1
SMART GRID

Digitalization in the energy sector in Chile

Smart Substation

Feeder Automation

Microgrids

The communication support schemes and real-time measurement techniques of smart grid enhance resiliency and forecasting as well as offer protection against internal and external threats.

Application presence by country

Uses/Applications	Germany	Finland	Japan	China	USA	UK	Sweden	France	South Korea	Singapore
Smart Substation	□	■	□	□	□	□	□	□	□	□
Feeder Automation	□	□	□	□	■	■	■	■	■	■
Microgrids	■	□	■	■	■	■	■	□	□	■

Application potential by sector

Uses & Applications	Transportation	Industry	Buildings	Electricity Generation	Finance	Public Sector	Main type of energie
Smart Substation	□	■	□	■	□	□	Electricity
Feeder Automation	□	□	□	■	□	□	Electricity
Microgrids	■	■	■	■	□	■	Electricity

Enabling Technologies

Technologies	Load monitor	In home display	Smart thermistat	Smart light	Smart plug/switch	Smart appliance	Hub	Smart meters	AMR/AMI	V2G	EV/PHEV	IED (relays, SCADA...	PMU	WAMS	Smart Sensors	Sensor and actuator	LAN/HAN/NAN/WAN	Cloud	5G	Machine learning	Data mining	Nature inspire	ANN	Multi-agent systems	Clustering	NLP	Digital twin	Autonomous vehicle	Blockhain	Actuators	3D printers
Uses & Applications	Smart home & Smart building							Smart grid							IoT & IoE					Big data, machine learning & AI										Physical action	
Smart Substation	□	□	□	□	□	□	□	■	■	□	□	■	■	■	□	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Feeder Automation	□	□	□	□	□	□	□	□	■	□	□	■	■	■	□	□	■	□	□	□	□	□	□	□	□	□	□	□	□	□	□
Microgrids	□	□	□	□	□	□	□	■	■	■	■	■	■	□	■	■	■	■	□	□	□	□	□	□	□	□	□	□	□	□	□

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1.1 Smart Substation

In this kind of substation, the workstation, protection devices, and low-level transducers are connected together on an optical fiber communications backbone.

Common examples

- In the future it's expected to have a high penetration of distributed resources, which leads to a scenario of bidirectional flows which could bring stability and protection problems. This is why the installation of smart substation is crucial to have a better control and monitoring of the grid.

Opportunities

■■■■■ By improving control and monitoring of substation, its's possible to reduce maintenance and operation costs, reduce the physical space needed, improve personell safety and collect more accurate information.

■■■■■ Better and faster communication technologies allow an adequate response to contingencies.

Information, infrastructure and regulation requirement

- Infrastructure needed for the communication systems.
- It's necessary that National Energy Commission include this technology in its transmission planning plans and in the technical normative.

Barriers

■■■■■ **Economic:** high investment cost; incentives are required.

■■■■□ **Security:** system operation information must be safeguarded.

■■□□□ **Others:** lack of quantification of potential benefits.

Application synergies

- Smart substations are crucial to applications like DER (2.4), Energy storage (2.2) and Microgrids (1.3), in order to have a more reliable and fast communication system.

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Smart Substation

International real application

Iberdrola, one of the world's largest electricity utilities, joined forces with Intel and six other actors to create a new intelligent, open standard for secondary substations. The consortium is embracing the need for better efficiency by developing a Secondary Substation Platform reference architecture that uses Intel CPUs to facilitate the deployment of a standards-based, open, interoperable, and more secure architecture[1].

[1] "Iberdrola anuncia una alianza para acelerar la digitalización de las subestaciones secundarias" Iberdrola, November 11, 2019.

Examples of international goals

🇬🇧 The Smart Grid Enablers project of the British public utility Northern PowerGrid seeks to modernize all its 8,000 substations by 2023.

🇫🇮 The objective is to achieve the joint modernization of the grid to increase the use of renewable energy and abandon the use of fossil fuels.

National key partners and resources

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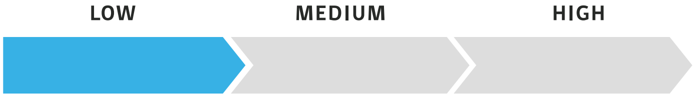
Public policies recommendations to Chile

- Include this kind of projects in the transmission planning plans.
- Define sovereignty of the data explicitly in the regulation.

CURRENT STATUS OF THE APPLICATION IN CHILE



FORECAST OF FUTURE DEMAND FOR THE APPLICATION

1.2 Feeder Automation

FA is the ability to monitor and control the distribution network remotely, to collect and provide information to consumers in a useful manner.

Common examples

- In case of an emergency, like the fall of a tree on a transmission line, thanks to feeder automation it's possible to have a faster detection and perform the necessary procedures (open switches, call emergency institutions, etc.)

Opportunities

■■■■■ Reliability and resilience can be improved by better control and communications systems.

■■■■■ It's possible to recognize the origin of a contingency, which could generate a faster response for its clearance and reduction of failure time.

■■■■□ The information about the state of the grid could be useful to generate changes in DERs configuration according to the needs of the grid.

Information, infrastructure and regulation requirement

- It's necessary to give economic incentives to distribution companies in order to implement this type of equipment.
- There's a lack of regulation that aims to improve quality standards and supply security.

Barriers

■■■■■ **Economic:** current level of digitalization is low, so it becomes very expensive in terms of investment.

■■■■□ **Others:** the need to collect information requires infrastructure that costumers may not want to accept.

Application synergies

- Thanks to the technological advances in the implementation of FA, it's possible to use applications such as DER (2.4) and Energy storage (2.2).

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Feeder Automation

International real application

The Easergy T300 of the European company Schneider, is a remote terminal unit used in low and medium voltage distribution systems. It can reduce outage time by advanced fault detection, communication and automation. It allows to decrease up to 5 times the System Average Interruption Duration Index (SAIDI) and Frequency Index (SAIFI)[2].

[2] "A powerful Remote Terminal Unit for feeder automation".
Available on https://www.se.com/ww/en/product-range-presentation/62399-easergy-t300/

Examples of international goals

- No specific targets were found

National key partners and resources

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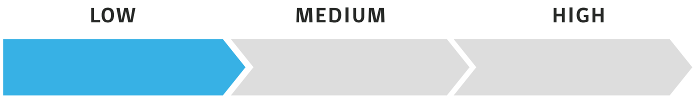
Public policies recommendations to Chile

- Modernize technical normative: adopt common data architecture, tools and standards.
- Encourage investment by private parties in projects associated with digitalization: recognize value-added services.

CURRENT STATUS OF THE APPLICATION IN CHILE



FORECAST OF FUTURE DEMAND FOR THE APPLICATION

1.3 Microgrids

A group of interconnected loads and distributed energy resources (DERs) with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and can connect and disconnect from the grid to enable it to operate in both grid-connected or island modes.

Common examples

- When there is a very remote area, it is expensive to build transmission lines to reach the place, so it is more convenient to build a microgrid that can be self-sustaining.
- Asia Pacific leads the world in microgrid with 9,9 GW installed capacity, followed by North America with 8,8 GW and the Middle East & Africa with 3,6 GW.
- Remote, commercial and industrial microgrids represent nearly 70% of all microgrid capacity globally[2].

[3] "Interesting statistic on global microgrid projects" June 16, 2019,
Availabe on https://www.smart-energy.com/renewable-energy/interesting-statistics-on-global-microgrid-projects/

Opportunities

■■■■■ They are capable of isolating during contingencies, giving continuity of electricity supply to consumers.

■■■■■ They can provide electricity to rural places that are currently disconnected from the main grid.

■■■■□ They can help to reduce electricity bills, by operating in islanded mode in peak demand hours.

Information, infrastructure and regulation requirement

- Installation of distributed resources is required, as well as control and protection devices.
- It's necessary to objectively define the microgrid concept.

Barriers

■■■■■ **Infrastructure:** new infrastructure is needed due to bidirectional power flows, stability and protection problems, coordination with centralized gid, safety, etc.

■■■■■ **Regulatory:** lack of clear definition of microgrid and its obligations.

■■■■■ **Economic:** it depends on the reduction of production costs of renewable generation, storage technologies and energy management systems.

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Microgrids

Application synergies

- Participants of the microgrid could be in a Demand response (2.1) program to operate in island mode in certain hours of the day to get revenues for it.
- By aggregating and coordinating distributed resources it's possible to form a VPP (2.3) and compete with conventional generators.
- It's possible to commercialize energy between microgrids connected to the main grid (P2P (3.1))

International real application

The Renewable Energy Integration Demonstrator – Singapore (REIDS) is the largest hybrid microgrid test and research platform in the tropics. Launched by the Nanyang Technological University Singapore (NTU), supported by the country's Economic Development Board (EDB) and National Environment Agency (NEA), REIDS aims to study, and demonstrate the ability to achieve sustainable, affordable energy access to all parts of Southeast Asia. The REIDS initiative will serve as a model for the planning, deployment, and operation of physical microgrids tapping into the renewable potential in the region.

Examples of international goals

🇺🇸 The target for 2020 is to develop commercial scale microgrid systems (capacity<10MW) capable of reducing outage time of required loads by >98%, while reducing emissions by >20% and improving efficiency by >20%.

🇪🇺 Not specific goal tied directly to microgrids, but they are considered to be an important factor in the energy transition.

National key partners and resources

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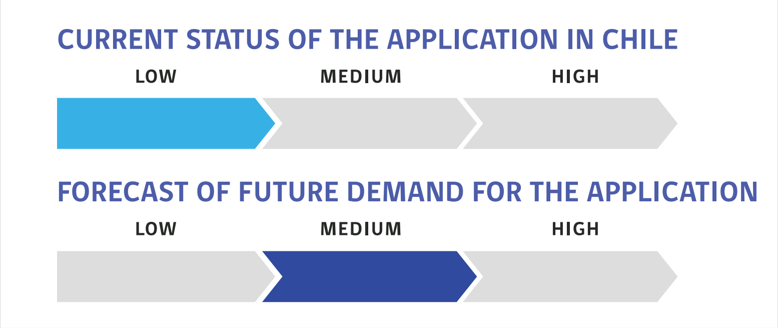
Public policies recommendations to Chile

- Encourage investment by private parties in projects associated with digitalization: recognize value-added services.



CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

2
DER MANAGEMENT

Digitalization in the energy sector in Chile

DSM/DR

Energy Storage

VPP

Distributed Energy

DER Management alludes to the way in which the energy resources distributed in the electrical network are managed, seeking that said management efficiently take advantage of the availability of resources according to the conditions in which the system is found.

Application presence by country

Uses/Applications	Germany	Finland	Japan	China	USA	UK	Sweden	France	South Korea	Singapore
DSM/DR	🟦	🟦	🟦	🟦	🟦	🟦	⬜	⬜	⬜	🟦
Energy Storage	🟦	🟦	🟦	🟦	🟦	🟦	⬜	🟦	🟦	🟦
VPP	🟦	⬜	🟦	⬜	🟦	🟦	⬜	⬜	⬜	🟦
Distributed Energy	🟦	⬜	🟦	🟦	⬜	⬜	🟦	⬜	🟦	🟦

Application potential by sector

Uses & Applications	Transportation	Industry	Buildings	Electricity Generation	Finance	Public Sector	Main type of energie
DSM/DR	🟦	🟦	🟦	🟦	⬜	🟦	Electricity
Energy Storage	🟦	🟦	🟦	🟦	⬜	🟦	Electricity
VPP	⬜	🟦	🟦	🟦	⬜	⬜	Electricity
Distributed Energy	⬜	🟦	🟦	🟦	⬜	🟦	Electricity

Enabling Technologies

Technologies	Load monitor	In home display	Smart thermistat	Smart light	Smart plug/switch	Smart appliance	Hub	Smart meters	AMR/AMI	V2G	EV/PHEV	IED (relays, SCADA...	PMU	WAMS	Smart Sensors	Sensor and actuator	LAN/HAN/NAN/WAN	Cloud	5G	Machine learning	Data mining	Nature inspire	ANN	Multi-agent systems	Clustering	NLP	Digital twin	Autonomous vehicle	Blockhain	Actuators	3D printers
Uses & Applications	Smart home & Smart building							Smart grid							IoT & IoE					Big data, machine learning & AI										Physical action	
DSM/DR	⬜	⬜	🟦	⬜	🟦	🟦	⬜	🟦	🟦	⬜	⬜	⬜	⬜	🟦	⬜	⬜	🟦	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜
Energy Storage	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	⬜	⬜	⬜	🟦	🟦	⬜	⬜	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜
VPP	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	🟦	🟦	⬜	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜
Distributed Energy	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦

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2.1 Demand Side Management(DM)
Demand Response (DR)

Changes by end consumers from their normal electricity consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce less use of electricity at times of high wholesale market prices or when system reliability is compromised.

Common examples

▷ An industry that does not have problems with changing its operating hours (for example a mine), could perfectly participate in a DR program, since it only has to adjust to what is requested by the utility and thus has the possibility of reducing its costs.

Opportunities

■■■■■ Consumers can get financial benefits by reducing or shifting their energy demand.

■■■■■ It improves the reliability of the grid, since transmission element are less stressed.

■■■■□ Reducing electricity when demand is highest often results in lower wholesale prices.

Information, infrastructure and regulation requirement

▷ Users must give permission to access their information.

▷ Smart metering is required.

Barriers

■■■■■ **Economic:** low participation due to low economic incentives and uncompetitive prices for sale of energy to the system.

■■■■□ **Technical:** if an excessive response to demand occurs, this can generate problems in the network

■■■□□ **Security:** given that massive access to system information is needed by users, it becomes more susceptible to attacks; the information needed to implement this technology can be considered sensitive by the users.

■■■□□ **Others:** difficult accessibility to information, especially critical in rural areas.

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Demand Side Management(DM)
Demand Response (DR)

Application synergies

- Microgrids (1.3) users may participate in a DR program in order to get revenues for it.
- Users may have an Energy storage (2.2) system or DER (2.4) to continue with the electricity supply during the hours that network power should not be used according to the DR program.

International real application

BeeBryte, a France and Singapore company, provides cloud-based intelligence software that can monitor real-time load for large commercial and industrial consumers. It uses artificial intelligence for weather forecast, occupancy, usage and energy price signals, the software can automatically switch loads such as HVAC systems to battery storage based on time-of-use charges and delivers up to 40% savings in utility bills[4].

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[4] "International Review of Demand Response Mechanisms in Wholesale Markets", June 2019.

Examples of international goals

The goal is to generate 200 MW of flexible power by 2020, through a response energy system to centrally controlled demand.

National key partners and resources

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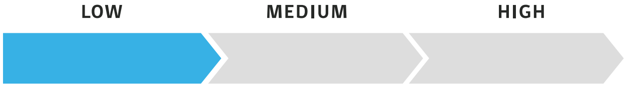
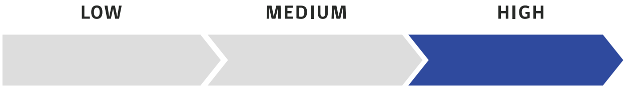
Public policies recommendations to Chile

- There must be a participatory process where each of the agents can intervene and evaluate the proposed regulatory environment and the agents' responsibility need to be well defined.
- The information delivered and the amount of user participation must be limited to avoid threats such as induced blackouts.
- A tariff and tax adjustment are needed to establish a demand management, enabling a variety of hourly price schemes that encourages the user to intervene to reduce peaks.

CURRENT STATUS OF THE APPLICATION IN CHILE



FORECAST OF FUTURE DEMAND FOR THE APPLICATION



2.2 Energy Storage

The conversion of electrical energy from a power network into a form in which it can be stored until converted back to electrical energy.

Common examples

- In addition to traditional storage technologies such as lithium or lead acid batteries, there is the possibility of storing thermal energy in molten salts and then use that heat in a steam turbine and generate electricity.

🇺🇸 The National Renewable Energy Laboratory (NREL) has launched a project aimed at increasing the efficiency of thermal storage to then use the energy to drive a turbine-generator set.

Opportunities

■■■■■ Reduction in conventional technologies due to increased permissible penetration of NCRE's due to increased flexibility in production/consumption offset.

■■■■■ Electric power plants infrastructure reduction due to better exploitation of produced energy in time.

■■■■□ Electric power plants and transmission management improvement due to better consumption peak control efficiency.

■■■□□ Gives flexibility to the system due to the ramp capacity it can deliver.

Information, infrastructure and regulation requirement

- Infrastructure development
- Energy balance framework to full usage of storage availability

Barriers

■■■■■ **Economic:** It's currently not competitive compared to the conventional alternatives due to technologies' higher investment costs.

■■■■□ **Regulation:** the regulation and participation of energy storage in some markets are not fully defined.

■■■□□ **Others:** displacement of conventional generation plants.

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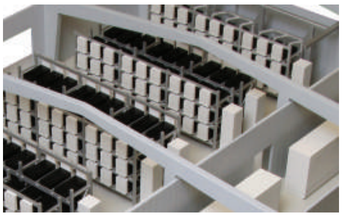
Energy Storage

Application synergies

- Energy storage it's a great ally with DER (2.4), in particular with technologies that use intermittent resources, such as PV panels, wind turbines, mini hydro, etc., since it's possible to stored energy during periods of abundance and use it in scarcity periods.

International real application



Daimler has launched a 13 MW "second use" project in the German town of Lünen, and a 15 MW project in Hanover. It's the world largest second-use battery storage and its build form retired car batteries.

Examples of international goals

The goal is to eliminate the 50 MW limit for this type of project.

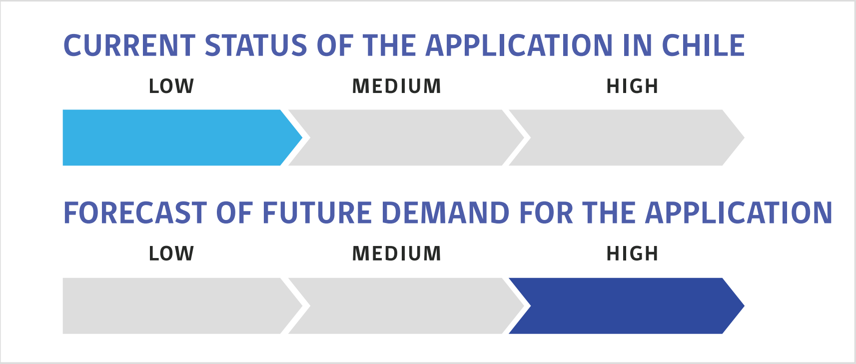
It's expected that by 2035 the costs of storage technologies will have a 50% decreased approximately. Also, incentive schemes for investments in storages related to distributed installations are in place.

The goal is to have 200 MW of energy storage by 2025.

National key partners and resources

Public policies recommendations to Chile

- Establish economic incentives for the participation of flexible resources in energy markets (energy, capacity, and ancillary services) that effectively reflect the value of their flexibility.


CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

2.3 Virtual Power Plant (VPP)

Distributed power plant that aggregates the capacities of various DER in order to participate in operation of the system and the electricity market as a special power plant.

Common examples

▷ If a person owns several properties in different places, and has distributed generation in each of these, it is possible to participate in the wholesale or contract market as a single generator in the form of VPP.

▷ World VPP capacity was almost 4 GW in 2019. Leading the market is Europe, with 2.1 GW under VPP control (mostly through supply-side VPPs), followed by Asia Pacific and North America with 1.1 GW and 0.7 GW under VPP control in 2019, respectively.

Opportunities

■■■■■ They can reduce operational costs by competing with conventional generators thanks to their lower equivalent fuel cost.

■■■■■ They provide opportunities for the development of other digitalization uses such as microgrids, energy storage, DSM, etc.

Information, infrastructure and regulation requirement

▷ Smart metering is required.

▷ Not the same regulations as conventional generators, but special rules for VPP.

Barriers

■■■■■ **Economic:** Infrastructure: internet quality and access by the resources used for VPPs; high computational cost.

■■■■□ **Regulation:** complexity in legal and/or regulatory terms.

Application synergies

▷ By aggregating different elements like Microgrids (1.3), DER (2.4) and Energy storage (2.2), it's possible to form a VPP.

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Virtual Power Plant (VPP)

International real application

Moixa, a UK company, has announced plans to build a virtual power plant made up of solar panels, batteries and electric vehicles (EVs). They will begin installing clean energy infrastructure in 250 council homes, as well as in 100 schools and council buildings in the region. Together these technologies will offer a combined 4 MW of generation and 4,2 MWh of storage capacity.

Examples of international goals

- No specific targets were found

National key partners and resources

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ACERA asociación chilena de energías renovables a.g.
empresas eléctricas A.G.
ACEN Asociación Chilena de Comercializadores de Energía

Public policies recommendations to Chile

- There mut be a regulatory adjustment so that the VPPs can participate in the energy market as they are generators that cannot be regulated under the same parameters as conventional generation.

CURRENT STATUS OF THE APPLICATION IN CHILE

LOW	MEDIUM	HIGH
🟦		

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

LOW	MEDIUM	HIGH
	🟦	

2.4 Distributed energy (electricity/DG and gas)

Energy production applications at or near the point of consumption, which may or may not be connected to the distribution system.

Common examples

- There are different types of distributed generation technologies, such as photovoltaic and wind systems, cogeneration, gas turbine, batteries, etc.

🇺🇸 In 2015 the DER installed capacity was 264 GW and it's expected that in 2025 will be almost 400 GW.

Opportunities

■■■■■ **Economic:** Lower costs thanks to technological advances in this application, such as the decreasing cost of solar panels and energy storage.

■■■■■ **Environmental:** In contributes to climate policies by reducing emissions.

■■■■■ **Security:** Since the energy is produced directly in the consumption points, it allows to decongest the network

Information, infrastructure and regulation requirement

- Smart metering is required
- Subsidies for the incorporation of distributed generation can encourage its adoption.

Barriers

■■■■■ **Infrastructure:** There must be an update of electrical systems in both technical (two-way power flow) and regulatory (tariffs) aspects.

■■■■■ **Economic:** Considerable investment cost.

■■■■□ **Others:** Large amount of information needs to be handled.

Distributed energy (electricity/DG and gas)

Application synergies

- Distributed energy resources are the main part of applications such as Microgrids (1.3) and VPP (2.3). They give them the possibility of disconnecting from the main grid to operate in island mode and to aggregate various DER in order to compete with traditional plants respectively.
- Operating along Energy storage (2.2) systems, it's possible for example to store the excess generated during the day of PV panels and use them at night.
- By installing DER in residential or industrial applications, users become Prosumers (3.1).

International real application

The Tesla's Solar Glass Roof was launched in 2019. It consists in roof tiles that have a 10 kW capacity for a 2,000 square-foot roof and a cost of 42,500 USD[5].

[1] "Solar Roof", Available on https://www.tesla.com/es_mx/solarroof

Examples of international goals

It's estimated that in 2024 the growth of distributed PV could be 50% higher compared to 2019.

The planning goal is having 60 GW of distributed solar energy by 2020 and 15 GW of distributed energy gas.

It's expected to supply more than 15% of the energy from distributed sources.

National key partners and resources

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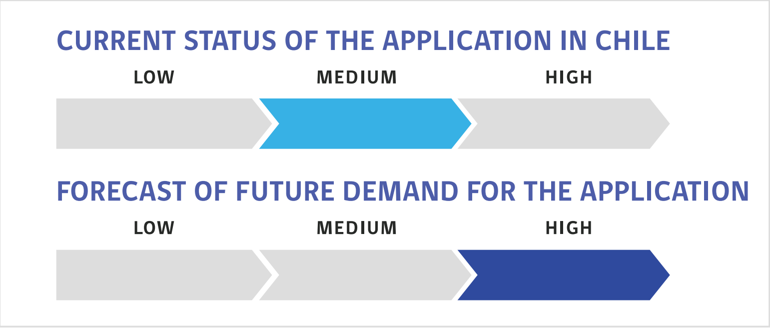
Public policies recommendations to Chile

- Regulatory frameworks for a fair allocation of infrastructure costs. If support from local authorities is added to the above, the incentive is even greater.



3
CUSTOMER DOMAIN

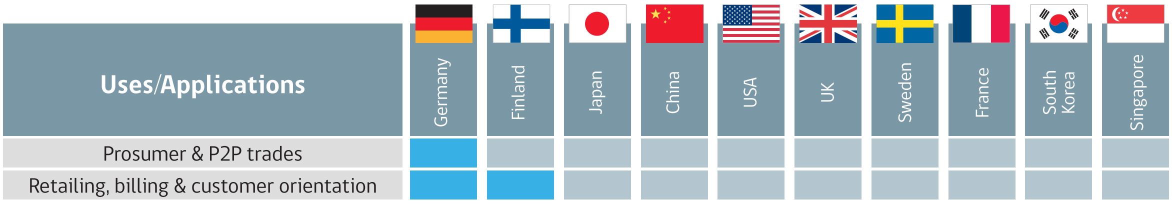
Digitalization in the energy sector in Chile

Prosumer & P2P trades

Retailing, billing & customer orientation

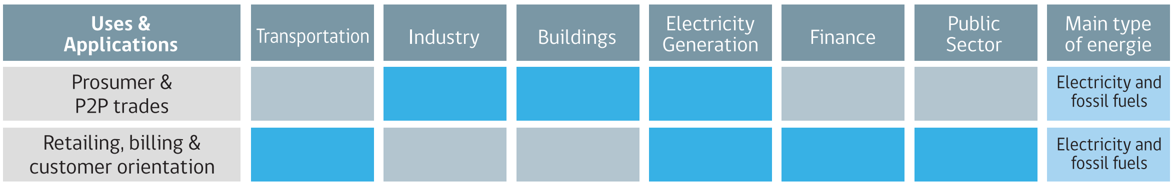
This class contains the uses whose focus is on the end user and how this participates in the system, considering aspects such as billing or the existence of the prosumer as a relevant agent for the energy system.

Application presence by country



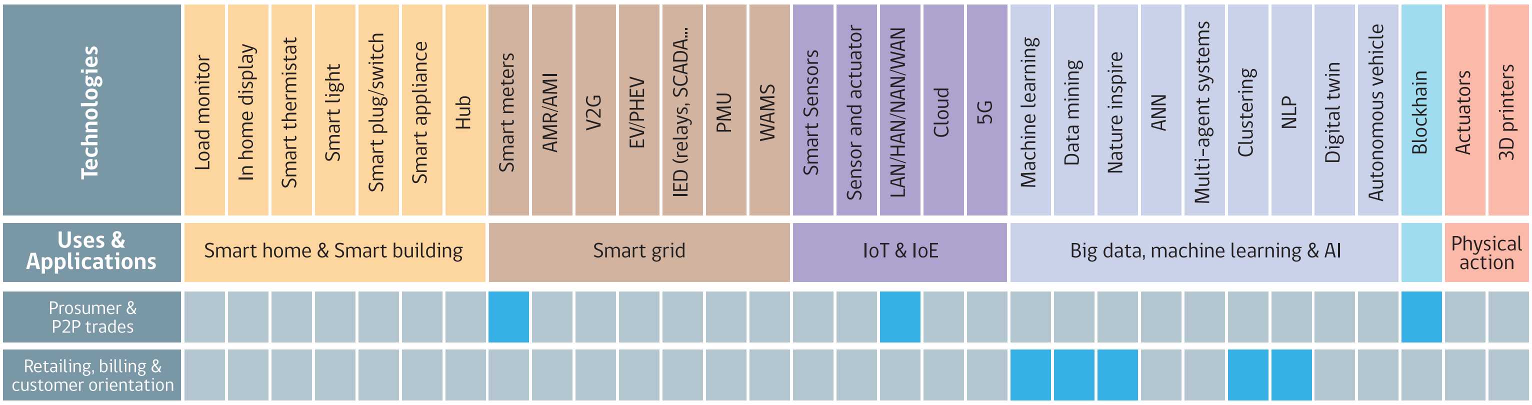
Uses/Applications	Germany	Finland	Japan	China	USA	UK	Sweden	France	South Korea	Singapore
Prosumer & P2P trades	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜
Retailing, billing & customer orientation	🟦	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜

Application potential by sector



Uses & Applications	Transportation	Industry	Buildings	Electricity Generation	Finance	Public Sector	Main type of energie
Prosumer & P2P trades	⬜	🟦	🟦	🟦	⬜	⬜	Electricity and fossil fuels
Retailing, billing & customer orientation	🟦	⬜	⬜	🟦	🟦	🟦	Electricity and fossil fuels

Enabling Technologies



Technologies	Load monitor	In home display	Smart thermistat	Smart light	Smart plug/switch	Smart appliance	Hub	Smart meters	AMR/AMI	V2G	EV/PHEV	IED (relays, SCADA...	PMU	WAMS	Smart Sensors	Sensor and actuator	LAN/HAN/NAN/WAN	Cloud	5G	Machine learning	Data mining	Nature inspire	ANN	Multi-agent systems	Clustering	NLP	Digital twin	Autonomous vehicle	Blockhain	Actuators	3D printers
Uses & Applications	Smart home & Smart building							Smart grid							IoT & IoE					Big data, machine learning & AI										Physical action	
Prosumer & P2P trades	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	⬜
Retailing, billing & customer orientation	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	🟦	🟦	⬜	⬜	🟦	🟦	⬜	⬜	⬜	⬜	⬜

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by the German Bundestag

3.1 Prosumer & P2P trades

Prosumer means generator and consumer, e.g., household with photovoltaic units. Peer-to-peer energy (P2P) trading is the buying and selling of energy between two or more grid-connected parties.

Common examples

- P2P energy trading platforms such as blockchain will allow consumers to share their excess energy amongst one another and control how it's distributed through the grid. Using blockchain, all transactions are public and once on the blockchain cannot be altered in any way creating full transparency.

Opportunities

■■■■■ It contributes in terms of flexibility or balance, from an economic point of view.

■■■■□ Those without solar panels are still able to access renewable energy at a reasonable price from their neighbors.

■■■■□ Encourage the participation of citizens in existing or new markets.

Information, infrastructure and regulation requirement

- Updating the laws that encourages this participation is required.
- Smart meter required

Barriers

■■■■■ **Others:** Lack of participation

■■■■■ **Infrastructure:** Dependence on an internet connection with a highly secure system.

■■■□□ **Security:** The sovereignty of the information processed must be determined and who or whom would have access to said information must be defined; there must be a cybersecurity system capable of dealing with possible attacks.

Application synergies

- In order to have the prosumer status it's necessary to have DER (2.4) to inject power to the main grid.
- Prosumers can be in DSM (2.1) programs in order to get revenues for injecting/consuming in certain hours of the day.
- P2P trades would be impossible without smart grid technologies such as Feeder automation (1.2) or Smart substation (1.1).

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Prosumer & P2P trades

International real application

Power Ledger

Power Ledger is an Australian technology company that has developed a blockchain-enabled peer-to-peer renewable energy trading platform. The platform facilitates the buying and selling of renewable-generated electricity in real time, enabling users with solar panels to trade their excess solar energy with their neighbors. Currently, it has 22 projects across eight countries including Australia, the United States, Italy and Thailand.

Examples of international goals

▷ Check goals of DER to know more in terms of penetration level.

🇫🇷 Lack of participation seeks to be solved with incentives through taxes, fees or the promotion of other measures, such as energy storage.

🇩🇪 In order to move towards a more modern energy matrix, there are important gaps such as the improvement of the feed-in-tariff or upgrades to the "Act on the Digitization of the Energy Transition" which obliges users to generate more than 1kW from solar energy to install a smart meter on their own.

🇸🇪 It's necessary to overcome the lack of a clear objective and increase the limit of 255kW for the tax exemption.

National key partners and resources

Ministerio de Energía – Gobierno de Chile

COORDINADOR ELÉCTRICO NACIONAL

CNE COMISIÓN NACIONAL DE ENERGÍA

empresas eléctricas A.G.

Public policies recommendations to Chile

▷ Promote the entry of prosumers to the electricity market, incorporating economic incentives (taxes, tariffs) or the promotion of other complimentary measures (e.g. energy storage).

CURRENT STATUS OF THE APPLICATION IN CHILE

LOW	MEDIUM	HIGH
●		

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

LOW	MEDIUM	HIGH
		●

3.2 Retailing, billing & customer orientation

Retailing: Retailers trade power to consumers and may aggregate or broker DER between market or consumers in the future. Most are connected to a trading organization to allow participation in the wholesale market. Billing: Managing consumer billing information, sending billing statements, and processing received payments. Customer orientation applications use a variety of digital technologies and mostly aim at providing a benefit to the customer, which in some cases could be monetized by the service provider. These applications offer additional benefits to the user and increase revenues.

Common examples

- If a client wants the energy s/he is consuming to be only of renewable origin, through the retail market it is possible to deliver this type of services

Since 2001, the Energy Market Authority (EMA) has progressively opened the retail electricity market to competition. Their options are to buy electricity from: (i) An electricity retailer; or (ii) The wholesale electricity market; or (iii) (Default) SP Group at the regulated tariff. The Open Electricity initiative includes digital services oriented to help users to make informed decisions, for instance, an online price comparison tool.

Since the French electricity and natural gas markets were fully opened up to competition on the 1st of July, 2007, consumers have been free to choose their energy supplier. The non-residential market is much more open (36% of sites pay market rates) than the residential sector (where just 19% of homes pay market rates).

Opportunities

■■■■□ This use entails an improvement in the user experience, through a feeling of closeness and transparency on the part of the electricity companies.

Information, infrastructure and regulation requirement

- Smart meters are necessary to participate in energy retail market.
- Information given to customers must be clear in order to maintain a good relation with them.

Barriers

■■■■■ **Regulatory:** A regulatory reform is required that must be tailored to the reality of each country in order to ensure competition in the retail energy market.

■■■■□ **Security:** Information must be safeguarded.

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Retailing, billing & customer orientation

Application synergies

- Improvement of user experience and engagement in this and other uses (e.g., EV (5.1), DSM (2.1)).
- With Process optimization & automation (4.1) it's possible to automate certain processes in order to improve customer experience.

International real application

Community choice aggregators (CCA) it's a way to participate in the retail market, in which local entities in the United States aggregate the buying power of individual customers within a defined jurisdiction in order to create large contracts with generators, something individual buyers may be unable to do. Marin County launched California's first CCA program, Marin Clean Energy (MCE), on May 7, 2010, offering 60%-100% renewable energy at competitive and stable rate. The CCA provides electricity service to more than 480,000 customers[6].

MCE | My community. My choice.

[6] Marin Clean Energy, Available on https://www.mcecleanenergy.org/

Examples of international goals

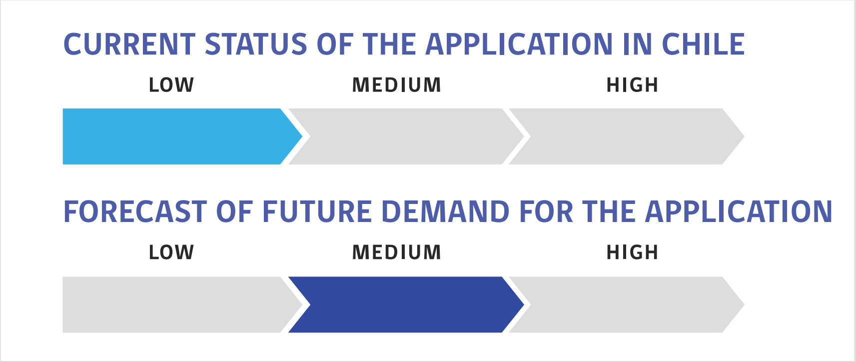
- No specific targets were found

National key partners and resources

Ministerio de Energía, Gobierno de Chile | COORDINADOR ELÉCTRICO NACIONAL | SEC SUPERINTENDENCIA DE ELECTRICIDAD Y COMBUSTIBLES | empresas eléctricas A.G.

Public policies recommendations to Chile

- Regulation must be updated in order to allow retail competition.
- Promote the implementation of smart meters to facilitate the introduction of this type of schemes and to improve the quality of customer service.



4
PROCESS MANAGEMENT

Digitalization in the energy sector in Chile

Process Optimization & Automation

Emission monitoring

This class is associated with uses whose objective is to improve processes associated with energy generation and / or consumption and also for internal processes.

Application presence by country

Uses/Applications	Germany	Finland	Japan	China	USA	UK	Sweden	France	South Korea	Singapore
Process Optimization & Automation	⬜	⬜	⬜	⬜	🟦	🟦	⬜	⬜	⬜	⬜
Emission monitoring	⬜	⬜	🟦	⬜	🟦	🟦	⬜	⬜	🟦	⬜

Application potential by sector

Uses & Applications	Transportation	Industry	Buildings	Electricity Generation	Finance	Public Sector	Main type of energie
Process Optimization & Automation	🟦	🟦	🟦	🟦	⬜	⬜	Electricity and fossil fuels
Emission monitoring	⬜	🟦	⬜	🟦	⬜	⬜	Fossil fuels

Enabling Technologies

Technologies	Load monitor	In home display	Smart thermistat	Smart light	Smart plug/switch	Smart appliance	Hub	Smart meters	AMR/AMI	V2G	EV/PHEV	IED (relays, SCADA...	PMU	WAMS
Uses & Applications	Smart home & Smart building							Smart grid						
Process Optimization & Automation	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜
Emission monitoring	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜

Technologies	Smart Sensors	Sensor and actuator	LAN/HAN/NAN/WAN	Cloud	5G	Machine learning	Data mining	Nature inspire	ANN	Multi-agent systems	Clustering	NLP	Digital twin	Autonomous vehicle	Blockhain	Actuators	3D printers
Uses & Applications	IoT & IoE					Big data, machine learning & AI										Physical action	
Process Optimization & Automation	🟦	⬜	🟦	🟦	⬜	🟦	🟦	⬜	🟦	🟦	⬜	⬜	🟦	🟦	⬜	🟦	🟦
Emission monitoring	🟦	⬜	🟦	🟦	⬜	🟦	⬜	⬜	🟦	⬜	🟦	⬜	⬜	⬜	⬜	⬜	⬜

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4.1 Process optimization & automation

The incorporation of this use entails an improvement in the efficiency of the processes through the deployment of equipment and technology.

Common examples

🇸🇬 Energy Story is a program of the Singapore Ministry of Commerce and Industry, and one of its 4 lines of work is related to the optimization of the electric power generation process using gas as a source, in order to improve the efficiency of the processes through the deployment of equipment and technology.

Opportunities

■■■■■ Reduction of operational costs.

■■■■■ Facilitate continuous productivity throughout the day.

■■■■□ Reduce human errors.

■■■□□ Creation of new job profiles.

■■■□□ Improve costumer experience.

■■■□□ Increase satisfactory levels of employees.

Information, infrastructure and regulation requirement

- Infrastructure is needed to automate processes.
- Constant communication with workers must be maintained during the automation process.

Barriers

■■■■■ **Economic:** high investment cost.

■■■□□ **Human capital:** resistance from employees.

■■■□□ **Others:** limited applicability for some class of problems; increased dependence on non-humans.

Application synergies

- The automation of some processes related to client service could lead to a better costumer orientation (3.2).

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Process optimization & automation

International real application

Xcel Energy (electric and gas utility in US) uses sensor data in wind turbines to develop high-resolution wind forecasts through predictive analytics and artificial intelligence, thanks to which it has been able to reduce costs for end customers by $ 60 million as a result of the increase in generation efficiency.

Examples of international goals

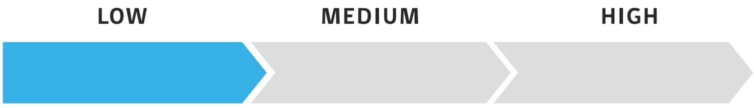
The European Commission stated that artificial intelligence could contribute up to EUR 13.33 trillion to the global economy in 2030.

National key partners and resources

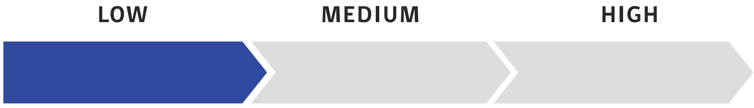
Public policies recommendations to Chile

- Promote digitalization on small and medium companies through economic instruments.
- The incorporation of automation initiatives has to be carried out in an informed manner.

CURRENT STATUS OF THE APPLICATION IN CHILE



FORECAST OF FUTURE DEMAND FOR THE APPLICATION



4.2 Emission monitoring

Emission monitoring refers to detecting, measuring, and avoiding methane emissions. It aims to provide effective monitoring and quantification of emission levels at low cost.

Common examples

- In order to comply with the agreed international treaties regarding the amount of emissions (for example the Paris agreement), it is necessary to have an emissions monitoring system to ensure their correct accounting.

🇺🇸 The US Environmental Protection Agency (EPA) created the Emission Measurement Center (EMC) that provides information on test methods for measuring pollutants from smokestacks and other industrial sources.

Opportunities

■■■■■ It facilitates decision-making and mitigation actions according to the situation and context.

Information, infrastructure and regulation requirement

- Monitoring system infrastructure
- Use of Big Data applications to capture, store and process large amounts of data associated with methane emissions.

Barriers

■■■■■ **Economic:** lack of economic incentives for the main emitters of pollutants; high cost of modernizing monitoring systems.

■■■■■ **Security:** unavailability to access all the necessary information.

Application synergies

One of the sectors where emission monitoring is necessary is mobility (e.g., Personal transport (5.1), Public transport (5.2), Cargo transport (5.3)), in order to make public policies according to the context.

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Emission monitoring

International real application

Eco Analysis Corporation
an Assosiated Company of Fujitsu

Eco Analysis Corporation is a Japanese company that provides environmental monitoring systems that are highly cost-effective and count with total support from system introduction planning through system design, construction, and operation. They also provide environmental analysis data.

Examples of international goals

The goal is to reduce emissions to zero by 2050, and for that, emission monitoring becomes relevant in verifying that the objectives are being met. A better management of uncertainty is also crucial to achieve the desired results with emission monitoring.

Both the USA and Japan seek to reduce emissions to zero by 2050. Just as the United States, Japan has a continuous emissions monitoring system to support the fulfillment of this goal. Despite having emission monitoring systems, the main gap for the objective of this use is the need for a change in people's behavior and business ethics.

National key partners and resources

Ministerio de Energía – Gobierno de Chile
Ministerio del Medio Ambiente – Gobierno de Chile
Ministerio de Transportes y Telecomunicaciones – Gobierno de Chile
SEC – Superintendencia de Electricidad y Combustibles
Ministerio de Vivienda y Urbanismo – Gobierno de Chile
Ministerio de Agricultura – Gobierno de Chile

Public policies recommendations to Chile

- It's necessary to adopt technologies that manage uncertainty in a better way, such as forecasting and predictive analysis.

CURRENT STATUS OF THE APPLICATION IN CHILE

[✓ LOW] MEDIUM HIGH

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

LOW [✓ MEDIUM] HIGH

5
MOBILITY

Digitalization in the energy sector in Chile

- **Transportation for Personal Use**
- **Public Transport**
- **Transport Cargo**
- **Shared Mobility**

This class includes those mobility applications that have incorporated digital technologies in some of their processes. Incorporation of mobility is important as transportation and electromobility are closely associated with energy.

Application presence by country

Uses/Applications	Germany	Finland	Japan	China	USA	UK	Sweden	France	South Korea	Singapore
Transportation for Personal Use	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Public Transport	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Transport Cargo	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦
Shared Mobility				🟦			🟦			

Application potential by sector

Uses & Applications	Transportation	Industry	Buildings	Electricity Generation	Finance	Public Sector	Main type of energie
Transportation for Personal Use	🟦		🟦				Fossil fuels and electricity
Public Transport	🟦						Fossil fuels and electricity
Transport Cargo	🟦						Fossil fuels and electricity
Shared Mobility	🟦						Fossil fuels and electricity

Enabling Technologies

Technologies	Load monitor	In home display	Smart thermistat	Smart light	Smart plug/switch	Smart appliance	Hub	Smart meters	AMR/AMI	V2G	EV/PHEV	IED (relays, SCADA...	PMU	WAMS	Smart Sensors	Sensor and actuator	LAN/HAN/NAN/WAN	Cloud	5G	Machine learning	Data mining	Nature inspire	ANN	Multi-agent systems	Clustering	NLP	Digital twin	Autonomous vehicle	Blockhain	Actuators	3D printers
Uses & Applications	Smart home & Smart building							Smart grid							IoT & IoE					Big data, machine learning & AI										Physical action	
Transportation for Personal Use										🟦	🟦																	🟦			
Public Transport										🟦	🟦																	🟦			
Transport Cargo											🟦																	🟦			
Shared Mobility										🟦	🟦									🟦						🟦	🟦	🟦			

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5.1 Transportation for personal use

Related to the incorporation of digital technologies and electricity in transport for personal use (vehicles, bicycles, motorcycles, scooters, among others).

Common examples

🇰🇷 The Korean New Deal determines that by 2025 there will be 1,130,000 electric cars and 200,000 hydrogen fuel cell cars circulating throughout the country.

Opportunities

■■■■■ It may increase the overall customer satisfaction in urban areas by reducing traffic time.

■■■■■ Reduce de emissions of GHG.

■■■■■ Safer for people as it reduces the probability of accidents with autonomous vehicles and advanced driving assistance systems (ADAS).

■■■□□ Revenues for users of personal electric vehicles from participating in the complementary service market.

Information, infrastructure and regulation requirement

- It's necessary the development of charging points infrastructure to incentive the use of electric vehicles.

Barriers

■■■■■ **Infrastructure:** low market penetration of vehicles equipped with connected vehicle's technology.

■■■■■ **Economic:** the cost of incorporating V2X technology in vehicles is still high (around US $1500 to US $2000 per unit as of 2020).

■■■□□ **Regulation:** lack of regulation that imposes the mandatory incorporation of wireless connectivity in vehicles, to enable the use of road safety applications based on vehicle-to-everything (V2X) communications.

■■■□□ **Others:** lack of consensus about the technology to be massively adopted by vehicle manufacturers.

Application synergies

- Electric vehicles may participate in DSM (2.1) program in order to charge the vehicle in certain hours and get revenues for it.
- Personal transport will be beneficiated by Smart traffic (7.2) and Smart parking (7.6).

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Transportation for personal use

International real application

The Toyota Mirai is a mid-size hydrogen fuel cell vehicle (FCV) manufactured by Toyota, and represents one of the first FCV vehicles to be mass produced and sold commercially. Under the United States Environmental Protection Agency (EPA) cycle, the 2016 model year Mirai has a total range of 502 km (312 mi) on a full tank making the Mirai the most fuel-efficient hydrogen fuel cell vehicle rated by the EPA, and the one with the longest range.

Examples of international goals

The "Road to Zero" strategy establish that the goal is that all new cars have to be electric by 2040, even though there is pressure to meet it by 2030.

The French National Assembly passed the long-time coming Mobility Orientation Law that proclaims a ban on sales of passenger cars and light commercial vehicles running on fossil fuels (petrol, diesel, natural gas, etc.) by 2040, and to outlaw these vehicles from the roads by 2050.

National key partners and resources

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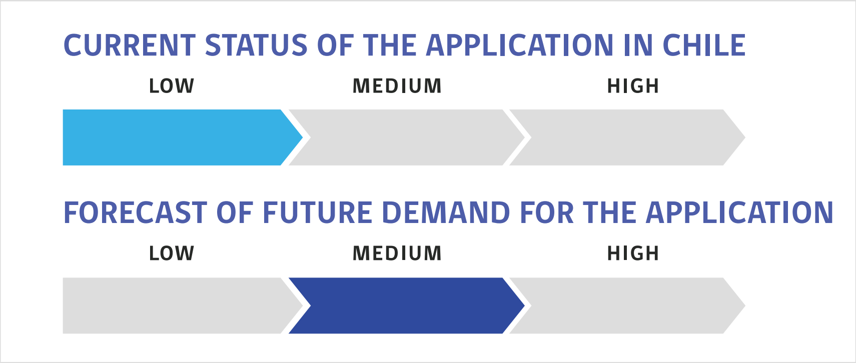
Public policies recommendations to Chile

▷ A major reform of the legal framework that supports the operation of private transportation, including civil and penal responsibilities that involve not only the owner of a vehicle but also the car manufacturer that programs and maintains the "virtual" drivers in every car.



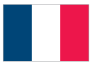
5.2 Public transport

In this context, the application refers to the incorporation of digital technologies and electricity in public transport in all its forms (bus, airline, train, ferry, among others).

Common examples

The European Commission and the German federal government have promoted an electrification plan for the transport system whose joint financing reaches 1,850 million euros until 2031. This injection of money will not only allow the purchase of new electric and hybrid trains and buses, but also for the creation of charging infrastructure throughout the country and the reconstruction of the railway system.

The British government has launched a program that authorities can apply to become the UK's first fully electric bus city. The winning area had up to £ 50 million to help pay for a new fleet of electric buses, reduce emissions and clean the air in their community.



There is a government initiative that aims to improve public transport connections in rural areas of the country. The law also proposes that there would be comprehensive access to information on transport solutions, schedules and rates, both in the city and in the countryside. Also, it is proposed that employers pay their staff a bonus for using more sustainable transportation methods. This initiative even incorporates the legal framework for the integration of autonomous buses.

Opportunities

■■■■■ Improve the experience and increase use of public transport.

■■■■■ Optimize the energy use of public transport.

■■■■■ Lower emissions.

■■■■□ Better fiscalization.

■■■□□ Know travel times more precisely.

Information, infrastructure and regulation requirement

- Infrastructure needed to have a charging network.
- There must be regulations that incentive the use of public transport.

Barriers

■■■■■ **Others:** interoperability and standardization issues.

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Public transport

Application synergies

Public transport will be beneficiated by Smart fleet management (7.8) and Smart traffic (7.2).

International real application

France is integrating new AI tools into security cameras in the Paris metro system to check whether passengers are wearing face masks. The software began a three-month trial in the central Chatelet-Les Halles station of Paris this week. The goal is not to identify or punish individuals who don't wear masks, but to generate anonymous statistical data that will help authorities anticipate future outbreaks of COVID-19.

Examples of international goals

- No specific targets were found

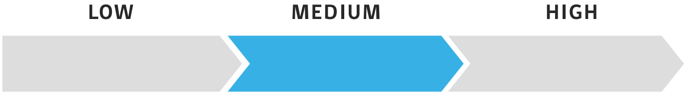
National key partners and resources

Ministerio de Energía – Gobierno de Chile | Coordinador Eléctrico Nacional | CNE Comisión Nacional de Energía | Ministerio de Transportes y Telecomunicaciones – Gobierno de Chile | Metro de Santiago | ACHILA Asociación Chilena de Líneas Aéreas A.G. | Red Metropolitana de Movilidad

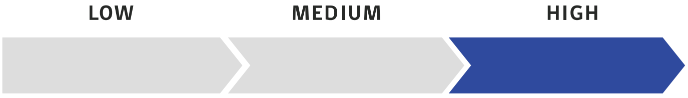
Public policies recommendations to Chile

- Regulation must promote transport modes and applications that benefits society.

CURRENT STATUS OF THE APPLICATION IN CHILE



FORECAST OF FUTURE DEMAND FOR THE APPLICATION



5.3 Transport cargo

It refers to the incorporation of digital technologies and electricity in the commercial transport systems of goods or products.

Common examples

For cargo transportation to mature in the USA, new market strategies are required in electromobility, considering the participation of several players, such as owners of cargo infrastructure or mobility providers (for example, providers of cargo transportation services).

Opportunities/ What problem is solving

■■■■■ Operational cost reduction.

■■■■■ Improving safety for vehicles, pedestrians, and other vulnerable road users

■■■■■ Significant reduction in GHG emissions.

Information, infrastructure and regulation requirement

▷ Infrastructure needed for the creation of a transport network that allow cooperation with the smart grid

Barriers

■■■■■ **Economic:** high cost of vehicles with these technologies.

Application synergies

▷ Considering that freight transport can be scheduled, the intelligent transport network can be combined with the smart grid so that users know when it is convenient to carry out transport or recharge their vehicles. (Energy storage (2.2) and DR (2.1)).

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Transport cargo

International real application

Volvo Trucks has signed a landmark agreement with Brønnøy Kalk AS in Norway to provide its first commercial autonomous solution transporting limestone from an open pit mine to a nearby port. The solution consists of limestone being transported by six autonomous Volvo FH trucks on a five kilometer stretch through tunnels between the mine itself and the crusher[7].

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[7] "Volvo Trucks provides autonomous transport solution to Brønnøy Kalk AS", November 20, 2018. Available on https://www.volvogroup.com/en-en/news/2018/nov/news-3126261.html

Examples of international goals

The smart city Sweden program establishes that in order to meet the goal of zero use of fossil fuels in mobility it's necessary to achieve a greater charging capacity of electric vehicles, for which projects of wireless electric roads are being developed (useful for transporting loads in long distances).

The goal is that vehicles have zero emissions by the year 2040. The UK is currently working on this objective but there are gaps to meet it, some of them are the development of high-performance batteries and charging infrastructure.

National key partners and resources

Ministerio de Energía Gobierno de Chile

COORDINADOR ELÉCTRICO NACIONAL

CNE COMISIÓN NACIONAL DE ENERGÍA

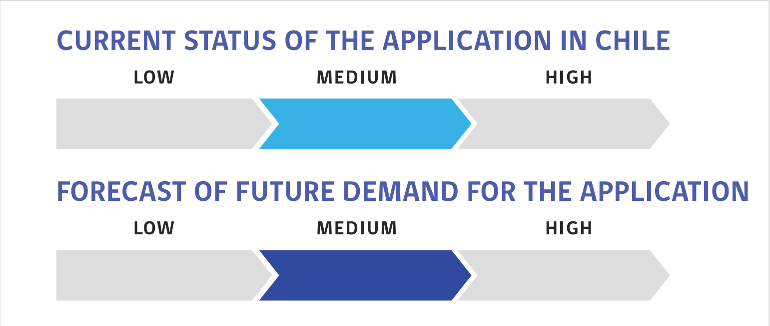
empresas eléctricas A.G.

Ministerio de Transportes y Telecomunicaciones Gobierno de Chile

ACHILA ASOCIACIÓN CHILENA DE LÍNEAS AÉREAS A.G.

Public policies recommendations to Chile

- There must be a regulatory adjustment so that the VPPs can participate in the energy market as they are generators that cannot be regulated under the same parameters as conventional generation.



5.4 Shared mobility

Shared mobility refers to the shared use of electric or non-electric means of transport (vehicles, bicycles, among others), according to the needs of the users.

Common examples

In Germany, the number of people using carsharing has grown rapidly in recent years. As of January 2018, there were 2,110,000 customers registered with 165 car-sharing providers in 677 different German cities and communities.

Shared mobility is considered in UK's "Future of Mobility: Urban Strategy". Currently the adoption of shared mobility alternatives is growing. The number of car club members across the UK increased almost eight-fold between 2007 and 2017, to nearly 250,000 members.

Opportunities

■■■■■ Reducing car ownership.

■■■■□ Reducing gas emissions.

■■■□□ New Business models.

Information, infrastructure and regulation requirement

▷ Infrastructure to have bike and scooter centrals.

Barriers

■■■■■ **Infrastructure:** the need to connect vehicles and users to the internet.

■■■■■ **Economic:** high cost of implementing microcontrollers to bicycles or scooters.

■■■■□ **Regulation:** laws and regulations associated with the entity responsible for the vehicle, insurance, technical reviews, etc. must be defined.

■■■□□ **Others:** there might be mistrust for this service.

Application synergies

▷ Shared mobility will be beneficiated by Smart fleet management (7.8) and Smart traffic (7.2).

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Gobierno de Chile

Federal Ministry for Economic Affairs and Energy

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Shared mobility

International real application

Nextbike is the first and biggest German bike rental and is operating in more than 60 German cities and 25 countries worldwide. It gives the possibility to pay for km or a monthly plan[8].

[8] Nextbike. Available on https://www.nextbike.de/en/

Examples of international goals

No specific targets were found.

National key partners and resources

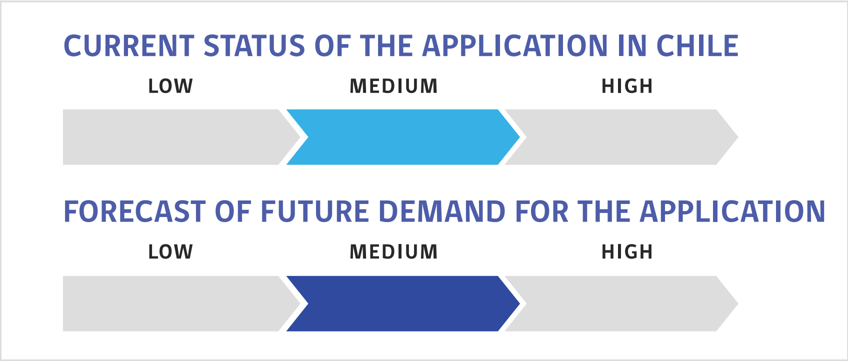
Ministerio de Energía
Gobierno de Chile

CNE COMISIÓN NACIONAL DE ENERGÍA

Ministerio de Transportes y Telecomunicaciones
Gobierno de Chile

Public policies recommendations to Chile

- Flexible regulatory framework, which allows the implementation of shared mobility and the implementation of associated enabling technologies (autonomous vehicle, V2G, EV, among others).


CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

6 DATA MANAGEMENT

Digitalization in the energy sector in Chile

Predictive Maintenance

Forecasting and predictive analytics

This class groups uses oriented to data analysis using Smart Meters and / or AMIs. These uses allow to have a more reliable network for the information and forecasts that they deliver.

Application presence by country

Uses/Applications	Germany	Finland	Japan	China	USA	UK	Sweden	France	South Korea	Singapore
Predictive Maintenance	■	□	□	□	□	□	□	□	□	■
Forecasting and predictive analytics	■	■	□	□	■	■	□	□	□	□

Application potential by sector

Uses & Applications	Transportation	Industry	Buildings	Electricity Generation	Finance	Public Sector	Main type of energie
Predictive Maintenance	■	■	■	■	□	■	Electricity and fossil fuels
Forecasting and predictive analytics	■	■	■	■	■	■	Electricity and fossil fuels

Enabling Technologies

Technologies	Load monitor	In home display	Smart thermistat	Smart light	Smart plug/switch	Smart appliance	Hub	Smart meters	AMR/AMI	V2G	EV/PHEV	IED (relays, SCADA...	PMU	WAMS	Smart Sensors	Sensor and actuator	LAN/HAN/NAN/WAN	Cloud	5G	Machine learning	Data mining	Nature inspire	ANN	Multi-agent systems	Clustering	NLP	Digital twin	Autonomous vehicle	Blockhain	Actuators	3D printers
Uses & Applications	Smart home & Smart building							Smart grid							IoT & IoE					Big data, machine learning & AI										Physical action	
Predictive Maintenance	□	□	□	□	□	□	□	■	■	□	□	■	□	■	□	□	□	□	□	■	□	□	□	□	□	□	■	□	□	□	□
Forecasting and predictive analytics	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	■	□	■	□	■	□	□	□	□	□	□

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6.1 Predictive maintenance

This condition-driven preventive maintenance program uses direct monitoring of the mechanical condition, system efficiency, and other indicators to determine the actual mean-time-to-failure or loss of efficiency for each machine-train and system in the plant.

Common examples

Predictive maintenance is part of Germany's digitization agenda (BDEW, n.d.), within the category of digital services, in which it is mentioned that the gap to reach digitization of products and services is a new corporate culture and a greater capacity for innovation.

In the United Kingdom, maintenance is part of the innovations with artificial intelligence; the gap for their implementation is a greater presence of these technologies (which requires investment) and other related technologies such as technologies for data acquisition in real time (mainly through the cloud).

Opportunities

■■■■■ Significant cost reduction.

■■■■■ Increases supply security by optimally managing equipment maintenance.

Information, infrastructure and regulation requirement

▷ Infrastructure required for data acquisition.

▷ This use involves handling a large amount of information

Barriers

■■■■■ **Infrastructure:** it's necessary to have a greater adoption of technologies (and advances in them) that complement this use (acquisition of data in real time, AI, etc.); more computational resources compared to current maintenance systems; labelling data, can be an exceedingly expensive effort.

■■■■□ **Others:** it relies on historical data that may need to be built up and not necessarily available immediately; Lack of trust, knowledge and understanding of potential benefits.

Application synergies

▷ With a continuous Emission monitoring (4.2) system, it's possible to detect an abnormal situation in order to predict possible maintenance.

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Predictive maintenance

International real application

NextEra Energy (American energy company Fortune 200) applies machine learning to optimize the operating parameters of its fleet of wind turbines, with the aim of maximizing production and performing predictive maintenance, obtaining a reduction of between $ 3 to $ 4 per MWh.

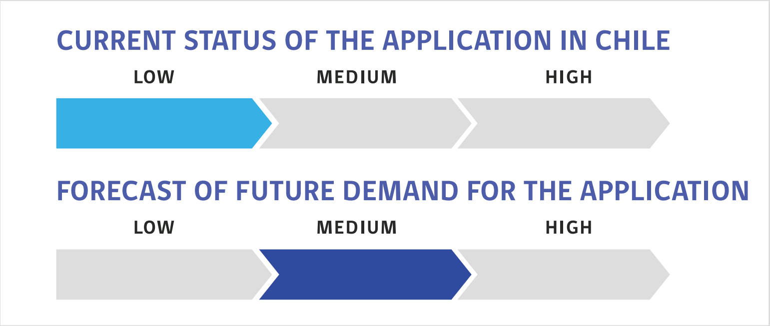
Examples of international goals

The desired state is one where predictive maintenance is mature in the network, so the gap is to achieve greater adoption of this use by adding improvements in its operation using new technologies such as, AI, Cloud Services, IoT, etc.

National key partners and resources

Public policies recommendations to Chile

- Promote policies to increase the public investments in digital infrastructure, build a large-sale ICT infrastructure.
- Promote articulation between the different institutions related to the digitization of the different sectors at the national level.



6.2 Forecasting and predictive analysis

Forecasting is a technique that uses historical data as inputs to make estimates that are predictive in determining the direction of future trends. Predictive analytics is the use of advanced analytic techniques that leverage historical data to uncover real-time insights and to predict future events.

Common examples

🇺🇸 The U.S. Department of Energy has sponsored, in partnership with the National Oceanic and Atmospheric Administration, public, private, and academic organizations, two projects to advance wind and solar power forecasts.

Opportunities

■■■■■ It makes better use of renewable energy sources by being able to feed the algorithms that predict their behavior with data, and thus obtain accurate predictions that allow better planning and operation.

■■■■■ Management of consumers data could lead the policy making process in terms of better understanding of demand elasticity, demand forecasting, consume patterns and responsibilities in the peak hours, etc., these examples apply for electricity, transport and heating.

■■■□□ Labelling data can be an exceedingly expensive effort.

Information, infrastructure and regulation requirement

- Infrastructure required for data acquisition.
- This use involves handling a large amount of information

Barriers

■■■■■ **Economic:** High investment cost for equipment to obtain the relevant data and information.

■■■■□ **Regulation:** there are no external incentives for electrical system operators.

■■■■□ **Others:** historical data may not be easy to obtain.

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Application synergies

- DER (2.5) owners would be interested in a forecasting tool in order to get the highest possible profit.
- By demand forecasting it's possible to manage Demand response (2.1) in a better way.

International real application

Greenbyte is a USA company that has customers in more than 30 countries, and it offers a software platform that help owners of renewables sources to make more informed decisions by using forecasting and predictive analysis[9].

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[9] Greenbyte, Available on https://www.greenbyte.com/about

Examples of international goals

- No specific targets were found

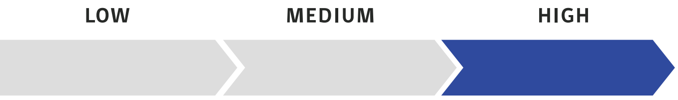
National key partners and resources

Public policies recommendations to Chile

- Reduce the digital gap among the different territories of the country.
- Develop pilot programs to promote the use of different digital applications, involving the public, private sector, and academia sector, which may reduce the barriers of entry of different technologies.

CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION



7
SMART CITY

Digitalization in the energy sector in Chile

- Smart Lightning
- Smart Traffic
- Smart home & building
- Smart industry
- Smart farm
- Smart parking
- Smart waste management
- Smart fleet management

Smart City is a vision of future urban area where smart ICT technologies will connect every major sector of the city through rich features such as the smart economy, smart mobility, smart environment, smart people, smart living, and smart governance.

Application presence by country

Uses/Applications	Germany	Finland	Japan	China	USA	UK	Sweden	France	South Korea	Singapore
Smart lightning		●		●	●		●			●
Smart traffic		●	●	●	●	●			●	
Smart home & building	●		●	●		●	●	●	●	●
Smart industry			●	●	●			●	●	
Smart farm				●		●			●	
Smart parking		●			●					
Smart waste management										
Smart fleet management		●				●				●

Application potential by sector

Uses & Applications	Transportation	Industry	Buildings	Electricity Generation	Finance	Public Sector	Main type of energie
Smart lightning		●	●			●	Electricity
Smart traffic	●	●				●	Electricity and fossil fuels
Smart home & building		●	●				Electricity and fossil fuels
Smart industry		●			●	●	Electricity and fossil fuels
Smart farm		●					Electricity and fossil fuels
Smart parking	●					●	Electricity and fossil fuels
Smart waste management		●	●			●	Electricity and fossil fuels
Smart fleet management	●	●				●	Electricity and fossil fuels

Enabling Technologies

Technologies	Load monitor	In home display	Smart thermistat	Smart light	Smart plug/switch	Smart appliance	Hub	Smart meters	AMR/AMI	V2G	EV/PHEV	IED (relays, SCADA…	PMU	WAMS	Smart Sensors	Sensor and actuator	LAN/HAN/NAN/WAN	Cloud	5G	Machine learning	Data mining	Nature inspire	ANN	Multi-agent systems	Clustering	NLP	Digital twin	Autonomous vehicle	Blockhain	Actuators	3D printers
Uses & Applications	Smart home & Smart building							Smart grid							IoT & IoE					Big data, machine learning & AI										Physical action	
Smart lightning		●		●											●	●	●		●											●	
Smart traffic									●																						
Smart home&building	●	●	●	●	●	●	●	●							●		●	●	●	●											
Smart industry						●									●			●		●	●				●			●			●
Smart farm			●	●	●			●							●		●	●	●	●	●				●					●	
Smart parking								●							●		●	●	●	●											
Smart waste management		●													●		●	●	●	●										●	
Smart fleet management										●	●				●		●	●	●	●								●			

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7.1 Smart lightning

Smart lightning refers to lighting designed for energy efficiency, providing comfort and without neglecting safety. It usually consists of high-efficiency systems, controllers and sensors, in order to manage lighting considering the occupation and the presence of natural light.

Common examples

🇸🇪 Grow Smarter was a project that receives the support of the European Commission in the first call for "Smart cities and communities". Among its lines of work, Smart street lighting stands out because it aims to implement the most successful technology to control a city's lighting program in order to provide optimal lighting for residents while reducing energy use and emissions of CO_2. After 12 months of evaluations the results were between 14.4% and 46% of annual energy savings.

Opportunities

■■■■■ It contributes to energy efficiency.

■■■■□ Improvements in road safety.

Information, infrastructure and regulation requirement

▷ Installation of a remote monitoring and control system is required.

▷ Customers information must be protected.

Barriers

■■■■■ **Economic:** high investment cost.

■■■■■ **Security:** the data of the intelligent lighting system must be safeguarded.

■■■■□ **Others:** it requires the support of citizens.

Application synergies

▷ Through Forecasting and predictive analysis (6.2), it's possible to optimize the use of light by predicting the weather conditions.

▷ DER (2.4) and Energy storage (2.2) may be used in order to have a self-sustainable lightning system.

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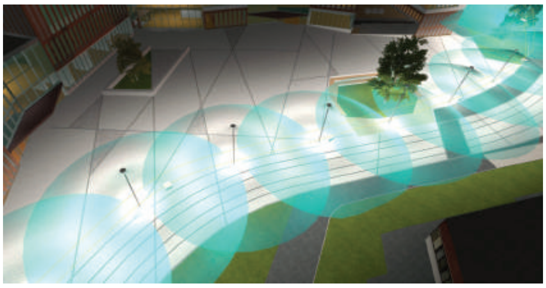
Smart lightning

International real application



LuxTurrim 5G it's a Nokia project that aims to allow viable commercial opportunities for digital services for the smart city environment. The project includes the technical development of the smart light poles with integrated 5G radio technology, different sensors and other devices, as well as modern urban planning and new digital services and business concepts related to security, navigation, smart lighting, climate monitoring, information exchange and publicity.

Examples of international goals

The Singapore Land Transport Authority (LTA) announced that it will intensify its efforts to convert all roads in the city-state to more energy-efficient lighting systems by 2022. To this end, energy-efficient LEDs have been implemented and it is planned to replace the public lighting system with a Remote Control and Monitoring System (RCMS), in order to be able to control street lights remotely in response to lighting needs according to weather conditions.

National key partners and resources

Ministerio de Energía – Gobierno de Chile
CNE Comisión Nacional de Energía
empresas eléctricas A.G.
Subsecretaría de Prevención del Delito – Gobierno de Chile
AMUCH Asociación de Municipalidades de Chile

Public policies recommendations to Chile

- Application of pilot projects that show the benefits for society.
- Consider citizen education plans.
- Develop comprehensive strategic plans that include the implementation of various uses related to Smart City, in order to take advantage of synergistic opportunities and common solutions to detected gaps or barriers.

CURRENT STATUS OF THE APPLICATION IN CHILE

LOW	MEDIUM	HIGH
■		

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

LOW	MEDIUM	HIGH
		■

7.2 Smart traffic

Smart traffic refers to the improvement of vehicular traffic flow using traffic signals and status data (number of vehicles and pedestrians), in addition to keeping travelers informed about the next bus or train in real time through the use of digital signage.

Common examples

🇸🇬 The "smart mobility 2030" program, whose objectives are complemented by this use. Within its objectives is the reduction of traffic congestion and mitigating the impact of accidents on the roads; to achieve this is necessary to renew both fleets and infrastructure, allowing the use of new technologies to implement intelligent traffic.

Opportunities

■■■■■ Contributes to the reduction of emissions thanks to the reduction it implies in travel times.

■■■■□ Increases the well-being of people due to the better functioning of the traffic.

Information, infrastructure and regulation requirement

- Required telecommunications infrastructure and fleet renewal for greater penetration

Barriers

■■■■■ **Infrastructure:** A greater implementation of VANETs and 5G stations is required; renewal of fleets so that more vehicles can participate; lack of capacity to analyze large amounts of data and integration of platforms.

■■■□□ **Others:** not all users will have vehicles capable of interacting with this technology.

Application synergies

- All uses in the mobility class (Private (5.1), Public (5.2), Cargo (5.3) and Shared mobility (5.4)) benefit from smart traffic applications.

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Smart traffic

International real application

Fintraffic is a Finland company specialized to provide and develop traffic control and management services in all traffic forms (air, railway, land and maritime traffic). They're responsible for road traffic management in Finland and they're dedicated to provide and develop services that ensure safe and fluid transportation.

Fintraffic

Examples of international goals

In England there is the National Traffic Control Center (NTCC), whose objectives promote this use. To achieve the desired state of this use, it is necessary to implement VANETs and 5G, technologies that are currently under development by the department for transportation.

National key partners and resources

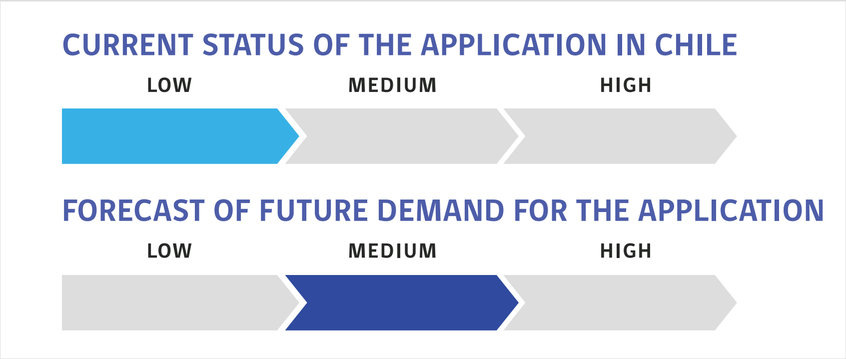
Ministerio de Energía
Gobierno de Chile

CNE COMISIÓN NACIONAL DE ENERGÍA

Ministerio de Transportes y Telecomunicaciones
Gobierno de Chile

Public policies recommendations to Chile

- Support companies for the development of innovation in software related to the efficient management of the city.
- Consider citizen education plans.
- Develop comprehensive strategic plans that include the implementation of various uses related to Smart City, in order to take advantage of synergistic opportunities and common solutions to detected gaps or barriers.



CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

7.3 Smart home & building

A smart home incorporates a communications network that connects the key electrical appliances and services, and allows them to be remotely controlled, monitored or accessed.

Common examples

Of about 117 million U.S. homes in 2016, about 17 million had some type of smart home device. By 2020, 40 million smart thermostats are expected in U.S. homes with 50 million smart light bulbs, and 12 million smart water leak detectors.

Smart home devices are becoming ever more present in UK households. Penetration has reached almost a quarter (23%) with smart speakers (11%) leading the way (Tech UK, 2019). A PWC survey indicated that £10.8 billion will be spent on smart home devices in 2019, in the UK.

The South Korea smart home market is anticipated to exceed US$ 6 Billion by 2025. In the country, household penetration for smart home applications was estimated at 20.6% in 2018.

Opportunities

■■■■■ Increase in the security of supply thanks to the greater control of the network.

■■■■□ Increase in the well-being of people by improving security, commodity, energy efficiency, etc.

Information, infrastructure and regulation requirement

▷ Equipment required in order to monitor and control home applications.

Barriers

■■■■■ **Economic:** high cost of the technology necessary for this use and unclear benefits to consumers.

■■■■□ **Others:** there is no single technology standard established; lack of interoperability.

■■■□□ **Security:** customers may be against to share their data.

Application synergies

▷ Through a smart home application is possible to manage DER (2.4) and check surplus of generation to sell it to the system; also, it's possible to respond to economic signals and participate in a DR (2.1) program.

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Smart home & building

International real application

HomeKit is a software framework by Apple, that lets users configure, communicate with, and control smart-home appliances using Apple devices. By designing rooms, items, and actions in the HomeKit service, users can enable automatic actions in the house through a voice command or through the Home app. The software can control, among others, air conditioners, cameras, doors, lights, locks, speakers, televisions and windows[10].

HomeKit

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[10] Marin Clean Energy, Available on https://www.mcecleanenergy.org/

Examples of international goals

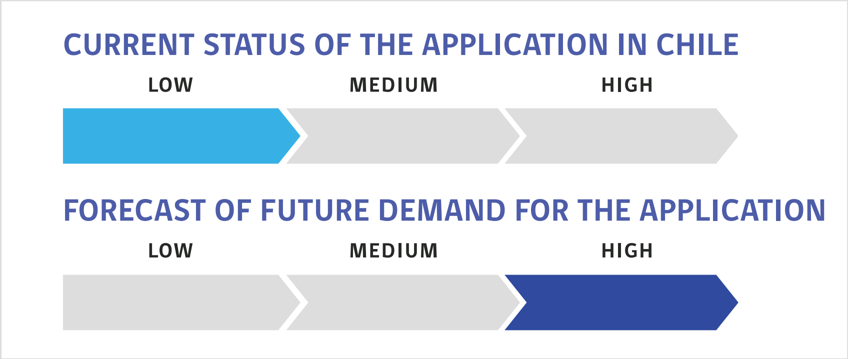
- Develop broad standards in the smart home and building industries.

National key partners and resources

Ministerio de Energía, Gobierno de Chile | CNE Comisión Nacional de Energía | Empresas Eléctricas A.G. | CChC Camara Chilena de la Construccion

Public policies recommendations to Chile

- Consider citizen education plans.
- Develop comprehensive strategic plans that include the implementation of various uses related to Smart City, in order to take advantage of synergistic opportunities and common solutions to detected gaps or barriers.



7.4 Smart industry

Smart Industry seeks to allow easier tracking of transport and logistics flows. It also involves the automation of industrial processes and manufacturing.

Common examples

The Industry of the Future initiative (European Commission, 2017) is transversal and aims to modernize the entire French industry. For this, more than 500 trained experts provided support to more than 7,400 SMEs throughout France between 2016 and 2017. On the other hand, industrial companies have invested around 25,000 million euros a year in R&D since 2016, which represents two thirds of the total R&D expenses contracted by French companies, where the automotive sector has become the engine of innovation, taking 13% of the total.

Opportunities

■■■■■ Improves the efficiency of production processes.

■■■■■ Streamlines administrative processes by incorporating digitization of information.

Information, infrastructure and regulation requirement

▷ Equipment for processes automation.

Barriers

■■■■■ **Economic:** important investments in equipment and training.

■■■■□ **Security:** data might be associated with sensitive information so cybersecurity is crucial.

■■■■□ **Human capital:** lack of personnel trained in data analysis.

■■■■□ **Others:** lack of standardized measurement and verification.

Application synergies

▷ With Process optimization & automation (4.1) it's possible to automate certain processes in order to improve energy efficiency.

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Smart industry

International real application

ABB launched a new generation of robots to be used to automate processes in sectors like electronic, health attention, logistic, food and drink. The robots are intuitively designed so that clients don't need a great knowledge in programming, so they help to unlock industries that today have low levels of automation.

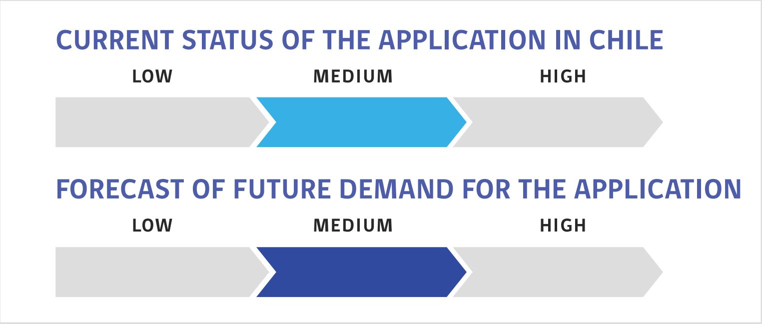
Examples of international goals

The Korean New Deal proposes that by 2025 there will be 15 smart industrial complexes, which will be simulation centers to test manufacturing processes and adopt remote monitoring systems against the emissions of toxic chemicals, using AI and drones. On the other hand, its National Artificial Intelligence Strategy aims to build 100 smart factories by 2022, and 2000 by 2030, which are based on AI, which increases productivity and reduces waste through process optimization. by analyzing digital data using AI.

National key partners and resources

Public policies recommendations to Chile

- It requires state support for those SMEs that cannot make the transition to smart industry, considering their economic capacity and knowledge on the subject.
- High investment cost could be beaten through government intervention by incorporating a tax relief for investment in robotics or information technology for SMEs.



CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

7.5 Smart farm

Smart farm aims to improve water utilization and irrigation by taking advantage of weather forecast and agricultural data, key trends and anomalies, and evapotranspiration index.

Common examples

Smart Farm is part of the government's "Industrial Strategy" which, among other objectives, seeks to boost agricultural productivity through new technologies. For smart farming, the gap between the current and the desired state is the adoption of artificial intelligence and automation in the agricultural industry.

Smart Farming is currently being used in China, taking advantage of advances in big data and even 5G. The use of 5G technologies is an innovation waiting for its breakthrough, because although they have already started to configure 5G stations for smart cultivation, a greater adoption of these stations is expected in the future to optimize production.

Opportunities

■■■■■ It allows the optimization of water use.

■■■■■ It reduces the costs of electricity services thanks to the efficient use of energy.

■■■■□ It increases social welfare thanks to the improvement in the productivity of farms.

Information, infrastructure and regulation requirement

▷ Internet access must be guaranteed in mostly rural areas.

Barriers

■■■■■ **Others:** constant need to have access to the Internet (especially complex in rural communities); since it´s an intervention of highly manual processes, farmers could resist to it and maintain the status-quo.

■■■■□ **Human capital:** lack of knowledge or interest on the part of potential users.

Application synergies

▷ Forecasting and predictive analysis (6.2) could help to predict weather conditions in order to improve plantation performance.

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Smart farm

International real application

The Smart Agri-Systems initiative spearheaded by the University of Leeds seeks to work with farms and businesses to develop solutions, from advanced monitoring technology to big data analytics. Examples of smart farming to be looked at include the incorporation of sensors on the farm, either fixed, or on drones and robotic crawlers. These can monitor soil temperature and humidity, map crop growth and density, assess ground water composition, and track the weather, with data analyzed to project crop performance.

Examples of international goals

The goal is to adopt artificial intelligence and automation technologies in the agricultural industry.

National key partners and resources

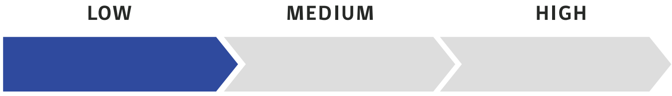
Ministerio de Energía – Gobierno de Chile | CNE COMISIÓN NACIONAL DE ENERGÍA | empresas eléctricas A.G. | Ministerio de Agricultura – Gobierno de Chile

Public policies recommendations to Chile

- Accompany the implementation of any program or initiative by a campaign that aids in justifying the adoption of these uses.
- Support companies for the development of innovation in software related to the efficient management of the city.

CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION



7.6 Smart parking

Smart parking is a system that allows energy saving and the delivery of information in real time to users in order to minimize waiting and circulation times.

Common examples

🇺🇸 In San Francisco, through smarter pricing for parking, the city helps to achieve the right level of parking availability by periodically adjusting meter and garage to match demand. Known as "demand-responsive pricing," this encourages people to park in underutilized blocks and garages, helping to open up spaces in busy areas and at busy times.

Opportunities

■■■■■ It increases the well-being of the population by reducing both the time spent looking for parking and the time that a vehicle is parked.

■■■■□ It helps the authority to supervise the compliance of regulations (vehicular restriction) or in emergencies (stolen cars).

Information, infrastructure and regulation requirement

▷ Cameras and sensors needed to monitor and manage car positions.

▷ Requires a real-time information system.

Barriers

■■■■■ **Regulatory:** a regulatory reform may be needed in order to implement smart parking in populated cities with parking regulation that do not conceive dynamically assigned prices nor spaces.

■■■■■ **Infrastructure:** equipment required for spatial-temporal monitoring of parking space and traffic.

Application synergies

▷ Smart parking helps users of Personal transport (5.1) to find the optimal location to park their cars, based on destination location, parking availability, among others.

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International real application

The US-based company Parkwise develops a phone application using artificial intelligence (AI), which connects drivers through their smartphones, so they are helping each other to find empty parking spots easier. Furthermore, when a driver is about to leave their parking spot, the application notifies other drivers about the free parking space[11].

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[11] "5 top smart parking startups out of 634 in smart cities", July, 2019, Available on: https://www.cleverciti.com/en/resources/blog/5-top-smart-parking-startups-out-of-634-in-smart-cities

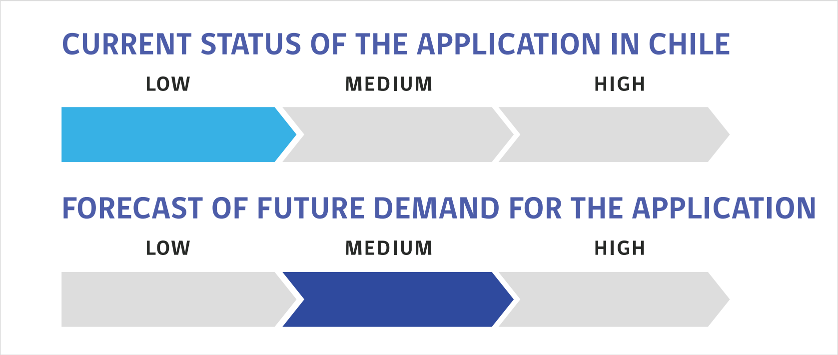
Examples of international goals

- No specific targets were found.

National key partners and resources

Public policies recommendations to Chile

- Support companies for the development of innovation in software related to the efficient management of the city. Application of pilot projects that show the benefits for society.



7.7 Smart waste management

Smart waste management refers to the use of sensors and connectivity between garbage containers to monitor the level of garbage inside and improve collection routes, in order to generate cost savings, reduce CO2 emissions from trucks and increase the satisfaction of citizens.

Common examples

🇩🇰 The Waste Management Plan (WMP) is a framework for actions related to waste aimed at citizens, businesses and the municipality of Kolding. This plan has a focus on zero waste and circular economy, and involves the refurbishment of commercial buildings, educating the population on the subject, among others.

Opportunities

■■■■■ This use brings with it an improvement in the well-being of people thanks to the efficient management of waste (visual and odor pollution).

■■■■□ Automated categorization of waste.

■■■□□ Route optimization of waste pick-up trucks.

Information, infrastructure and regulation requirement

▷ Equipment to monitor fill rate, location, usage, etc. and for categorization of waste.

Barriers

■■■■■ **Regulatory:** High investment cost

■■■■□ **Human capital:** it requires an awareness program for citizens, regarding the problem of emissions and the importance of its monitoring and incorporation of mitigation measures.

■■■■□ **Regulatory:** lack of regulatory and market pressures.

■■■□□ **Others:** high computational cost.

Application synergies

▷ When optimizing waste pick-up trucks routes, it's possible to contribute in the Smart traffic (7.2).

Smart waste management

International real application

The Track 1000 of the Belgian company Sensolus is a sensor and a tracker that has to be attached to the waste container and through a mobile app gives information of containers occupation, pick up schedule, recycling points, among others.

Examples of international goals

🇩🇰 The goal of WMP is to achieve a high level of recycling: from 25% in 2013 to 50% by 2022.

National key partners and resources

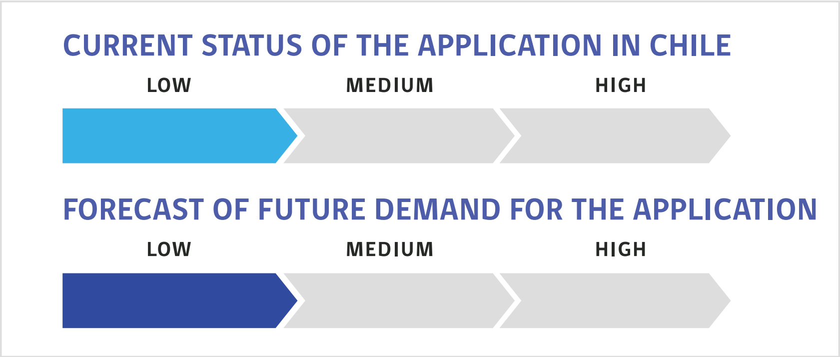
Ministerio de Energía
Gobierno de Chile

Ministerio del Medio Ambiente
Gobierno de Chile

AMUCH
ASOCIACIÓN DE MUNICIPALIDADES DE CHILE

Public policies recommendations to Chile

- Promote awareness program for citizens.



7.8 Smart fleet management

This application addresses several specific challenges of controlling fuel and maintenance expenses, driver and passenger safety, and providing good customer service. Smart cities can employ fleet management solutions to manage the vehicles in their fleet more efficiently and analyze the causes of traffic congestion through the data captured by those vehicles.

Common examples

Within the "Smart Mobility 2030" program, the Intelligent Fleet Management System is considered, whose goal is to integrate and simplify resource management, together with improving productivity and quality of service. The gap in achieving these improvements is the integration of information from different bus operators, as well as greater integration of sensors and location-based services.

Opportunities

■■■■■ Reduction of fuel consumption.

■■■■■ Reduction in operating costs.

■■■■■ Reduction of traffic congestion.

Information, infrastructure and regulation requirement

▷ New technologies and algorithms required to optimize routes and occupation.

Barriers

■■■■■ **Technical:** It considers an important penetration of sensors.

■■■■■ **Security:** Sovereignty of the information processed must be determined

Application synergies

▷ Smart fleet management is crucial to optimize Public transport (5.2) systems (buses, subways, airplanes, etc.) in order to improve the quality of life of users.

▷ Transport cargo (5.3) get benefices from smart fleet management, since it gives the possibility to manage different kind of transport to reduce costs and times both on and off the route.

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Smart fleet management

International real application

Avnet is a distributor of electronic components based in Arizona and it offers a real-time fleet monitoring service that includes optimal routing, engine data sensors, vehicle's idling time, among others.

Examples of international goals

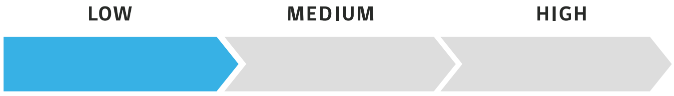
As in smart traffic, this use is for the objectives of the NTCC, whose gap between the current and desired state is the implementation of VANETs (vehicle ad hoc networks) and 5G stations.

National key partners and resources

Public policies recommendations to Chile

- Develop comprehensive strategic plans that include the implementation of various uses related to Smart City, in order to take advantage of synergistic opportunities and common solutions to detected gaps or barriers.

CURRENT STATUS OF THE APPLICATION IN CHILE



FORECAST OF FUTURE DEMAND FOR THE APPLICATION

8
OTHER USES

Digitalization in the energy sector in Chile

- Market Management & Operation
- Ancilliary Services
- Energy Management
- Operation (Monitoring Control/Reporting)
- Teleworking

Application presence by country

Uses/Applications	Germany	Finland	Japan	China	USA	UK	Sweden	France	South Korea	Singapore
Market Management & Operation	●				●					
Ancilliary Services				●	●	●				
Energy Management	●		●			●	●	●		
Operation (Monitoring/ Control/Reporting)					●	●				
Teleworking	●	●	●	●	●	●	●	●	●	●

Application potential by sector

Uses & Applications	Transportation	Industry	Buildings	Electricity Generation	Finance	Public Sector	Main type of energie
Market M&O				●	●		
Ancilliary Services	●	●	●	●			Electricity
Energy Management	●	●	●	●			Fossil fuels and electricity
Operation				●			Electricity
Teleworking	●	●	●	●		●	Fossil fuels and electricity

Enabling Technologies

Technologies	Load monitor	In home display	Smart thermistat	Smart light	Smart plug/switch	Smart appliance	Hub	Smart meters	AMR/AMI	V2G	EV/PHEV	IED (relays, SCADA…	PMU	WAMS
Uses & Applications	Smart home & Smart building							Smart grid						
Market M&O														
Ancilliary Services	●											●	●	●
Energy Management	●	●						●	●					●
Operation								●	●			●	●	●
Teleworking		●												

Technologies	Smart Sensors	Sensor and actuator	LAN/HAN/NAN/WAN	Cloud	5G	Machine learning	Data mining	Nature inspire	ANN	Multi-agent systems	Clustering	NLP	Digital twin	Autonomous vehicle	Blockhain	Actuators	3D printers
Uses & Applications	IoT & IoE					Big data, machine learning & AI										Physical action	
Market M&O					●	●									●		
Ancilliary Services	●	●	●	●	●											●	
Energy Management			●	●	●	●										●	
Operation	●	●	●			●			●						●	●	
Teleworking			●	●	●								●				●

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8.1 Market management & operation

Market managers include independent system operators (ISOs) for wholesale markets and forward markets in various ISO/regional transmission organizations (RTOs) regions. Market operators help with the smooth functioning of the market, and their functions include price quotation streams, balancing, audit, financial and goods sold clearing, and more.

Common examples

By managing the market it's possible to add new actors in order to have more competition; for example, adding the figure of the retailer, consumers can decide on the option that best suits them, in terms of energy price, power source, DR programs etc.

Opportunities

■■■■■ It promotes innovation by including different actors into the market.

■■■■■ Improvement of supply security by the complementary services market.

Information, infrastructure and regulation requirement

- Regulation update needed to allow new actors and new instruments to monitor market.

Barriers

■■■■■ **Economic:** low or no market incentive for companies to incorporate new technologies and business models or prioritize customer choice; high entry barriers for participation in the wholesale and retail market of DER and third-party energy service providers.

■■■■□ **Security:** it requires a cybersecurity system to accompany it in order to prevent and better respond to possible attacks and interruptions.

■■■□□ **Others:** No incentives or requirements for companies to share electricity data.

■■□□□ **Regulation:** competition at the wholesale level varies from state to state and regions.

Application synergies

- DER (2.4), Energy storage (2.2) and VPP (2.3) could be beneficiated by the digitalization of market management since it could allow their participation in order to massify their uses.
- The digitalization of market management is necessary to make applications like DR (2.1) and P2P (3.1) a reality.

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Market management & operation

International real application

The IDE4L project developed digital tools that allow the flexible demand to be integrated into the market, considering the technical limitations of the network in the market operation.

IDE4L ideal grid for all

Examples of international goals

- No specific targets were found.

National key partners and resources

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CNE COMISIÓN NACIONAL DE ENERGÍA

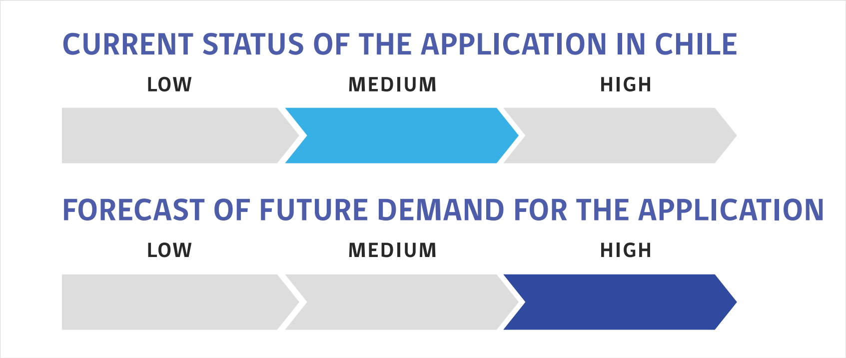
empresas eléctricas A.G.

SEC SUPERINTENDENCIA DE ELECTRICIDAD Y COMBUSTIBLES

TDLC Tribunal de Defensa de la Libre Competencia

Public policies recommendations to Chile

- Determine strategies to remove barriers and facilitate new markets, allow new transactions and empower consumers.



8.2 Ancillary services

Enable a market to provide spinning reserve, voltage support, frequency support, and other services. Through these ancillary services, the aim is to give greater stability and robustness to the network.

Common examples

Ancillary services can include:

- Frequency regulation, which is a service that corrects for short-term changes in electrical imbalances that might affect the stability of the power system.
- Contingency reserves, which are used to respond to an unexpected failure or outage of a system component, such as a generator, transmission line, circuit breaker, switch or other electrical element.
- Black-start regulation, which supplies electricity for system restoration in the unlikely event that the entire grid loses power.

Opportunities

■■■■■ It reduces the time without supply.

■■■■□ It leads to new business models.

Information, infrastructure and regulation requirement

- It's necessary to update the existing infrastructure to increase its computational capacity for its correct implementation in the market.

Barriers

■■■■□ **Others:** It's necessary to have generation forecast information or the response on demand suggest that the ancillary services should be able to work in conjunction with these applications.

■■■□□ **Regulatory:** changes should be considered to make it easier for new agents to enter the complementary services market.

■■□□□ **Economic:** It's required to correctly define the associated payments, so that there is a correct remuneration associated with the provision of these services.

Application synergies

- The integration of DER (2.4) requires ancillary services, considering the variability of renewable energies, in addition to the versatility provided by Energy storage (2.2) and EVs (5.1).
- A Microgrid (1.3) or a VPP (2.3) could participate in ancillary service markets, such as frequency and voltage regulation.

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Ancillary services

International real application

NEMOCS, by the company Next Kraftwerke is a VPP software that allows to connect, monitor and control decentralized power producers, consumers and storage systems. It allows prosumers to participate in ancillary services by adjusting power production, consumption and storage systems depending on grid requirements. In addition to this, the control system displays external data like grid frequency or market prices and their respective market value.

Examples of international goals

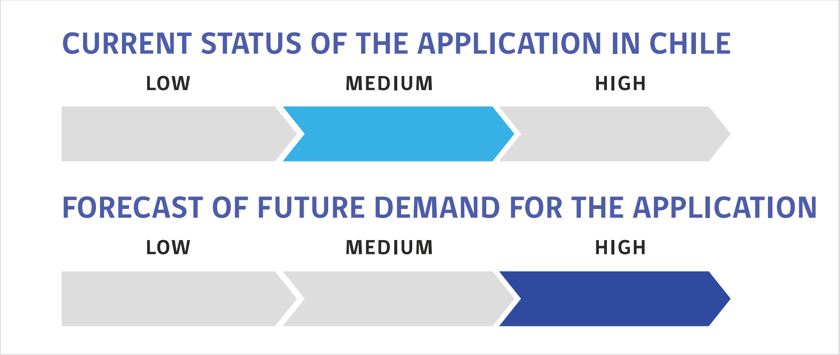
The "Smart Grid Vision and Routemap" intends to establish a framework of standards that form the basis of an intelligent network for all residential homes, industrial warehouses and associated buildings; within this framework of regulations this use should be considered.

In the Chinese case, the modernization of the network aims to facilitate the incorporation of NCRE. For this purpose, the ancillary services become relevant thanks to the robustness they give to the network. In "Regulatory pathways for smart grid development in China" gaps are mentioned, being the one that best fits to this use the development of technologies for updating the distribution network and a greater insertion of energy storage (as an ancillary service).

National key partners and resources

Public policies recommendations to Chile

- Promote the adoption of a common data architecture, tools, and standards to reduce bugs and raise the quality, reliability, and security of devices and services, and that facilitates economies of scale and data sharing across different institutions.



8.3 Energy management

Energy management functions may be inclueded in IHDs (In Home Displays) to, among others, inform the consumer about energy cost and usage, and responsiveness to price signals on the basis of consumer-entered preferences. It includes the connection of thermostats in buildings or sophisticated heating, ventilation and air conditioning (HVAC) management systems in homes, offices, public buildings and shopping centers.

Common examples

The revenue in the South Korean Smart Home Energy Management segment reached US$170 Million in 2018. Energy management is one of the key factors driving the Smart Home industry.

Opportunities

■■■■■ Greater savings in energy consumption.

■■■■■ Reduction of the price of energy.

■■■■□ It implies a promotion of innovation.

Information, infrastructure and regulation requirement

- Efficient system needed to have an effective energy management.
- Regulation about data privacy required.

Barriers

■■■■■ **Economic:** reduction in energy bills needs to meet users' expectations.

■■■■■ **Human capital:** users need to learn about the management system, which represents a one-time investment.

■■■■■ **Security:** users could be subtracted from this application due to suspicions about the use that could be given to their information.

Application synergies

- The IoT and the growing number of products and services offered by private companies associated with Smart homes (7.3) (Amazon, Apple, Microsoft, etc.) bring opportunities for the energy management system, providing it with a greater number of devices to control and extract information.
- Electrification of heat and applications such as Smart lighting (7.1) complement energy management in order to facilitate the entry of this use.

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International real application

EcoFactor is a cloud-based home energy management platform providing services to utilities and home service providers. It has 3 principal services: Proactive energy efficiency, that uses data collected from Internet-connected thermostats to run energy algorithms, and automatically minimizes consumer energy consumption; Optimized demand response, that based on consumption patterns gives the best DR program; HVAC performance monitoring, that with analytics algorithms and pattern recognition can be used to identify lapses in HVAC performance and notify consumers early.

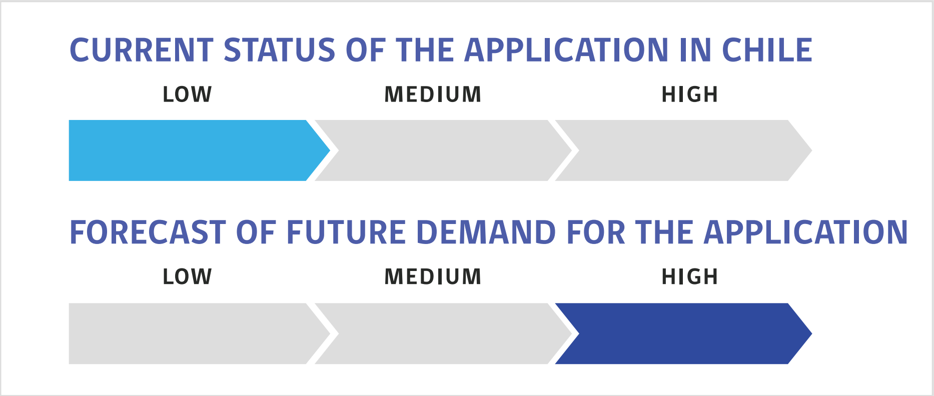
Examples of international goals

- No specific targets were found.

National key partners and resources

Public policies recommendations to Chile

- Increase the public investments in digital infrastructure, build a large-sale ICT infrastructure, including massification of 5G and AI technology.


CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION

8.4 Operation (monitoring/control/reporting)

Monitoring: Supervises network topology, connectivity and loading conditions, including breaker and switch states, as well as control equipment status. Control: Supervise wide area, substation and local; carry out automatic or manual control. Reporting: Operational statistics and reporting roles, archive online data, and perform feedback analysis about system efficiency and reliability.

Common examples

In the document "Cyber Physical System for the Energy Transition" it is said that digitalization will enable the development of a new set of tools in control rooms that can offer the operator a whole new level of hyper-vision and automation, from two days ahead up to real time, to face a context of an increasing number of uncertainties and interlinkages.

Opportunities

■■■■■ Cost reductions.

■■■■■ Reduction of times without energy supply.

■■■■□ Increase supply security.

Information, infrastructure and regulation requirement

- Measurement and control infrastructure needed.

Barriers

■■■■■ **Security:** reports could generate conflicts in users if they include information from users who use distributed resources.

■■■■■ **Regulatory:** delay in its implementation due to the legislative processes or the creation of necessary regulations in each country.

Application synergies

- The increase in DER (2.4) in the network gives coherence and support to the inclusion of these technologies, in addition to ad-hoc networks and the IoT can facilitate the use of these technologies

- Advances in Predictive maintenance (6.1) in conjunction with this use will allow significant cost reductions, and reduction of times without energy supply, and increased supply security.

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Operation (monitoring/control/reporting)

International real application

The Catapult report sponsored by the Department for Business, Energy & Industrial Strategy, Ofgem and Innovate UK, provides a series of recommendations on how to harness the power of data in the British energy system. The document recognizes the operational benefits of the digitization of the energy system, referring to solutions that combine strategic monitoring with data science, analysis and modeling to maximize the value of the investment, instead of relying solely on the massive deployment of equipment. The report repeatedly recommends that in addition to regulatory interventions there should be long-term data strategies on the part of organizations.

Examples of international goals

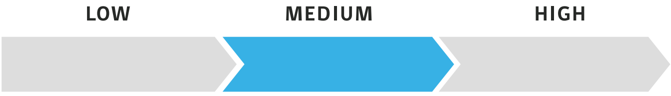
In the "Cyber Physical System for the Energy Transition" document, "System operation" is one of the five layers in the digital grid concept. The policy objectives highlighted in this document that analyze more than 100 projects in the ENTSO-S domain are: 1) At least 40% cuts in greenhouse gas emissions (from 1990 levels), 2) A 32% share for renewable energy, and 3) 32.5% improvement in energy efficiency.

National key partners and resources

Public policies recommendations to Chile

- Increase the public investments in digital infrastructure, build a large-sale ICT infrastructure, including massification of 5G and AI technology.

CURRENT STATUS OF THE APPLICATION IN CHILE



FORECAST OF FUTURE DEMAND FOR THE APPLICATION

8.5 Teleworking

Teleworking means that employees use information and communication technologies (ICTs) to work from home, in telecentres or in other places.

Common examples

The Singapore Computer Emergency Response Team, seeks to make teleworking safer, which is why it promotes and is expected to implement telework policies at the corporate level.

Opportunities

■■■■■ Reduction of greenhouse gas emissions due to the decrease in the need to mobilize employees to their jobs.

■■■■□ It implies a reduction in expenses and time for employees, and also entails greater time flexibility.

■■■□□ For employers, office maintenance costs are reduced.

Information, infrastructure and regulation requirement

- Equipment needed so that the worker can carry out his work from home.
- It’s required to establish a legal maximum working hour in order to not expose teleworkers to longer workdays.

Barriers

■■■■■ **Infrastructure:** need for connectivity improvements at residential level.

■■■■■ **Human capital:** lack of employee training.

■■■■■ **Security:** personnel information may be targeted by cyber-attacks.

■■■■■ **Others:** ambiguity between personal space and workspace; unavailability of digital data; some tasks are not possible to carry out in teleworking mode

Application synergies

- If more workers engage in teleworking, the use of Personal and Public transport (5.1-5.2) will decrease, then less emissions are generated and costs are reduced.

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Operation (monitoring/control/reporting)

International real application

In a European Commission investigation, teleworking in the EU was analyzed, both before and after the COVID-19. The study shows that the sectors that most switched to teleworking are education, ICT, administrative and and commerce. However, there are others that are difficult or impossible to perform away from the standard worksite, like sales, electric/electronic and personal service[12].

European Commission

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[12] "Telework in the EU before and after the COVID-19: where we were, where we head to". European Commission, 2020.

Examples of international goals

With the Korean New Deal, up to 40 percent of the work is expected to be done remotely.

The cybersecurity and infrastructure security agency hopes to increase cybersecurity in telecommuting through improvements in related infrastructure.

National key partners and resources

Ministerio de Energía
Gobierno de Chile

Ministerio del Trabajo y Previsión Social
Gobierno de Chile

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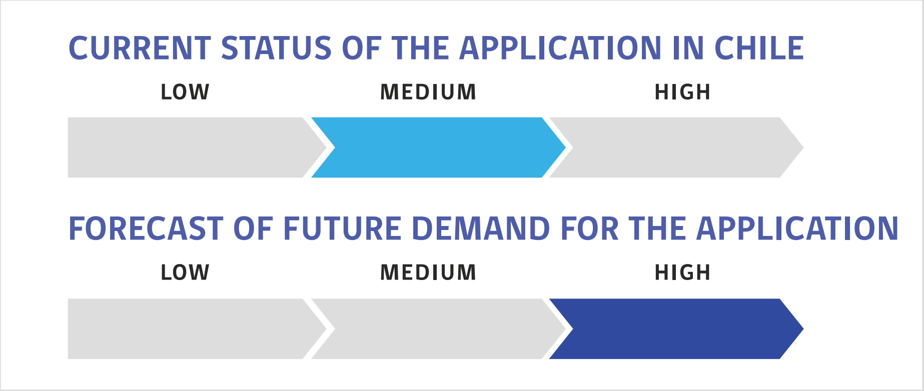
Dirección del Trabajo

Public policies recommendations to Chile

- In order to reach the desired state where teleworking is mature in Chile, training of the workers is needed.



CURRENT STATUS OF THE APPLICATION IN CHILE

FORECAST OF FUTURE DEMAND FOR THE APPLICATION