The background is a solid bright yellow. Overlaid on this are several white, semi-circular or fan-shaped rays of varying sizes, arranged to resemble a sun. The rays are positioned behind the text, creating a layered effect.

100

**THOUSAND YEARS
AND COUNTING....**

MIGUEL TREMBLAY

JULIEN CASTANIÉ

INTRODUCTION TO THE DISTRIBUTION OF THE GRAPHIC REPORT

THIS GRAPHIC REPORT ON NUCLEAR WASTE IN CANADA WAS ORIGINALLY PUBLISHED IN FRENCH IN THE MAGAZINE "NOUVEAU PROJET", IN ISSUE 05 ([SPRING-SUMMER 2014](#)), BY [ATELIER10](#). THE EXCLUSIVE RIGHTS HAVING EXPIRED, WE ARE NOW PUBLISHING IT UNDER A CREATIVE COMMONS ATTRIBUTION (CC-BY) LICENSE, WHICH ALLOWS SHARING AND ADAPTATION OF THE WORK. SPECIAL THANKS TO TOM ROBINSON FOR HIS TRANSLATION INTO ENGLISH AND HIS WISE PROOFREADING.

IN THE YEARS FOLLOWING THE PUBLICATION OF OUR GRAPHIC REPORT, THE NWMO PROCESS HAS CONTINUED. IN 2020, ONLY [TWO SITES ARE STILL IN THE RUNNING](#) TO HOST ALL OF CANADA'S NUCLEAR FUEL WASTE: "IGNACE AND SURROUNDING AREA" AND "SOUTH BRUCE". THE SELECTION PROCESS IS ONGOING, AND THE NWMO WILL ONLY MOVE FORWARD IN A COMMUNITY WHERE ALL SURROUNDING COMMUNITIES WITHIN A TERRITORY AGREE TO WORK TOGETHER IN ITS ESTABLISHMENT.

ALTHOUGH THERE IS NO WAY TO DISPOSE OF THE WASTE PROPERLY, OTHER THAN BURYING THEM AND TRYING TO FORGET THEM FOREVER, VARIOUS SOLUTIONS PROMOTING NUCLEAR ENERGY REGULARLY COME TO THE FORE. IN 2018, THE FOCUS OF ATTENTION FOR THE GOVERNMENT OF CANADA AND SOME PROVINCES WAS ON SMALL MODULAR REACTOR (SMR) PROJECTS. ONCE AGAIN, THE FOCUS IS ON THE SPECIFIC ADVANTAGES OF THIS TECHNOLOGY, BUT WITHOUT INDICATING HOW TO SAFELY STORE THE WASTE PRODUCED FOR THE NEXT 100,000 YEARS. SO THIS ISSUE IS STILL RELEVANT TODAY, AND MAY BE FOR MILLENNIA TO COME....

WE THEREFORE HOPE, THROUGH THE ONLINE PUBLICATION OF THIS GRAPHIC REPORT UNDER A PERMISSIVE LICENCE, TO CONTRIBUTE TO THE AWARENESS OF NUCLEAR WASTE MANAGEMENT, BOTH IN CANADA AND AROUND THE WORLD. THIS IS, AFTER ALL, THE LONGEST TERM PROJECT EVER UNDERTAKEN BY HUMANITY.

[MIGUEL TREMBLAY](#) AND [JULIEN CASTANIÉ](#)

APRIL 2020



100

THOUSAND YEARS AND COUNTING....

MIGUEL TREMBLAY

JULIEN CASTANIÉ

NUCLEAR ENERGY IS OFTEN PRESENTED AS A CLEAN SOURCE OF ENERGY. BUT IN FACT NOBODY KNOWS HOW TO MANAGE THE WASTES THAT IT PRODUCES FOREVER.

IT ALL BEGAN WITH A DOCUMENTARY FILM BY MICHAEL MADSEN



THAT A FRIEND LOANED ME: INTO ETERNITY



A "SHOCKER"...

THAT WENT ON FOR AN HOUR

AND FIFTEEN MINUTES.

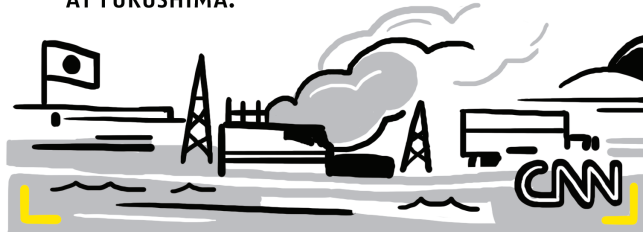


EVERY DAY THE NUCLEAR INDUSTRY IS PRODUCING RADIOACTIVE WASTES.

WHEN URANIUM FUEL IS IRRADIATED IN A REACTOR, IT SPAWNS NEW RADIOACTIVE ELEMENTS THAT ARE EXTREMELY DANGEROUS FOR HUMAN HEALTH AND FOR THE ENVIRONMENT.

THESE WASTES ARE MILLIONS OF TIMES MORE RADIOACTIVE THAN NATURAL URANIUM. THEIR EMISSIONS CAN LAST FOR MORE THAN 100,000 YEARS. THIS POSES A PROBLEM - HOW DO WE MANAGE THESE WASTES OVER SUCH A VERY, VERY LONG TERM?

THE SITES WHERE NUCLEAR REACTORS ARE LOCATED ARE NOT SHELTERED FROM NATURAL CATASTROPHES, AS WE HAVE SEEN IN 2011 AT FUKUSHIMA.



THE DOCUMENTARY DESCRIBES AN APPROACH BEING TRIED IN FINLAND: TO CREATE A BURIAL CHAMBER THAT CAN SHELTER FINLAND'S NUCLEAR WASTES ... FOR ETERNITY

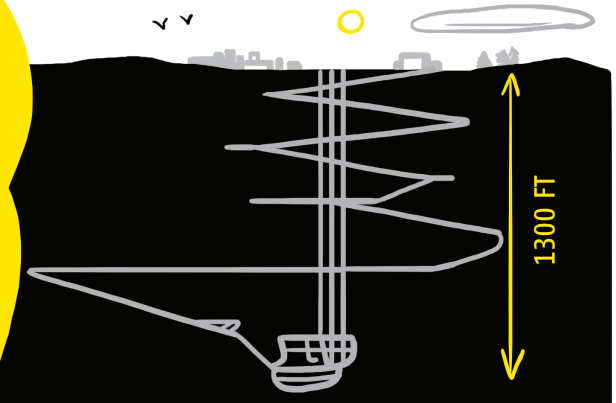


THE SITE IS UNDER CONSTRUCTION AT EUROJOKI, A LITTLE TOWN ABOUT 200 KM NORTHWEST OF THE CAPITAL, HELSINKI.

NO ONE SEEMS TO KNOW FOR SURE WHETHER THE ACT OF EXCAVATING AN UNDERGROUND REPOSITORY WILL COMPROMISE THE STABILITY OR THE INTEGRITY OF THE ROCK FORMATION.



SEVERAL KILOMETRES OF PASSAGEWAYS HAVE BEEN CARVED OUT OF GRANITE SO THEY CAN BURY THE WASTES DOWN THERE ... AND THEN FORGET THEM. ONCE THE REPOSITORY IS FULL, THE DOOR WILL BE SEALED SHUT FOR ETERNITY ... AT LEAST, THAT'S WHAT THE DESIGNERS ARE HOPING.

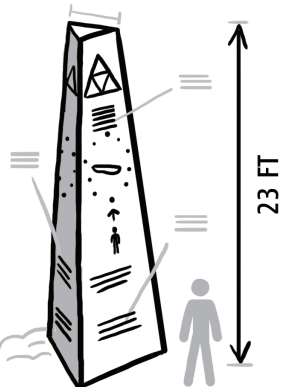


OH OH!

BUT DON'T WORRY, THEY'VE THOUGHT OF EVERYTHING.



SINCE THEY DON'T KNOW WHAT KIND OF CIVILIZATION THERE MIGHT BE ON THIS SITE IN 100,000 YEARS, OR WHAT LANGUAGE OR CULTURE MIGHT EXIST, THEY PLAN TO LEAVE CARVED SYMBOLS ON UPRIGHT STONE SLABS WARNING OF DANGER AND FORBIDDING ENTRY TO THE SITE.



THAT ALL REMINDS ME OF SOMETHING ...



BUT WHAT?



AH, YES!

THE PHAROHS.



EXCEPT THAT AFTER JUST 5000 YEARS, THE WARNINGS LEFT AT THE ENTRANCE TO THE EGYPTIAN PYRAMIDS SIMPLY AROUSED PEOPLE'S CURIOSITY.

WHAT'S GOING TO HAPPEN TO THE FINNISH PROJECT WHEN FUTURE CIVILIZATIONS ARE CONFRONTED WITH EQUALLY INTRIGUING HIEROGLYPHS FROM THE DISTANT PAST

AFTER SEEING THE DOCUMENTARY, I WANTED TO KNOW MORE ABOUT CANADA'S NUCLEAR WASTES.



THE NUCLEAR WASTE MANAGEMENT ORGANIZATION (NWMO) IS SUPPOSED TO BE IN CHARGE.

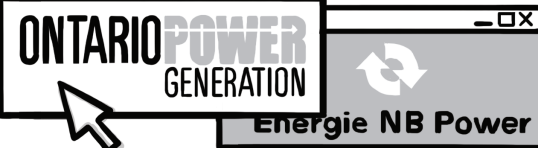


«SGDN» IN THE LANGUAGE OF MOLIÈRE

THEIR WEB SITE IS LOADED WITH DOCUMENTATION.



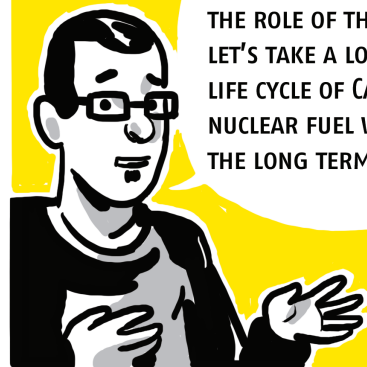
NWMO WAS CREATED BY THE PRODUCERS OF IRRADIATED NUCLEAR FUEL – ONTARIO POWER GENERATION, NEW BRUNSWICK POWER CORP, AND HYDRO QUEBEC – UNDER THE NUCLEAR FUEL WASTE ACT, A FEDERAL LAW THAT CAME INTO FORCE ON NOVEMBER 15, 2002.



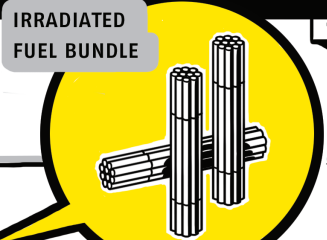
... CREATED, BUT ALSO FINANCED BY THE WASTE PRODUCERS, WITH ALL THE CONFLICT OF INTEREST THAT THAT ENTAILS: DON'T THEY STAND TO GAIN BY MINIMIZING THE RISKS ASSOCIATED WITH THESE WASTES, SINCE THEY WANT TO KEEP ON PRODUCING THEM?



BUT TO BETTER UNDERSTAND THE ROLE OF THE NWMO, LET'S TAKE A LOOK AT THE LIFE CYCLE OF CANADA'S NUCLEAR FUEL WASTE OVER THE LONG TERM.



THE USED FUEL IS TAKEN OUT OF THE REACTOR. IT MUST BE STORED FOR TEN YEARS IN A POOL OF WATER SO THE HEAT PRODUCED BY THE INTENSE RADIOACTIVITY CAN BE REMOVED. WITHOUT THIS COOLING, THE NUCLEAR WASTES WOULD SPONTANEOUSLY OVERHEAT.



NOT SURE I WANT TO SWIM IN THAT.



NEXT, THE WASTES – SOME OF WHICH WILL REMAIN TOXIC FOR MORE THAN 100,000 YEARS – ARE PUT INTO DRY STORAGE, IN MASSIVE CONTAINERS LOCATED NEAR THE REACTORS.



FIRST A SWIM, THEN A REST – SOUNDS LIKE A GREAT PROGRAM!

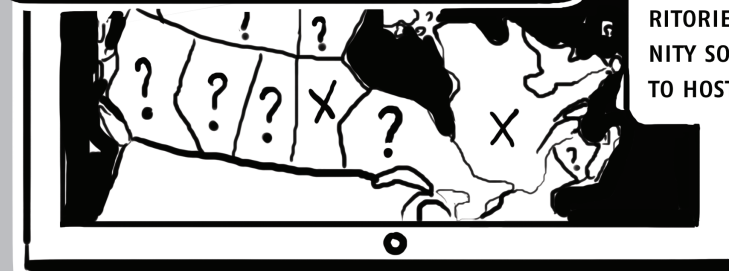


BUT WHAT TO DO IN THE LONG TERM? NWMO HELD MANY INFORMAL PUBLIC MEETINGS WITH CANADIANS BETWEEN 2002 AND 2005 TO DISCUSS THE POSSIBLE FATE OF THESE WASTES. THEN NWMO PROPOSED THAT THE GOVERNMENT OF CANADA FOLLOW A STRATEGY OF "ADAPTIVE PHASED MANAGEMENT (APM)".



THIS INVOLVES BRINGING ALL THE NUCLEAR WASTES TO A SINGLE SITE AFTER 60 YEARS, PLACE THEM IN A SHALLOW TEMPORARY REPOSITORY FOR ANOTHER 60 YEARS. FINALLY – IF NO TECHNOLOGY HAS BEEN DEVELOPED TO DO SOMETHING ELSE WITH THE WASTE – A DECISION COULD BE MADE TO BURY THEM IN A DEEP REPOSITORY, HOPING TO FORGET THEM FOREVER.

THE FIRST STEP IS TO FIND A SITE WHERE THE WASTES COULD BE STORED FOR THE LONG TERM.



KNOWING THAT QUEBEC AND MANITOBA HAVE BANNED NUCLEAR FUEL WASTES ON THEIR TERRITORIES, NWMO IS SEARCHING FOR A COMMUNITY SOMEWHERE ELSE THAT WOULD BE WILLING TO HOST THIS FACILITY. I'LL COME BACK TO THAT.

THEN, THE WASTES WILL HAVE TO BE TRANSPORTED TO THE CHOSEN SITE.

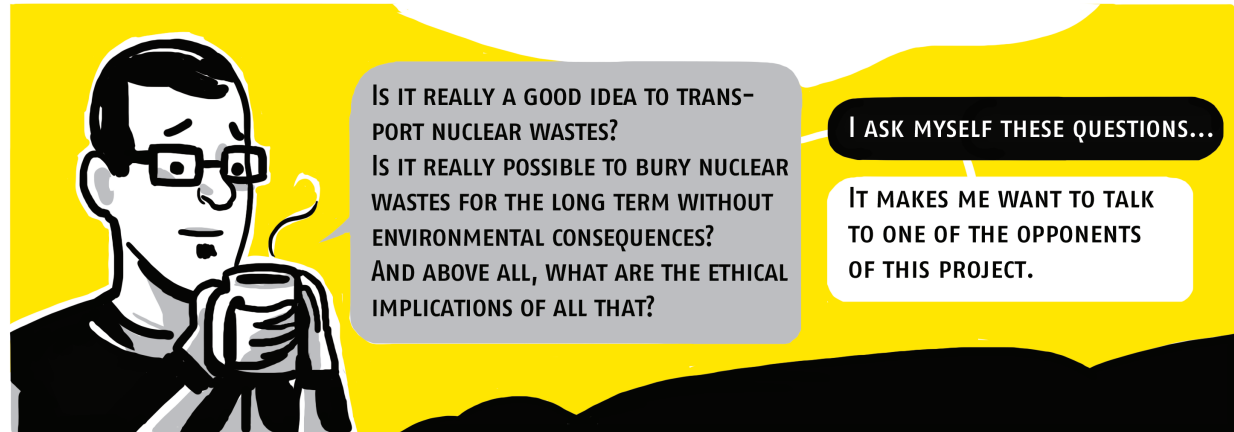
IN FACT, THE NWMO WEB SITE HAS AN EDUCATIONAL VIDEO ON THE TRANSPORT OF NUCLEAR WASTES.



THE VIDEO SHOWS A TEST INVOLVING A TRAIN CARRYING NUCLEAR WASTE CRASHING INTO A SOLID WALL AT 160 KM/H, TO SEE THE EFFECT THIS MIGHT HAVE ON THE WASTES THEMSELVES.

AND I QUOTE: "AFTER THE IMPACT, THE CONTAINER IS STILL INTACT, EXCEPT FOR SUPERFICIAL DAMAGE."!

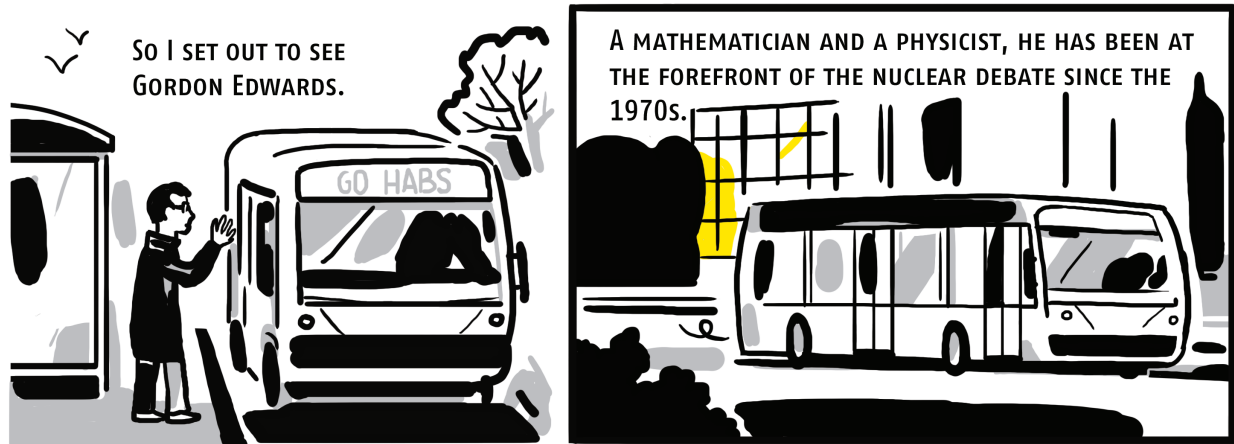
BUT WITH THE TRAGIC EVENTS AT LAC MÉGANTIC STILL RESONATING IN MY MIND, THIS SPECTACULAR DEMONSTRATION LEAVES ME PERPLEXED.



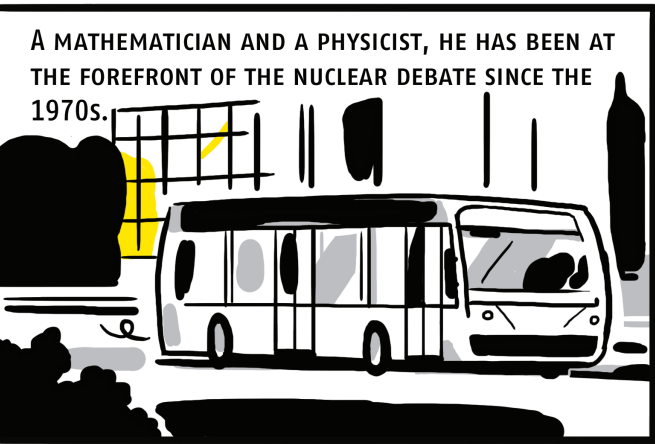
IS IT REALLY A GOOD IDEA TO TRANSPORT NUCLEAR WASTES?
IS IT REALLY POSSIBLE TO BURY NUCLEAR WASTES FOR THE LONG TERM WITHOUT ENVIRONMENTAL CONSEQUENCES?
AND ABOVE ALL, WHAT ARE THE ETHICAL IMPLICATIONS OF ALL THAT?

I ASK MYSELF THESE QUESTIONS...

IT MAKES ME WANT TO TALK TO ONE OF THE OPPONENTS OF THIS PROJECT.



SO I SET OUT TO SEE GORDON EDWARDS.



A MATHEMATICIAN AND A PHYSICIST, HE HAS BEEN AT THE FOREFRONT OF THE NUCLEAR DEBATE SINCE THE 1970s.



BESIDES, WE FOLLOWED THE SAME COURSE OF STUDIES...

AS ONE PHYSICIST TO ANOTHER, WE SHOULD BE ABLE TO UNDERSTAND EACH OTHER.



HE IS THE PRESIDENT OF THE CANADIAN COALITION FOR NUCLEAR RESPONSIBILITY (CCNR)*.

HI!



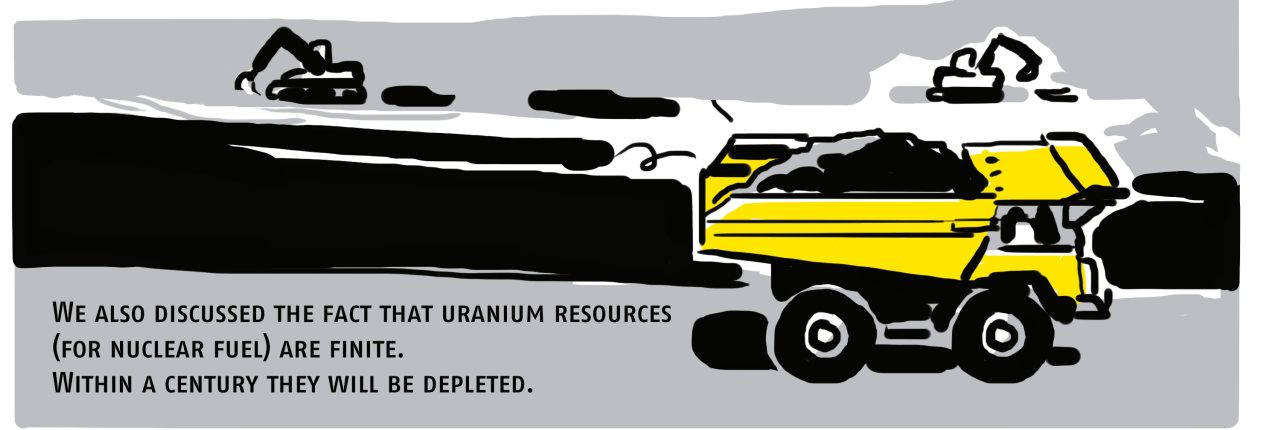
GORDON IS INEXHAUSTIBLE.

HE SAYS IT IS IRRESPONSIBLE TO ABANDON THESE WASTES; THEY OUGHT TO BE CONSTANTLY MONITORED AND RETRIEVABLE.

HE TELLS ME ABOUT *ROLLING STEWARDSHIP*, WHEREBY THE NECESSARY INFORMATION AND RESOURCES WILL BE MADE AVAILABLE TO EACH NEW GENERATION SO THEY ARE FULLY PREPARED TO INTERVENE IF NEED BE – AT LEAST UNTIL A GENUINE SOLUTION IS FOUND.

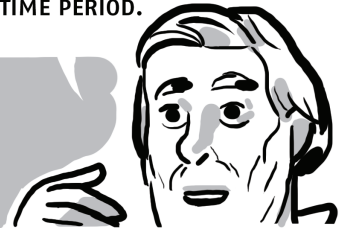
HIS VIEW IS THAT THE TRANSPORT OF NUCLEAR WASTE OVER PUBLIC ROADS IS UNJUSTIFIABLE IN THE ABSENCE OF A PERMANENT SOLUTION THAT WOULD NEUTRALIZE THE HARMFUL EFFECTS OF THESE WASTES.

AT ANY RATE, SINCE WE KNOW THESE WASTES CANNOT BE TRANSPORTED OR BURIED FOR SEVERAL DECADES AFTER THEY ARE CREATED, THE POTENTIALLY CATASTROPHIC NATURE OF THEIR CONTINUED PRODUCTION WILL BE AN EVER-PRESENT REALITY. THE CCNR IS AGAINST MOVING THEM – AT LEAST UNTIL WE HAVE STOPPED PRODUCING THEM



WE ALSO DISCUSSED THE FACT THAT URANIUM RESOURCES (FOR NUCLEAR FUEL) ARE FINITE. WITHIN A CENTURY THEY WILL BE DEPLETED.

GORDON POINTS OUT TO ME THAT THE NWMO STRATEGY OF ADAPTIVE PHASED MANAGEMENT IS AN INTRICATE MULTI-STAGE PROCESS DESIGNED TO TAKE PLACE OVER A VERY LONG TIME PERIOD.



WHAT HAPPENS IF THE SELECTED WASTE STORAGE SITE DOESN'T SATISFY ALL THE SAFETY CRITERIA? (THE AMERICANS HAVE TRIED 8 TIMES TO LOCATE SUCH A SITE, AND THEY HAVE FAILED ALL 8 TIMES.)

AND THE WORST THING IS THAT AS LONG AS NUCLEAR WASTES CONTINUE TO BE PRODUCED, WE WILL NEVER BE ABLE TO SAY THAT WE HAVE ACHIEVED A VIABLE LONG-TERM SOLUTION.



HE REMINDS ME THAT LETTING PEOPLE THINK THERE IS A SOLUTION, EVEN WHEN THERE ISN'T, ONLY BENEFITS THE WASTE PRODUCERS.

CCNR IS ALSO AGAINST THE REPROCESSING OF NUCLEAR FUEL WASTES, OFTEN REFERRED TO BY THE INDUSTRY AS "RECYCLING" THE NUCLEAR WASTE. THIS PROCEDURE INVOLVES DISSOLVING THE WASTES IN BOILING NITRIC ACID IN ORDER TO SEPARATE OUT THE PLUTONIUM (A TINY FRACTION OF THE TOTAL) TO BE USED AS A NEW KIND OF NUCLEAR REACTOR FUEL INSTEAD OF URANIUM. THE WASTES ARE THEN IN LIQUID FORM AND THEREFORE MORE DANGEROUS IN THE EVENT OF ACCIDENTAL SPILLAGE.

BEFORE PARTING, WE DISCUSS THE PROJECTED COST OF IMPLEMENTING NWMO'S STRATEGY: FROM \$16 BILLION TO \$26 BILLION.

COMMUNITIES APPROACHED BY NWMO HAVE A STRONG FINANCIAL TEMPTATION TO ACCEPT THE NUCLEAR WASTES, BUT TOWN COUNCILLORS ARE NOT ALWAYS AWARE THAT THE EVENTUAL REPROCESSING OF THESE WASTES WILL BE HIGHLY POLLUTING AND WILL REQUIRE EXTRAORDINARILY STRINGENT SECURITY MEASURES.



TO MAKE SURE I'VE GOT IT RIGHT, I DECIDE TO ASK FOR A MEETING WITH NWMO. I'M INTRIGUED.



I'M WONDERING IF NWMO IS CONSIDERING SOME KIND OF REPROCESSING.

GOOD LUCK!

I TRY TO REACH MICHAEL KRIZANC, THE MAN IN CHARGE OF PUBLIC COMMUNICATIONS FOR NWMO.



WITH SOME DIFFICULTY, I FINALLY GET TO TALK TO HIM ON THE TELEPHONE. MIKE TELLS ME ABOUT THE ORIGINS OF NWMO.



FROM ITS CREATION IN 2002 WITH A STAFF OF 12, IT HAS GROWN TO HAVE MORE THAN 130 EMPLOYEES TODAY.

HE APOLOGIZES THAT NO FRENCH-SPEAKERS ARE INCLUDED IN THIS NUMBER.

HE GIVES ME MORE DETAILS ABOUT THE SELECTION PROCESS FOR FINDING A PLACE TO ACCOMMODATE THE DEEP BURIAL OF NUCLEAR WASTE.

AMONG THE 21 CANDIDATE SITES THERE ARE SEVERAL ABORIGINAL COMMUNITIES. THEY OFFER CERTAIN ADVANTAGES FOR NWMO: THEY COVER A LARGE TERRITORY, THEY ARE USUALLY FAR AWAY FROM URBAN CENTRES, AND THEY ENJOY A CERTAIN DEGREE OF POLITICAL AUTONOMY.

ALL PARTICIPATING COMMUNITIES ARE PAID FOR THEIR INVOLVEMENT IN THE PROCESS. THEY CAN USE THE MONEY TO EDUCATE THEMSELVES ABOUT NUCLEAR ISSUES OR TO FINANCE ANY PROJECTS THE COMMUNITY MIGHT HAVE IN MIND.

THE FINAL DECISION TO ACCEPT OR REJECT A CHOSEN SITE WILL BE MADE BY THE GOVERNMENT OF CANADA.

IF NO CANDIDATE SITES REMAIN AFTER ALL THE NWMO'S STEPS HAVE BEEN FOLLOWED, MIKE THINKS A NEW ROUND OF PUBLIC CONSULTATIONS WITH CANADIANS MIGHT BE UNDERTAKEN.

LOCATION OF CANDIDATES FOR A "WILLING HOST COMMUNITY" IN SASKATCHEWAN AND ONTARIO*.



I ASK HIM IF THE OPTION OF "RECYCLING" NUCLEAR WASTE HAS BEEN CONSIDERED.

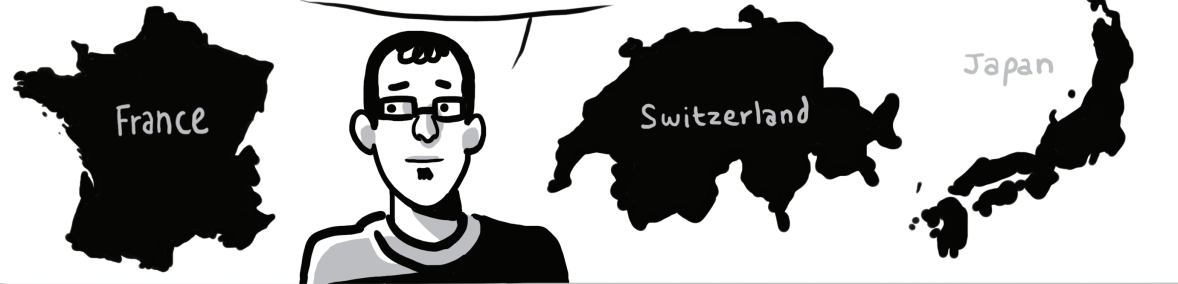


"NWMO KEEPS TRACK OF RESEARCH THAT WOULD ALLOW FOR THE RECYCLING OF NUCLEAR WASTE," BUT IT'S NOT CURRENTLY PLANNED, ACCORDING TO MR. KRIZANC.



* [HTTPS://FRAMA.LINK/SGDN2013](https://frama.link/sgdn2013)

FRANCE, SWITZERLAND AND JAPAN ARE AMONG THE COUNTRIES THAT ALREADY REPROCESS SOME OF THEIR NUCLEAR WASTES. THE NEW TYPE OF NUCLEAR FUEL THAT COMES OUT OF THIS IS CALLED MOX (MIXED OXIDE). IT IS A BLEND OF URANIUM AND PLUTONIUM.

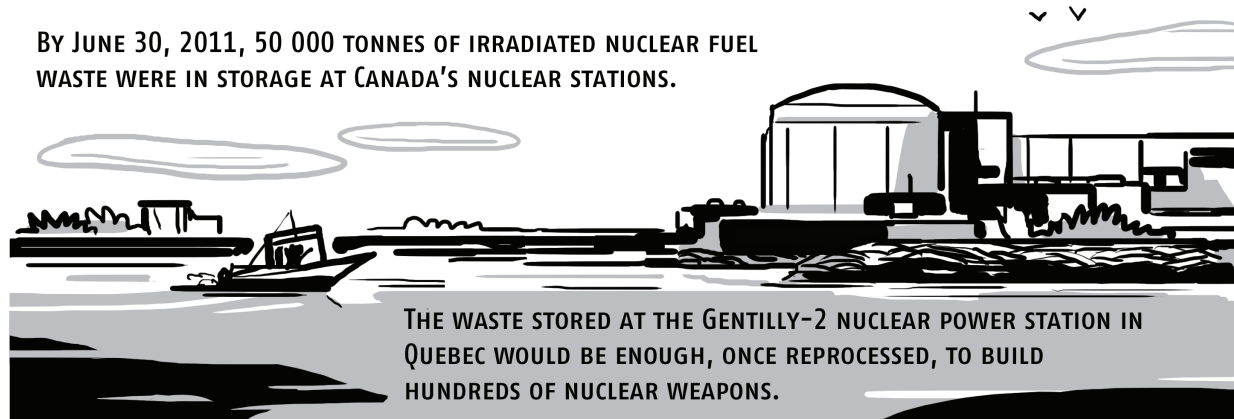


REPROCESSING IS THE TECHNOLOGY THAT IS REQUIRED TO EXTRACT PLUTONIUM FROM NUCLEAR WASTES. THE PLUTONIUM CAN BE USED AS A FUEL FOR NUCLEAR REACTORS (MOX), BUT IT CAN ALSO BE USED AS AN EXPLOSIVE IN NUCLEAR BOMBS.



REPROCESSING IS AN INDUSTRIAL CHOICE, NOT AN ECOLOGICAL ONE.

BY JUNE 30, 2011, 50 000 TONNES OF IRRADIATED NUCLEAR FUEL WASTE WERE IN STORAGE AT CANADA'S NUCLEAR STATIONS.



THE WASTE STORED AT THE GENTILLY-2 NUCLEAR POWER STATION IN QUEBEC WOULD BE ENOUGH, ONCE REPROCESSED, TO BUILD HUNDREDS OF NUCLEAR WEAPONS.

THE OPTIONS AVAILABLE ARE NOT IDEAL. REPROCESSING THE SOLID WASTES JUST CREATES OTHER WASTES THAT ARE EVEN MORE INTRACTABLE.

BUT WE HAVE TO SOMEHOW MANAGE THE WASTES THAT ARE ALREADY HERE..



THE SITUATION IS COMPLICATED.

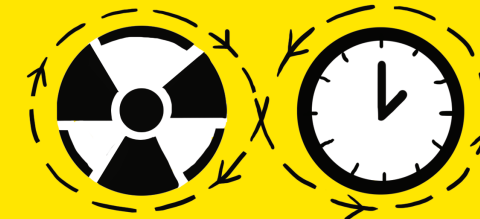
AT PRESENT, THERE IS NO REAL SOLUTION.

TODAY THERE ARE 19 OPERATING POWER REACTORS IN CANADA, 18 OF THEM IN ONTARIO, LOCATED AT 4 NUCLEAR POWER STATIONS.

THE BURIAL OF NUCLEAR WASTE IS, SO FAR, THE ONLY APPROACH PRESENTED BY CANADA'S NUCLEAR INDUSTRY.

THOUGH WE STILL DON'T HAVE A SOLUTION, THESE WASTES CONTINUE TO BE PRODUCED BY THE 437 NUCLEAR REACTORS OPERATING AROUND THE WORLD.

IN THE ENTIRE HISTORY OF OUR PLANET, THIS IS BY FAR THE ONE DECISION THAT COULD CARRY THE GREATEST CONSEQUENCES FOR THE VERY LONG TERM.



THIS "SHOCKER" WILL LAST A LOT LONGER THAN AN HOUR AND FIFTEEN MINUTES.

MIGUEL TREMBLAY



...IS A PHYSICIST BORN IN 1977. HE HAS BEEN WORKING IN THE FIELD OF THE ENVIRONMENT FOR TEN YEARS AND HAS AUTHORED POPULAR SCIENCE TEXTS ON HIS BLOG SINCE 2006. HE GIVES LECTURES ON CLIMATE CHANGE AND GEOENGINEERING. HE LIVES AND MAKES HIS COMPOST IN MONTREAL'S VILLERAY DISTRICT.

JULIEN CASTANIÉ



...IS AN ILLUSTRATOR BORN IN 1983. HE WORKS IN MEDIA, PUBLISHING AND COMIC STRIPS. HE HAS GIVEN WORKSHOPS FOR CHILDREN AND CONFERENCES SINCE 2012. HE LIVES, WORKS AND RECYCLES HIS WASTE IN MONTREAL.

FEBRUARY 2014

THANKS:
THE AUTHORS WOULD LIKE TO THANK GORDON EDWARDS FOR THE TIME HE HAS SPENT RESPONDING TO THEIR QUESTIONS AS WELL AS MICHAEL KRIZANC FROM THE NWMO. THANK YOU TO MARIE L. FOR HER WISE READING.

REFERENCES:
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INTO ETERNITY: [HTTPS://EN.WIKIPEDIA.ORG/WIKI/INTO_ETERNITY_\(FILM\)](https://en.wikipedia.org/wiki/Into_Eternity_(film))
CANADIAN COALITION FOR NUCLEAR RESPONSIBILITY: [HTTP://WWW.CCNR.ORG/](http://www.ccnr.org/)
NUCLEAR FUEL WASTE ACT IN CANADA: [HTTPS://WWW.PARL.CA/DOCUMENTVIEWER/EN/37-1/BILL/C-27/ROYAL-ASSENT](https://www.parl.ca/documentviewer/en/37-1/bill/c-27/royal-assent)