SWITCHON CASE COMPETITION 2022

WORKING FOR CHANGE

COLOMBIA

By: ACF legends from Colombia

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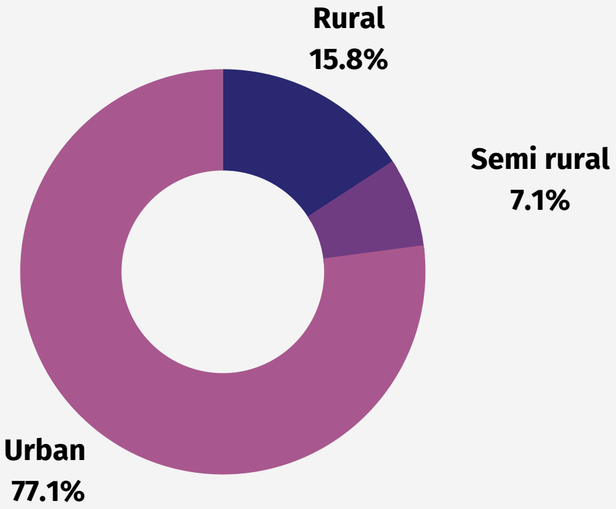
COLOMBIA

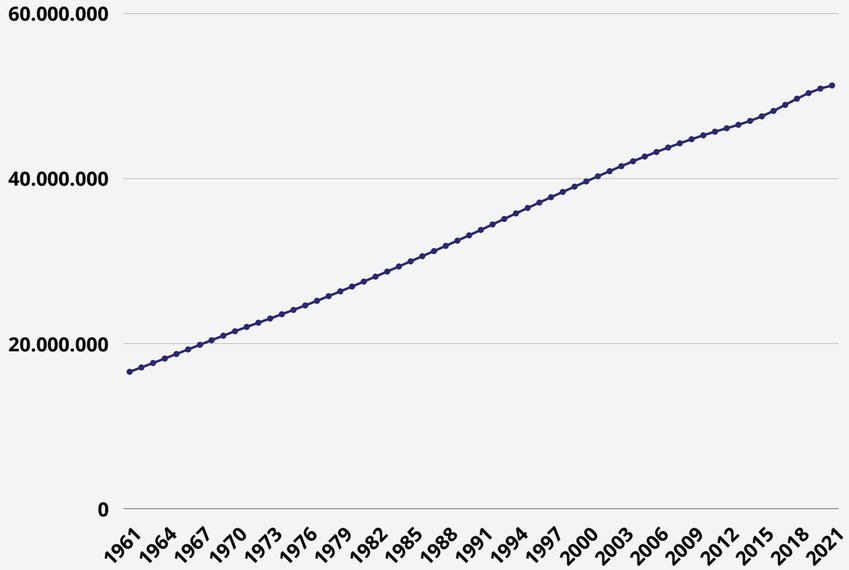
General information

- Located in the extreme northwest of South America.
- Land area: 1,141,748 km2
  Maritime domains: 928,660 km2
- The climate is determined by trade winds, humidity and altitude above sea level

Population distribution



Source: Consulate of Colombia
World bank



- The current population of Colombia is 52,131,382 (the third largest population in South America)

ECONOMY

- The Colombian economy has recovered vibrantly from the COVID-19 crisis.

GDP
per capita

6,131.2 USD

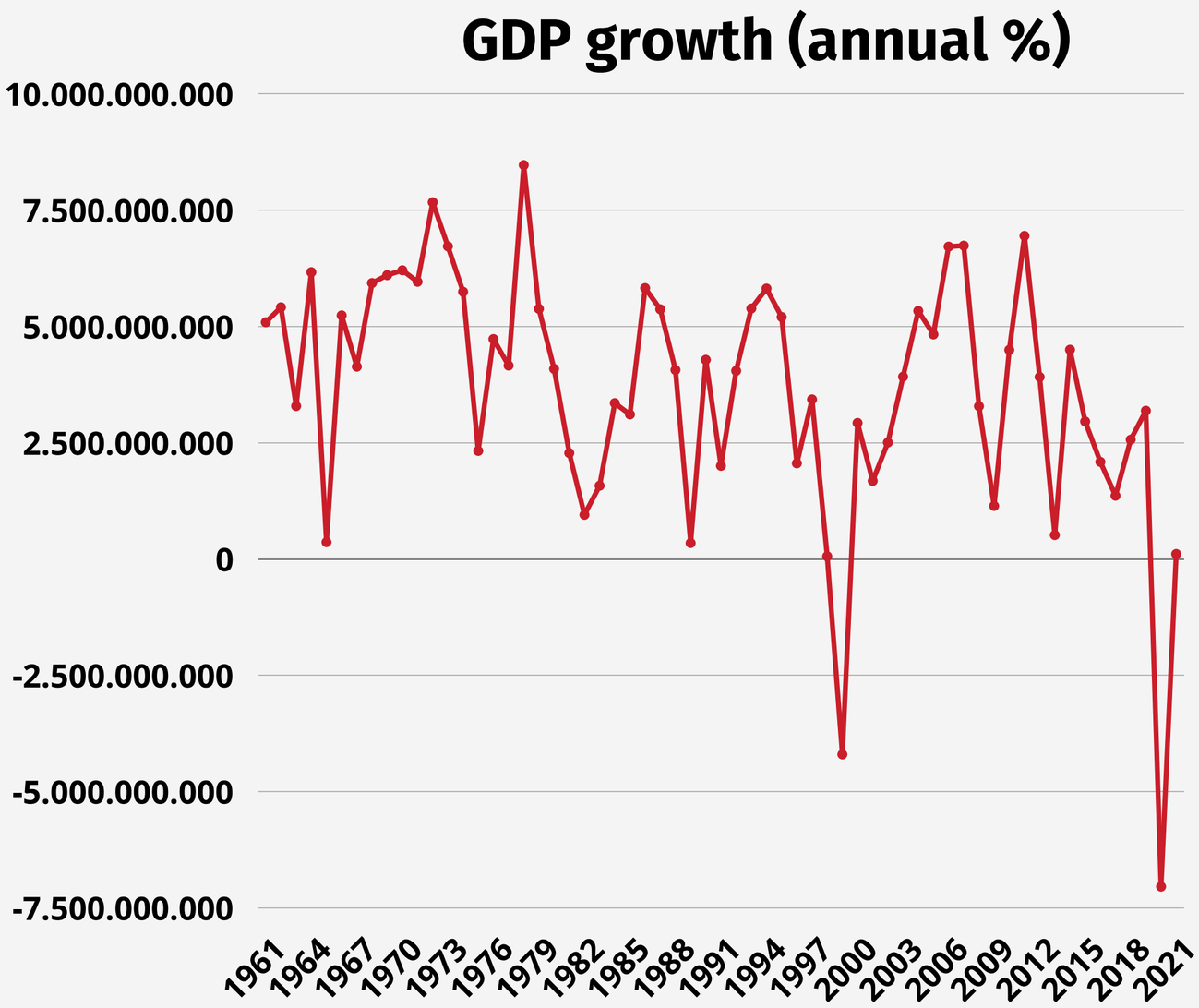
GDP
growth (annual %)

10,6

GDP

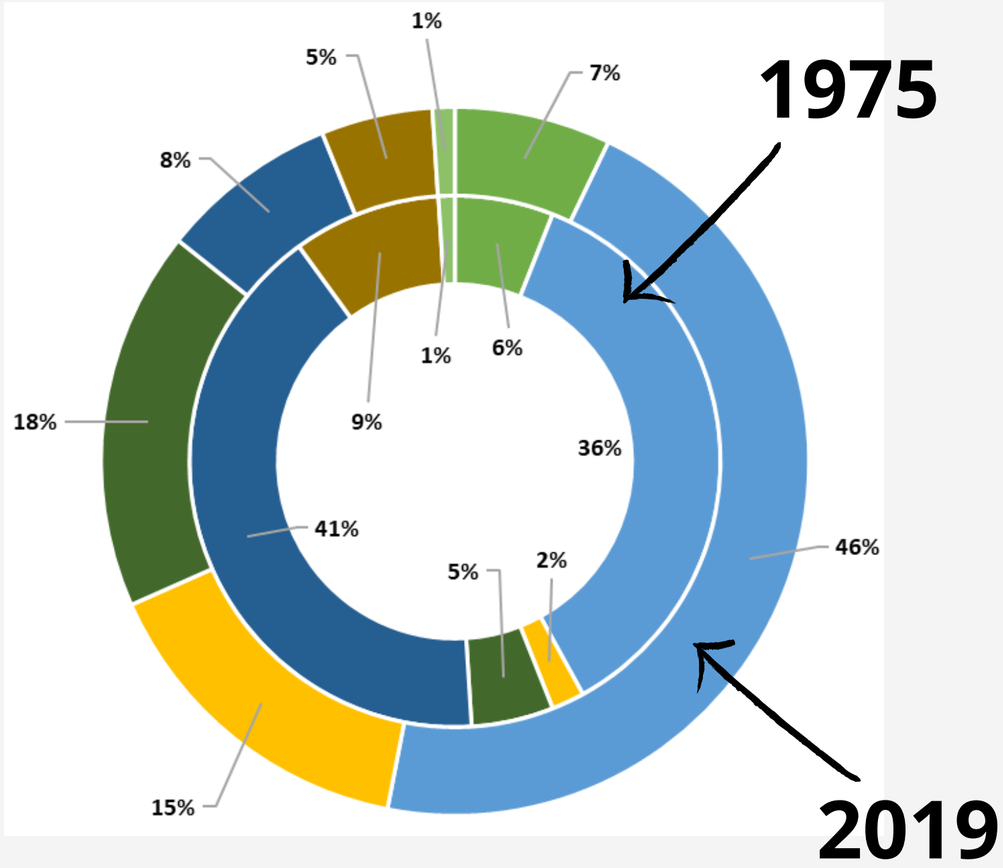
314,3 billions USD

Source: The World Bank



ENERGY

matrix 1975 - 2019



Source: UPME, 2020

Colombia's laws aim at energy transition

- Mineral Coal
- Oil & derivatives
- Natural gas
- Electricity
- Wood
- Bagasse
- Other

ACCESS TO ELECTRICITY

in Colombia

Source: UPME, 2019
IPSE, 2022

ON GRID SYSTEM

Nuquí, Chocó, Colombia

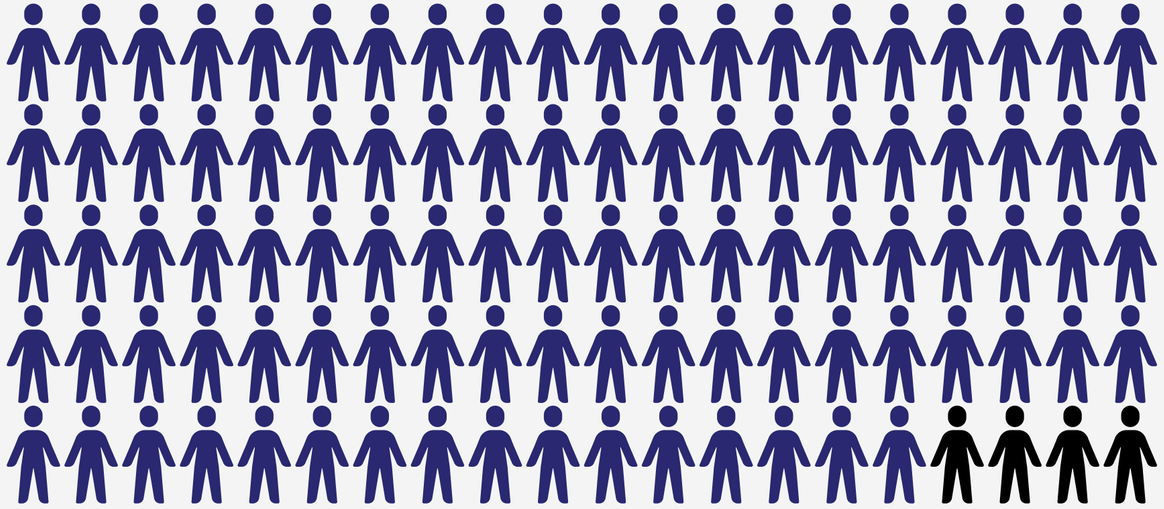
Medellín, Antioquia, Colombia

OFF GRID SYSTEM

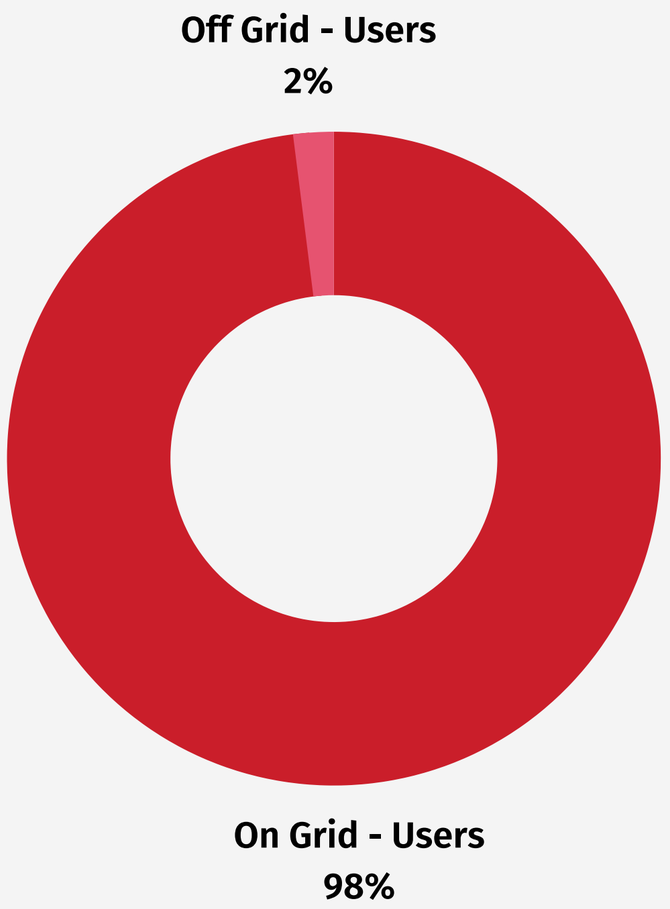
ACCESS TO ELECTRICITY

in Colombia

Source: UPME, 2018

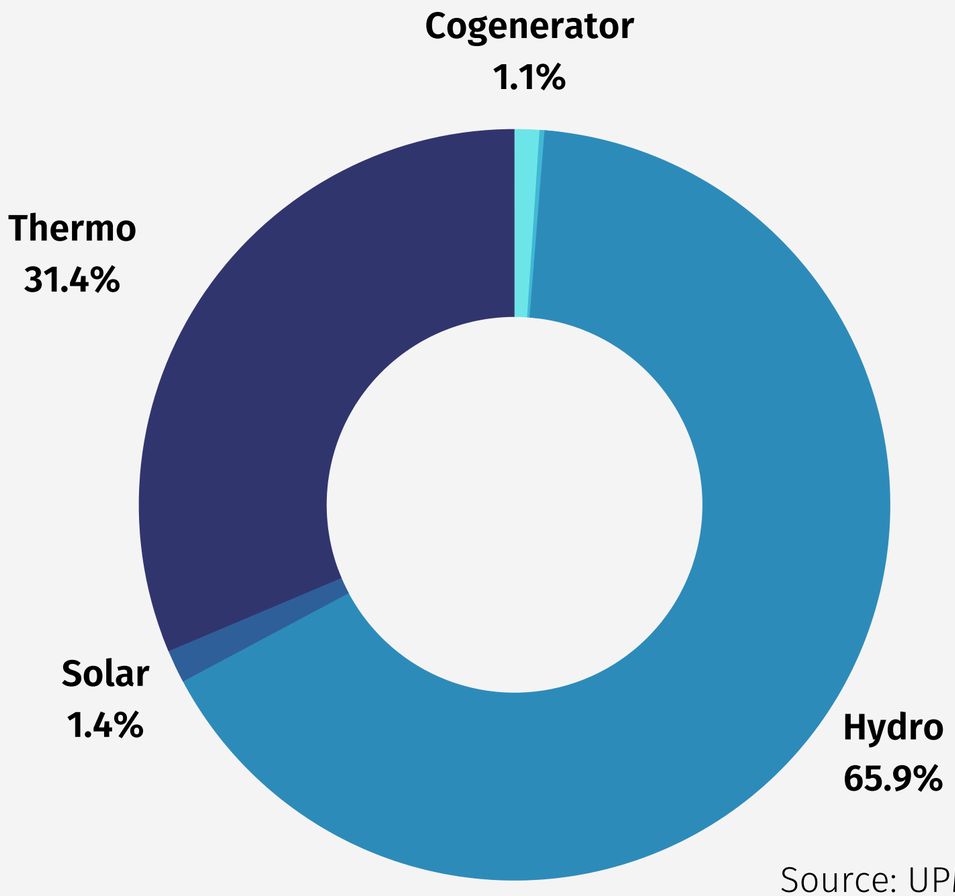


96.53 % of the population have acces to electricity.



Distribution of electricity users

ON GRID SYSTEM



Source: UPME, 2019

Electricity generation in ON GRID System
Total capacity installed: 18156,07 MW

KEY FACTORS: ON GRID

- Dependence on hydroelectric generation.
- The support system is thermoelectric that work with fossil fuels and also is expensive.
- Energetic monopoly; there are few companies that provide energy service.
- In some points of the grid the quality of the sevice is deficient.
- The consumption of the energy is very ineficient.
- Colombia is a potential energy hub for the region and the country can change its dendence on the exportation of fossil fuels.

DATA ON GRID

CRUCIAL FACTORS	OBJECTIVE	INDICATORS	BASE LINE	GOAL 2050
Reliability	Matrix diversification	% of non-conventional energy sources in the energy matrix	Rating: C Ranking:73	Rating: A
	Resilient energy infrastructure	Service quality indexes	SAIDI: 37.7 h/year SAIFI: 48 times/year	SAIDI: 3-5 h/year SAIFI: 2-5 times/year
Availabilty	Allow reliable access assuring quality standars	World energy council's energy equity index.	3.1%	12%-20%
Energy efficiency	Efficient uses of eneregy resources	% of useful energy	31%	50-70%
STI (Science Technology Innovation)	Promote research and innovation, encourage human technical skills	# research groups	210	210+
		GDP percentage invested in STI	0.74%	1%

Source: UPME, 2020

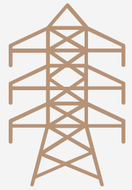
ON GRID SOLUTION MATRIX

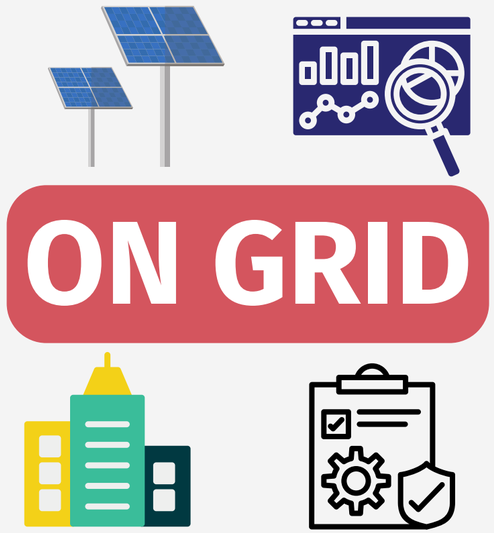
		CHALLENGES						
		Hydro dependence	Fossil fuels backup systems	Energy monoply	GDP highly dependent of fossil fuels	Energy hub	Energy inefficiencies in consumption	Service quality
Possible solutions	Matrix diversification	X	X		X	X		
	Small hydro				X	X		
	Micro GRIDs and distributed generation			X	X	X		X
	Improvements in grid and coverage expansion				X	X		X
	STI investment and professional training	X	X	X	X	X	X	X

POSSIBLE SOLUTIONS

Matrix diversification

- Solar PV complexes
- Eolic parks
- Biogas/biomass
- Mini Hydro





Micro GRIDs and distributed generation

- Escalable systems
- New generation areas
- New companies, more competitivity
- Renewbable sources

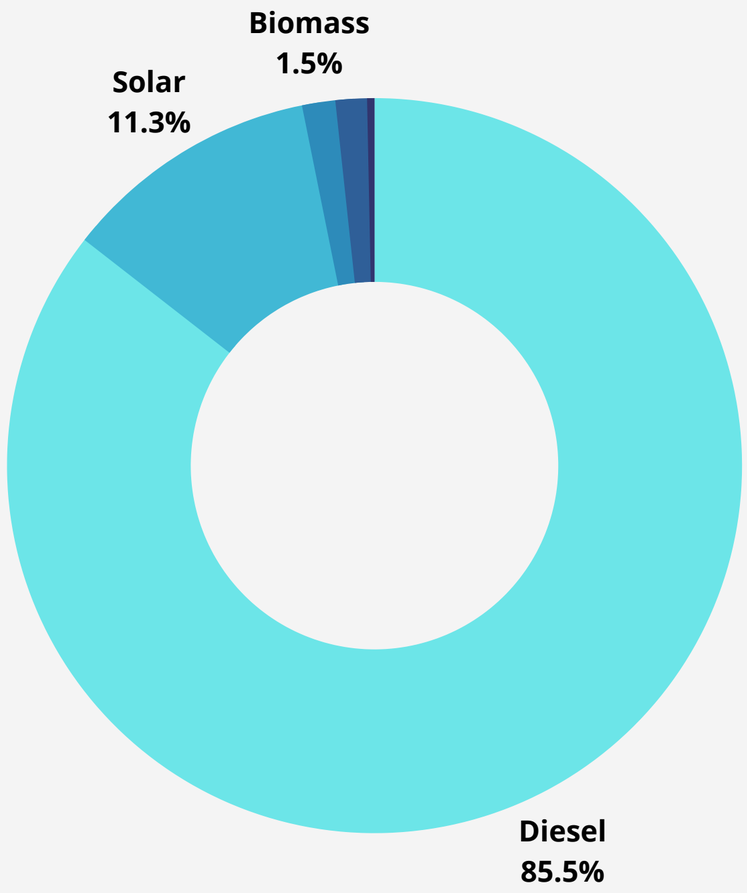
Improvements in grid and coverage expansion

- International grid to export
- O&M
- Coverage expansion off-grid to on-grid

STI investment and professional training

- Energy efficiency
- Promote research groups
- Financing of industrial technologies
- Scholarships

OFF GRID SYSTEM



Electricity generation in OFF GRID System
Total installed capacity: 309.43MW

Source: IPSE, 2022

KEY FACTORS: OFF GRID

- The users only have electricity few hours in the day.
- There are people that are still out of the on-grid and off-grid energy system that need the access to energy.
- The generation in off grid system depends on diesel plants.
- There is a lack of proper telemetry monitoring system that helps to know how the service of electricity is in the off grid.
- The off grid population have low payment capacity and low educational level.
- This population still cooking with firewood.
- There is a difficult on the O&M on the projects and the community is not included in the implementation of those projects.

DATA OFF-GRID

CRUCIAL FACTORS	OBJECTIVE	INDICATORS	BASE LINE	GOAL 2050
Reliability	Matrix diversification	% of non-conventional energy sources in the energy matrix	Rating: C Ranking:73	Rating: A
	Service quality improvement	% of users with more than 10 hours per day of electricity service in Off grid	36%	75%
Availabilty	Allow reliable access assuring quality standars	World energy council's energy equity index.	3.1%	12%-20%
Energy efficiency	Efficient uses of eneregy resources	% of useful energy	31%	50-70%
STI (Science Technology Innovation)	Promote research and innovation, encourage human technical skills	# research groups	210	210+
		GDP percentage invested in STI	0.74%	1%
	Digitization and data usage in the energy sector	% of localities with telemetry monitoring system	9%	90-100%
Sustainable development	Transition to modern cooking fuels	per capita consumption of unclean cooking fuels	132 Ton/1000 hab	36-70 Ton/1000 hab

Source: UPME, 2020

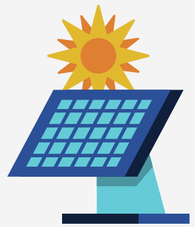
MATRIX SOLUTIONS OFF -GRID

		CHALLENGES						
		Diesel dependency	Low telemetry of service	Service quality	Low payment capacity	Lack of professionals and technicians	Inneficient project management	Cooking with firewood
Possible solutions	Hybrid systems with renewable sources	X	X	X				X
	Pre-paid system		X		X			
	O&M contracts		X	X		X	X	
	Micro GRIDs and distributed generation	X	X	X				X
	STI investment and professional training	X	X	X	X	X	X	X

POSSIBLE SOLUTIONS

Energy Systems

- Individual Solar PV systems
- Mini Solar PV systems
- Digital telemetry



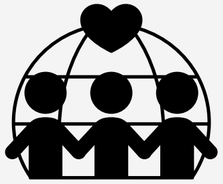
OFF GRID

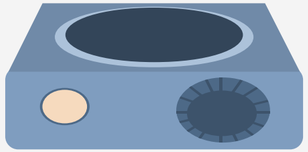
O&M Contracts

- Big energy companies
- Corporate social responsability
- Extend projects life-cycle

Involvement of the off-grid communities

- Training in energy
- Local Employement opportunities
- Improve the local economy





STI INVESTMENTS

- Electric cooking technologies
- Digital telemetry in old energy systems
- Scholarships

IMPLEMENTATION

THE 3 PILLARS OF WORKING FOR CHANGE

ENERGY EDUCATION (STI)

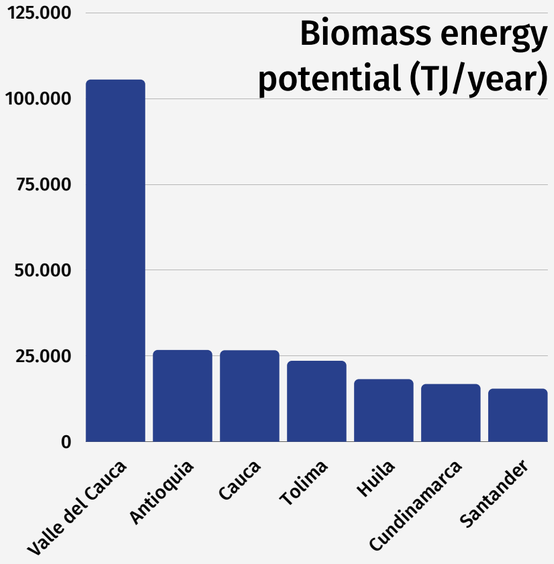
ENERGY GENERATION

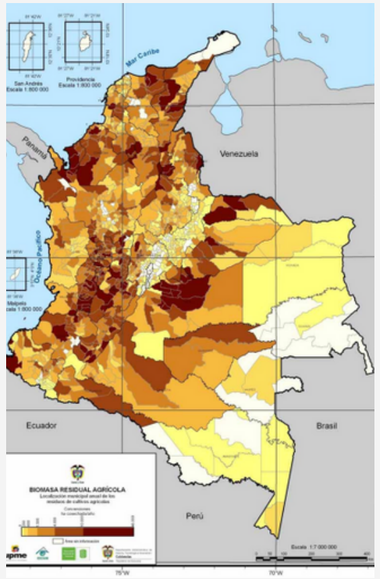
ENERGY INFRAESTRUCTURE IMPROVEMENTS

ENERGY GENERATION

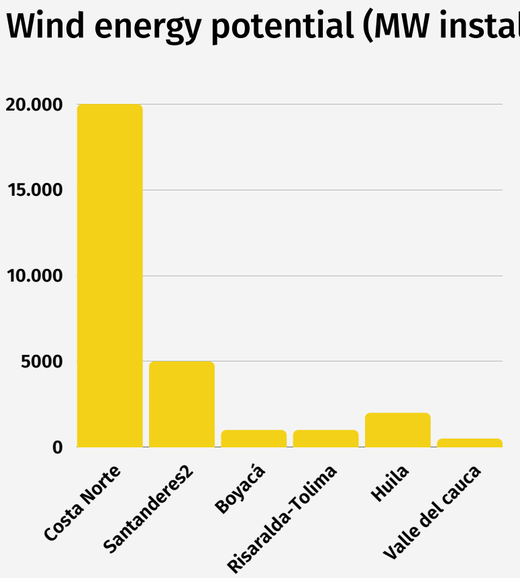
Source: UPME, 2015

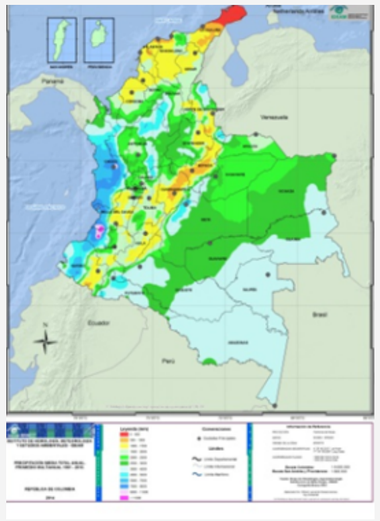
BIOMASS ENERGY



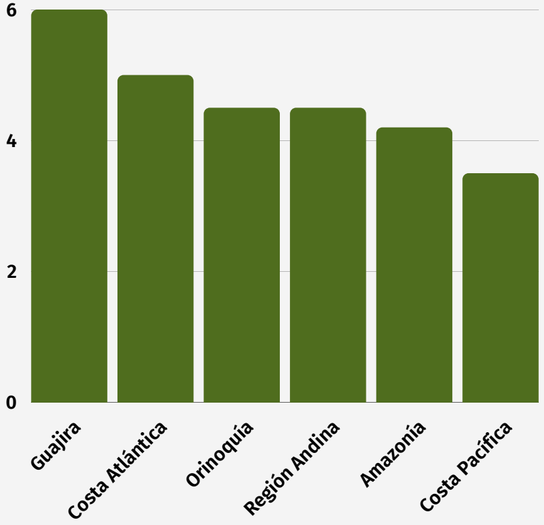


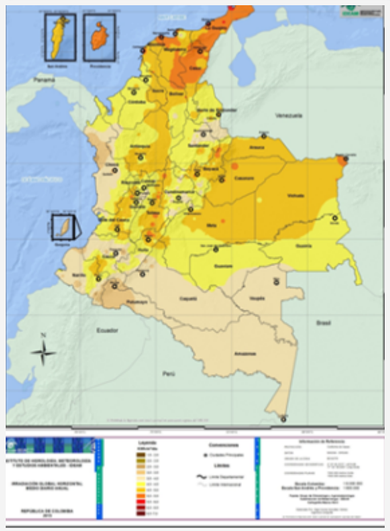
WIND ENERGY



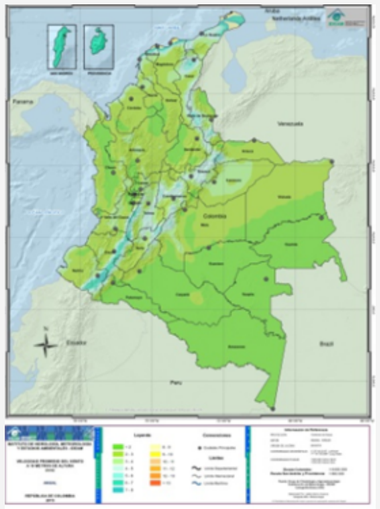


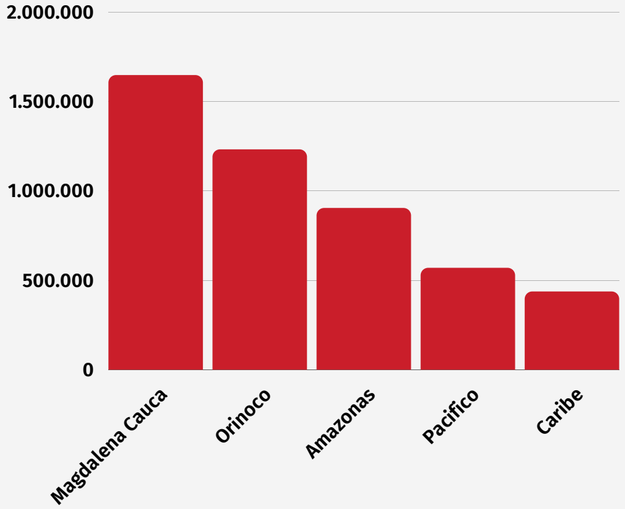
SOLAR ENERGY





HYDRO ENERGY





Source: IRENA, 2022

COST OF RENEWABLE ENERGY

Type of energy	CAPEX (USD/kWh)	LCOE (USD/kWh)	OPEX (% of CAPEX per year)	CAPEX + OPEX of a 25 year generation project (USD/kWh)
Solar PV energy	857	0.048	0.5% - 1.5%	1071.25
Biogas energy	2353	0.067	2% - 6%	4706
Hydro energy	2135	0.048	1% - 4%	3469.4
Eolic energy	1325	0.033	5% - 9%	3643.75

Source: IRENA, 2022

ENERGY GENERATION

ON GRID

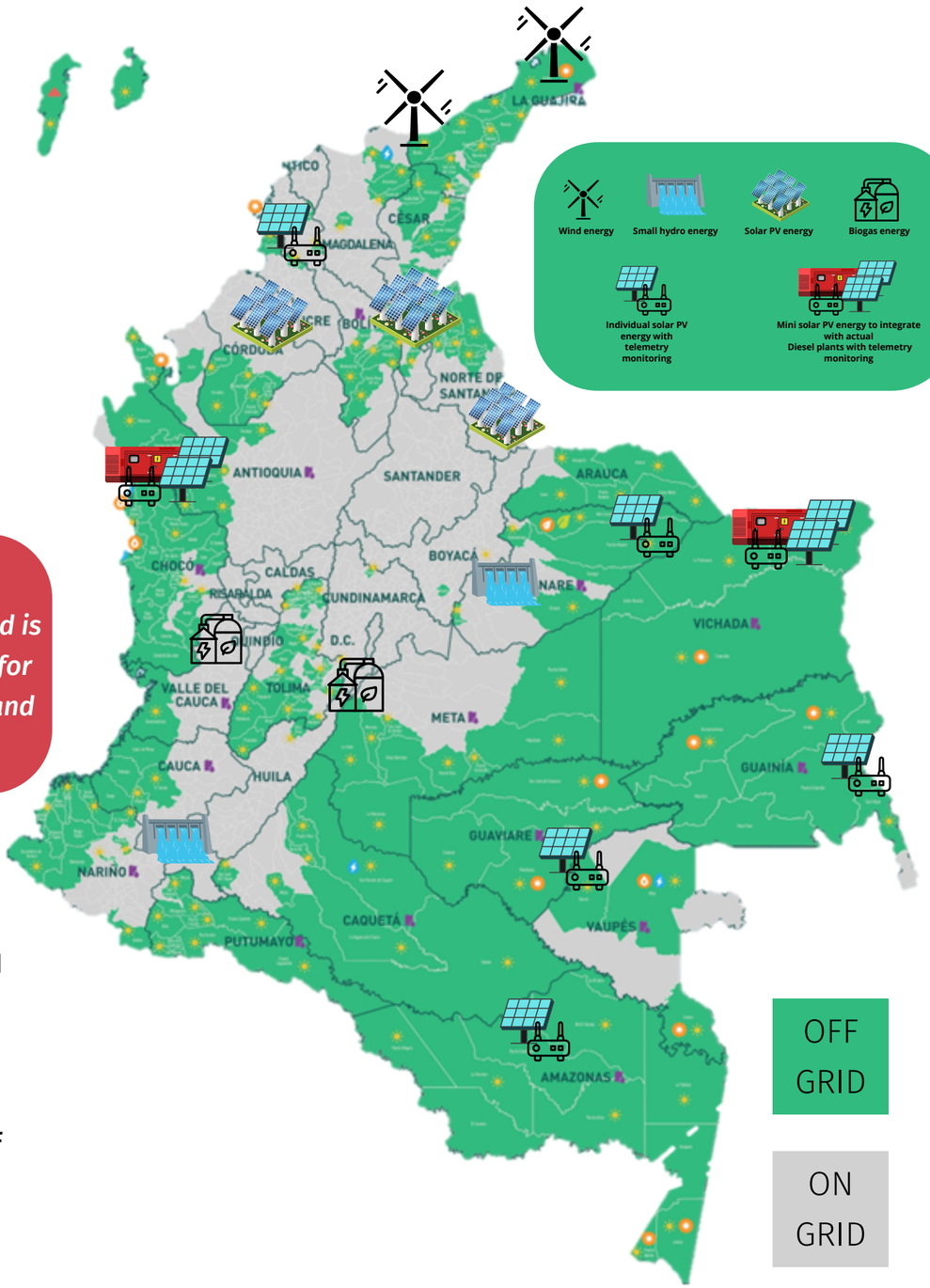
- This solution takes advantage of the vast resources to produce energy across the country land.
- The installed capacity for the ON GRID solution is 330 MW distributed on different energy generation plants of 20MW or less.
- The generation plants will be ubicated in the extremes of the on grid.
- It is necessary to connect the new generation plants to the grid.
- The energy matrix will be diversified and climate-proof.

ON GRID + OFF GRID

The generation in the extremes of the on grid is going to improve the quality of the service for the population of the extremes of the grid and integrate off grid users to the grid.

OFF GRID

- The solar PV energy is the option for the OFF GRID because is modular and is the cheapest nowadays.
- The installed capacity for the OFF GRID solution is 236MW, that are divided in Mini Solar PV system of 0.5MW and Individual Solar PV system of 0.2kW.
- The individual Solar PV system solution is for the users that don´t have access to energy at this moment.
- The Mini Solar PV system is for connect this system and strength the diesel plants that generate energy for the OFF GRID communities at the moment.
- All the installed system will have telemetry monitoring systems.



ENERGY INFRASTRUCTURE IMPROVEMENTS

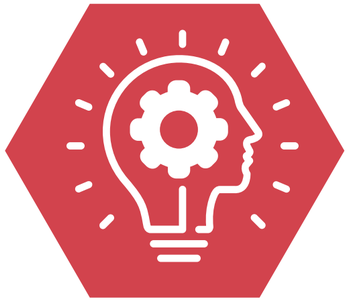
Connect off-grid areas to the grid

Grid maintenance and technology jump

Energy export infrastructure to neighbour countries

Co-financing industry efficient machinery in order to increase useful energy vs energy produced

EDUCATION - STI



- Financing on nuclear and hydrogen energy generation research

- O&M Suport and training for local communities given by the ON GRID energy companies.

- Replacement of unclean fuel stoves

- Scolarships for energy related careers

OVERVIEW OF THE PLAN

- **$ 411.335.833 USD per phase**
- **$ 1.234.007.500 USD for 30 years**
- **10 years to complete each one**
- **Loan every ten years, every one paid off in that time (10 years)**

2023

Phase 1 initiates

- Solar parks **X 3**
- Eolic parks **X 1**
- Mini hydroelectric plant **X 1**
- Biogas complex **X 1**
- Hybrid systems
- Individual PV system
- Improvements on grid
- STI programs

2032

Phase 2 initiates

- Solar parks **X 3**
- Eolic parks **X 1**
- Mini hydroelectric plant **X 1**
- Biogas complex **X 1**
- Hybrid systems
- Individual PV system
- Improvements on grid
- STI programs

2041

Phase 3 initiates

- Solar parks **X 3**
- Eolic parks **X 1**
- Mini hydroelectric plant **X 1**
- Biogas complex **X 1**
- Hybrid systems
- Individual PV system
- Improvements on grid
- STI programs

2053

All 3 phases of the implementation are in operation

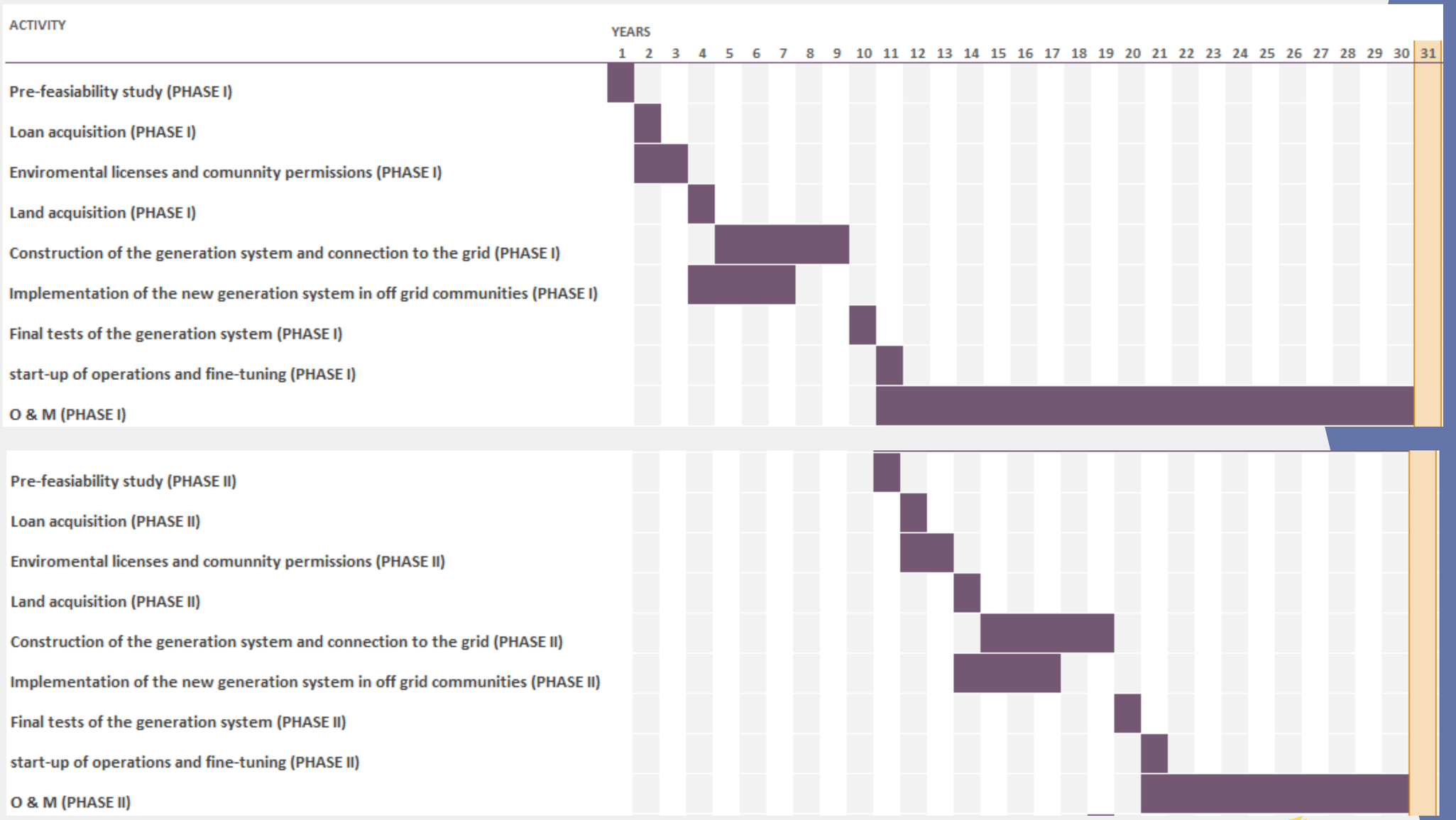
- Evaluation of the indicators
- Project closes

$ 145.992.500 Million USD (aprox. 10% of total budget) for contingencies and unexpected events

TIMELINE - ENERGY GENERATION

PHASE I

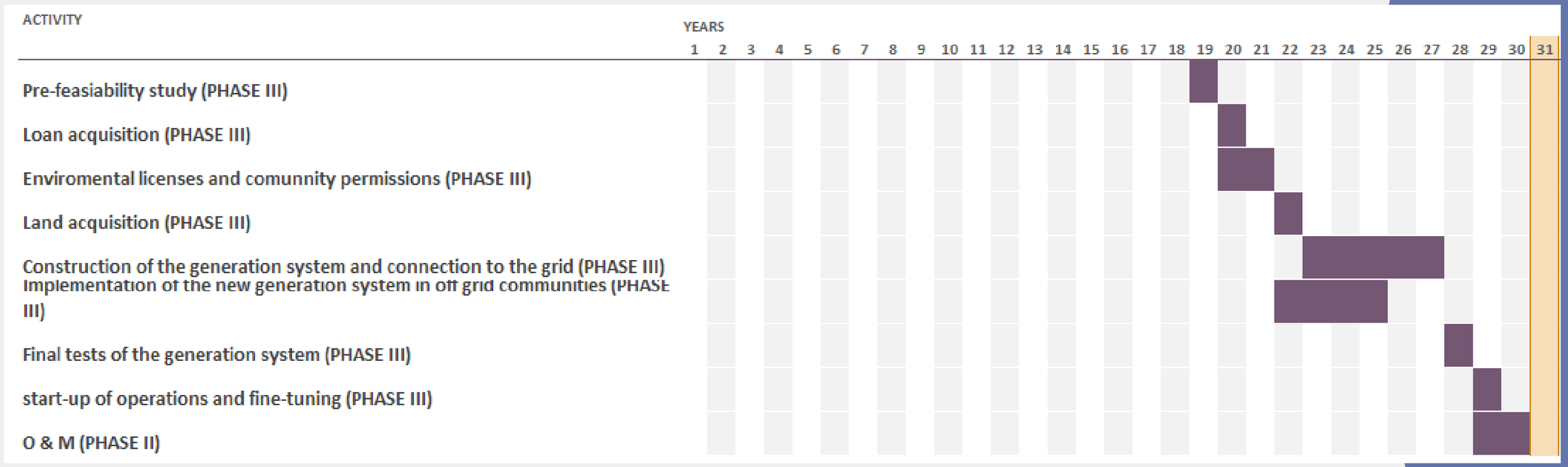
PHASE II



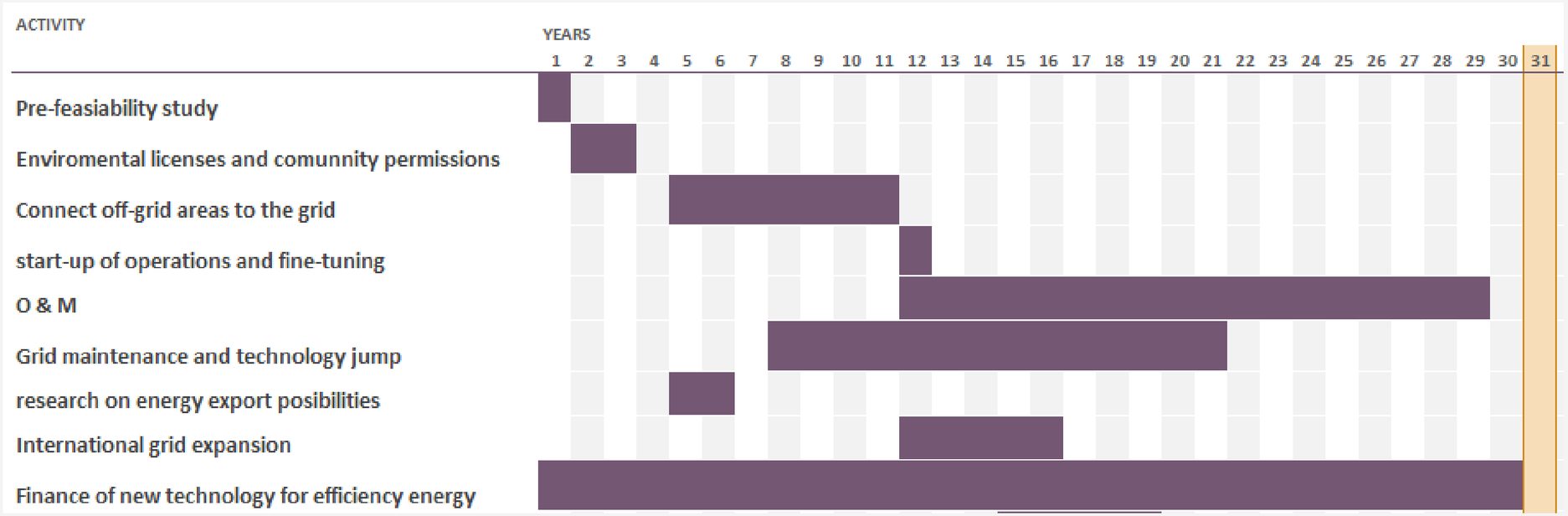
Solution implementation

TIMELINE - ENERGY GENERATION

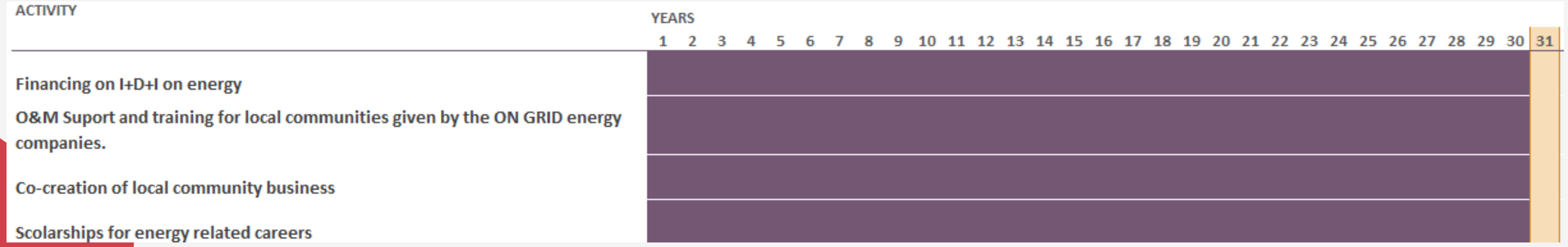
PHASE III



TIMELINE - ENERGY INFRAESTRUCTURE IMPROVEMENTS



TIMELINE - ENERGY EDUCATION (STI)



Solution implementation

BUDGET - ENERGY GENERATION

Product	Target users	Energy capacity per unit	Cost per unit (USD)	Number of units	Total energy capacity	Total cost (USD)
Biomass energy system	ON GRID - OFF GRID	10MW	94.120.000	3	30MW	141.180.000
Eolic energy sistem	ON GRID - OFF GRID	20MW	72.875.000	3	60MW	218.625.000
Minihydro energy system	ON GRID - OFF GRID	20MW	69.387.500	3	60MW	208.162.500
Solar PV energy system	ON GRID - OFF GRID	20MW	21.425.000	9	180MW	192.825.000
Individual solar PV systems	OFF GRID	0.2KW	214	180000	36MW	38.565.000
Mini solar PV system	OFF GRID	0.5MW	535.625	400	200MW	214.250.000
TOTAL					**566MW**	**1.013.607.500**

BUDGET - ENERGY INFRAESTRUCTURE IMPROVEMENTS

Product	Target users	Cost per year	Years of investment	Total cost (USD)
Off grid expansion to on grid and international grid	ON GRID- OFF GRID	4000000	12	48.000.000
Maintenance and renovation of the grid	ON GRID	400000	14	5.600.000
Finance of new technology for efficenct energy consumption	ON GRID	3000000	30	90.000.000
TOTAL				**143.600.000**

BUDGET - ENERGY EDUCATION (STI)

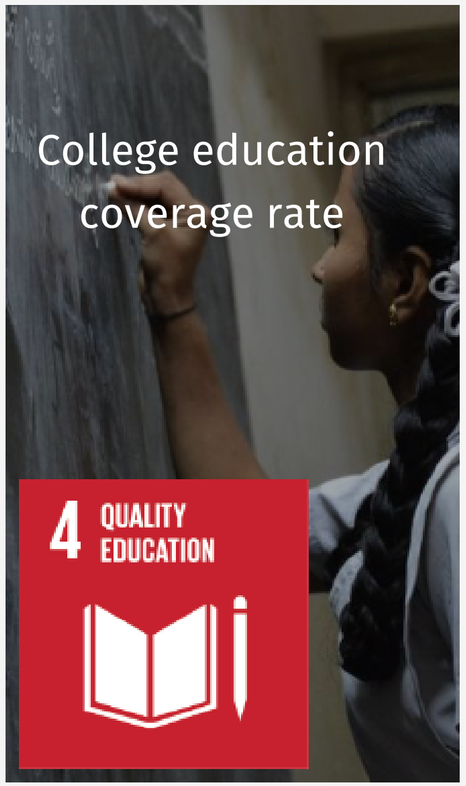
Product	Target users	Cost per unit USD/each	Number of units	Total cost
Scolarships for bachelors degree related to clean energy	ON-GRID AND OFF GRID	10.000	6000	60.000.000
Finance research groups in Hidrogen and Nuclear energy	ON-GRID AND OFF GRID	500.000	30 years of investment	15.000.000
Electric stoves in replacement of unclean fuel stoves	OFF-GRID	10	180000	1.800.000
TOTAL				**76.800.000**

FINANCE

Bank	Interest rate	Amount to be loaned (USD)	Grace period	Time to pay	Amount to be paid (USD)
WB- WORLD BANK	3%	411.335.833	10 Years	10 Years	$ 552.800.963,83
IDB- INTERAMERICAN DEVELOPMENT BANK	3%	411.335.833	10 Years	10 Years	$ 552.800.963,83
CAF-LATINAMERICAN DEVELOPMENT BANK	3%	411.335.833	10 Years	10 Years	$ 552.800.963,83

IMPACT IN SDG

Colombia has set its SDG goals, we aim to make a better country with this implementation, these are the ones we plan to influence directly



Baseline (2015): 49,4%
Goal (2030): 80,0%

Baseline (2015): 96,9%
Goal (2030): 100%

Baseline (2015): 8,6%
Goal (2030): 17,9%

Baseline (2015): 0%
Goal (2030): 20,0%

IMPACTS IN DATA

0,168

Number of beneficiaries per dollar spent OFF-GRID

122,3

kWh/usd
All energy generation

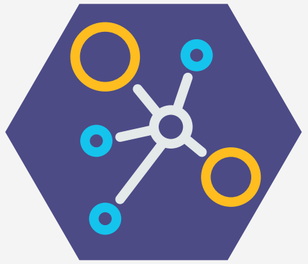
900k

New users of energy in rural areas (OFF-GRID)

122,3

Total installed capacity for 2050 (MW)

CONCLUSION



- Reinforce what we have: strengthen interconnected system at the ends where the quality is not as high as it could be. Through maintenance and the development of new generation plants.

- Aim to new technologies: the matrix can be diversified with the proposed solution, taking advantage of the potential of each region of the country.

- Education is a must: strong component in education and research, in association with the national industry, joining efforts for the country's progress.