REKK Regional Centre for Energy Policy Research

Introduction of REKK EGMM

March 2017

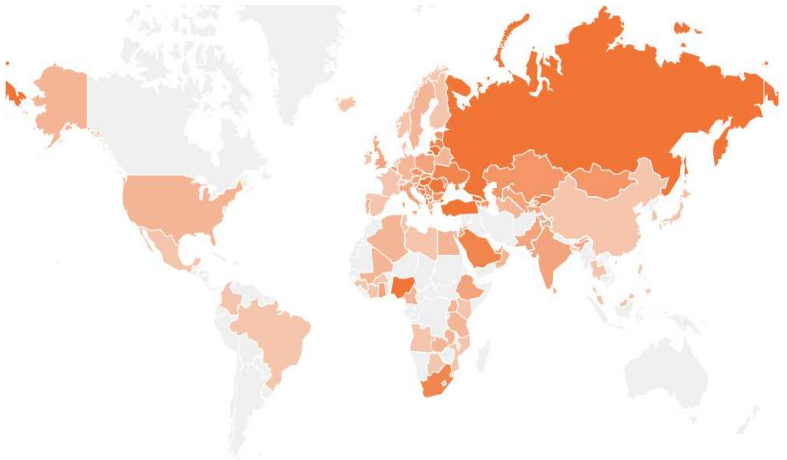
Péter Kotek

Senior Research Associate

REKK
at Corvinus University of Budapest

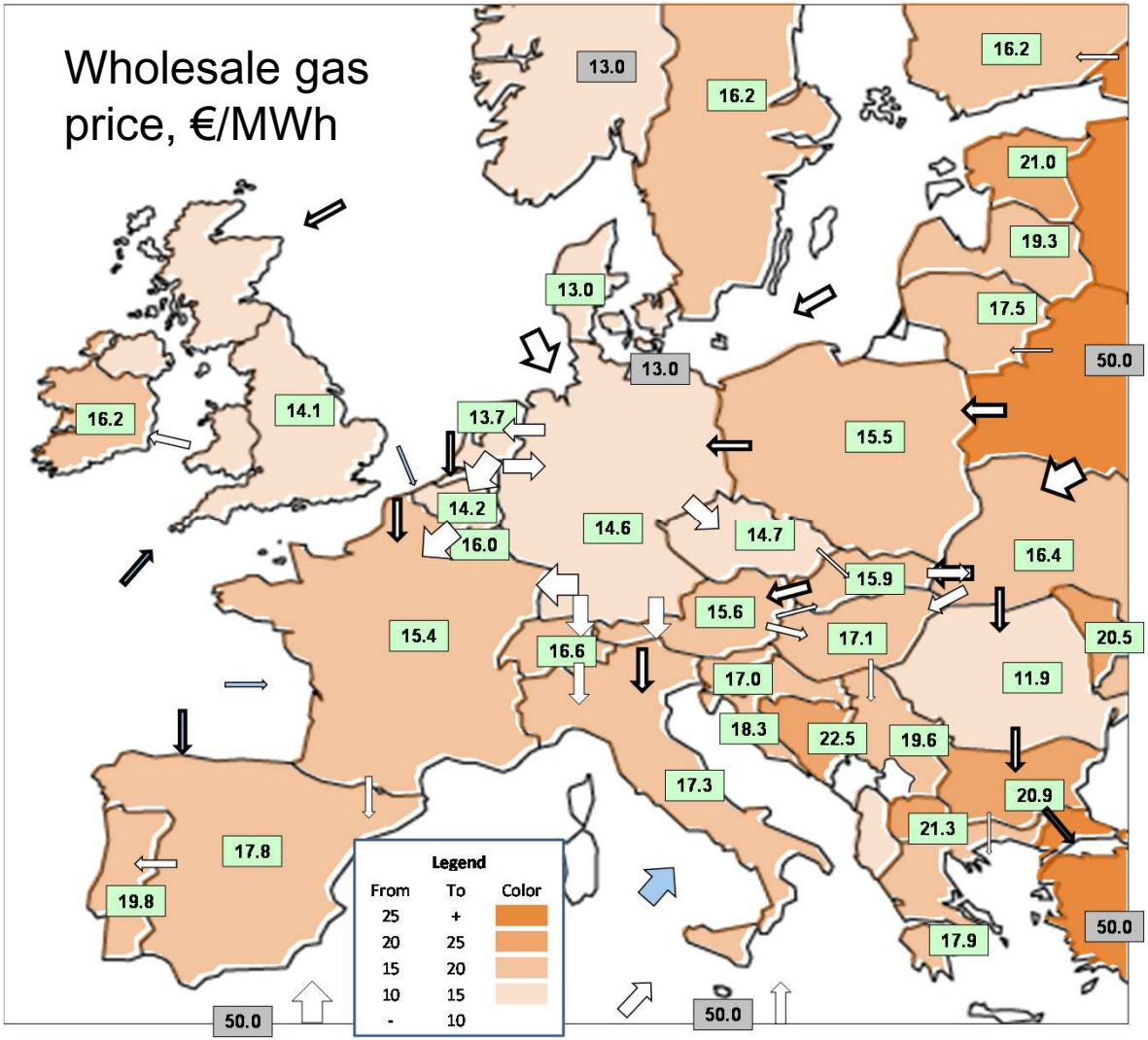
REKK Regional Centre for Energy Policy Research

- 20 full-time researchers
  - Electricity
  - Natural gas
  - District heating
  - Renewable energy
  - Water economics
- Applied research and consulting
  - Gas and electricity market modelling, Central Eastern European (CEE) focus
  - Market participants, regulators and TSOs in CEE region
  - Strong cooperation with European Commission
- Training activities
  - More than 2000 students enrolled to trainings facilitated by REKK and ERRA since 2004
  - Global coverage – besides Europe regulators and industry experts from Africa, Middle East and Central Asia
- Think Tank activities
  - Conferences and workshops with a CEE market focus



www.rekk.hu

European Gas Market Model – major characteristics



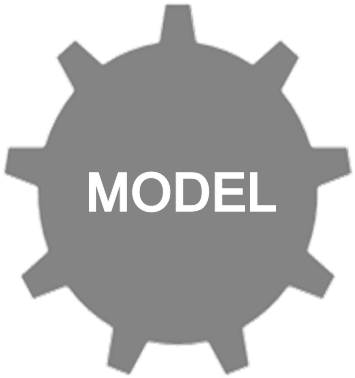
- Whole Europe (35 countries) is modelled
- Competitive prices by countries; price modelled for each 12 months
- Trade is based on long term contracts and spot trade within the EU and with exogenous countries and global LNG market (NO, RU, TR, LNG)
- Natural gas flows and congestions on interconnectors
- Physical constraints are interconnection capacities (transmission tariffs are also included)
- Trade constraints: TOP obligations with flexibility
- Domestic production and storage facilities are included
- Arrows: modelled gas flows
- LNG market representation is linked to Asian LNG prices

One gas year – 12 months

REKK Regional Centre for Energy Policy Research

INPUT

- Demand by countries (annual quantity, monthly distribution)
- Domestic production (annual quantity, minimum and maximum production)
- LTC contracts (ACQ/DCQ), flexibility
- Infrastructure: Interconnectors, storage, LNG, tariffs
- External price: for LTC, LNG, DZ, NO, TR, RU



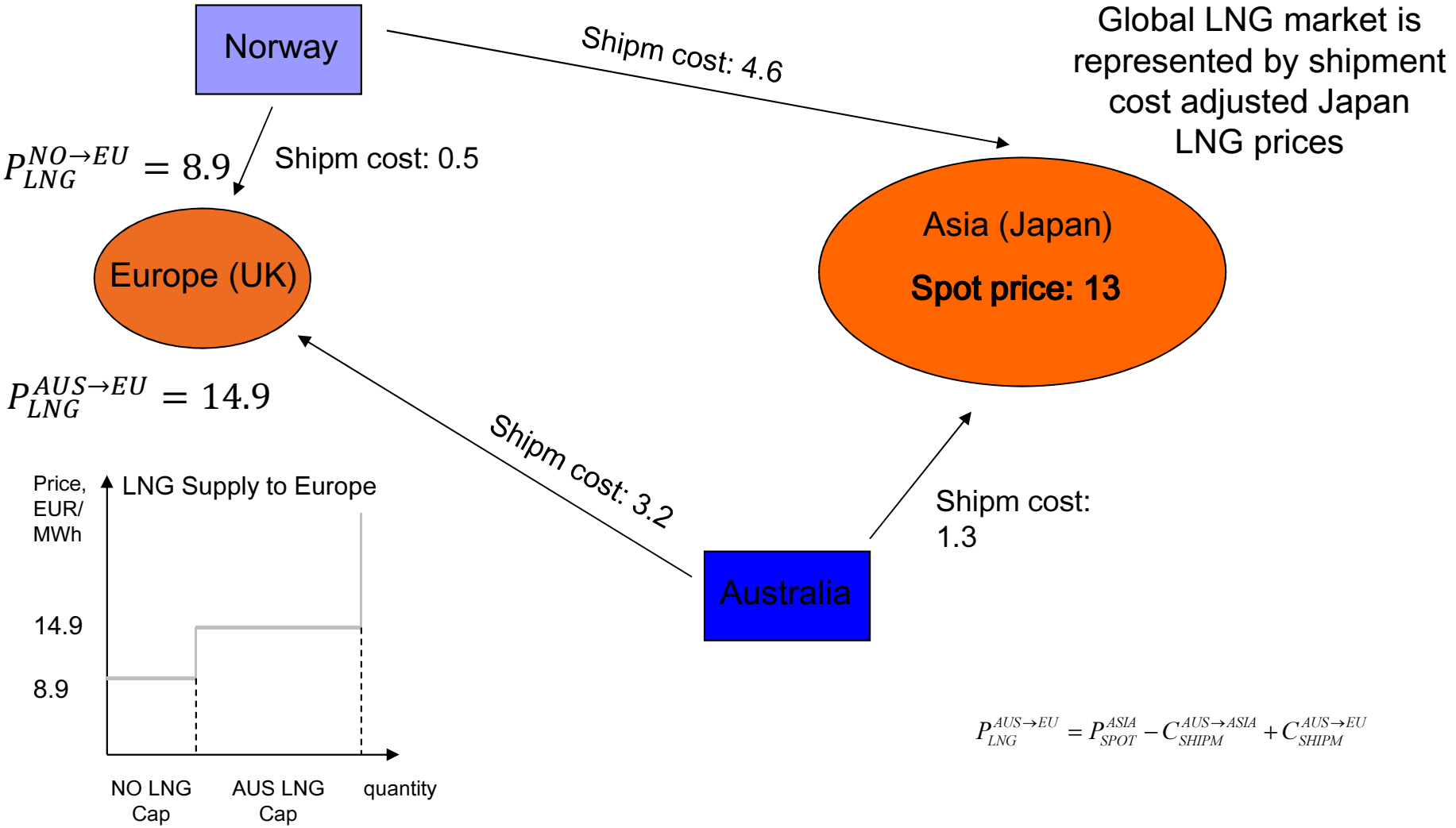
OUTPUT

- Wholesale gas price by country
- Consumption by countries
- Gas flows on interconnectors
- Storage stock change
- Import through long term contracts and spot trade

Social welfare:

- Consumer surplus
- Producer surplus
- Storage operation profit
- Storage arbitrage profit
- Net profit from long-term contracts
- TSO auction revenue
- TSO operation profit
- LNG terminal operator's profit

A simple model of spot LNG pricing for Europe (in EUR/MWh)



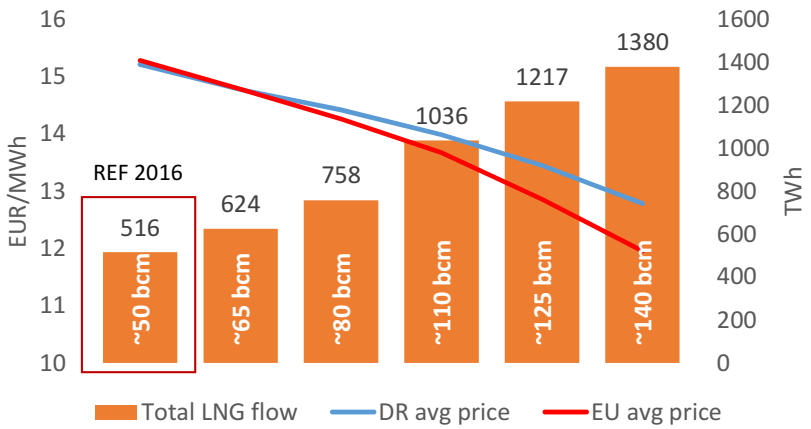
$$P_{LNG}^{AUS \to EU} = P_{SPOT}^{ASIA} - C_{SHIPM}^{AUS \to ASIA} + C_{SHIPM}^{AUS \to EU}$$

Examples of model usage

REKK Regional Centre for Energy Policy Research

1. Effects of increased LNG supply to European prices (study)
2. Nord Stream expansion and infrastructure investment in Europe (study)
3. New infrastructure project evaluation (CBA) (study)

1. Increased LNG flows to Europe split the Western and Eastern market due to bottlenecks

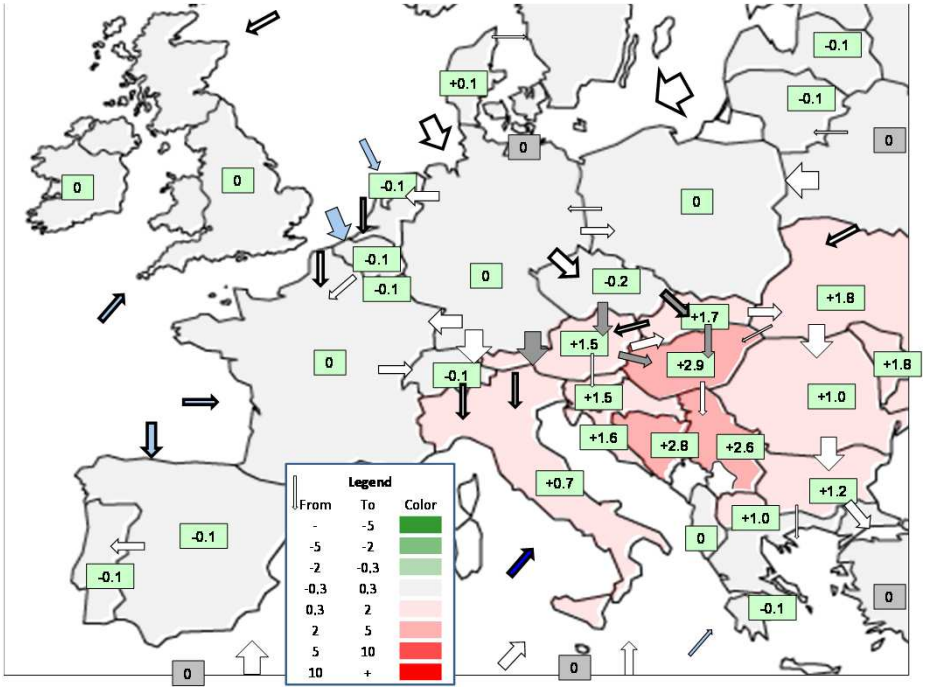


LNG flows (bcm/year)	Price change (%) ~50 bcm	~65 bcm	~80 bcm	~110 bcm	~125 bcm	~140 bcm
AT	0%	-5%	-8%	-12%	-15%	-20%
BA	0%	0%	0%	-1%	-4%	-5%
BG	0%	0%	0%	0%	0%	0%
CZ	0%	-3%	-6%	-8%	-13%	-18%
DE	0%	-4%	-7%	-11%	-15%	-21%
HR	0%	-3%	-6%	-9%	-13%	-15%
HU	0%	-2%	-3%	-5%	-8%	-11%
MD	0%	-1%	-1%	-3%	-5%	-8%
RO	0%	0%	0%	-1%	-1%	-1%
RS	0%	-1%	-2%	-4%	-7%	-9%
SI	0%	-4%	-8%	-12%	-16%	-19%
SK	0%	-2%	-4%	-7%	-11%	-15%
UA	0%	-1%	-2%	-4%	-6%	-9%
DR	0%	-3%	-5%	-8%	-12%	-16%
EU	0%	-3%	-7%	-11%	-16%	-22%

- We modelled the price effects of increased LNG flows in our 2016 reference
- Due to infrastructural constraints (no LNG terminal and high tariffs on interconnectors) in the region, DR countries benefit less than the EU as a whole
- DR countries may not receive actual LNG „molecule”, but other spot gas crowded out in Western Europe by cheaper LNG sources
- Average EU wholesale gas price might decrease below 12 €/MWh at LNG flows of 140 bcm/year; DR prices are 7% higher
- Average DR price covers large differences in individual prices
  - Main beneficiaries of larger flows include DE (through NL), AT (through IT and DE) and SI (through AT and IT)

2. Nord Stream 2 project divides Europe

- Scenario assumptions
  - Realisation of Nord Stream 2, doubling current capacity to 110 bcm/year
  - Most long-term Russian contracts assumed to re-routed (RU-AT, RU-BA, RU-CZ, RU-FR, RU-DE, RU-HU, RU-IT, RU-RS, RU-SK, RU-SI)
  - LTCs crossing the Balkans route and Ukraine are kept intact (RU-UA, RU-RO, RU-BG, RU-MK, RU-GR, RU-TR)
  - Delivery point is at the border of each country
  - Price of Russian gas delivered is unchanged for all contracts
- Nord Stream expansion effects
  - General price increase in Danube Region and CSEE
  - Marginal price drop in Western Europe

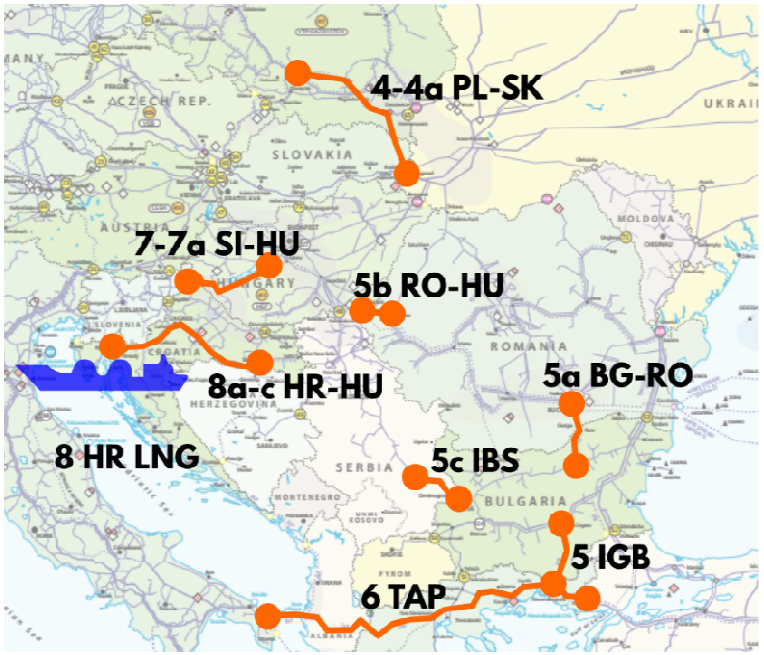


2. What infrastructure is needed to re-connect the European markets?

REKK Regional Centre for Energy Policy Research

LNG terminals of: PL, GR, IT, HR, are connected with PCI projects to DR

	Infrastructure element
4	PL-SK
4a	PL-SK + low PL LNG tariff
5	IGB
5a	IGB+BG-RO
5b	IGB+BG-RO+RO-HU
5c	IGB+IBS
6	TAP +IGB
7	IT LNG + SI-HU
7a	Low IT LNG + SI-HU
8	HR LNG
8c	Low HR LNG + low HR-HU



2. Nord Stream 2 creates additional investment needs

REKK Regional Centre for Energy Policy Research

- Total welfare change to reference was considered the benefit of the project
- Investment was made in t-1
- Benefits were awarded for a 25 year lifetime
- Projects with positive social NPV in base case (without Nord Stream):
  - IGB
  - IGB with TAP
  - HR LNG
- Nord Stream causes general price hike in the region, thus any new infrastructure has stronger welfare effect
- Additional investment need ~1000 Mn EUR with NS expansion

	Social NPV, M€	
	Without NS	With NS
PL-SK	-521	-456
PL-SK low	-702	-514
IGB	261	1145
IGB+BG-RO	-262	495
IGB+BG-RO+RO-HU	-680	77
IGB+IBS	-46	1296
IGB (with TAP)	236	1677
IT LNG +SIHU	-128	-74
low IT LNG +SIHU	-303	-74
HR LNG	373	857
Low HR LNG+low HR-HU	717	1625

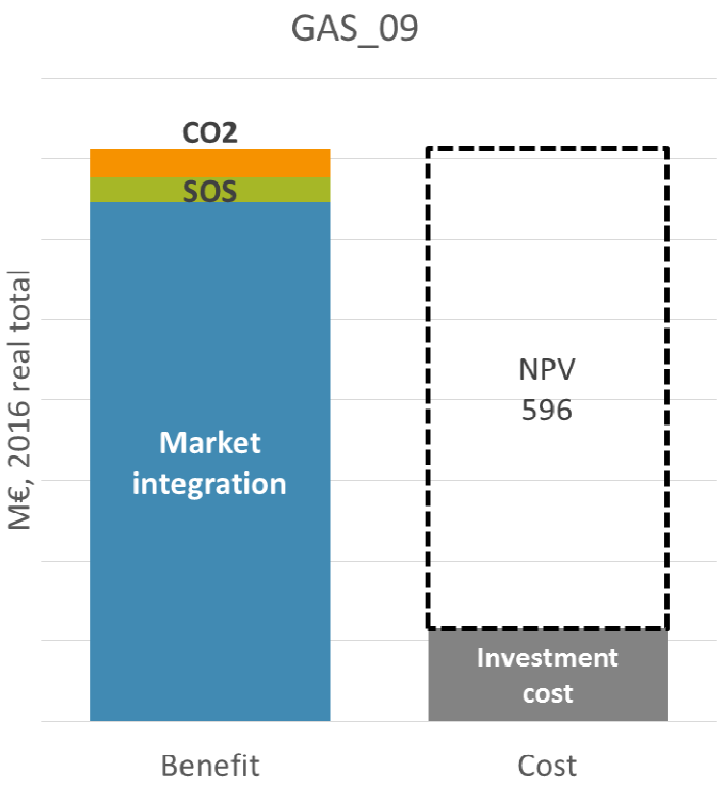
3. Sample project evaluation (CBA, social NPV)

	Welfare change, M€					CO_2, M€	Inv. cost, M€	NPV, M€
	Cons.	Prod.	Trad.	Infra	Total			
AL	1	0	0	0	1	0	XXX	1
BA	18	0	-8	11	20	1	XXX	21
BG	68	-2	-72	364	358	1	XXX	313
GR	-9	0	5	432	428	0	XXX	428
HR	-4	1	-1	-45	-48	0	XXX	-48
HU	218	-11	-143	-359	-294	4	XXX	-290
IT	263	-24	-189	-3	47	4	XXX	51
KO*	0	0	0	0	0	0	XXX	0
ME	0	0	0	0	0	0	XXX	0
MK	7	0	-4	1	4	0	XXX	5
MD	7	0	0	1	7	0	XXX	7
PL	35	-9	-20	-1	4	1	XXX	5
RO	93	-57	-3	4	36	2	XXX	39
RS	273	-34	-147	102	193	14	XXX	138
SK	33	0	-41	-125	-132	1	XXX	-131
UA	229	-164	-38	24	52	7	XXX	59
Region	1232	-300	-662	407	676	36	XXX	596

Sensitivity for NPV	Best est.	Flat oil	-10% LNG	+10% LNG	-50% in EnC CP	-25% in EnC CP	-20% in Europe	-10% in Europe	+10% in Europe	+20% in Europe	with-out HR LNG
GAS_09											

Utilization: from BG to RS 91%,
from RS to BG:2%

Project code	Country A	Country B	Capacity, GWh/d A→B	Capacity, GWh/d B→A	Date
GAS 09	BG	RS	39	39	2019



REKK Regional Centre for Energy Policy Research

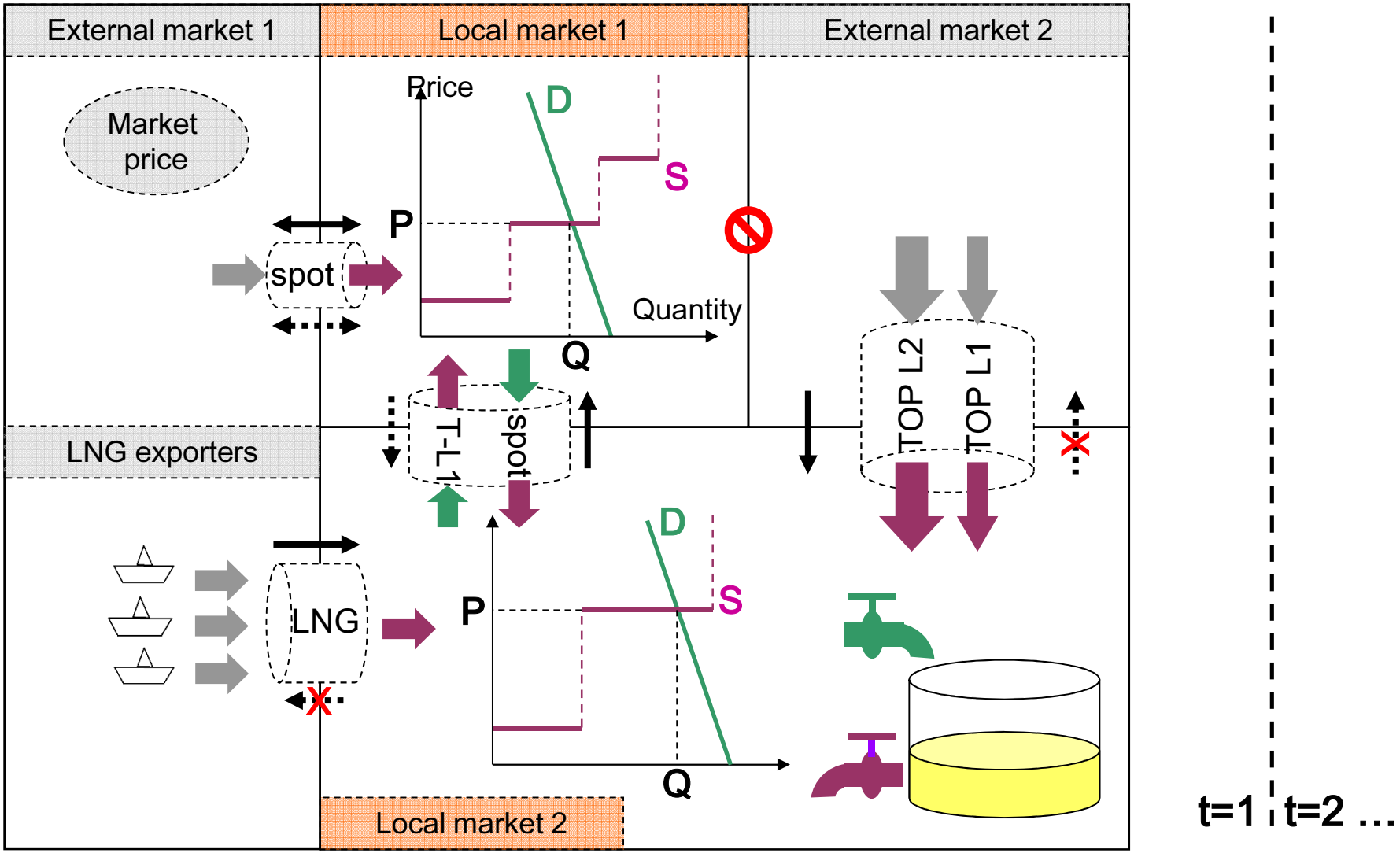
Thank you for your attention

Péter Kotek

peter.kotek@rekk.hu

Senior Research Associate

Model scheme



EGMM references

- Analysis of the CSEE gas storage market; the impact of system use charges on the demand for gas storage capacity (E.ON, 2012) and (Hungarian Min. of Foreign Affairs, 2013)
- CBA of PECI projects for the Energy Community (2013, 2016)
- The impact of gas infrastructure corridors on the regional gas market (MoFA RoBoGo, March 2014), FGSZ South Stream (April 2014)
- Supply Security analyses related to the Ukrainian crisis (2014, Atlantic Council, EFET, IDDRI)
- How can renewables and energy efficiency improve gas security in selected Member States? (2015, Towards2030 – Dialogue project)
- CBA of PCI projects for the Hungarian Energy and Public Utility Regulatory Authority (2014-2015, Hungarian regulator)
- Measures To Increase The Flexibility And Resilience Of The European Natural Gas Market (2014, IEA)
- CESEC gas infrastructure corridor modelling (2015, European Commission)
- LNG receiving capability of Europe at different price scenarios and pricing strategies and infrastructure bottlenecks (2016 Danube region)
- Effect of tariffs on natural gas pipeline utilisation and flows in the CESEC region (2016, European Commission)

CBA and CBCA related references

REKK Regional Centre for Energy Policy Research

- CBA of the PL-SK gas interconnector (Hungarian Regulator)
- CBA analysis of the RO-HU-AT gas corridor (Hungarian Regulator)
- Expert opinion on the Croatian (Krk) LNG CBA (Hungarian Regulator)
- CBA analysis of the HR-SI gas interconnector (Hungarian Regulator 2015)
- SI-HU interconnector (Slovenian TSO Plinovodi 2016)
- Evaluation of PECI infrastructure for Energy Community Secretariat (2016)