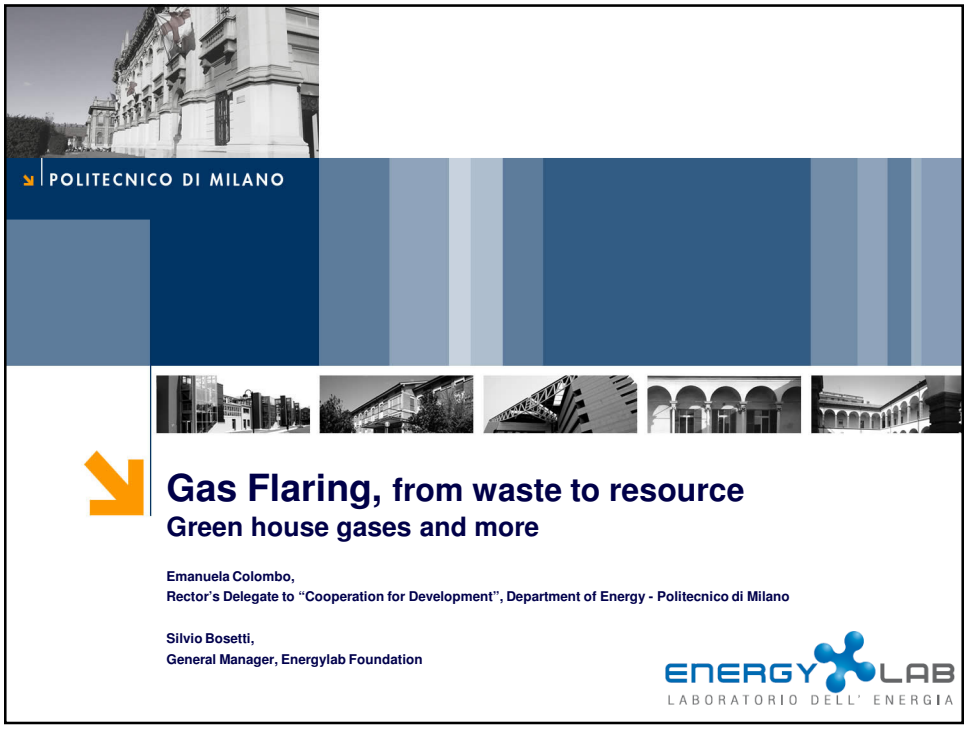
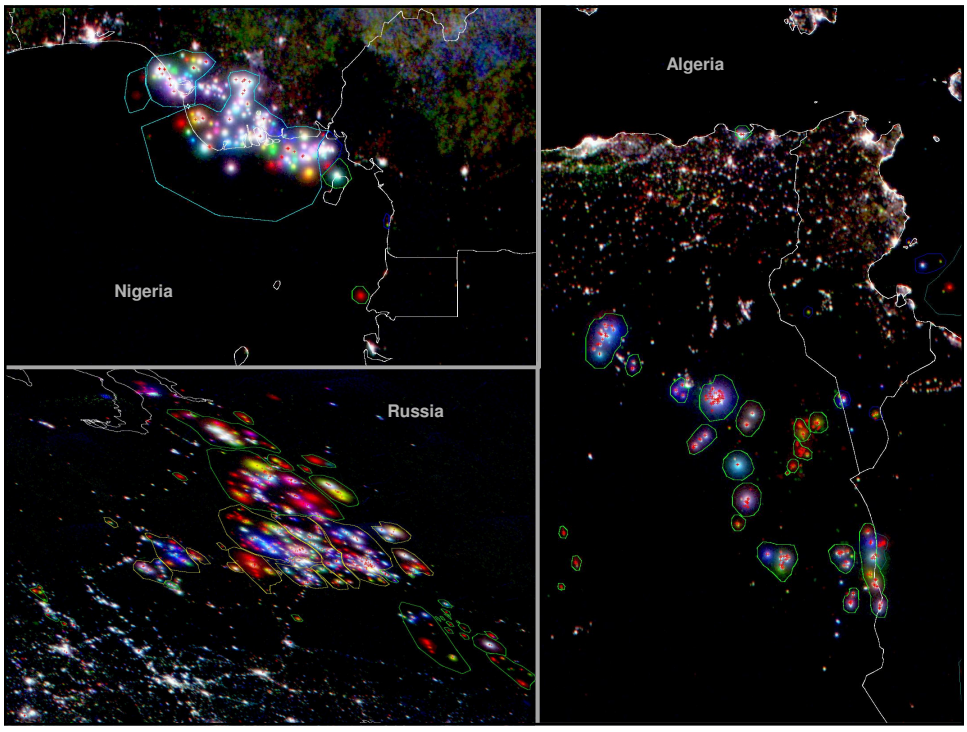

POLITECNICO DI MILANO
Gas Flaring, from waste to resource
Green house gases and more
Emanuela Colombo,
Rector's Delegate to "Cooperation for Development", Department of Energy - Politecnico di Milano
Silvio Bosetti,
General Manager, Energylab Foundation
ENERGY LAB
LABORATORIO DELL' ENERGIA


Nigeria
Russia
Algeria

Summary

- **Gas Flaring status and data @ 2009**
- From Waste to Resource
- Global Initiatives, and (Not) Final Consideration

Key Energy statistic, 2009
BP Statistic 2009
OCSE DAC statistic 2009

Gas Flaring status @ 2009

The issue and the numbers

Associated gases are mainly made by **natural gas**:

- quantities are small to develop any market opportunity **(economic level)**
- CH_4 is a green house gas with an impact force **21** times grater than $C0_2$ **(environmental level)**
- it is a valuable energy resource compared with other fossil source **(social level)**

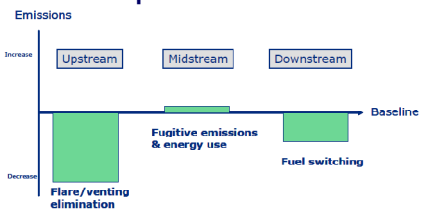
From satellite data at the **National Geophysical Data Center** of the US government gas flares have been isolated and quantified. Compared to lights they

- produce **circular patterns** with wide rims
- tend to be located **outside of urban areas**
- persist for years, but **not for decades**

Gas Flaring status @ 2009

The issue and the numbers

Gas Flaring is still nowadays the standard industrial practice to release in the atmosphere the associated gas:



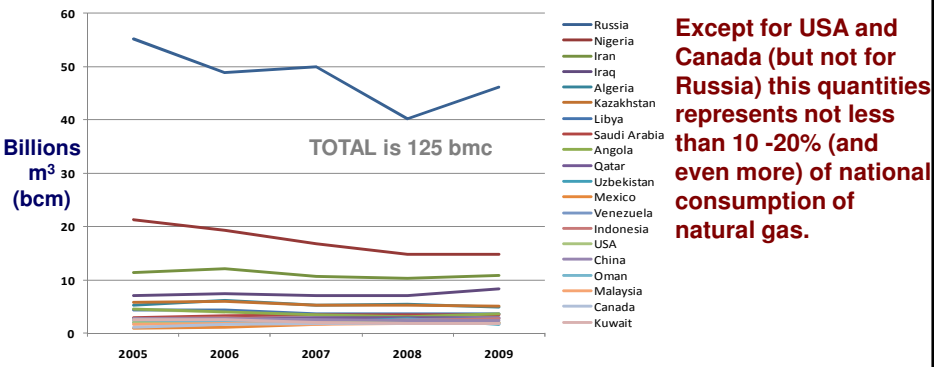
- **Flaring** is one of the different sources in the **gas value chain** including
  - **venting,**
  - **fugitive**
  - **combustion**
- **Flaring** is environmentally less critical than **venting**
- **Flaring** is a worst practice compare **to standard alternatives:**
  - capture and reinjection into the oil reservoir
  - capture and delivery to end use/market through
    - **pipelines**
    - compressed gas **(CNG)**
    - liquefied natural **(LNG),** petroleum **(LPG**) gases,
    - gas-to-liquids **(GTL)**
  - on-site **power generation**,

Gas Flaring status @ 2009

The issue and the numbers

The estimated amount of gas flared is **120-140 bcm a year since 2005**

Estimated data, trend 2005-2009



Except for USA and Canada (but not for Russia) this quantities represents not less than 10 -20% (and even more) of national consumption of natural gas.

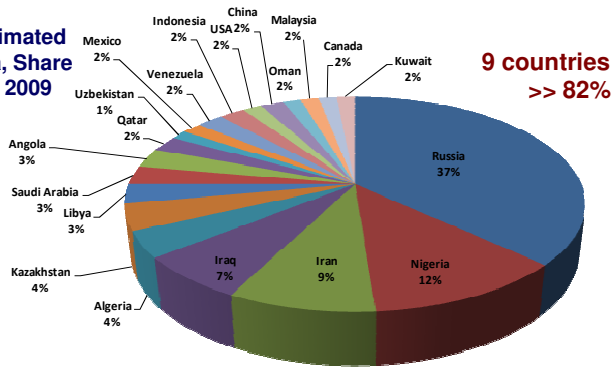
A general tendency to **decrease gas flaring is confirmed up to 2008. In 2009 China, Canada, Kuwait, Iran, Venezuela, Russia, Angola, Indonesia and Iran inverted the trend.**

Gas Flaring status @ 2009

The issue and the numbers

The estimated amount of gas flared is **125 bcm in 2009**

Estimated data, Share @ 2009



9 countries >> 82%

Primary Energy FFF= Flared For Free

Country	Gas flared 2009 (bcm)	Primary energy FFF (Mtoe)
Russia	46.1	38
Nigeria	**14.8**	**12**
Iran	10.9	9
Iraq	8.3	7
Kazakhstan	5.0	4
Algeria	**4.9**	**4**
Libya	**3.6**	**3**
Angola	**3.6**	**3**
Saudi Arabia	3.5	3
Qatar	2.9	2
Venezuela	2.8	2
Indonesia	2.7	2
China	2.4	2
USA	2.0	2
Mexico	2.0	2
Oman	1.9	2
Kuwait	1.9	2
Malaysia	1.9	2
Canada	1.9	2
Uzbekistan	1.7	1
ALL	64	103

LHV 34.5 MJ/m3 is assumed for conversion

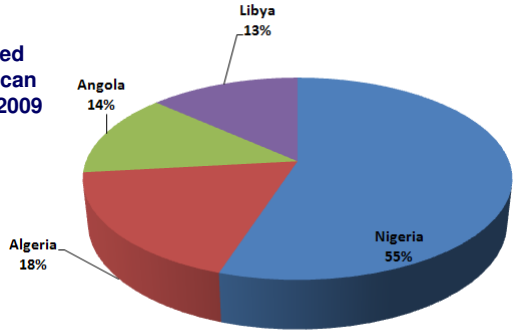
Russia and **Nigeria** are responsible of the **49%** of the total
Iran, Iraq, Algeria and **Kazakhstan** add another **24%**
Lybia, Saudi Arabia and **Angola** add another **9%**

Gas Flaring status @ 2009

The issue and the numbers in Africa

The estimated gas flared in Africa is **26.9 bcm , the 21.5% of the Total**

Estimated data, African Share @ 2009



Primary Energy FFF= Flared For Free

Country	Gas flared 2009 (bcm)	Primary energy FFF (Mtoe)
Nigeria	**14.8**	**12**
Algeria	**4.9**	**4**
Libya	**3.6**	**3**
Angola	**3.6**	**3**
ALL	64	103

LHV 34.5 MJ/m3 is assumed for conversion

For a rapid comparisons 26.9 bcm are

	Africa		Europe and Eurasia		Italy	
	bcm		*bcm*		*bcm*	
Natural Gas production	**193**	14%	**963**	3%	**8**	331%
Natural Gas consumption	**95**	28%	**1144**	2%	**78**	34%

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.... to Resource

Perspective need to be changed

It is wasted energy
It is an environmental concern
It is waste of many
It is wasted development

By converting the "**primary energy flared for free**" into number of power plants a simple exercise (with all the limitation of a simple exercise) may give us some more comprehensive information

Country	Primary energy FFF (Mtoe)	Number of equivalent Combined Cycle Power Plant
Nigeria	12	13
Algeria	4	4
Libya	3	3
Angola	3	3
ALL	103	107

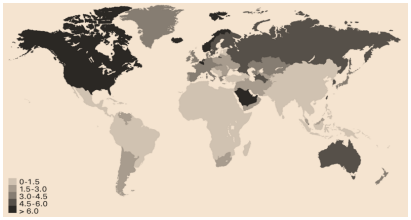
The number of equivalent combined cycle power plants (800 MW) is evaluated by assuming :

1. **LHV (CH4) 34.5 MJ/m^3**
2. **Power plant efficiency 0.56**
3. **Load factor 0.85**

Gas flaring might be analyzed in term of equivalent power plants and be viewed as a resource

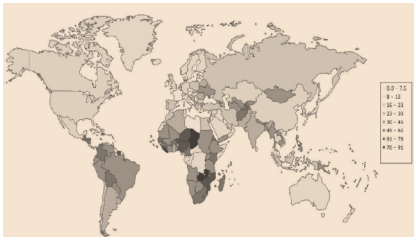
Why the world is demanding energy?
What is the problem of access to energy?
Where is the problem mainly located?

Energy is linked to Development and vice-versa



Population (%) living below the poverty line

Pro capita consumption of energy



The Energy issue presents the well know paradox of disparities

Special attention to the LOW (Income) and LOW (HDI) economies

Access to energy is a socioeconomic , not ONLY a technical, problem

Gas Flaring and Access to Energy

Gas flaring is also not a technical problem
- Gas is a **well known source** of energy
- **Small scale devices** for end use are know and high efficient
- **Macro scale plants** for power generation are a standard in the sector

Gas flaring is not only an environmental problem
- Emissions are **high**
- Emission are obtained **without any benefit**

Gas flaring is an economic and social problem
- any (piece of) solution could support some global concerns
  - **access to energy** in some region
  - local **development**
  - global **sustainability** of the energy sector

Access to energy may be mitigated by achieving profit form gas flaring solution Partnerships, Commitments of local and international players, social responsibility, reliability and an innovative approach will play a key role

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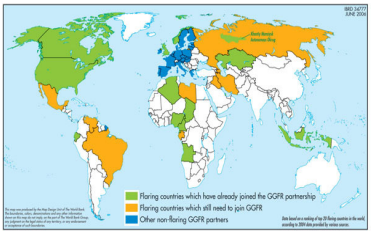
World Wide initiative and global action

The Global Gas Flaring Reduction private public partnership By World Bank

The World Bank's GGFR public-private partnership was launched at the World Summit on Sustainable Development in **Johannesburg in 2002**. GGFR supports the efforts of oil producing countries and companies **to reduce flaring and venting.**



GGFR partners have established a **collaborative Global Standard for gas flaring reduction,** providing a framework for governments, companies, and other key stakeholders to consult, take collaborative actions and reduce barriers to associated gas utilization

The GGFR partnership is a catalyst for reducing wasteful and undesirable practices of gas flaring and venting through policy change, stakeholder facilitation and project implementation.

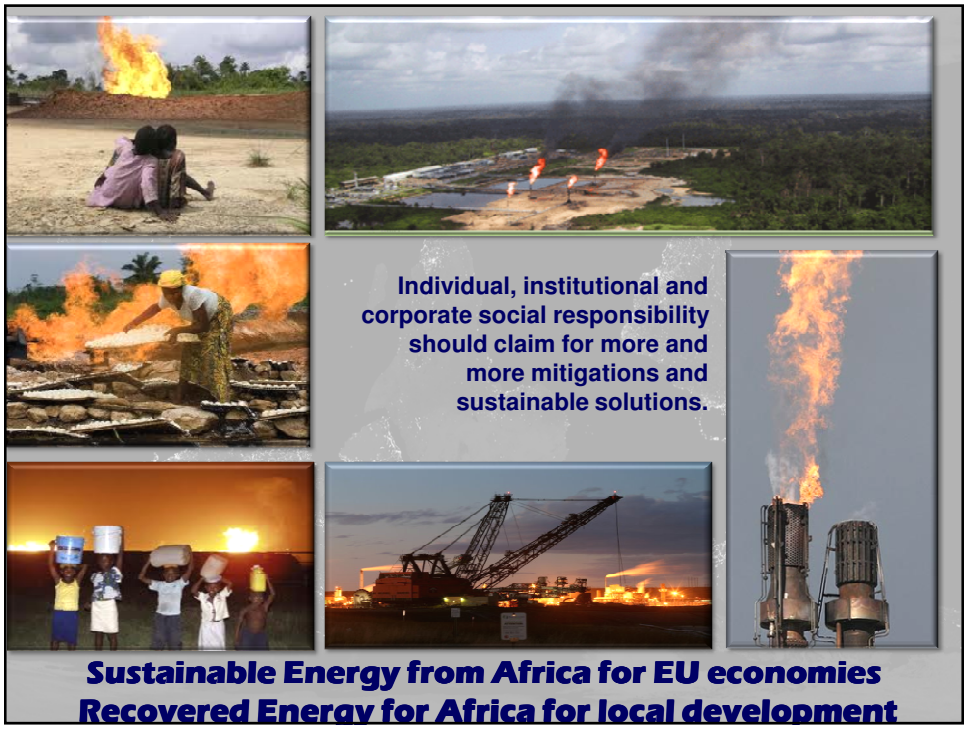
GGFR partners include: Algeria (Sonatrach), Angola (Sonangol), Azerbaijan (SOCAR), Cameroon (SNH), Canada (CIDA), Chad, Ecuador (PetroEcuador), Equatorial Guinea, France, Gabon, Indonesia, Iraq, Kazakhstan, Khanty-Mansiysk (Russian Federation), Nigeria (NNPC), Norway, Qatar, United Arab Emirates (Masdar Initiative), the United States (DOE) and Uzbekistan (Uzbekneftegaz); BP, Chevron, ConocoPhillips, ENI, ExxonMobil, Marathon Oil, Maersk Oil & Gas, Shell, StatoilHydro, TOTAL, Qatar Petroleum; OPEC Secretariat, European Union, the World Bank and the IFC.

Some possible action lines

Gas flaring Reduction	Contingency level	Structural level

Short medium time frame	• **To study technologies reducing cost and scale effect**
	  • CNG, LPG, LNG
	  • methanol, DMT
	  • Hydrates
	• **To investigate CDM** to support gas flaring reduction (EU benefit)
		• **Promote and Joint global initiative such as the Global Gas flaring reduction partneship by WB** (with all parties involved)
		• **To involve local government and institution**
		• **to support oil companies in** assessing the alternatives

Longer time frame	• **To foster market** opportunities at the **local level** • **To foster market opportunities** and the international level (EU benefit)	• Negotiate with OECD member state, or multilateral agencies for shifting a **part of the development AID to support gas flaring reduction**




L'unico modo per scoprire i limiti del possibile
è avventurarsi un po' più oltre, entro l'impossibile.
The only way to discover the true boundary of possible
is to proceed a bit further into the impossible
Blaise Pascal