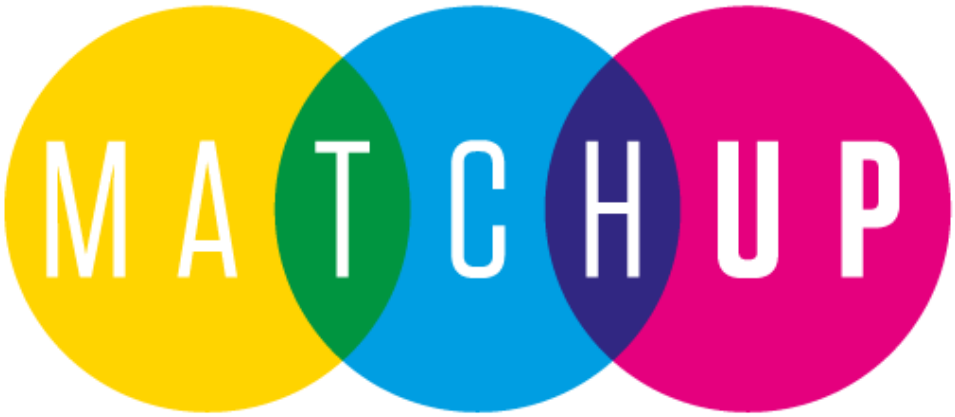

MAtchUP

D4.5: Improved Concept of Energy Infrastructures at District-City Level in Antalya- First version

WP 4, T 4.4

30.09.2019

September, 2019 (M24)

Authors: Ömer Akyürek

MAtchUP - SCC-1-2016-2017

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Technical References

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Project Title	MAximizing the UPscaling and replication potential of high-level urban transformation strategies - MAtchUP
Project Coordinator	Ernesto Faubel Ayuntamiento de Valencia efaubel@valencia.es
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Version	Person	Partner	Date
0.1	Ömer Akyürek	DEM	31.07.2019
0.2	Ömer Akyürek, Barış Derici	DEM, ANT	04.09.2019
1	Ömer Akyürek	DEM	11.09.2019
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Abbreviations and Acronyms

Acronym	Description
GHG	Greenhouse Gas
ICT	Information and Communications Technology
KPI	Key Performance Indicator
PV	Photovoltaic
LFG	Landfill Gas
WP	Work Package
EPBD	Energy Performance in Buildings Directive
SCC	Smart Cities and Communication
SPP	Solar Power Plant
SEAP	Sustainable Energy Action Plan
RES	Renewable Energy Sources
DSO	Distribution System Operator
EMRA	Energy Market Regulatory Authority
TS	Turkish Standard
UPS	Uninterrupted Power Supply
SCADA	Supervisory Control and Data Acquisition
TL	Turkish Lira
HDPE	High Density Polyethylene Pipe

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0 Abstract

This report constitutes Deliverable “D4.5: Improved Concept of Energy Infrastructures at District City Level”. The final version of this report will be delivered in September 2020 (project month M36). One of the core objectives of this document is to describe the detailed design of the energy infrastructure interventions to be implemented in Antalya.

The deliverable is related with Task 4.4 under WP4 but mostly subtasks 4.4.1 (Smart Grids), 4.4.3 (Clean Energy Generation) and 4.4.4 (Smart Energy Integration, RES, Storage and Management at District Level). The aim of this deliverable is to provide detailed information on the interventions and actions that will have an impact on smart energy infrastructures. Antalya, which is one of the Lighthouse Cities within MAtchUP have an ambitious target to implement two large scale electricity generation facilities, which will result in increased penetration of local renewable energy and decreased CO2 emissions. These interventions are also in line with the cities sustainable energy action plans and will help significantly in reaching its goal of reducing GHG emissions by 20% by 2020. Deployment of smart meters will enable data gathering and integration to the Urban Platform, which strengthens the path towards a smarter grid and energy management at district level.

Partners contributing to this specific task and sub-task will define the specification of technical integration of RES in different grids, and energy from waste management and smart meters that will enable the data flow.

A brief technical definition of related interventions is explained in section 3. In section 4; the execution of the works namely the management structure, time plan, health, safety and waste management and risk mitigation are explained for the three actions smart meters, solar power plant and LFG. Section 5 explains the status of the interventions, business model and citizen engagement.

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1 Introduction

1.1 Purpose and target group

MAtchUP project activity involves several actions which will demonstrate technical integration of renewable energy systems and storage in electricity network. The actions focus on renewable energy while optimizing the electricity generation and lowering the CO_2 levels of the city. Cities are responsible of 2/3 of the energy consumption while emitting approximately 70% of CO_2.

An energy transition is crucial in fight against climate change and cities are committed to implementing the 2030 Agenda for Sustainable Development with a target to make cities inclusive, safe resilient and sustainable. Hence Antalya is undertaken two major investments for Grid Connected Local Renewable Energy System, which will also increase its renewable energy penetration.

This document will provide detailed information on the concept, design, implementation and responsibilities of actions related with energy infrastructures at city level in Antalya. This deliverable is an open document being a source of information for the interested public and input for a number of related tasks within the MAtchUP project as described below.

1.2 Contribution from partners

Partner	Contribution
ANT	WP Leader. Leading definition of the actions.
SAM	Define financial part and the accompanying business models of interventions. Also involved in monitoring activities.
DEM	DEM is the task leader for T4.5 and will coordinate the efforts in developing the deliverable D4.5. DEM will support the municipality in the definition of the intervention design DEM will support all energy actions and involved in monitoring activities.
ANP	Will support the municipality in the definition of the intervention design. Will be involved in monitoring activities.
AKD	Will support the municipality in the definition of the intervention design. Will support all energy actions and will involve in monitoring activities

1.3 Relation to other project activities

Deliverable	Relation to other project activities
D4.14	D4.14 describes the design of the interventions to be implemented in the city of Antalya in a general perspective and is the basis for all further tasks under WP4. D4.5 gives a more detailed description of the design and the status of the interventions.
D5.x	The objective of WP5 “Technical, social and economic evaluation” is to setup a strong evaluation framework to be deployed in each lighthouse city

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	with the aim to assess the effectiveness of the proposed intervention, deployed in the associated individual actions. Therefore, D4.5 is linked to WP5 deliverables.
D6.x	The objective of WP6 “Exploitation and market deployment – innovative business models” is to design innovative business models and financial mechanisms to foster the implementation of smart city solutions, to identify exploitable results and to design an ad hoc strategy for their deployment and replication.

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2 General overview

With over 2.3 million population and a strong presence of sectors such as tourism, agriculture and commerce, Antalya is the 5th largest and developed city in Turkey. Although there are some industrial activities within the City, the main economical drivers are tourism, service sector (high density of hotels etc.) and greenhouse cultivation resulting in high energy demands and consumption. Antalya benefits from approximately 300 days of sunshine throughout the year with a daily mean temperature ranging between 9.9^{0}C (January) and 28.4^{0}C (July). The hot temperature values decrease the energy demand for space heating while increasing the cooling demands which is mostly covered by Air Conditioning Units.

Based on the most up-to-date information, the total energy consumption is calculated as 25,812 GWh for 2017 and approximately 30% of this consumption (7,814 GWh) corresponds to electricity consumption from the grid.

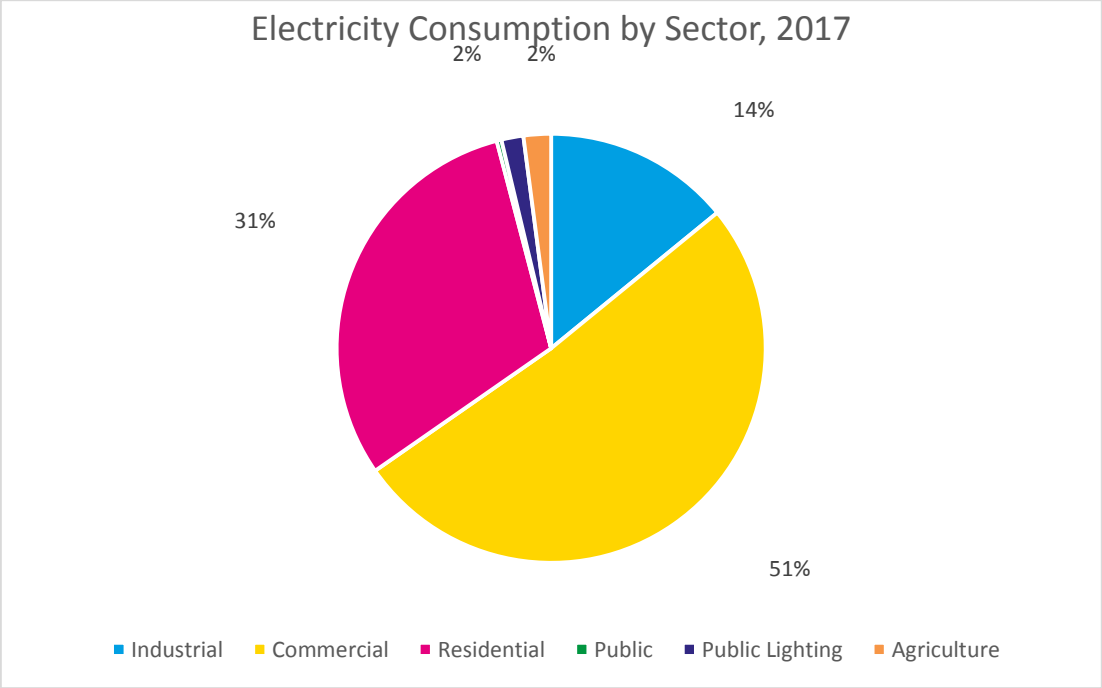

Figure 1 Breakdown of electricity consumption of Antalya

There are total 72 electricity generation facilities in Antalya with a total installed capacity of 2,050 MW, with a total electricity generation of 6,706 GWh/year. The majority of the electricity generation belongs to a 1,150 MW capacity Natural Gas Power Plant (Aksa Enerji) which is responsible of approximately 70% total electricity generation within Antalya.

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27.9% of the generation is based on renewable energy sources, while 71% of generation is based on fossil fuels. The majority of the renewable energy generation is based on Hydro Power with a share of 93% of total renewable energy generated.

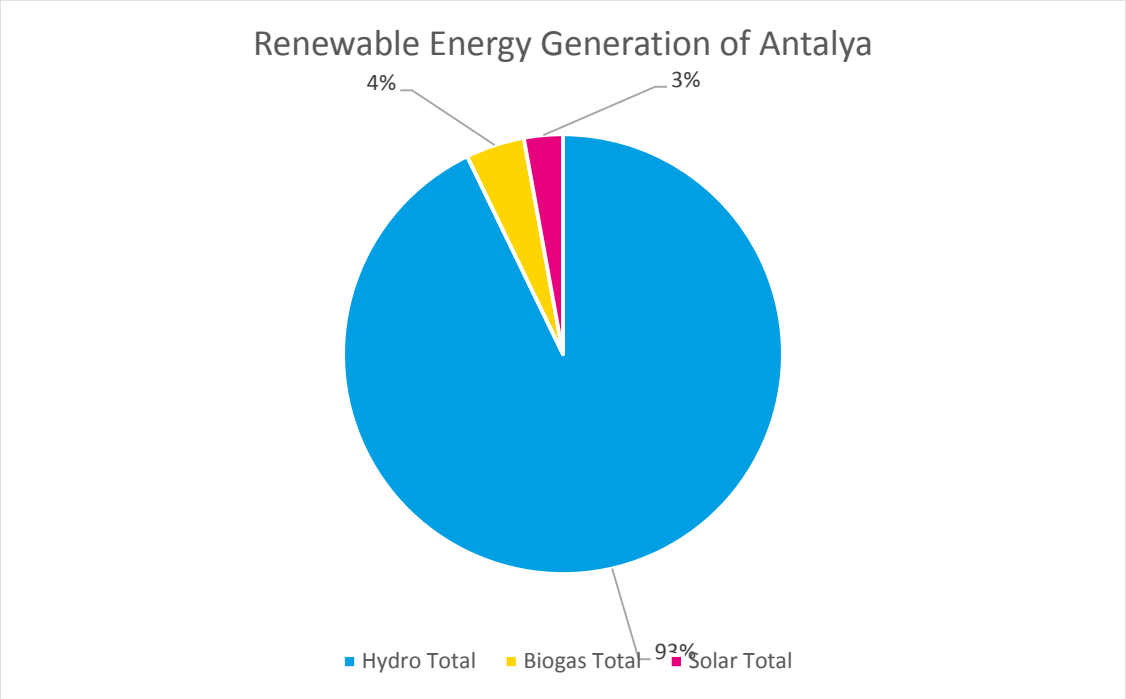

Figure 2 Breakdown of renewable energy generation by source in Antalya

The total installed capacity of Solar Power is 38 MW within Antalya with 39 Power Plants. Electricity from Biogas Utilization totals to a 4.1 MW capacity with 2 Operational facilities.

Antalya is part of the interconnected electricity system. An interconnected electrical grid system is described as the system where several generation stations are connected in parallel. Although hot spots for electricity generation and consumptions can be identified within the grid, there is no dedicated or isolated grids. This means electricity generated within Antalya is not exclusively consumed within Antalya.

Turkish electricity system has a mixed energy generation capacity with the majority of generation is based on Natural Gas, Hydro Resources and Coal. Natural Gas has 37.2% share in generation followed by Coal Power with 33.3% and Hydro Power with 14.1%. The Emission Factor for the grid electricity is 0.557 tCO_2 eq/MWh.

There are total of 1,625,174 registered users to the electricity distribution grid operator (Medium and Low Voltage Level), which only 41,433 of them use smart meters[1].

[1] Reference: Akdeniz Elektrik Dağıtım A.Ş. (DSO of Antalya). http://www.akdenizedas.com.tr/

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Legislative Structure:

Most relevant legislative guidance for electricity generation from renewable energy sources (including solar and biogas) as well as investments are "Regulation on Renewable Energy for the Purpose of Electricity Generation" and "Communique on Electricity Generation without License"[2]. In accordance with the applicable laws and regulations the following general rules and guidance applies:

- Electricity generation from renewable energy sources are eligible for guaranteed purchase from the grid operators with a fixed tariff based on type of source and use of local / domestic products in their system. For Solar and Biogas project activities the base tariff is 13.3 $cent/kWh.[3]
- Renewable energy investments under 1 MW capacity and intended for self-consumption are exempted from licensing procedures[4].

With regards to Grid Connected Electricity Storage, the legislative aspect regulating electricity storage is not inclusive enough to cover comprehensively a storage application specifically aiming grid flexibility. The legislative structure only defines storage as a UPS system also for the renewable energy systems. This allows Renewable Energy Systems to have a storage capacity; however a scenario where a storage unit/group connected to the grid and is importing / exporting electricity from and to the grid is not defined from a legislative point of view (acting as a grid level flexibility unit). There are several pilot projects and storage units under research and development efforts but a structured commercial implementation is not yet available within Turkey. On 8th February 2019, EMRA (Energy Market Regulatory Authority) has published a draft version of the first legislation on electricity storage for consultation from the sector. In accordance with this draft legislation, electricity storage as a flexibility unit activity is described providing a legislative basis to this type of actions. However, the enactment date of this legislation or its provisions are not certain for now.

[2] Ref: http://www.yegm.gov.tr/yenilenebilir/y_mevzuat.aspx

[3] The related article was amended on March 2019. Now Power Plants below 5 MW capacity can only benefit from offset-electricity for their excess generation from the single tariff price. Power Plants with >5MW capacities will continue to sell their electricity to the grid from guaranteed tariff. This is applicable only for power plant investments starting after March 2019.

[4] The related article was amended on March 2019. The threshold for the unlicensed applications was raised to 5MW capacity. This is applicable only for power plant investments starting after March 2019.

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3 Technical definition of the interventions

One of the main objectives of the MAtchUP Project is to deploy innovative solutions in the energy, mobility and ICT sectors with a strong monitoring program to validate all of them. As being one of the three Lighthouse Cities in MAtchUP Project, Antalya will address real pilot of transformation in energy sector also including high ratio of RES. These pilots will result in very ambitious energy savings, CO_2 emission reductions, supported by ICT solutions as main enabler to collect relevant information, fostering open data use. This will be achieved by incorporating RES based to a large degree on a high level of local resources and high shares of self-consumption.

MAtchUP will implement high share of renewable at district level. As part of the MAtchUP project Antalya will implement two large scale Renewable Energy Generation Systems.

- LFG utilization and Electricity Generation Power Plant, and;
- Solar Power Plant

Smart meters will be deployed to these sites to enable data gathering and upload to the Urban Platform with a standardized format.

Initially a district electricity storage system (based on battery technologies) was also planned to be integrated with the RES (SPP). This was to achieve integration of innovative storage technologies to increase the global performance of RES contribution, going beyond the business as usual management of grids by introducing flexibility capabilities. However, the activity faced legislative barriers jeopardizing realization of grid level storage. There is a very high likelihood that the related action will be amended. This issue is further detailed under section 3.3 of this deliverable.

Under Deliverable 5.1 “Technical Evaluation Procedure”, the intervention(s) for improved concept of energy infrastructures at city level has been identified as “Urban RES”. The intervention Urban RES involves three main MAtchUP activities:

- District Level Renewable Energy Generation
  - [A10] PV systems with a total capacity 5 MWp
  - [A11] LFG and electricity generation
- Smart Energy Integration through Storage
  - [A12] Integration of district electricity storage
- Smart Grids
  - [A7] Smart Meters

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3.1 Smart Grids

Within the scope of MAtchUP Project activity, smart meters will be deployed to demo sites to enable data gathering and upload to the Urban Platform with a standardized format. Also, smart meters for the dwelling in the new construction will be installed and integrated to BEMS which will allow residents to manage and monitor the energy.

Smart Meters:

The action involves introduction of smart meters in newly built area of Kepez Santral District as well as to large scale renewable energy generation facilities connected to the grid. This will enable development of dynamic data management. The data will be aggregated at various levels from individual consumers (dwelling) to building and even to district level. To complement available data, supply of complementary standardized aggregated data, supply of contextual data and integration into the urban data platform.

3.2 Clean Energy Generation / District Level RES

There are two Renewable Energy System Actions / Interventions within the scope of MAtchUP Project activity. The following sections provide technical definitions of the interventions.

3.2.1 [A10]: PV System with a Total Capacity of 5 MWp

The action involves integration of Solar Power Plant with a total of 4.86 MWp to the city infrastructure. The Power Plant is planned to operate for self-consumption. The electricity generated will be used to power irrigation pumps within the city, and any excess energy (if any) will be sold to the grid from the suitable electricity tariff. The Power Plant is located in Antalya, Döşeme District, North West of Antalya City Centre.

3.2.2 [A11]: LFG and Electricity Generation

The Project involves the installation of the LFG collection technology for the purpose of electricity generation in Kızıllı Waste Management Site in Antalya. Waste management site receives 3000 tons/day (max) of Municipal Waste. The landfill receives only Municipal Solid Waste since 2003 covering a land of 75 hectare. Kızıllı landfill area is the largest and main landfill area within Antalya serving for almost 70% of the total city population. Prior to the project activity, there were no waste management, LFG flaring, destruction or utilization. The landfill was operated as a wild landfill area and all the methane was emitted to the atmosphere without any treatment.

The project involves Renewable Energy Generation from Municipal Waste. There are two major activities for electricity generation:

- Capturing the LFG in the landfill which is later burned in the gas engines to generate electricity

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- Generating methane in Anaerobic Digesters which is later sent to the gas engines to generate electricity.

The generated electricity is then imported to grid. The facility is expected to reach an annual production capacity of approximately 52.6 GWh/year once fully operational.

3.3 Smart Energy Integration. RES, Storage and Management at District Level

A district electricity storage system (based on batteries) was planned to be integrated in the city to store the electricity generated by the PV Power Plant. The battery group is planned to reach to a total storage capacity of 720 kWh through installation of 300 units. The battery group was planned to operate as a flexibility unit.

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4 Executive project of the actions

4.1 A7 Smart Meters

4.1.1 Management structure

This action is under two separate interventions in terms of management structure.

A. Smart meters deployed for electricity monitoring and management of District Level Renewable Energy Systems [Action 10 and Action 11]. As explained under section 4.1.2, these meters are property of the DSO which in this case is the Akdeniz Elektrik Dağıtım A.Ş. The meters sealed by the DSO at the time of commissioning of the facility since they are also used for billing purposes. Purchase, installation and maintenance are under the responsibility of the facility owner. The initial costs as well as maintenance and repair costs are transferred to the owners of the facility.
B. Smart meters deployed for electricity monitoring and management of High-Performance Buildings [Action 1 and Action2]. Similar to District Level RES implementation, the DSO will be the owner of these meters if the meters are installed to the distribution network, which is defined as between building main switchboard and the step-down transformer station. In this case again purchase, installation and maintenance will be under the responsibility of the facility owner. The initial costs as well as maintenance and repair costs are transferred to the owners of the facility.

   There is also an option for A1 and A2, where the smart meters are installed inside the building before the official meters (installed for billing purposes) as either a shadow meter measuring the whole consumption of the building from a single location or as separate meters installed for each flat to monitor each flat's consumption. In this case, the initial investment as well as the investment will be under the responsibility of the construction company. However, the maintenance and repair would be the responsibility of property owners.

The following table summarizes the management structure for smart meters implementation:

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	Responsible			
	Action 10 (SPP)	**Action 11 (LFG)**	**Action 1 (Residential B)**	**Action 2 (Tertiary Buildings)**
Design	By Regulation	By Regulation	By Regulation	By Regulation
Investment	Antalya Metropolitan Municipality	Sub-Contractor	SURYAPI	ANTEPE
Construction / Implementation / Installation	Sub-contractor	Sub-contractor	SURYAPI	Sub-contractor
Monitoring	Antalya Metropolitan Municipality	Sub-contractor	Property owner / tenants	Antalya Metropolitan Municipality
Operation	Antalya Metropolitan Municipality	Sub-contractor	Property owner / tenants	Antalya Metropolitan Municipality
Maintenance	Antalya Metropolitan Municipality	Sub-contractor	Property owner / tenants	Antalya Metropolitan Municipality

Table 1 Responsibilities and management structure (A7)

4.1.2 Technical specifications of the city infrastructure

Heightened demand for power availability, distributed generation, and greater efficiency are creating a need for more consumption and power quality measurements at the edge. Smart electricity meters allow you to accommodate auxiliary meters through a standards compliant interface and are fully capable of securely connecting to ZigBee radio frequency or LonWorks® PL, M-bus, Multipurpose Expansion Port (MEP) or Open Smart Grid Protocol (OSGP) devices for Home Area Network integration, energy management or other services. A Smart Meter and Powerful Grid Sensor are combined on smart meter.

A sophisticated and advanced Building Energy Management (BEM) system will be deployed like BEMOSS that will be integrated with the Urban ICT Platform to monitor these smart meters. Kepez Santral BEM will be able to integrate Smart Appliances, Smart Grid, Smart Meters, Smart Street Lighting, Building Automation System and IoT devices. This BEM is expected to provide scalability, robustness, plug and play, open protocol, interoperability, cost-effectiveness, as well as local and remote monitoring, allowing it to work with load control devices from different manufacturers that operate on different communication technologies and protocols. It supports different communication technologies and data exchange protocols like Ethernet (IEEE 802.3), Serial (RS-485), ZigBee (IEEE 802.15.4) and Wi-Fi (IEEE 802.11); and BACnet, Modbus, Web, ZigBee API, OpenADR and Smart Energy Profile (SEP) protocols. With

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its multi-layer architecture, it can be easily expandable to the entire building and it allows remote and local monitoring by supporting enhanced security features.

On district level, smart meters are the property of the distribution company (DSO), which in this case is Akdeniz Elektrik Dağıtım A.Ş.[5].

Technical specifications of the meters could be overwhelmingly long depending on the brand and model selected. However, the minimum and critical requirements for technical specifications of the smart meters are summarized as follows:

- The smart meters, which will be deployed to each RES facility, will have a min accuracy class of B (1%) or C (0.5%) in accordance with TS EN50470-1 and TS EN504470-3 standards. This will allow a high accuracy in monitoring results.
- The meters will allow monitoring electricity generation and consumption with at least 4 different tariff modes programmable for each day separately. This will allow monitoring the electricity generation separately based on applicable smart tariffs available to the facility.
- The meters will allow integration to all communication protocols through a standard optic port. These protocols will be in accordance with TS EN602056-21. This will allow standardization and integration of smart meters to the Urban ICT Platform of Antalya.
- The smart meter shall continue to operate as usual and store its data in case of energy failures.
- The electricity meter shall enable a continuous monitoring with at least 15 min frequency.
- The smart meter shall be able to monitor both electricity generation and consumption (bidirectional). This will allow calculating the net electricity delivered to the grid.
- The smart meter will have an operating temperature range of at least -40^{0}C to 85^{0}C. This will allow operating in hot climates such as Antalya without any problem.

4.1.3 Planning of the task's infrastructure

The electricity smart meters for both [A10] PV System, with a Total Capacity of 5 MW and [A11] LFG and Electricity Generation, are deployed and the meters are monitoring electricity generation. The acceptance of meters from the DSO, which marks the start of monitoring for these power plants are presented as follows:

[5] Ref: www.akdenizedas.com.tr

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Start of monitoring for full capacity for [A10] PV System With a Total Capacity of 5 MW	3/04/2019
Start of monitoring for full capacity for [A11] LFG and Electricity Generation	28/06/2019

Table 2 Start of monitoring dates

A SCADA system will be integrated to the monitoring for [A10]. This is planned for 2nd Quarter of 2020.

4.1.4 Health, safety and waste management requirements

Occupational Health and Safety:

Occupational Health and Safety Law No: 6331 (OHS), which is based on the EU Directive No 89/391 was enacted in 2012. The installation of the equipment and operation will be conducted in accordance with the provisions of this Law and related regulations.

Waste Management Requirements:

During periodic maintenance or repair, any waste such as cables, fuses, etc. will be sorted depending on their toxicity and hazardous class and any waste considered as hazardous waste will be managed in accordance with the requirements of Hazardous Waste Management Regulation No29314.

Since there are no moving parts, there is no use for lubricant oil as waste.

The applicable rules and regulations demand that electricity meters should be renewed every 10 years period. The old meters will be managed in accordance with the requirements of “Regulation on Waste Electrical and Electronic Devices” No28300.

4.1.5 Risks and proposed risk-mitigation measures

Smart meters for District Level RES are already implemented, there are no foreseen major risks associated with the implementation of the project activity. The electricity generation is currently being delivered to the grid and the electricity is monitored through a bi-directional electricity meter. Since this electricity meters are also used for billing and offset purposes between the Facilities and the DSO a high-quality monitoring is assured. There are two electricity meters for each generation unit acting as the main and spare, and all data is stored in backup computers as well as within the meters itself. A SCADA system is planned and deployed for monitoring which will also allow connection to the urban platform. This will lower any risk associated with data loss.

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4.2 A10 PV System with a Total Capacity of 5MWp

4.2.1 Management structure

The project is owned and coordinated by Antalya Metropolitan Municipality / Department of Agricultural Services. The Municipality has sub-contracted the permit and licensing process, as well as the construction and commissioning work to a private company. Once the project is commissioned, Antalya Metropolitan Municipality will be responsible for the operation and maintenance (except for the first two years of operation) and monitoring of the facility. In accordance with the requirements of the sub-contracting agreement, the subcontractor will be responsible for maintenance and repair for the first two years of operation.

The project is financed by Antalya Metropolitan Municipality co-financed by BAKA (West Mediterranean Development Agency)

The following table summarizes the management structure for Action 10

	Responsible
	Action 10 (SPP)
Design	Antalya Metropolitan Municipality & Sub-contractor
Investment	Antalya Metropolitan Municipality & BAKA Development Agency
Construction / Implementation / Installation	Sub-contractor
Monitoring	Antalya Metropolitan Municipality
Operation	Antalya Metropolitan Municipality
Maintenance	Antalya Metropolitan Municipality and Sub-Contractor (the first 2 years of operation only)

Table 3 Responsibilities and management structure (A10)

4.2.2 Technical specifications of the city infrastructure

The Power Plant is planned to be constructed in two phases.

The first phase covers the initial 2 MWp capacity and the other phase covers the 2.86 MWp capacity reaching to a total of 4.86 MWp installed capacity. As explained under Section 2, at the time of applications, legislation provided a convenience to PV systems with a capacity under 1 MWp. Any PV system equal or below 1 MWp installed capacity was exempted from licensing procedures. Hence the SPP has been planned as a

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group of smaller SPPs. Once the total capacity is reached, the SPP will consist of the following subsystems; 2 x 420 kWp; 2 x 600 kWp; 1 x 900 kWp; 2 x 960 kWp.

Figure 3 Arial photo of Antalya SPP

Figure 4 Planning Area

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The SPP will consist of over 19,000 Polly-Crystalline PV modules with a capacity rating of 260 Wp each. Each module is expected to reach an efficiency of 16% - 17%. The total area of the SPP will cover over 70,000 m^2. The system's overall technical lifetime is expected to exceed 25 years.

The main equipment of the system consists of:

- Solar Panels
- Mounting structure (Fixed Mount)
- On-Grid Inverter
- Monitoring equipment and system (including bidirectional electricity meter)
- AC Electric Panel
- Protective switch panels and circuit breakers
- DC & AC cabling
- Grounding

Antalya benefits from high solar radiation values. During June the solar radiation levels reach to an average of 6.93 kWh/m^2 per day, with 11.55 of hours of sunshine duration. This value drops to an average of 1.92 kWh/m^2 per day with 4.55 hours of sunshine duration during December month when it is lowest. The annual average is 4.51 kWh/m^2 per day. This irradiation levels result in a potential of 27.6 kWh/m^2 over a year with 8.24 hours of sunshine duration. Rainfall regime of the area is also an important factor in energy generation from PV systems. Antalya has a yearly average rainfall amount of 1066.9 mm/year.

The maximum expected generation will be on June- July while the minimum will be observed December -January. Monitoring results show that the electricity generation in June 2019 (with full capacity operational) has reached 961 MWh. The total annual electricity generation of the SPP is expected to reach 8 GWh/year. Monthly distribution of the expected generation is as follows:

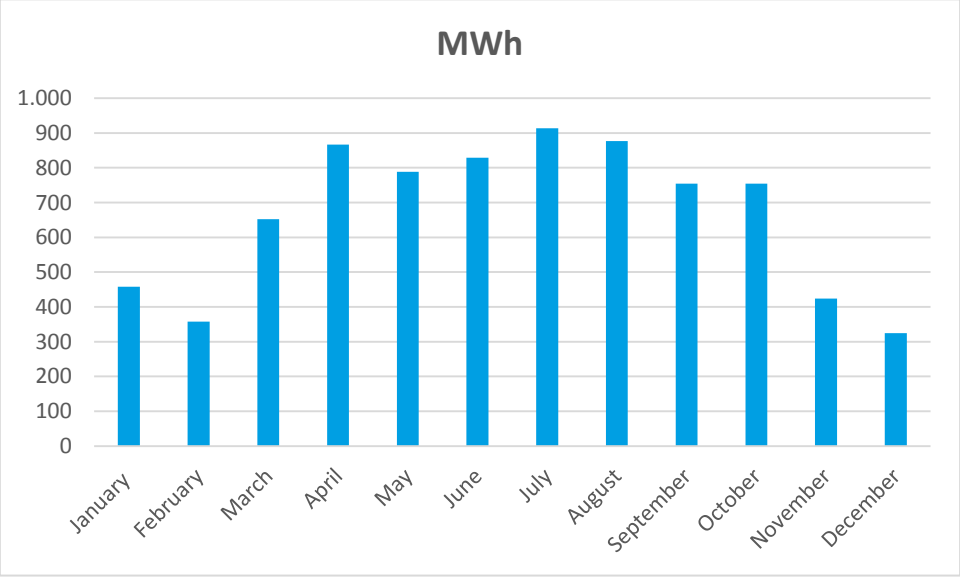

Figure 5 Estimated annual production

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As mentioned earlier the generated electricity will be used to power irrigation pumps in Antalya. There are 153 consumption pump stations under 44 agricultural irrigation cooperatives representing over 7,500 farmers with a total agricultural land of approximately 17,960 hectare. The total demand for the pumps is estimated as 8,5 GWh/year[6].

The required investment will be covered by Antalya Municipality with also availability of co-funding from BAKA (West Mediterranean Development Agency). The SPP will be connected to the national grid system. The generated electricity will be mostly used to cover energy demand of irrigation pumps, which are normally powered by electricity from the grid. The successful commissioning of the SPP will substitute the fossil fuel concentrated grid electricity with renewable energy.

4.2.3 Planning of the tasks

As of April 2019, all stages and sections of the Solar Power Plant is commissioned and is operational with 4.86 MWp capacity.

#	Date	Milestone
1	05/26/2017	Commissioning of section A
2	05/26/2017	Commissioning of section B
4	11/17/2016	Commissioning of section C
5	11/17/2016	Commissioning of section D
6	03/04/2019	Commissioning of section E
7	03/04/2019	Commissioning of section F
8	03/04/2019	Commissioning of section G
9	03/04/2019	Start of monitoring
10	2nd Quarter of 2020	Integration of monitoring to Antalya Urban Platform

Table 4 Planning of the tasks

[6] Ref: http://antalya.bel.tr/haberler/antalya-tariminda-yeni-bir-donem-basliyor

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4.2.4 Health, safety and waste management requirements

Occupational Health and Safety:

Occupational Health and Safety Law No: 6331 (OHS), which is based on the EU Directive No 89/391 was enacted in 2012. The SPP construction and operation will be conducted in accordance with the provisions of this Law and related regulations.

Waste Management Requirements:

SPPs in general have an insignificant footprint both during construction and during operation. Approximately 15 people worked on the site for the installation of the equipment and 1 security person is on site during the operational phase. The waste water amount is expected to be 0.216 m^3/day for 1 person. The Power Plant has connection to the city sewerage infrastructure and the waste water will be disposed in the City Waste Water Treatment Centre. The amount of generated Solid Waste is also very low with an estimated 1.12 kg/day per person. This waste is considered as Municipal Waste and will be collected periodically to be managed in the Municipality Waste Management Facility and landfilled in accordance with the requirements of the related regulation.

During periodic maintenance or repair, any waste such as cables, fuses, collectors, solar cells etc. will be sorted depending on their toxicity and hazardous class and any waste considered as hazardous waste will be managed in accordance with the requirements of Hazardous Waste Management Regulation No29314.

Since there are no moving parts, there is no use for lubricant oil as waste. Due to the electricity generation principle there are no emissions of any kind. Since there are no moving parts, the noise levels are expected to be very low (Approximately 45 dB).

4.2.5 Risks and proposed risk-mitigation measures

Since the project is currently under operation, there are no foreseen major risks associated with the implementation of the project activity. The electricity generation is currently being delivered to the grid and the electricity is monitored through a bi-directional electricity meter. Since this electricity meter is also used for billing and offset purposes between the SPP and the DSO a high-quality monitoring is assured. There are two electricity meters acting as the main and spare, and all data is stored in backup computers as well as within the meters itself. A SCADA system is planned and deployed for monitoring which will also allow connection to the urban platform. This will lower any risk associated with data loss.

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4.3 A11 LFG and Electricity Generation

4.3.1 Management structure

The project is owned and coordinated by Antalya Metropolitan Municipality / Department of Agricultural Services. The Municipality has sub-contracted the permit and licensing process as well as the construction, commissioning work and operation to a private company for 29 years in return of project finance (Built-Operate-Transfer Model)

	Responsible
	Action 11 (LFG)
Design	Sub-contractor
Investment	Sub-contractor
Construction / Implementation / Installation	Sub-contractor
Monitoring	Sub-contractor
Operation	Sub-contractor (Will be transferred to Antalya Metropolitan Municipality after 29 years)
Maintenance	Sub-contractor (Will be transferred to Antalya Metropolitan Municipality after 29 years)

Table 5 Responsibilities and management structure (A11)

4.3.2 Technical specifications of the city infrastructure

The project includes two activities, one being the LFG extraction and utilization project and the other one is the anaerobic digestion, biogas generation and utilization. The Kızıllı Waste to Energy Facility is within Kızıllı Landfill Area in Antalya and has been accepting Solid Municipal Waste since 2003. The landfill area is the biggest landfill area in Antalya, receiving MSW from 13 districts including Kepez, and providing services to over 2 million citizens. The daily MSW accepted to the Landfill is approximately 500 ton/day during off seasons reaching to 2500 – 3000 tons/day during summer months. The waste consists of approximately 60% organic and 40% non-organic wastes. The breakdown of waste characterisation of the MSW in Antalya is presented as follows:

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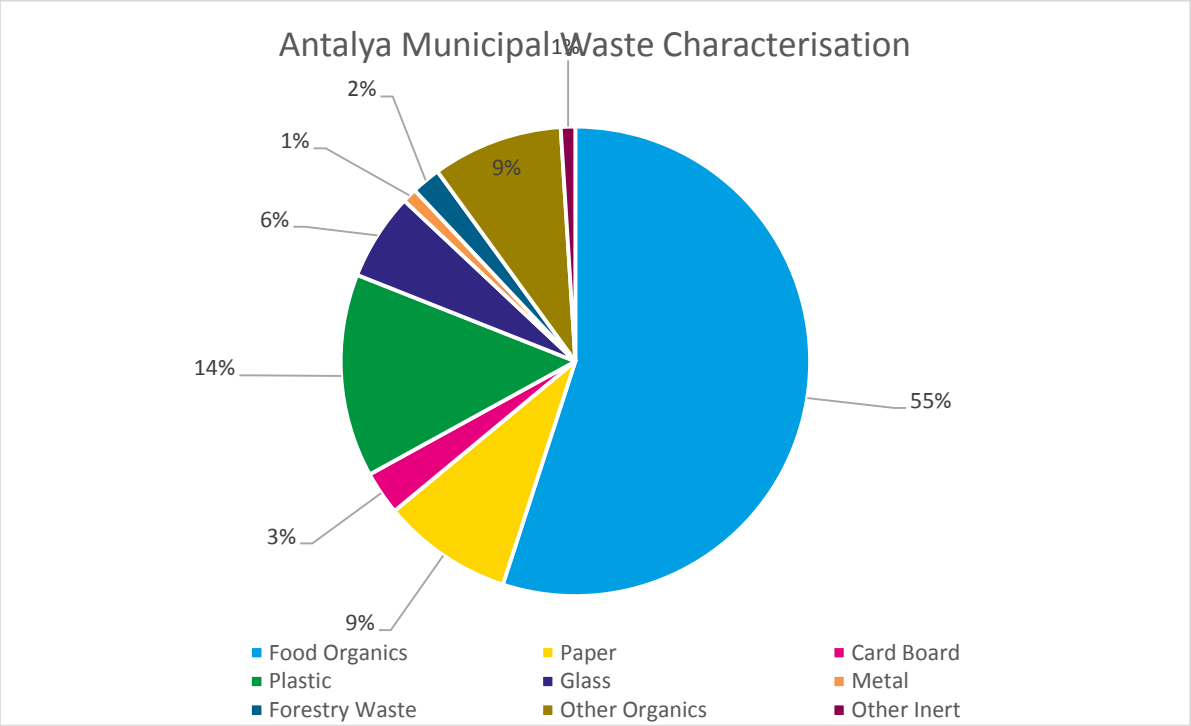

Figure 6 Antalya municipality waste characterisation

According to the Sustainable Energy Action Plan Report of Antalya, GHG emissions from Municipal Waste degradation is calculated as 385,010 tCO2e/year, which is 4.3% of the total City Emissions for year 2012[7].

Figure 7 Arial view of Antalya Kızılı Waste to Power project

[7] Antalya Sustainable Energy Action Plan 2015

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The project activity involves several actions:

- Covering of the landfill area: the landfills will be covered with a 60 cm thick clay layer. On top of the clay layer, a 10 cm thick sand layer, a 30 cm thick soil and a 15 cm thick top soil layer will be laid out for erosion control and plant growth. This will also reduce odour nuisance and prevent LFG to be emitted to the atmosphere.
- Deployment of LFG collection system. The collection system consists of vertical wells drilled into the landfill area together with the horizontal piping to transfer the collected gas from the landfill (HDPE Pipeline). The LFG collected from these wells are gathered at several manifolds where each incoming gas pipe is coupled to system to measure the flow rate, gas concentrations, and the calorific value of the LFG in order to effectively monitor and optimize the well operating conditions. The gas collection system also includes a LFG storage unit.
- Anaerobic Digesters: Fresh waste entering the landfill area will be sorted in the recycling facility; organic waste will be then transferred to anaerobic digestion units. In these digesters the organic waste will be digested and methane will be produced. The biogas will be then fed to the gas engines to generate electricity.
- Energy generation units: The captured LFG and biogas from the anaerobic digesters will be utilized in internal combustion gas engines for electricity generation. The generated electricity will be then exported to the electricity grid.
- Landfill leachate drainage system: The project activity includes installation of a leachate collection system in which the leachate is collected through underground canals and transported through pipes to the Municipalities Waste Water Treatment Centre
- Gas flaring: An enclosed flaring system is planned for a safety measure. This system will only be used if the captured amount exceeds the amount of gas burnt in the engines.
- Gas Boosters. There will be several gas boosters to provide the required discharge pressure.
- Grid Connection: The generated electricity will be delivered to the grid via 34.5 kV feeder substation.

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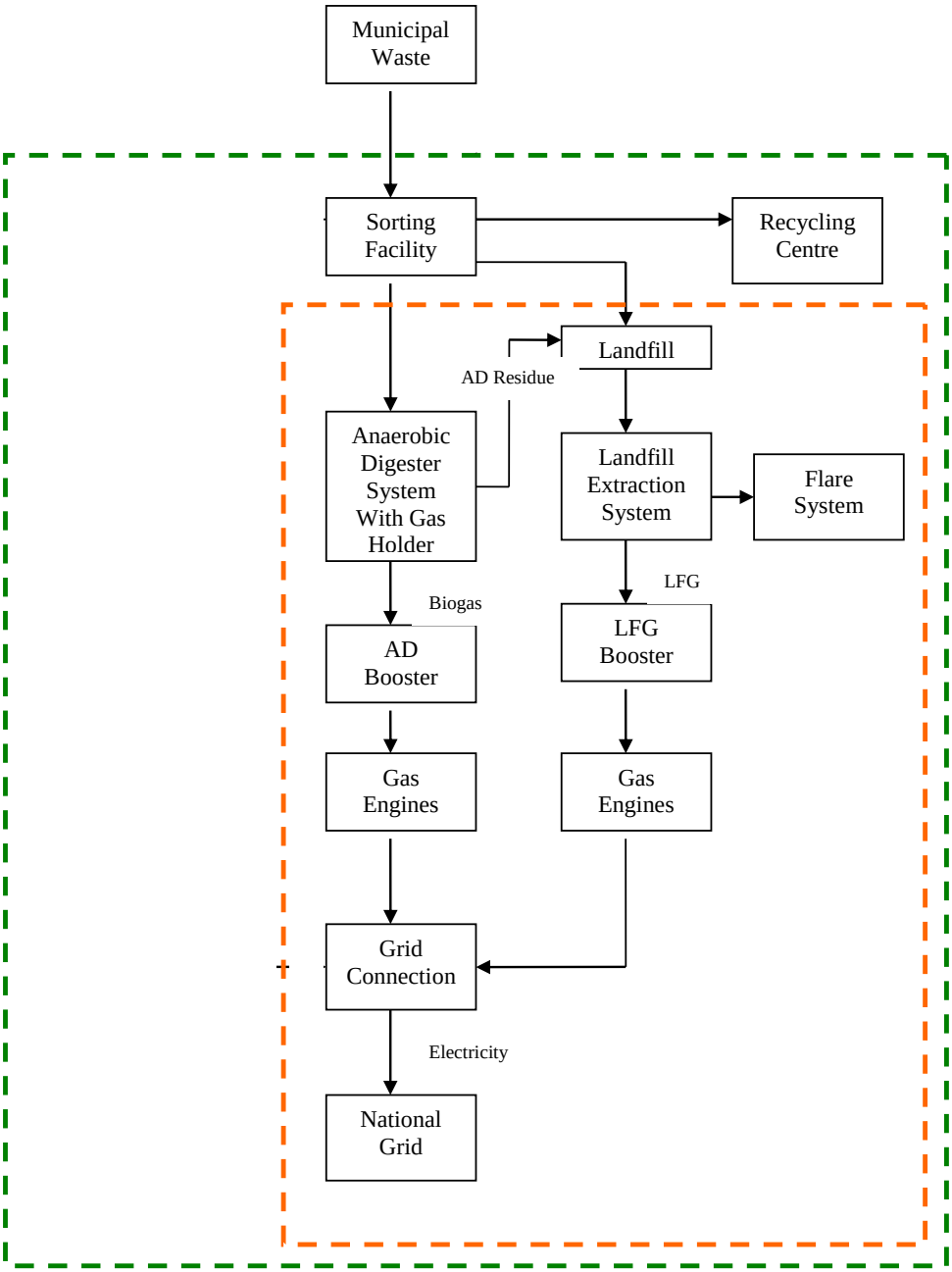

Figure 8 Kızılı Waste to Energy Project

The total capacity is planned to reach 25.47 MW with the installation of 18 gas engines of 1415 kW each. The engines will be grouped in two sections with a dedicated booster for each group. There will be 12 digester tanks feeding biogas to dedicated engines. The power plant is estimated to utilize 97,445,270 m^3/year biogas and LFG per year to generate approximately 183 GWh/year electricity. 6 engines will be dedicated to LFG utilization, while 12 engines will be dedicated to biogas utilization.

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The system will be also supported with two balloon type gas holders to provide flexibility to LFG and biogas. A flare system will be installed for safety issues.

4.3.3 Planning of the tasks

Currently the facility is operational with 25.47 MW installed capacity with 18 engines installed and commissioned. Important milestones of the project activity are summarized as follows:

#	Date	Milestone
1	13/10/2017	Commissioning of 2 x 1.415 MW engines
2	11/09/2017	Commissioning of 8 x 1.415 MW engines
3	22.02.2018	Commissioning of 3 x 1.415 MW engines
4	24.05.2018	Commissioning of 2 x 1.415 MW engines
5	21.06.2018	Commissioning of 1 x 1.415 MW engines
6	28.06.2019	Commissioning of 2 x 1.415 MW engines
7	28.06.2019	Start of monitoring
8	2nd Quarter of 2020	Integration of monitoring to Antalya Urban Platform

Table 6 Planning of the tasks

4.3.4 Health, safety and waste management requirements

Occupational Health and Safety:

Occupational Health and Safety Law No: 6331 (OHS), which is based on the EU Directive No 89/391 was enacted in 2012. The Facility construction and operation will be conducted in accordance with the provisions of this Law and related regulations.

Waste Management Requirements:

The facility is expected to have an insignificant footprint both during construction and during operation. Approximately 25 people will be working on site during the operational phase. The waste water amount is expected to be 5.4 m^3/day. The Facility has connection to the city sewerage infrastructure and the waste water will be disposed in the City Waste Water Treatment Centre. The amount of generated Solid Waste is also very low with an estimated 28 kg/day. This waste is considered as Municipal Waste and will be collected periodically to be managed in the Municipality Waste Management Facility and landfilled in accordance with the requirements of the related regulation.

During periodic maintenance or repair, any waste such as cables, fuses, collectors, etc. will be sorted depending on their toxicity and hazardous class and any waste

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considered as hazardous waste will be managed in accordance with the requirements of Hazardous Waste Management Regulation No29314

Any oil waste during the operational lifetime will be stored, transported and managed in accordance with the stipulations of “Management of Waste Oils” No28812.

Leachate from landfills of municipal, commercial and mixed industrial waste may be characterised as a water-based solution of dissolved organic matter (alcohol, acids etc.), inorganic macro components (sulphate, chloride etc.), heavy metals (lead, nickel, copper, mercury) and xenobiotic organic compounds like halogenated organics. The high concentrations of organic contaminants and ammoniacal nitrogen create the highest environmental risks. Leachate running into the aquatic environment has acute and chronic impact on the environment, seriously diminishing bio-diversity and reducing populations of sensitive species.

The facility of this project will collect the generated leachate and treat it according to environmental regulations, avoiding any hazard to surrounding aquatic resources and the associated risks for the environment and public health. The leachate will be sent to the waste water treatment centre in accordance with the stipulations of “Regulation on Management of Landfills”.

4.3.5 Risks and proposed risk-mitigation measures

Since most of the capacity of the project is currently under operation, there are no foreseen major risks associated with the implementation of the project activity. The electricity generation is currently being delivered to the grid and the electricity is monitored through a bi-directional electricity meter. Since this electricity meter is also used for billing and offset purposes between the SPP and the DSO a high-quality monitoring is assured. There are two electricity meters acting as the main and spare, and all data is stored in backup computers as well as within the meters itself. A SCADA system is planned and deployed for monitoring which will also allow connection to the urban platform. This will lower any risk associated with data loss.

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4.4 A12 Integration of District Electricity Storage

4.4.1 Management structure

The regulating authority is the EMRA (Energy Market Regulatory Authority). The permits and technical requirements are defined by the local DSO (Akdeniz Elektrik Üretim A.Ş.). As explained under section 4.4.2, the implementation of a grid connected storage as flexibility unit is not possible from a legislative structure; hence an amendment is being prepared by the project team to be presented to the Commission at the earliest convenience.

4.4.2 Technical specifications of the city infrastructure

Electricity distribution networks are now faced with increasing penetration of small scale decentralized renewable energy generation. Antalya is no exception for this trend. Within Antalya, the energy generation characterization shows a wide mix of sources including, Hydro, Biogas, Solar, Natural Gas. 27.9% of the generation is based on renewable energy sources, while 71% of generation is based on fossil fuels. In total there are 72 electricity generation units in Antalya of which 49 of them are smaller than 5 MW capacity. Of these 49 small power plants, 40 of them are Solar Power Plants with an average capacity of 1MW. This shows a trend towards a more decentralized generation within the Distribution Grid.

The intermittent nature of the electricity generation of RES, specifically solar and wind leads to issues related with grid quality and reliability. Energy storage technologies offer promising solutions that can manage variability and potentially decouple short-term variations of supply from demand. Benefits of storage technologies include; increasing energy access; and improving electricity grid stability, flexibility, reliability, and resilience.

A 720 kWh capacity storage was planned in Antalya, which would be linked with the 5 MWp SPP [Action 10] consisting of approximately 300 battery cells with 2,400 kWh capacity each. The general idea behind the concept was to have an electricity storage unit directly connected to the grid which would store electricity from the SPP when the demand (irrigation pumps) is lower than the generation. This stored energy could be used later when the demand is higher than the generation. This time-shifting would allow to manage variability and potentially decouple short term variations of supply and demand. This will have a positive impact on the local grid's congestion issue as well.

Time shifting through storage would also have an impact on the feasibility of the actions as well. The electricity generation from a SPP naturally peaks during noon hours however the electricity is required mostly in the afternoon, which is also the peak hours for the grid when the demand is the highest. Conventionally the SPP delivers the electricity to the grid at any time available where the irrigation pumps draw energy from the grid at any time they demand. On a monthly basis the consumed energy is offset from the generated electricity. Using a battery storage group for flexibility would also have a positive impact on lowering peak loads.

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With regards to Grid Connected Electricity Storage, the legislative aspect regulating electricity storage is not inclusive enough to cover comprehensively a storage application specifically aiming grid flexibility. The legislative structure only defines storage as a UPS system also for the renewable energy systems. This allows Renewable Energy Systems to have a storage capacity, however a scenario where a storage unit/group connected to the grid and is importing / exporting electricity from and to the grid is not defined from a legislative point of view (acting as a grid level flexibility unit). There are several pilot projects and storage units under research and development efforts but a structured commercial implementation is not yet available within Turkey. On 8th February 2019, EMRA (Energy Market Regulatory Authority) has published a draft version of the first legislation on electricity storage for consultation from the sector. In accordance with this draft legislation, electricity storage as a flexibility unit activity is described providing a legislative basis to this type of actions. However, the enactment date of this legislation or its provisions are not certain for now.

Therefore, the implementation of a grid connected storage as flexibility unit is not possible from a legislative structure; hence an amendment is being prepared by the project team to be presented to the Commission at the earliest convenience.

4.4.3 Planning of the tasks

The district level electricity storage action will be amended for exclusion due to legal barriers which are not foreseen to be overcome during the project timeframe.

4.4.4 Health, safety and waste management requirements

The district level electricity storage action will be amended for exclusion due to legal barriers which are not foreseen to be overcome during the project timeframe.

4.4.5 Risks and proposed risk-mitigation measures

The district level electricity storage action will be amended for exclusion due to legal barriers which are not foreseen to be overcome during the project timeframe.

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5 Implementation

5.1 Smart Grids

This section covers [Action 7] “Smart Meters”.

5.1.1 Status of the intervention

The electricity smart meters for both [A10] PV System with a Total Capacity of 5 MW and [A11] LFG and Electricity Generation are deployed and the meters are monitoring electricity generation. The acceptance of meters from the DSO, which marks the start of monitoring for these power plants are presented as follows:

Start of monitoring for full capacity for [A10] PV System With a Total Capacity of 5 MW	3/04/2019
Start of monitoring for full capacity for [A11] LFG and Electricity Generation	28/06/2019

A SCADA system will be integrated to the monitoring for [A10]. This is planned for 2nd Quarter of 2020.

5.1.2 Risks found and corrective actions performed

There have been no corrective actions performed.

5.1.3 Business model and financial scheme applied

The total investment cost is expected to be approximately 90,000 € including equipment, installation and commissioning. Smart meters are eligible costs under MAtchUP for up to 87,710 Euro.

5.1.4 Citizen engagement strategy implemented

Citizen engagement strategy of Antalya for Kepez Smart District has started before demolition of the project area completely. People living in the district have been informed by the experts from Municipal Urban Transformation Directorate, Ministry Of Environment And Urbanisation as well as SAMPAŞ which is a consultant company. In the context of citizen engagement several meetings has been organised in order to inform right owners

Furthermore, in regard to MAtchUP, citizen engagement activities have started immediately after the kick-off meeting in Valencia. Press release issued by three mayors has been posted by local regional and national media in order to raise awareness what smart city implementations have been planned in the project.

In addition, “City needs and priorities” workshop has been organised with the wide range of participants including municipal departments and companies, public bodies,

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chamber of engineers, representatives from local Agenda 21 and local NGO's. During workshop, MAtchUP interventions have been presented and discussed regarding four main pillars; energy, mobility, ICT and social. Besides, "Smart City" survey has been conducted in the workshop.

5.1.5 Next steps

Installation of meters is completed and the meters are currently operational and monitor the electricity generation of both facility [A10 & A11]. The monitoring system will be integrated to the urban platform. This is estimated to be finalised by 2nd quarter of 2020.

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5.2 Clean Energy Generation. District City Level Renewables

This section covers [Action 10] “PV Systems with a Total Capacity of 5 MWp” and [Action 11] “LFG and electricity generation”.

5.2.1 Status of the intervention

Both actions are well advanced in terms of implementation and generating electricity. The Solar Power Plant is fully operational since 03/11/2019 and is generating electricity with an installed capacity of 4.82 MWp. The electricity is currently used for self-consumption for irrigation pumps around Antalya. The electricity production is currently being monitored through bi-directional meters. A SCADA system is planned and deployed for monitoring which will also allow connection to the urban platform.

5.2.2 Risks found and corrective actions performed

No correction actions have been performed.

5.2.3 Business model and financial scheme applied

Action 10 (PV Systems with a Total Capacity of 5 MWp):

The project is owned and coordinated by Antalya Metropolitan Municipality / Department of Agricultural Services. The project is financed by Antalya Metropolitan Municipality Co-Financed by BAKA (West Mediterranean Development Agency). The total initial investment is 19,174,458 TL for the total capacity. The first phase is completed with approximately 8,382,000TL while the second phase was 10,792,458 TL. Approximately 70% of the total investment cost is co-financed by BAKA (West Mediterranean Development Agency, Turkey)[8].

The generated electricity is used to power 153 irrigation pumps. The electricity is free of charge to the farmers. Approximately 7,500 farmers are benefiting from this SPP. Any surplus amount of energy is sold to the grid from the RES feed in tariff of 13.3 $cent/kWh.

Action 11 (LFG and electricity generation):

The landfill is owned by the Municipality. The right of use of the landfill (including the right to utilize the Landfill Gas) is transferred to a private company with a tendering process. The Private Company acts as Energy Generator though utilization of LFG also undertaking the investment and construction & operation responsibilities of the LFG utilization facility. The facility is transferred back to the Municipality after 29 year of operation.

[8] As of 09/09/2019 $/TL exchange rate is 5.71.

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The total initial cost is approximately 250,000,000 TL (40M€ approx.. change rate September 2019) which is undertaken by a private company ITC Invest Trading and Consulting.

The facility has an electricity generation license and all the electricity generated is exported to the grid from the RES feed in tariff of 13.3 $cent/kWh.

5.2.4 Citizen engagement strategy implemented

Citizen engagement strategy of Antalya for Kepez Smart District has started before demolition of the project area completely. People living in the district have been informed by the experts from Municipal Urban Transformation Directorate, Ministry Of Environment And Urbanisation as well as Sampaş which is Consultant Company. In the context of citizen engagement several meetings has been organised in order to inform right owners

Furthermore, in regard to MAtchUP, citizen engagement activities have started immediately after the kick-off meeting in Valencia. Press release issued by three mayors has been posted by local regional and national media in order to raise awareness what smart city implementations have been planned in the project.

In addition, “City needs and priorities” workshop has been organised with the wide range of participants including municipal departments and companies, public bodies, chamber of engineers, representatives from local Agenda 21 and local NGO’s. During workshop MAtchUP interventions have been presented and discussed regarding four main pillars; energy, mobility, ICT and social. Besides, “Smart City” survey has been conducted in the workshop.

5.2.5 Next steps

Construction and commissioning of the facilities are finalized. The monitoring system will be integrated to the urban platform. This is estimated to be finalised by 2nd quarter of 2020.

5.3 Smart Energy Integration. RES, Storage and Management at District City Level

This section covers [Action 12] “Integration of district electrical storage”.

5.3.1 Status of the intervention

The district level electricity storage action will be amended for exclusion due to legal barriers which are not foreseen to be overcome during the project timeframe.

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5.3.2 Risks found and corrective actions performed

With regards to Grid Connected Electricity Storage, the legislative aspect regulating electricity storage is not inclusive enough to cover comprehensively a storage application specifically aiming grid flexibility. Therefore, the implementation of a grid connected storage as flexibility unit is not possible from a legislative perspective, hence an amendment is being prepared by the project team to be presented to the Commission at the earliest convenience.

One alternative is to install the storage capacity in connection with the PV installation for public buildings [Action 3]. This PV system is planned to generate electricity for the mobility charger stations. The PV system has a planned capacity of 345 kWp and is already linked with a battery group of 240 kWh [Action5], which is working as a UPS system. The capacity of the battery group under Action 12 could be transferred to the battery capacity under [Action 5]. In this setup the battery group will be connected to the RES, Grid and chargers via an inverter, there will be no direct connection to the grid eliminating the need of a permit / license from the distribution company or regulatory authority. This setup will still achieve the anticipated benefits of using a battery storage capability for flexibility.

This issue will be further discussed in the amendment process.

5.3.3 Business model and financial scheme applied

The district level electricity storage action will be amended for exclusion due to legal barriers which are not foreseen to be overcome during the project timeframe.

5.3.4 Citizen engagement strategy implemented

The district level electricity storage action will be amended for exclusion due to legal barriers which are not foreseen to be overcome during the project timeframe.

5.3.5 Next steps

The district level electricity storage action will be amended for exclusion due to legal barriers which are not foreseen to be overcome during the project timeframe.

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6 Conclusions

Renewable Energy Systems are crucial Ingredients for combating climate change and for the wellbeing of cities. It does not only reduce GHGs but also contribute to reduce air pollution and improve public health. Inhabiting approximately 2/3 of the population and responsible for most of the energy demand, Cities are both a major source of the problem itself as well as representing a significant potential for the solution. Decentralized Renewable Energy Systems are becoming more and more important in this Energy Transformation. The conventional approach in energy generation was from large scale centralized fossil fuel power plants, transmitted to cities where they are consumed. However, this conventional approach falls shorter each day in addressing requirements and developments in energy management. Currently, cities are becoming more and more energy independent with integration of smaller renewable energy generation units within their service grids. Grids are becoming smarter and more flexible to cope with the challenges due to the fluctuating nature of renewable power generation. This brings the necessity of a well observed and monitored energy infrastructure.

Under MAtchUP, Antalya has set target to implement two renewable energy systems, one based on Solar and second based on municipal wastes. Both facilities will significantly increase its share of renewable energy generation from renewable energy resources. Antalya has committed to an ambitious target to reduce its GHG emissions by 20% in 2020. Realization of the 5 MWp SPP and the Waste to Energy Power Plant will contribute in realizing this target. Both facilities are expected to generate approximately 190 GWh/year electricity doubling its current generation from biogas and solar. This will lead to emission reduction of an estimated 288,400 tCO_2 including emission reductions from avoiding methane[9].

As of September 2019, Antalya Metropolitan Municipality has successfully commissioned two power generation facilities [Action 10] & [Action 11]. They are currently commissioned as full capacity and are operational. Both facilities have also started to monitor its electricity generation [Action 7]. The commissioning of these actions is a major milestone in MAtchUP Antalya.

Under [Action 12] a district electricity storage connected to the grid was planned to offer flexibility to the grid. Through the progress of MAtchUP, Antalya team has discovered that the legislative structure in Turkey regulating electricity storage is not inclusive enough to cover comprehensively a storage application specifically aiming grid flexibility. Several attempts have been made to solve the issue, which will allow the team to implement the Action as anticipated, however associated risks on not completing this action within timeline of MAtchUP is high. The legislative aspect regulating electricity storage is not inclusive enough to cover comprehensively a storage application specifically aiming grid flexibility. Therefore, the implementation of a grid connected storage as flexibility unit is not possible from a legislative perspective,

[9] Ref: Antalya Sustainable Energy Action Plan, 2015

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hence an amendment is being prepared by the project team to be presented to the Commission as next step.

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