Name of the technology: 1.2 Combined cycle

Stage of development:
Widely used technologies (the technology is used by many actors on global/EU level).

Technical application:
Typical applications including combined heat and power. The operation of cogeneration power plants based on heat load curve - to produce thermal energy for heating and domestic hot water.

Short summary (up to 200 characters):
Combined Cycle Gas Turbines (CCGT) is a form of highly efficient energy generation technology that combines a gas-fired turbine with a steam turbine. Combined cycle plants are usually powered by natural gas. The combined cycle power plant has: a compressor, a combustor, a gas turbine with electric generator, a heat recovery steam generator, steam turbine with electric generator. The combined-cycle system includes single-shaft and multi-shaft configurations. The single-shaft system consists of one gas turbine, one steam turbine, one generator, and one HRSG, with the gas turbine and steam turbine coupled to the single shaft. Multi-shaft systems have one or more gas turbine generators and HRSGs that supply steam through a common header to a separate, single steam turbine generator.

Justification – why was this technology selected (up to 500 characters).
- high electric efficiency 58 %
- total efficiency (80 – 85)%
- start time (0,5 – 2) hours
- good operation
- low specific heat consumption
- low investment cost
- high reliability
- possible heat recovery
- capacities up to 800 MW
- reasonably long life

Characteristics (up to 500 characters):
There are many combined cycle systems in a variety of applications including industrial facilities; to produce electricity with high efficiency, cogeneration to produce electricity and thermal energy for process steam needed an industrial process at different levels of pressure or/and hot water for district heating system in localities).

The thermodynamic cycle of the basic combined cycle consists of two power plant cycles. One is the Brayton cycle which is a gas turbine cycle and the other is Rankin cycle which is a steam turbine cycle.

Power plant size is important in the investment cost. A larger power plant sizes benefit from economies of scale (lower initial cost per kilowatt) and improved efficiency.

Combined cycle power Units are made up of one or more such gas turbines, each with a waste heat steam generator arranged to supply steam to a single steam turbine, thus forming a combined cycle power Unit. Typical Combined cycle Unit sizes offered by three major manufacturers (Alstom, General Electric and Siemens) are roughly in the range of 50 MW to 500 MW and costs are about $600/kW.

Impact on the economy (up to 1000 characters):
Combined cycle systems are mature and popular. The systems adapt easily to a variety of industrial facilities and district heating system. The technology is mature and proven. Main impact is on climate change (cogeneration), but the instalment of such systems also brings many advantages in other areas, like job creation and bettering of life standard.

Global development (up to 1000 characters):
The first gas turbine installed in an electric utility in the United States was applied in a combined cycle. This was a 3.5 MW gas turbine that used the energy from the exhaust gas to heat feedwater.
To increase the overall efficiency of electric power plants, multiple processes can be combined to recover and utilize the residual heat energy in hot exhaust gases. In combined cycle mode, power plants can achieve electrical efficiencies up to 60 percent.

These combined-cycle systems provide flexibility with features that include:

- High Thermal Efficiency
- Low Installed Cost
- Fuel Flexibility
- Flexible Duty Cycle
- Short-Installation Cycle
- High Reliability/Availability
- Low Operation and Maintenance Costs –
- High Efficiency in Small Capacity Increments

Milestones[1] *(List at least one milestone per year against which the progress towards the achievement of the local/regional 2020 targets can be measured)*

Given the scope of the roadmaps (municipally or regionally based) technological improvements that would require major research and development processes would tend to fall outside of the scope of these roadmaps. This does not necessarily mean that such technological improvements cannot be used as milestones, but that before any such technological improvements are stipulated in the milestones, the capacity of the municipal and/or regional stakeholders, and the capacity of the municipality/region to collaborate with external partners, should be carefully considered.

Milestones more likely to fall within the scope of this roadmap are those that are able to help measure desired changes in the deployment and/or wider usage of the previously identified key energy technologies or those that measure the effects of this changed deployment or usage (i.e. production of thermal energy (GWh); increase of thermal energy production (%); installed capacity (GW or m2); increase of installed capacity (%); CO2 reduction (t)).

Year	2015	2016	2017	2018	2019	2020
Milestones			**35 MWe installed capacity**			

The group assumed a hypothetical amount of 35 MWe of installed combined cycle until 2020.
They assumed an installed capacity of 35 MWe in year 2017.

Financial Gaps
(List financially related challenges that need to be addressed in order to increase the uptake/wider usage of this technology)

1. **Lack of predictability when launching the financial instruments at national level.**
2. **High bureaucratic public procurement procedures**
3. **Lack of cooperation between public authorities and private investors.**

Policy Gaps

(List important policy gaps that prevent the uptake/wider usage of the key technology)

1. **Lack of interest and active involvement on behalf of local authorities**
2. **Lack of awareness-targeting actions meant to increase knowledge on legislative provisions, financial and technical solutions**
3. **Lack of institutional transparency and high bureaucratic public procurement procedures.**

Financial Instruments and Period of Implementation

(List all relevant financial instruments that can address the above financial gaps and will contribute to the uptake/wider usage of the key technology. Please add the start year and years of important developments for the financial instrument.)

1. **Support actions for public-private partnership (PPP)**
2. **Support schemes for legal entities (reinvestment of profit)**

Policies and Period of Implementation

(List all relevant policies that can address the above policy gaps and will contribute to the uptake/wider usage of the key technology. Please add the start year and years of important developments for the policy.)

1. **Rising the level of importance and involvement of the local authorities**
2. **Restructuring of the state-owned enterprises for a better governance and financial management**
3. **Transposition of the new Public Procurement Directive as well as the ex-ante conditionality on Public Procurement for accessing EU Structural funds 2014÷2020**
4. **Increasing institutional capacity of existing Programs Implementation Units (for accessing ESIF 2014-2020) in order to assist from the early stages of the project and reduce project evaluation processes**

Stakeholders

(List all relevant stakeholders for the implementation of the policy and/or financial instrument above)

1. **Municipalities, administrations, ministries.**
2. **Building associations, corporations.**

Policy Recommendations

(*Relevant policies for this particular technology have already been identified above. This section aims to provide the steps needed for the practical implementation of the policies and financial instruments listed above.)*

1. **Identification of “Champions” that could be the motivated players in starting the public-private partnership (PPP).**
2. **Organise meetings to develop the public-private partnership (PPP).**
3. **Formally launch public-private partnership (PPP) and start procuring gas turbine at preferential prices.**