

○ Bagnore geothermal power plant

Flash power plant for electricity production placed in Italy.

Development and application of the simplified model for the Climate Change impact category

27/04/2020

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G E O E N V I

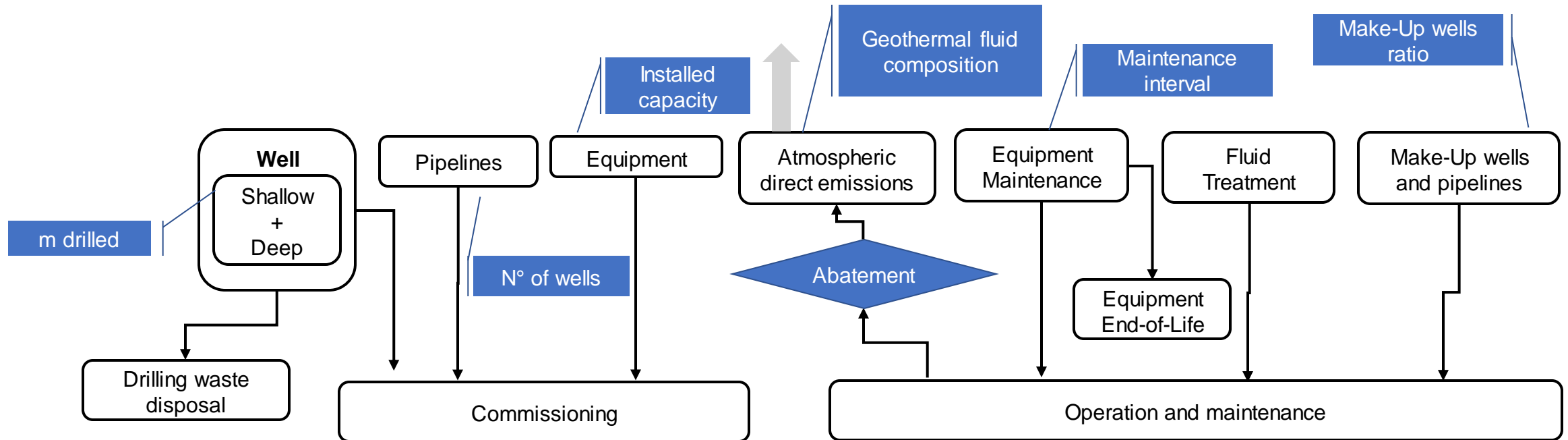
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3 / Definition of the reference parametrized life cycle inventory model

Step 2 : Definition of the reference parametrized LCA model

- Simplified scheme of the LCA reference parameterized model
- Main variables used for parametrization highlighted in blue



4 / Definition of the reference parametrized life cycle inventory model

Step 2 : Definition of the variables for the reference parametrized LCA model

Parameters definition

Param	Default for Bagnore case study	min	max	unit
Well length	2273	586	4727	m
Operating Hours	8670	7600	8760	hours
AMIS Unavailability	226	17	457	hours
Hg abatement ratio	0.8	0.7	1	unitless
H ₂ S abatement ratio	0.9	0.7	1	unitless
CO ₂ abatement ratio	0	0	0.3	unitless
LifeTime	30	20	40	years
Maintenance interval	4	2	6	years
Installed capacity	61000	20000	120000	KW _e
AVG Load	0.99	0.8	1.1	Unitless
Make-Up well ratio	0	0	16	N° units
Flow Rate	400000	100000	800000	kg/h
fNCGs	0.073	0.006	0.12	Unitless
fCO ₂	0.92	0.58	0.92	Unitless
fCH ₄	0.025	0.002	0.025	Unitless

The table reports the 15 key parameters selected as variables into the model.

The ranges try to cover wider geothermal fields.

Ranges definition and modelling are still in development

5 / Identification of the key variables
&
Simplified model for climate
change, total

Step 4 : Generation of the simplified model for Climate Change

The analysis of the relative importance of the Sobol index allows to select **3 parameters** which explain **91% of the variance**.

The simplified equation for Climate change impact category is:

$$Kg CO_2eq = \frac{1.94 * FlowRate * fNCG + 5.89 \cdot 10^{-5} * FlowRate + 0.0113 * InstalledCapacity + 605.463}{InstalledCapacity}$$

- **Flowrate**: flow rate of the geothermal fluid entering the turbine in Kg/h
- **fNCG** : the mass fraction of the Non-Condensable Gases contained into the fluid
- **Installed Capacity**: is the installed electric capacity expressed in KW_e

6 / Identification of the key variables
&
Simplified model for climate
change, total

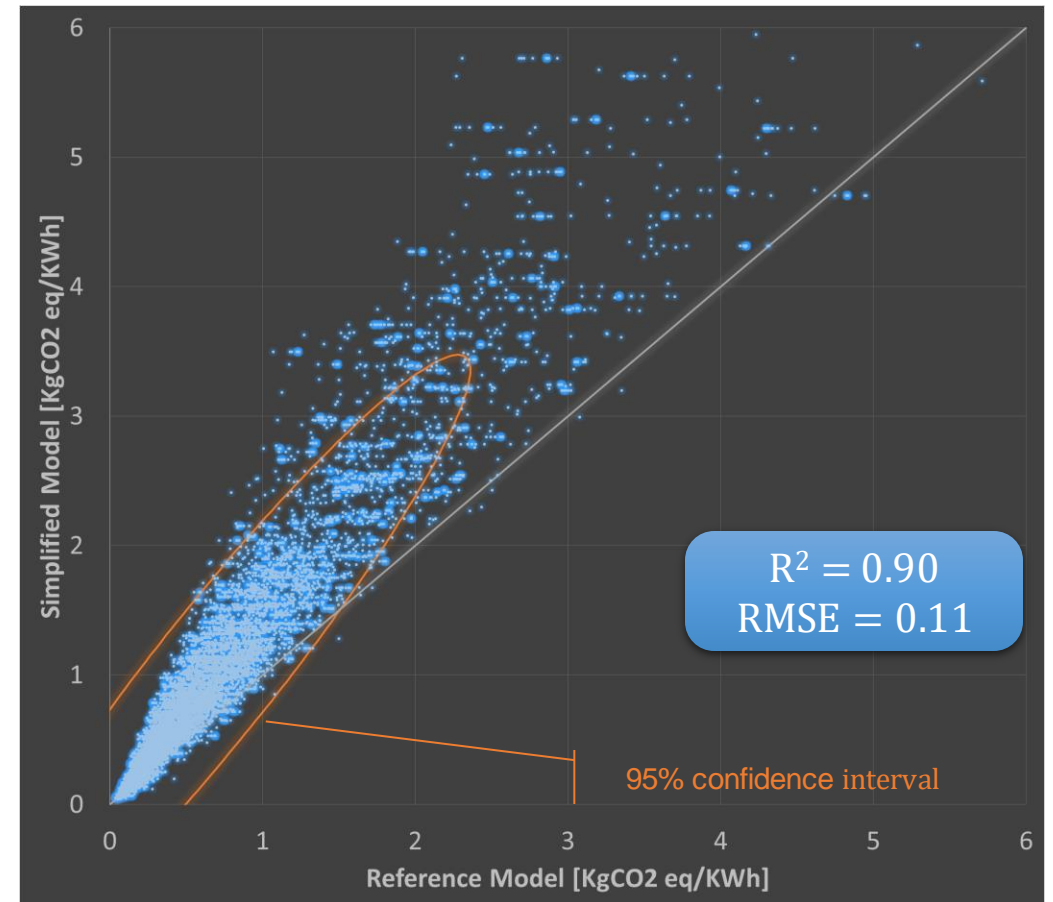
○ Step 4 : Validation of the simplified model with the Reference detailed LCA model

The simplified model is valid only for the following **key** conditions:

- Flash geothermal system producing *only electricity*
- *Medium to high content of NCGs (0.6% to 9% mass)* mainly composed by CO₂
- *Flow rate* between 100 and 800 tons/hour
- *Installed capacity* ranging from 20 to 120 MWe

The function gives results compliant to the ILCD 2018 Method

Variable	Observations	Minimum	Maximum	Mean	Std. deviation
Detailed Model	22000	0.037	6.558	0.705	0.676
Simplified Model	22000	0.040	7.770	1.040	0.994



○ Step 5 : Validation of the simplified model with literature

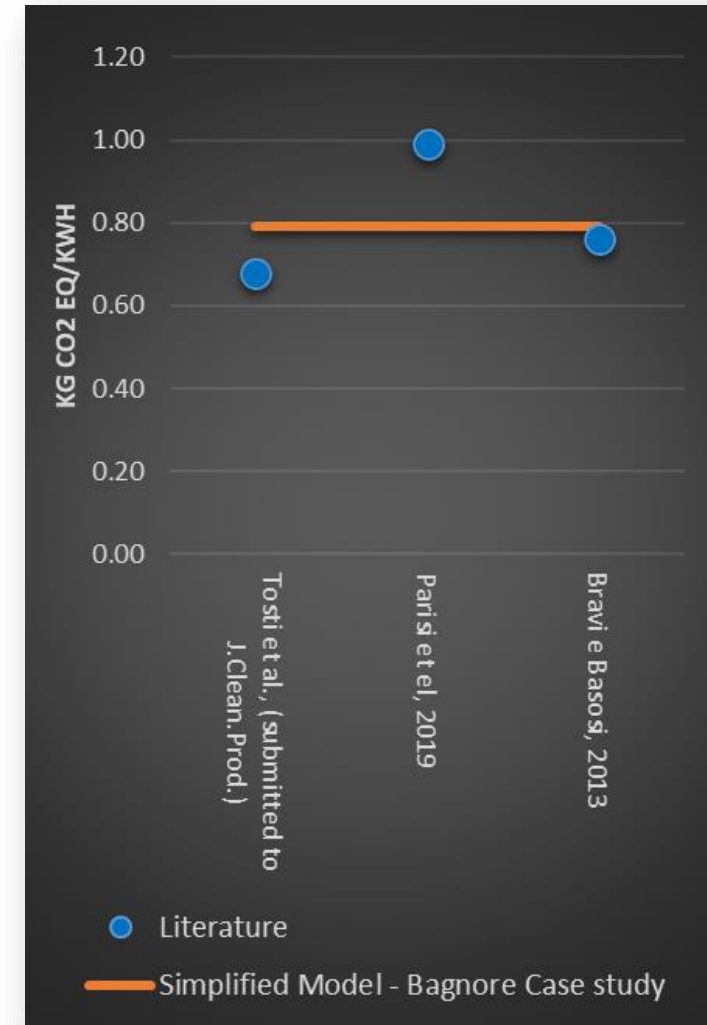
The result of the simplified model developed starting from the Bagnore case study shows good accordance to literature results.

The differences showed could be explained:

- The impact method used are different in respect to the one used for the generation of the simplified model, leading to quite different results
- Statistical descriptors shows overestimation of the simplified model results

Further development will be:

- *Correlation between the geothermal Flow Rate and the Installed Capacity to reduce input parameters dimension*
- *Development of the simplified model for power plant producing both heat and electricity*



Thank you for your attention

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