

OVERVIEW ENERGY GAS SPECIFICATIONS

RENEWABLE ENERGY & SECURITY OF SUPPLY

IEA Bioenergy Task 33 Gasification of Biomass and Waste

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Professional background: From project development, to project finance and project assessment in renewable energy:

- *Project development: After having finished his studies in 'Forestry, natural resources & risk management' at the Swiss Federal Institute for Technology in 1996 Oliver worked for SDC in Russia to support a large scale IFC project in forestry & timber industries on-site. In the year 2000 he founded the private consultancy c4c ltd. that focused on large Swiss-based multinationals like Nestlé, Rieter, Eaton Corp., Krono Holding, etc. to improve their worldwide investment portfolio regarding carbon economy aspects.*
- *Project finance: After having sold its shares of c4c ltd. in 2005 to the German shipping company Ahrenkiel he launched the private equity company 'Swiss Climate Invest' in cooperation with Swiss Invest Group and Mr. Joseph Deiss (advisory board). During that time he gained additional further education in finance and on-the job training for international private equity transactions.*
- *Project assessment: In 2009 Oliver became Head Climate Services & Sustainability SQS; the Swiss market leader in certification services. The new SQS branch Climate Services did grow rapidly and conducted more than 150 assessment services on infrastructure projects for clients like The World Bank, UNDP, CAF, large scale multinationals and financial institution's in 44 countries worldwide.*



OVERVIEW ENERGY GAS SPECIFICATIONS

in the context of

Renewable Energy & Security of Supply

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Energy Gas Specifications

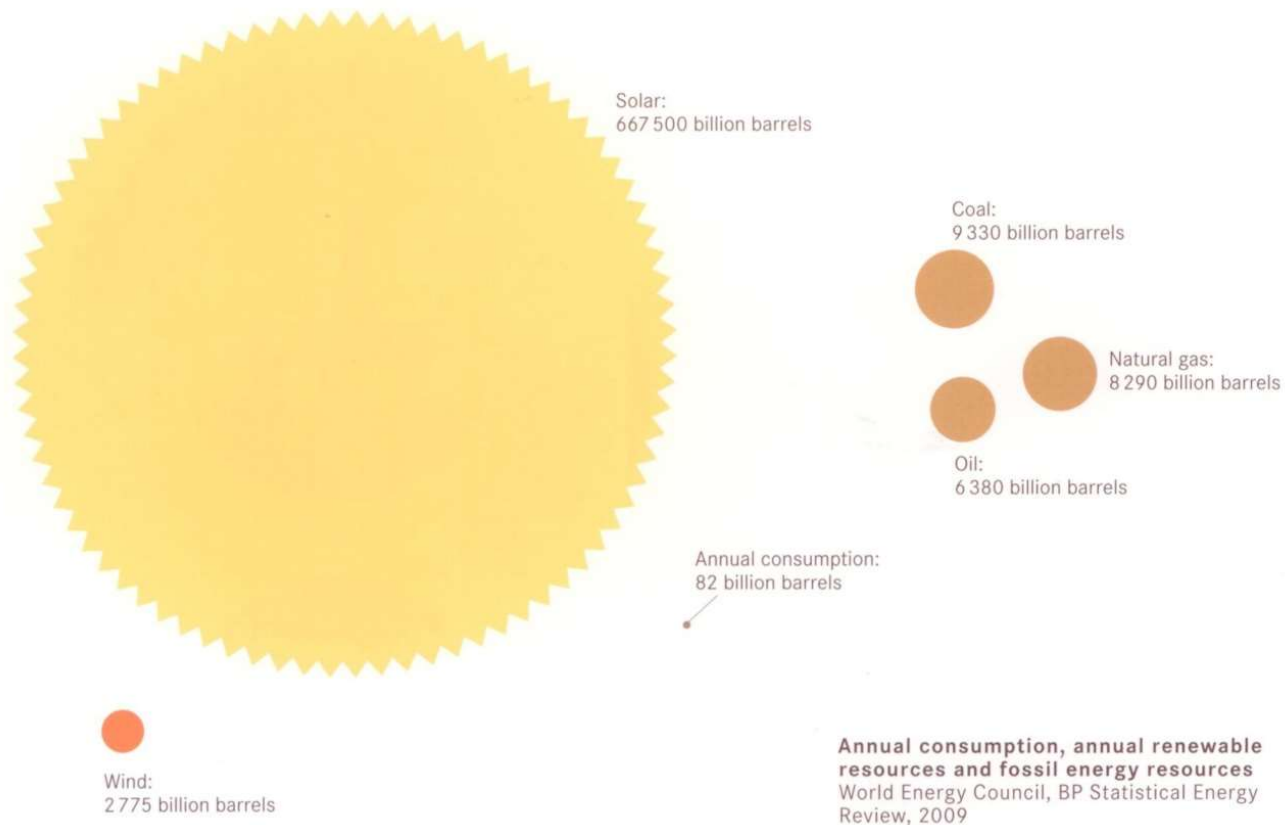
Starting point:

*The overall purpose of **product specifications** is to provide a true & fair presentation of its **'Inner Quality'**.*

*The **'Insetting'** of **technical aspects and sustainable benefits** along the **whole value chain** is the key driver for a premium energy gas product and should be reflected by its specifications as a true & fair presentation.*



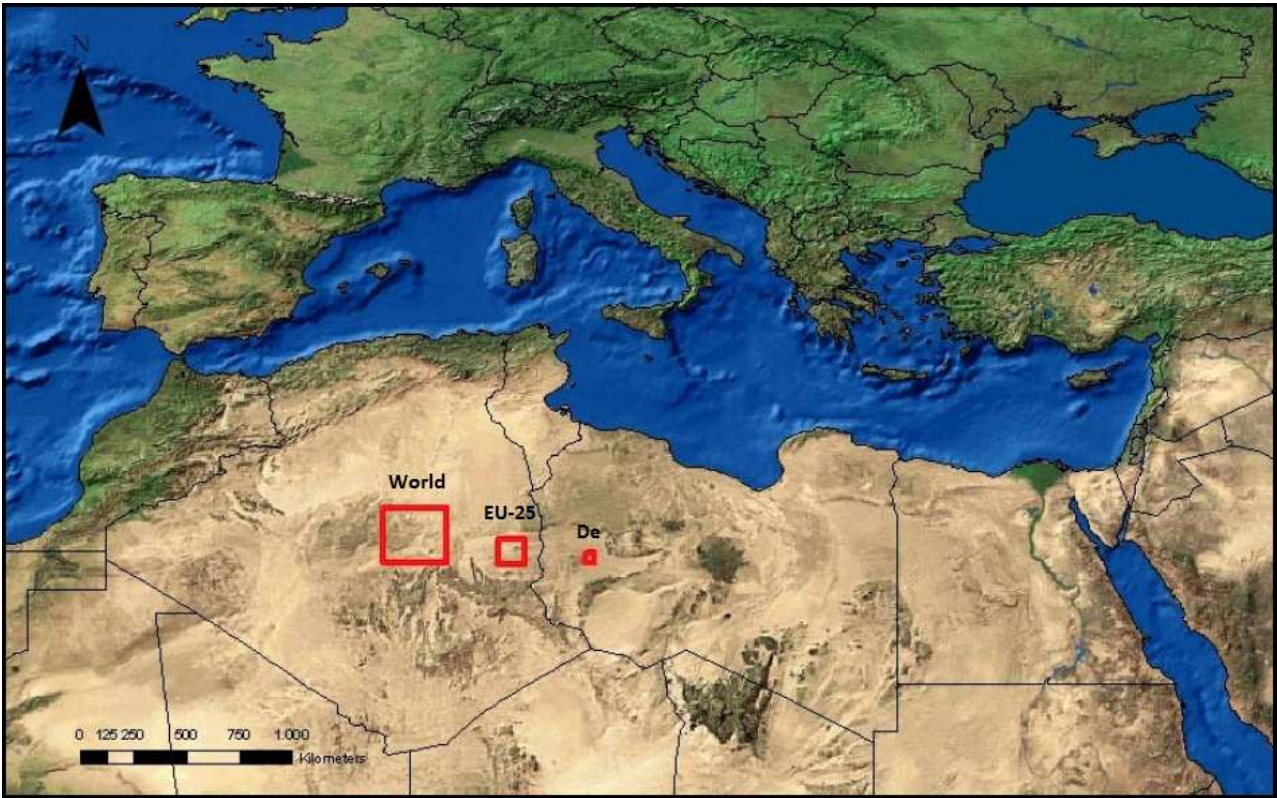
Renewable Energy & Security of Supply



World's total annual energy consumption, annual renewable resources and fossil energy resources

Graph: Julius Bär, 2011

Renewable Energy & Security of Supply



Renewable Energy & Security of Supply

In contrast to other global challenges like biodiversity, water, soil, etc. energy itself is available in general.

To ensure a secure, reliable and sustainable energy supply we have to consider:

- Strategy: On what kind of resources do we have to focus?*
- Technology: What are the best available technologies to harvest?*
- Partnership: Who are the most reliable partners at the long-run?*

Renewable Energy & Security of Supply

- The Global Grid (ETHZ 2013)
 - Smoothing out supply and demand
 - Minimizing power reserves
 - Reducing the storage problem
 - Lower volatility of electricity price
 - Enhancing power system security
 - Additional benefits ('Green Economy')



Conclusion:

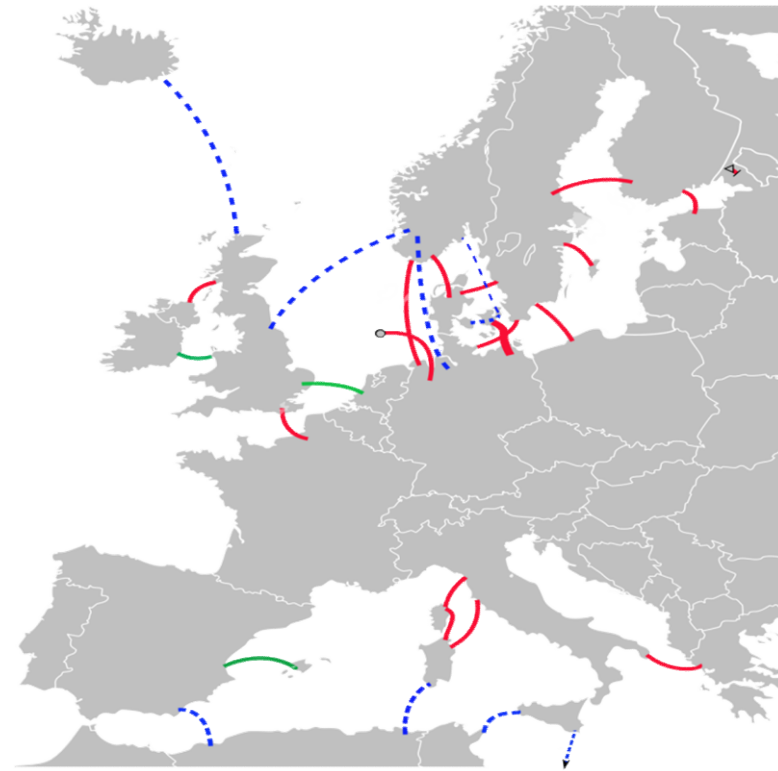
There is a fundamental need for international cooperation to reduce fossil fuel consumption and to phase-out nuclear power.

Renewable Energy & Security of Supply

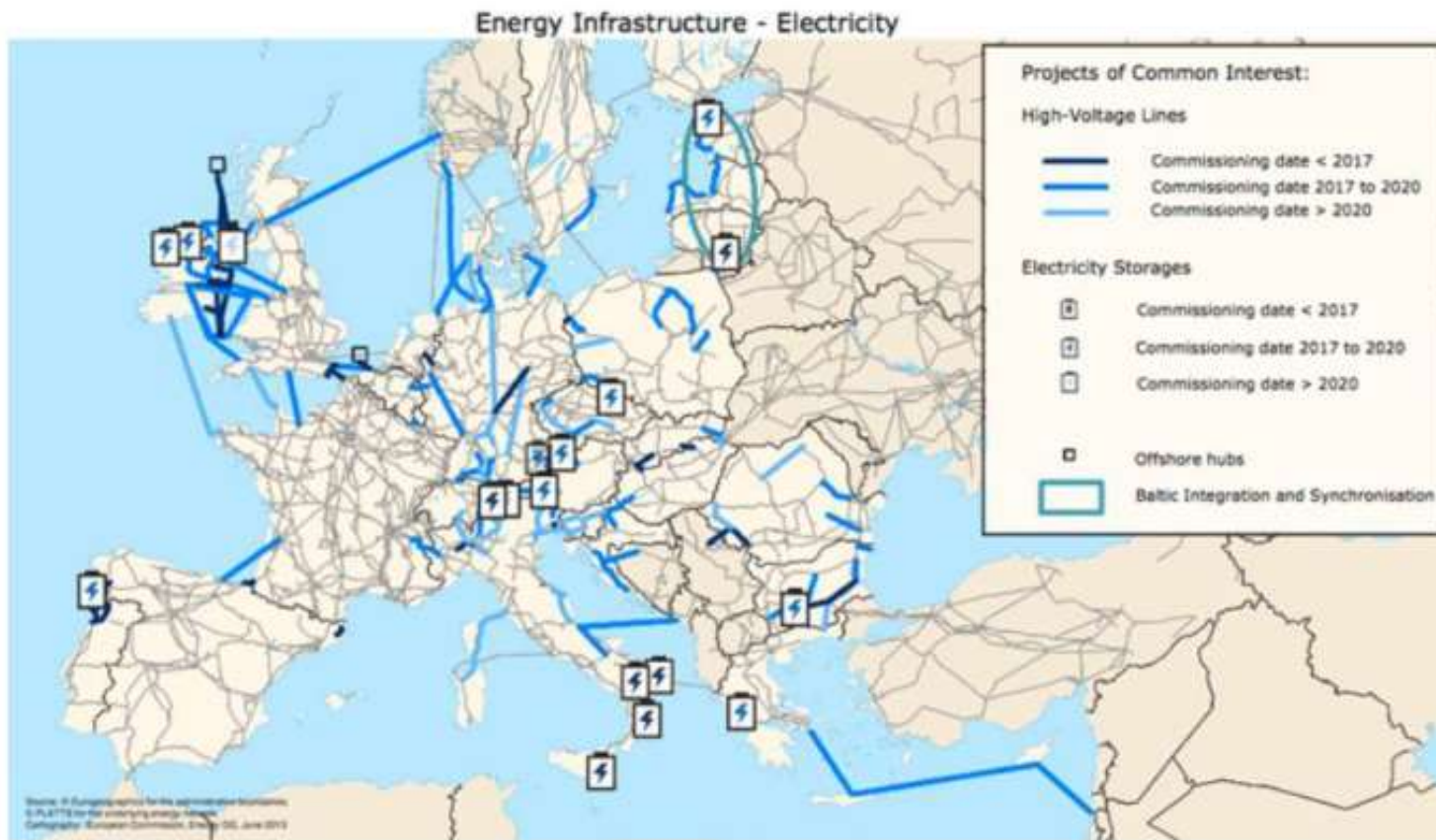
- East – West
 - Nord Stream, TAP
 - others
- West – East
 - Nuclear power supply
- South – North
 - Desertec, others
- North – South
 - Iceland, Norway – Europe

HVDC:
(s: wikipedia)

Red: Existing
Green: Under construction
Blue: Under development



Renewable Energy & Security of Supply



Global Electric Energy Grid "The World Game's highest priority objective."

Linking the renewable energy resources around the world reduces global pollution, population growth, world hunger, and increases living standards, international trade, cooperation and world peace.

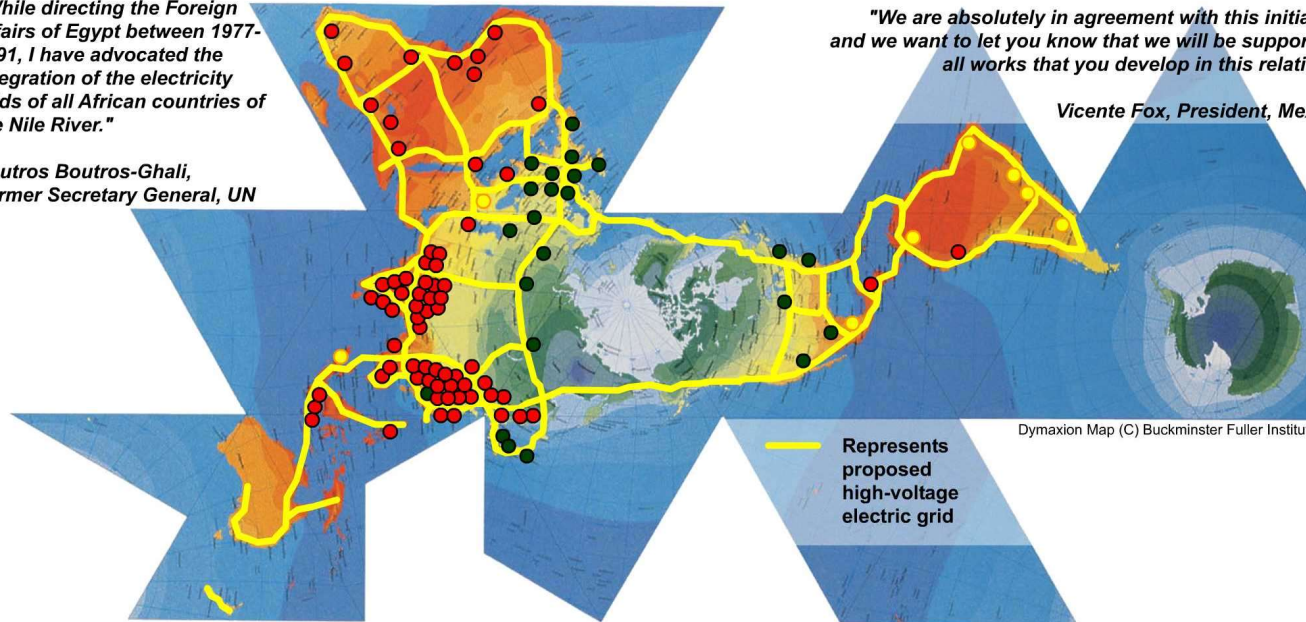
Dr. R. Buckminster Fuller

"While directing the Foreign Affairs of Egypt between 1977-1991, I have advocated the integration of the electricity grids of all African countries of the Nile River."

*Boutros Boutros-Ghali,
Former Secretary General, UN*

"We are absolutely in agreement with this initiative and we want to let you know that we will be supporting all works that you develop in this relation."

Vicente Fox, President, Mexico



Each dot represents 1% of humanity (60+ million people) and the color represents the following energy statistics:

- Less than 1000 kWh/capita -- Regions in Emergency
- 1000 - 2000 kWh/capita -- Regions in Transition
- Over 2000 kWh/capita -- Developed Regions

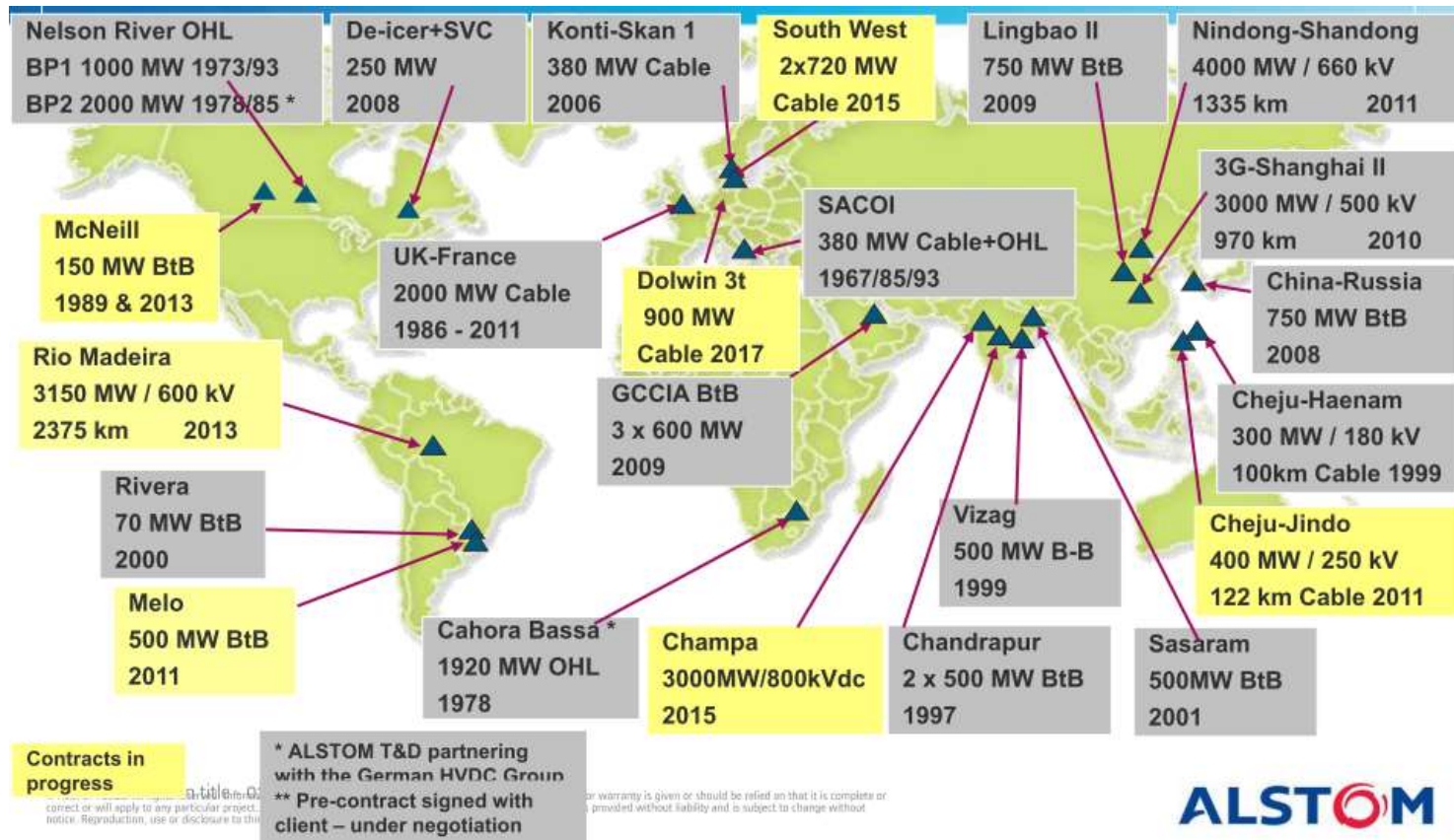
"We need more comprehensive thinking and long-range global planning. I invite you to investigate the GENI Initiative as I have. It offers hope for all humanity."

Walter Cronkite, News Anchorman

GENI

Global Energy Network Institute - World Trade Center - 1250 6th Avenue, Suite 901 - San Diego, CA 92101
www.geni.org - info@geni.org - 619-595-0139 - Fax: 619-595-0403 a 501 (c)(3) not-for-profit educational organization

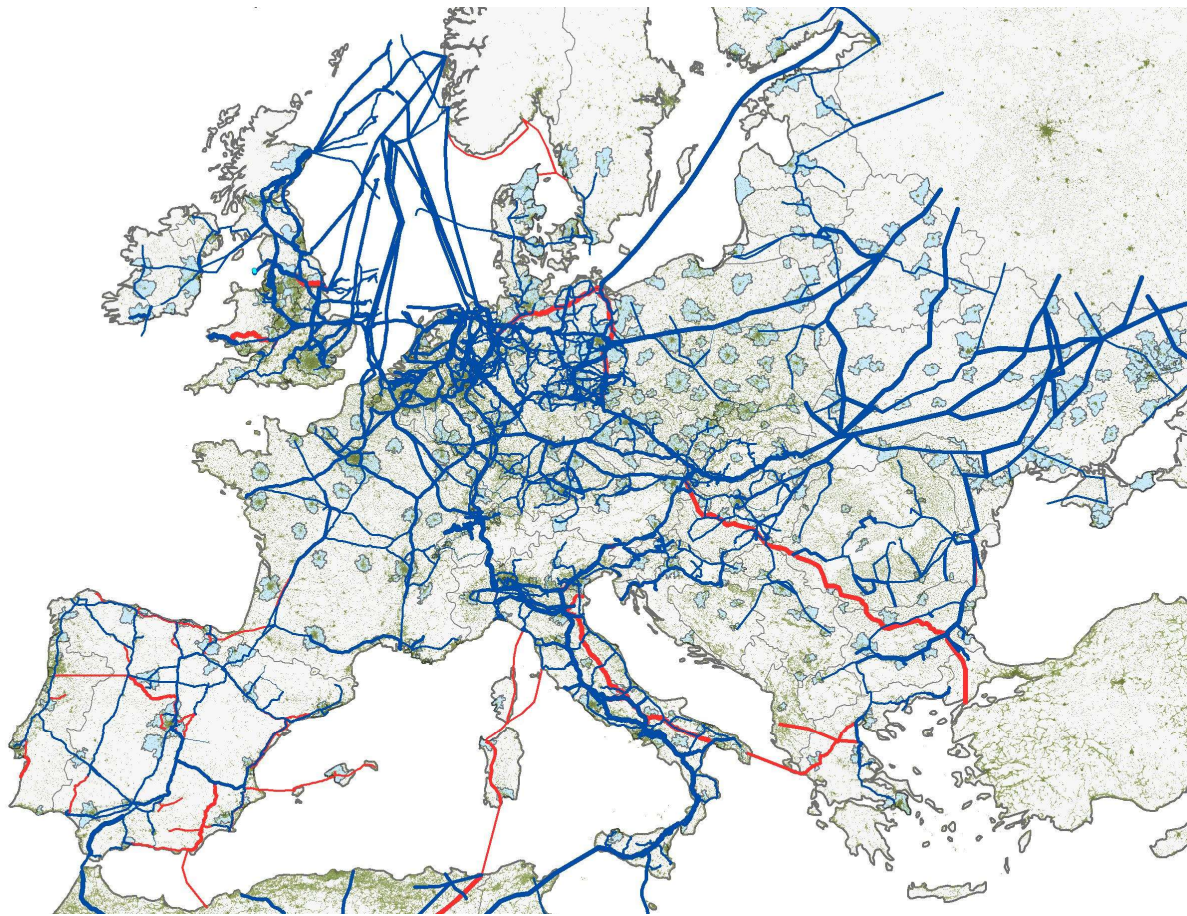
Renewable Energy & Security of Supply



The Global Grid is not a vision. It's under construction.



Renewable Energy & Security of Supply



The European natural gas network is built already.

Source: ETHZ, 2016

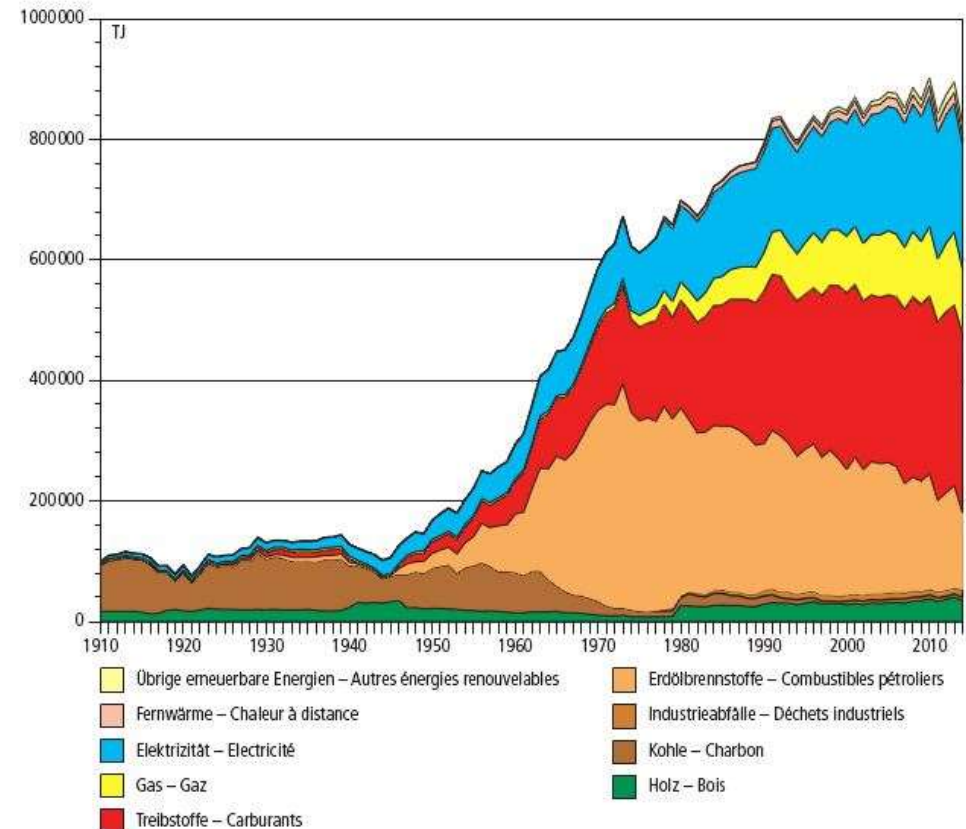
Swiss Gas Market

PRIMARY ENERGY MARKET

- In 2014, the total primary energy supply (TPES) in Switzerland was **26,7 million tons of oil equivalent (Mtoe)**, reflecting an increase of 0.5% per year over the last decade.
- **Fossil fuels account for 52%** (13,9 Mtoe) of TPES. Switzerland has a significant share of oil in TPES at 40%, but low shares of natural gas (12%) and coal (< 1%). Nuclear also makes a large contribution to the energy mix with 25%. Renewable energy sources account for 23% (6,2 Mtoe), mainly hydro (12%) and biofuels/waste (9%). Other RES, such as solar and wind, have much smaller shares.
- Most of the **growth in energy supply is from increases in natural gas, biomass and waste, and geothermal** (heat pumps). The country's self sufficiency, as the share of domestic energy production in TPES, is around 48%.

Source: IEA, BFE

Endenergieverbrauch 1910–2014 nach Energieträgern
Consommation finale 1910–2014 selon les agents énergétiques



Quelle: BFE, Schweizerische Gesamtenergiestatistik 2014 (Fig. 1)
Source: OFEN, Statistique globale suisse de l'énergie 2014 (Fig. 1)

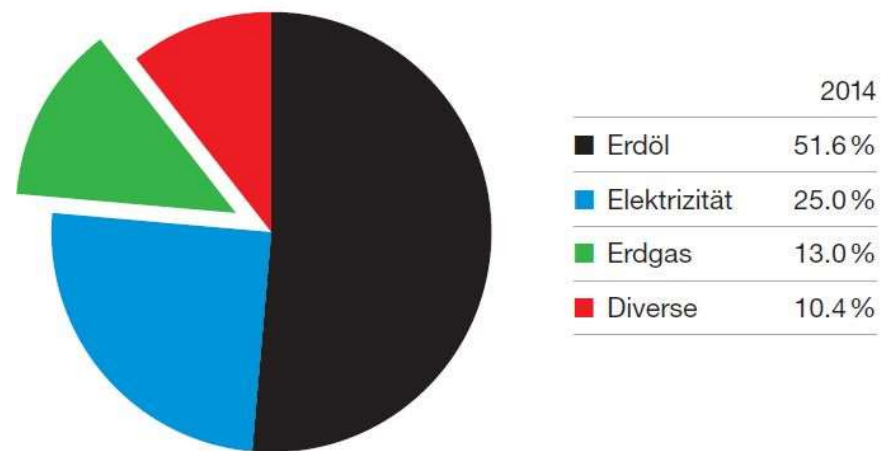
Swiss Gas Market

PRIMARY ENERGY MARKET (2)

- In 2014 the total final energy consumption was 825'770 TJ. The **residential sector** is the largest consumer, accounting for 31% (6.5 Mtoe). **Transport consumed 29%, industry 21%** and the commercial sector 19%.
- Natural gas and renewable energy have increased** their share in residential energy consumption. Oil accounts for 95% of transport energy, electricity 4.5%, natural gas 0.3% and biofuels 0.1%.

Endenergieverbrauch 1980–2014

TJ	1980	2013	2014	Veränd. 2013/14
■ Erdöl	489'480	468'230	425'810	-9.1 %
■ Elektrizität	126'910	213'560	206'880	-3.1 %
■ Erdgas ²⁾	30'370	120'750	107'100	-11.3 %
■ Diverse ³⁾	51'530	92'350	85'980	-6.9 %
Total	698'290	894'890	825'770	-7.7 %
Erdgas inkl. Verbrauch zur Produktion von Elektrizität und Fernwärme:				
	35'210	129'080	112'070	-13.2 %



Swiss Gas Market

GAS MARKET STRUCTURE - GAS UTILITIES

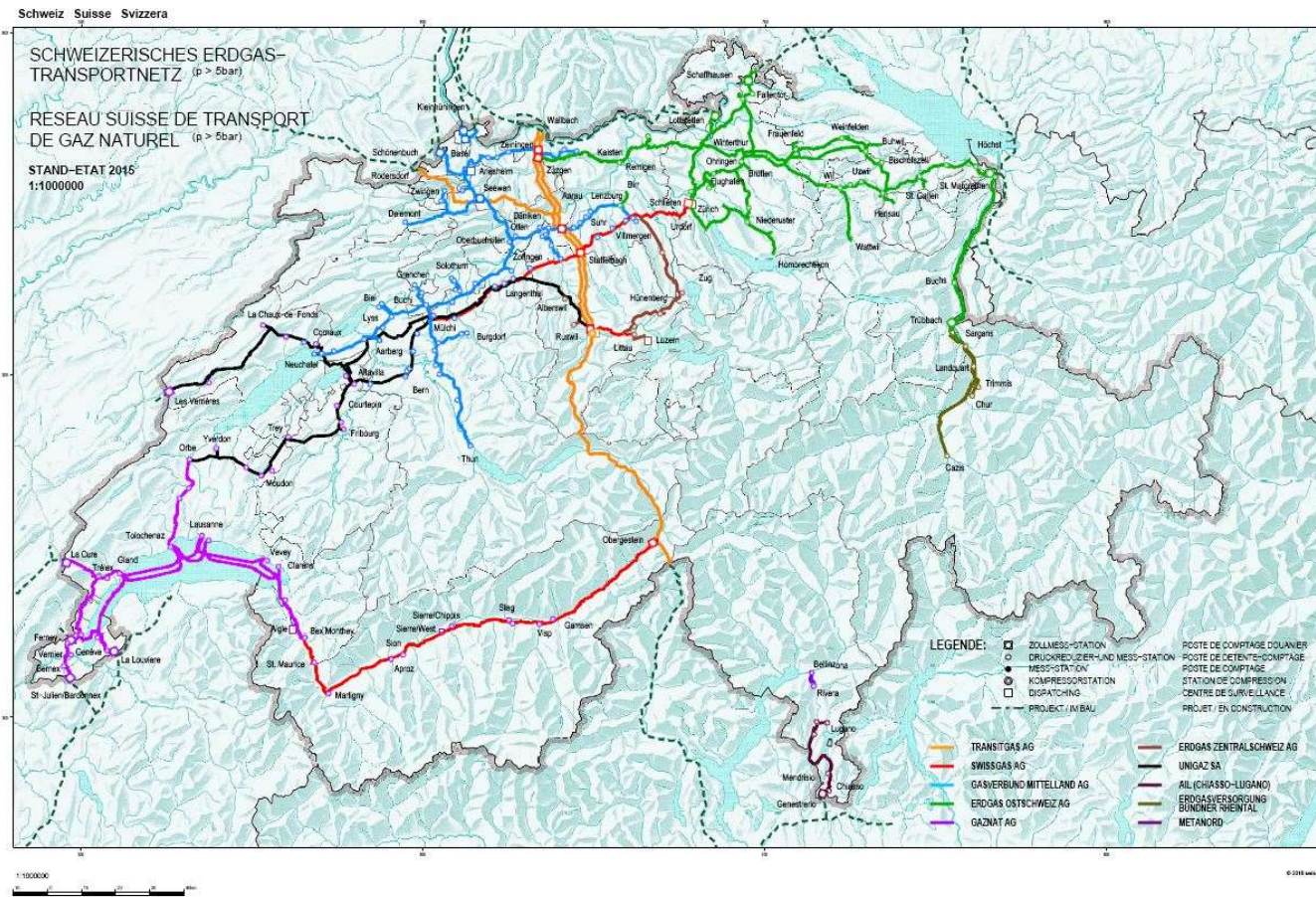
- **Switzerland has around 85 gas utilities**, most of them are local monopolies owned by the Cantons and Municipalities. They are also often involved in other activities, such as supplying electricity, heat or water. In 2014, the 9 biggest utilities, owned by the largest cities, sold half of the gas, whereas the 42 smallest utilities accounted for only 10% of total sales.
- **Vertical integration in gas transmission and distribution is strong.** For the gas procurement, the local monopolies have set up 4 regional companies:
 - Gasverbund Mittelland AG
 - Erdgas Ostschweiz AG
 - Gaznat SA
 - Erdgas Zentralschweiz AG
- Each **regional company operates its own HP-grid** and procures most of the gas through Swissgas AG, the gas industry's vehicle for imports. The regional companies also have direct import contracts with foreign suppliers.
- ALL in Lugano is taking care of the gas distribution in Southern Ticino but is not directly connected with Swissgas.

Source: Swissgas, BFE, Erdgas

Facts and Figures related to the Swiss Gas Sector (2014)	
Number of municipalities in Switzerland	2'324
Number of gas supplied municipalities	961
Population in gas supplied municipalities	6'150'000
Number of residential buildings	1'696'000
Number of gas heaters in residential buildings	270'000
Gas consumption of residential buildings (in TWh)	11,8
Number of gas fueling stations	135
Number of biogas plants (feeding into gas network)	23
Biogas fed into gas network (in GWh)	213
Length of Swiss gas network (in km)	19'500
Value of gas infrastructure (in CHF)	13-20 Bn
Investments of the gas sector (in CHF)	323 Mn
Gas consumption (in TWh)	30
Swiss share of EU total consumption	0,7%

Swiss Gas Market

GAS INFRASTRUCTURE - TRANSPORT NETWORK



Source: BFE

Swiss Gas Market

GAS INFRASTRUCTURE - TRANSITGAS

- Although Switzerland has 12 cross-border interconnections with the European gas pipeline network, some **70% of Switzerland's gas imports** (around 2,6 bcm/y) come through the double entry point of the **Transitgas pipeline**.
- The total length of this pipeline is 293 km in Switzerland, from Wallbach (51.5 mcm/d) on the German border and Oltingue (19.5 mcm/d) on the French border to Griespass (55.9 mcm/d) on the Italian border.
- The pipeline is operated by Transitgas AG, which is owned by Swissgas (51% of shares), Fluxys (46%) and E.ON Ruhrgas (3%).



Source: Swissgas, IEA

Swiss Gas Market

GAS MARKET OVERVIEW - SUPPLY

- In 2014, **natural gas accounted for 12% of Switzerland's total primary energy supply** and for 2% of electricity generation (Cogen). Natural gas has been the fastest growing energy source, which has increased by 24% since 2000.
- **Switzerland has no relevant domestic gas reserves and relies entirely on imports**, most of which are secured in the form of long-term supply agreements with EU partners (DE, NL, FR and IT). The gas imports in 2014 amounted to 3,0 Mtoe (3.7 bcm). Approx. 95% of the gas consumed in Switzerland is produced in the Netherlands (27%), Russia (24%), Norway (23%), Germany (13%) and Algeria (8%).

Gas Supply and Demand in Switzerland (GWh)						
	Domestic Production	Imports	Biogas feed-in Grid	Electricity & Heat Prod.	Self-Consump. & Grid Losses	Final Consumption
2012	0	34'034	89	2'247	119	31'757
2013	0	35'841	128	2'314	112	33'543
2014	0	31'047	192	1'381	107	23'751
2015	-	-	-	-	-	-

Swiss Gas Market

GAS MARKET OVERVIEW - DEMAND

- In Switzerland, the gas consumption rose in the past decade by around 1.5% p.a. Households represent the largest consumer group with a share of around 40%, followed by the industrial sector with around 33% and the commercial sector with 24%. Power generation (in decentralized, industrial CHP units) accounts for 8% of gas demand.
- In 2014, **end-customer expenses** for the procurement of natural gas amounted to **2,54 billion CHF**.

	Final Consumption (GWh)		Final Consumption (TJ)		Change in %	Share of Total Consumption in %	
	2013	2014	2013	2014	2013-14	2013	2014
Natural Gas	33'543	29'751	120'750	107'100	-11,3	13,5	13,0
Biogas	486	492	1'750	1'770	1,1	0,20	0,21

Source: IEA, BFE

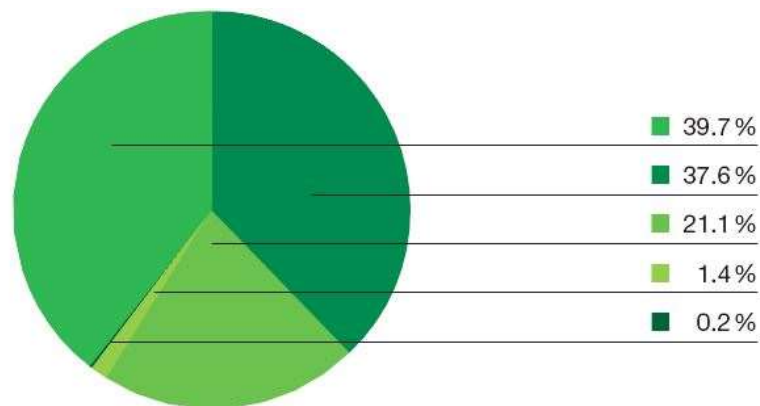
Natural Gas Balance 2014 (in TJ)	
Production	0
+ Import	111'770
= Gross Consumption	111'770
+ Energy Transformation	
• Cogen Power Plants & District Heating etc.	-4'970
• Renewables (Biogas)	690
+ Self-consumption of energy sector, grid losses, storage	-390
= Final Consumption	107'100
• Households	39,7%
• Industry	37,6%
• Services	21,1%
• Transport	1,4%
• Agriculture	0,2%

Swiss Gas Market

GAS MARKET OVERVIEW (4) - CONSUMER STRUCTURE

- Since natural gas is used in Switzerland mainly for heating, **the demand between summer and winter varies substantially**. However, this depends strongly on the consumer structure. In areas where a large proportion of recipients are industrial enterprises, which utilize gas for the production of process heat, the seasonal differences are smaller.

□ .



2014	TJ
Haushalte	42'520
Industrie	40'210
Dienstleistungen	22'630
Verkehr	1'500
Übrige	240
Total	107'100

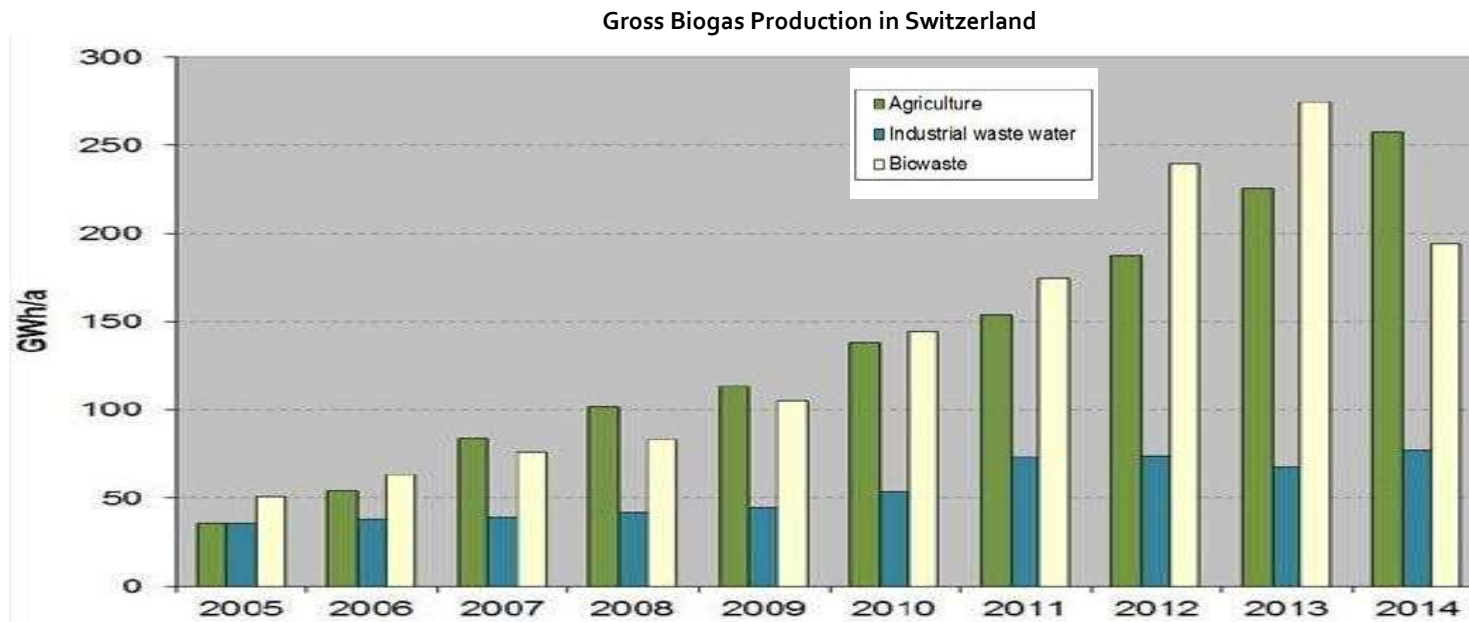
Quelle: Schweizerische Gesamtenergiestatistik

Source: Erdgas, BFE

Swiss Gas Market

BIOGAS MARKET - PRODUCTION & SUPPLY

- The term **biogas** refers to all gases that have been produced as a result of a biological or chemical conversion of biomass.
- Biogas is chemically identical to natural gas (methane) and is produced out of plant waste, slurry and manure from livestock farming and organic waste such as sewage sludge and food waste. Biogas can be used as fuel to drive engines or as combustible to generate heat.

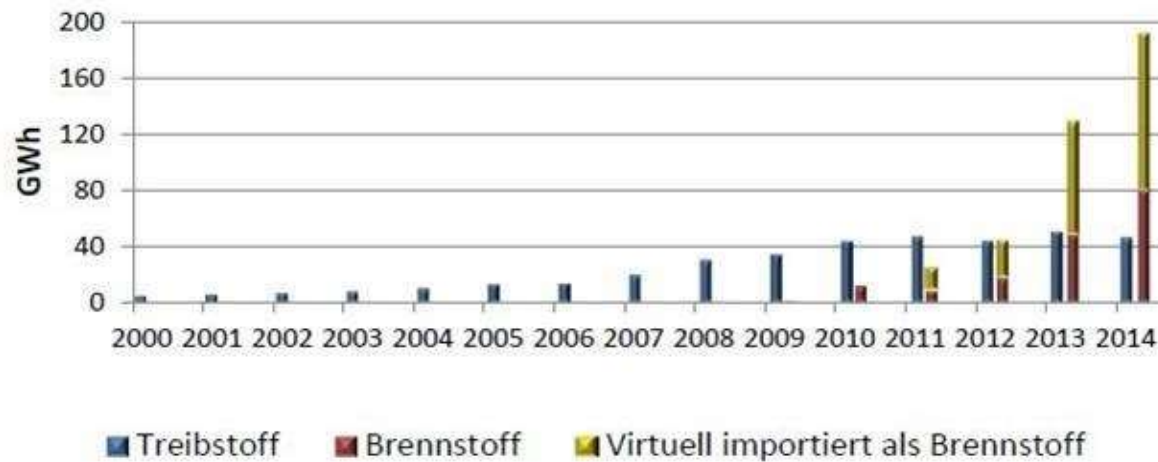


Source: BFE, IEA, VSG

Swiss Gas Market

BIOGAS MARKET - POTENTIAL

- In Switzerland, the use of biogas has steadily increased in recent years. Compared to 2005, electricity production from biogas has doubled and feeding into the gas network has increased by factor 10. The use of domestically produced biogas as fuel for heating rose significantly since 2010.



Quelle: Verband der Schweizerischen Gasindustrie (VSG, 2015)

Swiss Gas Market

BIOGAS MARKET - PROCUREMENT PRICES

- Price indications concerning procurement of biogas, based on offers (April 2016).

Origin	Delivery	Type	Price
Biogas Switzerland	Physical Supply	Standard	13 Rp./kWh
		Nature Made Star	15 Rp./kWh
	Certificate	Standard	8-10 Rp./kWh
		Nature Made Star	12 Rp./kWh
Biogas EU	Physical Supply	Standard	7 Rp./kWh
	Certificate	Standard	4,5 Rp./kWh

Swiss Gas Market

BIOGAS MARKET - MOBILITY PRICES

- Price indications for natural gas / biogas in the mobility sector:

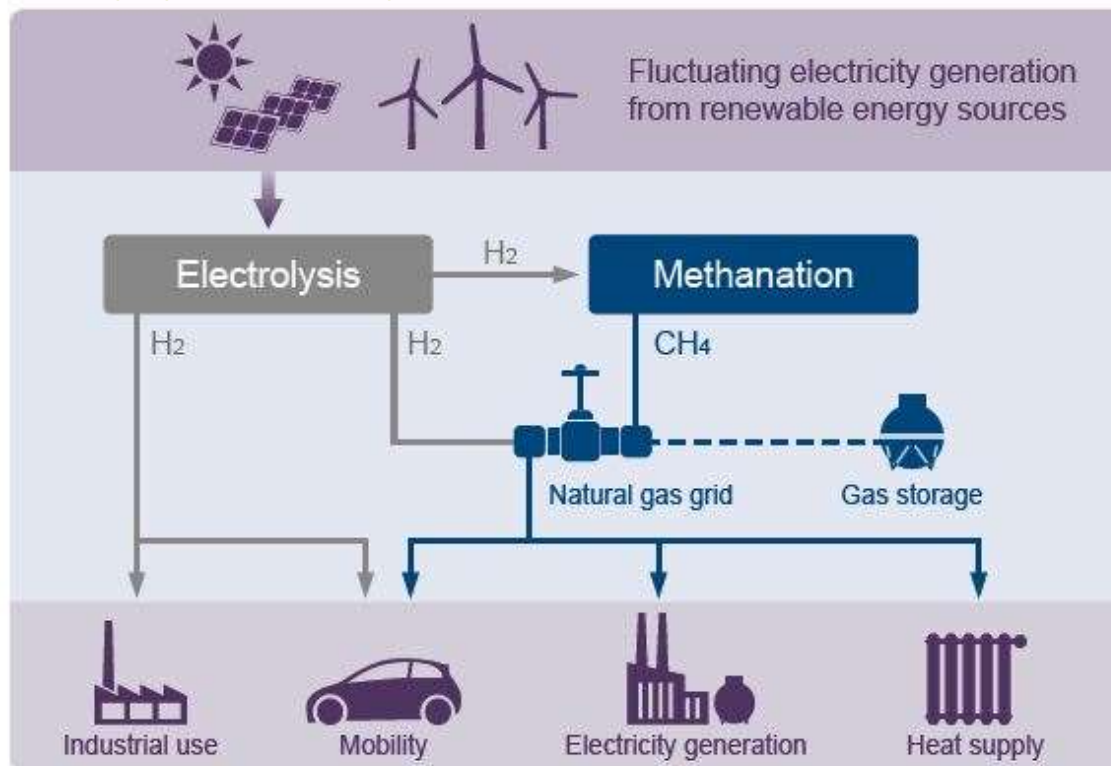
Procurement Market	
Natural Gas Portfolio Mix Price (Estimation March 2016)	2-3 Rp./kWh
CO ₂ Levy resp. Mineral Oil Tax	1.5 Rp./kWh
Biogas Upgrade (10% Biogas of 9 Rp./kWh)	0.9 Rp./kWh
Procurement Price for Mobility Biofuel	4.5-5.5 Rp./kWh
Distribution Market	
Mixing Proportion (90% Natural Gas, 10% Biogas)	
Selling Price of Biofuel (March 2016) (Selling Price Gasoline: CHF 1.30 per litre with 10 kWh)	10 Rp./kWh (13 Rp./kWh)

Source: E360, IBB, BFE

Swiss Gas Market

POWER-TO-GAS - MARKET OVERVIEW

- Increasing production of renewable electricity from intermittent sources (e.g. wind and solar) leads to periods of low spot prices of electricity, which can be used for **Power-to-Gas (PtG) conversion**.



Source: BFE, DENA, ENEA

Swiss Gas Market

POWER-TO-GAS: PROJECTS IN SWITZERLAND

- Following PtG plants are currently in planning or already realized in Switzerland:

- **HSR, Rapperswil**

The Institute for Energy Technology (IET) at Hochschule für Technik Rapperswil operates since 2015 the first PtG plant in Switzerland with an electrical output of 25 kW and a production of about 1 Nm³/h of methane.

- **EMPA, Dübendorf**

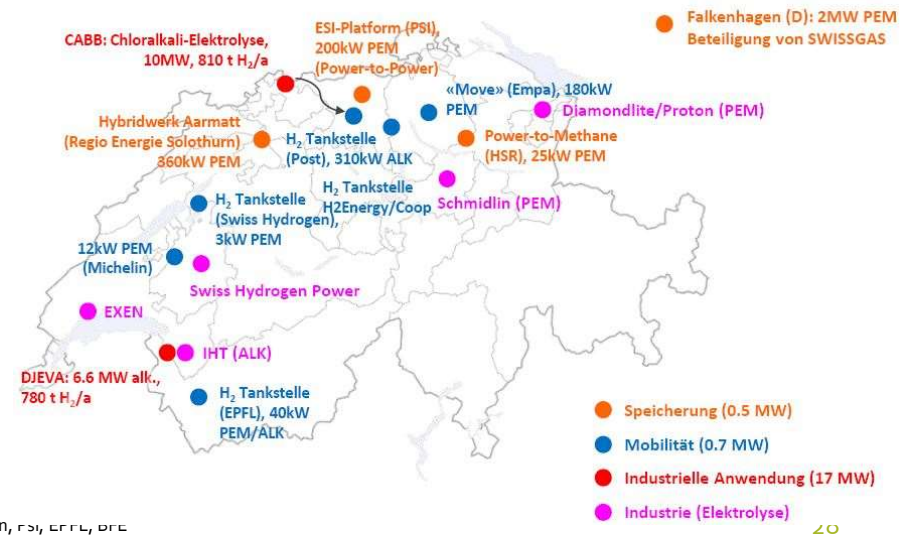
EMPA's demonstration platform "move" is a project for the decentralized production of renewable fuels for the use in different drive concepts (electric, fuel cell and gas-powered vehicles). The electrolyzer will have an installed capacity of 180 kW and will produce around 60 kg/d of hydrogen.

- **Paul Scherer Institute (PSI), Villigen**

PSI's demo plant "Energy System Integration Platform" has an electrolyzer with an installed capacity of 100 kW (by overload 300 kW) and an output pressure of 50 bar.

- **Regio Energie Solothurn**

In 2015, Regio Energie Solothurn put its hybrid plant "Aarmatt" in operation. The plant consists of an electrolyzer with an input of 350 kW and an output of 60 Nm³/h hydrogen as well as a cogeneration unit with an installed capacity of 1,2 MW and a hydrogen storage for 180 Nm³ at 30 bar.



Swiss Gas Market

POWER-TO-GAS - SNG FOR MOBILITY

- **Hydrogen and SNG is used as mobility fuels** in hydrogen or CNG vehicles respectively.
- The **CNG** refueling stations can be supplied either by the natural gas grid or by a container based solution.
- **Hydrogen** mobility cannot rely on existing pipeline infrastructures and depends solely on cylinder based supply, unless the H₂ is produced in a Power-to-Hydrogen plant directly on site.

Fuel Economy (Liters of gasoline-equivalent per 100km)								
	Gasoline	Diesel	Electricity	CNG	Bio-H ₂	Bio-SNG	Bio Ethanol	Bio Diesel
Current Techn. Scenario	9.63	8.95	1.84	8.84	5.36	8.84	9.63	8.95
Mature Techn. Scenario	6.85	6.18	1.51	7.16	3.94	7.16	6.85	6.18

Source: IEA, OECD, ENEA

Fuel economy assumptions to estimate travel cost (CHF/km) by fuel options for typical fleet average passenger duty vehicle

Swiss Gas Market

POWER-TO-GAS - GREENHOUSE GAS EMISSIONS

- Switzerland aims to **reduce greenhouse gas (GHG) emissions by 50%** relative to 1990 levels by 2030. At least 30% of this reduction must be achieved within Switzerland itself. The rest may be attained through projects carried out abroad.
- Switzerland, which is responsible for 0.1% of global GHG emissions has, based on the **structure of its economy**, a low level of emissions (6,4 tons/capita/year).
- At present, the transport sector is the most significant source of CO₂ emissions**, followed by the industrial sector, service sector and households. Agriculture and waste are the main sources of laughing gas and methane emissions.
- SNG from PtG plants** has an unmatched low carbon footprint and reduces therefore GHG emissions of fuel production by 96%.

Source: BAFU, EU Commission, Etogas

Life cycle analysis of various fuels: GHG Intensity (gCO₂/MJ)

Fuel or energy type placed on the market*	Raw material source and process*	Life cycle unit GHG intensity [gCO ₂ eq/MJ]*
Compressed synthetic methane in spark ignition engine	Sabater reaction of hydrogen from non-biological RE electrolysis	3
Compressed Hydrogen in fuel cell	Electrolysis fully powered by non-biological RE	9
Hydrogen in fuel cell	Coal with Carbon Capture and Storage of process emissions	53
Compressed Gas in spark ignition engine	Natural Gas, EU mix	69
Liquefied Petroleum Gas in spark ignition engine	Any fossil sources	74
Liquefied Gas in a spark ignition engine	Natural Gas, EU mix	75
Petrol, diesel or gasoil	Waste plastic derived from fossil feedstocks	86
Petrol	Conventional crude	93
	Natural Gas-to-Liquid	93
Diesel or gasoil	Natural Gas-to-Liquid	94
	Conventional crude	95
Compressed Hydrogen in fuel cell	Natural gas using steam reforming	104
Petrol	Natural bitumen	107
Diesel or gasoil		109
Petrol	Oil shale	131
Diesel or gasoil		134
Petrol	Coal-to-Liquid	172
Diesel or gasoil		172
Compressed Hydrogen in fuel cell	Coal	234

* Binding calculation method for GHG footprints of transport fuels, defined by EU Commission in October 2014

Swiss Gas Market & Energy Gas Specifications

Conclusions

The 'Inner Quality' of renewable gas is the key driver for market price and growth rate.

*The current **energy gas specifications** due reflect technical aspects and GHG mainly.*

*The 'Insetting' of **sustainable benefits** along the whole value chain can be improved significantly.*

Next steps

- Think globally – a basic need of our time
- Demonstrate your co-benefits
- Do the externalization of the internal benefits
- Generate an added value to bridge the gap
- Let's bring sustainable projects as a real asset to the ground

Thank you for your attention!

Oliver Stankiewitz

