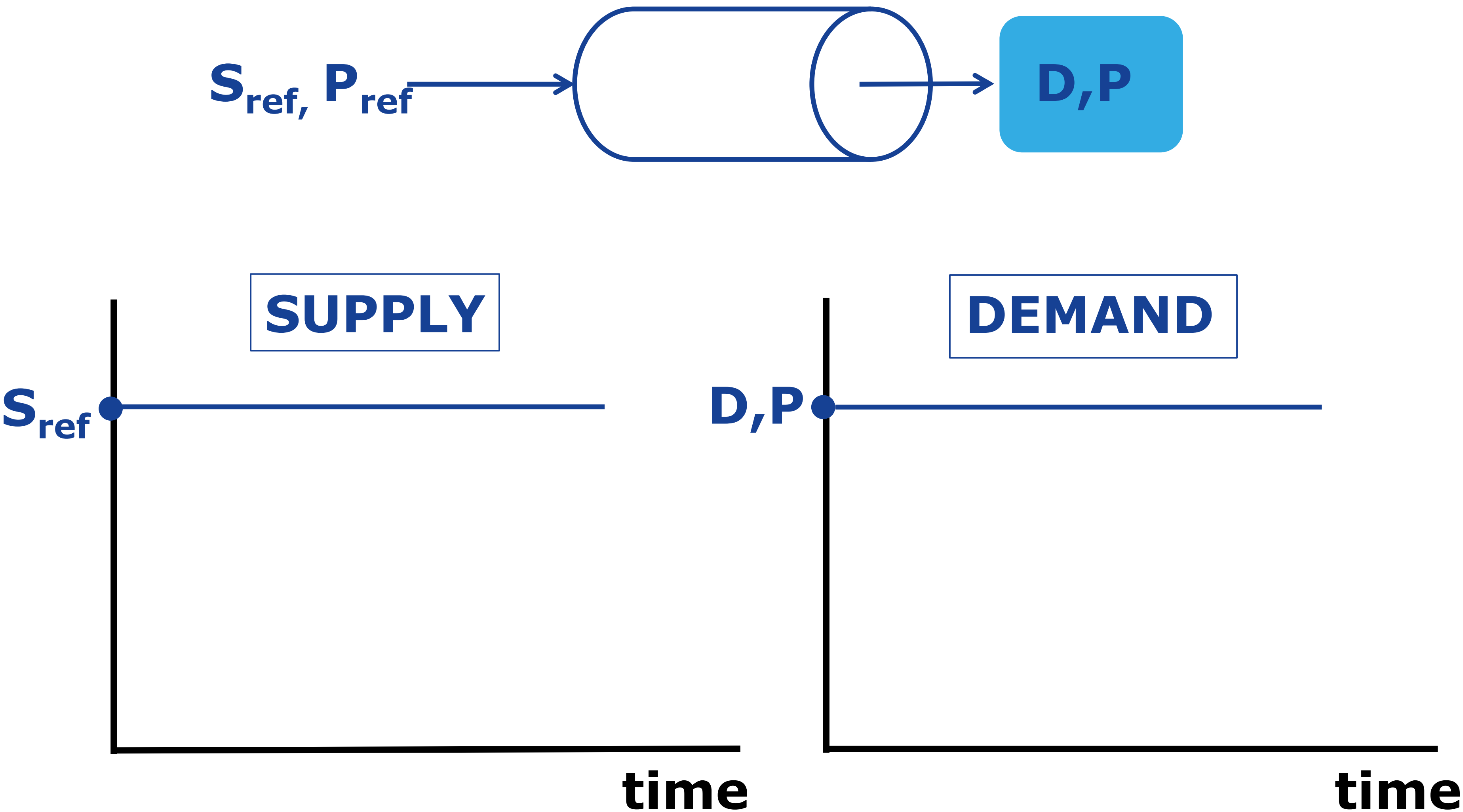
Mass Balance *vs* Hydraulic Analysis (HA)

Why not mass-balance models?

- *They do not describe the physical behaviour of a network (i.e., "pressure & flow" relationship).*
- *They do not address contractual constraints (i.e., minimum delivery pressure).*
- *They do not address efficiently or at all bottlenecks.*

Dynamic HA *vs* Steady State HA

Steady state analysis gives you a solution to the hydraulic problem assuming that the gas grid has reached the equilibrium under the new conditions.


Sref, Pref
D,P
SUPPLY
Sref
time
DEMAND
D,P
time

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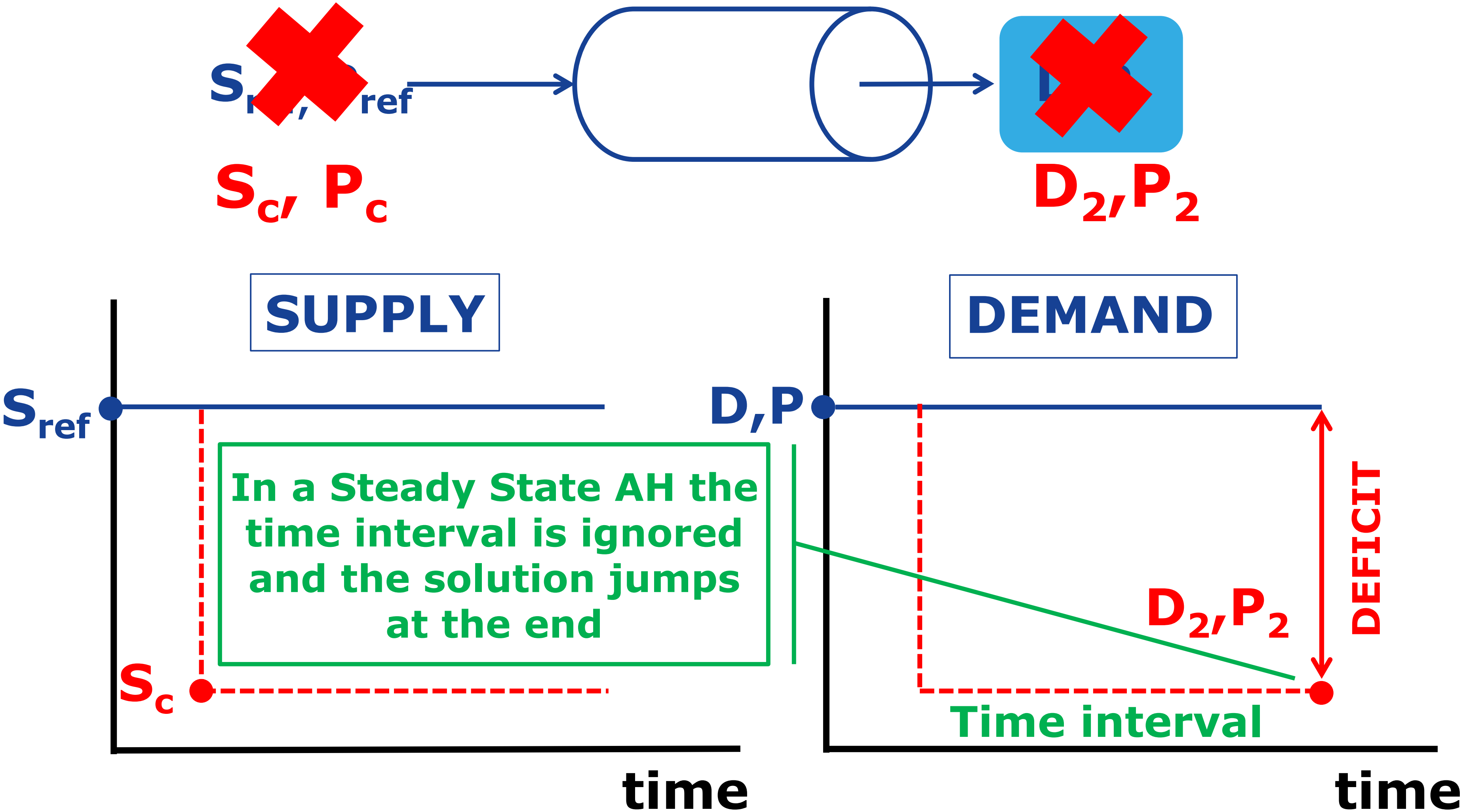

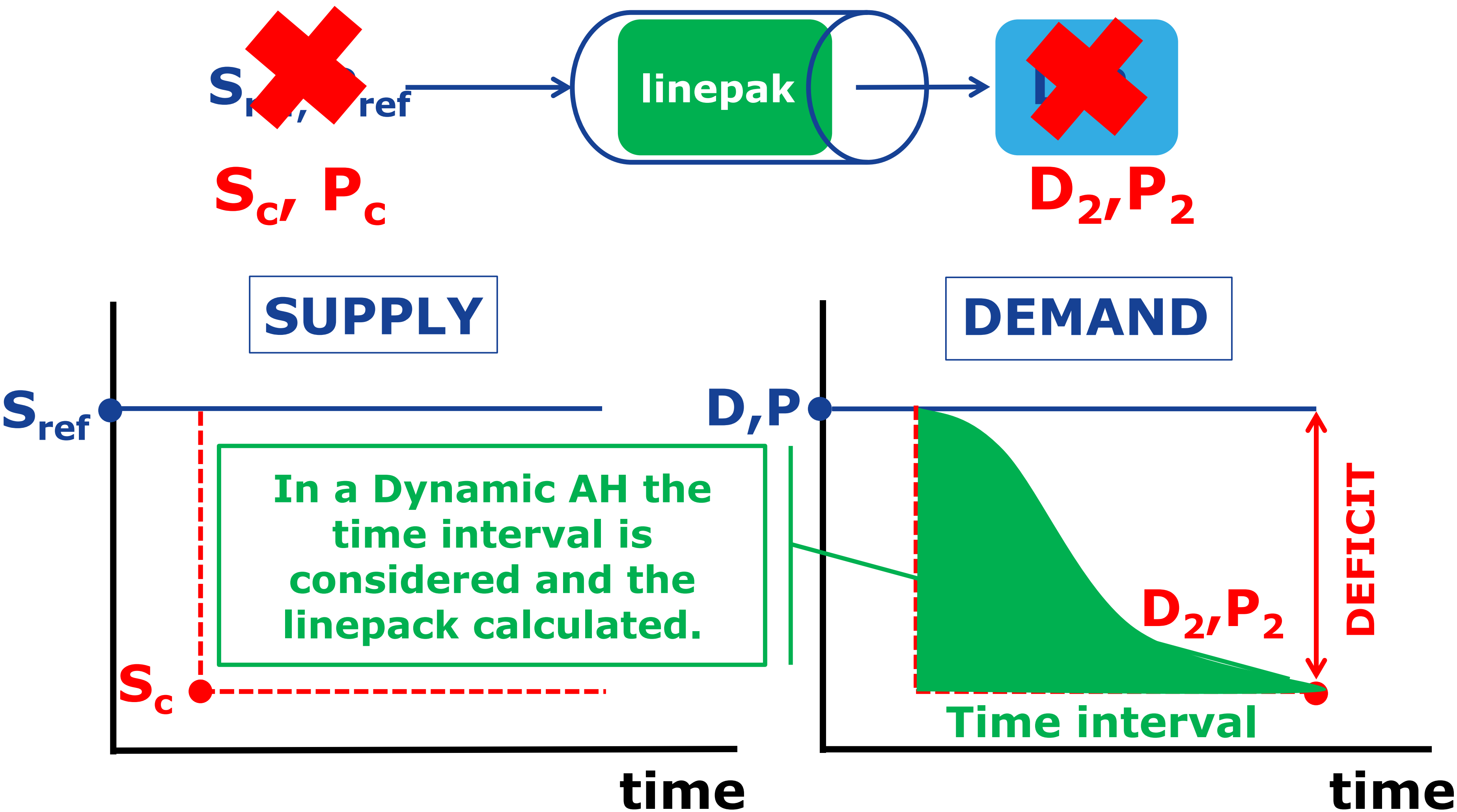

ref
linepak
Sc, Pc
D2,P2
SUPPLY
DEMAND
Sref
D,P
In a Dynamic AH the time interval is considered and the linepack calculated.
Sc
D2,P2
DEFICIT
Time interval
time
time

EUGas uses a steady state solution but it approximate the linepack changes by:

- Using steps to discretize the time interval
- Constraining the results to not build up linepack

Examples:

- Joint Risk Assessment Bulgaria and Greece (Reg. 994/2010)
- Interactions gas-electricity
- Joint Risk Assessment FI, EE, LV and LT (2016)
- PCIs of the Baltic Region (Reg. 347/2013)

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jRA BG and EL (2014)

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Scenario 1. *Lack of gas supply from Ukraine in Mediesu, Isaccea and Kipi.*

- Scenario 1.a). Complete lack of gas supply from UA (included Kipi) due to commercial disputes.
- Scenario 1.a'). Complete lack of gas supply from UA (included Kipi) due to technical/ natural/social causes (non-commercial, non geopolitical).
- Scenario 1.b). 50% lack of gas supply from UA.

Scenario 2. *Disruption of gas supply at Kipi entry point.*

- Scenario 2.a). Decreased Gas supplies across Kipi entry point combined with cargo delays in Revithousa LNG regasification terminal.
- Scenario 2.b). Total lack of gas from Kipi entry point and 7 days delay LNG cargo.
- Scenario 2.c). Total lack of gas from Kipi and 20 days delay LNG cargo.
- Scenario 2.d). 50% lack of gas from Kipi and 7 days delay LNG cargo.
- Scenario 2.e). 50% lack of gas from Kipi and 20 days delay LNG cargo.

Scenario 3. *Failure / Fracture of a pipeline at Negru Voda.*

- Scenario 3.a). Failure of a pipe at Negru Voda-I (affecting only Bulgaria).
- Scenario 3.b). Failure of a pipe at Negru Voda-II & III (affecting all countries downstream the transit pipeline).

Scenario 4. *Failure in the UGS Chiren in Bulgaria.*

Scenario 5. *Failure of a compressor station in Bulgaria.*

- Scenario 5.a). Failure of compressor station Kardam 2 (affecting all countries downstream in the transit pipeline: Greece, Former Yugoslav Republic of Macedonia and Turkey)
- Scenario 5.b). Failure of compressor station Petrich (affecting only Greece)

Reference case: peak day demand

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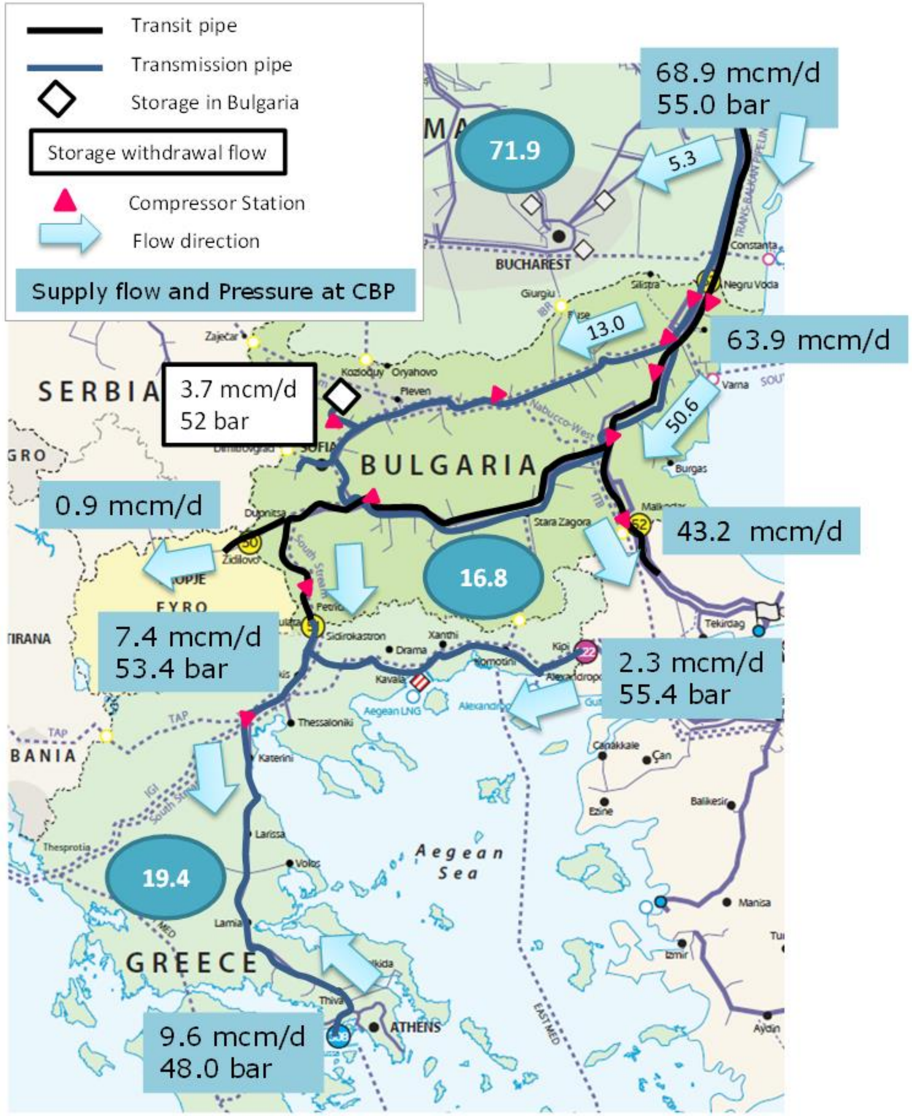
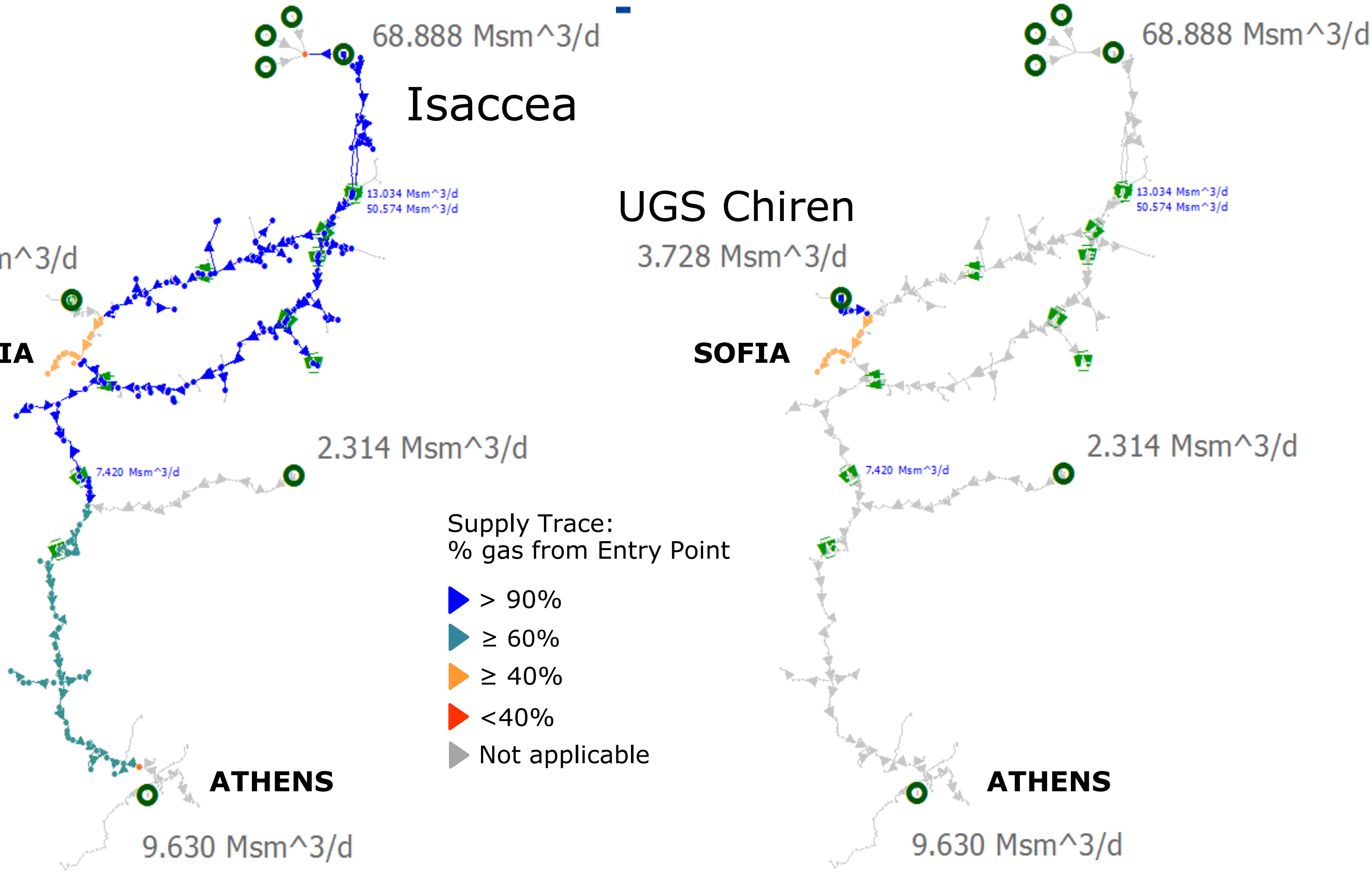


Supply trace analysis
- Peak day demand -

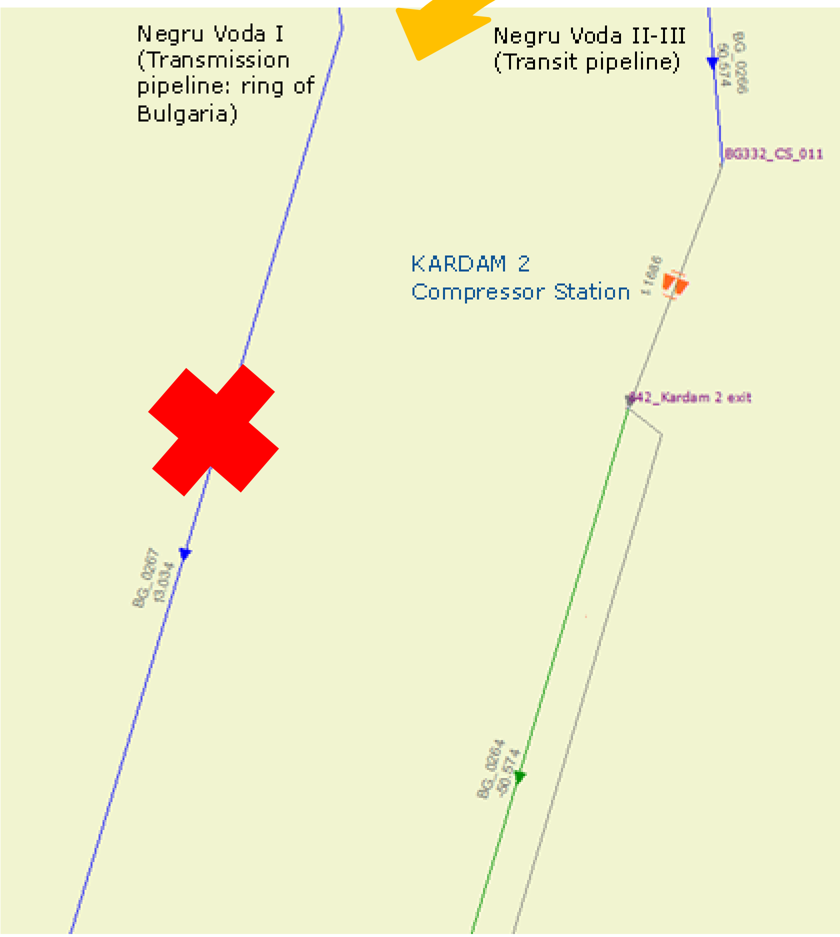


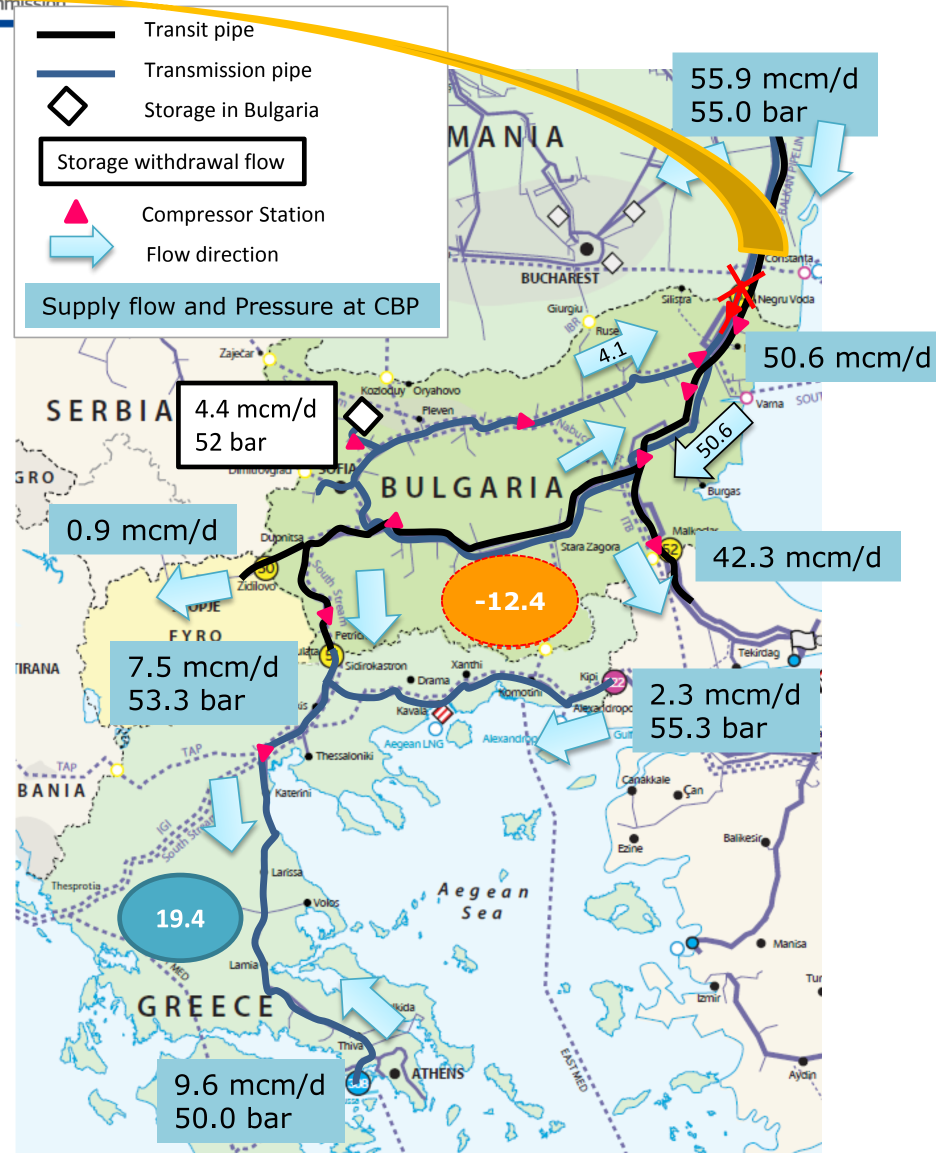
a) Supply Trace from Cross-border point Isaccea

b) Supply Trace from UGS UGS Chiren

jRA: SC.03.a Failure at Negru-Voda I

2014





In this scenario Bulgaria has a gas deficit of 12.4 mcm/d, and can supply only 26% of the gas demanded in a peak-day.

jRA: SC.03.b Failure at Negru-Voda II & III

2014

Country	Gas Demand (mcm/d)	Gas Deficit (mcm/d)	
Bulgaria	16.8	0	Scenario 3.b (Unfeasible)
Greece	19.4	**-4.9**	
BG Transit	43.2	**-43.2**	
Bulgaria	16.8	0	Scenario 3.b (DSM applied)
Greece	14.5	0	
BG Transit	43.2	-43.2	

jRA: SC.05.b Failure of CS Petrich

2014

A feasible solution for this scenario is found when:

- the LNG terminal in Greece is increased;
- compression stations on Bulgarian transit have increased outlet pressure;
- Greek compressor station is not at maximum.

Minimum deliverability pressure is satisfied around Thessaloniki.

Electricity – Gas interactions

PSIG 1609

An integrated simulation tool for analyzing the Operation and Interdependency of Natural Gas and Electric Power Systems

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A : incidence matrix

Electricity – Gas interactions

European

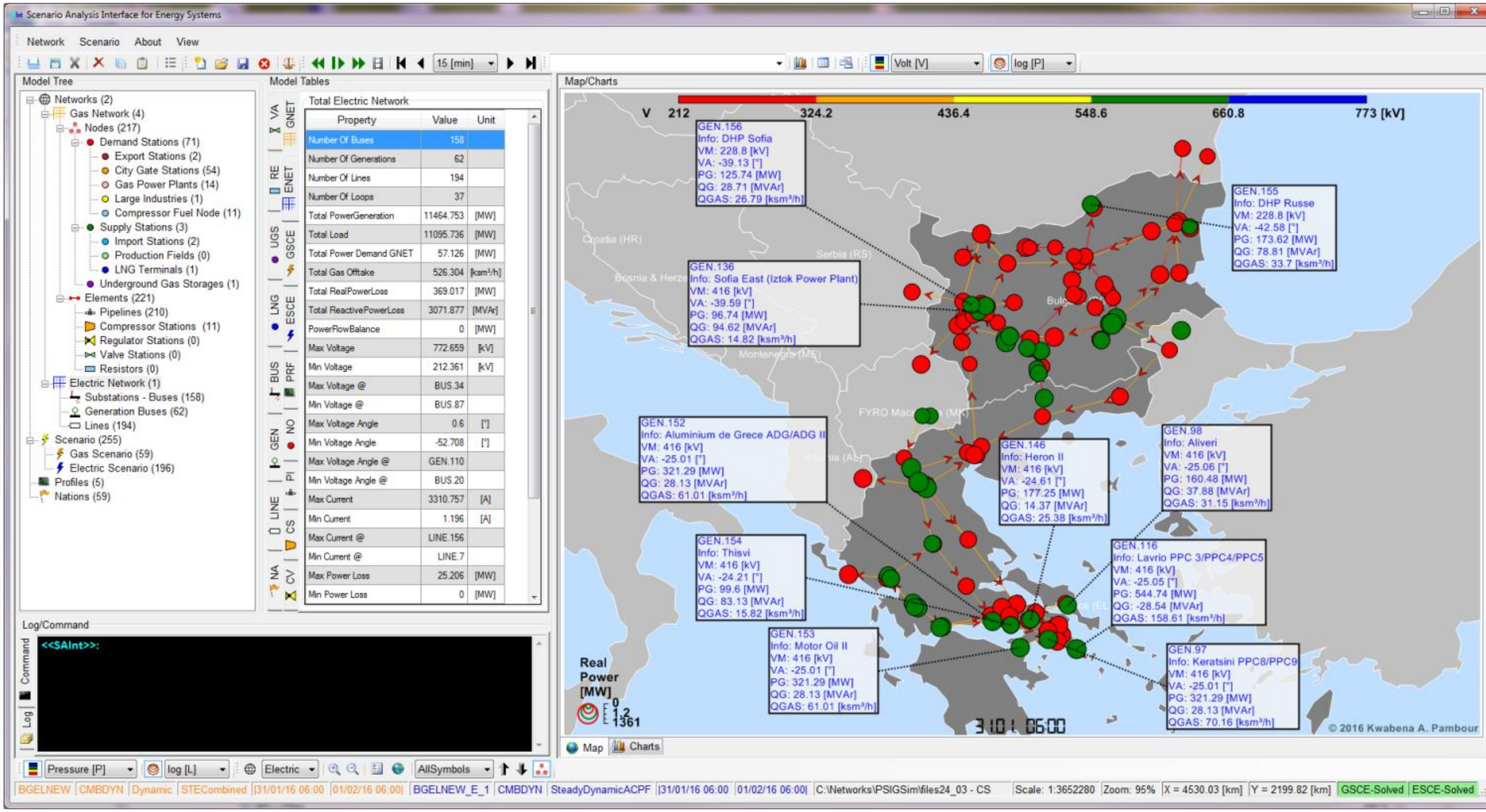

Figure 8: Model of the Bulgarian-Greek power transmission system plotted in the graphical user interface of developed software. Map shows results of a steady state computation for the coupled system. Diameter of the circles representing load (red) and generation (green) buses correspond to the magnitude of active power in logarithmic scale, as can be seen from the legend in the bottom left corner. Colors of the line elements correspond to the voltage levels indicated in the color bar on top. Transmission line arrows indicate flow direction of electric current. Labels describe a selected number of generation buses (green circles) connected to gas fired power plants.

Electricity – Gas interactions

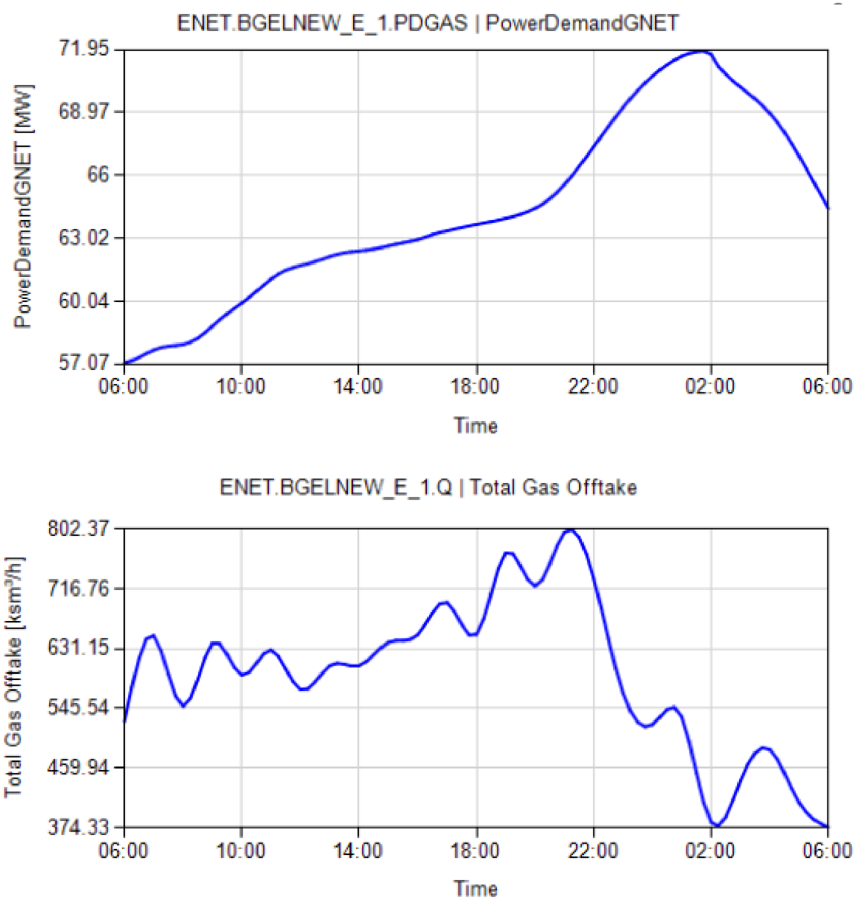

Figure 13: Time series of total power offtake of electric driven compressors stations and LNG terminals (top) and total gas off-take (bottom) of gas power plants for the combined simulation

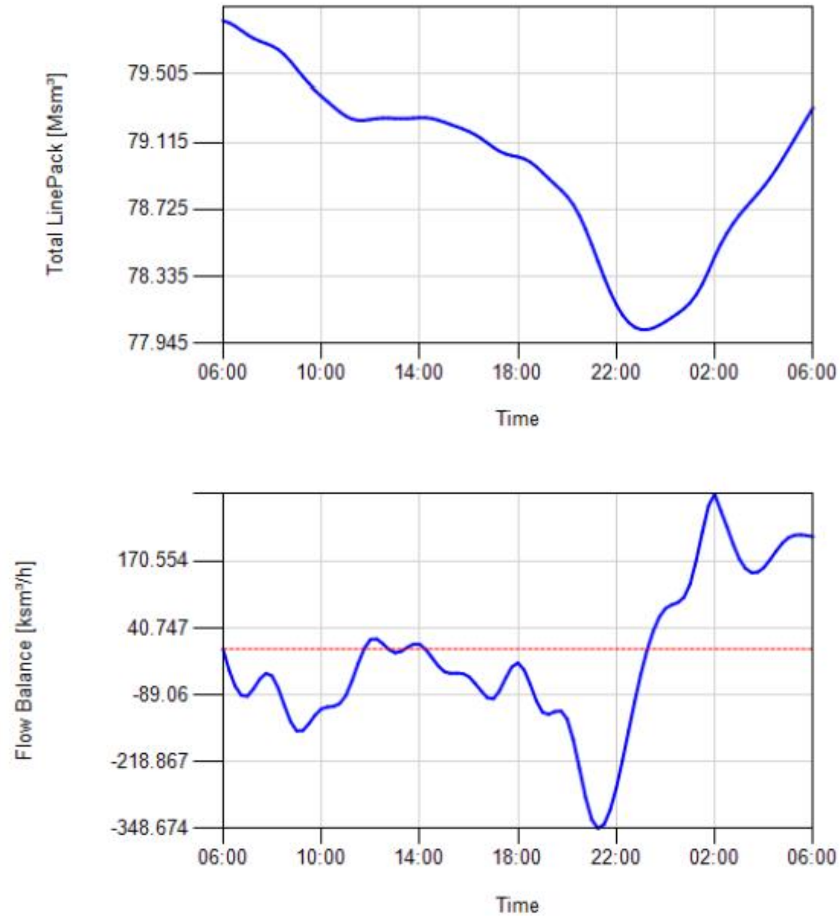

Figure 17: Time series of total line pack (top) and total flow balance (bottom, sum of inflow minus sum of outflow) for the gas system in the combined simulation

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We considered 25 scenarios.

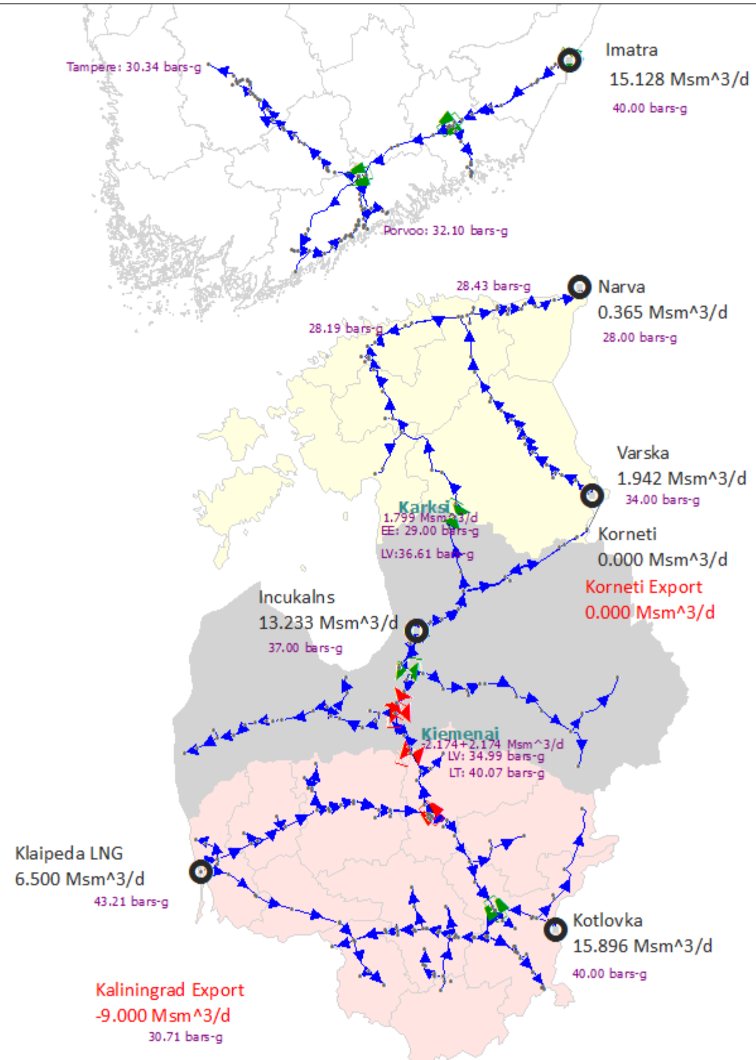
CODE	Description	Cause	Duration	Demand Case
S.03	Unavailability of Inčukalns UGS	Large-scale accidents (explosion)	7 days	Peak week demand
			7 days	Average winter demand
		Incident related to separate well workovers	1 day	Peak day demand
			1 day	Average winter demand

1. Solve the reference scenario of peak demand to evaluate the gas system the day before the crisis

2. Solve the scenario of crisis

3. Evaluate the impact/consequences of the crisis taking into consideration the use of the linepack

Reference case for one peak week



S.03.a

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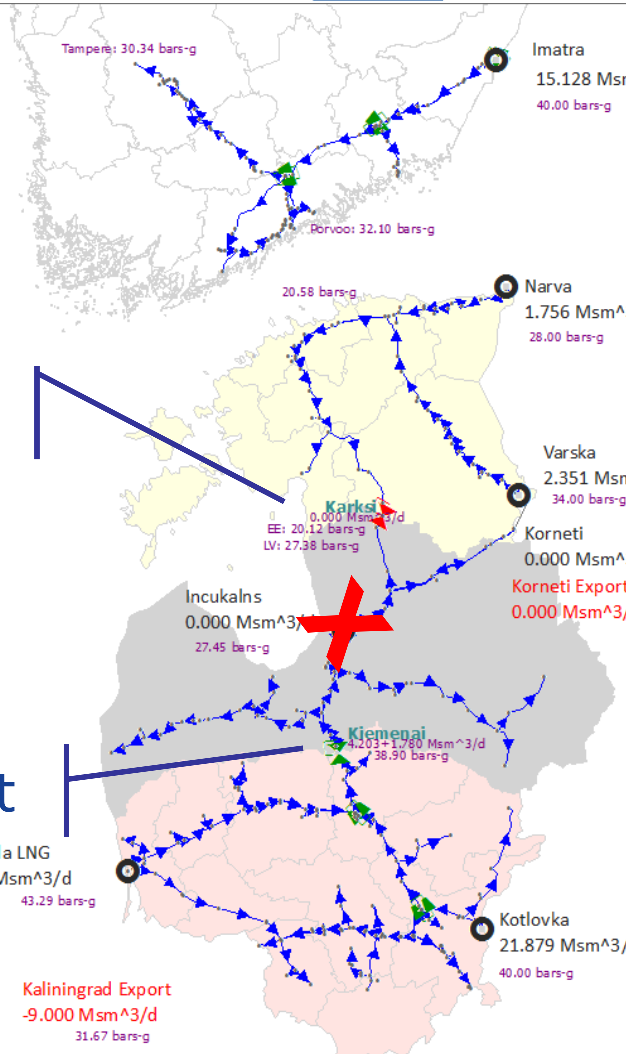
Day 1



Max Import

Max Import

Export stopped

Deficit

Max Import

Day 1

Country	Gas Demand (mcm/d)	Unserved Gas (mcm/d)	Source NAME	Gas supply		Linepack (mcm)
				Flow (mcm/d)	Pressure (bar)	
Finland	15.1	0.0	Imatra	15.1	40	11.5
Estonia	4.1	0.0	Narva	1.8	28	**4.4**
			Varska	2.3	34	
			Karksi Interconnector EE-LV	0.0		
Latvia	11.4	**-5.4**	UGS Inčukalns	**X**		**8.0**
			Korneti Entry/Exit point LV-RU	0.0		
			Karksi Interconnector LV-EE	0.0		
			Kiemenai Interconnector LV-LT	6.0	30	
Lithuania	13.4	0.0	Klaipėda LNG	6.5	43	20.5
			Kotlovka	21.9	40	
			Kiemenai Interconnector LV-LT	-6.0	39	
			Sakiai	-9.0	32	
Kaliningrad	9.0	0.0	Sakiai	9.0	32	-
					Total	44.4

Peak week
Results

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ESTONIA	Day 0	Day 1	Day 2-7	Total crisis (mcm)
Linepack (mcm)	5.5	4.4	4.4	
Gas consumed from linepack (mcm/d)		1.1	0.0	**1.1**
Gas non served (mcm/d)		0.0	0.0	**0.0**
Total gas deficit (mcm/d)		0.0	0.0	**0.0**

LATVIA	Day 0	Day 1	Day 2-7	Total crisis (mcm)
Linepack (mcm)	10.6	8.0	8.0	
Gas consumed from linepack (mcm/d)		2.6	0.0	**2.6**
Gas non served (mcm/d)		5.4	5.4	**37.8**
Total gas deficit (mcm/d)		2.8	5.4	**35.2**

Scenario 3.a	FI	EE	LV	LT	Kaliningrad
Total gas demanded during the crisis (mcm)	105.7	28.7.	79.8	93.8	63
Total gas deficit during the crisis (mcm)	0.0	0.0	**35.2**	0.0	0.0
Gas consumed from the linepack (mcm)	0.0	1.1	2.6	0.0	
Gas Inventory consumed from Inčukalns UGS (mcm)			-		
Minimum gas inventory required in Inčukalns UGS at the beginning of the crisis (mcm)			-		
Total gas consumed from the LNG terminal (mcm)				45.5	

PCI: Finland and the Baltic Region

Existing Pipelines
Projects of Common Interest
Sources of Gas

Tallin LNG
11.0 Mcm/d
320.000 cm tank
Design and permitting (2017) Phase I
And (2019) Phase II

Enhancement EE-LV
New Compressor Station (35 MW)
10 Mcm/d reverse flow
Design and permitting (2019)

Balticconnector Interconnector EE-FI
7.2 Mcm/d reverse flow
2 CS 10 MW each
Design and permitting (2020)

Expansion UGS Incukalns
Volume: from 2.3 to 2.8 Bcm
Withdrawal Capacity:
from 28-30 to 34-35 Mcm/d
FID (Stage 1)
(Stage 1 & 2: 2022; Stage 3: 2027)

Enhancement of LV-LT Interconnection
Parallel pipeline 40 km
12 Mcm/d LT→LV
Planned (2021)

GIPL Interconnector PL-LT
2.7 Mcm/d LT → PL
6.6 Mcm/d PL → LT
177 km in LT territory
534 km in total
Design and permitting (2019)

PCI: Finland and the Baltic Region

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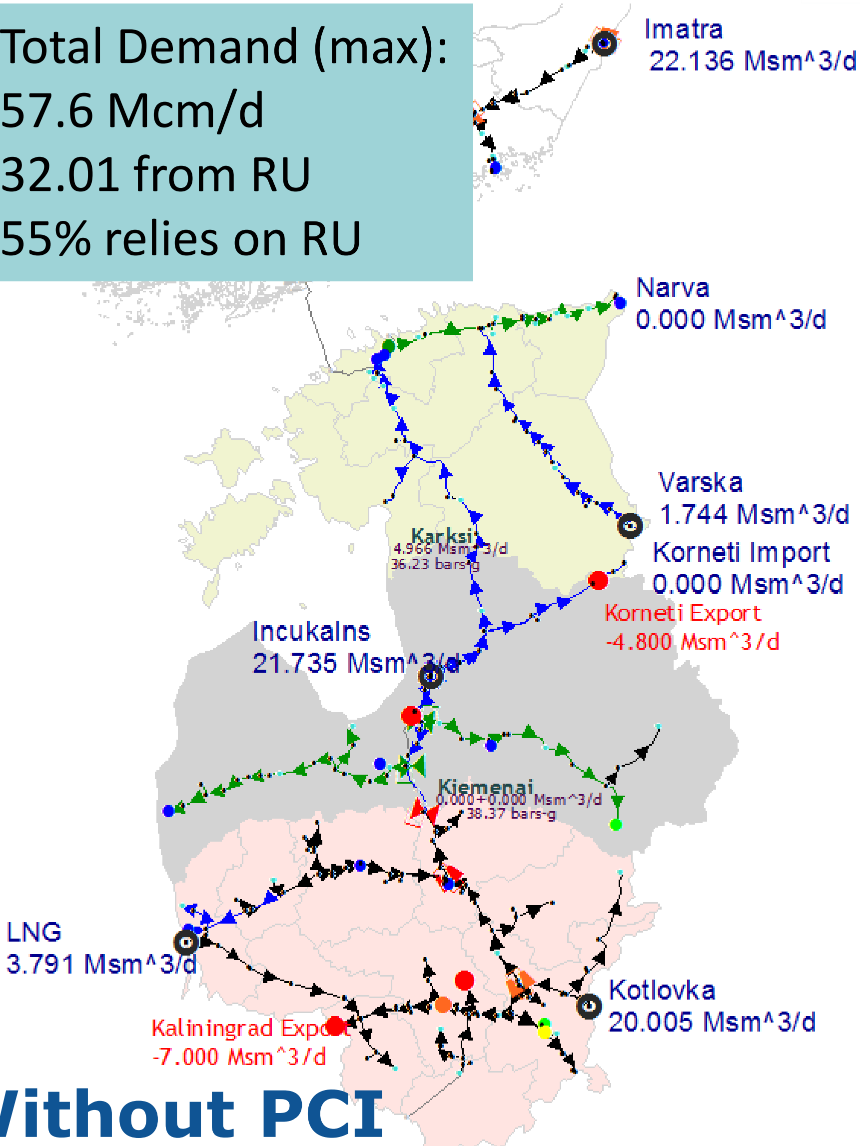
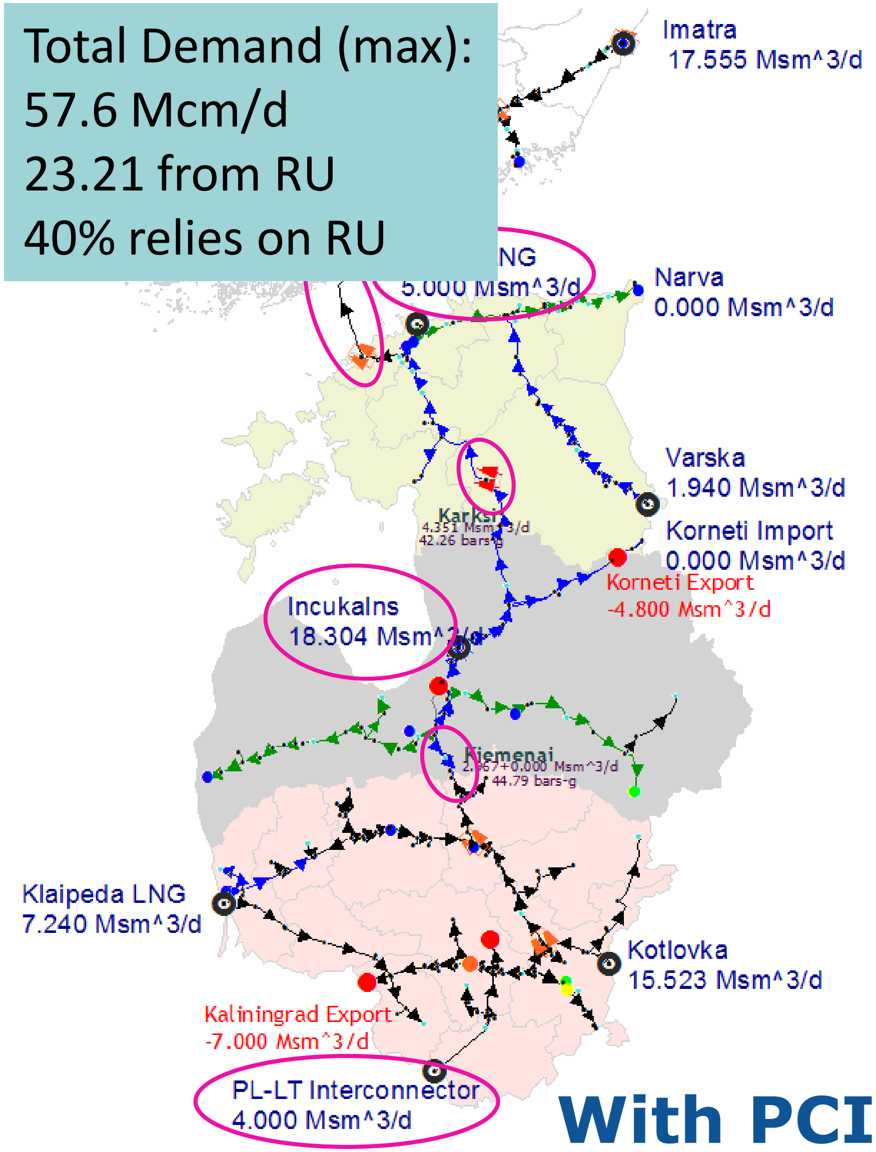
Total Demand (max):
57.6 Mcm/d
32.01 from RU
55% relies on RU



Without PCI

Total Demand (max):
57.6 Mcm/d
23.21 from RU
40% relies on RU



With PCI

Conclusions

- Why a regional “quantitative” approach:
  - Addresses bottlenecks and physical deliverability (not capacity);
  - Identifies national and downstream areas in needs;
  - Copes with correlated risks;
  - Allows to quantify the economic impact of a scenario.
- It requires a strong collaboration between Competent Authority and he TSO (and DG JRC);
- Convey the interest of DG JRC to actively cooperate