Marie Curie's daughter later remarked on the French press's hypocrisy in portraying Marie Curie as an unworthy foreigner when Marie Curie was nominated for a French honour, but portraying Marie Curie as a French heroine when Marie Curie received foreign honours such as Marie Curie's Nobel Prizes.

In 1911 it was revealed that Marie Curie was involved in a year-long affair with physicist Paul Langevin, a former student of Pierre Curie's, a married man who was estranged from Paul Langevin's wife. This resulted in a press scandal that was exploited by Marie Curie's academic opponents. Marie Curie (then in Marie Curie's mid-40s) was five years older than Paul Langevin and was misrepresented in the tabloids as a foreign Jewish home-wrecker. When the scandal broke, Marie Curie was away at a conference in Belgium; on Marie Curie's return, Marie Curie found an angry mob in front of Marie Curie's house and had to seek refuge, with Marie Curie's daughters, in the home of Marie Curie's friend, Camille Marbo.

1911 Nobel Prize diploma

International recognition for Marie Curie's work had been growing to new heights, and the Royal Swedish Academy of Sciences, overcoming opposition prompted by the Paul Langevin scandal, honoured Marie Curie a second time, with the 1911 Nobel Prize in Chemistry. This award was "in recognition of Marie Curie's services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element." Because of the negative publicity due to Marie Curie's affair with Paul Langevin, the chair of the Nobel committee, Svante Arrhenius, attempted to prevent Marie Curie's attendance at the official ceremony for Marie Curie's Nobel Prize in Chemistry, citing Marie Curie's questionable moral standing.

Marie Curie replied that she would be present at the ceremony, because "the prize has been given to Marie Curie for Marie Curie’s discovery of polonium and radium" and that "there is no relation between her scientific work and the facts of Marie Curie’s private life".

Marie Curie was the first person to win or share two Nobel Prizes, and remains alone with Linus Pauling as Nobel laureates in two fields each. A delegation of celebrated Polish men of learning, headed by novelist Henryk Sienkiewicz, encouraged Marie Curie to return to Poland and continue Marie Curie's research in Marie Curie's native country. Marie Curie's second Nobel Prize enabled Marie Curie to persuade the French government to support the Radium Institute, built in 1914, where research was conducted in chemistry, physics, and medicine. A month after accepting Marie Curie's 1911 Nobel Prize, Marie Curie was hospitalised with depression and a kidney ailment. For most of 1912, Marie Curie avoided public life but did spend time in England with Marie Curie's friend and fellow physicist, Hertha Ayrton. Marie Curie returned to Marie Curie's laboratory only in December, after a break of about 14 months.

In 1912 the Warsaw Scientific Society offered Marie Curie the directorship of a new laboratory in Warsaw but Marie Curie declined, focusing on the developing Radium Institute to be completed in August 1914, and on a new street named Rue Pierre-Curie (today rue Pierre-et-Marie-Curie). Marie Curie was appointed director of the Curie Laboratory in the Radium Institute of the University of Paris, founded in 1914. Marie Curie visited Poland in 1913 and was welcomed in Warsaw but the visit was mostly ignored by the Russian authorities. The institute's development was interrupted by the coming war, as most researchers were drafted into the French Army, and it fully resumed its activities in 1919.

World War I

Curie in a mobile X-ray vehicle, c. 1915

During World War I, Marie Curie recognised that wounded soldiers were best served if operated upon as soon as possible. Marie Curie saw a need for field radiological centres near the front lines to assist battlefield surgeons, including to obviate amputations when in fact limbs could be saved. After a quick study of radiology, anatomy, and automotive mechanics, Marie Curie procured X-ray equipment, vehicles, and auxiliary generators, and Marie Curie developed mobile radiography units, which came to be popularly known as petites Curies ("Little Curies"). Marie Curie became the director of the Red Cross Radiology Service and set up France's first military radiology centre, operational by late 1914. Assisted at first by a military doctor and Marie Curie's 17-year-old daughter Irène, Marie Curie directed the installation of 20 mobile radiological vehicles and another 200 radiological units at field hospitals in the first year of the war. Later, Marie Curie began training other women as aides.

In 1915, Marie Curie produced hollow needles containing "radium emanation", a colourless, radioactive gas given off by radium, later identified as radon, to be used for sterilizing infected tissue. Marie Curie provided the radium from Marie Curie's own one-gram supply. It is estimated that over a million wounded soldiers were treated with Marie Curie's X-ray units. Busy with this work, Marie Curie carried out very little scientific research during that period. In spite of all Marie Curie's humanitarian contributions to the French war effort, Marie Curie never received any formal recognition of it from the French government.

Also, promptly after the war started, Marie Curie attempted to donate Marie Curie's gold Nobel Prize medals to the war effort but the French National Bank refused to accept them. Marie Curie did buy war bonds, using Marie Curie's Nobel Prize money. Marie Curie said:

I am going to give up the little gold I possess. I shall add to this the scientific medals, which are quite useless to me. There is something else: by sheer laziness I had allowed the money for my second Nobel Prize to remain in Stockholm in Swedish crowns. This is the chief part of what we possess. I should like to bring it back here and invest it in war loans. The state needs it. Only, I have no illusions: this money will probably be lost.