

CODE2

Cogeneration Observatory
and Dissemination Europe



D2.2 Cogeneration Roadmap

*Member State: **SLOVENIA***

*Partner Name: **JSI***

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1. Where are we now?: Background and situation of cogeneration in the member state.

1.2 Current status: Summary of currently installed cogeneration

According to the official statistical data¹, the production of electricity from 36 CHP plants with installed capacity of 337 MW_{el} in 2011 equalled 1.145 GWh, which is 0,9% more than a year before and 31,3% more than in 2002. CHP electricity generation share in total gross electricity generation in Slovenia is growing and was 7,1% in the year 2011. Useful heat production in 2011 was 3.042 GWh with slight decrease trend compared to the previous years, as shown in Table 3.

Table 1: National statistics on cogeneration in Slovenia 2008 - 2011

	Installed CHP capacity (MW _{el})	Total CHP electricity generated (GWh)	Total CHP heat supplied (GWh)	Total electricity generated (GWh)	Total CHP share on electricity (%)
2008	335	1.106	3.325	16.398	6,7
2009	327	1.025	3.119	16.401	6,3
2010	333	1.135	3.223	16.433	6,9
2011	337	1.145	3.042	16.056	7,1

Source: Statistical Office of Republic of Slovenia

Steam turbines are still prevailing CHP technology in Slovenia although with decreasing electricity generation due to stop of old autoproducers plants in industry (autoproducers have 20% share in total capacity and electricity generation) as shown in Figure 1. Almost all new CHP plants are powered by internal combustion engines, where not all new units are covered by national statistics².

¹ Statistical office of the republic of Slovenia. Data is prepared following the EUROSTAT methodology for CHP.

² National statistics is not yet covering small scale CHP units in tertiary sector, although some data are available from the Borzen who is managing the support scheme.

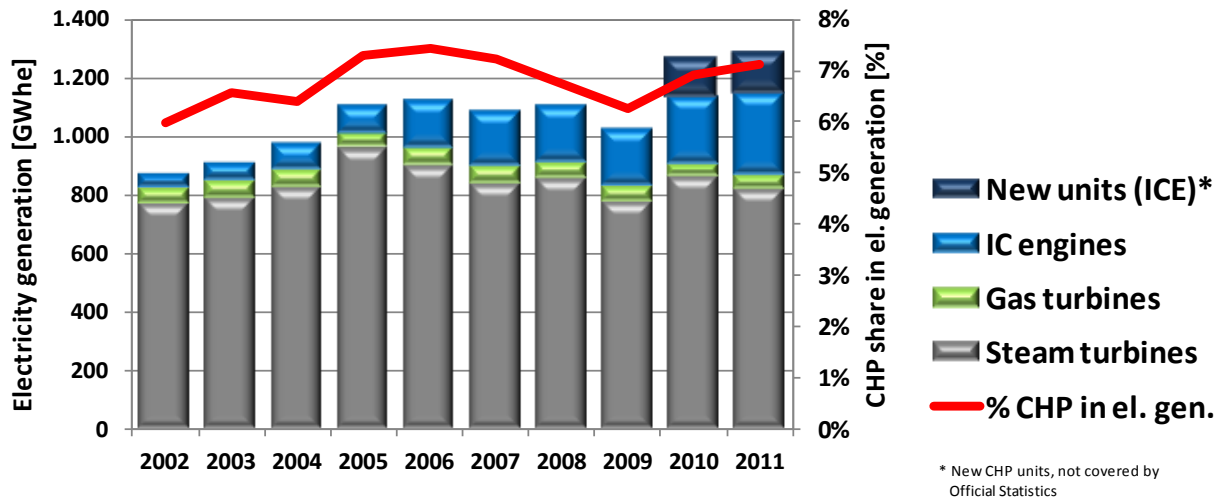


Figure 1: CHP technology development in Slovenia

Coal has still almost 60% share in CHP fuel consumption, following by growing other fuels shares (23% of natural gas, 13% of wood biomass and 5% of biogas) as shown in Figure 2.

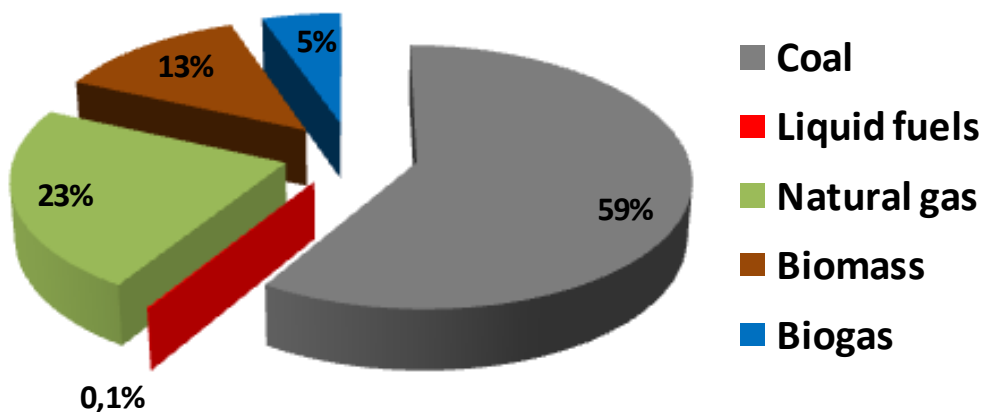


Figure 2: Fuel structure of CHP plants in Slovenia in year 2011

Slovenia has old tradition of district heating (DH) with DH networks operating in 49 municipalities with 734 km of DH network and 1 km of district cooling network. Share of CHP heat supply is growing and is close to 80% in recent years (more than 95% in two largest DH systems in Ljubljana and Velenje, less in other smaller DH systems), as shown in Figure 3.

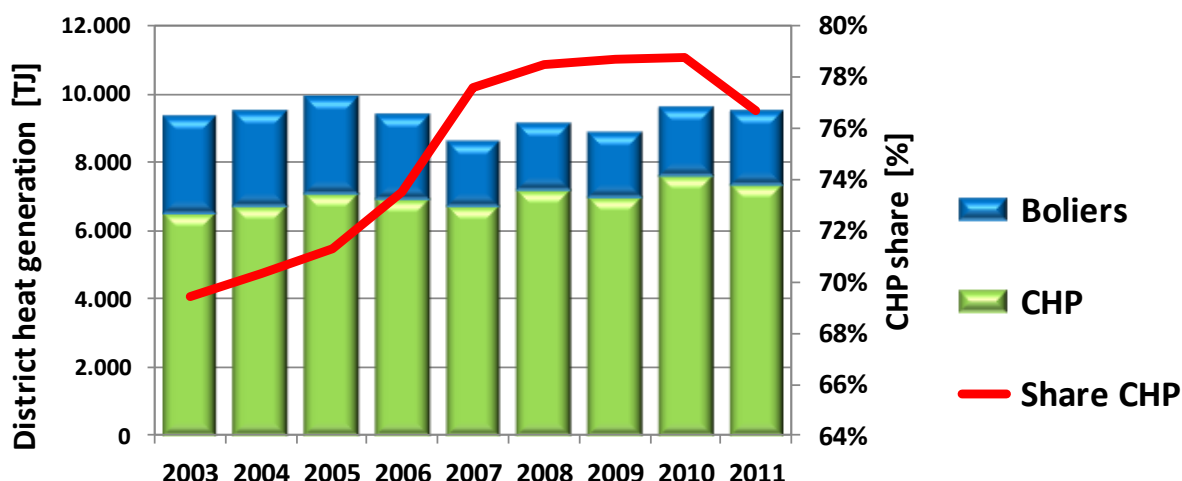


Figure 3: Structure of district heating heat supply – share of CHP

1.1 Energy and Climate Strategy of Slovenia

One of the most important challenges we face today is also to ensure a reliable, competitive and environmentally sustainable energy supply and energy services to all consumers. In Slovenia already Energy Law from 1999 has followed these goals. Nowadays a Slovene national energy policy is more and more influenced by the common EU energy policy and therefore national goals are very often derived from the goals on the EU level.

The fundamental document for CHP and energy policy in general in Slovenia is Energy Law³, which transposes CHP Directive into Slovenian legislation. It introduces also a feed-in support scheme, which is then more in detail defined in a special act on electricity support from high efficiency CHP⁴. This act is the main CHP support instrument in Slovenia.

The first goal for cogeneration was included in the first national energy programme ReNEP⁵ from 2004 – CHP electricity production should have doubled from 800 to 1.600 GWh yearly in the 2000-2010 period. This goal was not achieved, as the electricity production from cogeneration in 2010 reached only 1.135 GWh (Table 1). The CHP goals until 2020 have not yet been adopted. In the proposal for the new national energy programme NEP for the period until 2030⁶, the goals are currently set to 18% share of cogeneration in the gross final energy consumption until 2020 and to 23% share until 2030.

³ Energetski zakon (EZ), Ur.l. RS, [27/2007](#)-UPB2, [70/2008](#), [22/2010](#), [37/2011](#) Odl.US: U-I-257/09-22, [10/2012](#), [94/2012](#)-ZDoh-2L.

⁴ Uredba o podporah električni energiji, proizvedeni v sproizvodnji toplote in električne energije z visokim izkoristkom, Ur.l. RS, št. [37/2009](#), [53/2009](#), [68/2009](#), [76/2009](#), [17/2010](#), [81/2010](#).

⁵ Resolucija o nacionalnem energetskega programu, Ur.l. RS, [57/2004](#).

⁶ Osutek predloga Nacionalnega energetskega programa Republike Slovenije za obdobje do leta 2030: »Aktivno ravnanje z energijo« (http://www.mzip.gov.si/fileadmin/mzip.gov.si/pageuploads/Energetika/Zelena_knjiga_NEP_2009/NEP_2010_2030/NEP_2030_jun_2011.pdf).

Despite the fact that there are currently no CHP goals adopted on a national level, is the extent of support for cogeneration in different economic sectors and using different fuels included in several strategic documents:

- **The national renewable energy action plan for the 2010-2020 period (NREAP)⁷** is introducing 80% share of heat produced from RES, CHP or waste heat in the district heating systems by 2020 and exclusive use of RES, CHP or district heating in all buildings with installed heat capacity over 250 kW from 2012 onwards.
- **The national energy efficiency action plan for the 2008-2016 period (NEAP 1)⁸** defines the development of CHP in sectors, which are not included in EU ETS. According to this plan energy savings achieved by implementing CHP in households and tertiary sector should reach 102 GWh per year by 2016. In 2010 the achieved savings were estimated to 9,1 GWh, i.e. only 26,7% of the NEAP 1 goal⁹. Total savings due to the efficient use of RES and installation of new CHP systems are estimated to app. 3% of all final energy savings planned by the plan. Support for CHP installed by autoproducers in industry is not a part of this action plan.
- **The proposal of the new national energy efficiency action plan for the 2011-2016 period¹⁰**: a further support of CHP systems within the feed-in support scheme is foreseen. In the 2010-2016 period all together 55 MWe of newly installed CHP electrical capacity in industry, service sector and households are planned, while the final energy savings are estimated to reach 307 GWh per year by 2016, out of which 95 GWh in the service sector and households, which is little less then predicted by NEAP 1. The total installed electrical capacity of the new CHP systems is planned to reach 92 MWe by 2020 and the total final energy savings are estimated to 490 GWh per year (industry 325 GWh, service sector 126 GWh, households 39 GWh).
- **Operational programme for green house gases mitigation until 2012 (OP TGP)¹¹**: Action plan has foreseen cogeneration between other measures for GHG emissions reduction, where installation of new CHP systems in district heating plants, industry and building sector and installation of biomass cogeneration should contribute 313 kt CO₂-eq of GHG emissions savings in the year 2012.

The key public institutions responsible for cogeneration policy and support implementation in Slovenia are:

- **Ministry of Infrastructure and Spatial Planning of the Republic of Slovenia** as the main regulative body for cogeneration;

⁷ Akcijski načrt za obnovljive vire energije za obdobje 2010–2020 (AN OVE); http://www.energetika-portal.si/fileadmin/dokumenti/publikacije/AN_OVE/AN_OVE_2010-2020_final.pdf.

⁸ Akcijski načrt za učinkovito rabo energije za obdobje 2008-2016 (AN URE 1); http://www.energetika-portal.si/fileadmin/dokumenti/publikacije/AN_URE/AN_URE1.pdf.

⁹ AN URE 1 goal for 2010 was defined by using a linear interpolation of the goal planned for 2016.

¹⁰ Drugi nacionalni akcijski načrt za energetska učinkovitost za obdobje 2011–2016 (AN URE 2); http://www.energetika-portal.si/fileadmin/dokumenti/publikacije/AN_URE/AN_URE2.pdf.

¹¹ Operativni program zmanjševanja emisij toplogrednih plinov do leta 2012 (OP TGP); http://www.energetika-portal.si/fileadmin/dokumenti/publikacije/OP_TGP/OP-TGP_2012.pdf.

- **Energy Agency of the Republic of Slovenia – JARSE** as energy regulator, which is issuing declarations for CHP units (GoO) and provisions for the CHP support;
- **Borzen** – a centre for the RES and CHP support, which acts as market operator and is managing also the feed-in support scheme.

1.3 Policy development

New feed-in support scheme approved in 2009 is the main CHP support instrument in Slovenia, managed by Borzen - a centre for the RES and CHP support. –The level of the CHP support depends on the type of fuel, unit’s capacity and number of working hours (Table 1). After entering the scheme the units are entitled to receive the support for 10 years.

Table 1: Structure of the feed-in support scheme for CHP units

Type of fuel	Number of working hours	Unit’s capacity	
Biomass Fossil fuel	≤ 4.000 h/year > 4.000 h/year	Micro	(≤ 50 kWe)
		Small	(≤ 1 MWe)
		Lower middle	(1 to 5 MWe)
		Higher middle	(5 MWe to 25 MWe)
		Lower big	(25 MWe to 50 MWe)
		Higher big	(50 MWe to 200 MWe)

Power plant owners have the option of choosing between two types of support:

- **"guaranteed purchase"**, where Borzen takes over the total produced electricity (the producer is included in the special balance group, operated by Borzen)
- **"operating premium"**, where the producer sells electricity on the market or consume it on site and get paid premium as a difference between the full ("guaranteed purchase") price and the market price, which is determined ex ante on a yearly level.

RES producers with installed capacity over 5 MWe and CHP producers with installed capacity over 1 MWe can only receive the "operating premium" type of support. Level of premiums in the year 2013 is shown in Figure 4 and Figure 5.

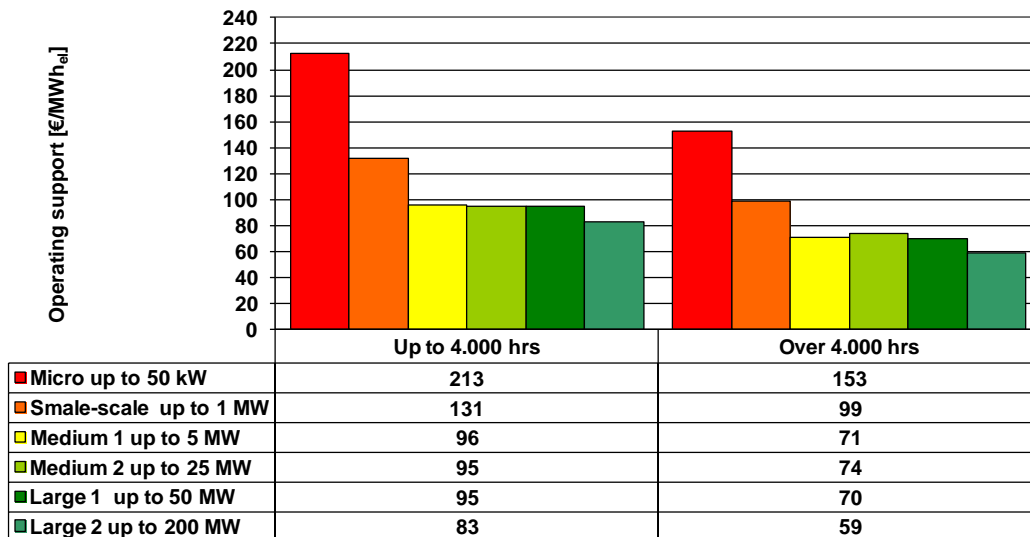


Figure 4: Feed-in premium for fossil CHP in the year 2013.

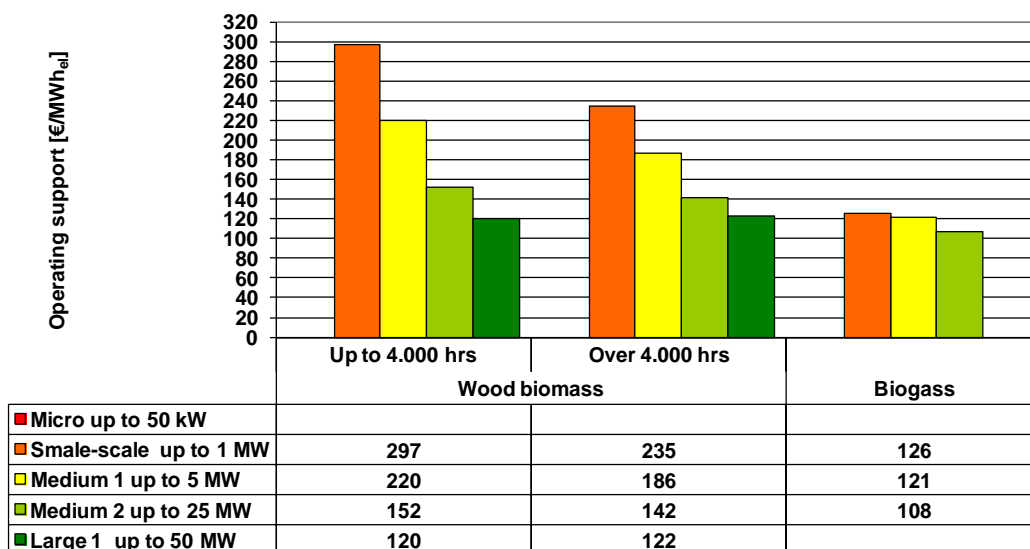


Figure 5: Feed-in premium for wood biomass and biogas CHP in the year 2013.

The feed-in system is based on guarantees of origin. All producers included in the scheme must issue and transfer to Borzen guarantees of origin as proof of RES / CHP production.

The feed-in scheme is financed through dedicated add-on charges on the network fee bills of all users of electricity in Slovenia.

Introduction of the feed-in support scheme in Slovenia in 2009 has contributed to the installation of quite some number of new small scale CHP units especially in the service sector, including public sector. According to the data of BORZEN, there were 42 new CHP units with a total installed capacity of 6,7 MWe included in the scheme at the end of 2011 (Figure 6). The capacity of vast majority of these units (81%) was smaller or equal to 50 kWe.

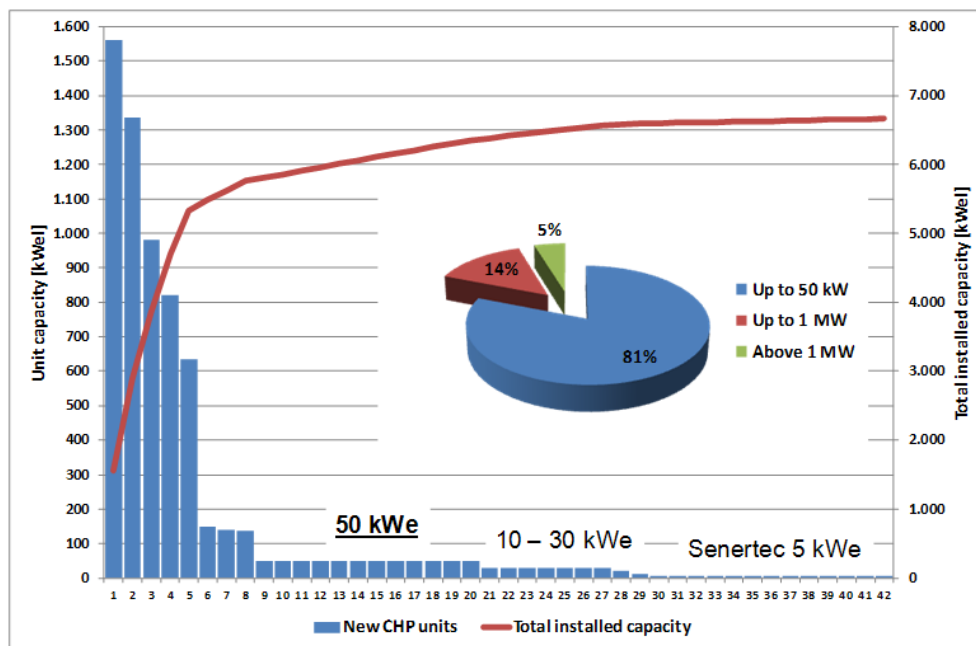


Figure 6: New CHP units included in the feed-in support scheme at the end of 2011

All new CHP plants supported through the new support scheme in 2011 produced 184 GWh of electricity (36% of total electricity generation in the RES&CHP support scheme). Total CHP support costs in 2011 were 15 million EUR (24% of all RES&CHP support costs) with average level of support 75 €/MWhel (111 €/MWhel for RES support).

New support scheme as key CHP support instrument triggered significant number of new CHP investment and established favourable environment for CHP development in all sectors.

1.4 Awareness

The main reason for the actual evident raise of awareness about cogeneration in Slovenia is dissemination of good practice of successful implementation of CHP projects triggered by incentive environment of the feed-in support scheme.

Cogeneration investments rely on a commercial proposition and a functioning market for the application of cogeneration. The policy intervention of the European Union to support cogeneration and assist the removal of market barriers is an important element of creating a good commercial proposition however in itself it will not be sufficient to grow sales of cogeneration if the customers are unaware or misinformed and lacking support within influencing groups or and if the supply chain of skills and suppliers does not exist.

A final buying decision by a customer is the result of a set of complex interactions, involving the supplier, the supply chain and the customer. External conditions influence the process as do the market structure and the policy structure. A mature market for a product is characterized by a high degree of awareness among all the relevant players in the market and ongoing buying and selling activity.

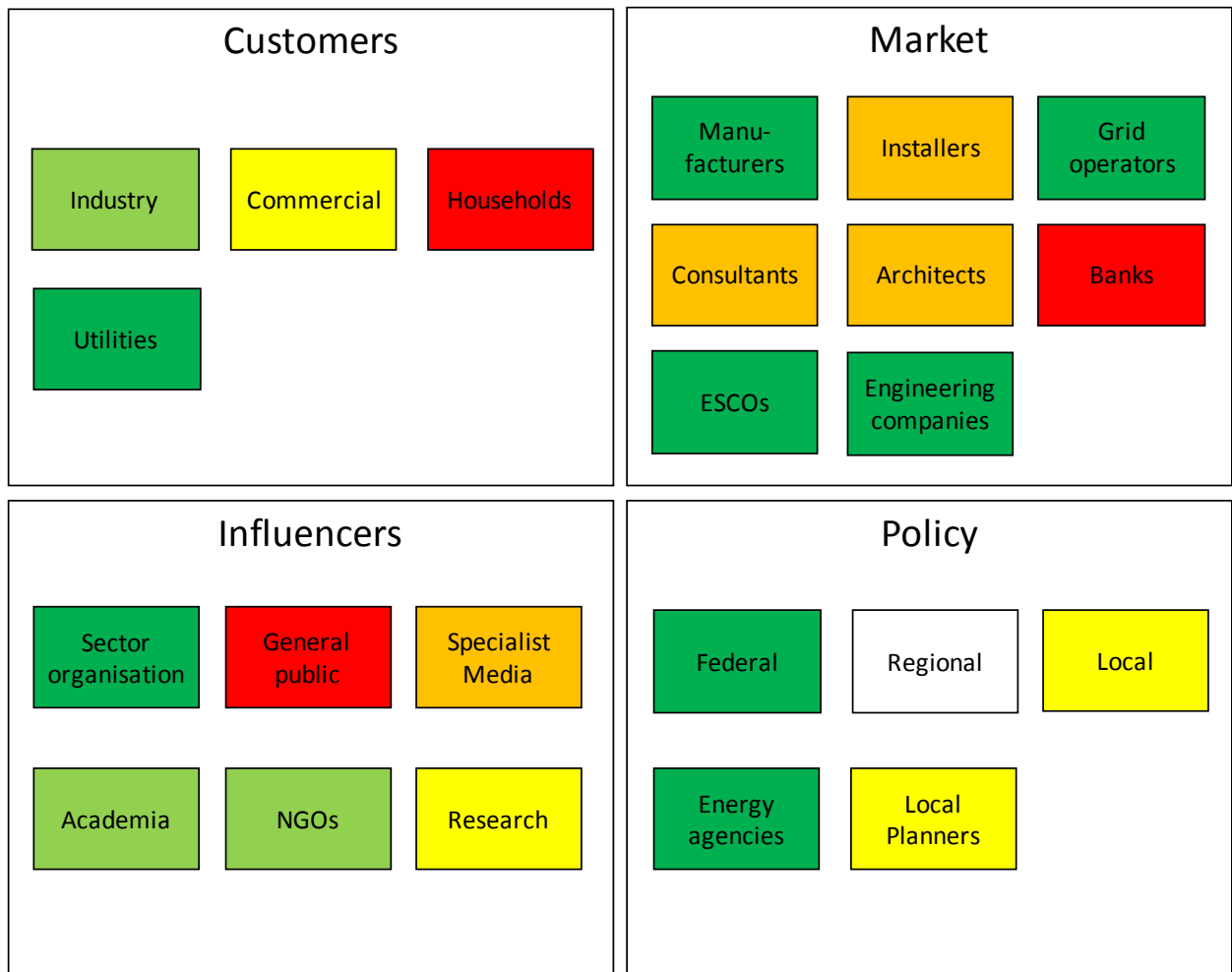
The following 4 groups of socio-economic actors can play an important role in the cogeneration market, either by direct involvement or by creating the appropriate economic and market structure:

- **Customers:** utilities (DH), industry, households, SMEs (services);
- **Market and supply chain:** manufacturers, installation companies, grid operators, consultants, architects, banks/leasing, ESCOs;
- **Policy structure:** energy and climate legislators on all levels of various institutions on state, regional and local level, energy agencies, planners;
- **Influencers:** sector organisations, general public, media, academic area, NGOs, research.

The list is not exhaustive but contains all the most relevant players.

An assessment of awareness of cogeneration among key market actors in Slovenia has been developed through performing interviews with a sample of the key actors dealing with cogeneration in Slovenia (state and local public administration, interest groups and cogeneration providers). Final results of the four groups of the socio-economic actors for cogeneration awareness assessment are shown in **Figure 7** (more information is presented in **Annex 1**)

Figure 7: Assessment of four groups of the socio-economic actors awareness of cogeneration in Slovenia



- | | | |
|---|-----------------|---|
| 1 | Poor | ■ |
| 2 | Low | ■ |
| 3 | Early awareness | ■ |
| 4 | Interest | ■ |
| 5 | Active market | ■ |

General public awareness about cogeneration is in Slovenia low. Except for the professional public and technical enthusiasts most of the people have never heard about this technology and if they did, they very often see it as a complicated and expensive technology causing additional noise, emissions etc. Compared to the cogeneration leading member states (Germany and Belgium) we have identified next key differences in the awareness:

- Firm governmental and political support and awareness** about advantages and contribution of cogeneration to the energy policy targets is still not yet present. Although cogeneration is properly positioned in several strategic documents and supported by very incentive feed-in support scheme, mid and long term perspectives are still not clear and causing uncertain environment for the investors. Lack of financial resources for the support scheme and consequently uncertain future support is key barrier at the moment.

- **Lack of awareness in banks and financial institutions:** the financial sector is regarding cogeneration still very cautious (lack of proper knowledge/understanding, too complicated, too high risks), which makes borrowing money from banks for CHP projects much more difficult compared to the other investments, like PV plants. This is crucial in the moment of financial crisis in Slovenia, where access to the financing resources is one of key issue for the successful project implementation.
- **Proper knowledge and awareness in whole chain responsible for successful CHP project implementation:** this is a large challenge for several indicated actors, which is crucial for wider quality CHP project implementation, especially in services and households sector.

1.5 The economics of CHP

Current Feed-in support scheme enables good economic conditions for new CHP investments with foreseen 12% return of investment for the majority types of CHP projects in Slovenia in spite of current very unfavourable energy market prices conditions.

Current energy market trends are very unfavourable for cogeneration in Slovenia:

- Recent decrease of electricity prices, linked to the EEX prices is especially influencing district heating CHP plants selling electricity on the competitive electricity market¹².
- Increase of natural gas prices which are in general on higher level compared to other EU member states¹³
- Ratio between electricity and natural gas price is around 1.5, which is far from the necessary level around 2.5

Recent natural gas and electricity prices by Eurostat consumers groups and the ratio between electricity and natural gas prices (CHP Energy price ratio) are shown in the following Figure 8. **Additional support of existing and new CHP units through the feed-in support scheme is key instrument, essential for both the CHP operational cost recovery and the necessary return of investment of new CHP plants in current unfavourable energy market conditions. Without the support we do not expect any new CHP investments and stop of operation of existing units would happen.**

Feed-in support scheme according to the EU state-aid rules enables “normal return on capital” where 12% discount rate is used for setting the level of support¹⁴. That means that in general we can presume **12% return of investment** for the majority of CHP projects in Slovenia where investment and operation costs do not vary significantly from the reference costs from the Methodology¹⁴. Yearly support adjustment mechanism considering electricity, natural gas and wood biomass market prices assures stable return of investment over the 10 years supporting period.

Current unfavourable market conditions request additional small operation support to cover the difference between larger operational costs and electricity market price for CHP units older of 10 years as well.

¹² On the other hand final end use electricity prices are growing (additional fees on RES, CHP, etc.).

¹³ After the long period of growing, negative trends of natural gas prices have happened in 2013.

¹⁴ Methodology for Determining the Reference Costs for High-Efficiency Cogeneration, Ljubljana, 2009.
http://www.mg.gov.si/fileadmin/mg.gov.si/pageuploads/Energetika/Sprejeti_predpisi/Methodology_CHP.pdf

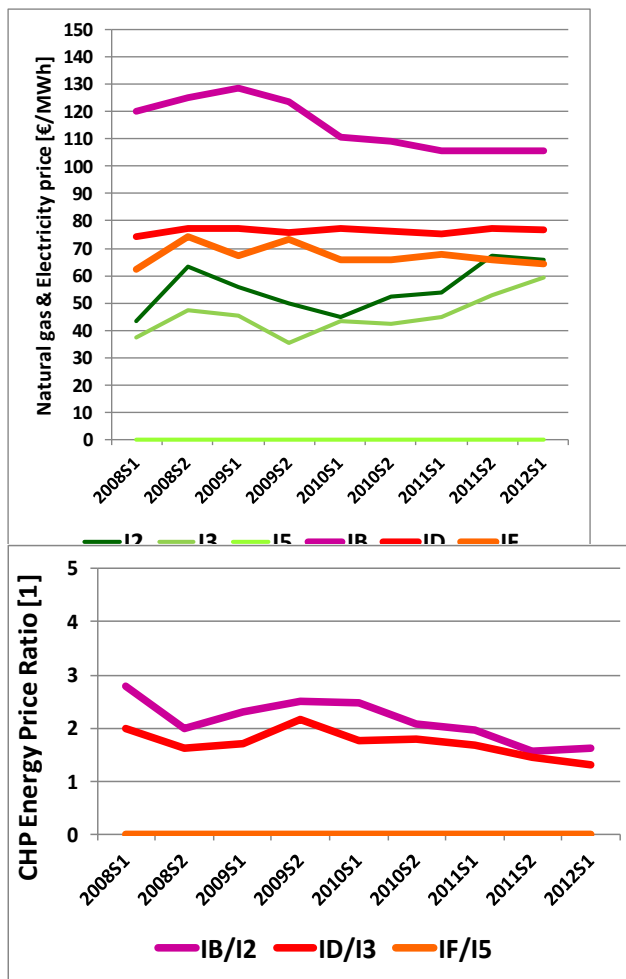


Figure 8: Recent natural gas and electricity prices and the CHP Energy Price Ratio for Slovenia

Economic assessment of four typical CHP projects for Slovenia¹⁵ in market conditions in the year 2012 proved the guaranteed profitability by the support scheme (Figure 9). Economic indicators (IRR and simple payback time) of micro and small scale CHP units are even slightly better than these results whereas district heating and biogas CHP units are close to the foreseen 12% IRR. More information about the CHP economic assessment you can find in Annex 2.

¹⁵ Micro CHP unit with 50kWe gas engine, 1 MWe gas engine in industry and services, 10 MWe combined cycle unit in district heating and 50 kWe biogas unit.

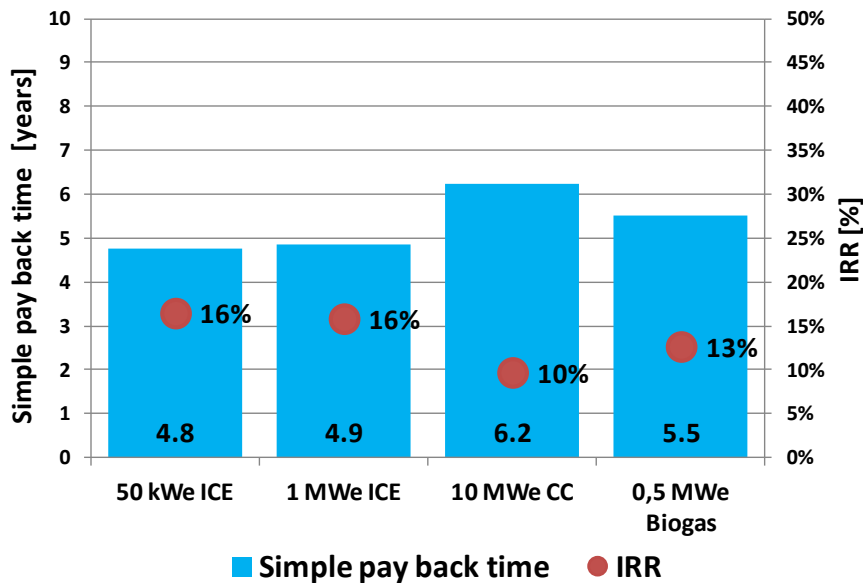


Figure 9: Economic indicators of typical CHP projects in Slovenia in year 2012

1.6 Barriers to CHP

1.6.1 Barriers noted in the 2007 report to the commission

In the report to the commission¹⁶ in 2007 Slovenia presented results of survey on barriers to the development of cogeneration plans by potential investors and highlighted the five main barriers for realization of CHP investment plans as shown in Figure 10.

Generally too high risks and poor economics of CHP projects at that time were main obstacles for the investors beside lack of resources, administrative procedures and still poor awareness and access to the information. The high expectations in terms of the payback period, the risk involved were highlighted and the preference for investors to make profit more easily by other forms of investment emerged as a barrier. These high expectations in terms of yield appear to be the major obstacle to the expansion of cogeneration in Slovenia before the approval of new CHP support scheme in 2009.

¹⁶ Analysis of the potential for the application of high-efficiency cogeneration of thermal energy and electrical energy in Slovenia, Report to the European Commission in accordance with Article 6 and Annex IV of Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand, Ljubljana, July 2007

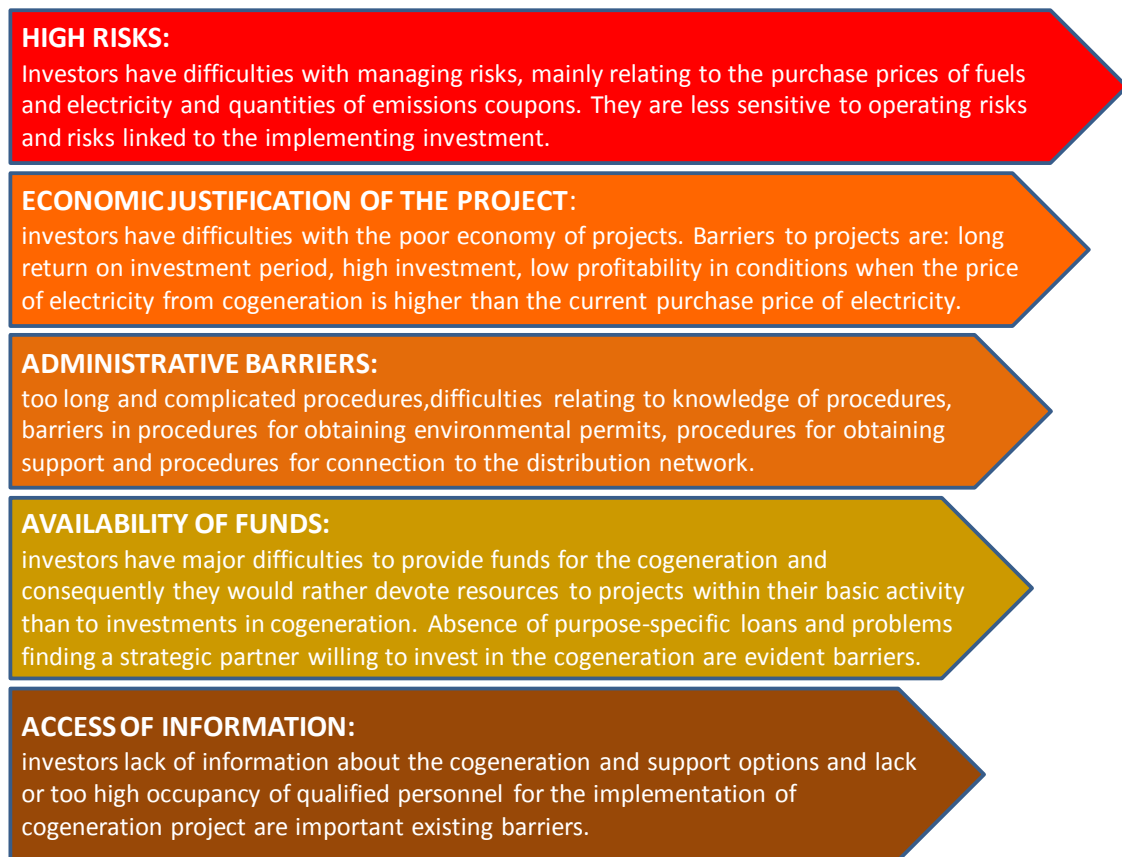


Figure 10: Main highlighted barriers from potential CHP investor's survey in 2007

1.6.2 General barriers independent of the application area

Although the conditions and the investment framework for cogeneration has significantly change since 2007 we are still facing with important barriers preventing faster development of CHP investments in Slovenia as presented in following subchapters

1.6.2.1 Uncertain CHP support scheme stop and postponed several projects in 2013

Too fast recent growth of PV plants in Slovenia has caused significant burden for financing the RES and CHP electricity support scheme. Strong resistance of large industrial consumer to the necessary increase of fee for scheme financing resulted in issuing the amendment of Energy law with proposal for changing the current Feed-in support model to the limited tender support model. Although Energy law amendment has not yet been approved, current uncertain support situation completely stopped planning and implementation of new CHP investments in Slovenia as due to the current unfavourable energy market conditions, proper support level is key precondition for the economic operation and feasibility of all CHP plants.

After four years of application, **support scheme would need deep evaluation to improve the cost-effectiveness and to remove some noticed problems and**

inconsistencies (especially linked to the micro CHP units and individual treatment of new CHP technologies¹⁷).

1.6.2.2 Absence of the support for CHP plants older than 10 years is threat for stopping of the operation of several modern CHP plants

Introduction of supporting framework also for depreciated CHP units (older than 10 years) is not allowed according to the EU State aid guidelines. How to solve this problem is the huge challenge, where most probably the solution should be found on the EU level (Following current guidelines such support is allowed only for wood biomass CHP plants, if plant operation costs are higher than the electricity market prices). Very limited and low operating support would enable further economic operation of several modern high efficiency CHP units, installed 10 years ago.

1.6.2.3 Lack of the private investment funds is key reason for absence of new larger CHP investment

Very difficult access to the financial resources (bank loans) in current economic crisis is key barrier for exploitation of huge economic CHP potential in industry and large CHP investment (100 MW_e CC on natural gas) in Ljubljana (TE-TOL)¹⁸. Uncertain future operation of industrial companies and their high level of indebtedness is key obstacle for banks and potential ESCO entry in CHP project implementation. Current uncertain support framework, lack of knowledge and support to the energy contracting model in industry and limited experiences and knowledge on CHP in financial institutions is amplifying the problem of financing new CHP investments nowadays in Slovenia.

1.6.2.4 Weak energy policy is reflecting in non consistent measures and local energy planning destroying the potential for cogeneration

As the new national energy programme NEP for the period until 20306 has not yet been approved, Slovenia has no explicit target for CHP except the measures including CHP in the National energy efficiency action plan, the National renewable energy action plan and the Operational programme for greenhouse gas emissions mitigation. Lack of consistent policy and priorities for further development of district heating & cooling systems is even more serious as it is reflecting in inconsistent support measures¹⁹ and local conflict of other heat supply options in the area of district heating networks.

¹⁷ Project based individual setting of the support level after the plant installation is used in current support scheme for new market immature CHP technologies. Despite of higher support uncertainty about the guaranteed support level have been recognized as risk between potential investors.

¹⁸ Implementation of partial switch from coal to natural gas by new combined cycle unit installation (100 MWe) in TE-TOL in Ljubljana is still uncertain, due to huge problems with closure of bank financing portfolio. Absence of certain CHP support as key requested guarantee for the project from banks is the main reason for moving away the start of the project with all necessary permissions and licences for implementation.

¹⁹ Cohesion found subsidies programs are giving preference to RES utilisation without distinction if the object is connected on district heating network (several wood biomass boilers and heat pumps were subsidized although installed in the buildings supplied by district heat).

1.6.2.5 Rigid heat prices regulation for district heating is obstacle for economic operation and development of district heating systems

Additional obstacle is very rigid state regulation of heat prices in district heating systems, which is not adapted to the cogeneration specifics, especially in current situation with very low electricity market prices which, need some additional allocation of costs on the heat price. Current situation is not giving proper foundation and framework for necessary retrofit and optimisation of existing DH systems or even planning of extensions and future development of DH&C in Slovenia.

1.6.2.6 Poor general awareness is reflecting on wrong decision bad public opinion

General public awareness about cogeneration is in Slovenia low. Except for the professional public and technical enthusiasts most of the people have never heard about this technology and if they did, they very often see it as a complicated and expensive technology causing additional noise, emissions etc. and not as, if properly designed, an efficient way for heat and electricity production or a green technology contributing to lower primary energy consumption and greenhouse gas emissions.

Poor general awareness is reflecting in non-optimal energy solutions of decision makers on different levels (national and local planning, companies and institutions, architects, smaller investors, installers, etc.), low confidence of financial institutions to provide financing to CHP project and in some cases also people opposition to the proposed CHP project implementation due to the unfounded fear of CHP influence to the environment²⁰ (noise, emissions, etc.).

1.6.2.7 Long administrative procedures and high grid connection costs is getting important highlighted obstacle for larger development of micro CHP

Current still complex, numerous and time consuming administrative procedures mainly linked to the grid connection and for acquiring feed-in support is still a significant barrier, especially for more broad small scale and micro CHP development²¹. Grid connection costs are getting higher and higher share in total investment costs on micro level²².

²⁰ One larger environmental NGO was performing campaign against use of gas engines in cogeneration plants due to danger of formaldehyde emissions. Local initiative was organised in smaller municipality to stop the CHP unit installation in smaller local boiler house concerned by the potential low frequency noise emissions.

²¹ Two step procedure in application of the support managed by Agency of Energy : 1. Application for obtaining a declaration for the production facility, 2. Application for the support, could be merged to one uniform procedure to simplify and speed up the process. Lack of staff at Energy agency is bottleneck for the issuing of the support resulting in several months necessary for getting the support.

²² Connection costs and technical requirements for CHP units from 1 to 999 kWe are almost the same, resulting in more and more high share of connection costs in total investment costs of micro CHP units.

2. What is possible? Cogeneration potential and market opportunities

2.1 Potentials and market opportunities

Up to 500 MWe of new additional CHP capacity with 2,7 TWh_e electricity generation and at least 2,5 TWh of useful heat supply could be installed in Slovenia till the year 2030. This market potential is only 50% of assessed technical potential, which is growing by new market CHP technology development.

Overall **technical CHP potential** in Slovenia assessed in 2007²³ is **more than 1.000 MW_e** (4 TWh_e), with the highest potential in industry (350 MW_e), households (260 MW_e), services (210 MW_e) and district heating (210 MW_e). Especially micro and small scale CHP potential in households and services could be significantly higher by application of recent new efficient CHP technologies which would systematically replace existing heating boilers with more than 90% exergy losses.

The present (2009) feed-in support scheme offers proper economic conditions for further market development of fossil and renewable cogeneration in all sectors. **Overall market potential till the year 2030 could reach up to 500 MW_e of new additional CHP capacity and 2,7 TWh_e electricity generation (23% share in gross electricity consumption in the year 2030) as assessed in recent (2011) analysis for NEP6:**

1. **Industry:** largest potential (up to 120 MWe) is in paper, rubber and chemical industry with new, repowering and replacing of existing expired steam turbines with new gas turbines and combined cycle CHP plants. Additional up to 130 MW_e smaller CHP units could be installed in different industrial companies, of that at least 10 MW_e fired on wood biomass.
2. **District heating:** at least 100 MW_e of CC plant on natural gas is planned to be installed in the CHP plant Ljubljana (TE-TOL) to replace one of the existing units (B2) on the imported coal. After 2020 installation on site of additional 100 MW_e CC is planned, dependent on future construction of incineration CHP plant in Ljubljana (at least 10 MW_e) and future conditions for operation of existing units on coal with wood biomass co-firing. Substantial market potential exists also in other smaller district heating systems (at least 35 MW_e), incentivised by provision of NREAP⁷ for obligatory 80% of heat produced from RES and CHP in the district heating systems.
3. **Services:** market potential of small scale CHP units is more than 50 MW_e with at least 150 small scale and double more micro CHP units in all sectors with access to the natural gas network.
4. **Households:** potential is divided in two size categories:
 - **small scale CHP units 15 MW_e** in multifamily houses and block of flats without district heating connected to the natural gas distribution system (at least 150 units).

²³ Analysis of the potential for the application of high-efficiency cogeneration of thermal energy and electrical energy in Slovenia, Report to the European Commission, Ljubljana, July 2007.

- **Micro CHP units (1–3 kW_e) 30 MW_e** in single family houses linked to the natural gas distribution system (at least 5.000 – 10.000 units), where market availability of technology at acceptable price or additional (investment) support mechanism is crucial for the wider expansion.

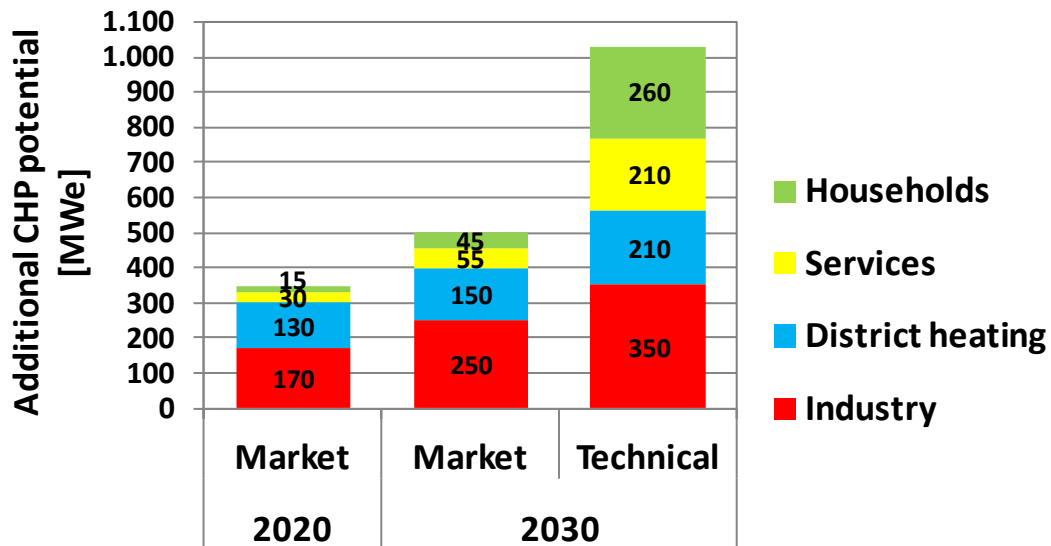


Figure 11: Additional market and technical CHP potential till the year 2030

Further development and market breakthrough of micro CHP technologies could have significant influence on the size of expected market potential, where the span between the assessed technical and market potential is the largest. Faster recent development of efficient fuel cells could play important role here²⁴. Assessed market and technical potential of micro CHP fits well with the CODE2 micro CHP potential analysis **where** (More information you can find in **Annex 3**).

New market proven technologies for gasification of wood biomass or other small scale biomass technologies could bias the broader use of wood biomass fired CHP plants (up to 40 MW_e) in industry and use of cogeneration also in areas that are not covered by natural gas distribution grid (substantial part of Slovenia). Limited potential for small scale CHP application on biogas from medium farms agriculture waste and sewage water treatment plants could be exploited too. CODE 2 Bio-energy CHP Potential Analysis for Slovenia assessed potential RES CHP heat generation in the year 2030 on the level of 115 ktoe (1336 GWh) which is 12% about presented market CHP potential⁶ and seems realistic estimate considering expected role of new biomass CHP technologies. (More information you can find in **Annex 4**)

In parallel with fast development of heat pumps applications in Slovenia, CHP can provide necessary additional electricity production in winter period, where the condensing coal

²⁴ More than 50.000 fuel cell CHP units installed in Japan since 2009 and reduced investment costs of technology speed up the market breakthrough of fuel cells, which is expected already in 2015. EU pilot project [Ene.field](#) with planned deployment of up to 1,000 residential Fuel Cell units in 12 key member states is strong support to the push for the European industry (Fuel Cells: Technology Update & Market Outlook, John Murray, Delta Energy & Environment, 2013).

power plants are the only source for increased electricity demand driven by heat pumps as shown in **Figure 12**.

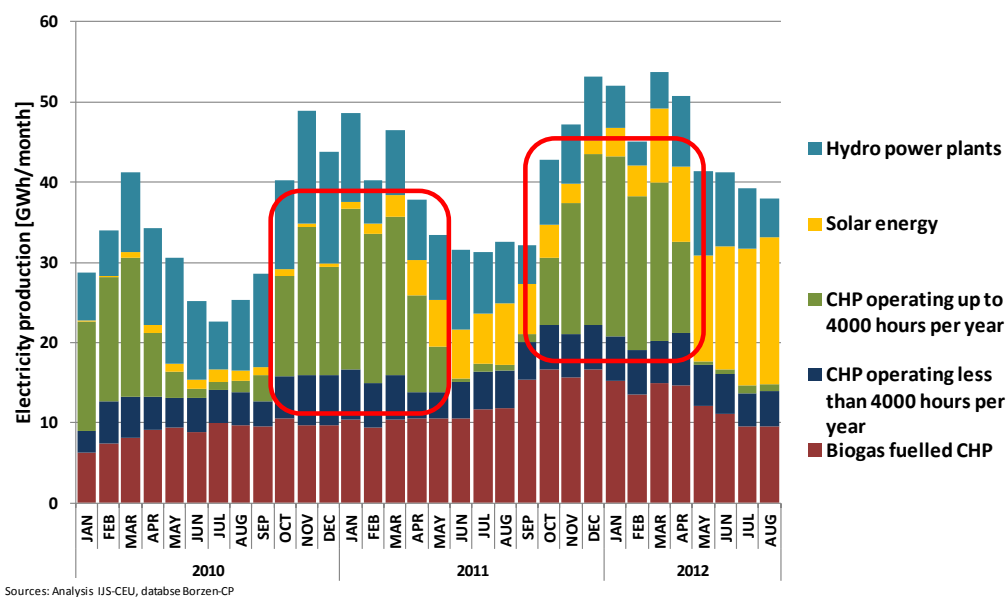


Figure 12: Dispersed electricity generation development 2010 – 2012 – important role of CHP generation in winter period for heat pumps electricity supply

Different types of CHP units could have substantial role in planned development of smart grid in Slovenia as predictable and flexible operation units for offering system services (balancing of PV and other RES plants, e-mobility, etc.).

2.2 Considering the framework of the EED

Efficient heating and cooling as new objective of the EED could bring important benefits to the future planning and utilization of heat market in Slovenia with benefits for further development of cogeneration as well:

- **Lack of clear priorities in heat supply** – new comprehensive approach as basis for the shaping of national and local legislative rules could stop current anarchy situation in the investments in the new heat supply.
- **New assessment of heating and cooling potential** could bring new information of the real technical potential and advantages of CHP and DHC options. CBA for market potential could contribute to better awareness of the CHP opportunities in all sectors and potential contribution to the national strategic climate energy goals with approval of necessary additional adequate measures for the CHP support.
- **Assessment of energy efficiency potential in gas and electricity infrastructure:** as cogeneration has positive influence on better infrastructure utilisation, decrease of losses and load balancing, assessment should better position the role and contribution of CHP units to the energy efficiency in gas and electricity grids.
- **Article 15: Access to electricity networks and priority of dispatch** - implementation could introduce several important improvements and new issues for CHP units:

- enable conditions for introduction of system services from CHP (demand response, balancing, etc.)
- simplification of administrative procedures for micro CHP - **simple notification “install and inform”**, net metering, etc.
- **Article 7: Energy efficiency obligation schemes** – energy supplier’s programmes to fulfil 1.5% energy saving target per annum will most probably include also cogeneration and will accelerate new investments.
- **Article 8, 9, 18: Promotion and obligation of energy audits, energy management, energy services and individual metering** will improve the conditions for better planning and implementation of CHP projects in all sectors (better data availability, raise of awareness, better support, etc.)

We assume that EED implementation is very exacting task which should be well coordinated and carried out as part of the whole energy policy process with integration of large number of relevant stakeholders. Successful implementation of EED should have several positive effects on CHP development in Slovenia.

3. How do we arrive there? The Roadmap

3.1 Preliminary remarks

Having in mind that good return on investment for cogeneration units in Slovenia is fundamental for further investment and the positive picture of the Slovenian CHP economics matrix (**Table 2**) is a strong basis for developing scenarios for the future. The matrix suggests that for the majority of CHP categories (green) there is *“normal” – acceptable economic conditions* provided by the existing support scheme which has triggered interest and new investments. In spite of generally positive picture the position for micro CHP (red) is not so favourable²⁵:

- **Micro fossil CHP:** economics for the smallest house micro CHP units (nano 1 – 5 kW_e) is still *“modest”* – very marginal due to still high investment costs of the technology,
- **Micro RES CHP:** economics is in general *“poor”* and is not enabling proper return on investments (too high costs of market premature technology).

Table 2: CHP economics matrix

Slovenia	Micro		Small & Medium		Large		
	up to 50kW		up to 10 MW		more than 10 MW		
	NG	RES	NG	RES	NG	Coal	RES
Industry	Green	Yellow	Green	Green	Green	Red	Green
District heating	Grey	Grey	Green	Green	Green	Red	Green
Services	Green	Yellow	Green	Green	Grey	Grey	Grey
Households	Yellow	Red	Green	Green	Grey	Grey	Grey

Legend:

- “normal”** CHP Investment has **good economic benefits**, return on investment acceptable for the investors, **interest for new investment exists**; there are no significant economic barriers for the implementation.
- “modest”** CHP Investment has **modest/limited economic benefits** and return on investment(?), **limited interest for new investments**.
- “poor”** CHP Investment has **poor or negative return on investment (Z?)** or is **not possible due to other limitations, no interest/possibilities for new investments**.
- Not applicable** for the sector
- NG** **Natural Gas** or appropriate fossil fuel
- RES** **Renewable energy sources** (wood biomass, biogas, etc.)

²⁵ As coal CHP units can not fulfil 600 kg CO₂/MWh_{el}; they are not eligible for the support and in current market conditions coal CHP Investment has poor or negative return on investment.

3.2 Overcoming existing barriers and creating a framework for action

In accordance with the Energy law a new Energy strategy (National energy programme - NEP⁶) should be approved in Slovenia with special emphasis on energy efficiency and RES to achieve EU goals for the year 2020 and 2030 with the long term perspective till the year 2050.

Following NEP sub-strategy on cogeneration and presented economic cogeneration potential, we propose the **Strategy for development of cogeneration till the year 2030** with next three key quantitative goals for cogeneration (Figure 13):

1. **CHP electricity generation should supply at least 18% of gross final electricity demand in the year 2020 and 23% in the year 2030;**
2. **Till the year 2020, 80%²⁶ of all district heat production in existing district heating systems should be supplied by high efficiency cogeneration, RES or waste heat utilisation. At least 20% of heat should be supplied from RES.**
3. **Sustainable heat supply for all new and renovated buildings should be provided by district heat, RES, waste heat or cogeneration.**

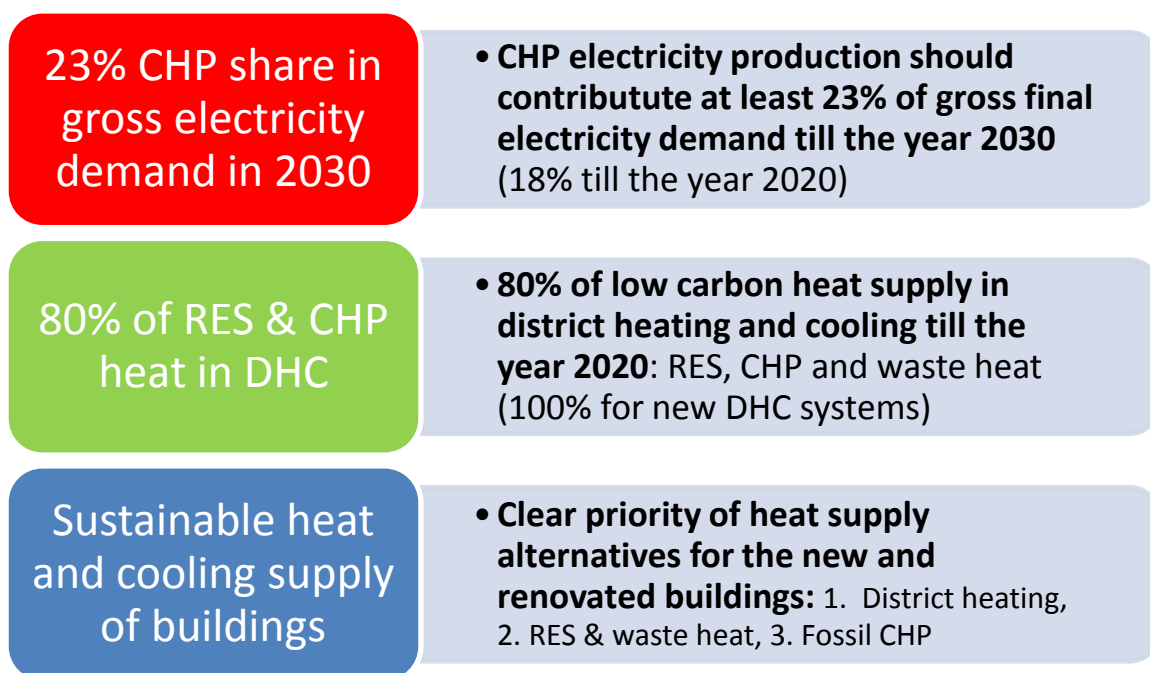


Figure 13: Key goals of the Strategy for development of cogeneration till the year 2030

The main requirement to achieve these measurable goals of the cogeneration strategy we should establish a **proper supporting framework with the following different specific measures to address the barriers identified and fill policy and market gaps.**

²⁶ For all new district heating systems this share should be 100%.

3.2.1 Stable, predictive and effective support framework for high efficiency cogeneration

3.2.1.1 *Fast approval of the New energy law and providing stable CHP support also in the future*

Ministry of infrastructure and spatial planning should as soon as possible prepare the New energy law and within define the future support scheme of cogeneration. Based on the successful experiences of existing support scheme we propose to keep the well accepted “Feed-in” support model with necessary modifications based on the deep evaluation of past operation and new market conditions. Fast preparation and approval of the Energy law and executive legislation by the Government and the Parliament is crucial to overcome current uncertainty for the investors by announced changes of legislation.

3.2.1.2 *Revision and regular evaluation & optimisation of the support scheme*

Directorate of energy should provide regular evaluation and optimisation of the support scheme to provide efficient operation and effective use of financial resources by next measures:

- Enforcing the institution responsible for scheme performing (Agency of Energy, Borzen, Ministry responsible for energy) and establish better actors’ coordination for prompt solving of actual problems and scheme failures.
- Establish yearly evaluation of the scheme operation and necessary revisions and optimisation of the support level following the actual market conditions and development (prices of energy, technology, etc.) to assure financially supportable and effective operation.
- Solving perceived existing problems:
 - **Shaping new proper support for old and reconstructed CHP plants** in accordance with EU State aid guidelines (common initiative on the EU level)
 - **Setting level of support for micro CHP units on wood biomass**
 - **Simplification of setting support level for the new market immature CHP technologies**

3.2.1.3 *Providing necessary finance resources for stable support scheme operation*

Directorate of energy in cooperation with Ministry of Finance and Ministry of Economic Development and Technology should assure necessary finance resources to enable stable support scheme operation by yearly adaptation of the existing fee paid by electricity consumers and introduction of new financing sources: fee for fossil and nuclear electricity producers, climate fund, EU cohesion funds for new potential new investment supports, etc., for stable scheme operation.

3.2.1.4 *Simplification and unification of network connections rules is important step toward faster development of micro cogeneration*

Directorate of energy in cooperation with Agency of Energy, DSO (SODO) and TSO (ELES) should continue the process of simplification and unification of network

connections requests (technical - metering specifications, standard costs, etc.) especially for the small scale CHP units, where current high requirements result in disproportionate share of investment costs. Activities should go in line with the development of “smart grid” concept and new innovative implementation and support mechanism (simple notification “install and inform”, net metering, etc.)

3.2.2 Establishing sustainable heating and cooling is key prerequisite to fulfil EU targets in Slovenia

Assuring sustainable heat supply is prerequisite for further developing and economic operation of district heating and cooling systems (DHC) in Slovenia. To enable future development of DHC in line with the strategic goals and decarbonisation of energy supply, DHC systems development should follow the next orientations from the proposal of NEP:

- **Obligatory 20% of RES heat and**
- **80% of RES & CHP & waste heat till 2020 in existing DHC systems** (100% in new DHC systems)

Without sustainable heat supply in DHC systems we cannot assure obligatory connections to the DHC and the systems will not be competitive to the other individual heating alternatives²⁷.

Directorate of energy should prepare needed revisions of the Energy law to prescribe this obligation to the existing DHC and to introduce this obligation in the process of issuing permits for new DHC systems and local energy concepts preparation.

3.2.2.1 Preparation of legislation acts for setting the heating mode priorities on local and building level is crucial for the future development of DHC and cogeneration.

Directorate for energy should prepare clear rules (Energy law provision) for setting heating mode priorities in the local energy concepts and for the new and renovated individual buildings consequently:

- 1. District heating & cooling**
- 2. RES (CHP and other technologies) & waste heat,**
- 3. Fossil CHP (with low carbon fuels <0,23kgCO₂/kWh_f)**

3.2.3 Raise of awareness and promotion to enable wider application of cogeneration

3.2.3.1 Support for development of new financing & business models is key for the project implementation facing lack of private capital in the economic crisis

Further development and support of energy contracting and new innovative business models is very important to facilitate the CHP project implementation in sectors having limited capital and problems with access to the financial resources (bank loans) in current economic crisis. Ministry of finance and Directorate of energy should:

²⁷ Following EU state aid guidelines we can provide proper support for the modernisation of DHC systems and to enable their economic and competitive operation.

- remove noticed legislative uncertainties,
- prepare guidelines for implementation energy contracting projects in public sector,
- implement several demonstration projects to educate or involved actors (public sector, banks, ESCO's),
- provide proper inclusion of cogeneration in green public procurement,
- provide better quality assurance for CHP projects implementation
- establish technical office as facilitator and support for CHP projects in cooperation with Ministry responsible for public administration.

3.2.3.2 General promotion campaign of cogeneration to qualify potential decision makers and raise awareness to the advantages of cogeneration

Current very low general awareness on the advantages of cogeneration requests implementation of wide promotion campaign in Slovenia. Campaign steered by Directorate of Energy should be implemented in cooperation with Local energy agencies and other interested market actors with special focus on good practice exchange.

Ministry of education and science should provide better incorporation of cogeneration in education and research programs.

Ministry of economic development and technology should strengthen international cooperation and establish support of domestic equipment providers.

Precise overview of needed actions, deadlines and responsibilities for the implementation of **the Strategy for development of cogeneration till the year 2030** is shown in **Table 3**.

Table 3: Actions, terms and responsibilities for implementation of the CHP strategy

Actions	Deadline	Responsibilities
Preparation of New energy law	September 2013	Ministry responsible for energy
Revision an regular evaluation and optimisation of the Feed-in CHP & RES electricity support scheme	2013,2018, 2023	Ministry responsible for energy;
Effective performing of the support scheme: Providing necessary financial resources Permanent improvements of administrative procedures Simplification and unification of network connections rules	2013 2013 2014	Ministry respons. for energy, Ministry of economic development and technology Ministry of Finance DSO, Agency of energy
Obligatory 80% of sustainable heat supply in DHC systems and larger buildings: Update of Energy law (DHC) Update of Rules for energy efficiency in buildings	2013 2014	Ministry responsible for energy Ministry responsible for spatial planning
Setting the heating mode on local and building level: Update of Energy law (DHC) Update of Rules for energy efficiency in buildings	2013 2014	Ministry responsible for energy Ministry responsible for spatial planning
Support for development of new financing & business models Necessary update and clear legislation interpretation (Public procurement and Public private partnership) Proper inclusion of CHP in Green public procurement Education and support activities for potential investors, demonstration projects. Quality assurance Establishing technical office	2013 2013 2014	Ministry of finance, ECO Fund, SID Bank Ministry of finance, Ministry responsible for energy Ministry resp. for public administration
Raise of awareness and promotion of cogeneration Promotion activities, good practice exchange Incorporation of cogeneration in education and research. International cooperation and support of domestic equipment providers	2014 2014 2013	Ministry responsible for energy, Local energy agencies, etc. Ministry of education and science Ministry of economic development and technology

Expected measurable results of the proposed Strategy for development of cogeneration till the year 2030 are shown in **Table 4**, to enable intermediate checking of the Strategy implementation success.

Table 4: Expected results of the Cogeneration strategy

CHP	Expected new additional el. capacity
New installed high efficiency CHP units:	
Industry	165 MW till 2020 and additional 95 MW till 2030
DHC (without TE-TOL)	20 MW till 2020 and additional 6 MW till 2030
Services	28 MW till 2020 and additional 27 MW till 2030
Households	11 MW till 2020 and additional 25 MW till 2030

3.3 Roadmap impact assessment

A significant part of the assessed CHP economical potential presented in chapter 2.1 could be economically exploited by further use of the already established support mechanisms till the year 2030 as “**business as usual**” but the potentials will be far away from being completely fulfilled using this approach.

With the proposed **Road map Cogeneration strategy** implementation we can significantly improve the environment for CHP development and facilitate faster and more balanced growth of CHP utilisation in all applicable areas: district heating, industry, services and households, including small scale and micro CHP. We have used the following standard energy and environmental indicators for the Roadmap impact assessment:

- **Electricity generation from CHP:** CHP generation could be more than doubled till the year 2030 to 3,7 TWh from current 1,1 TWh in 2011.
- **Share of CHP electricity in gross final electricity demand²⁸:** in the year 2030 CHP could contribute at least 23% of gross final electricity demand compared to current 8% share.
- **Heat generation from CHP:** 2,8 TWh of current CHP heat generation could be increased to 5,3 TWh in the year 2030.
- **Share of CHP heat in gross final heat demand²⁹:** one quarter of expected heat demand in the year 2030 could be supplied by CHP compared to current 12% share.
- **Primary energy savings (PES):** 4,5 TWh or 5,5% of current primary energy supply³⁰ could be reached by CHP. Increase of PES for 2,1 TWh in the year 2020 compared to the year 2010, represents 20% of set indicative national target on energy efficiency till the year 2020³¹.
- **RES electricity generation:** 0,7 TWh or 22% of electricity from high efficiency cogeneration in the year 2020 will be generated from RES, contributing more than 20% to the planned increase of RES electricity to fulfil obligation of 25% share of RES in final energy demand till 2020 from RENEAP.
- **CO₂ savings:** potential CHP CO₂ savings in the year 2030 could reach 0,9 million tCO₂.³²

Graphical presentation of used heat and electricity indicators for Business as usual and Roadmap scenario is shown in **Figure 14** and **Figure 15**.

²⁸ Same indicator is used for calculation of RES electricity contribution to the set goal in the year 2020. Gross final electricity consumption includes final energy demand, network losses and power plants own consumption.

²⁹ Same indicator is used for calculation of RES heat contribution to the set goal in the year 2020. Gross final heat demand includes total final heat and fuel consumption (also heat not appropriate for CHP) and distribution losses).

³⁰ General estimate on 20% of primary energy savings is used in the assessment.

³¹ Slovenia has set indicative target for achieved energy savings in the year 2020 on the level of 10,8 TWh (National reform program 2013-2014, May 2013).

³² General estimate assuming achieved PES and CO₂ emission factor for natural gas (natural gas has the largest share in CHP fuel consumption, use of coal is levelling by the use of RES).

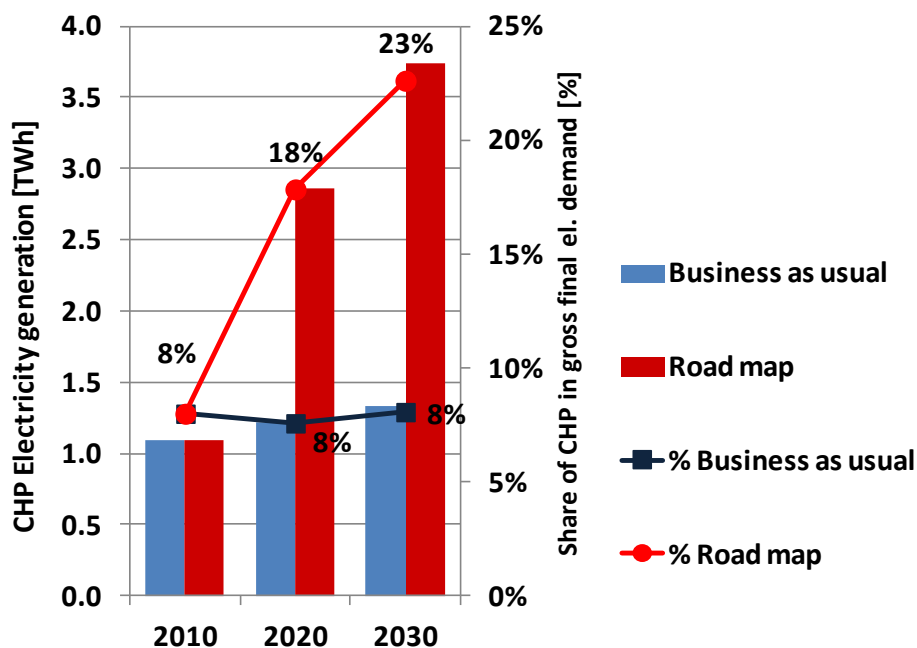


Figure 14: CHP Electricity indicators for Roadmap and both scenarios

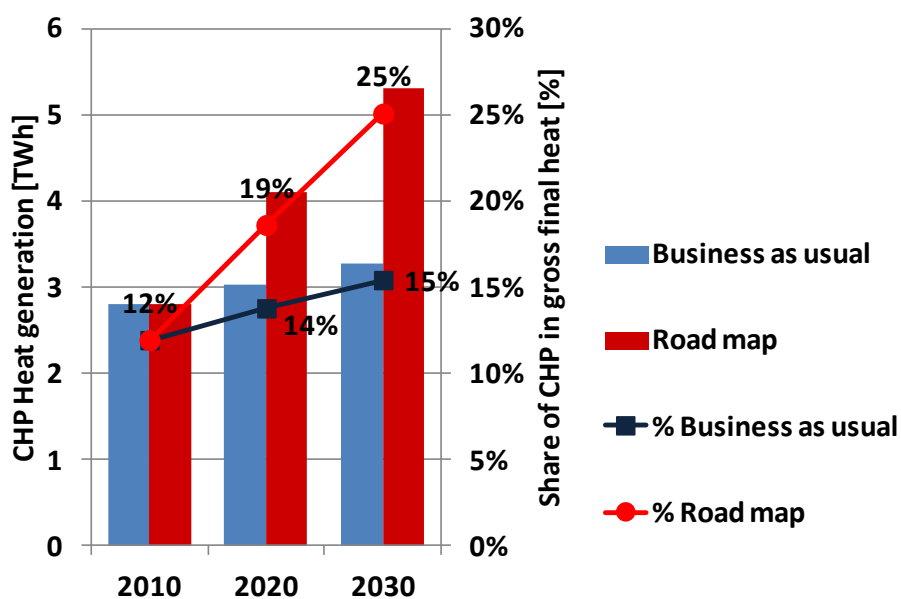


Figure 15: CHP Heat indicators for both scenarios

The advantages of proposed Road map strategy are evident, as cogeneration could contribute more than ¼ of future electricity and heat demand compared to only 10% or 15% in the business as usual expected CHP development.

4. Conclusions

Presented Cogeneration Roadmap for Slovenia proved several advantages and benefits of exploitation of assessed 500 MWe economic potential of high efficiency cogeneration in

Slovenia. By removing of the listed barriers and facilitating faster and more balanced growth of high efficient cogeneration utilisation in all applicable sectors till the year 2030, cogeneration in Slovenia could:

- **Supply 4 TWh or more than 20% of gross final electricity demand**
- **Provide more than 5 TWh of heat or ¼ of gross final heat demand**
- **Generate more than 20% of requested electricity generation from RES**
- **Reduce CO₂ emissions for close to 1 mto CO₂**
- **Contribute more than 20% to set targets on Energy Efficiency and RES electricity generation till the year 2020**

Roadmap implementation would have several other positive effect on development of new energy services and Slovenian CHP technology providers, on new jobs creation, reduction of energy imports and would have significant benefits for the whole economy in the sensitive period of sustainable economic crisis recovery.

5. Sources

The following list covers main sources used:

1. Report of the Republic of Slovenia on progress in the promotion of cogeneration on the basis of Article 6(3) of Directive 2004/8/EC, Ljubljana, February 2007.
2. Analysis of the potential for the application of high-efficiency cogeneration of thermal energy and electrical energy in Slovenia, Report to the European Commission in accordance with Article 6 and Annex IV of Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand, Ljubljana, July 2007.
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6. Annex 1: Stakeholder group awareness assessment

Table 5: Ratings of CHP awareness of different influential groupings

Users	
Industry	The level of awareness about cogeneration in industry is in general high. The emphasis is on CHP gas systems, while there is still only little information available on biomass cogeneration. However, lately there were no major new CHP units installed, mainly due to the lack of money as also technology providers are reluctant to offer cogeneration in industry via a business model of energy supply contracting (ESC) as their risks are perceived too high.
Utilities	The cogeneration is especially well developed in district heating systems, but well known also among other utilities. Its use is increasing, but rather slow.
SMEs	Awareness about cogeneration in SMEs, with emphasis on the service sector, including public sector, is still on a relatively low level, but improving fairly fast. This is proved by the fact that the service sector is in last two years seeing a fast installation of smaller units (up to 200 kWe) in restaurants, hotels, shopping malls, schools and homes for retired people. A lot of these projects were implemented using ESC offered by technology providers.
Households	CHP is an energy efficiency measure which is in comparison to an energy efficient building envelope retrofit or an installation of a solar photovoltaic system not that easy to be seen, so the word about CHP goes mainly from mouth to mouth in a limited group. The level of general public awareness about CHP is therefore low, but it is expected to be improved with micro CHP units becoming more competitive.
Market and supply chain	
Manufacturers/ Technology providers	In Slovenia there is at the moment only one manufacturer of CHP systems, but several technology providers, which act as main cogeneration promoters, planers and often also as ESCOs for the implementation of CHP projects.
Installation companies	The awareness about CHP is on a quite low level.
Grid operators	With increasing number of smaller CHP units also a level of awareness about CHP among grid operators has risen. However, it is quite often that CHP users complain about long and complicated process for the connection of a CHP system to the electrical grid.
Consultants	Consultants are in principle acquainted with CHP, but often a detailed know-how is missing.
Architects	The awareness about CHP is on a quite low level.
Banks, leasing	The financial sector is regarding cogeneration still very cautious (lack of proper knowledge/understanding, too complicated, too high risks), which makes borrowing money from banks for CHP projects very difficult.
ESCOs	Most of the ESCOs, which are offering ESC, are at the same time also CHP technology providers, and thus main cogeneration promoters. Also among ESCOs, which are primarily offering EPC is the awareness about CHP high.
Policy	

Policy makers on different levels	Regulation and support related to cogeneration are in Slovenia centrally controlled and so far this support has been good. The main actors for CHP promotion on a state level are Ministry of infrastructure and spatial planning as the main regulative body for cogeneration, Energy Agency of the Republic of Slovenia as regulator and Borzen as a centre for the RES and CHP support, which is managing also the feed-in support scheme which is the key driver for new CHP investments (facing problems on scheme financing today). Lack of knowledge and expert capacities are key reasons for still rather low awareness on cogeneration in large number of smaller municipalities in Slovenia.
Energy agencies	Energy agencies are the most important organisations promoting CHP among potential technology users as well as technology providers, constructors and designers of building technology systems on the local level. It is especially important that these agencies emphasize the importance of proper design of CHP units and thus support the sustainability of cogeneration projects.
Planners	CHP is in principle known, but the project initiators are technology providers not planners.
Influencers	
Sector organisations	Among the main actors in promoting cogeneration in Slovenia are Jožef Stefan Institute, Energy Efficiency Centre (JSI-EEC) as COGEN Slovenia - Slovenian national member in COGEN Europe, Economic interest grouping of natural gas suppliers (GIZ DZP), which is promoting use of natural gas and Slovenia District Energy Association (SDDE), which links companies and individuals working in the field of district energy supply. The largest share of heat supply delivered by cogeneration in Slovenia comes from the district heating sector.
General public	General public awareness about cogeneration in Slovenia is low. Most of the people have never heard about this technology and if they did, they very often see it as a complicated and expensive technology and not as an efficient way for heat and electricity production or a green technology. It is expected that the level of awareness will improve with micro CHP units becoming more competitive.
Media	There is almost no information regarding CHP in media for the general public. Professional media focuses mainly on small scale/micro CHP.
Academic area/ Research	In Slovenia there is no direct research on cogeneration. The most active research institutions in this area are Jožef Stefan Institute, Energy Efficiency Centre, as the COGEN Slovenia, and Faculty of Mechanical Engineering at the University of Ljubljana, which has specialised in bigger trigeneration units and district cooling.
NGOs	Among environmental NGOs CHP is in principle known, but usually not in details, some NGO more focused on RES.

Legend:

	Active CHP market		Low CHP awareness
	Interest in CHP		Poor CHP awareness
	Early CHP awareness		

7. Annex 2: Economic assessment of typical CHP projects in Slovenia

Sector		Heating in services and multifamily houses	Industry and service process heat and heating supply	District heating	Bio gas CHP (agriculture, waste, industrial wastewater or sewage treatment)
		50 kWe ICE	1 MWe ICE	10 MWe CC	0,5 MWe Biogas
Technology		ICE	ICE	CC	ICE
Power	MW_B	0,05	1	10	0,5
Efficiency-el.	Eff _{EL}	34%	40%	46%	38%
Efficiency-th.	Eff _H	56%	45%	42%	37%
Efficiency-sum.	Eff _{SUM}	90%	85%	88%	75%
Operation	h/a	4.000	6.500	3.500	7.500
Fuel	MWh	588	16.250	76.087	9.868
Electricity	MWh	200	6.500	35.000	3.750
Heat	MWh	329	7.313	31.957	3.651
Investment	EUR	115.000	1.100.000	9.500.000	2.000.000
	€/kWeI	2.300	1.100	1.000	4.000
O&M costs	% of Inv.	5%	7,0%	3,5%	4%
	€/MWh	28,8	11,8	9,5	21,3
Price of fuel	€/MWh	71	64	59	20
Value of electricity	€/MWh	106	65	58	
Other market revenues	€/MWh				
Value of heat	€/MWh	78	71	66	15
Support					
Electricity	€/MWh _{El}	122,44	61,84	63,75	156,31
Other support or benefits	€/a				
Investment subsidy	€				
Costs & revenues					
Fuel	€/a	-41.482	-1.042.600	-4.504.348	-197.368
Electricity	€/a	21.140	422.500	2.030.000	0
Heat	€/a	25.811	521.300	2.102.029	54.770
Support	€/a	24.488	401.960	2.231.250	586.163
Other market revenues	€/a	0	0	0	0
O&M costs	€/a	-5.750	-77.000	-332.500	-80.000
TOTAL	€/a	24.207	226.160	1.526.431	363.564
SPB	years	4,8	4,9	6,2	5,5
IRR	%	16%	16%	10%	13%

8. Annex 3: CODE 2 micro CHP potential analysis for Slovenia

Country statistics

Population: 2 050 000 (2010)
 Number of households: 760 000 (2010)
 GDP per capita: € 21 000 (2010)
 Primary energy use: 5 000 ktoe/year (2010)
 GHG-emissions: 20 Mton CO_{2,eq}/year (2010)

Household systems (± 1 kWe) Boiler replacement technology

Present market (2013)
 Boiler stock: 262 000 units
 Boiler sales: 25 000 units/year

Potential estimation

Indicator	Score
Market alternatives	0
Global CBA	0
Legislation/support	1
Awareness	0
Purchasing power	1
Total	2 out of 12

SME & Collective systems (± 40 kWe) Boiler add-on technology

Present market (2013)
 Boiler stock: 82 500 units
 Boiler sales: 7 800 units/year

Potential estimation

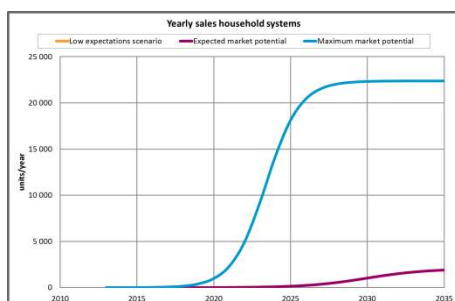
Indicator	Score
Market alternatives	0
Global CBA	3
Legislation/support	3
Awareness	1
Total	7 out of 9

Expected final market share: 8% of boiler sales in Household sector

Expected final market share: 15% of boiler sales in SME & Coll. sector

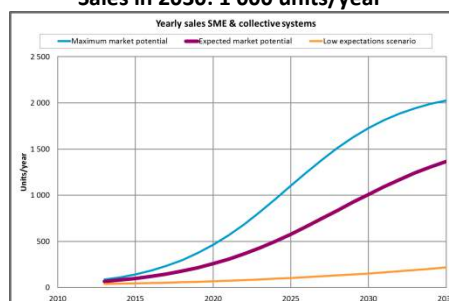
Yearly sales

Sales in 2020: 10 units/year*
 Sales in 2030: 1 000 units/year*



Yearly sales

Sales in 2020: 260 units/year*
 Sales in 2030: 1 000 units/year*



Stock

Stock in 2020: 30 units*
Stock in 2030: 3 300 units*
 Stock in 2040: 18 200 units*

Stock

Stock in 2020: 1 800 units*
Stock in 2030: 7 000 units*
 Stock in 2040: 14 000 units*

Potential savings in 2030

Primary energy savings:
 0 PJ/year*
 2 ktoe/year*
GHG-emissions reduction:
 0.0 Mton CO_{2,eq}/year*

Potential savings in 2030

Primary energy savings:
 5 PJ/year*
 121 ktoe/year*
GHG-emissions reduction:
 0.1 Mton CO_{2,eq}/year*

*Corresponding to the expected potential scenario.

The score card is used to assess the relative position of an EU country based on current regulations, markets and economics. The score itself functions as input to the implementation

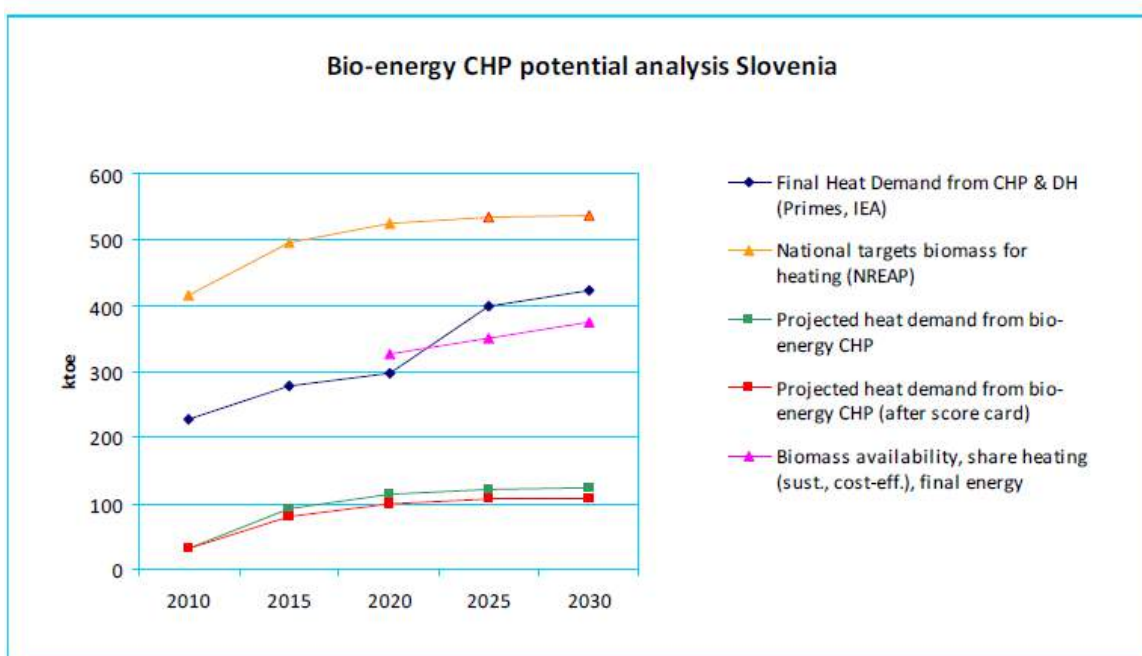
model to 2030.

±1 kWe systems (Households) <i>Boiler replacement technology</i>	±40 kWe systems (SME & Collective systems) <i>Boiler add-on technology</i>																										
Scorecard	Scorecard																										
<table border="1"> <thead> <tr> <th style="background-color: #A9A9A9;">Indicator</th> <th style="background-color: #A9A9A9;">Score</th> </tr> </thead> <tbody> <tr> <td>Market alternatives</td> <td>0</td> </tr> <tr> <td>Global CBA</td> <td>0</td> </tr> <tr> <td>Legislation/support</td> <td>1</td> </tr> <tr> <td>Awareness</td> <td>0</td> </tr> <tr> <td>Purchasing power</td> <td>1</td> </tr> <tr> <td>Total</td> <td>2 out of 12</td> </tr> </tbody> </table>	Indicator	Score	Market alternatives	0	Global CBA	0	Legislation/support	1	Awareness	0	Purchasing power	1	Total	2 out of 12	<table border="1"> <thead> <tr> <th style="background-color: #A9A9A9;">Indicator</th> <th style="background-color: #A9A9A9;">Score</th> </tr> </thead> <tbody> <tr> <td>Market alternatives</td> <td>0</td> </tr> <tr> <td>Global CBA</td> <td>3</td> </tr> <tr> <td>Legislation/support</td> <td>3</td> </tr> <tr> <td>Awareness</td> <td>1</td> </tr> <tr> <td>Total</td> <td>4 out of 9</td> </tr> </tbody> </table>	Indicator	Score	Market alternatives	0	Global CBA	3	Legislation/support	3	Awareness	1	Total	4 out of 9
Indicator	Score																										
Market alternatives	0																										
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Market alternatives	Market alternatives																										
<p>There is strong competition of other heating technologies in households: heat pumps (low electricity prices, natural gas is available only in more dense populated area), wood biomass (cheap fuel, subsidies available), district heating systems in towns.</p>	<p>There is strong competition of other heating technologies in services: district heating systems in towns, heat pumps (low electricity prices, natural gas is available only in more dense populated area)..</p>																										
Global CBA	Global CBA																										
SPOT: 16 years	SPOT: 5 years																										
Legislation/support	Legislation/support																										
<p>Current incentives on micro CHP are not yet sufficient for the economic project implementation in households</p>	<p>Current incentives on micro CHP offers good incentives for this size CHP project implementation in service sector which resulted in several new unit investments in last three years.</p>																										
Awareness	Awareness																										
<p>Due to the too high investment costs and not sufficient support for the economic implementation, current awareness of micro CHP technologies for households is still very low or poor on all levels.</p> <p>Manufacturers are not yet active in the market.</p>	<p>With proper support and several number of successful CHP projects in recent years, awareness in services is growing and is on medium – early awareness level.</p>																										
Purchasing power																											
GDP: € 21 000 per year																											

9. Annex 4: CODE 2 Bio-energy CHP Potential Analysis for Slovenia



Figures (projections)	2010	2020	2030
Final heat demand from CHP and DH (PRIMES, IEA), ktoe	227	299	423
(Projected) heat demand from bio-energy CHP and DH (after score card), ktoe	31	100	107
Bio-energy penetration rate in CHP markets (2009: EEA, Eurostat)	13,6% (2009)	33,3%	25,4%
Biomass availability, share heating (sust., cost-eff.), final energy (Biom. Futures), ktoe		327	376



Framework Assessment (Score card)	Score	Short analysis
Legislative environment	++ 3 (of 3)	Support for CHP and RES; Ambition goals for CO ₂ reduction
Suitability of heat market for switch to bio-energy CHP	+ 2 (of 3)	Potential in paper and chemical industry; 50% of heat use directly in industrial process (cement, steel...), not appropriate for CHP.
Share of Citizens served by DH	+ 2 (of 3)	17% citizen served by DH; 77% share of heat from CHP in DH systems mostly from coal; Obligatory 20% heat for DH from RES (proposed)

National supply chain for biomass for energy	++ 3 (of 3)	More than 60% of Slovenia covered by forests; Support to for the processing of fuel wood biomass; Support for the establishment of energy crops
Awareness for DH and CHP	++ 3 (of 3)	Biomass association, association for sustainable development; Public campaign, workshops and conferences; Several new small and micro DH on wood biomass (too small for available CHP technologies).

10. Annex 5: Assumption used in market extrapolation