CRHIAM
CENTRO DE RECURSOS HÍDRICOS PARA LA AGRICULTURA Y LA MINERÍA

INOVAGRI
International Meeting

Irrigation and Energy:

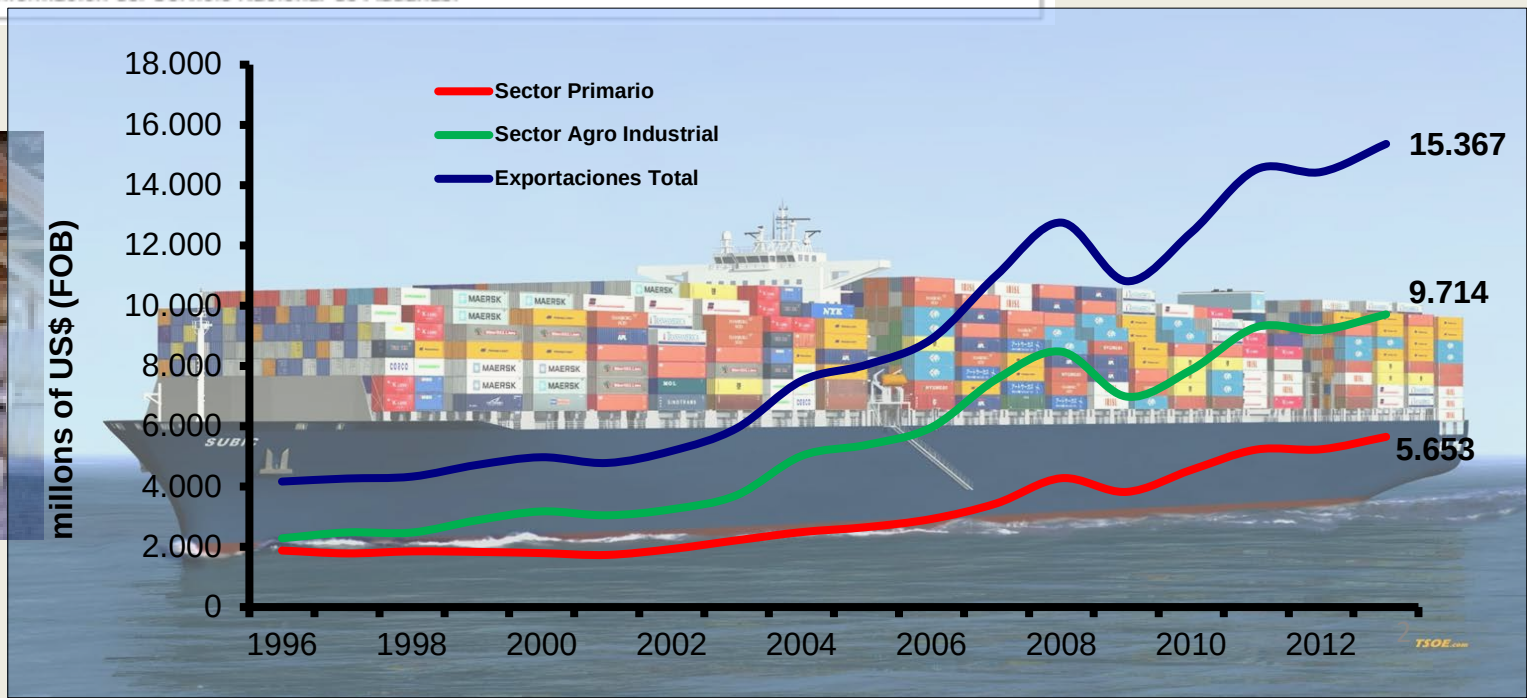
INDICATORS AND RATIONAL USE

Universidad de Concepción

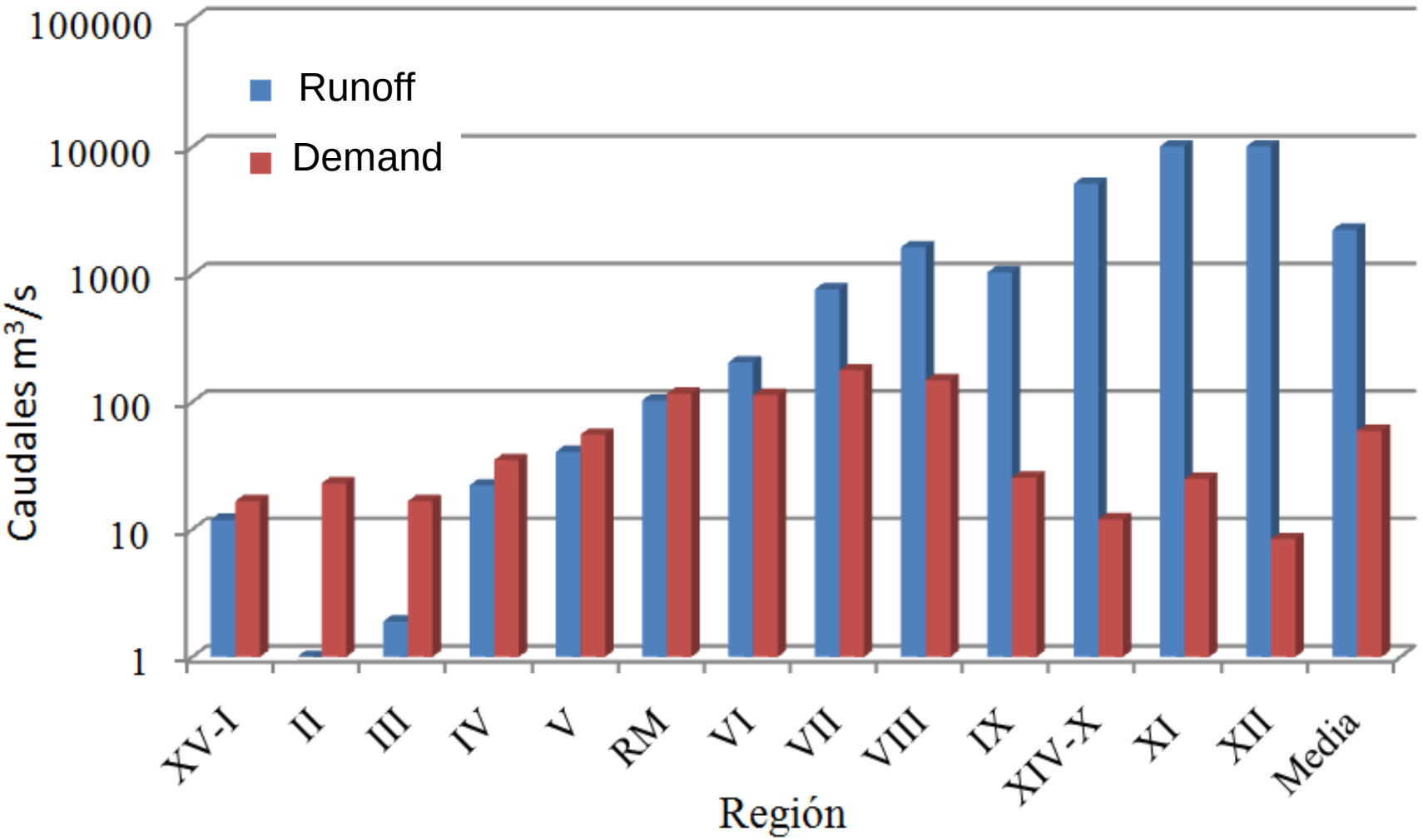
Universidad del Desarrollo
Universidad de Excelencia

CONICYT
Ministerio de Educación
Gobierno de Chile

Agricultural exports

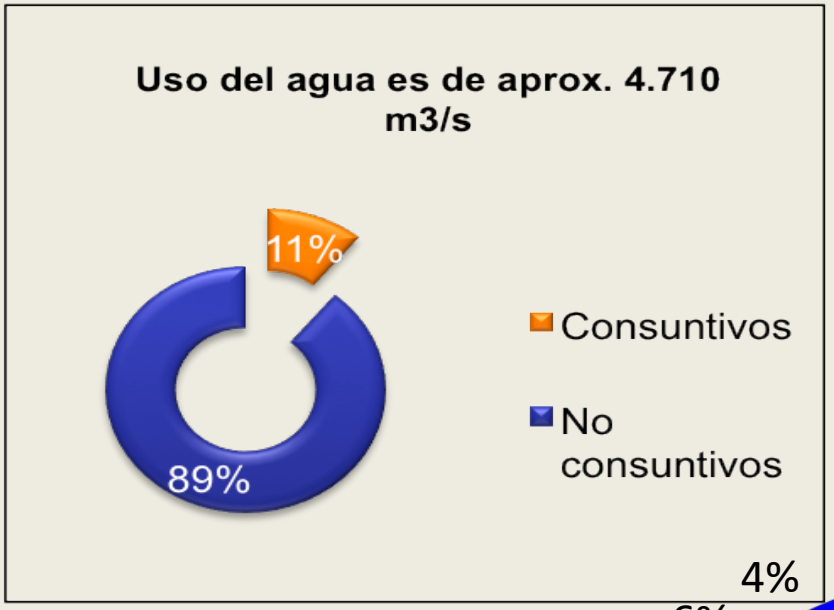


Water availability and water demand

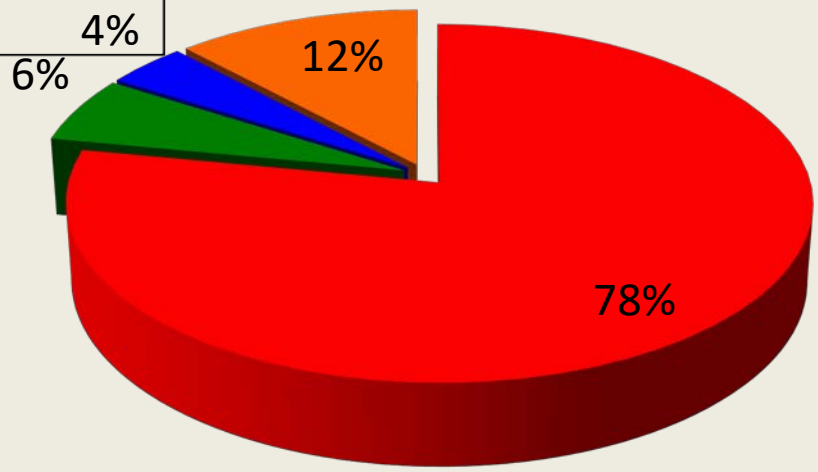


Fuente: Banco Mundial (2011). Escala logarítmica.

Uses of Water



Consumptive use



Fuente: DGA, 2011.

As demand grows, there is increasing competition for resources between energy, agriculture, fisheries, livestock, forestry, mining, transport and other sectors with unpredictable impacts for livelihoods and the environment (FAO 2011c).

It is necessary to increase the productivity irrigated land

On the other hand, there are daily increased pressure to protect the environment

Chile's agriculture Facts

- Current water use for irrigation ca. 14 billion m^3 per year.

- ca. 4 billion additional m^3 for next 40 years to match agriculture growth.

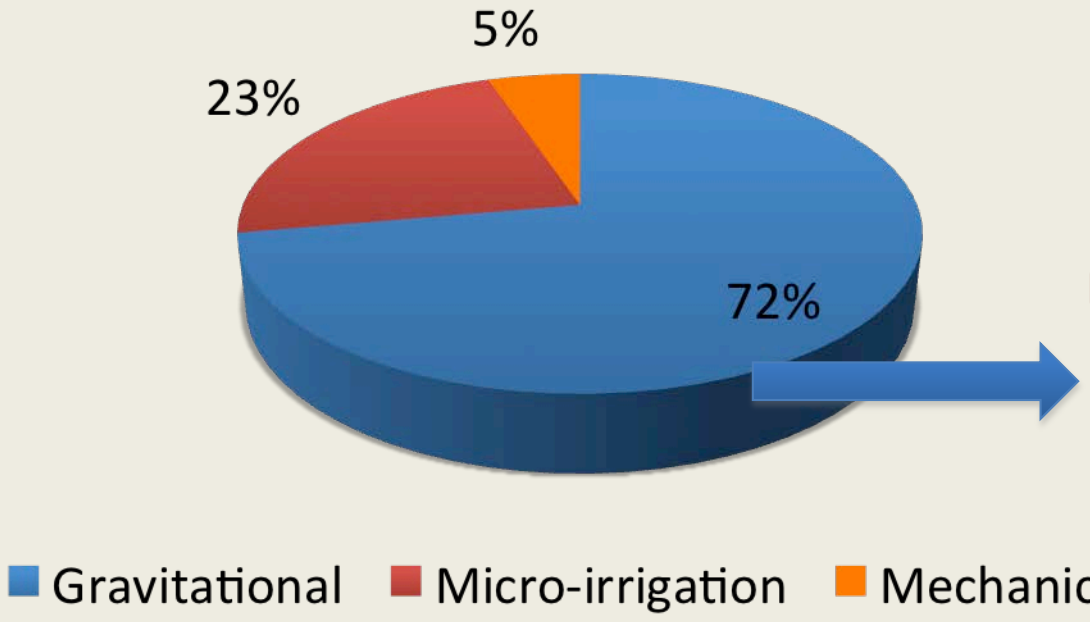
- 1900 to 1970= 0.5 million hectares
- 1970 to 2015 = 1.1 million hectares.

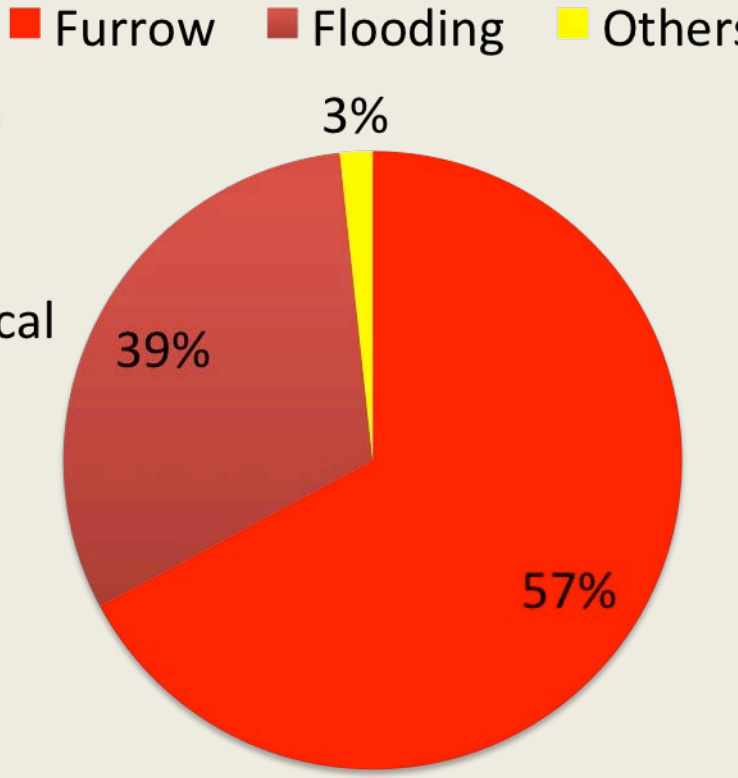
- About 70% of this growth was funded by the State. Between 1997 and 2007, the irrigated area grew only 30,000 hectares (3%).

- Over the same period, the area under non-gravitational irrigation increased from 9 to 28%.

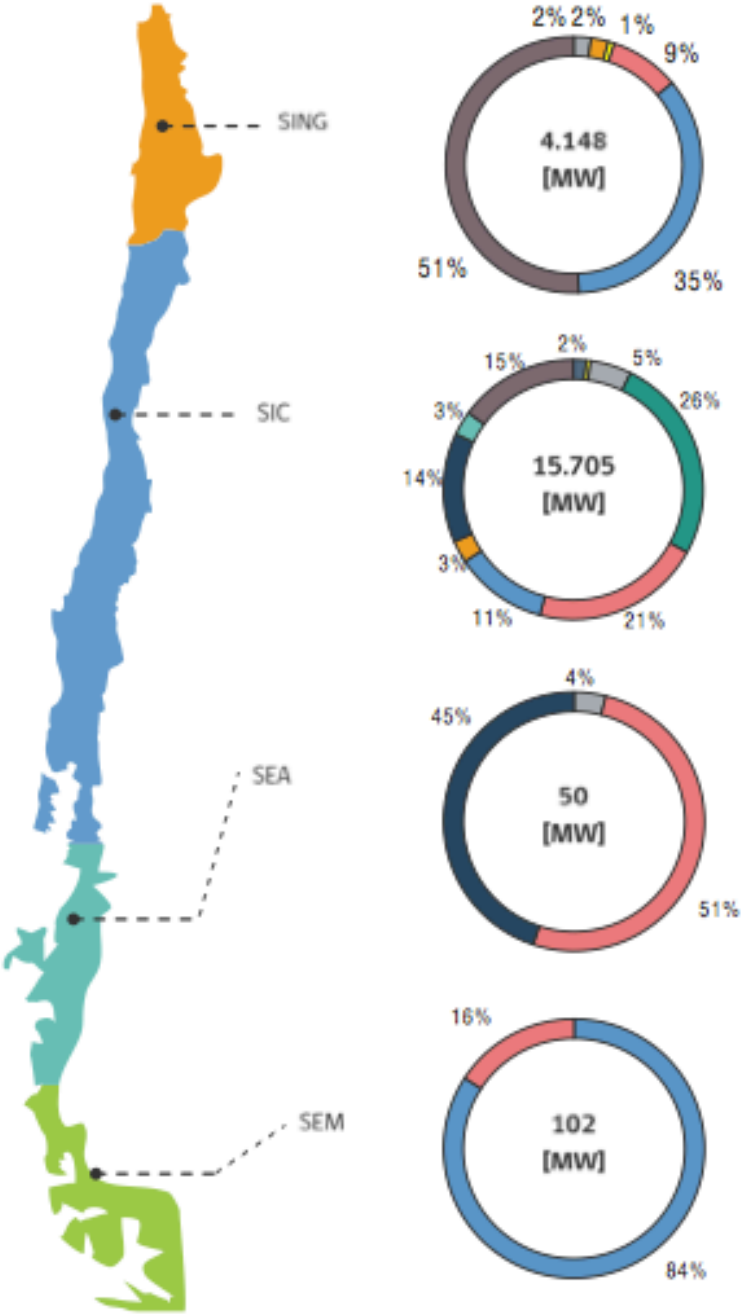
Irrigation

Total = 1.130.000 Ha.





Capacidad Instalada por Tecnología



Capacidad Instalada por Sistema

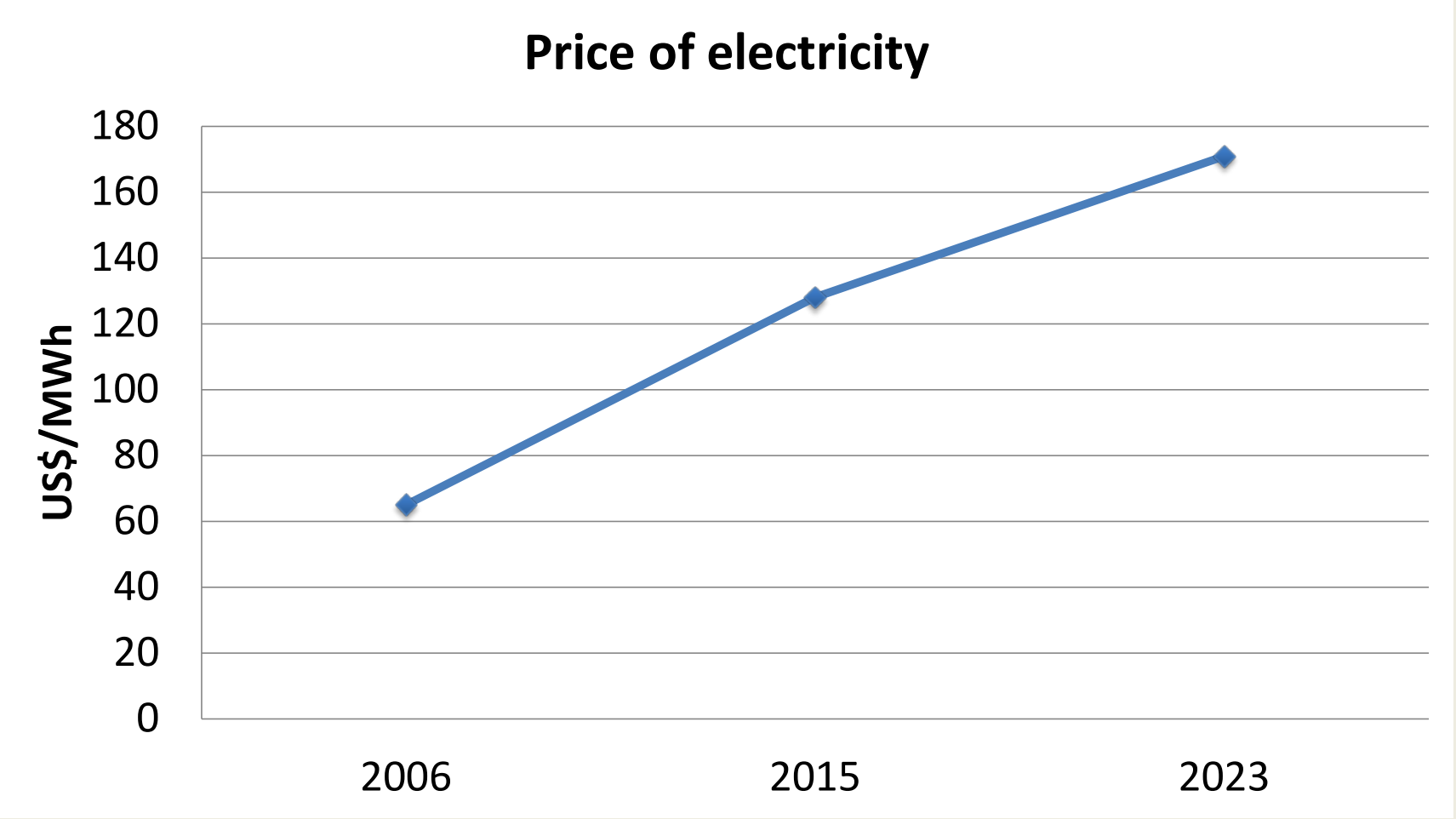
Sistema	Capacidad [MW]	Capacidad [%]
SING	4.148	20,7%
SIC	15.705	78,5%
SEA	50	0,3%
SEM	102	0,5%

Fuente: CDEC - SIC / CDEC - SING y CNE

Centrales en prueba

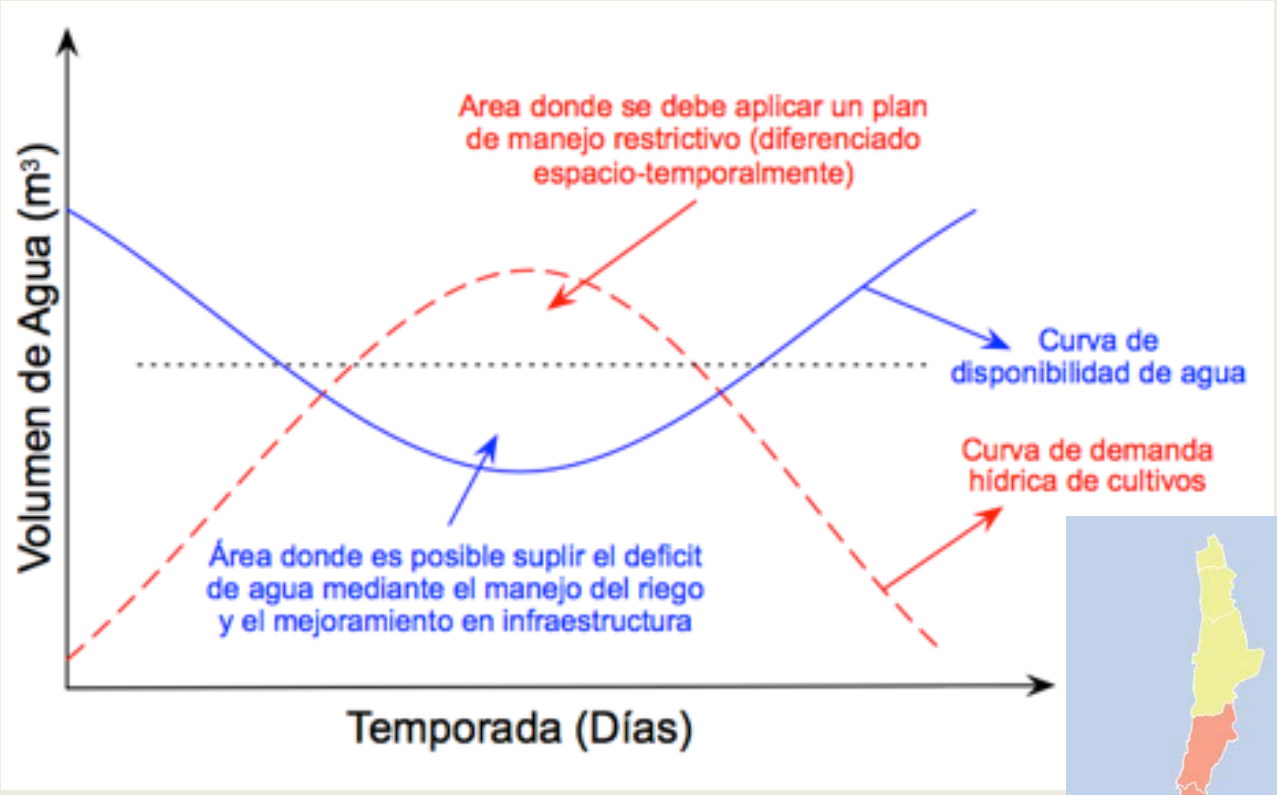
Fuente: CDEC - SIC / CDEC - SING y CNE

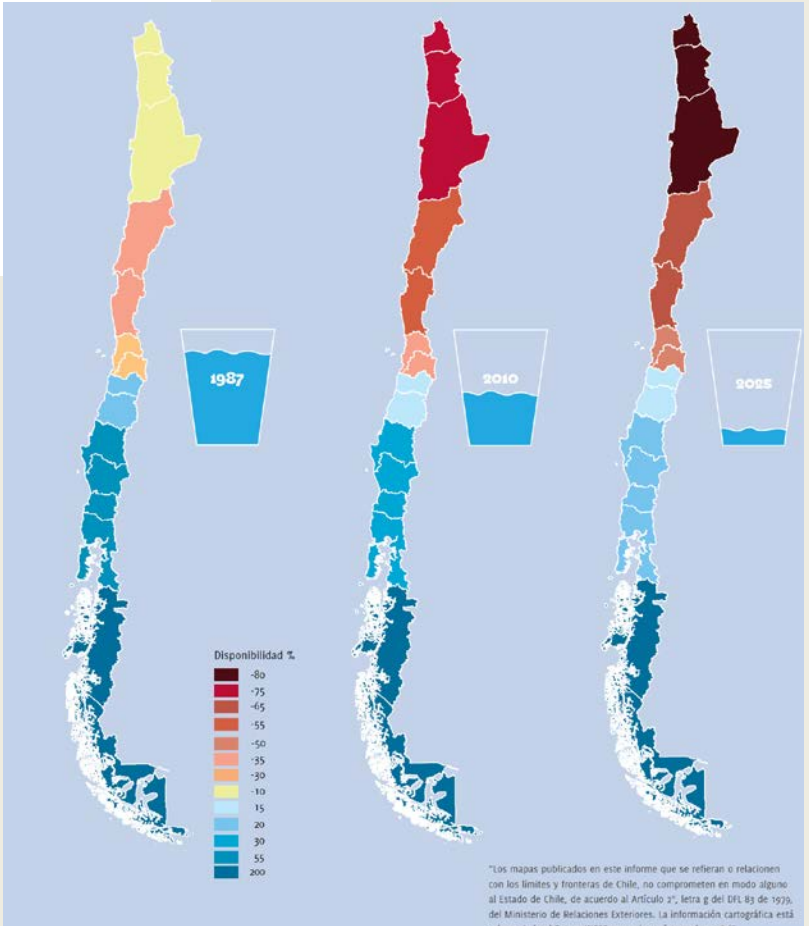
Chile imports 60% of its primary energy (National Energy Balance BNE 2012) so we are a country subject to instability and price volatility in international markets and supply constraints which are caused by political or weather events or marke



Current state of precipitation

INFORME DE PRECIPITACIONES Lunes 24 de agosto de 2015						
Ciudad	**Últimas 24 horas**	**Total a la fecha**	**Normal a la fecha**	**Año pasado igual fecha**	**Deficit o Superavit**	**Normal Anual**
Arica	s/p	1.8	0.4	0.7	>100	0.5
Iquique	s/p	4.4	0.4	s/p	>100	0.6
Calama	s/p	17.1	5.2	3.0	>100	5.7
Antofagasta	s/p	38.4	0.9	0.2	>100	1.7
Caldera	s/p	35.2	s/i	7.5	s/i	s/i
La Serena	s/p	67.1	64.2	65.0	5	78.5
Valparaíso	s/p	190.1	317.5	235.2	-40	372.5
Rodelillo	s/p	303.3	s/i	281.1	s/i	s/i
Pudahuel	s/p	141.6	220.1	119.8	-36	261.6
Santiago	s/p	161.5	254.7	159.3	-37	312.5
Tobalaba	s/p	181.0	270.7	208.1	-33	347.2
Juan Fernández	s/p	589.6	807.3	645.9	-27	1041.5
Curicó	s/p	389.0	552.3	492.3	-30	701.9
Chillán	s/p	648	841.6	824.6	-23	1107.0
Concepción	s/p	463.2	854.7	830.6	-46	1110.1
Temuco	0.1	839.5	835.0	737.9	1	1157.4
Valdivia	5.9	1388.2	1405.6	1395.0	-1	1871.0
Osorno	8.4	815.7	983.4	1039.5	-17	1331.8
Puerto Montt	30.6	1012.1	1272.2	1153.6	-20	1802.5
Coyhaique	18.5	908.6	904.3	757.7	0	1205.9
Balmaceda	4.8	406.9	459.0	331.9	-11	611.6
Punta Arenas	0.6	363.4	253.7	205.2	43	375.7
s/i = Sin información s/p = Sin precipitación 0.0 = Trazas de precipitación						
Informe emitido con información de las 09:00 hora local						

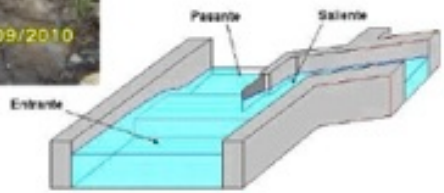

Area donde se debe aplicar un plan de manejo restrictivo (diferenciado espacio-temporalmente)
Curva de disponibilidad de agua
Curva de demanda hídrica de cultivos
Área donde es posible suplir el deficit de agua mediante el manejo del riego y el mejoramiento en infraestructura
Volumen de Agua (m³)
Temporada (Días)

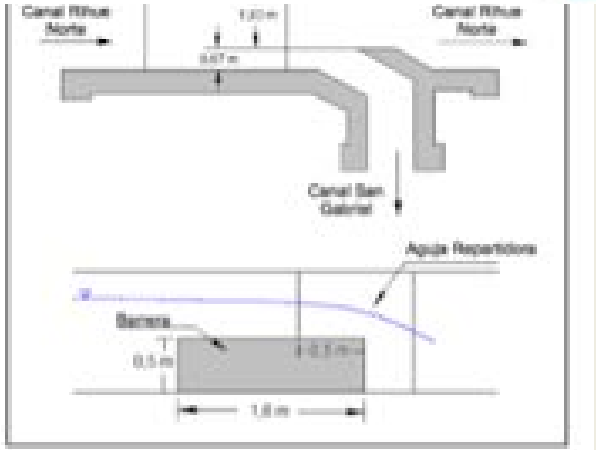

1987
2010
2025
Disponibilidad %
-80
-75
-65
-55
-50
-35
-30
-10
15
20
30
55
200

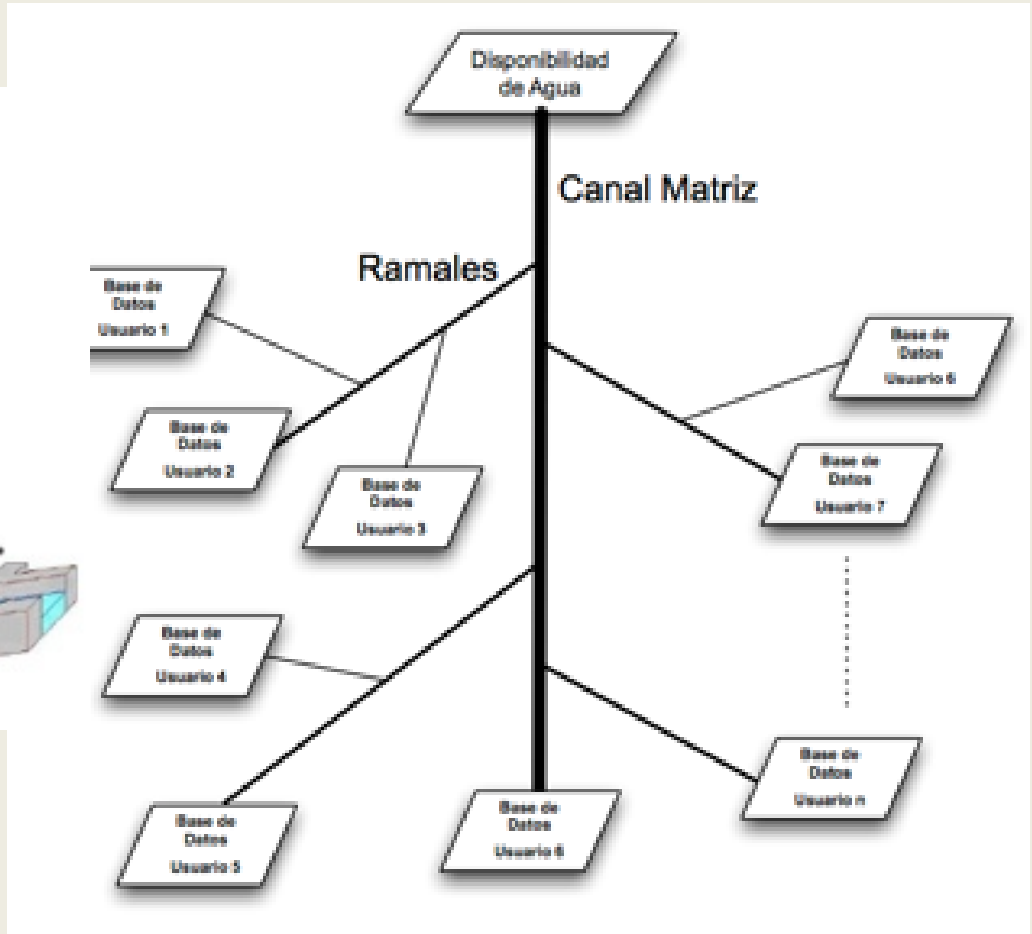
Farmers' capacity to cope with climate scenarios of reduced availability is low or zero.

This depends on the size of production and the technological level you have.

At critical stages, it is common to apply water distribution strategies such as shifts between irrigators, affecting the irrigation efficiency.



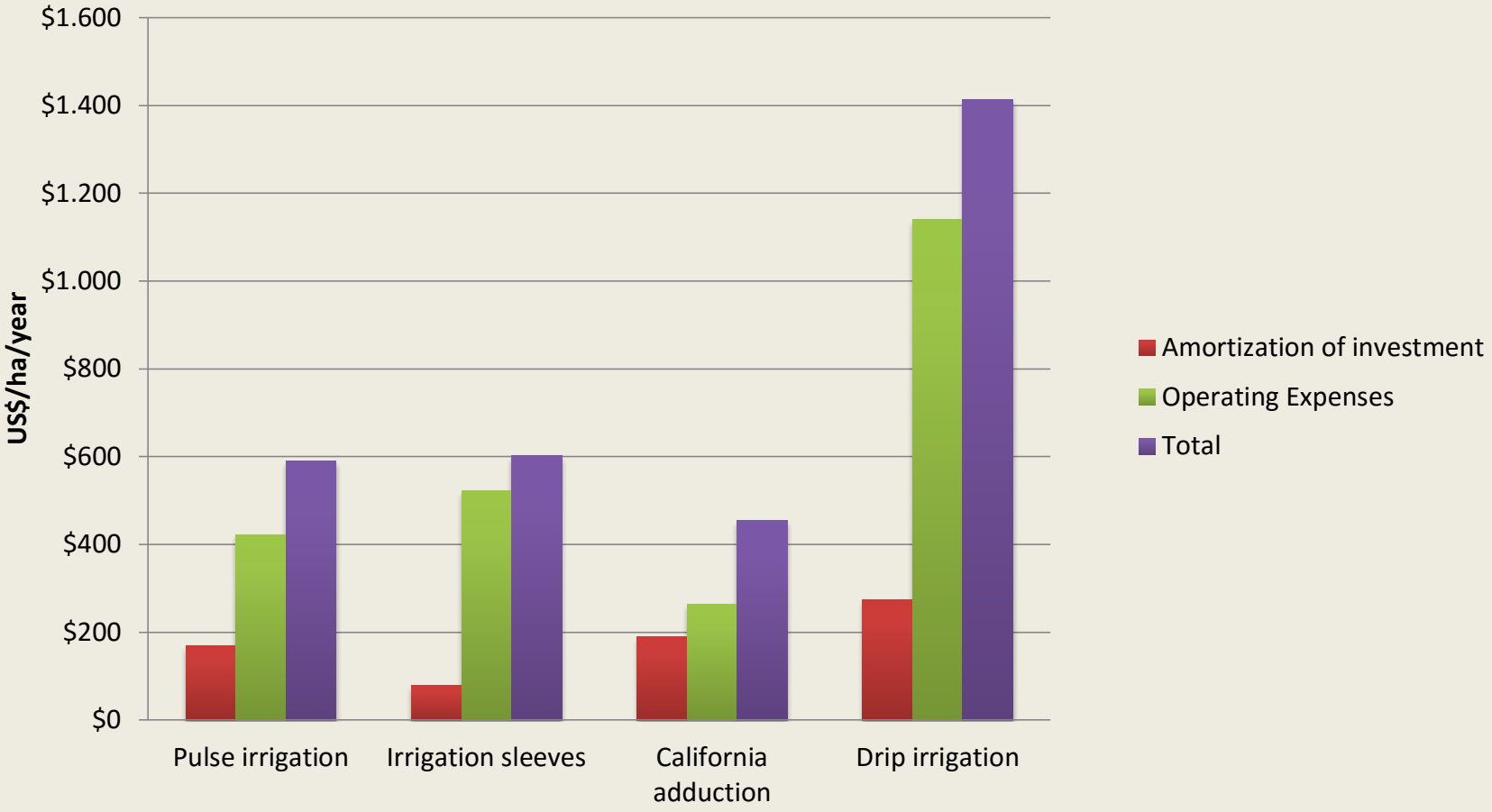




More sophisticated systems are designed to apply a particular precipitation with a defined frequency irrigation. In the event it is necessary to submit to shift water among farmers is impossible to apply the water demanded a shorter time interval. This is solved with the use of dams accumulation of which lack the majority of small and medium farmers in Chile.

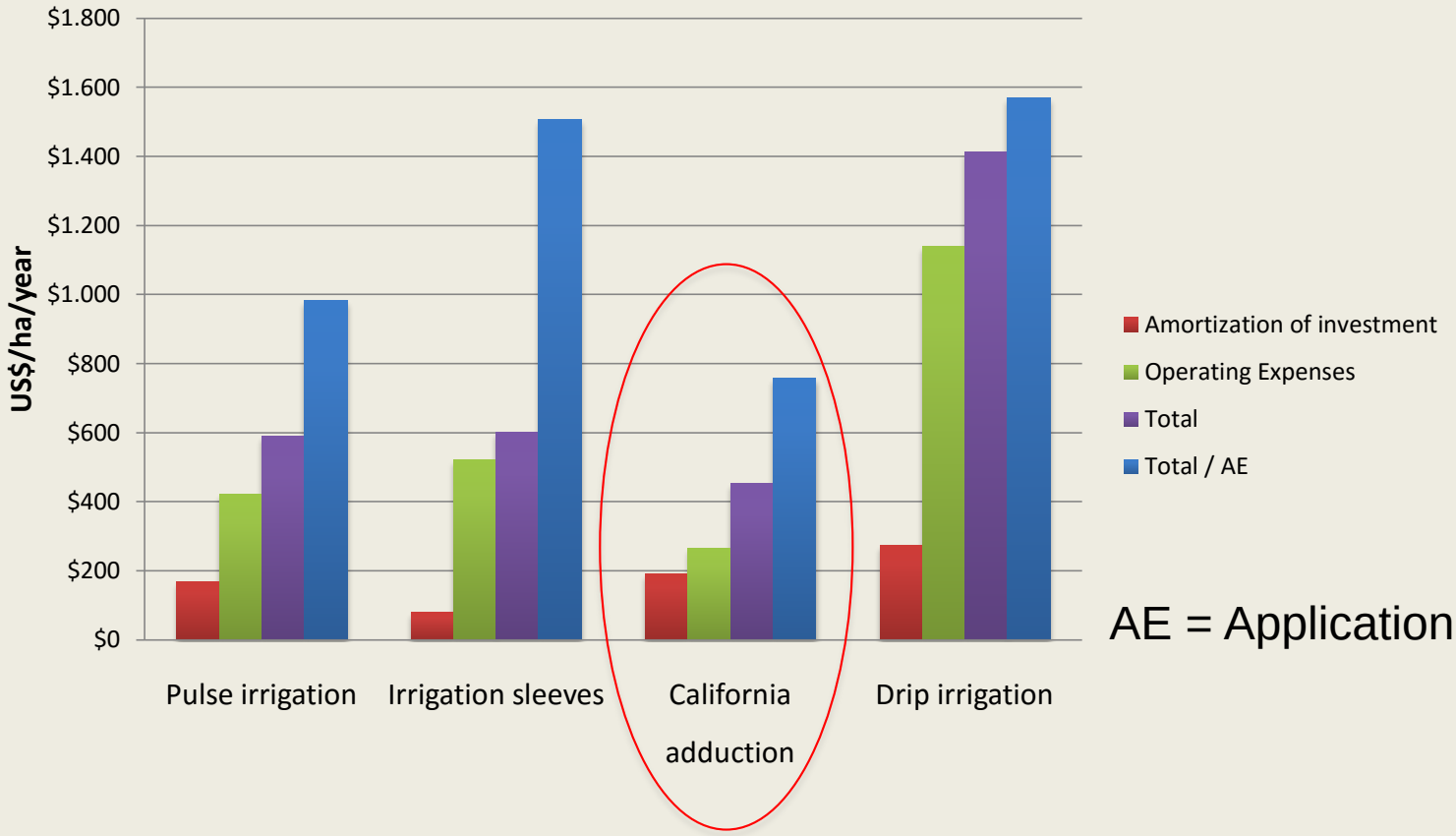
Upstream land use will affect the quality of water entering irrigation areas, especially sediments (erosion caused by agriculture) and chemical composition (agricultural and industrial pollutants).

Cost comparison of different irrigation systems



- The annualized calculation is with interest rate at 4%
- Surface for 5 ha.

Cost comparison of different irrigation systems



AE = Application efficiency

Normalization of cost in terms of the efficiency of water use, in order to guide the prioritization of public investment in irrigation and planning

- In the case of furrow irrigation, it is possible to comply with the application of water required by the crops under irrigation shifts. The main challenge is to make it a suitable design and programming in water management.
- There is pump water restriction¡

- To ensure the efficient use of water is important to analyze the relationship between variables furrow irrigation and the parameters that determine the quality of irrigation, production, and deep percolation as a basis for the design and management of furrow irrigation.

An increase in the length of the furrow reduces the values of RE, RDE, and TDE. However, an increase in the flow rate and the cutting time produces increased efficiencies. Inversely, an increase in the length of the furrow increases the value of AE, while an increase in the inflow discharge and reduce cutting time.

$$AE = 17.715624 \cdot Q^{-0.42332} \cdot L^{0.456306} \cdot T_{CO}^{-0.343620}$$ (Application efficiency)

$$RE = 26.19527 \cdot Q^{0.139828} \cdot L^{-0.084872} \cdot T_{CO}^{0.437575}$$ (Requirement efficiency)

$$RDE = 31.083153 \cdot Q^{0.206051} \cdot L^{-0.132540} \cdot T_{CO}^{0.477585}$$ (Requirement distribution efficiency)

$$TDE = 44.447201 \cdot Q^{0.214309} \cdot L^{-0,138887} \cdot T_{CO}^{-0.405306}$$ (Total distribution efficiency)

Unlike AE, RE, RDE, and TDE parameters you have a good correlation with relative production. TDE and AE are recommended for use in design, management and operation of furrow irrigation systems, to establish good irrigation practices and prevent pollution parameters.

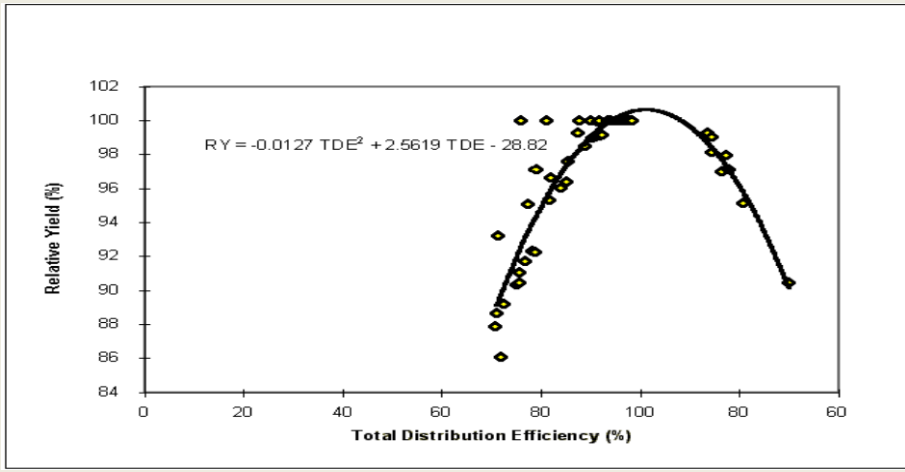
$$(RY) = M_i \cdot (MCR)_i^2 + N_i \cdot (MCR)_i + O_i \qquad i = 1,2,3$$

Cases of over-application of water:

$$TDE_e = 200 - TDE_o$$

$$PR_d = -0.0127(TED)^2 + 2.5619(TED) - 28.82$$

$$PR_e = -0.0127(200 - TED)^2 + 2.5619(200 - TED) - 28.82$$



Currently we are working on improving the design and automation of systems Californian adduction thereby allowing responding to the need to improve the management of surface irrigation contamización reduce risk, higher energy costs and the problem of low labor availability for surface irrigation.

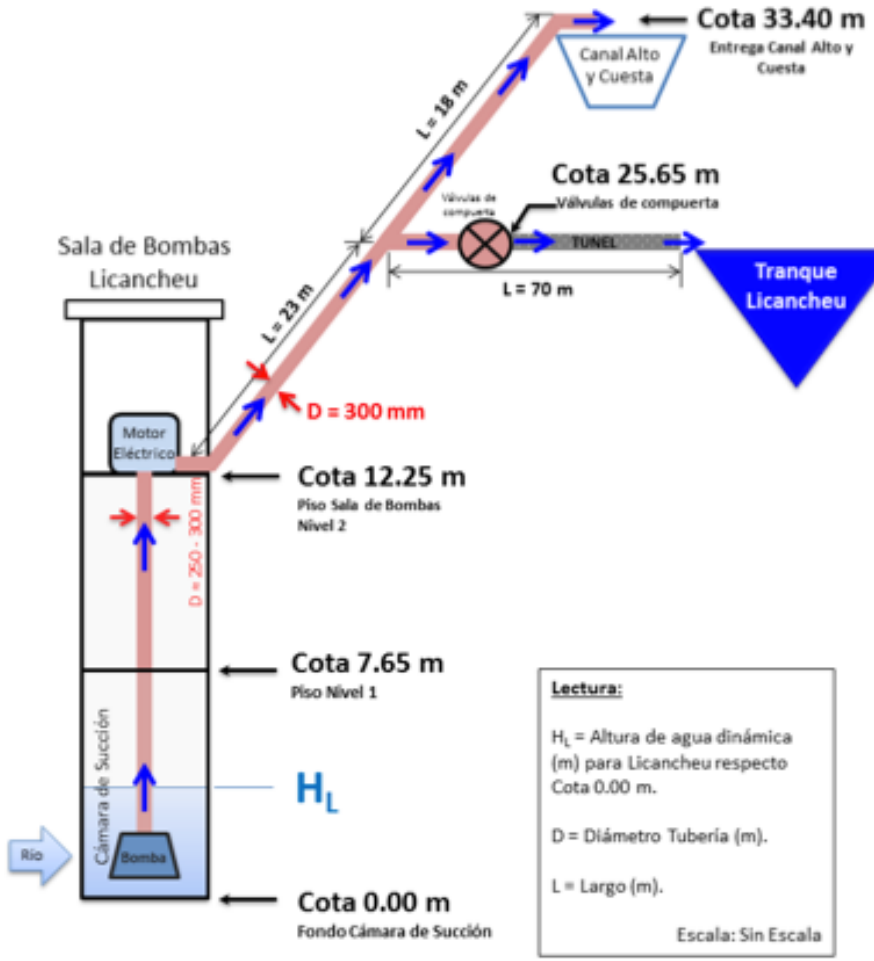
Photovoltaic Energy

Características Técnicas Sist. Fotovoltaico Rapel

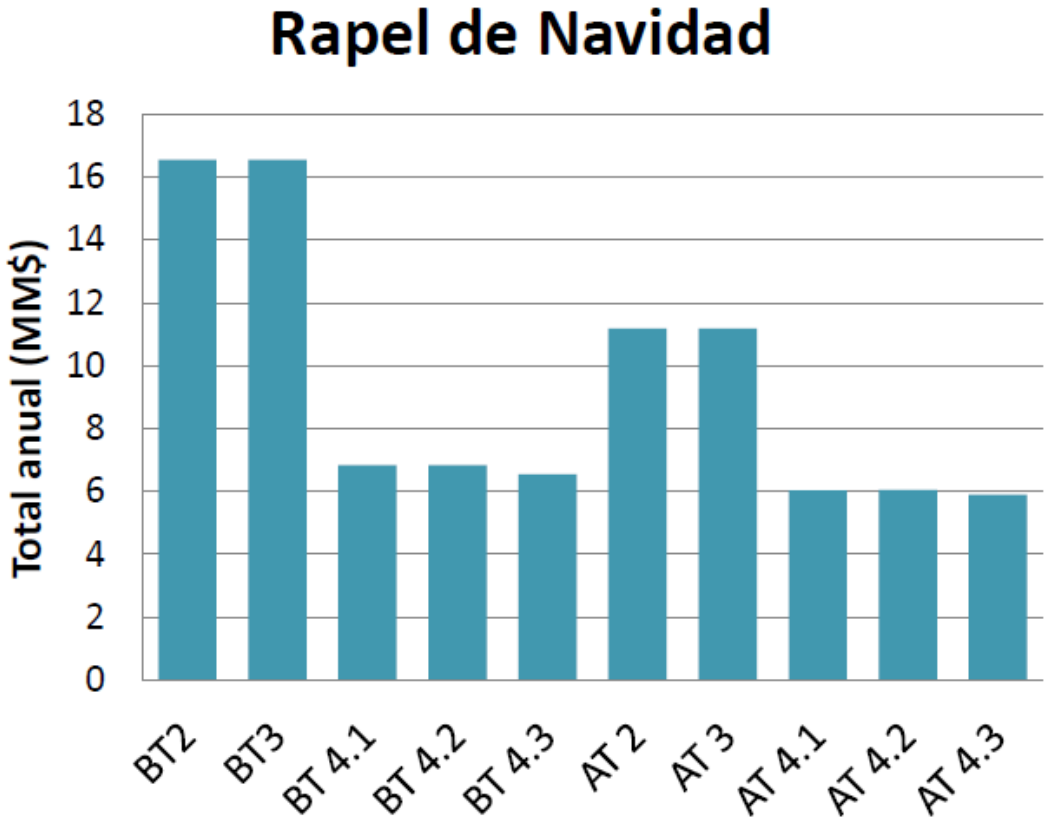
- Sistema de generación de energía basado en energía fotovoltaica que apoya total o parcialmente el sistema eléctrico (On-Grid).
- Cap. Máx. de generación: 39,6 kWp
- Nº Total de Paneles: 176 de 225 W c/u.
- Cap. Máx. Efectiva: 34 kW.
- Nº Total de Inversores: 2 de 20 kW c/u.

Características Técnicas Sist. Fotovoltaico Licancheu

- Sistema de generación de energía basado en energía fotovoltaica que apoya total o parcialmente el sistema eléctrico (On-Grid).
- Cap. Máx. de generación: 40,32 kW
- Nº Total de Paneles: 168 de 240 W c/u.
- Cap. Máx. Efectiva: 34 kW.
- Nº Total de Inversores: 3 de 15 kW c/u.

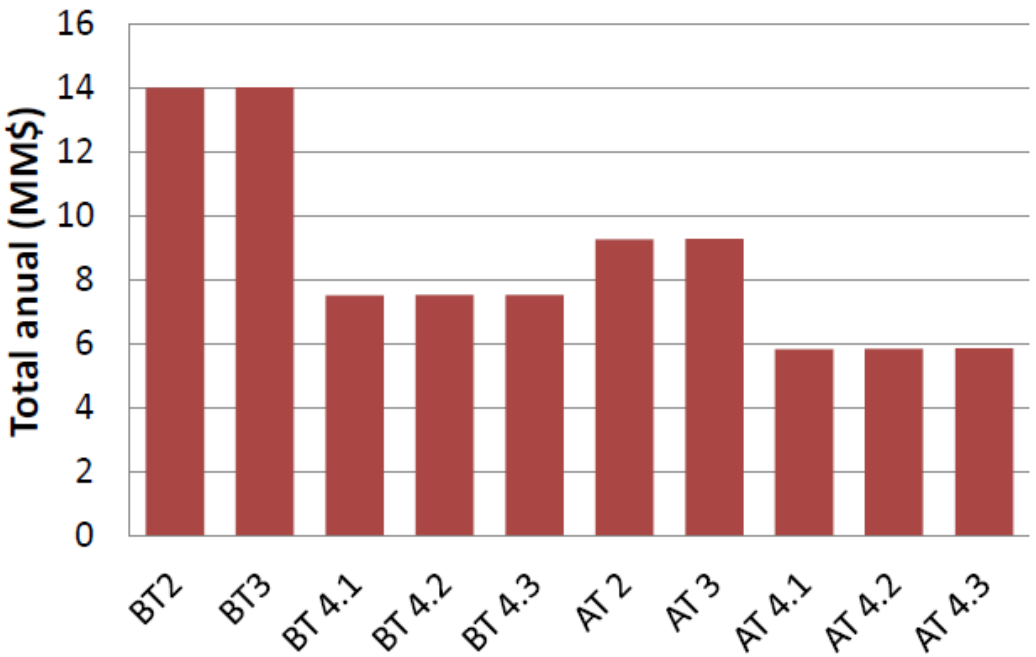


Electric tariffs



	TOTAL ANUAL ($)
BT2	16.535.774
BT3	16.543.695
BT 4.1	6.836.176
BT 4.2	6.844.096
BT 4.3	6.549.292
AT 2	11.171.605
AT 3	11.179.526
AT 4.1	6.036.201
AT 4.2	6.044.122
AT 4.3	5.896.172

Electric Rates



	TOTAL ANUAL ($)
BT2	13.986.984
BT3	13.994.905
BT 4.1	7.510.093
BT 4.2	7.518.013
BT 4.3	7.520.552
AT 2	9.258.935
AT 3	9.266.856
AT 4.1	5.834.272
AT 4.2	5.842.193
AT 4.3	5.844.732

Reduce Operating Costs

	Licancheu
Consumo Energía Histórico (kWh/año)	63.936
Valor de la Energía ($)	60
Costo en Energía ($)	3.836.176
Energía Fotovoltaica Potencial (kWh)	33.458
Nuevo Gasto en Energía (kWh)	30.479
Ahorro en Costos Energía ($)	2.007.458

1 Real = 200 pesos Chilenos
1 Dólar = 700 pesos Chilenos

Reduce Operating Costs

	Rapel
Consumo Energía Histórico (kWh/año)	31.143
Valor de la Energía ($)	60
Costo en Energía ($)	1.868.555
Energía Fotovoltaica Potencial (kWh)	33.458
Nuevo Gasto en Energía (kWh)	- 2.315
Ahorro en Costo Energía ($)	2.007.458

1 Real = 200 pesos Chilenos
1 Dólar = 700 pesos Chilenos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Gobierno de Chile
MINISTERIO DE AGRICULTURA
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Gobierno de Chile
CHILE
Avanza
con todos
SISTEMA DEMOSTRATIVO DE
BOMBEO DE AGUA FOTOVOLTAICO
Convenio Ministerio de Energía e INIA
Fecha de instalación: Octubre 2013

Potencia: 4,7 Kwp
Bomba Solar con caudal hasta 34 m3/hr.
Superficie de riego: 5 ha.
Cultivo: Frambuesa y Mora
Sistema de riego: Goteo
Emisor: Gotero regular 1,6 l/hr a 30 cm, doble linea.
Costo : US$ 24.590.-

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Gracias

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