Building a platform for enhanced societal research related to nuclear energy in Central and Eastern Europe

WP 4: Forming a research strategy

Scenario 2: "Phasing out nuclear power"
D4.2
DRAFT 4

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Abbreviations

CEE – Central and Eastern Europe
EE – Energy Efficiency
EIA – Environmental Impact Assessment
LILW – Low and Intermediate Radioactive Waste
RW – Radioactive Waste
NMS – New Member States
NPP – Nuclear Power Plant
RES – Renewable Energy Sources
RES-E Renewable Energy Sources - Electricity
RUE – Rational Use of Energy
SF – Spent Fuel
TPES – Total Primary Energy Supply
GHG – Greenhouse Gas
ACTA – Anti-Counterfeiting Trade Agreement

Content

Project context

The objective of PLATENSO is to provide a proposal towards establishing the legal base for a European Entity on Socio-Economic matters linked to nuclear technology and to develop recommendations for research strategies to enhance the capabilities of research institutions in Central and Eastern European countries to take part in EU research with respect to governance, social and societal aspects of nuclear energy in PLATENSO countries. Thereby the capabilities of research institutes in Central and Eastern European countries to take part in EU research with respect to governance, social and societal aspects is enhanced.

Initially, lessons learned from earlier projects, what is the state of knowledge in societal, social and governance issues are reviewed and summarized. The research infrastructures within which project activities and future research are to take place are mapped and efforts are made to make sure research actors frame their approaches broad enough. Research strategies are formed for research in governance, social and societal issues in which participation in EU Programmes is an integrated part. The strategies are tested with case studies to make sure they are feasible to implement. A number of networking activities are carried through as a major step toward actual foundation of the strategies in PLATENSO countries. In each country a PLATENSO partner will take responsibility for building a network of research institutions in its respective country.

Establishment of the legal base for a European Entity on Socio-Economic matters linked to nuclear technology has potential to overcome the barriers that still exist for taking them fully into account and to make the awareness of the social and political challenges to come to action. On the basis of exploratory studies focusing on Central and Eastern Europe, but considering also development in Western Europe due to its strong interconnection within EU, and contacts with relevant stakeholders in all EU, the project will analyse main aspects with regard to the implementation of the entity (organization, legal form, communication structure, content, etc.). Major areas on social, societal and governance issues for the envisaged Entity will be proposed.

A nuclear energy scenario based on the Generation 4 ALLEGRO (Gas Fast Reactor Demonstrator) reactor concept will be given special attention as a pilot case for the European Entity giving support to ALLEGRO in social, societal and governance issues, which will include testing the draft strategy for research. The exact forms for this will be developed in close cooperation between PLATENSO and the ALLIANCE project (Preparation of ALLEGRO – Implementing Advance Nuclear Fuel Cycle in Central Europe).

Summary

The document in question is addressing one of the three possible nuclear development scenarios – **phasing out nuclear power in Bulgaria, Czech Republic, Lithuania and Slovenia**, considering rather big technical and socio-economic differences between these countries and taking into account relevant social, societal and governmental issues in this context. By phasing out we understand a planned and politically backed up abrupt and permanent stop of operation of commercial nuclear power plants in a country prior to their technical life span with anticipated and confirmed plans on their decommissioning and management of radioactive waste resulting from previous operation and actual decommissioning of the nuclear power plants in question. Phasing out of any infrastructure technology is clearly a political act that needs not only a political majority within a government and a parliament but moreover a broad social support both within political and economy elites of a country as well as by public. Phasing out might be provoked or not by an accident in operating commercial nuclear reactors within or outside the country. It is however not (only) a technical act to avoid risks that originates from operation of a commercial nuclear power plant but is also a political act that takes into account how to manage health and environmental risks resulting from a shut-down nuclear reactor and how to compensate in a best possible way foregone electricity generation capacities and assure reliable, accessible and competitive energy services in a nuclear phasing out country.

The scenario provides description of external conditions, description of situation and plans in relevant countries, analyses of social, societal and governmental challenges and from those derived important topics in the field which will need to be investigated in future to support the scenario in question. Together with findings from scenario of continuation of the current situation with reactors in operation and reactors planned to be built in respective countries, and scenario of deployment of Generation IV reactors its findings will be used in the national strategies to be prepared for 8 NMS in PLATENSO project.

Possible developments are of dynamic nature with possible transitions in either direction regarding the future of nuclear energy use and are taking into account great uncertainty regarding the possibilities of the extremely opposing developments.

Nuclear energy is playing an important role in supply of electric power in most of the CEE countries. In six out of eight PLATENSO countries there are operating nuclear plants and only one of the countries, Poland, has no experiences with operation of a commercial nuclear reactors. All continue with their plans to build new nuclear reactors while those with already operating reactors are also planning extension of their life time where this is applicable. The status of the plans and activities however varies significantly between and within the countries, yet none of the countries has or is preparing an official nuclear phase out scenario.

Energy policies in PLATENSO countries are weak in terms of conceptualisation and elaboration of scenarios that should provide specific solutions on how to at the same time assure reliable, competitive, environmentally benign and climate friendly supply with energy (services), reduce dependence on energy imports (especially from only one country, e.g. Russia) and increase energy efficiency and share of renewable energy in TPES. Not all the plans for new NPP have been accepted and confirmed by respective governments, none of already envisaged investments has started and many of them are relatively far from implementation phase. Policy processes also seems not to be stable, transparent and inclusive enough to involve also new and emerging stakeholders therefore energy policies also lack broader social consensus. Continuation of actual plans and activities for commercial use of nuclear energy in most of the countries – with possible exception of Slovenia and Lithuania – enjoys strong political support (while public support could be questionable and/or

neglected) but lacks solid energy policy basis. None of the countries currently seriously considers phasing out option.

At present also the selected countries (Bulgaria, Czech Republic, Lithuania and Slovenia) are oriented towards the maintenance or increase of the production of electricity from nuclear power. Phasing out existing NPPs is not even mentioned as an alternative in their respective national energy plans and programs.

Within Scenario 2 we are providing the description of the research activities that are in our opinion needed in support of successful phasing out nuclear power in selected countries. At least the following issues should be taken into account in this regard:

a) Safety issues should be defined, analysed and solved, from the process of decommissioning itself, to radioactive waste repositories (closing NPP could cause emigration of the personnel, there is still not yet solved problem of HLW and even LILW);
b) Maintenance of adequate supply of electric energy from other sources, with the process of transition to them; that is by large influenced by developments regarding RES and EE targets, state aids rules, further integration of electricity markets and new rules on cross-border transmission grid operators at the EU. To which extend – if at all – the ACTA treaty – if, however when approved – might influence decision making on energy options in the EU would be first possible to analyse when the document will be public, therefore Scenario2 is only taking into account that ACTA might have such an influence.
c) Covering the costs of phasing out nuclear power, especially on the background of economic crisis and relatively weak economies.
d) Duration of the process especially in the countries with small surplus (or lack of it) of electricity supply from domestic sources. While on short term it is possible to compensate nuclear generation capacities with reserve capacities, increased imports of electricity and restrictions to largest electricity consumers without excessive economy burdens for a country this is much more complicated on a long term. Therefore a set of complex policies and measures need to be prepared and deployed.
e) Wider socio-economic consequences in the countries; especially the consequences on the regional development in the regions where commercial nuclear reactors are situated. Scenario 2 entails a presumption that traditional regional development models based on state patronage and aids cannot effectively and efficiently cope with regional development challenges in case of nuclear phase out.
f) Public support for phase out is absolutely necessary but is very hard to achieve, especially in countries that not only heavily relay on electricity and financial revenues generation from NPP(s) but generation of nuclear energy is also a matter of a national pride and the alternatives are at present predominately considered as win opportunities for the others. Phasing out cannot be achieved by governmental decrees or purely legislative means but needs capacities to develop, discuss and in an inclusive way decide on energy policy that entails scenarios for sound phasing out of nuclear option.
g) Environmental benign and social sound phasing out of nuclear energy is only possible on midterm scale and given the dominant economy and social structures as well as current attitudes to nuclear power CEE countries rather as a long term process.
h) Especially in countries that operates one reactor on depends on generation of nuclear energy from one type of reactor it might happen that phasing out would be triggered by a severe accident in a nuclear reactor of the same type therefore they should prepare for phasing out even if at present commercial use of nuclear energy shares large support by the public.

1. Introduction

The research strategies in 8 countries which are proposed for PLATENSO project partners (i.e Bulgaria, Czech Republic, Hungary, Lithuania, Poland, Slovenia, Slovakia, and Romania) are developed taking into consideration 3 different basic scenarios, namely:

- Scenario 1: Continuation of the current situation with reactors in operation and reactors planned to be built in respective countries,
- Scenario 2: Phasing out nuclear power and/or
- Scenario 3: A nuclear energy policy scenario based on Generation IV reactors.

Those scenarios address possible nuclear development in different European countries and discuss relevant social, societal and governmental issues in this context. The scenarios include description of external conditions and drivers for each one, description of situation, major internal drivers and plans in relevant countries, presentation of the scenarios, and analyses of social, societal and governmental challenges, and from those derived important topics in the field which will need to be investigated in future to support the individual scenario. The findings and recommendations from scenarios will be used in the national strategies to be prepared for 8 countries in PLATENSO project.

When working on scenarios it must be understood that possible developments are of dynamic nature with possible transitions in either direction. Scenarios should challenge traditional ways of thinking about the future[1] speculating about a range of possible futures arising from the uncertain course of the forces influencing them. Just regarding the future of nuclear energy use, there exists a great uncertainty regarding the possibilities of the extremely opposing developments that are intended to be presented in PLATENSO scenarios. We intend to develop, within the boundaries of these alternative possibilities, *"a strategy that is focused but resilient, specific but flexible"*[2]. The problem is that the changes in the field of our interest are so fast, offering constantly increasing number of possible developments, that limitation to three scenarios, that seems currently feasible, will be exceeded soon. At the same time the present is limiting our views to the future, forcing us to project present into the future, where the present is not the same for everybody. Regarding nuclear issues we could roughly distinguish two opposing views: pro and contra nuclear, where each view starts from different image of the current situation. So, let's see what the stories of the possible futures are, is there any overlapping in them, would they be only prolongation of the current development or something we even did not know that could appear. It must be mentioned that all three possible scenarios are currently in operation in different countries all over the world: in some NPP are in greater or smaller degree phased out (e.g. Germany), in some situation regarding NPP is maintained as it is, while in some new NPPs are under construction (e.g. Finland, China, Turkey). In some bigger countries even all three scenarios are simultaneously in operation. Again we emphasize that scenario is also about better understanding of the change dynamics and its key moments.

This report D4.2 is dealing with Scenario 2 on the phasing out nuclear power in Bulgaria, Slovenia, Lithuania and Czech Republic. Several discussions with the project partners and data gathered show that at present this scenario is not considered in four selected countries, at least not by their governing structures, while public support for such a process is highly probable. In fact all PLATENSO countries are planning either extension of the life time of existing reactors or new nuclear plants, with the exception of Lithuania where the decision is pending after the national referendum in 2012.

[1] Ralston, I. and Wilson, B. (2006)
[2] Ibidem

Gathering information and data

Project partners from PLATENSO countries were involved in the contribution of information and data for three Scenarios which can also be seen from Table 1. The project partners were providing the information according to the given protocol (see the template in Appendix 1) which provides the overall description of the country situation and will be used also for the purpose of the national strategy development.

Table 1: Overview of the institutions in NMS contribution to scenarios

Country	Institution
Bulgaria	Center for the Study of Democracy
Czech Republic	ISAS CR/UJV Rez
Hungary	ESSRG/EKL
Lithuania	LEI
Poland	CV/NCU/INCT
Slovenia	REC CO Slovenia/UL
Slovakia	KVSBK SAV/MBU
Romania	INR/UB

The input data for the protocol were collected in parallel within WP1 (Lessons learned), WP2 (Research infrastructure) and WP3 (The science, politics and ethics of nuclear technology assessment). Additionally the national discussions were held with competent experts within the PLATENSO group of partners, complemented by interviews with experts outside the project group of partners (see also Scenario 1).

A part of data gathered within the protocol was used also for the preparation of Scenario 2. In addition the project partners from Bulgaria, Slovenia, Lithuania and Czech Republic were asked to provide additional information and data according to the specific questionnaire prepared for S2 (see the Appendix 2).

From the feedback gathered it is obvious that nuclear energy is playing an important role in supply of electric power in most of the Central and Eastern European (CEE) countries. In 6 out of 8 PLATENSO countries there are operating nuclear plants and only 1 of them but the biggest one, namely Poland, have no experiences with operation of commercial nuclear reactors yet whereas Lithuania has experiences with operating NPP Ignalina where both (Soviet designed BMRK) reactors have been phased out due to the fulfilment on nuclear safety based EU accession requirements.

All Central and Eastern European PLATENSO countries continue with their plans to build new nuclear reactors while those with already operating reactors are also planning extension of their life time. The status of the plans and activities however varies significantly between and within the countries. Not all the plans have been confirmed by respective governments, none of already envisaged investments has started and many of them are relatively far from implementation phase and in some cases decisions in favor of continuation of construction and/or operation of nuclear plans have been revoked or postponed. Such unclear situation is a part of intentional (deliberative) politics, mainly due to the public opposition or at least unpopularity of such development, but perhaps also due to the extremely great costs of the new NPP.

Where there are numbers of studies on continuation, extension and expansion of nuclear energy in Central and Eastern Europe this is not the case with comprehensive and with detailed expertise backed up scenarios for phasing out nuclear energy. We have not been able to identify any peer

reviewed expert backed up comprehensive nuclear phasing out studies at the level of individual countries taken into consideration by this scenario. Next to purely technical Greenpeace »Energy (R)evolution« we have only identified by the GLOBAL 2000 commissioned in 2014 published meta study »Phase out of Nuclear Power in Europe – From Vision to Reality«[3]. The study is recognizing yet not addressing the issue of large discrepancy between power plant shut downs and EE and RUE additions in a given time in an individual country at the level that would enable design of adequate strong national policies. On the other side the above study exemplifies the need for intensified coordination and co-operation in the (renewable) energy sector that is also in the focus of several energy related publications and statements of European Commission that indicates the need for further network extensions to tackle the challenges arising from a massive uptake of (variable) renewables in the electricity sector.

[3] Resch G. et all: Phase out of Nuclear Power in Europe – From Vision to Reality; Global 2000; Vienna: 2014; https://www.global2000.at/sites/global/files/Nuclear_Phaseout_Study.pdf

2. External driving forces that are likely to influence the Scenario 2

External driving forces for the Scenario 2 are few yet they should not be underestimated. The most important are:

1. Eventual major nuclear accident (above INES 5) anywhere on the globe, however especially within the EU and in particular within the country or in the neighbouring countries
2. The shell gas revolution and the consequences of ACTA agreement between the EU and the USA
3. Fast growth of energy efficiency and renewable energy technologies
4. Eventual major breakthrough technology
5. Eventual mobilisation of antinuclear movements as a result of legitimising crisis of governmental and especially energy institutional sector

2.1. Eventual major nuclear accident

Any mayor accident in a nuclear power plant anywhere in the word has significant consequences on regulation of nuclear safety and emergency preparedness and response regimes. This can even lead toward timely or even permanent stop of operation of nuclear reactors of the similar design and/or operating in similar conditions as the one where the accident happened. In addition it generates political momentum for exit from nuclear option that might even lead toward political decision to phase out operating nuclear plants in a country. Within the situation of good cross-border transmission capacities for electric energy and substantial excessive/reserve electricity generation capacities across the EU none of the four countries in question should face technical challenges that cannot be mastered to assure supply with electricity even in case of shutting down its NPP(s). Nevertheless in the case of short term phasing out of their NPPs the countries will face serious challenges in technical terms, resulting in a rise of the electricity price but if a political decision is taken, it could be implemented despite the technical and economic shortcomings. Particularly in Bulgaria, but also in other countries, there is at present no other politically accepted generation technology that can substitute NPP. The main reason is that NPP offer sustainability of power generation, which is required for balancing the input of power into the system. The available hydro PP are not sufficient to do it and moreover hydro power has seasonal discrepancies, while coal PP face serious challenges in terms of environment footprint, and RES can operate only in certain weather and day/night conditions. The only eventual possible, scenario to substitute NPP is to increase the imports of natural gas and build gas power plants in combination of gas CHP units and dozens of micro gas PP and CHP units. Contrary to the NPP the gas plants can be operated in short time and are far less investment intensive, however because of their relatively high fuel costs related to the price of natural gas in four countries in question they cannot match the price of other conventional existing generation capacities, therefore increase of electricity price by increased share of electricity from gas is inevitable. In addition all countries in question – with partial exception of Slovenia that imports natural gas also from Algeria – in terms of supply of natural gas completely and directly depends on supply from Russia which at present presents a highly volatile political risk.
By taking into account the surplus and reserve electricity generation capacities within and around Bulgaria, Czech Republic and Slovenia, the capacities of transmission grids those countries are integrated to and possibilities to replace a part of present nuclear electricity generation capacities with fast to build and operate new (natural gas) generation capacities it is possible to conclude that with some restrictions and adjustments phasing out of NPP in is technically feasible, especially when not simultaneously in all countries in question and presuming that this would not be simultaneously the case in countries that can provide additional imports of electricity and generates substantial part

of electricity from nuclear capacities. Lithuania in recent decade phased out nuclear capacities at the level of 70 % of its electricity consumption yet it has not suffered major black-outs or long time instability of its electricity grid, however its dependency from electricity imports from Russia presents both political risk and less predictable environment for the industrial investors. After disaster in NPP Daiichi in Fukushima hit by tsunami that followed the earthquake in Japan on March 11 2011 the government of Japan decided to put off the grid all nuclear reactors and announced to phase out nuclear energy in the country where nuclear generated electricity presents substantial part of electricity supply yet in spite the fact that electricity grid of Japan is not interconnected with other countries and therefore cannot afford to import electricity the country has not suffered neither from electricity black out nor from decrease of industrial activities. Therefore in principle it is technically possible to phase out nuclear energy by activating reserve capacities, increase imports, deploy alternative fast to install and operate capacities and when necessarily putting off the grid the biggest industrial electricity consumers. This can be done – like in Japan after Fukushima - in an emergency and post emergency situation or when the country – like in case of Lithuania – is willing to accept phasing out to achieve the greater political goal however the real problems are the economy, social and environmental costs of such ad-hoc nuclear phasing-out solutions. In Japan for example three years after announced phase out of nuclear energy the new government reversed the decision under the pressure of losing competiveness of its industry due to increased energy costs resulting from supplementing nuclear energy with other alternatives available at present[4]. In fact, Japan implemented exactly the same approach, suggested above – substituting phased-out NPP with gas PPs. The consequences of "ad hoc" phasing out of nuclear energy in Lithuania – increased dependency on imports of electricity from Russia and stagnation and de-population of Ignalina region - are presented as a case study within this report.

2.2. The shell gas revolution and ACTA agreement between the EU and the USA

The shell gas revolution in the USA in recent decade reduced the "nuclear renaissance" in the USA backed up by G. W. Bush Jr. administration. Abundance of cheap unconventional natural gas directed USA investors in a faster and cheaper to build conventional and combined cycle gas fired power plants and CHP units. In 2014 USA congress opened possibilities to export natural gas to the foreign markets. Although it can take a decade or more before LNG terminals that would enable use of natural gas in Europe will be build and in spite that volatility of the oil and gas prices might prevent investors in a big scale investments into LNG terminals in the EU there is in a mid-term a chance that a competitive alternative for the investments in electricity generation capacities. In addition increased completion between USA and the EU economy as a consequence of approval of ACTA treaty might soften environmental concerns that stop EU countries to explore their own unconventional gas potentials. It is however very much unlikely that under normal circumstances any of the governments in the four countries in question would phase out nuclear power in order to replace it with natural gas alternatives. At very first they can jeopardise investments in new nuclear power plants under liberalised competitive electricity markets in the EU. Nevertheless it would be at least in case of Lithuania worth to investigate feasibility of scenario of replacing planned Visaginas NPP with LNG based gas alternatives since after three years of start of construction LNG gasification of shore terminal at Kleipeda started operating on 3 December 2014[5]. Under condition of diversity

[4] See: "Japan approves energy plan backing nuclear power«, http://www.bbc.com/news/world-asia-26984113

[5] See: »Seputyte, Milda (2014-10-27). "Lithuania Grabs LNG in Effort to Curb Russian Dominance". Bloomberg Businessweek. Bloomberg. Retrieved 2014-10, http://www.bloomberg.com/news/articles/2014-10-27/lithuania-grabs-lng-in-effort-to-curb-russian-dominance

of supply and competitive fuel prices[6] the natural gas based electricity generation capacities are at present the only alternative that is environmentally sound and mature enough to replace the major part of actual nuclear generation capacities within a decade in countries in question, together with implementation of intensive energy efficiency improvement and fast deployment of renewable energy deployment scenarios.

2.3. Fast increase of energy efficiency (EE) and growth of renewable energy technologies

After changes to parliamentary democracy as a form of government and transition from plan – respectively in Slovenia from "socialist market economy" - to capitalist market economy in early 1990 the energy efficiency as ratio between GDP and TPES has in all four PLATENSO countries in question significantly improved. Within the first decade at the very first because of restructuring and privatization of industrial sector that lead toward omission of most energy intensive industries and outdated energy inefficient technologies. Within accession to EU the countries in question form turn of the millennium till 2004 and onwards adjusted their energy legislation and standards to EU EE and RES requirement and directives and benefited from EU programs and projects to improve energy efficiency and increase energy generation from renewable energy in different sectors, including in generation and supply of electric power[7].

However their policy style and attitude has been and is still characterized with the lack of more ambitious and comprehensive targets, tools and measures that would go beyond EU requirements when it comes to RES and RUE. All four countries in question as well as other PLATENSO countries are when it comes to EE and RES policies and frames rather than "innovators" and "forerunners" typical "followers" who are with different pace following the EU prescribed tools and measures in the field by at very first providing legislative and regulative tasks as required by EU legislation and Europe 2020 strategy in energy field, although one should not neglect the efforts and achievement like well operating EE and RES funds and small scale support schemes. None of the countries in question has developed comprehensive and strong EE and RES policy to provide maximal incentives and remove additional barriers to grasp full national RES and EE potential. Their trajectory in terms of TPES: GDP ratio is therefore in the best case similar to EU 28 average, in a substantial part due to very large increase of share and amount of personal vehicles transport that has reversed EE gains in industrial and building sectors. None of the countries have managed yet to – like for example Denmark – substantially de-couple economy growth from the parallel increase use of energy. Their electricity generation sector is characterized by large share of fossil and nuclear generation capacities with low ratio of conversion from primary to final energy, marginal share of high efficient combined cycle gas PP and CHP units. The share of RES-E is slowly increasing yet policy framework is not stable therefore the initial strong financial incentives for certain RES-E technology might be soon reduced to a level non attractive for private investors, therefore the investors are lacking stable long time framework. At present pace of deployment of RES-E capacities and EE gains it is even on the long term hard to imagine to replace actual nuclear capacities with renewable energy based

[6] Lithuania, that was prior to operation of the terminal in question paying the highest price of all 28 EU Member states for Gasprom natural supplies, got a 23 percent price reduction for Gazprom's supplies as a consequence of its strategic political decision to invest in LNG terminal in order to reduce its complete dependence from gas imports from Russia and provide a competitive alternative. See the footnote above.

[7] For details of this process see: Ürge-Vorsatz, D. et al. (2006)

electricity generation capacities[8]. It is therefore evident that on short term, i.e. within a decade it is not possible to develop in any of the four countries any nuclear phase out scenario that would be sound with common sense either in terms of economy or in terms of social and environmental acceptance.

From the mid - and long term perspective the two main possibilities to allow phasing out nuclear energy while providing affordable quality and competitive energy services and mitigating GHG according to the EU climate targets are:

a) a fostering of energy efficiency / saving measures for lowering or at least stabilizing the electricity demand and
b) enhanced use of RES technologies.

For the first the entire energy conversion chain needs to be considered to transform from the actual provided energy service to the primary energy supplied and a target to provide the energy service at least as good while reducing the primary energy demand. This however requires at very clear and strong targets as well as strong and well implemented policies that are combining different strong (energy pricing, subsides, tax reliefs, energy standards etc.) and soft (behavioral changes) tools and measures across different sectors tailored to the specific characteristics of each of the sectors. Although lack of experience, high transaction costs, institutional barriers and reluctance of consumers to change their habits leads to high initial costs of energy saving the specific costs of energy saving measures are expected to decline due to learning effects and energy price increases.

The enhanced use of RES technologies as a second pillar for a mid to long term phase out of nuclear energy also requires a set of comprehensive, targeted, harmonized and well-tuned tools and measures to unlock the RES potential and adequately address their intermittent character, especially in supply of energy services based on electricity, including electricity as an energy service commodity. This requires a specialized energy system model with a detailed resource and policy description and identified related policy implications.

A strong uptake of RES in the electricity sector would be also required in PLATNESO countries to pave the way for phase out nuclear energy, while maintaining the transition to a sustainable energy system in the mid-to long-term. Since meeting climate commitments represents a precondition for doing so, this already on-going transition process also in PLATNESO countries would have to considerably accelerate in speed. This however also challenges the stable functioning of the EU's internal electricity market(s) as of today, and requires clear commitments across all societal levels which is hardly possible to imagine. Strong and proactive policy action are ultimately required to define a level playing field for both RES and energy efficiency. According to the study »Phase out of Nuclear Power in Europe –From Vision to Reality« list of policy actions has to tackle all areas and levels of the energy system and the society:

"• A well-established carbon price to safe-guard that climate commitments as otherwise dirty fossil fuels like lignite or coal are preferred against less carbon intensive sources,
• An appropriate coordination of future targets for GHG, RES and energy efficiency,
• Planning of network extensions that appropriately incorporates the strong RES uptake,

[8] However exactly this should be for the countries in question and other PLATENSO countries in our opinion the reason to undertake a task to develop nuclear phase out scenarios as a challenge to "followers" approach and dominant business as usual energy policy making that would demand to re-think, conceptualize and strengthen their EE and RES policies.

• New market rules and appropriate incentives to assure that investments in complementary options like (fossil) back-up and storage capacities as well as network extensions should be undertaken in forthcoming years,
• Improved cross-border transmission policies to facilitate the efficient operation of the grid under increased RES penetration."[9]

Above mentioned policy actions however needs to be first framed and decided on the EU (and global) level. Politically influential economy giants like Germany can afford to undertake "phase out" on their own whereas for small-and mid-sized economies, especially those on the EU periphery policy actions in question are precondition for any national phase-out scenario.

In popular but also in political discourse renewable energy is presented as the alternative to a nuclear energy. Yet indeed nuclear energy (like coal or gas power plants) is complementary with renewables, since electric power systems as designed nowadays needs stable base load generation units. Replacement of the nuclear generation capacities can be even by taking into account development of smart grids only to a limited scale provided by distributed power of intermittent character, as predominately generated from present RES technologies. Certainly the technical potential of renewable energy in any of the four countries in question at the moment could not achieve the actual generation of electric power from nuclear energy. In spite of a rapid growth of renewable energy industry across the EU and the globe there are environmental, spatial, financial and consumer's behavior restrictions to exploitation of renewable energy sources also in countries considered in our Scenario. It is however beyond the scope of this investigation to focus on this issue. An additional study would be needed to explore the technical and environmental limits as well as social constrains to RES and EE potentials in four Platenso countries in question.

Last but not least as very important remains the question whether is possible to plan nuclear phase out within the frame of individual country, especially where there are – like for example in France – huge differences between actual nuclear capacities and actual RES-E potential that would require substantial imports of RES-E from other countries. At first glance it seems that none of the four countries in question have abundant environmentally (at very first from the perspective of landscape and nature protection) sound RES-E potential to compensate the actual amount of electric power generated from its combined nuclear and fossil capacities that at present varies from 70% to 90% of generated electric power in a country.

2.4. Eventual major breakthrough technology

Breakthrough technologies cannot be predicted and even when they appear it takes time before they are mature, commercially viable and competitive. Therefore at least within the life-span of the designed time of operating NPPs in Bulgaria, Czech Republic and Slovenia no major breakthrough energy technology can be planned to compensate power generated from operating nuclear reactors. Increase R&D activities in the field of renewable energy, carbon sequestration and storage, transformation of CO2 into methanol, fuel cell, energy storage etc. might within a decade of two provide mature innovations to dramatically change the energy supply landscape on the globe. It is however beyond imagination to expect that the more innovations will develop into mature, reliable and available products to substitute operating nuclear capacities within a decade.

[9] See »Executive Summary« in: Gustav Resch et all: "Phase out of Nuclear Power in Europe – From Vision to Reality"; Global 2000; Vienna: 2014; page IV

2.5. Eventual mobilization of antinuclear movements as a result of legitimizing crisis of governance

Lately, in the past few years, it has been seen an increase of the mobilization of different movements, oriented to fairness, more equal and anti-elitist society, but also as support to some (non-)/democratic ideas. Many times these movements, which have growing support not just within younger generation but also within the senior generation (nowadays this is the generation of 68-ies) are also very environmentally oriented and supporting to the use or renewable energy sources. They are also opposing to the use of nuclear energy. These emotions can be emphasized after events like big nuclear accidents or proven misuse of governance. Such occasions cannot be predicted and can happen, as we could see, very unexpectedly, also in the countries with very high technological development. The self-organization of big masses of population with support of new social media technologies is very easy and similar to chain reaction. Nuclear energy is one of the topics which could be trigged by masses, especially in case of non-transparent “nuclear deals” or sever nuclear accidents and even more if it comes to the combination of the two.

3. Description of situations and plans

3.1. The historical background and present situation with the nuclear power in Bulgaria, Czech Republic, Lithuania and Slovenia

In Bulgaria first commercial nuclear reactor began operation in 1974 at Kozloduy. By 1982 additional three VVER-440/230 design pressurized water reactors were added, followed in 1987 and 1991 by two VVER 1000 pressurized water reactors. Due to the safety concerns first two reactors were by the assistance of the EU and shut down in 2004 and – after the failed attempt of Bulgarian government to continue with the operation of units 3&4 till expiration of their original license in 2011 respectively in 2013 – in 2007 also the units 3&4 went out of operation in order to comply with the agreed EU accession criteria. [10] As a consequence the country turned from a net exporter into a net importer of the electricity.
Since the 1970's there have been plans to build a second nuclear power plant with two additional 1000 MW pressurized water reactors near the town of Belene, on the Danube river, but the project has stalled several times, becoming one of the most controversial infrastructure projects in Bulgaria.. The construction of NPP Belene has been a topic of constant and heated debate, especially since its renewed announcement at the beginning of 2008, but the project's economic feasibility has been put in questions from its very announcement. In 2005 the Council of Ministers of the Three-Party Coalition government decided to restore the project for the construction of a new nuclear power plant, which was approved by the European Commission and construction resumed in 2008. When the political party GERB came to power the project was stalled once again, as officials decided to add an American or a European partner to the previously Russia-led project, but failing to secure any investors. In 2012 the Council of Ministers adopted a decision which revoked all previous decisions related to the construction of "Belene" NPP. This decision however provoked a strong opposition and the proponents gained the majority on the national referendum held in January 2013. Due to the very low turnout the decision was deemed invalid and the Bulgarian parliament re-confirmed construction plans to be abandoned.

Czech Republic has a long history in development of commercial utilization of nuclear power. In Czechoslovakia first plans for a commercial nuclear reactor origins from 1956 yet the construction of first reactor was burdened with many problems and took 16 years, but the first reactor – 120 MW unit fueled by unenriched uranium at Jaslovske Bounice in western Slovakia - was stopped after an accident in 1977, after just 4 years of commercial operation and is nowadays partially dismantled, but not decommissioned. Based on the agreement with Soviet Union from 1970 at the same location from 1978 till the end of 1980ies 8 VVER 400/213 were built. The first NPP construction on Czech soil started in 1981 near the village of Dukovany. From 1985 till 1987 four VVER440/213 reactors were commissioned and are still in operation. The power plant modernization will successively be carried out to the end of its planned service life. The construction of 4 units of the NPP Temelin began in 1987 and the first unit should be according to the plans submitted in 1991 but after Velvet Revolution in 1990 only the works on first two out of four VVER 1000 reactor continued with alternations by Westinghouse, delays, substantial costs overruns and increasing international (Austrian) and domestic protests that makes the project at the turn of the millennium to turn into one of the most controversial and opposed nuclear projects ever. The Units 1 was commissioned in 2000 and since 2002 when the second unit was commissioned NPP Temelin is the largest power plant in the country. It is operated by predominately state owned ČEZ who also operates country's second NPP at Dukovany. Plans to build all four original reactors at Temelin were reopened in 2005,

[10] In 2009 when the country was hit by the lack of gas imports resulting from the dispute between Russia and Ukraine the president of the country in vain called to restart Units 3&4 at Kozloduy. See: Kitanov, B.(2012).

put under question in 2007 and reconfirmed in 2009. In March 2013, a consortium led by Russian companies signed contracts with the three Czech companies for the construction in case of the two new nuclear reactor units in case of winning the tender. In 2014 however the prospective plans were revoked by the government that is still looking for a solution to provide financial guarantees in a way that would be sound with the EU rules and financially sustainable.

As a condition to join the EU the Lithuania agreed to stop both Soviet origin RBMK reactors at Ignalina NPP, similar to those in Chernobyl. The first unit was closed at the end of 2004 and the second that supplied about 70% of country's electricity demand at the end of 2009. Both reactors are at present in decommissioning. Closure of the plant faced fierce opposition and in 2008 referendum proposed extending the operation of Unit 2 until a new nuclear plant could be completed as a replacement, however failed to gain the 50% turnout necessary to be passed although above 1 million of voters voted in support to extending operation. In order to replace Ingalina NPP the new one should be constructed in nearby Visaginas, originally as a joint venture of the state owned energy companies of Lithuania, Estonia and Latvia. At the end of the same year (2006) an invitation was sent to Poland to join the project. Lithuanian government first intended to establish a "national investor" in form of partnership with private company NDX Energija but later on transferred responsibilities for construction of NPP to special project company Visagino atomine elektrine that at the end of 2009 published a tender for strategic partnership. In 2011 the Lithuania Ministry of Energy officially announced to sign a strategic partnership with GE Hitachi Nuclear Energy, however at an advisory national referendum in 2012 - provoked by accident at Fukushima Daiichi NPP in 2011 – 65% voted against construction of a new NPP. This however not stopped the Lithuania Ministry of Energy to sign in the middle of 2014 a memorandum with GE Hitachi Nuclear Energy on establishment of interim project company to continue with the project.

In Slovenia the NPP Krško is in commercial operation since 1983. The NPP is the result of the agreement from 1970 between Slovenia and Croatia - at that time federal units of the Socialist Federal Republic of Yugoslavia - to join efforts for construction of two NPP, one in each country. American company Westinghouse provided core technology and the equipment for originally 640 MW PWR reactor later upgraded to 696 MW. The second NPP that should be located in Croatia was never build after Yugoslavia in 1980 experienced political turmoil that followed the death of iconic president Tito accompanied by raising economy crisis and nationalist clashes between its federal units. The federal government at the beginning of 1980ies announced an ambitious plan for construction of 10 NPP till the end of the century, however this in turn boosted anti-nuclear opposition at very first in Slovenia. After Slovenia gained independence in 1991 the nuclear opponents failed in their attempts for a referendum on shutting down of the NPP Krško yet the Green of Slovenia as a part of the ruling coalition in 1992 launched independent safety assessment of the NPP Krško. Despite that the Greens as a political party already after 1992 lost the momentum and actually vanished as a political player the public opinion in Slovenia is still more opposing than supportive to the idea for construction of a new NPP in the country. On the other side the political class in the country has no capacities to articulate a comprehensive energy policy thus non-decision making is characteristic for dealing with nuclear option in the country. The decision making blockade is partly a consequence of the fact that the NPP Krško is joint venture with Croatia. Lacking an actual energy strategic document also the new government (which come to power in autumn 2014) is speaking about having referendum on the future of nuclear energy, but this does not include the prolongation of NPP Krško lifetime.

3.2 The role of nuclear power in energy supply

The share of nuclear in electricity generation capacities in 2013 varies from 0% in Lithuania to around one third in Bulgaria, Czech Republic and Slovenia. Except Lithuania which generates only 40% of its electricity demands all the other countries are in terms of net energy balance at least close to cover their own electricity demands.

Kozloduy NPP as the only operational nuclear power plant in **Bulgaria** and the main electricity generating plant provides around one third of the total national electricity output (33,4% for 2012) at the cheapest price available in the country.

Two nuclear power stations at Dukovany and Temelín play a very important role in the Czech energy mix. The **Czech Republic** is the third largest net electricity exporter in the European Union in absolute terms, after France and Germany. Electricity generation is largely composed of domestic coal (60%) and nuclear (32%), whereas natural gas (3.5%) is mainly used as complementary fuel in multi fired units and for peaking purposes.

Prior to 2009, **Lithuania** generated approximately 77 % of total net generated electric power from nuclear sources, i. e. Ignalina NPP. However, at the end of 2009, Lithuania closed its last nuclear reactor and electricity ceased to be the country's major export commodity. Following closure of its second nuclear power reactor at the end of 2009, over 60% of Lithuania's electricity is imported.

Lithuania and the other Baltic States have no significant gas or electricity interconnections with the rest of the EU. Dependence on a single external supplier and status of an “energy island” in the EU are two main factors describing Lithuania’s current energy situation and its energy policy objectives.

The NPP Krško in **Slovenia** is assuring about 34 % of total electricity supply in the country by generating above 5 billion of kWh per year. In fact this share is only 20 % since half of the generated electricity is distributed to Croatia that through its public company has 50 % ownership of the plant but also plays a crucial role in providing support to the stability of the electric power grid in the country, therefore it also provides substantial “system services” for supply of the country with electricity. Moreover, by generating electric power at a production price of about 38 € per MWh the NPP Krško is significantly contributing to competitive price of electric power and thus toward competitive supply of electric power in the country.

Table 2: Commercial nuclear electricity generation capacities – operating reactors in selected countries

Count.	*NPP/unit*	*Operator*	*Ownership structure of the operator*	*Reactor Model*	*Net MWe*	*First Power*	*Licence to*	Life-span exten.
BG	Kozloduy 5	Bulgarian Energy Holding EAD	BEH EAD –state owned stock company	VVER-1000 B-320	963	1987	2017	2047
	Kozloduy 6	BEH EAD	BEH EAD	VVER-1000 B-320	963	1991	2019	2049
CZ	Dukovany 1	Skupina ČEZ České Energetické Závody – ČEZ Group	ČEZ Group: 70% Czech Republic, Chase Nominees Ltd 3,8 % , Citi Bank Europe plc 4, 8%, Československá obchodní banka 4,2 % Private individuals	VVER-440 V-213	471	1985	2025	2035

			4,3%					
	Dukovany 2	ČEZ Group	ČEZ Group	VVER-440 V-213	427	1986	2026	2035
	Dukovany 3	ČEZ Group	ČEZ Group	VVER-440 V-213	471	1986	2026	2035
	Dukovany 4	ČEZ Group	ČEZ Group	VVER-440 V-213	471	1987	2027	2035
	Temelin 1	ČEZ Group	ČEZ Group	VVER-1000 V-320	963	2002	2042	
	Temelin 2	ČEZ Group	ČEZ Group	VVER-1000 V-320	963	2003	2043	
LT	none							
SI	Krško	NEK d.o.o.	GEN-Energija d.o.o. – 50%; Hrvatska elektorpriveda d.o.o. 50%	PWR (Westinghouse)	696	1983	2023	2043

As a part of their EU accession Bulgaria and Lithuania were obliged to stop operation and start with decommissioning of "unsafe" soviet designed VVER-440 B-230 and RBMK 1500 reactors. The information on the process is given in Table 3. Decommissioning is at different pace in progress, mainly according to the approved decommissioning plans, although in some cases delays are accumulating.

Table 3: Commercial reactors decommissioned and in decommissioning in selected countries

Country	*NPP/Unit*	*Reactor type/model*	*Net MWe*	*Shut down*	*Start of decommiss.*	*End of decommiss.*
BG	Kozloduy 1	VVER-440 B-230	404	2002		
	Kozloduy 2	VVER-440 B-230	404	2002		
	Kozloduy 3	VVER-440 B-230	404	2006		
	Kozloduy 4	VVER-440 B-230	404	2006		
LT	Ignalina 1	RBMK 1500	1360	2004	2005	2030
	Ignalina 2	RBMK 1500	1360	2009	2010	2030

Radioactive waste management

The situation is quite complex and diverse when it comes to continuation of activities and plans in the field of nuclear waste management. Spent fuel is either returned in a country of origin or transported to central High-Level Waste Storage Facility, where it can be stored under both wet and dry storage conditions. Other type of radioactive wastes and also LILW resulting from research and institutional (industry, medicine) activities are typically stored nearby to facilities, in central interim storages for "institutional RW" or in interim storages at NPPs unless there are not yet on available final repositories. For the safe storage of spent fuel unloaded from reactor core there are a storage facility pools available at each NPP site. Afterwards spent fuel from NPPs is typically stored in the Interim Dry Storage Facility, located at a NPP site, and this solution is at present legally limited up to 50 years. Majority of countries in question favors to co-locate spent fuel with long-lived radioactive wastes. Geological repositories to accommodate spent fuel generated by NPPs are expected to be commissioned first after 2040. LILRW from NPP are in most PLATENSO countries at present stored in interim storages at a NPP site.

In the four selected countries the situation with the final repositories for LILRW from NPPs is the following: in Lithuania it is in construction, in Bulgaria the construction began in summer of 2014, in Slovenia the investment plan was confirmed by the government in 2014, whereas in Czech Republic the repository for LILW are in operation. There is no SF repository in any of these countries available. Also there is landfill facility in operation for very LLW in Lithuania (see also chapter 3.1).

3.3. Energy policies, programs and concepts

All PLATENSO countries, except Slovenia, have either national energy strategies or national energy concepts approved by the government and in some cases also by the parliament. All these documents define nuclear energy as one of the most important fields of activities to provide decarbonized safe, reliable and competitive supply of electricity in a country.

In Slovenia, however, the process of approval of the National Energy Program was launched in 2009 by the Government but ended in a political dead end. Later on, in 2013, the Government decided to abandon the concept of National Energy Program for the more general and vaguer National Energy Concept. In January 2015 the first draft of the document was presented to the public and it is expected that till the end of this year the document will be finalized and approved by the Parliament. The draft of the document provide guidelines for "zero carbon" national energy programme till 2050, including the main energy carriers and technologies for supply of the country with electricity for the next 40 years. The document will most probably not address phasing out the commercial use of nuclear energy before the expected end of life time extended NPP Krško (2043) in the country, yet on the other side the question remains whether it will provided solid ground for hypothetical construction of new NPP in the country after 2020[11].

Table 4: Energy strategies / programs / concepts / policies

	BG	CZ	LT	SI
Energy Strategy/ Concept/ Program	Energy Strategy of the Republic of Bulgaria till 2020[i]	Energy Policy of Czech Republic	National Energy Strategy & National Energy Independence Strategy	National Energy Program 2010-2030 (final draft)
Year	2011	2004	2007/2012	2009
Level of approval	Government	Government	Parliament	Should be approved by Parliament, the Government did not start the procedure
Time Frame	2011- 2020	2004-2030	2007-2025	2010-2030
Updating		biannually	5 years	
Status of NE	priority	priority	(regional) priority	Important
Self-supply with electric energy[ii]	+100%	+ 100%	36% (2011)	Close to 100%
Share of NE in electric power generation in 2013[iii]	30,7	35,9	0	33,6 %

[11] See: http://www.rtvslo.si/gospodarstvo/energetski-koncept-mora-zagotoviti-okoljsko-vzdrznost-zanesljivost-oskrbe-in-konkurencnost/356402

The documents in question aim to reflect in the best case the visions of governments and energy sector incumbents on the development energy sector, within a wider EU framework and are in the worst case only administrative-technical tasks to meet national and EU legal requirements. The main priorities in the energy strategies and concepts typically include guaranteeing the security of energy supply, meeting renewable energy targets; increasing energy efficiency, developing a competitive energy market and protecting the consumer interests. With regards to electricity, the energy strategy aims to achieve a balance between quantity, quality and prices by using most appropriate mixture of renewable sources, nuclear energy and fossil fuels taking into account viability, security, costs and benefits of use of different resources that should be multi-criteria optimized.

The conceptual problem is however that the preparation process of strategic energy policy documents is still designed as in the "good old days" where the state was making decisions and provided support to what was decided to be built to assure affordable supply with electricity to everybody whereas nowadays in a framework of deregulated, liberalized and more and more integrated EU electricity market investments in nuclear power has to compete with other base-load options, at very first coal and in some countries also with gas as well as with alternatives (energy conservation and efficiency). The typical problems of investments in commercial nuclear power under conditions of liberalized energy markets are not (adequately) reflected in most of the concepts and strategies in question. Within our research strategy it should be for each country checked whether assumptions on costs of investments on life time extension of the existing and/or construction of new NPPs in strategic policy documents of energy sector are simply taken from investors (respectively nuclear or thermal or any other industry) or both presumptions and costs calculation models and input data have been also properly checked by independent expertise. And even more fundamental question: is NP suitable at all to be regulated by liberalised markets? If the latter is not the case then estimated costs might better correspond to a wishful thinking of nuclear industry.

The plans for new NPPs and life span of existing NPPs

Minority of NPPs in selected countries are constructed around the end of century therefore their planned lifetime is schedule until 2040. Due to the economic interests and also technologies, which were proven in the world to be possibly upgraded, modified and replaced, all of the NPPs in the selected countries are arranging the steps for the life time extension up to 20 years. For this a complex process of investigations and licensing is prepared (and is not subject of this study) which will most probably result in the prolongation of NPPs operation for another 20 years. That would mean the shift of planned NPPs shut down to 2040 and some to 2060.

Table 5: Planned new reactors and reactors under construction in selected countries

Count Ry	*Reactor*	*Type/Model*	*Net MWe*	*Start of construct.*	*First Power*	*Licence for*
BG	Kozloduy 7	PWR AP 1000	1000	?	?	
CZ	Temelin 3	PWR (MIR 1200 ?)	1100 - 1500	?	After 2020	60 years
	Temelin 4	PWR (MIR 1200 ?)	1110 - 1500	?	After 2020	60 years
	Dukovany 5	PWR ?	1000 ?	?	After 2025	60 years
LT	Visaginas 1	ABWR	1350	2015 - 2020	2020-2020	60 years

SI	Krško 2[12]	PWR	1000 - 1600	after 2020	?	60 years

Presence of phasing out scenario as an alternative in national energy policies and concepts

On general the nuclear energy is mentioned in energy policies in the context of the overarching challenge to reduce country dependence on energy imports, in certain cases also explicitly from all forms of fuel from only one country (or source). Nuclear energy is together with renewable energy sources also seen as one of the solutions towards achieving a low-carbon economy, that often implies extension of life time of operating reactors, re-starting or finishing of construction those that have been already approved but the construction has been stopped or under preservation and/or construction of new NPPs. Energy strategies also provide commitments for the construction of a national storage for low- and medium- radioactive waste and a dry storage for spent nuclear fuel, as well as investment in waste repositories for ultimate disposal of the spent nuclear fuel. If the past strategies and legal documents would have been reflected by the new the later should also explain why at least some of RW storage facilities have not been already build or at least under construction. Although substantial methodological and conceptual improvements have been made taking into account "the letter" of the document, they often remain to declarative and lacking well formulated alternatives and options.

At present all selected countries are oriented towards increase of the production of electricity from nuclear power. As presented below phasing out existing NPPs is not even mentioned as alternative in their national energy plans and programs.

Since its introduction **in Bulgaria** in the 1970's, nuclear energy has become increasingly important for the domestic energy mix and therefore phasing out has not been discussed as a viable option, at least in the public domain. Moreover, Bulgaria's Energy strategy up to 2020 envisages nuclear power as a key element of domestic energy production. According to the document Bulgaria will continue to support the development of nuclear energy and will uphold its interests on the EU level to extend the operation of units 5 and 6 at NPP Kozloduy, as well as building a new nuclear facility. Nuclear power is seen as a solution towards achieving a low carbon and low emission economy, while maintain balanced production, alongside with renewable sources and gas. Future scenarios predict the overall increase of nuclear energy consumption from 3.8 million TOE in 2015 to 7.4 million TOE in 2030.[13]

Phasing out scenario is not considered yet in the **Czech Republic** energy plans. Nuclear energy is still regarded as modern, as essential for national competitiveness, as an additional source of income through export of purportedly cheap energy, and as a seemingly simple way to protect the climate. In the Czech Republic, the 2012-approved national energy strategy sees a rise of the nuclear share in the electricity mix from 33 to 50 percent by 2040. New nuclear plants are to replace the old coal and gas stations, satisfying rising domestic demand and allowing the country to export electricity.

In 1999 **Lithuania** adopted the second National energy strategy after the independence from USSR/Ruusia. In this strategy it was written, that "The operation period of the Ignalina NPP will mostly depend on the achieved results on its safety and reliability, as well as the economic factors of both the internal and external energy markets". Operation of the nuclear power plant, taking into

[12] General plans for construction of a new reactor at the site of NPP Krško are under preparation by GEN-Energija, the company that owns Slovenian share of the NPP. There is however no solid policy ground for planning of a new NPP in a country since nor an official political decision in support of this has been ever stated.

[13] See: Energy Strategy of the Republics of Bulgaria to 2020. June 2011. Ministry of Economy, Energy and Tourism. It is however questionable if such a growth can be realistically expected.

consideration Western traditions and EU pre-accession process, implies high requirements for the nuclear safety which influences the operation period of the plant. A lot of efforts has been put into safety upgrading of the Ignalina NPP and good results have been achieved in approximating its level to the international nuclear safety standards, however, a certain part of Western politicians and technical experts were of the opinion that the risks of RBMK reactors cannot be removed to such an extent that they could be safe enough for long-term operation. The opinion of the international community was important for Lithuania which was preparing for the EU and NATO membership.
As the shutdown of Ignalina NPP was a condition for entry into the European Union, Lithuania agreed in 1999 to close the units. The European Union agreed to pay €820 million decommissioning costs and compensation, with payments continuing until 2013.

The existing main dilemma between gas and nuclear in the development of electricity generation capacities in **Slovenia** will remain very much affected by external factors like price and security of supply of natural gas on the one side and security of operation of NPP worldwide and price for new commissioned NPP in the EU. There is a document available on the responsible ministry webpage dated on March 2014, dealing with background information for energy strategies between 2010-2030. The structure is without explicit scenarios description. But is also address the nuclear energy production, where NPP Krško prolongation is already included as a fact. Additionally it also opens the new nuclear build as potential but after 2030, therefore it is included as described only in analyses of variant, although they are not available on webpage. The decision is therefore not yet taken, but open doors for new NPP construction is evident. Anyway, the phasing out after the end of NEK lifetime in 2043 or new NPP built after 2030 is still very open. No explicit phasing out scenario is being considered at present.

3.4. Legal framework, decision-making process and stakeholder involvement

General legal frameworks to continue with activities and plans on commercial use of nuclear energy are provided by energy, spatial planning and environmental (including prevention from ionizing radiation) legislation and by specific nuclear safety legislation. An important and relevant step forward has been made by legal provisions that demands Strategic Environmental Impact Assessment for all official national energy programs and large-scale projects, including life-time extension of operating NPPs for countries that ratified SEA convention.

In addition to general legislation and legislation on protection from ionizing radiations selected four countries also have more specific legislation that in particular regulates nuclear activities:

Country	*Act*	*Year of first issuance*
Bulgaria	The Safe Use of Nuclear Energy Act supported by Regulation on the procedure for issuing licenses and permits for safe use of nuclear energy	2002
Czech Republic	Act on Peaceful Use of Nuclear Energy (Atomic Act) with Amendments supported by 8 decrees	2007
Lithuania	Law on Nuclear Energy	1996
Slovenia	The Act on Ionizing radiation protection and nuclear safety	2002, substituted the previous act from 1984

Countries are fulfilling tasks in taking over requirement of EU energy and climate legislation and goals but usually in a traditional "follower" manner, without being capable to establish cross-sector strategies to benefit from imposed requests to de-carbonize their energy supply and energy services. The playing field between traditional and new players in energy arena is often not leveled and concerted action in the field of energy is rather exception than a rule.

Decision-making processes and stakeholder involvement

Decision making process is generally not designed and carried out to allow transparent and fair participation of all stakeholders and there are few incentives to level playing field for those who are not in this or the other manner already involved in preparatory activities and does not have direct access to expertise and advantages in getting strategic information in spite of Aarhus convention as a part of the legal system of every PLATENSO country. One of the reasons for this could be increasing opposition of general public to nuclear energy due to its catastrophic potential, but also democratic deficit in the majority of CEE countries and strong commercial interests of multinational and national companies. Governments are trying to maintain a kind of balance between all these forces by formally not making any decisive move.

For a decision making process in PLATENSO countries it is also characteristic that at the level of national energy strategies there are few well-structured and elaborated alternatives, including competing energy scenarios. For most countries the Greenpeace prepared the national versions of its Energy [R]evolution where also scenarios with no nuclear power are calculated, as a result of the rapidly increasing use of renewable and energy efficiency. Nevertheless playing with alternative scenarios is not popular among political elites in PLATENSO countries.

In Slovenia a coalition of environmental NGOs in 2009 succeeded that a scenario without new coal and nuclear capacities was calculated and included in a portfolio of scenarios of the draft of the National Energy Program, however challenged by abundance of competing scenarios the government rather stopped the process and proposed to start less concrete National Energy Concept as to select one scenario and defend it in a parliament.

In Bulgaria both the decision-making process and the implementation of large scale infrastructure project in the energy sector over the last decade, have proved to be examples of non-transparent, fraudulent and susceptible to high-level corruption, business deals, as a result of major governance deficiencies. Thus, the involvement of a broader group of stakeholders in the decision-making has been hindered, in order to prevent the use of independence expertise. Particularly, regarding the lawsuit for EUR 1 billion before the International Court of Arbitration of Investment Disputes in Paris, brought by Rosatom, when the Belene NPP project was officially ceased by the Bulgarian state, the non-transparent and ad-hoc shifting of Bulgaria's energy policy has damaged the country's position in the arbitration, which in case of a loss may cause excessive financial burden on the Bulgarian Energy Holding, and indirectly on the state budget.

Within a decision making process on commercial nuclear facilities also in other PLATENSO countries the legal provisions can be often ignored or directly violated. Nevertheless an adequate legislation is an important and strong tool for legal based and transparent decision making on nuclear issues but – as any tool – does not operate on its own.

3.5. Public attitude related to nuclear energy

Public opinion surveys investigating public attitude related to nuclear energy

In all four selected countries public opinion surveys investigating public attitude related to nuclear energy have been implemented. The results show that support for nuclear energy (e.g. constructions of new NPP or waste disposal plants) differ in four countries, and range from high opposition to prevailing support.

In **Lithuania** a broad number of public opinion polls were implemented from 2010 on. A quick overview shows that public opinion in 2010 and 2011 was pretty much in favour of construction of a new nuclear plant. The results of the poll in November 2011 show that only 29% of the respondents did not agree with the construction of a new NPP, while 2/3 of respondents thought that a new NPP should be built near the Ingalina NPP. This attitude had gradually changed and the proposal of a new NPP was rejected by 65% of voters at the referendum held in October 2012. The mostly negative attitude continued also in pools made in 2013 and 2014.

In **Bulgaria** the Eurobarometer survey from 2009 provides interesting insight into public opinion on nuclear energy in the country. Over 70% of Bulgarians seemed to believe that nuclear energy helps the country be less dependent on imports of oil and gas (though Bulgaria import all of its nuclear fuel from Russia) and it ensures competitive and stable prices. Furthermore 42% of the interviewees supported the increase of nuclear energy in the country's energy mix. 46 % of Bulgarians believed that the benefits of nuclear power outweigh the risks it poses and 62% viewed nuclear energy as a whole as a benefit rather than a risk. However 47% of the respondents believe that the existing power plants pose risks for them and their families. About half of the respondents believe that the local authorities and the relevant legislation ensure the safe operation of the NPP. Despite the relatively strong support for nuclear energy, Bulgarians seem to be the least informed among all Europeans about nuclear power, based on a series of targeted questions, to which they only gave 29% of correct answers. A referendum was held in January 2013 on the construction of a new nuclear power plant in Belene. While 60% of voters said "yes" to nuclear power, the low turnout meant that the issue was returned to the parliament, where the Belene project was officially halted.

In **Slovenia** surveying the public opinion's attitude to nuclear issues strengthened in 1992 in the period when the Green Party of Slovenia was an influential parliamentary party. The key dilemma was whether the public opinion agreed with the efforts of the Green Party, which at the time demanded to abandon nuclear energy by 1997. Although the public opinion was never strongly in favour of the nuclear energy option, the idea to close down the practically "brand new" Krško nuclear power plant appealed even less to the public opinion. In a number of surveys related to nuclear energy (e.g. about LILW repository, about attitudes toward different types of energy sources, etc.) opposition toward nuclear energy was evident. ARAO, the Radioactive Waste Agency systematically has been monitoring the changing attitude of the public to nuclear technology in Slovenia, in particular the public's attitude to a RW repository, at the local, regional and national levels. These surveys often revealed that there was a wide gap between the ambitions of local political leaders and the local public opinion on the acceptability of RW repository. The public opinion poll results of 2011 compared to previous years show growing negative view of the general public on nuclear energy and radioactive waste. This is at least partially the result of the Fukushima accident in March 2011. And it is perhaps partly also the result of the standstill in the LILW repository planning which occurred following the confirmation of the location in 2009.

In **Czech Republic** a number of surveys investigating public's attitude towards nuclear power over a long time have been conducted since 1994. The questions were related to the people support or rejection of nuclear power engineering in the country, and their attitude towards Temelin NPP. The results show a relatively constant score (above 60%) in favour of nuclear power and also in favour of extending Temelin NPP. Another public opinion research in Czech Republic was related to the

localities considered for the deep repository siting. In the referenda carried out in the period 2003 to 2008 the citizens protested against the proposed nuclear waste disposal. It is an evidence of the very attractive subject for the citizens, who feel distressed by the potential existence of the disposal site in their vicinity, are afraid of something unknown and are concerned about the enhanced radioactivity. In all cases of local referenda on locating a deep geological repository, 80-99% of inhabitants voted against the storage of radioactive waste in the given location. The participation was between 51 and 95%. The last public opinion poll in 2012 showed that public attitude to geological surveys was gradually changing and some of the sites were in favour. Most of the sites were aware that the acceptance of the surveys is not approval to construct the repository.

3.6. Public debates related to phasing out nuclear power

In **Czech Republic** no public debates were initiated by politicians and professionals. The following events were performed:

- European and local opponents of nuclear energy organized activities as for example the conference Nuclear Energy Conference 2014 in Prague in May. The opinions of Stephen Thomas University of Greenwich Business School, independent consultants and others on world general retreat from nuclear energy were presented there.
- Research of socio-economic impact of the different scenarios of Dukovany NPP development undertaken by Charles University and Energetic Trebicsko Association, Title: Scenarios for the future development of micro region Dukovany nuclear power plant, using an approach Territorial Impact Assessment. Supported by the Technological Agency of the Czech Republic, two years project (2014-2015).
- ÚJV Řež, a. s. organised a workshop in Brno in September 2014 „Future of energy in the Czech Republic – role of nuclear energy“. Contemporary situation was described as economically problematic in relation to renewal of the old and building of new nuclear capacities as well. Professionals and top managers from nuclear business, technology and research wish to preserve their traditional high level know-how but they have to seek new opportunities abroad.

In Czech Republic the Government and politicians cannot admit possibility of phasing out nuclear power as the aim of state energy policy is to sustain nuclear energy in energetic mix. The research mentioned was initiated by local people because of their fear of economic and social impact of phasing out Dukovany NPP. The research is only one that treats phasing out seriously.

Bulgaria

No public debates have been held in Bulgaria with regards to the option of phasing out nuclear power. Given the precarious state of the domestic energy system public debates are centred around a number of different large scale energy projects, including the construction of new units at NPP Kozloduy, NPP Belene, the South Stream gas pipeline (now suspended) and other regional gas interconnectors. The overall focus of public debates is on improving Bulgaria's energy import independence, as well as on the governance surrounding energy projects. Given that currently nuclear energy is the cheapest source of electricity generation, it is also presented as a valid option for future development, despite the unclear outcomes of the cost of construction of new facilities.

Lithuania

There was none or only few public debates on the closure of Ignalina NPP (at this period all attention was directed to the EU join), therefore the public discussion for the operation extend of Ignalina NPP Unit 2 was intensive after joint to EU. Therefore the parliament commission for problems of Ignalina NPP region analysed the region situation after closure of Ignalina NPP. For example this commission participated in workshop-meeting with IAEA experts in 19-20th February 2002 in Vienna. The IAEA

experts recognize that pushing from EU side to closure Ignalina NPP Unit 2 up to 2009 is political decision and it is not reasoned by economical calculations.
The first unit of Ignalina NPP was shutdown end of 2004 (after 21 years of operation) and decommissioning activities of it started immediately. Closure of the plant faced fierce opposition from the Lithuanian people. The plant provided income to most of local residents. To compensate this, a project was started to encourage tourism and other small businesses. People were afraid that the price of electricity would skyrocket or that Lithuania would be left to cope with the extremely high costs of decommissioning the plant and disposing of its nuclear waste.
Early in 2008 the Parliament approved a referendum on work-time extension of the Ignalina NPP. This referendum proposed extending the operation of Unit 2 until a new nuclear plant could be completed as a replacement. The electorate were asked to vote on the statement: "*I approve of the extension of operation of the Ignalina Nuclear Power Plant for a technically safe period, but not longer than completion of the construction of a new nuclear power plant.*" The referendum was planed to be held on 12th October of 2008 alongside with the parliamentary elections. The referendum was invalid due to low turnout (a minimum of 50% was required). Registered voters in the referendum were 48.44 %, 91.41% of the valid votes said "Yes" and 8.59 % of the valid votes said "No".
The Lithuanian government forecasted that the electricity price for households will rise by 30% from 2010. Analysts expected that the shutdown could cut Lithuania's gross domestic product growth by 1–1.5%, increase inflation by 1%, and increase also the concerns that Lithuania would become more dependent on Russian energy sources that could be withdrawn if relations deteriorate. Ignalina's production is being compensated by production of the fossil fuel Elektrėnai Power Plant as well as by imports from Russia, Latvia, Estonia, Ukraine, and Belarus. The Ignalina NPP Unit 2 was shutdown in 2009, after 23 years of operation.

Slovenia
The issue of phasing out of nuclear was debated in the first half of the 90s but is currently not debated in Slovenia. It looks like two major lobbies are involved in the new scenarios development: nuclear and coal/gas. It is not clear which option will prevail in the future and which one will be selected. The latest information on energy concept development shows that it will be prepared only in 2015, thus leaving Slovenia for 5 years without the adopted plan.
In the past, in 90s, during the governance of coalition of which also Green party was a member, the initiative for closure of NPP started and ended without referendum. The proposition did not receive sufficient number of supporter to open the referendum. This was also the result of "patriotic" reaction to Austrian open pressure on Slovenia to close down NPP in particular because the Austrian political members tried to support closer of NPP what was perceived in Slovenia as an intolerable interference of foreigners in the domestic affairs. From the descriptions above one can conclude that only sporadic individual attempts to start the debate on NP future exist. No specific public debate or public opinion polls that would have addressed the exit from the nuclear have been implemented in selected countries. Neither the potential weaknesses and threats, or the potential strengths and benefits were discussed with larger society. Discussions about nuclear future of Slovenia were held during the last years only between experts and some of the stakeholders (e.g. OVJE).

3.7. Stress test results

Stress tests of nuclear power plants required by the European Council are defined as focused assessment of safety margins and resistance of nuclear plants, on the background of events that occurred at the Fukushima-Daiichi nuclear plant in Japan following the tsunami on March 11, 2011.

The stress tests are specified in declarations of ENSREG (European Nuclear Safety Regulators Group) dated 13 March 2011 „EU Stress Tests Specifications".

Evaluation has been conducted by experts in nuclear safety, nuclear facility designing, accident management, emergency preparedness and severe accident phenomenology research, fully qualified for this activity. The evaluators proceeded in accordance with the deterministic approach assuming gradual failure of all preventive measures in evaluation of extreme scenarios.

Results of the targeted review of safety margins and resistance in Temelin and Dukovany NPP in **Czech Republic** confirmed that both power plants are capable to manage safely even in highly improbable extreme emergency situations, without a risk for the surrounding areas. No issue was identified which would require an immediate action.

Bulgaria
The stress test performed on units 3, 4, 5, and 6 of NPP Kozloduy gave positive results and showed that the power plant can withstand emergencies such as earthquakes, flooding, extreme climate conditions, airplane hits. The report also made suggestions for the further improvement of the safety conditions of the power plant including installing additional generators to be used in case of power cuts and an independent cooling system in the spent fuel storage facilities.

Lithuania
The results of the Ignalina NPP Final Stress Tests Report revealed that the company has implemented the relevant technical and organizational measures which would be adequate to control the emerging situation in order to protect at the maximum the people and the environment from the hazardous effects of ionizing radiation even in the most adverse conditions, such as earthquake, flood, prolonged blackout and failure of the nuclear fuel cooling systems.
VATESI (the regulator) approved the safety assessment results presented therein and obligated Ignalina NPP to work out the plan for implementing the recommendations provided in the Ignalina NPP Final Stress Tests Report, and to reconcile the plan with VATESI.

Slovenia
The main conclusion of stress test for Slovenia and NPP Krško were quite positive. The regulatory body already identified several areas where improvements need to be done (Slovenian Nuclear Safety Agency, 2011). There has been a separate report developed by Greenpeace (May 2012) where critical issues were presented regarding the results of stress tests, and in the particular for NPP Krško a list of issues were addressed. As a conclusion the Greenpeace report states that the Krško site is not suited as a site for an NPP; main hazards for the plant consist of earthquake and flood. Also the regulatory body think that several improvements of safety for NPP Krško need to be prepared and they until now already issued official requirement to NEK to provide several safety improvement measures. Therefore a lot of investments are under way, which will affect the energy production price. In addition, NGOs recognised that some important safety characteristics were excluded from evaluation which will in the future for sure open additional pressure to reduce the NPP life time.

From the relatively positive stress test results one can conclude that these tests did not influence significantly the public opinion about nuclear power. If the tests would disclose serious cases of bad NPP management and potential danger situations, this would have an impact on worsening public opinion.

3.8. Social, societal and governance issues

This dependency on imports of gas and oil, which maintain the country's energy security and complete the optimal energy mix, is one of the most important contra factors when phasing out nuclear power is in question. Nuclear power ensures reliable covering of the growing electricity consumption at least in the near future and builds sufficient reserves. In addition, electricity generation from present nuclear power plants offers the lowest costs.

Operating nuclear power plants bring employment opportunities to the local people, trade opportunities to domestic suppliers and investments to the development of the region, and help keeping a highly-qualified labour force in a high-tech field in the country (cca five to six hundred skilled professionals ensure a NPP operation). The nuclear power plants contribute significant amounts to the regional and national economies.

An important factor when considering phasing out scenario is the broad conviction that the use of nuclear power contributes positively in the fight against climate change. As nuclear power plants do not emit CO_2, other greenhouse gases, dust and other pollutants, and consequently do not contribute to global warming or pollute the air, unlike coal-fired or gas plants, they have a positive environmental impact. As regards the resources the world has sufficient reserves of uranium and there are sufficient production capacities for nuclear fuel from a number of suppliers, and as a result, there is no threat of dependence on potentially risky countries.

On the other hand the risks accompanying the use of nuclear power present the reasons for reservations and/or negative attitude towards nuclear power. This is a raising driving force in favour of phasing out nuclear power. Experiences after the past disasters (TMI, Chernobyl, Fukushima) taught us that in many societies the attitude towards nuclear energy changed significantly towards negative. But from the data gathered by PLATENSO partners one can observe quite diverse results of public opinion polls, namely relatively high number of people with the positive attitude towards the use of nuclear power in some countries. But it should be taken into account that economic development could support change in these attitudes toward the opposition to nuclear. Also because nuclear facility has some negative consequences for its neighbourhood: low real estate prices, perceived effect on farming, etc.

On the most fundamental societal level commercial use of nuclear energy is put under the question by its opponents because it in their opinion develops a pattern of dependence from a large scale power generation sources that are heavily centralised, out of control from those who are in this or other manner not involved in "nuclear business" and next to immanent technology risks and their potentially large and to a large extent irreversible consequences for human life and the environment also represents danger to citizens due to either its immanent requirements for enhanced role of experts and bureaucrats that cannot be put under effective control of the public authorities or because of risks of terrorism and nuclear proliferation that in order to prevent them requires enhanced control over the citizen, yet this presents risk to human rights and citizen's freedoms. Especially for countries that has both nuclear energy military programmes and centralized policy and decision making structures with strong role of public administration and state owned sectors the nuclear opponents are claiming more, opened, transparent and inclusive governance of nuclear issues as "mission impossible"[14].

[14] Although not anti-nuclear oriented the Local Information Committees (CLI) in France - established in cooperation between local citizen s initiatives and municipalities with a mission to provide more transparency and credible information on management of NPPs and waste management facilities in France – are claiming difficulties in communication with nuclear operators and authorities because of their "military mode" of communication. Symbolic gestures of Greenpeace activists that illegally enters and "occupies" yards behind the fences of NPPs are in France treated the same as true acts of

Many opponents to the nuclear energy expects that nuclear phasing out is will respectively should develop not only nuclear risks free but also less centralised and more participative structures of provision of energy services. In addition to this many also believes that by giving shift to energy conservation, energy efficiency and use of renewable sources next to reduce of environmental risks and more citizen's control and participation also more employment and business opportunities, at very first at local and regional level, will be created.

The governance of nuclear phase out is therefore not only a technical issue on whether and how is feasible to assure affordable, competitive and environmentally benign energy services in a country but it also requires adequate capacities for management of wider social conflict of citizen's groups and social institutions with different and opposing views and normative statements that are bound to different paradigms on how to ensure fairness and welfare for society and well-being to an individual. It is therefore indeed a fundamental question of democratic rule because one of conditions for modern democratic societies is that they are generating more normative concepts on how society should be organised that they are indeed capable manage to implement in practice. It demands more than just fair and equal treatment of all the parties involved in the conflict and acceptance of rationality of administrative public procedures. It requires access to information, justice and counter-expertise as well as participation at all stages of policy process, from agenda setting to evaluation of its outcomes[15]. Therefore even when an attempt to phase out a risk technology fails because the alternatives are not (yet) feasible, viable or competitive the results of well governed process should both increase the capacities of societal control over the technology in question and capacities for further development of the alternatives.

The decisions to phase out nuclear energy that was based on top-down political decision making - either as a consequence of pursuing a greater goal as this was the case in Lithuania that needed to "sacrifice" NPP Ignalina in order to "get a ticket to join the EU club" or as a consequence of a shock that followed a nuclear disasters in Daiichi NPP at Fukushima in March of 2011 - turned out to fail. In absence of well-elaborated and strong supported alternatives Lithuania is continuing with its activities to build a new nuclear power plant while Japan, faced with considerable increase of price of electricity that is jeopardising competitiveness of its economy, has revoked its decision to phase out nuclear energy. On the contrary it seems that in Germany - where phasing out of commercial use of nuclear energy is free of any relations between commercial and military use and is based on long term interlinked and mutual reinforcing process of development of alternative energy concepts and technologies, emergence and development of the Green Party as a challenger to corporative decision making style and increased engagement of the citizens not only in environmental protection but also in alternative forms of ownership and financing of renewable energy sources, energy conservation and energy efficiency – the decision for nuclear phase out firmly stands regardless to the changes in government or international political and economy developments.

A big SSG issue is also RW management. Even for LILW repository there is a big public concern to accept the site for such waste. Many countries, including all four in question, are trying to construct

terrorism and the authorities are reluctant to communicate with Greenpeace even when the later operates in "cooperative and constructive mode". In Slovenia on the contrary Greenpeace holds regular meetings in an open atmosphere with the NPP Krško owner and national nuclear safety administration.

[15] This process should at very first take place within the frame of a sovereign national state. While in the EU the member states are however still holds responsibilities for energy and in a large part also for nuclear safety policy they are due to global dependence on fossil fuels on the one side and increasing role of EU environmental protection and nuclear safety »acquis«, liberalized integrated energy markets and semi-mandatory climate & energy EU targets less and less in charge of energy policy and therefore incapable enable inclusive governance and/or organise energy policy making in a firm participatory way.

the LILW repository after several decades of site selection processes. This is even more true for SF (or HLW) repository as there is no single one in operation until now worldwide and will be a big challenge also in all CEE countries. Phasing out nuclear or not does not bring almost any improvement of the challenge since the RW management must be assured not depending on the volume of RW produced.

4. Scenario 2: Phasing out nuclear power - Analyses of social, societal and governance challenges, gaps and problems

4.1. Narrative description of Scenario 2 and SWOT analysis

Phasing out nuclear power means interruption of the existing NPP operation as well as abandonment of all plans for construction of new ones, though as a part of scenario we could imagine closing up old NPP and construction of new one next generation NPPs. It should be done in such a way, that the electricity prices remain the same or lower, security of supply is not jeopardized, and the impact on environment don't worsen, what is not easy to achieve. Plans for decommissioning of reactors and all related activities in the most appropriate exit time should be prepared, as well as the plans for spent fuel management. The new national energy policy should be accepted by the government and supported by general public, presenting the measures for energy production based on expansion of renewable energy and cogeneration, and more efficient use of energy. Relevant studies and plans for the construction, organization, human and other resources for starting the electricity production from gas, fuel and/or alternative sources should be prepared. At the national level the financial resources for the whole phasing out process are secured. For the region with the phasing out NPP the new regional development plan should be prepared, containing the economic alternatives for local industries and actors, and for specialized experts that remained unemployed after closure of NPP.

The exit from nuclear power brings several opportunities, but also uncertainties and risks. In the table below the strengths, weaknesses, opportunities and threats are provided for the phasing out option:

Table 6: SWOT analyse - Phasing out nuclear power

Strengths:	**Weaknesses:**
• Avoidance of nuclear accident in an operating NPP and avoidance of any nuclear accident in a phased out NPP after its full decommissioning; • "Open space" for structural changes in provision of energy supply services – urgent need for faster shift towards the new energy paradigm; • New technologies supported to replace nuclear use; • Improved chances of natural gas based high efficient electricity generation units (combined cycle PP and CHP) as climate sound "transition" to RES-E based energy system, backed up with most efficient and clean fossil power generation units • Satisfaction of the public, opposing the use of nuclear;	• Short term and long term increase of energy dependency of the countries; • Lack of energy policies that would incorporate the phase out option; • Decrease or annihilation of the importance and value of acquired capacities, knowledge and experiences in nuclear field; • Lack of appropriate economically competitive short term geo-political alternatives for replacement of NPP capacities; • Negative impact on economic and financial flows; • Negative impact on employment in the regions with NPP; • Short term and long term deterioration of nuclear safety caused by decrease of development perspectives;

	• Lack of adequate HR for radioactive waste and spent fuel management (including repository operation).
Threats: • Inability of articulation and aggregation of alternative options due to decomposition of energy-related political arena; • Uncertainties about the new energy prices for households and industry which might be affected; • Short term and long term deterioration of nuclear safety because of decrease of interests, sources and development perspectives in the regions with NPP; • Short term and long term increase of energy prices due to the dependency of electricity import; • Short to mid-term increase of CO2 and other harmful emissions caused by increased electricity generation from fossil fuels, at very first in case of generation from existing coal fired plants; negative impact on environment and climate change;	**Opportunities:** • Change of governance – political decision makers take the responsibility for preparation of energy policy options, including transparent deliberation among articulated options, compared by multi criteria; • Increased importance of energy services based on renewable resources, energy efficiency, distributed energy production, intelligent buildings, cities and networks (new energy paradigm); • Transformation of energy policy arena: entering of new actors into the preparation, adoption and implementation of new energy policy; • New employment possibilities for experts with specialised knowledge;

Table 7: SWOT analyse in the concrete case: Lithuanian phasing out nuclear power

Strengths: • The country's political determination to decommission INPP contributed Lithuania's integration in the EU (Lithuania joined the EU on 1 May 2004, phasing out INPP was a condition to join); • After the shutdown of Ignalina NPP, local electricity generation capacities are being increased and electricity sector is being restructured in order to ensure competitive and continuous electricity supply; • Satisfaction of part of public, which is not supporting use of nuclear; • Avoidance of nuclear accident in an operating Ignalina NPP.	**Weaknesses**: • The Ignalina NPP is the main economic engine of the region, thus its decommissioning disturbed the economic conjuncture that determines social and economic state in the region; • The decommissioning of the Ignalina NPP has a considerable detrimental effect on the structure of electricity sources, primary energy balance and electricity price for customer. • The decommissioning of the Ignalina NPP, lack of certainty in respect of financing of the measures related thereto and other external circumstances prior to Lithuania's accession to the EU in 2004 prevented from making efficient use of the surplus of available capacities, timely renovating them and taking specific decisions regarding the further development of the power system; • Lithuania's electricity and gas networks do not have any direct links to Western European energy systems. Lithuania's electricity power system physically belongs to the UPS/IPS system; • There were no possibilities to connect to a UPCTE electricity grid and integrate to common EU market, the reliability of operation of

	Lithuania's power system and electricity export and import possibilities depend on Russia's state owned energy company; • An alternative supply of natural gas was first possible at the end of 2014 by opening Visaginas LNG terminal , dependence on a single supplier of natural gas remains (gas accounts for approximately 75% in the production of district heating, for approximately 14% - in the generation of electricity; after the decommissioning of the Ignalina NPP, the demand for gas increased up to 75%); • Considerable quantities of radioactive waste and spent nuclear fuel have been accumulated; however, no strategy of management and disposal of spent nuclear fuel has not been developed;
Threats: • All the economic activities that used to fulfil the internal needs of Ignalina NPP and the region should notice a reduced purchasing power; • Decommissioning of the Ignalina NPP can result in withdrawal of some companies from the region that were related to the Ignalina NPP, leave of some skilled professionals and some of talented youth – because of pessimistic future perspective; • If the necessary competitive electricity-generating sources are not constructed and the reliability measures of the energy supply network, especially system interconnections with Poland and Sweden, are not implemented in proper time, the decommissioning of the Ignalina NPP and dismantling of reactors thereof, could pose a grave threat to the stable supply of electricity, while increased energy prices could become a heavy burden for consumers and the country's economy; • Emigration of qualified specialists and the attitude of the country's youth towards engineering and technical professions as low-prestige ones may complicate the introduction of modern technologies and cause a shortage of qualified specialists in the energy sector as well as in the field of research and development.	**Opportunities:** • With national and international support, there would be opportunities to create new companies with greater value added. The support would be provided to operating manufacturing companies, vocational training, the sector of tourism and agriculture, and for preparation and adoption of transport and energy infrastructure to meet the local/regional/European needs; • The expertise accumulated during the long period of safe and reliable operation of the Ignalina NPP, positive attitude of Lithuanian political parties and the part of public towards nuclear energy, and determination of governments and energy companies of the Baltic countries to co-operate in the field of energy create favourable preconditions for the construction of a new nuclear power plant; • With the completion of restructuring of the entire energy sector, full compliance with the requirements of EU directives and adoption of the main legal acts regulating the functioning of the sector as well as development of a system required to control the activities of energy enterprises, required preconditions for the creation of a competitive environment in Lithuania and a common electricity market of the Baltic States (it is already done in 2013) and for future integration into Western and Northern European markets will be finally created; • With the growth of imported organic fuel prices, indigenous and renewable energy resources, which are available, but are still underused might increasingly contribute to Lithuania's primary energy balance, reduce dependence on the import of fuel and mitigate detrimental consequences of the growth of organic fuel

	prices; • development of interconnections with the power systems of Poland and Sweden will increase the reliability of energy supply, enable integration into the Western European electricity market, more efficient use of the Kruonis Hydro Pumped Storage Power Plant and other power plants as well as transit of electricity;

4.2. Main issues and challenges derived from Scenario 2

Lithuanian experience

As Lithuania is the country where two NPP units (Ignalina Unit 1 and Unit2) were shut down relatively recently, this provides us with an opportunity to learn from their experiences[16]. Below is the list of social, societal and governance gaps and problems identified in Lithuania:

During the last decade before decommissioning of the Ignalina NPP, the plant has become the most wanted employer among citizens from the surrounding regions. INPP was the only workplace in the region that provided its employees with stable and relatively high wage as well as social benefits.

The population density in the INPP Region is quite low in comparison with others regions.
The population of the INPP region has been decreasing during the last two decades, like in the whole country. It may be noted that the relative decrease of the region's population is almost two times bigger than the corresponding rate in Lithuania. The decrease in population in the region is partly determined by population migration. Natural population fluctuation in the INPP region is also negative (mortality exceeds birth rate). This shows the general tendency of population of the INPP region becoming senile.

A 3 km-radius sanitary protection zone is set around the INPP where economic activity, not related with operation of the INPP, is limited. There are no permanent inhabitants in this zone.
The rate of registered unemployed and able-bodied population in the INPP region is bigger than the corresponding rate of Lithuania. The part of direct foreign as well as material investments for one inhabitant of the INPP region still strongly lags behind the corresponding average of Lithuania.

Because of its geographical location, the structure of industrial companies, sources of raw materials, number of people employed and other factors, the INPP region is considered as unviable. Therefore there is a danger that the place might become an economic backwater of Lithuania.

[16] Phasing out of nuclear power in Lithuania should be however understood against the countries ambitions to join the EU, therefore rather an "external" as "internal" conditioned political decision where positive expectations of the large majority of national political elites and the people of Lithuania about full integration to EU overshadowed concerns regarding safe and affordable energy supply of the country and social concerns in the Ignalina region. In order to demonstrate its capacities to assure safety from a "Chernobyl alike" nuclear disaster for EU citizens the EU has used "accession conditionality" to force Lithuania to carry out phasing out of Ignalina NPP without taking into consideration the way the decision will be made and its consequences. Therefore as a case study the Lithuanian case should be considered as very first relevant for "ad hoc phasing out" contrary to the phasing out of nuclear energy in Germany where over a longer period (about four decades) and by strong engagement of the citizens and the public a national consensus on planned phasing out with managed energy and social consequences was established.

The INPP region is on the very edge of Lithuania, therefore transport is an important part of the region's economic and social infrastructure. There is quite a well-developed road network in the INPP region that connects it with other regions of the country and neighbouring countries.

Right from the beginning of passing the decision regarding the INPP decommissioning, means coordinated by the state are implemented in the INPP region with the aim to control and decrease the impact on the socio-economic environment of the INPP region due to the shutdown of the INPP.
During the implementation of the Programme for Decommissioning of the State Enterprise Ignalina Nuclear Power Plant Unit 1, approved by the Government of the Republic of Lithuania in 2001, infrastructure was created, and legal base was expanded for the performance of INPP decommissioning and for the decrease of socio-economic results.

In order to keep qualified personnel, to mitigate negative socio-economic impact on them, and in order to ensure safe and continuous operation of the INPP and its decommissioning, the Law on Additional Employment and Social Guarantees for the Employees of the State Enterprise Ignalina Nuclear Power Plant of the Republic of Lithuania and the Order of the Minister of Social Security and Labour that regulates its implementation were passed[17].

Projects of INPP restructuring were performed for the liberalisation of the market (INPP divisions, that were not directly related with the manufacture of electric power, were separated from the power plant to establish separate companies).
INPP Region Development Council and State Enterprise INPP Region Development Agency for organizing the implementation of its decisions were established. The main aim of the latter institution is to mitigate the negative socio-economic impact in the INPP region after the INPP decommissioning and to create favourable conditions for the balanced socio-economic development of this region. Also State Enterprise Business Incubator of the INPP Region, Visaginas Information and Consultation Centre of the Ignalina Labour Exchange, and State Institution Visaginas Social and Psychological Help Service were established.

Seeking to mitigate the negative impact of socio-economic effects on the inhabitants of the INPP region the following documents were prepared and approved in 2004 by the INPP Region Development Council: INPP Region Development Plan, Small and Medium Business Development Programme of the INPP Region, Programme and Plan of Means for Work with the Youth of the INPP Region, Local Initiatives Support Programme of the INPP Region.

Seeking to mitigate the negative socio-economic impact in the INPP region after the decommissioning of the INPP, the following actions must be performed:

- Stimulate the implementation of the projects of the Ignalina NPP region development plan, planned to be funded from the structural funds of the European Union and other sources;
- Stimulate the implementation of the projects defined in the development plan of INPP region infrastructure;
- Ensure the activity of the state institutions INPP Region Development Agency and Visaginas Social and Psychological Service;
- Stimulate the development of small and medium business in the Ignalina NPP region;

[17] The fact that de-population of Ignalina region after shutting down the NPP was disproportionally above the de-population trends in other Lithuanian regions provides some evidence that it is not possible to compensate the negative effects of any ad hoc shut down large infrastructural object simply by the good (political) will of a legislator even when accompanied with more complex and detailed inter-sector measures.

- Create conditions for employees, stood off from the Ignalina NPP, to integrate into the labour market and to mitigate the impact of standing off – to provide them with special occupation and social guarantees;
- Stimulate highly qualified employees of the Ignalina NPP to ensure safe operation of the power plant.

Based on the countries situations and SWOT analyses for the Scenario 2, and also taking into consideration Lithuanian experience, the following issues and challenges were identified, some of them typically economic or technical, while others having the social, societal and governance character:

1. Complete absence of any public debate that would include phasing out of nuclear power scenario.
2. Lack of inclusive decision-making process and for the consensus of governmental and other relevant actors about the new energy paradigm and phasing out nuclear energy (need for a new participatory process in energy policy development, participatory issues related to the new phase - decommissioning of NPP and the related activities);
3. The need for a new energy policy and action plan that would define the most appropriate exit time, and the energy production redistribution with introduction of new energy sources, measures, actions,…;
4. Strong economic impact and consequences for local communities near NPP (loss of working positions for NPP staff and connected local firms, employment redistribution, also loss of compensation for NPP in value of 5 millions € yearly for local communities which is now the input to municipality budgets);
5. Availability of knowledge and related skills and expertise that will still be needed in the new phase; *Professionals and top managers from nuclear business, technology and research wish to preserve their traditional high level know-how but they have to seek new opportunities abroad;*
6. Interdependence of the whole nuclear sector – a major reduction and reorientation of experts to other areas, but at the same time a need to maintain the quality of services of whole structure of competent institutions (regulatory body, technical support organisation, waste management organisation, decommissioning experts);
7. Spent fuel management which is not available at present and for which the plan is to be stored on the site of NPP – in case of phase out, the licence for storage of SF would need to be renewed and perhaps changed;
8. The special situation linked with co-ownership on NPP Krško with Croatia and the responsibility for half of LILW and half of SF – division of waste and SF in case there is no common solution (as currently the case) and transportation of RW and SF on time to the Croatia. In this case of co-ownership a potential decision for phasing out scenario could only be achieved in agreement of both countries.

The following issues are specifically related to inclusive decision-making process and governance:

- Lack of instruments and channels for a trustful, reliable and in-time information of public related to nuclear power plants operation and phasing out;
- Lack of access to independent expertise on risks related to the NPP operation process, and to phasing out nuclear energy process;

- Lack of transparency and societal control over safety assessments and regulation of ending of nuclear activities;
- Lack of adequately institutionalized and/or due practiced procedures for involvement of stakeholders and public into a dialogue about future development, including the nuclear power and "non nuclear" future;
- Lack of inclusive governance, including lack of objectives and instruments (eg. representative council) for sound decision-making, not only in energy field but generally.

4.3. On-going research activities in the PLATENSO countries

Information regarding the role of research institutions in a range of countries, generally with reference to Eastern Europe, was implemented within PLATENSO project. Relevant projects were identified that project partners or others in their specific country have undertaken that have been funded by various bodies, including government departments, radioactive waste management organisations, regulators or others.

Out of 26 identified projects 10 can be assigned as technical studies in support to nuclear regulatory and technical activities in the respective countries (in yellow), 15 as "social studies" in the broadest sense of the concept (in light blue), while the study *National Research, Development and Innovation Strategy (2014-2020)* carried out by Romanian Institute for Nuclear Research is of a general character. As for "social studies" 4 of them are in the field of public opinion & opinion pools, 3 in the field of public participation, 2 in the field of social impacts of LILW repository while there is one study at each of discourse analysis, media studies, nuclear economics, employment psychology, deliberative democracy and social aspects of Nuclear Research.

The analyses of the collected information within WP 1 showed several conclusions (draft reports D1.1 and D1.2) which are relevant for national strategies and are linked to scenario 2:

- Social and societal issues at the local and regional levels in example countries can feed into efforts in other countries and in areas other than RWM, although results can in most cases not be transferred due to differences in national context. Social and societal issues at the national and EU levels related to nuclear energy would seem to be a green field for research which needs to be developed.
- In the governance area there are many experiences, but these tend to be in the narrow field of siting controversial RWM facilities (also due to the fact that in past 2 decades no new NPP has been under construction in PLATENSO countries). Research needs to become both broadened (to include all decision making phases – besides siting also policy making and programme - and other types of nuclear installations) and more tailored to addressing specific conditions for different phases, experiences of the challenge of involving regulators and NGOs, and to link informal processes to legal systems.
- There are different models for research infrastructure which have been used for social, societal and governance issues. They are clarifying examples which can be referred to when developing country-specific research strategies.

Inputs from WP 1 has not provided evidence on any comrehensive interdisciplinary project that would address the issue of phasing out of nuclear energy within the one, the other or in more PLATENSO countries in its complecity. Only certain technical support studies related to different aspects of nuclear regulatory framework, nuclear waste management, social acceptance of LILWs repositories and related procedures and public opinion pools that might be somehow partialy helpful also in addressing the nuclear phasing out have been identified within WP 1[18].

Problems:

- Lack of well elaborated and comprehensive studies on phasing out of nuclear power in four PLATENSO countries (and PLATENSO countries in general, where applicable) at the level of individual country at least at the level of well elaborated and peer reviewed energy scenarios. It is not possible to level playing field and have meaningful and constructive public debates on phasing out nuclear energy where on the one side there is a bulk of detailed pro-nuclear energy and environmental expertise, while on the other side only non-country specific general technical studies (Energy (R)evolution by Greenpeace) or interdisciplinary metastudies (Phase out of Nuclear Power in Europe – From Vision to Reality by GLOBAL 2000) are used as an argumentation back up by the opponents to nuclear energy.
- Lack of comprehensive interdisciplinary empirically backed up research on the decision making process on nuclear phasing out and management of nuclear safety, energy security and competitivnes as well as social and regional development risks. Comparative studies of phasing out of nuclear energy and management of the risks that followed in Austria, Sweden, Italy, Germany and Lithuania have in our knolwege not been carried out yet.
- Lack of further, more detailed and ongoing research on global and EU frameworks and conditions that would enable faster deployment of RES-E technologies, as defined by the study "Phase out of Nuclear Power in Europe –From Vision to Reality": a well-established carbon, an appropriate coordination of future targets for GHG, RES and energy efficiency, the planning of network extensions that appropriately incorporates the strong RES uptake, the new market rules and appropriate incentives to assure that investments in complementary options like (fossil) back-up and storage capacities as well as network extensions should be undertaken in forthcoming years and the improved cross-border transmission policies to facilitate the efficient operation of the grid under increased RES penetration.
- Lack of comprehensive and ongong interdisciplinary research of the developments of energy and environmental frameworks at EU level (including the impact of signing of ACTA treaty between the EU and the USA) and energy policies at national level in PLATENSO countries in question in terms of their contribution to phase out nucler energy in four PLATENSO countrires (in quesiton).
- According to above argumentation it looks like that one of the most important question is WHY in all four PLATENSO countries, there is lack of a research activities in the development of nuclear energy. The hypothetical answer would be that decision making institutions don't want to be constrained by any prejudice even if it is based on solid expertise.
- Since it is evident that at least in four PLATENSO countries in question that are – with partial exception of Czech Repubic – small pheripherial EU economies, the implementation of any realistic nuclear phase out scenario depends on broader EU cooperation in the field the

[18] It is however assumed by PLATENSO consortium that the list of research projects identified witin WP 1 does not reflect real amount of nuclear related research projects in the PLATENSO countries, wider mapping of national research activities needs to be done, in particular nuclear research topics: nuclear & energy/industrial /regional development policies, nuclear safety, emergency planning, preparedness and response; waste management, etc.

fundamental problem is decline of “European spirit” within the context of raising popular and populist movements in support of national framing of the global security and sustainable development chalanges.

- Last but not least phasing out nuclear energy while taking into account climate change mitigation issues inevitably means not only more renewable energy to assure energy supply of a nation but in many cases also deployment of large renewable energy generation and infrastructure capacities to cover energy demand in other parts of Europe. Therefore in the last instance phasing out of nuclear energy also means that the people who will protest against installment of RES-E capacities based on the argument that they are not willing to sacrifice “our landscape/nature” for “their energy profits” made by selling renewabe electricity to the other country will not be supported by majority of their fellow citizens. Without stronger European identity nuclear phase out might be a “luxury” that can afford large and strong European nations and this can reinforce already strong sentiment in the PLATENSO countries that nucler phase out is indeed yet another coercive tool of the dominance of the “German Europe” over countries at perihphery. Prior to EU accession the oponnents of nuclear energy in accession countries have been predomintly percieved positively even at least in public even within countries with predominant pro-nuclear sentiments because they have embodied a positive spirit of European integration. Now when we are facing not only “integration fatigue” but also problems with fundamental institutional designs of the EU this spirit has gone and nuclear phasing out support cannot be gained on EU faith but only on clear and well elaborated economy and social benefits at the national and the EU level. Therefore contextual studies on (anti)European dimenssions of nuclear phase out discourses and their possition of utterance should be investigated in order to understand what perceptions of EU and relation between the EU and the nation state are insribed in the discourses in question.

Missing issues:

- How next to necessary invesments in “phasing out” technologies create a social capital needed for “smooth” implementation of phase out nucler power in general and in four PLATNESO countries in question in particular.
- How to address “nuclear phase out” issue when it is evident that in short time it could be addressed only as a “nuclear emergency issue” since the environmentaly sound alternatives cannot be deployed on an adequate scale or by similar economy perfromance?
- Are there next to adequate energy policy also needed institutional changes and changes of governance in order to create conditions for phase out nuclear energy on mid or long-term?
- How to run a balanced and trustful “nuclear phase out” dabate in a country where there are few or none domestic “energy disidents” with credible technical competences that support phase out and detailed economy, technical and social expertis on risk managent in case of nuclear phase out needs to be imported or at least sponsored from abroad? The issue of “public participation” – what notions of public participation are in the background in the discourses of different stakeholders on “public participation on nuclear issues”. Does the term “public participation” mean that the people are informed by the plans and/or decisions of the authorities or does it also meant that their concerns and interests are taken into account by the policy and decision makers or they are even included in formulation of the issue, design, decision, implementation and evaluation of a decision?

5. Important social, societal and governmental topics derived from Scenario 2

Social, societal and governmental topics which need to be addressed in future regarding development of Scenario 2 with phasing out nuclear power are multi-layered, complex, interactive and country specific. Feelings of risk associated with nuclear in general public and gap between experts and lay opinion, decreasing trust into authorities connected also with global economic and social crisis present great obstacle to democratic reflection of the nuclear issue and real public involvement in decision making. Governments and other political bodies are generally escaping – due to its unpopularity - any involvement in public discussion on nuclear issues, leaving it to lower level bodies or commercial organisations. In politics however also non-decision taking is a form of decision making yet in this way no complex processes of structural changes in providing infrastructural services – as required in case of nuclear phase out - can be steered. When it however still comes to situation that an explicit decision regarding the future of commercial use of nuclear energy in a country should be made then the political elites in new democracies tend to use a referendum as a lightning rod that enables to postpone a decision. This situation naturally prevents any transparent planning of decision making process and/or respect of time frames and procedures when it comes to decisions. If there is a threat that the results of decision making process will not suit to the interest of most influential incumbents than the decision making process is terminated and the same happens when it turns that the design of decision making process does not match with complexity of the issues in decision as this is the case with nuclear scenarios that stem from very uncertain basis with too many variables. In this context general public is left aside because there is nothing in public space to be discussed on and decided about. In the background however different political and economy actors in the field of energy are making their deals and waiting to push them through the formal decision making process when there will be a window of opportunity they actively search for.

Several evidences for the above described dynamics of decision making processes on the future of nuclear energy in four PLATENSO countries in question were collected through the analyses for scenario 2 which need to be than further completed and elaborated in order to be used and specified in the context of an individual country.

5.1. Important research issues to be addressed for Scenario 2 in the future

In general multiple factors act as drivers or constrains to the process of phasing out nuclear power. The mix of constraints and strength are country specific but in these documents they are analysed in general, without specific analysis of their role and impact on developments in each individual country.

Inclusive and legitimate decision making process and inclusive governance are the main issues when the country is in front of such a decision as of operating or phasing out nuclear power and redistributing energy production. The new research actions in social, societal and governance issues have to address the topics of information provision, participation, and broadly speaking, development of participatory democracy not just by providing formal inclusion of interested

population, but also providing conditions for inclusive decision-making processes which would be perceived as legitimate.

The most important social, societal and governance factors are listed below (the list is not exhaustive):

1. **Putting phasing out nuclear power on political agenda and on dialogue with public**

Investigating the reasons and circumstances that prevent the phasing out scenario to be put on political agenda, and the arguments why this scenario should get an equal attention should be researched. There might be several and very different reasons why in an individual country not a single nuclear phase out scenario is on the political agenda. It might be that there is simply no political demand for such a scenario or demand is to week to be recognised as a legitimate issue on the political agenda because the large majority of citizens believe that nuclear energy provide safe, reliable and affordable supply of electricity whereas there is:

- no active minority in support of nuclear phase out or
- this minority is:
    - to small and/or
    - not adequately organised and/or
    - to week to precisely articulate alternatives and/or
    - has no capacities to aggregate and represent the interest of all those that might directly benefit from phasing out nuclear and/or
    - is perceived as representing the interest of "others" and not of the citizens of the country in question.

The issue is also in which context and by whom it is requested to put the nuclear phase out on the political agenda. Is this:

- a citizen's initiative or coalition of citizen's initiatives living in the vicinity of NPP and nuclear waste management facilities;
- an NGO active in the field of nuclear safety and/or energy policy or coalition of different NGOs and initiatives in fields of environmental protection, inclusive governance, alternative energy technologies, local sustainable economy development based on renewable resources etc;
- an opposition (parliamentary) political party, a coalition of political parties and/or by a political party lead coalition of political parties, citizen's initiatives and NGOs;
- a ruling political party or a coalition of political parties on power;
- a national government;
- a parliament or a government of another (neighbouring) country[19].

When it comes to the EU it should be clear that the EU has no mandate and power to request from any member states to phase out nuclear energy because the EU has no mandate over energy policy and consequently about selection of energy technologies yet it has a direct mandate on environmental protection and nuclear safety[20].

[19] Those kinds of requirements have in most cases of course reverse impacts on the chances of an initiative to succeed. Political representatives and the general public usually consider this as an unjustified intervention in a sovereign state matter.

[20] Therefore assuming that in case of Lithuania the EU has required to phase out nuclear energy when requiring and insisting to shout down the NPP Ignalina is indeed misleading. The EU has in fact required from Lithuania only to stop operating and later on decommission the NPP in question because its further operation was on expert basis assessed as a

It is also important who from the following stakeholders is providing support to the request of nuclear phase out, in which form (direct or indirect), at which level and in what capacities:

a) media,
b) trade unions,
c) political parties,
d) academic and other research institutions in fields of nuclear safety, energy policy, regional development, (macro)economy,
e) cluster of renewable energy technology R&D, industry and SMEs,
f) international NGOs and international NGO networks,
g) competing large energy producers (coal, hydro, gas),
h) the governments of the foreign countries.

To successfully put the issue of nuclear phase out on the political agenda there are some basic conditions:

- political culture should enable and allow a plurality of normative concepts on how society should organise in order to meet its energy needs in a sustainable way and prevent from any form of discrimination of those who are opposing to the authorities or powerful stakeholders;
- institutional set up should allow and provide at least minimal support for new options to emerge and articulate to the level of policy alternatives;
- proponents of a nuclear phase out should be willing and capable to carry out broad networking and organise broader coalitions in order to gain support from at least some stakeholders from media, energy technologies and policy expertise, political parties, conventional and new energy technologies, supply and services providers etc.
- formal public participation procedures should be at least in place and respected by policy makers, decision makers and administration respectively there should be effective sanctioning of their violation
- policy making process should tend to provide diversity of comparably articulated options while political decision making process should not tend to hide behind the only or the single best articulated technology option

2. Defining the paths for consensus reaching about the energy future without nuclear power

Phasing out of nuclear energy is not a simple act of political will without complex interdependent risks. Nuclear power plants are important parts of complex infrastructure systems of supply with electric power and cannot be simply shut down without risks human life, health and environment, security of energy supply, competitiveness of national economy etc. In a democratic society risk acceptance should be legitimised on the highest possible level of informed consensus. This means that a certain controlled risk is consciously accepted in return of certain development benefits. The concept of sustainable development should be in this sense understood as a search for and maintenance of consensus on the margins of still acceptable risks of technology and social development.

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serious risks to the EU citizens. In order to achieve this EU has used “accession conditionality” as a tool. For the same purpose the same tool has been used also in a case of shutting down of some other nuclear reactors in Bulgaria and Slovakia. EU requirements indeed lead to forced phase out of nuclear energy in Lithuania yet only as a consequence of pursuing nuclear safety objectives and not as an objective per se. Lithuania had not operated any other reactors that those that according to the safety concerns of the EU has been needed to be shut down, therefore as a “side effect” it has come to nuclear phase out. However this in conceptual terms should not be misunderstood as “nuclear phase out” since there was neither political process nor political decision in Lithuania to actually phase out nuclear energy.

Consensus, risks and development should be however understood as featured dynamic categories. In modern highly complex and dynamic societies one cannot presuppose the existence of consensus as given but as something fragile and easy to demolish that first needs to be established and cannot be maintained or restored without permanent efforts and learning processes. Risks too cannot be mastered in advance and once for ever but efforts to avoid, reduce and manage them inevitably lead to new and in many cases unpredictable risks. Last but not least also development goals nowadays cannot be fixed for a long time and in a comprehensive way because none has a full insight into full complexity and development dynamics of the system as a whole.

On the other side similar to decision to start or extend the commercial use of nuclear energy also a nuclear phase out demands provision of a development oriented consensus based on an adequate awareness, acceptance and management of related risks both at national and at local and regional level. By trying to establish any kind of development consensus one however needs to be aware that emergencies, non-intended consequences of actions of actors and irreversibility of some of decisions made in the past are generating new risks and setting new development challenges.

In our opinion the key issue related to design of a broad social consensus on phasing out nuclear energy as the most optimal direction for the society is the question how to approach in a consensus building manner the management of the following key areas of risks (Only key issues - the list is not exhaustive):

a) Maintenance and improvement of nuclear safety:
   - Are there enough capacities and resources for an adequate management of shut down NPP(s), nuclear wastes and decommissioning of nuclear reactors? If not how, by whom and when missing resources and capacities will be provided?
   - How to maintain and improve capacities, operational level and motivation of regulatory and other relevant authorities, reactor operators, surveillance and emergency teams etc. by taking into account that phasing out nuclear energy is not providing lasting mid and long term perspectives for current and future employees, organizations and institutions in charge for nuclear management and safety?

b) Provision of affordable, environmentally benign energy services and reliable, competitive and environmental sound supply with electricity:
   - What are the technical options to in a short term compensate phased out generation capacities and grid services? Where are the bottlenecks? How to get to the optimal technically sound, reliable and best price/performance options?
   - How to in mid-term prevent from significant increase of dependence from imports of electric energy, especially from markets with high price of electricity or markets under direct control of top political decision makers of a state that is not obliged the EU principles and rules?
   - How to in a short term prevent from probable significant increase of electricity price or its negative impacts to certain consumers (low income households, SMEs, electricity intensive industry and services etc.)?
   - How to on a short and mid-term prevent from or compensate increase of GHG and air pollutants?
   - What policies and measures in different sectors need to be developed, harmonised and implemented to enable concerted activities for nuclear free supply of energy services and electric energy. How the actors will be addressed, strengthened and supported to activate and disseminate provided tools and measures? How the obstacles and barriers will be identified and removed? How the lessons learned will be used to improve the quality management of the whole system and its parts?

- What – if any – changes and actions in broader EU and global framework are needed to make domestic actions possible, effective and efficient?

c) Maintenance of employment and social services, at very first at local and regional level:
   - How in a short term compensate loss of employment and tax (and other) revenues resulting from phase out of nuclear power. How and by whom the challenges will be turned into opportunities.
   - How to provide in a mid-term suitable new business and employment opportunities in regions characterised with large impact of electricity generation from nuclear power plants? What tools and measures are in this respect already available, which needs to be developed and by whom till when
   - For countries/regions that are part of or in a large part engaged by nuclear industry the same questions are relevant in a wider context

Without analysing in deep the EU and national context of phasing out nuclear energy – which should be one of focuses of comprehensive interdisciplinary research of future perspectives of nuclear energy also in PLATNESO countries - it is not possible to give a concrete proposals how to define paths to achieve a robust social consensus on how to phase out commercial use of nuclear energy. In general terms however the vertical consultation among different levels of governance, and the horizontal communication among sectors, including public, is required as a precondition of development consensus. Within this consultation is should also remain open if the lists of above mentioned list of key risks that need to be address is adequate and if subsequent issues are exhaustive and adequately formulated. How to design a participatory, opened and fair consultation processes in an individual country however cannot be answered without taking into account its media and political culture and institutional settings of policy making and political system as a whole.

2.1. Access to information and independent expertize

As most of information regarding energy planning and scenario is already publicly available one can assume that with some possible exceptions access to information relevant to phase out nuclear energy in four PLATENSO counties will not present a barrier that cannot be surpassed. On the contrary the access to expertise that is not at least by mind setting and expert's meta-practices bound to the paradigm of centralized energy supply system based on the economy of scale rationality might present a big challenge for any serious attempt for mid-term nuclear phase out[21]. "Business as usual" science and expertise dominates the scene in PLATENSO countries and holds national monopolies in expert legitimation of policy processes and their results. By simply engaging "coal and gas" friendly expertise in support of business as usual approach is not enough to solve the nuclear phase out equation. National "alternative approach" expert capacities might however be too

[21] For example in Germany at start and during 1980ies the revolt against nuclearized energy policy and corporative top-down decision making style does not only resulted in a birth and growth of a new parliamentary political party (Die Grünen) that put anti-nuclear politics at its flag but also in emergence of innovative R&D institutes that in addition to challenging and putting under question the arguments of nuclear industry and science that served its interests also provided professional expert ground for alternative energy concepts and technologies that shifted from paradigm of centralized fossil fuels and nuclear energy based permanently operating large units systems. Within two decades in the "greening" political and social environment the seeds of small scale independent alternative energy and energy policy expertise made roots in "mainstream R&D" and resulted in solid expertise in support of phase out nuclear energy in the country.
Developments in Germany are however unique and success patterns cannot be simply copied and successfully pasted in the actual realities of PLATENSO countries in question, last but not least also because large differences in size of population and economy.

weak in their capacities or lacking acknowledgment by scientific community and/or public to design robust comprehensive phase out scenario and significantly contribute to its legitimation in front of policy and decision makers and the public in general. Taking into account it is evident that scientific cooperation between domestic and foreign alternative energy and regional development expertise focused on development scenarios that will provide answers to the questions raised in a section above needs to be strengthened before formal process of design of nuclear phase out scenario. Required technical expertise can be of course also purchased on the international markets. However the fact that it cannot have a deep insight into countries traditions, habits and background of operation of institutions will not only limit the scope of its approach business as usual consultancy. Its "foreign status" will in addition or more probably at very first undermines the trust in their expertise in the eyes of general public. Therefore a solution how to overcome the dilemma "we can engage our experts but they are not independent while independent experts from abroad will not be trusted" needs to be solved.

2.2. Participatory processes at regional, national level

It is seems reasonable to assume that phasing out nuclear energy demands not only innovation and fast deployment of EE an RES-E concepts and technologies in a country but also social and institutional innovation that allows more entrepreneurial oriented structures to meet with challenges of provision of affordable energy services at national and provision of new business and employment opportunities at regional levels in order to counter-weight loss of nuclear structures in a country. Therefore development of participative system of territorial innovations is needed.

The conceptual bottom line is that there exists no model fitting all regions nor offers an ideal pathway for regions to excel in RTD and the development of an adaptive approach usable in different regional environments is needed. Although the overall strategy for creating a successful region obviously does not exist, at least there are some tested models such as Industrial Districts, Localised Production Systems, Cluster or Innovative Milieus that provide various important elements that influence a region and its actors to become more RTD-orientated.

Various EU projects in the field of participatory regional development - as for example CRIPREDE[22] -- have reinforced the importance of understanding how national and regional variations in innovation regimes can influence RTD performance. In contrast to routine innovation regimes an ideal-type innovation regime is entrepreneurial. It fosters the application of new and untested technologies, and therewith promotes a higher level for R&D activity and performance. Such an innovation regime is characterised by open structures and a variety of technological concepts with pioneer firms playing a dominating role. Different territorial innovation models such analyse regional development paths with an emphasis on RTD, innovation, and entrepreneurship in a wider meaning, including regional and local institutional dynamics. Territorial systems of innovations emphasize that firms are part of a wider network of public and private sector institutions, which are involved in RTD. Besides this, key features of such a territorial innovation system are linkages, and knowledge flows between institutions as well as learning.

As opposition against deployment of large scale RES-E technologies like for example wind parks in the EU is growing it gets more and more evident that not only new NPP but also large RES-E projects faces resistance and their sitting presents one of the key challenges for faster growth of RES-E generated electricity. Conflict potential must be reduced and conflict management capacities improved in order to reduce high transaction costs of new energy technologies. Therefore planning

[22] See: How_to_make_regions_more_innovative; http://www.academia.edu/2712391/

and improvement of the territorial innovation process that involves the stakeholders capable to design the right solutions and implement them at the right time is of a crucial importance.

CRIPREDE consensus building model provide useful and tested tools for that therefore it should be tested in PLATNESO countries within the context of providing participatory structures in support of nuclear phase out. It is based on six phases: awareness & inanities; interactive workshop on value setting & vision; consequences and obligations, interactive workshop on improvement of proposed strategies; finishing the strategy and implementation, development and further progress.

2.3. Coordination of new energy policy with other national and EU policies

EU does not have mandate on energy. Yet energy policies of the member states should take into account the mandate and the role that the EU plays in the areas of environmental protection, nuclear safety, common market & state aids rules, trans-European networks, R&D and innovation fostering and deployment programmes. With a particular regard to nuclear phase out that cannot be carried out without taking into account the necessary coordination with relevant EU directives and regulations and without taking advantages from different EU programmes the following areas are of special interest due to inevitable role that clean fossil fuels and RES-E will play in any of phasing-out scenario sound with general development trends in the EU:

- Achieving current and fix more ambitious future RES and RES-E targets at the EU and MS levels
- Making EE targets mandatory
- Appropriate planning of pan-European and cross-border networks (electricity grids, CEE connecting natural gas pipelines) capable to incorporate strong RES uptake
- Provision of new market rules and appropriate incentives to assure that investments in complementary options like (fossil) back-up and storage capacities as well as network extensions should be undertaken in forthcoming year
- Improved cross-border transmission policies to facilitate the efficient operation of the grid under increased RES penetration

If mid-term nuclear phase out in PLATENSO countries with operating commercial nuclear energy facilities should be considered as a real policy option than PLATENSO countries should also change their traditional follower role and enlist among the forerunners of RES and EE on the European floor. From current political perspective in the countries in question and by taking into account present institutional crisis of the EU that prevents to find solid solutions to balance the development between the most developed and economies at EU periphery it is however very much unlikely that PLATNESO countries will actually make steps in the proposed direction.

3. Consequences of the exiting nuclear energy phase out

In PLATENSO countries, studied for the Scenario 2, it is evident that there is no agreed any decision on the phasing out of nuclear although in some countries (like Lithuania) is not taken in the energy policy or the energy policy is under development and includes also scenarios without nuclear options (like Slovenia). But based on the analyses presented in previous chapters there are some important issues which will impact phasing out of nuclear and their consequences to the energy policy which would need to be addressed for the Scenario 2.

3.1. Economic, including energy price

The phase out of nuclear energy use would seriously endanger the energy supply especially since the nuclear present the base load for most of studied countries. This is very clearly evidenced by example in Lithuania which was during negotiation process to access the EU decided to shut down their NPP. Therefore a reliable and stable basic energy sources should be ensured in order to replace the usually large contribution in the energy supply. The phasing out of nuclear would increase the dependence on the electricity import which is now under the EU open electricity market more feasible but also very costly. In addition the new electricity production strategies (like gas, oil or coal) would increase dependence from the countries mainly out of EU which have such resources. In the current political situation such decision would highly impact geo political conditions and dependence on the foreign market which is not stable and not reliable (Russia and near and middle East or North Africa). Even is such substitution and replacement is feasible, it is also very expensive.

Germany as an example of country which decided to phase out nuclear in longer perspective is taking very serious and extensive actions in order to replace nuclear energy with other renewables and more effective energy use. In longer term the might be successful but this move from nuclear to other resources is very costly[23] (although we cannot underestimate the investment costs for new Generation 3 NPPs which are based on real example extremely high). Studies and analyses of economic effects of new energy sources introduction and replacement of nuclear energy should be performed for specific country situation with investigation of possible new sources. Such analyses should be performed for longer period in advance to enable the whole energy sector to adapt and to change.

3.2. Social, societal and government factors

Phase out of nuclear power plant is bringing many social and societal impacts as experienced in Lithuania for example. One of the major issues after the phase out of NPP which employ a big number of highly qualified employees and also provide job opportunities for other related entities (services for NPP operation and maintenance) is loss of employment possibilities. The consequences are even stronger in the communities with small number of population and regions which are mostly dependant on this only type of industry in the area. Although also during decommissioning activities for NPP dismantling qualified personnel are required but the number is slowly reduced dependent on the selection of decommissioning strategy. There are also some other social benefits linked with the NPPs operation in the region, like for example the benefit package which is feeding the communities budget directly (like in case of Slovenia the compensation is given in value of app. 5 millions € per year to communities in 10 km radius around NPP).

Such sudden break of employment possibilities impacts the population density and as proven in Lithuania it even during two decades two times bigger than the corresponding rate in Lithuania. The decrease of the population in the region is partly determined by the population migration and also by the negative birth rates that restructure the age distribution and increase the aging of population.

Reduction of benefit package for the municipalities in the affected area leads also to decrease of possibilities for new investments which are linked with their own funds. This make a kind of circle of related consequences which have very strong societal impacts: less projects, less infrastructure, migration of population, no job opportunities, aging of population, even further reduction of social services and so on. These challenges should be studies and consequences analysed long before the phase out on nuclear energy would takes place in order to restructure of industry, economy and to mitigate social and societal impacts. Some governmental issues should be also addressed like establishment of special legal and legislative exceptions and protections for the affected area and to help new industry organisation. Some examples of such approaches exist in relation to other

[23] For some popular arguments that are putting under question the rationale of German »phase out« see: "The costly muddle of German energy policy"; http://www.ft.com/cms/s/0/ffa462f2-4d4b-11e4-bf60-00144feab7de.html#axzz3Ufp6HjAE

industry phase out (like mining industry replacement in many areas across the world) and lessons learnt could be taken.

3.3. Environmental issues

Factor which can be attributed to the environment and are linked with phasing out of nuclear power plants are mostly positive impacts under assumption that the decommissioning activities are taking into considerations all international requirements and guidance and would be implemented to the end. The nuclear energy use is one of the rare examples of industry installations where the complete circle of burden is taken into account. The phase out of nuclear energy use would stop even very small direct impacts from NPP (gaseous release and direct ionizing radiation). Properly addressed decommissioning activities would enable even further reduction of environmental impacts. The open question here is the level of decommissioning, i.e. green field (unrestricted use of location) versus brown field (restricted use of location) which is foreseen and implemented. In the world many examples are available and in use, the question of the level of decommissioning implementation mainly depends on available funds, further location use plans and public acceptability. Also the doses to works during the implementation should be taken into account.

Very important environmental issue, which in fact does not depends so much on the nuclear phase out, is radioactive waste management and specifically spent fuel management. The issue of RWM is more or less solved in most of the countries (although in PLATENSO countries LILW repositories are now mainly under planning or construction phase). The big problem is SF management which is not solved internationally and would represent in nuclear phase out earlier challenge. Most of national plans foresee a kind of temporary SF storage, many times on NPPs sites. The early shut down of NPPs would also mean that SF solutions need to be properly solved earlier which for sure open another dimension of impacts. In any case, the RWM requires decades to be solved so the processes should be started soon enough to provide reliable and acceptable solutions.

4. Implementation of phasing out nuclear power

Implementation of phase out of nuclear power opens additional dimension of factors which should be addressed. Some relevant issues are listed below:

a. Definition of the most optimal date for exiting from nuclear energy in relation with the life span of existing NPPs
b. Assuring the staff with appropriate knowledge and expertize
c. Technological plans
d. Organization of processes

Based on the Lithuanian experiences the following actions should be performed in order to mitigate the negative socio-economic impact during the implementation of nuclear phasing out:

- Stimulate the implementation of the projects in the region based on development plan, planned to be funded from the structural funds of the European Union and other sources;
- Stimulate the implementation of the projects defined in the development plan for the region infrastructure;
- Ensure the activity of the state institutions which take care of the population health and welfare like Region Development Agency and Social and Psychological Service;
- Stimulate the development of small and medium business in the region;
- Create conditions for employees from nuclear sector to integrate into the labour market and to mitigate the impact of standing off – to provide them with special occupation and social guarantees;

- Stimulate highly qualified employees of the nuclear sector to ensure safe decommissioning of the power plant which could last also for several decades.

5. 2 Resources (human, funds…)

Even if it looks at first glans that the Scenario2 with phase out would not need big resources in terms of human staff and funding, there are still several demands. The nuclear phasing out would require trained and highly competent professionals for the decommissioning works which would last for several decades (up to 40 -50 years). The number of employee would be gradually decreasing with time which presents also a good opportunity to include the natural aging of experts and their retirement.

But having in mind challenges described in earlier chapter we can repeat the main finding from Scenario 1. Even for the nuclear phase out the work on SSG investigation should be organised and coordinated therefore plans to assure the resources, having in mind human resources and connected funds need to be recognised. Currently in all PLATENSO CEE countries there are some programs or plans regarding the nuclear energy development, dealing with technical (pre-) conditions and nuclear professional. As already mentioned they are not systematically addressing the whole nuclear energy area and are mainly developed partially, dealing with particular topics. For example, with the Council directive 70/2011/EURATOM on the establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, all countries will prepare national programme for the management of spent fuel and radioactive waste. They will include also the resources, but limited first to only RWM, and secondly, they will be focused on technical challenges for the countries. Clearly there is not national overview of approaches for nuclear energy phase out analysing also different social, societal and governance issues.

In fact, the specific country national development should be focused in tailoring broader picture of nuclear energy phasing out in order to satisfy described factors. Besides the technical challenges to phase out with nuclear also topics presented in previous sub-chapter should be addressed. This requires beside the technical experts also many other researchers and specialists, like psychologists, sociologists, political scientists, communicators, economists and others.

5. 3 Schedules

As presented in the chapter 3 on timeframes of nuclear eventual phase out of current NPPs operation and taking into account that there will be no future new builds, the probable schedules for studied countries in Scenario 2 are:

- 2020s: planned NPPs' lifetime – first tranche (shutdown and start of decommissioning),
- 2040s: planned NPPs' lifetime – second tranche, extended lifetime of first tranche (shutdown and start of decommissioning),
- 2060s: extended life time of second tranche of NPPs (shutdown and start of decommissioning),

From this overview it can be seen that the schedules for SSG issues will need to incorporate a very long time frames in parallel to the technical developments but mainly dependent on the country. Many different phases of nuclear energy programs will need to be addressed from decision in principle on the energy policy, concept and strategy, to different stages of facilities shut down and

then starting with decommissioning, development of proper RW management, especially issues connected with SF management which is in CEE countries not yet on the current agenda of solving (with some exceptions, like Czech republic). In parallel other important SSG issues like development of regional plans and strategies with reorientation to new industry sectors to assure the revitalisation and area development should be addressed.

All this steps in new energy implementation involving nuclear phase out will require interaction with society thus involving social, societal, governmental issues as an interdependent part of technical project. Most demanding parts of the schedules in this respect are new energy policy adoption and reorganisation of the regional development strategies as well as RWM for all waste types. Even in case of early phase out in 2020s the nuclear heritage will last at least another 30 or more years (taking into account normal period of decommissioning and also normal period for SF management including heat decay). Within the national strategies this should be tackled in the national context.

6. Conclusions and recommendations

6.1 Conclusions

Taking into account the lessons learned within this report the following conclusions can be drawn:

1. phasing out of commercial use of nuclear energy in Bulgaria, Czech Republic and Slovenia is with some restrictions and adjustments technically feasible even in short term in spite of considerable share of electricity that in those countries is provided from NPPs. Phasing out of nuclear reactors in Lithuania where about 70% of electricity was generated by commercial nuclear reactors can serve as a proof for this thesis.
2. Although "ad hoc" nuclear phase out in countries in question is technically feasible it is inevitability related to increased imports and costs of electricity, considerable loss of competitiveness of at very first electricity intensive industries as well as with economy and social stagnation of regions around NPPs. Last but not least also environmental performance of electricity generation and consumption would decrease due increase of GHG and air pollutants emissions. Here again the Lithuania can serve as a reference.
3. The negative effects of nuclear phase out would be strengthened by the fact that none of the countries is considering nuclear phase out as an option although this might be – at least for a limited period of time - triggered even by an event that none of the countries can have a direct impact on – a severe (above INES 5) accident in a NPP not only within a country but also within the EU or above, especially in case of similarity of reactor types.
4. The countries are not prepared even for an "emergency" phase out because the nuclear energy is a dominant energy option based on specific constellation of historical (communist) roots of nuclear energy in all countries, strong foreign interests to continue and expend the nuclear option, weak capacities to articulate and aggregate competitive alternative interests and possibilities of "state capture" by strong incumbent energy players. Except Slovenia where hesitation to accept its dominance is resulting in political delays and blockades of national energy policy strategy the dominance of nuclear option is confirmed by official national energy strategies and plans. At least life-span of existing operating nuclear reactors for at least 20 years is taken as a fact in Bulgaria, Czech Republic and Slovenia and is in the first two countries already confirmed by official decisions whereas construction of new NPP is discussed and at least indicated by official plans in all four countries.
5. In none of the four countries nuclear phase out is discussed within the mainstream expert, policy and media discussions on national energy policy. Within the mainstream – and in most cases even within official – discourse on energy (policy) renewable energy, energy conservation and energy efficiency are considered as complementary and not as an alternative to nuclear energy. As the alternative they are limited to few experts and environmental NGOs.
6. With exception of Lithuania where after national referendum on nuclear energy public opinion is rather against than pro nuclear oriented and in Slovenia where at present public opinion is neither clearly "pro" nor "anti" nuclear in the other two countries the public opinion seems to be firmly in favour of nuclear energy. However any severe nuclear accident anywhere in the world would have a strong impact on public acceptance of nuclear energy although this decreases by time.

7. According to our findings nuclear phase out in the four countries in question could be carried out only under assumption of more concerted actions at EU level aiming on necessary coordination of relevant EU nuclear safety directives and regulations, achieving current and fix more ambitious future RES and RES-E targets at the EU and MS levels, making EE targets mandatory, appropriate planning of pan-European and cross-border networks capable to incorporate strong RES uptake , improved cross-border transmission policies to facilitate the efficient operation of the grid under increased RES penetration and provision of new market rules and incentives to assure investments in complementary options.
8. In addition to adequate changes in legal frameworks, policies and measures on EU level the countries in should in any serious phase out strategy also change their traditional follower role and enlist among the forerunners of RES and EE; i.e. design and implement their RES and EE policies beyond EU requirements to grasp full RES & RUE potential (also) in terms of creation of new industrial, business and employment opportunities. This is however very much related to the changes of networks of political and economy elites.
9. In order to mitigate negative impacts of nuclear phase out on regional development in terms of economy and employment next to operational decommissioning activities also new entrepreneurial innovation regimes that fosters the application of new and untested technologies, and therewith promotes a higher level for R&D activity and performance needs to be introduced to regional development. Regional development should be characterised by open structures and a variety of technological concepts with pioneer firms playing a dominating role yet recognising that they are part of a wider network of public and private sector institutions that enables linkages, knowledge flows and learning between stakeholders. Therefore planning and improvement of the territorial innovation process that involves the stakeholders capable to design the right solutions and implement them at the right time is of a crucial importance for smooth phase out of any critical infrastructure.
10. Even consensual nuclear phase out might reduce the level of nuclear safety since less attention and resources might be allocated to (safe) maintenance of phased out NPP(s) and adequate management of spent fuel and other nuclear wastes. Therefore planning of nuclear phase out must take this aspect in the foreground and provide adequate solution to at least maintain the level of nuclear safety in a country.
11. Nuclear phase out will require interaction with society thus involving social, societal, governmental issues as an interdependent part of technical project. Most demanding parts of the schedules in this respect are new energy policy adoption and reorganisation of the regional development strategies as well as RWM for all waste types. Even in case of early phase out in 2020s the nuclear heritage will last at least another 30 or more years.
12. Last but not least nuclear phase out is also symbolical and therefore emotional gesture far from being purely based on energy and economic calculations. It raises high spirits and emotions both among proponents and opponents of nuclear energy. Conflict potential must be reduced and conflict management capacities improved also in order to reduce high transaction costs of new energy technologies.

6.2 Recommendations

Based on research undertaken by the authors of this report to understand the frameworks, possibilities, feasibilities and driving forces for nuclear phase out in the four PLATENSO countries – all of them new EU member states from CEE region – as well as related strengths, weaknesses, opportunities and threats leading the following recommendations could be proposed:

1. Nuclear phase out should be by political elites, energy policy makers and also by public recognised not as something "completely irrational /impossible" and even less as a "request of an enemy" but as a legitimate option that needs to be discussed and elaborated by providing support to expertise that legitimise it. Political elites and mainstream science should learn that due to an unexpected event nuclear phase out might appear not as an "eco-utopian" option but as an urgent request to be dealt with like it or not. Therefore it would be better to consider it not only as a threat but also as an opportunity to widen the scope of options, find optimal solutions in a case of emergency and by elaboration of win-win opportunities reduce the danger of being trapped in vigorous cultural social clash or being completely unprepared for situation beyond imagination (as it appeared on March 11 2011 in Fukushima, for example). To widen the set of elaborated options in order to be prepared for what might happen outside present expectations and frames is exactly the job that needs to be done in interaction between science and politics or at least it should be.
2. The studies on technical potential of alternative, no-nuclear energy options to provide quality and affordable energy services as well as competitive supply with electricity in a country should be supported and discussions on adequacy of presumptions, inputs, models and outputs of different energy scenarios should be encouraged in order to support scientific expertise as culture of non-coercive generation of consensus on a sustainable energy policy.
3. Next to more adequate and accurate assessment of technical potentials of other energy sources and technologies – including "negawats" - to compensate the role of nuclear power both in terms of quantity and reliability of supply of electricity as well as in terms of the role the nuclear power plant(s) are playing within electricity generation system the scientific research should focus to analyse in detail structural and system barriers that are hindering the developments of the alternatives to nuclear power and explore alternatives beyond existing technical and legal frames as determinants of feasible solutions.
4. In particular more attention and support should be provided for multi and interdisciplinary based understanding of the barriers for faster development and deployment of renewable energy, energy conservation and efficiency and smart electrical grids. While it is getting obvious that those are megatrends with wide potential for both "ecological modernisation" of energy sector and social sustainability in general the CEE countries in general are rather followers than forerunners in the field. A detailed policy analysis of renewable energy and energy efficiency policies in comparative perspective with most advanced EU countries and by taking into account a broader context of EU policies and measures related to topics such as "energy union", "liberalisation and integration of energy markets" and "climate change mitigation" should explain the reasons for rather restricted attitude of CEE countries to fully grasp their RES and RUE potentials and what needs to be done at the EU and at national levels to change this attitude.
5. This research should go hand in hand with research on new models of regional development characterised by new entrepreneurial innovation regimes that fosters the application of new and untested technologies based on open structures where pioneer firms playing a dominate role within a wider institutional framework of knowledge flows and learning processes between public and private sector. Only this kind of regional development enables territorial innovation process capable to face with large challenges on a regional level that results from phasing out of a nuclear power.
6. As phasing out nuclear power especially in mid-sized and small countries depends in large on frameworks, policies and measures imposed by EU decision making level. On the one side

those stakeholders that are interested for more nuclear transparency and safety are pushing for stronger requirements for the NPP operators, regulators and the member states on nuclear safety, transparency and third party liability. On the other side there is on the EU level also growing push for more ambitious RES and RES-E and biding EE targets, faster development of pan-European power grids and improved cross-border transmission policies to facilitate and support strong RES-E uptake etc. Regardless whether continuation of nuclear activities, construction of a new (type) of nuclear reactor or phasing out of a nuclear energy is at question also in CEE countries the political decision makers should see the full picture and not only the requirements of the one or the other EU directives and of course even less only the interests of one or the other powerful consortium of investors. Therefore CEE countries should invest considerably more efforts in research of energy policy developments at EU level in general and especially when interested for phasing out nuclear energy.

7. A special challenge that also needs to be investigated by multi and inter-disciplinary approach is how to at least maintain the level of nuclear safety under phasing out scenario. Even when phasing out could not be considered as realistic option there might be considerable benefits from this kind of studies since they might provide valuable insights on the weak points of present nuclear safety and RW management regimes.

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8. Appendix

The protocol for information collection Task 4.1

Date of Completion:	Completed by:
Country:	Organization:

(I)	**The state of the art of nuclear facilities in the country** *Short description of the existing and currently planned nuclear facilities: type (research reactor, NPP, RWM facilities), including the location, date of construction, expected/planned phase out, net electricity output (in case of operating and planned NPPs) and the operator.*

(II)	**The status of nuclear energy in energy policy of the country** *- What are the energy policy documents of the country (national energy concept/programme), and by whom and when they were approved?* *- What are the other relevant national action plans (Climate change/ national action plans for greenhouse gases mitigation etc.)?* *- What is the role and status of nuclear energy in each of those documents, when is it expected that those documents will be updated/replaced?* *- Are there any documents under preparation, what is the role of nuclear energy in those documents and by whom and when will they be prepared and by which institution do they need to be approved?* *- Is radioactive waste management (LILW, reprocessing, spent fuel repository) included in those documents and how do they address the issue of wastes from NPPs?*

(III)	**The role of nuclear energy in electricity supply of the country** - *What is the share of generated electricity from NPPs in the total electricity output of the country at present and in different energy scenarios in the future?* - *What is the net energy/electricity balance of the country: imports and exports of electricity from the country under different scenarios?* *For each scenario please provide details by whom it was prepared and commissioned and what is its present status (study- please provide the name of the study in the original language and its translation into English; pending/approved national energy policy document – please provide*

	details: name of the document, by whom and when it was approved or is expected to be approved. Please refer also to "nuclear free" scenarios addressing phasing out of nuclear energy (in terms of electricity supply), where applicable. *Do please also take into consideration "alternative" scenarios prepared by civil society organizations, where applicable.*

(IV)	**Siting Policy** *- Are there at present or in the foreseeable future any siting procedures regarding nuclear facilities?* *- What legal system is used (provide a brief description of the steps)?* *- Are there any exemptions for which this do not apply (such as extension of nuclear facility operation and what procedure is then used?* *- Are there any public opinion polls on siting: when and by whom were these commissioned and what are the results (in favour, against, undecided)?*

(V)	**Public Opinion Research on Nuclear Energy** *- please provide details on public opinion polls about nuclear facilities that have been carried out in the last five years with regard to:* *a) existing NPP(s) (which one(s))* *b) life time extension of existing NPP(s) (which one(s))* *b) planned NPPs (which one(s))* *c) existing and planned nuclear waste treatment facilities* *- when and by whom were these commissioned?* *- what were the results (in favor, against, undecided)?* *- are there considerable differences regarding support for nuclear power taking into consideration (please provide evidence):* *a) time?* *b) origin of the study?*

(VI)	**Economic benefits of nuclear power** *Please provide information – if it is available – on assessments of the impact of nuclear energy on national businesses and employment in the country related to:* *a) Phasing out nuclear energy* *b) Life time extension of existing NPP(s)* *c) Construction of new NPP(s)* *- what is the expected share of involvement of domestic companies in nuclear business by type of business activity (e.g. construction activities, supply of equipment/services, engineering, financial management, other)?* *- what is the number of expected new jobs from nuclear activities;* *- what is the financial turnover of the owners of the NPP?* *- what taxes are/will be paid to the state and to the local communities?* *Please provide for each assessment details of who commissioned it, who carried it out and whether it is publicly accessible (where) or not.*

(VII)	**Level of the inclusion/participation of stakeholders and the public in decision-making on nuclear power at the national level:** *- Are there any special legal provisions regarding public participation on nuclear issues, and for which type(s) of nuclear facilities in the fuel cycle they do apply (please provide details of the name of the relevant law/bylaw/decree and its content)?* *- Are there at present any political requirements to hold a nation-wide referendum on nuclear energy. Who will carry it out and to what does it refer (phasing out nuclear power, siting of new NPP(s), life-time extension of NPP(s), LILW management ….)?* *- Is there a political (binding or nonbinding) political decision to hold a nation-wide referendum on nuclear energy? Who will carry it out and to what does it refer (phasing out nuclear power, siting of new NPP(s), life-time extension of NPP(s), LILW management ….)?*

(VIII)	**Access to information on nuclear power activities** ▪ *Where and how is the information on existing and planned nuclear facilities available?* ▪ *Which institution(s) is/are hold responsible for issuing information and what are the procedures for obtaining information regarding:* • *Life-time extension of existing NPPs?* • *Repository for low and intermediate level radioactive wastes?* • *Repository for high level wastes and/or spent fuel?* • *Construction of new NPPs?*

(IX) Existence of local initiatives regarding nuclear facilities ▪ *The name and the location of each initiative, its status (formal or informal), year of establishment, focus (content), level of activity, degree of networking. Is it a single stand-alone initiative or part of a broader regional/national/trans-national network*? ▪ *Requirements for and access to independent expertise on nuclear power.* *Are there any claims of local/national initiatives on independent expertise?* ▪ *On which aspects of nuclear power?* ▪ *By which initiative? [what does this mean?]* ▪ *Which organizations are expected to provide independent expertise?* ▪ *Are there any public funds/resources for co-financing of the initiative? Please provide details.*
(X) Media reporting on nuclear activities ▪ *Are there – if any – media reports in the most important national media (newspapers, TV and radio stations) on current and planned nuclear activities in the country? Please provide details on the relevant media (name of the newspaper, TV/radio station/program etc.* ▪ *What is the actual stance of the main national media toward specific actual or planned nuclear activities in your country?* ▪ *What sources of information are reported in the media:* • *Official information from government/governmental agencies?* • *Information from regulator(s)?* • *Information from power supply companies and investors in nuclear facilities?* • *Information from R&D institutions in the field?* • *Information from national NGOs, local initiatives and citizens?* • *Information from trans-national NGOS (Greenpeace, Nuclear Watch international, European Environmental Bureau etc.)?* ▪ *How balanced is the media reporting on current and planned nuclear activities in your country?* *a) Well balanced – the media are providing information from different stakeholders on actual and planned nuclear activities/facilities* *b) Quite balanced – the media are providing information predominately based on one type of sources (which one?) but are also taking into consideration other sources (which one?)* *c) Unbalanced – the media are predominately providing information from one source (which one?) and only occasionally information from others (which one)*

d) *Biased – the media are providing information exclusively from only one type of source (which one?)*

(XI) Trust in institutions and/or information sources on nuclear activities ▪ *Has there been any research in the last five years on:* a) *Trust in those institutions in charge of nuclear activities? When and by whom was it carried out? What were the results?* b) *Trust in information sources on nuclear activities? When and by whom was it carried out? What were the results?*

Questionnaire for Scenario 2

PLATENSO partners from Bulgaria, Czech Republic, Lithuania, Slovenia

Country	Institutions
Bulgaria	CSD
Czech Republic	ISAS CR/IJZ REZ
Lithuania	LEI
Slovenia	REC CO Slovenia/UL

Q1: Please describe if and how the phasing out scenarios are considered and presented as alternatives in national energy policy documents and plans.
Q2: What are the main conclusions of the stress tests results?
Q3: Are there any public debates, plans, projects or other activities related to phasing out nuclear power going on in the country? Please describe.
Q4: Please list the SWOT elements: strengths, weaknesses, threats and opportunities for Scenario 2: Phasing out nuclear power, that are relevant in your country.
Q5: Please list and describe shortly the social, societal and governance gaps and problems related to phasing out nuclear power in your country.
Q6: Please list and describe briefly the research needs for addressing social, societal and governance gaps and problems related to phasing out nuclear power in your country.

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