The role of natural gas in the European energy transition

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Outline

- Natural gas (NG) in Limbo
- Main drivers and general outlook
- Challenges connected to NG
- Possible roles for NG
- Boundary conditions
- Research topics

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NG in Limbo

Clean or Dirty? Will continued / increased usage of natural gas have a positive or negative impact on GHG emissions?

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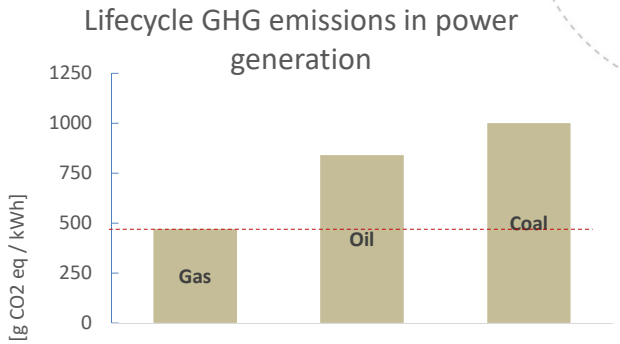
NG is a *clean* fuel / resource



Compared to other fossil-fuel based power generation

Based on median values Table A.II.4 *IPCC 2012 Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) www.ipcc.ch/report/srren/*

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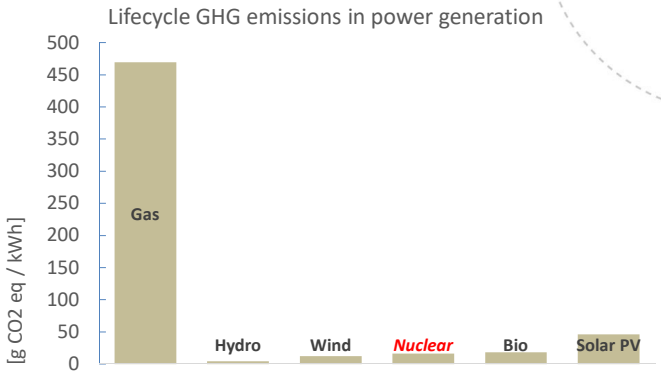
NG is a *dirty* fuel



Compared to RES-based power generation

Based on median values Table A.II.4 *IPCC 2012 Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) www.ipcc.ch/report/srren/*

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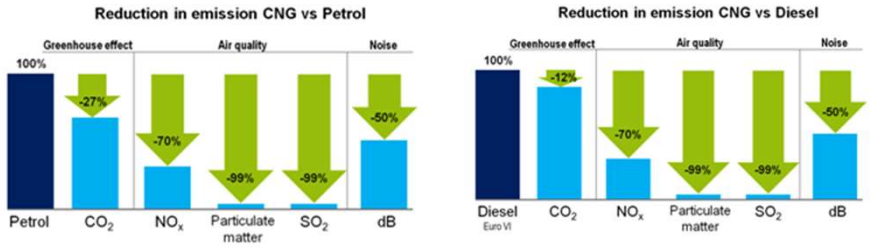
NG is clean



Compared to petrol and diesel in vehicles

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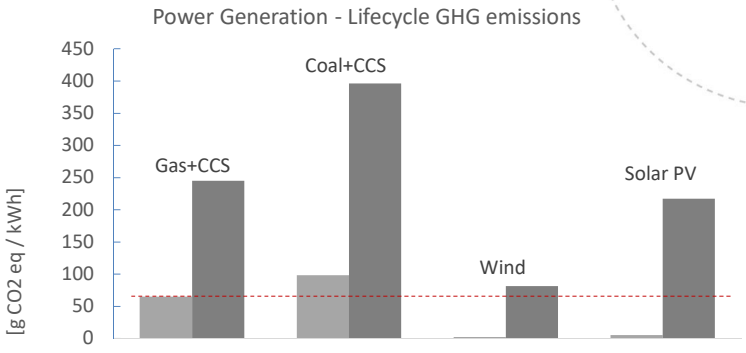
http://www.fluxys.com/belgium/en/About%20natural%20gas/fuelfortransport/CNG/CNG

is dirty

- Replacing all oil and coal used for power generation by NG today would reduce annual CO2 emissions by about 10 Gton only and add only about 3-5 years to use up 2°C carbon budget

Own estimate based on BP and IEA data

clean

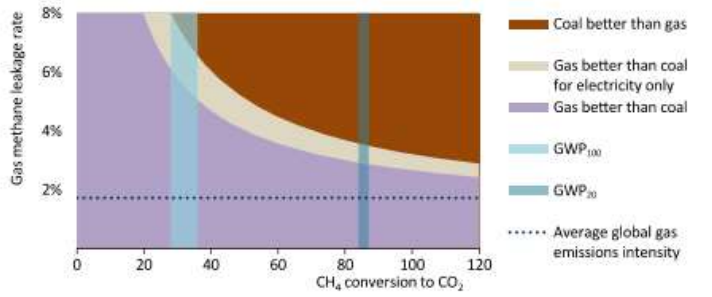


Best-case with CCS compared with badly done RES

Based on median values Table A.II.4 *IPCC 2012 Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) www.ipcc.ch/report/srren/*

clean

Figure 10.9 ▷ Greenhouse-gas emission intensity of natural gas compared with coal



The global average emission intensity of gas is low enough for gas to result in fewer GHG emissions than coal regardless of the timeframe considered

Source: IEA WEO 2017

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dirty

- Shale gas: methane leakage 3.6% - 7.9% (Howart et al. 2011)
- Two-four times NG global average (WEO2017)

- Worse than coal (20-year horizon) and comparable (100 years). (Howart et al. 2011)
  - LCA «standard» 100 year horizon & comparing domestic shale with import LNG *makes shale look less bad*

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So, it depends

- How is it produced and transported?
- What
  - is it used for?
  - does it replace?
  - are the alternatives?
- What happens to the emissions?

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Main drivers and outlook

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Supply-side drivers

- Plenty of supply, e.g.,
  - Middle East conventional resources
  - (US) shale gas
- Increasingly more LNG exporters, and shorter distances
  - Panama Channel + Northern Sea Route cut travel times

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Demand-side drivers

- Growing population & GDP: global energy + 30% (2040 vs 2015)
- Asia:
  - GHG & local air quality: India, China, …
  - Increasingly more gas-to-gas competition, e.g., Japan, South Korea
  - New markets: new distribution and transmission investment needed. (Too?) expensive to bring gas to new end-users. e.g., India
- Industry (most important driver growth!)
  - Feedstock, process heat
  - both growth and coal substitution
- Power (second)
  - Rising share electricity in final energy consumption
  - Rapidly falling costs clean energy technologies
  - Competing solutions for large-scale back-up, flexibility and balancing
  - Carbon / ETS prices
  - Technological Innovation Hydrogen value chain
  - CCS costs and acceptance
- Transport
  - not final solution unless negative emissions elsewhere

IEA, DIW, MIT

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«Not on track for Paris» Outlooks

- Gas consumption + 40-50% to about 5000 bcm by 2040
- Trade grows faster than consumption, LNG even more
- Europe
  - only region where production and consumption decrease.
  - Imports likely to increase
  - Netherlands net importer by 2020..? Much reduced swing from Groningen domestically and neighboring countries (none after 2030).
  - Norway only major producer-exporter; flat production outlook

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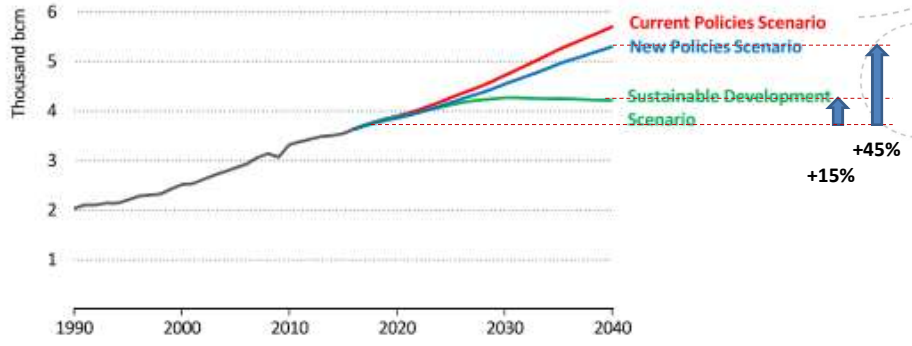
WEO2017 Three Scenarios

Figure 8.2 ▷ World natural gas demand by scenario



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Some analysis

H2020 LCE21 *SET-Nav*

NTNU stochastic power market model
EMPIRE

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Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation

SET-Nav
Strategic Energy Roadmap

The SET-Nav project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 691843 (SET-Nav).

Case Study 7.4: Unlocking flexibility and synergy in electric power and natural gas supply systems

Pedro Crespo del Granado, Christian Skar, Hector Marañon Ledesma (NTNU); Blazhe Gjorgiev, Giovanni Sansavini, Andrea Antenucci (ETH Zurich); Luis Olmos, Quentin Ploussard, Sara Lumbreras, Andres Ramos (Univerisidad Pontificia Comillas)

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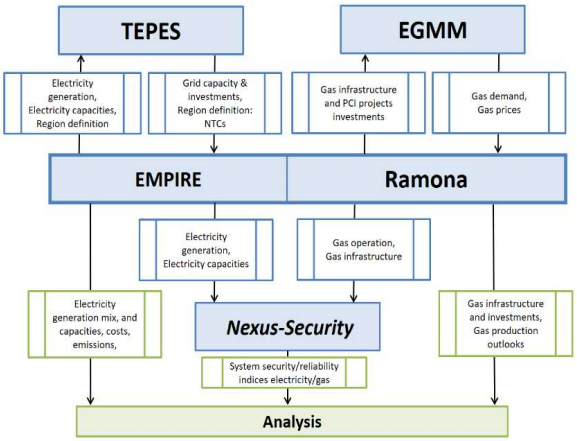
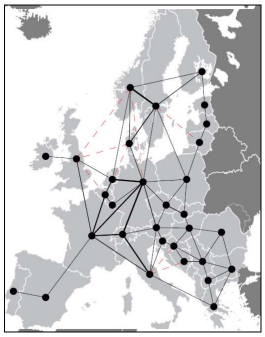
Modelling framework





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Cases

SET-Nav Strategic Energy Roadmap

- All models calibrated to PRIMES decarboniz scenario (E3MLab & IIASA 2016)
- Nuclear restricted [current cap levels; no replacement]
- No CCS
- **Flexi-Grid - Transmission**
  - Transmission expansion allowed (Electricity)
  - EMPIRE: intra-day demand response + curtailment
  - → *Grid expansion & hydro main sources flexibility*
- **Flexi-1 - electricity storage**
  - Transmission is restricted [current levels + 10Y ENTSO-E NW plan]
  - → More electricity storage and gas thermal plants.
- **Flexi-2 - gas infrastructure**
  - Transmission is restricted
  - Electricity storage expensive
  - Demand response (current levels)
  - → Gas thermal plants main flexibility provider.

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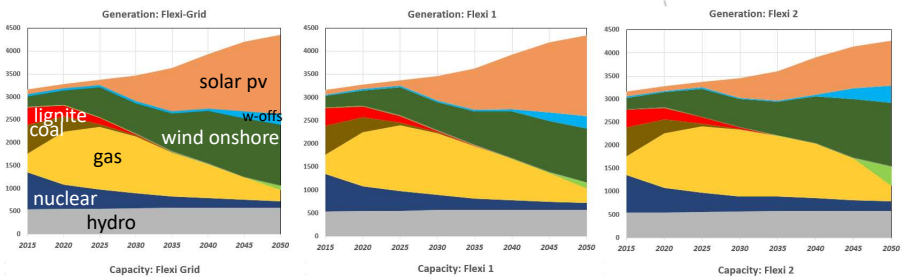
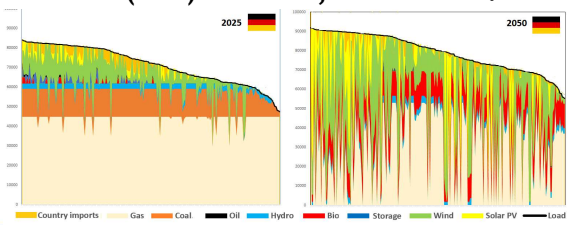
E3MLab and IIASA (2016). Technical report on Member State results of the EUCO policy scenarios. EUCO 27 scenario. Energy Modelling, European Commission. https://ec.europa.eu/energy/en/data-analysis/energy-modelling

EU power generation mix



Gas primarily base-load in 2025; in 2050 balancing.
Utilization 64 (+/-1)% in 2025; 15% in 2050.



Challenges

Climate, societial, … -
Broader than the energy system

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http://www.un.org/sustainabledevelopment/sustainable-development-goals/

The Paris Agreement

- Keep global temperature increase below 2°C above pre-industrial level; aim limit to 1.5°C
- Nationally determined contributions

https://unfccc.int/process/the-paris-agreement/the-paris-agreement

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Energy system specific challenges

- Decarbonizing and decentralization in two-three decades
  - need large volumes and capacities for backup, balancing and flexibility on various time scales
- Today electricity storage other than hydro reservoirs too expensive
  - Biomass.. (EMPIRE 2050). Availability? C-neutral w/o CCS?
- Hydrogen
  - Value chain still immature
  - Public acceptance and perceived safety
  - Chicken & Egg problem
  - low energy content hampers competitiveness long-distance transport
- CCS
  - Value chain still immature
  - Public acceptance and perceived safety
  - Chicken & Egg problem
  - Norway only European country with activity
  - CCS on quickly ramping gas-power technically possible. But CCS capital intensive; many operational hours – bad match with NG peak shaver.

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Other sectors - challenges

- Industry:
  - Feedstock
    - NG for some processes preferred input. Hard to replace (by something cleaner).
  - Process heat
    - Heat pumps and electric furnaces need powered
  - Inevitable emissions
    - E.g., cement. Negative emissions elsewhere or CCS. CCS cheaper. (starting at 50-75 €/ton)
- Transport – niches?
  - Road, ferries, short-sea shipping, inland navigation
  - Chicken and egg

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NG roles

Does NG have a role in low-carbon decentralized energy systems?

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NG roles Europe – back of the envelope

Horizon Application	2030	2050
Base-load power	Yes	Unlikely
Flexi power	Yes	Probably
IND - Feed stock	Yes	Probably
IND - Process heat	Yes	Probably
Building heating	Yes	Maybe
Transport	Niches	Maybe
Hydrogen feedstock	Yes	Probably

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Boundary conditions

What is needed to facilitate roles in the energy system?

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Boundary conditions for NG role

Application	Horizon: 2050
Base-load power	▪ CCS ▪ Negative emissions elsewhere; eg, BECCS
Flexi power	▪ No electricity storage break-throughs ▪ Remuneration of flexibility value ▪ CCS (?)
Building heating	▪ Negative emissions elsewhere (Electrification more likely)
Transport	▪ Negative emissions elsewhere
CH4+CCS=H2	▪ acceptance ▪ a market and infrastructure ▪ CCS

+ level-playing field for technologies considering all external effects including timely and reliable policy environment

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Research topics

- future energy system will rely on much broader range of energy supply and transportation technologies
- will allow and need more tailored solutions
- planning and management much more complex.
- Deterministic annual / seasonal average loads will become meaningless metrics.
- Gas market / system research will have to explicitly account for much lower time-scales and connect / link to other parts of the energy system
  - Sector linkage, carrier substitution, time-scales
  - Gas system supporting energy transition

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Millenials in gas research

- and others who'd like to stay active and relevant after 2030
- make sure to learn enough about the broader energy systems and policies to stay relevant as (gas market) researchers

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Role for NG in European energy

- Do we still need gas after 2040? No (!)
- Should we consider NG as part of the future energy mix? Yes
- Not considering NG (and CCS) in the transition or as constituents of a low-carbon future energy system may be very expensive.
- Keep all options open and aim at a level-playing field with fair incentives pricing in all external effects ranging from climate and health impact to flexibility and security of supply

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A special thanks to presenters and participants in the NTNU Energy Transition workshop

The role of natural gas

– Monday February 26th, 2018

Download presentations

- Aad Correljé - The changeing role of the Netherlands in European gas supply
- Asgeir Tomasgard - The role of natural gas in the future energy system - possibilities and challenges
- Christian von Hirschhausen - Research Outlook
- Franziska Holz - The role of natural gasin the Energiwende
- Jae Edmonds - The role of natural gas in climate mitigation
- Johannes Trüby - Global natural gas markets
- Katrina Groth - Presentation
- Kjetil Midthun - Flexibility from natural gas pipelines
- Lars Nord - Technological capabilities for power plants with CCS
- Mona Mølnvik - The value chain perspective
- Olivier Massol - The economics of shared CCS innfrastructure
- Reinhard Madlener - Homeowner satisfaction with low-carbon heating technologies
- Reinhard Madlener - Impacts of an ice-free northeast passage
- Robert Ritz - The role of natural gas policy & regulation
- Sergey Paltsev - The global role of natural gas in a climate strategy perspecitve
- Steven Gabriel - Shale gas and LNG - effects on global markets

AND NTNU POSTDOC
DR. PEDRO CRESPO DEL GRANADO

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THANK YOU

- R. Egging, A. Tomasgard, 2018. *Norway's role in the European Energy Transition*, Energy Strategy Reviews 20
- F. Holz, P.M. Richter, R. Egging, 2016. *The Role of Natural Gas in a Low-Carbon Europe: Infrastructure and Supply Security*, Energy Journal 37-SI3

https://www.censes.no

https://www.ntnu.edu/energytransition

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