20-20-20 targets contribution and EU R&D funding for renewable heating and cooling

Authors: **Simon Pezzutto[1], Wolfram Sparber[1]**
[1]Institute for Renewable Energy, EURAC Research,
Viale Druso 1, 39100 Bolzano, Italy
Phone (+39) 0471 055622, Fax (+39) 0471 055699
simon.pezzutto@eurac.edu, http://www.eurac.edu

Overview

The aim of this paper is to provide a comparison between the 20-20-20 targets contribution and the portion of research and development funding dedicated to the renewable heating and cooling sector in the European Union. Data has been collected through literature research and processed in order to assess the expected 20-20-20 targets contribution of the renewable heating and cooling sector and to quantify the European Union´s funding for energy related research and development. On the one hand, the renewable heating and cooling sector contributes to the 20-20-20 targets for approximately 40% regarding carbon dioxide emissions reduction, for around 45% concerning energy consumption coming from renewables and for around 57% to primary energy use reduction. On the other hand, the Seventh Framework Programme funding for renewable heating and cooling issues amounts to approximately 5% of the total energy budget.

1. Introduction

The EU is facing unprecedented energy challenges until 2020. Principally, these arise due to its high energy dependence on energy imports (mainly fossil fuels) and effects of climate change (1). Fossil fuels are imported by the EU basically from Russia, Africa and OPEC member countries (2). The EU itself covers less than half of its gross inland energy consumption (~46% in 2010) (3). Since 1990 the energy consumption in the EU has been growing constantly (4).

To increase EU's energy independence, combat climate change and strengthen its competitiveness, a set of goals has been set: the 20-20-20 targets.

The 20-20-20 goals aspire a reduction in EU greenhouse gas (GHG) emissions until 2020 of at least 20% below 1990 levels. Furthermore, 20% of EU's energy consumption is expected to come from renewable energy sources (RES) in 2020. In addition, a 20% reduction in primary energy use has to be achieved by improving energy efficiency with respect to 1990 levels (5).

A contribution to meet these ambitious energy and climate targets is given by renewable heating and cooling (RHC)

technologies: solar thermal, biomass, geothermal, district heating & cooling (DHC), heat pumps, hybrid systems and thermal energy storage (6).

As EU R&D funding, the Seventh Framework Programme (FP7) has been taken in consideration, being the most substantial EU R&D programme in force (2007-20013) (7). Furthermore, the IEE (Intelligent Energy Europe) and EEPR (European Energy programme for Recovery) funding for R&D in the energy sector has been considered as well for the time period of 2007-2013. A closer look has also been taken to the previous framework programme (FP6), where the portion dedicated to RHC R&D funding is lower than at FP7.

2. Methods

Data were collected from scientific literature and processed in order to assess the expected 20-20-20 targets contribution of RHC applications in Europe.

In the case of RHC contribution to CO_2 emissions reduction, the final energy consumption of RHC applications has been transformed into emissions savings using a conversion factor. In order to perform the conversion, different factors have been taken in consideration (8), (9). Analysing the contribution of each RHC technology to the total RHC final energy consumption, a conservative conversion factor of 3±20% has been used. The above indicated 20% uncertainty has been added, because the mentioned conversion factor refers to greenhouse gases, which consist for 80% of CO2 and for 20% of other gases (mainly H_2O, CH_4, N_2O and O_3) (10). Only CO_2 emissions has been considered and hence a unit of tCO2 and not tCO2 equivalent is used. In the following Figure 1, Figure 6 and text the RHC contribution to CO_2 emissions reduction has been indicated without specifying the related uncertainty.

Furthermore, to quantify the EU funding for energy related R&D an extensive database has been created, containing all FP6 and FP7 energy projects declared by the EC until February 2013. Collected data has been subdivided per different technologies within the non-nuclear energy (NNE) sector, which includes renewable energy sources (RES) too.

Since FP7 will be concluded by the end of 2013, the mentioned database comprehends the majority of this programme´s projects carried out within the energy sector.

Moreover, the above mentioned bottom-up approach´s results has been compared with top-down acquired data.

Next, RHC contribution to the 20-20-20 targets have been directly compared with related EU R&D funding portions for NNE.

What´s more, also the European R&D spending on nuclear energy has been quantified through EU´s indications, found in scientific literature, and directly confronted with these given to the NNE

R&D sector. The related funding for nuclear energy R&D has been retrieved mainly from the Euratom (European Atomic Energy Community) and ITER (International Thermonuclear Experimental Reactor), which are both standalone programs. These have been assembled to EU frameworks funding for NNE, in order to obtain a clear picture of the EU nuclear and NNE R&D finance for the time frame of FP1-FP7.

Finally, a technical and fundamental analysis has been carried out to evaluate possible future scenarios regarding EU R&D finance for the energy sector.

3. Results

First, RHC contributions to the 20-20-20 targets will be exposed (subsection 3.1), followed by findings concerning European RHC R&D funding (subsection 3.2). Moreover, a direct confrontation between both above named quantifications is given in subsection 3.3. Furthermore, a comparison between EU nuclear energy and NNE R&D funding succeeds (subsection 3.4). Finally, the Results section ends with a forecast regarding EU R&D energy sector funding (subsection 3.5).

3.1 RHC contributions to 20-20-20 targets

In matters of GHG emissions the EU set the goal of a 20% reduction from 1990 levels in 2020. The majority of CO_2 emissions (~80%) derives from fossil fuels combustion (11). RHC applications permit to substitute essentially fossil fuels consumption and therefore in the following statistics only CO_2 emissions are taken in consideration. CO_2 belongs to primary greenhouse gases and is the second most abundant GHG in the Earth´s atmosphere (10), (12). The overall European CO_2 emissions in 1990 accounted for arround 4130 mil. tCO_2/a. In 2020 the EU aims to reach total CO_2 emissions of about 3300 mil. tCO_2/a. Thus, expected savings result to be ~830 mil. tCO2/a in 2020. Related emissions savings deriving from RHC applications in the same year are estimated to be approximately 340 mil. tCO_2/a. Hence, arround 40% of the total CO_2 emission savings, the EU wants to reach in 2020, can be achieved by RHC applications (1), (13), (14), (8), (9), (15). See Figure 1:

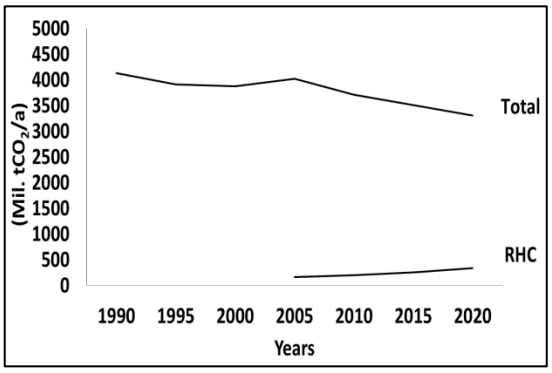

Figure 1: Development of CO_2 emissions (1990-2020) and related savings by RHC applications (2005-2020) in Europe (Mil. tCO_2/a) (1), (8), (9), (11), (13), (14), (15), (16), (17)

Next, total EU energy consumption in 2020 is expected to be about 1200 Mtoe/a. In the same year the EU aims to reach a total energy consumption of around 250 Mtoe/a from RES. Arround 45% of these 250 Mtoe/a, >110 Mtoe/a are estimated to come from RHC applications. Thus, regarding the 20% EU energy consumption expected to

derive from renewable resources in 2020, almost half is foreseen to be produced by the RHC sector (14). See Figure 2:

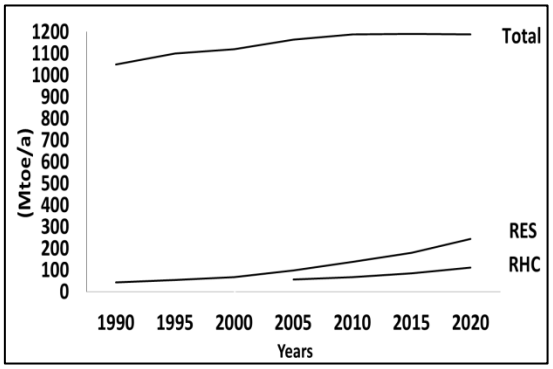

Figure 2: Development of total and RES final energy consumption (1990-2020) and related RHC final energy use (2005-2020) in Europe (Mtoe/a) (14), (15), (18), (19)

Going ahead, EU total primary energy consumption in 1990 accounted for approximately 1650 Mtoe/a. In 2020 the EU aims to reach a primary energy consumption of around 1320 Mtoe/a. Hence, in 2020 the reduction in primary energy consumption is expected to be 330 Mtoe/a. Related reduction deriving from RHC applications in the same year is estimated to be approximately 190 Mtoe/a. Thus, about 57% of the reduction, the EU wants to achieve in 2020, can be reached by RHC technologies (14), (20). See Figure 3:

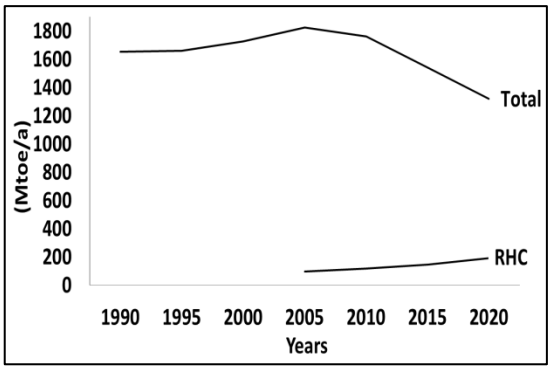

Figure 3: Development of total primary energy (1990-2020) and related RHC consumption (2005-2020) in Europe (Mtoe/a) (1), (15), (20), (21), (22)

Concluding, current achievements concerning the 20-20-20 targets have to be mentioned. According to taken measures, the EU-27 member countries are on the right track to reach the aims regarding GHG emissions reduction and share of energy consumption produced by renewable resources in 2020. On the contrary, the aim of improvement in the EU´s energy efficiency by reducing primary energy consumption is going to be failed according to 2007 projections.

Based on emission projections, submitted by the EU member states in 2010, the EU is going to over-achieve its GHG reduction settings by 0.9% in 2020. Furthermore, the EU reached a value of RES energy consumption corresponding to 12.5% in 2010, while its overall aim in the same year was of 10.7%. Finally, the EU will be able to save only around 207 instead of 368 Mtoe/a primary energy consumption in 2020 by projections of 2007 (23).

3.2 EU funding for RHC R&D

A short overview regarding the history of European R&D finance for the energy

sector (nuclear and non) in the seven framework programmes (1983-2013) is given. See Figure 4:

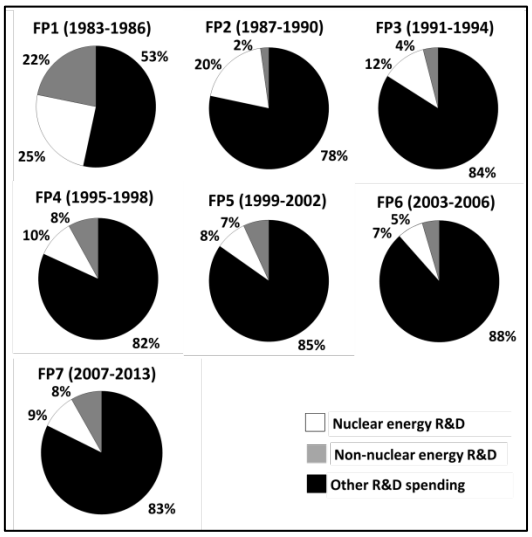

Figure 4: History of the EU R&D funding for the energy sector FP1-FP7 (nuclear and non) (24), (25), (26), (27), (28), (29), (30), (31), (32), (33), (34), (35), (36)

The NNE sector includes beside RES (wind energy, photovoltaics, concentrated solar power (CSP), ocean energy, hydro energy, geothermal energy, bioenergy and RHC) also following themes: coal CCS (carbon capture storage)-CO2 capture, coal CCS-CO2 storage, coal (other): coal topics not related to CCS-CO2 storage or capture, energy networks, energy efficiency (building), energy efficiency (CONCERTO): energy efficiency related to the so-called CONCERTO projects (large scale demonstration projects), energy efficiency (other): energy efficiency projects not related to buildings and large scale demonstrations, socio-economics, FCH/JTI FCH (fuel cells and hydrogen/Joint Technology Initiative fuel cells and hydrogen) fuel cells, FCH/JTI FCH (hydrogen), energy materials/FET (future and emerging technologies), energy storage, basic research: research aimed at understanding fundamental principles and all other areas: energy themes not fitting in the previously named sections, e.g. improvement of energy related scientific communications.

The “Other R&D spending” section in Figure 4 refers primarily to topics such as health, food, agriculture and fisheries, biotechnology, nanosciences, materials and new production technologies, environment (including climate change), transport (including aeronautics), socio-economic sciences and the humanities, space and security, nanotechnologies and information and communication technologies (ICT).

As it is visible in Figure 4, from the First Framework Programme (FP1) until FP7, the European R&D finance for the energy sector (nuclear and non) register a percentage decline. EU funding for energy related R&D decreased from about 47% of the total energy R&D finance in FP1 to around 17% in FP7 (State of the art: February 2013) (24), (31), (33), (37).

Nevertheless, it has to be stressed that beside the decrease in terms of percentage values, a constant rise in terms of total available amount of money took place. Hence, the finance for energy R&D in the FP6 was around 890 mil. € and at the FP7 about 4,650 mil. € (24), (37). Moreover, from FP6 to FP7 the total framework´s budget has more

than doubled, with approximately 20 and 50 bn. € respectively (37), (38).

Upon closer examination of Figure 4 it can be seen that nuclear energy R&D received more European R&D finance than RES and all other energy sectors together, as explained more in detail in subchapter 3.4 (31), (33), (37), (38), (39), (40).

Regarding the NNE sector, in FP7 officially 45% of the finance for the energy sector has been dedicated to RES (24). As it is visible in Figure 5, until February 2013, following the EC assignment classification, this goal has been almost matched (39).

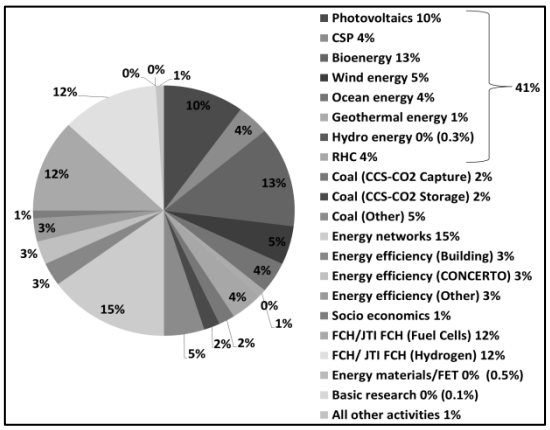

Figure 5: FP7 funding for different NNE sectors (39), (41), (42)

Like shown in Figure 5, themes concerning energy networks, bioenergy, FCH/JTI FCH (fuel cells), FCH/JTI FCH (hydrogen) and photovoltaics join the highest amount of FP7 finance with approximately 10-15% of NNE theme funding. Topics related to wind energy and coal (other) follow with about 4-5% funding. In the lower part are located RHC, ocean energy, CSP, energy efficiency (building), energy efficiency (other), energy efficiency (CONCERTO), coal (CCS-CO2 capture), coal (CCS-CO2 storage), socio-economics, all other activities, geothermal energy, energy materials/FET, hydro energy and basic research with values around 0-4%.

Most part of RES finance in the FP7 goes to bioenergy, followed by photovoltaics and at third place wind energy as shown in Figure 5. RHC, ocean energy and CSP are at the 4th,5th and 6th place with about 4% respectively. Geothermal energy comes next with approximately 1% and at the last place there is hydro energy with <1%.

Hence, following the EC assignment method, with funding percentages going from almost 0-15% in the RES part, RHC is located in the lower half with ~4%.

Moreover, following the EC assignment method, the RHC theme was allocated even lower in FP6 compared to FP7. With <1% RHC is to find at the penultimate position within the FP6 RES topics (39).

3.3 Confrontation of expected 20-20-20 targets contribution & EU R&D funding for RHC

Going through the FP7 NNE theme projects one by one, the RHC sector has been quantified with around 5%. This 5% has been achieved by assigning parts of other NNE topics´ projects, which deal with the RHC thematic, to the RHC section. E.g. at the “DIGeSPo” project, research has been undertaken to provide electrical power and heating

and cooling (H&C) through a CSP micro combined heat and power (m-CHP) unit. Hence, in this case 50% of the project funding has been accounted to RHC R&D, even if originally allocated under the CSP theme by the EC assignment method.

Nevertheless, as following the EC as the authors own assignment method, RHC remains in the lower part of RES funding within the FP7 NNE theme.

If the expected 20-20-20 targets contribution of RHC (approximately for 40% to reduction of CO_2 emissions, for around 45% to energy consumption coming from RES and for about 57% to reduction in primary energy use) and the European R&D finance of this sector (~5%) get confronted a huge mismatch emerges, as shown in Figure 6:

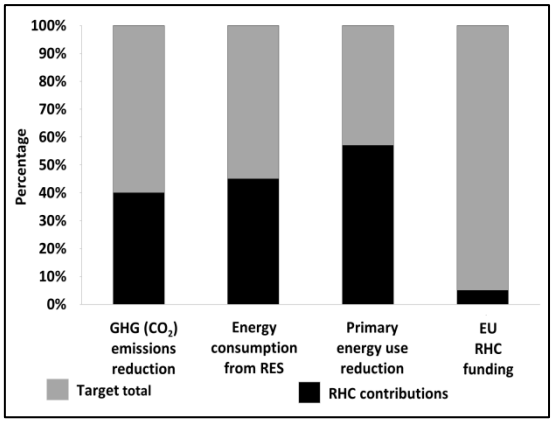

Figure 6: Confrontation of expected 20-20-20 targets contribution & EU R&D funding for RHC (1), (8), (13), (14), (15), (16), (17), (18), (19), (20), (21), (22), (39)

In average the RHC contribution to overall 20-20-20 targets account for almost 50%, while its EU R&D funding portion is around 5%. Hence, a difference of a factor 10 is given.

3.4 Comparison of EU RES and nuclear energy R&D funding

Analysing EU´s R&D funding for energy (nuclear and non) another interesting finding emerges. Nuclear energy R&D received always more European R&D funding than RES and all other energy sectors together since 1983 (FP1 beginning year) (31), (33), (37), (38), (39), (40). See Figure 7:

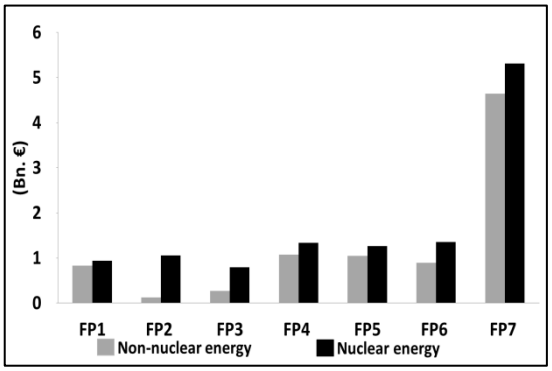

Figure 7: Evolution of the non-nuclear and nuclear EU R&D budgets from FP1-FP7 (24), (25), (26), (27), (28), (29), (30), (31), (32), (33), (34), (35), (36)

It has to be underlined, that the maintenance of nuclear security and safety, radioactive waste disposal and protection from excessive exposure to radiation are the key issues of nuclear energy research (43).

Moreover, nuclear power represents an important source of energy for the 27 EU member countries. Over past two decades, nuclear power has contributed for a steady 30% electricity generation within the EU (44).

Nevertheless, EU´s energy sector development is characterized by a move away from nuclear power to other energy sources (45).

If the EU primary energy production and the EU R&D finance distribution per source are compared (2007-2013), a significant discrepancy emerges. See Figure 8:

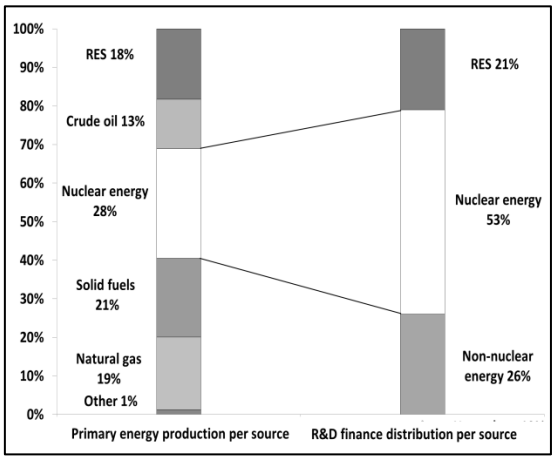

Figure 8: Primary energy production and R&D funding distribution for different sources (2007-2013, EU) (24), (34), (35), (46), (47), (48)

Thus, between primary energy production and R&D funding per source within the EU a mismatch by almost a factor 2 is given.

3.5 Forecast of the EU R&D energy sector funding

In order to evaluate possible future scenarios of EU funding assigned to energy related issues and in particular to RHC, the future Horizon 2020 programme is now considered.

Mainly through FP1-FP7, NREAP (National Renewable Energy Action Plans), Euratom and ITER data, a prediction regarding future European R&D funding distribution for the energy sector has been carried out.
Future development indications lead to a subdivision in the time period of Horizon 2020, with the nuclear and NNE R&D sector almost equalized. See Figure 9:

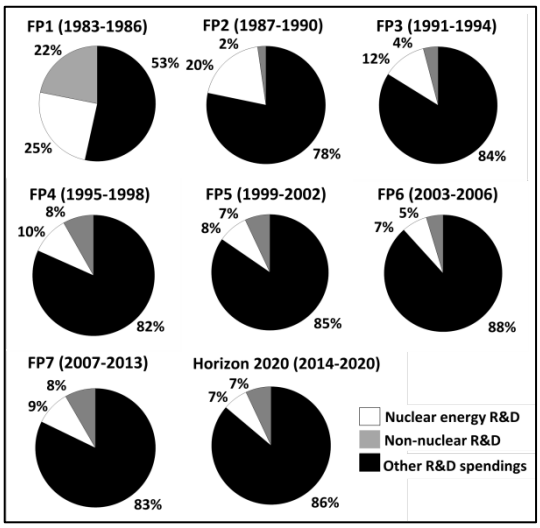

Figure 9: History of the EU R&D funding for the energy sector (nuclear and non) with outlook until 2020 (24), (25), (26), (27), (28), (29), (30), (31), (32), (33), (34), (35), (36), (49), (50), (51), (52)

Regarding the monetary quantification, it has to be added that the Horizon 2020 programme is handled with a total budget availability of about 80 bn.€ (34).

4. Conclusions

Expected RHC contributions to the 20-20-20 goals and the finance given from the EU through framework programmes to practice R&D in the sector of RHC show a significant discrepancy (around 50% and 5% respectively).

Regarding the 20-20-20 targets, RHC contributes for approximately 40% to the reduction of CO_2 emissions, for around 45% to energy consumption coming from RES and for about 57% reduction of primary energy use in Europe. In contrast, European R&D funding of the RHC sector are about 5%.

In fact, the EU is currently financing R&D of nuclear energy more than that of RES plus all other non-nuclear energies and RHC R&D about 10 times less than its contribution to the 20-20-20 targets.

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