

Building CERN's Future Circular Collider

An estimation of its impact on value added and employment

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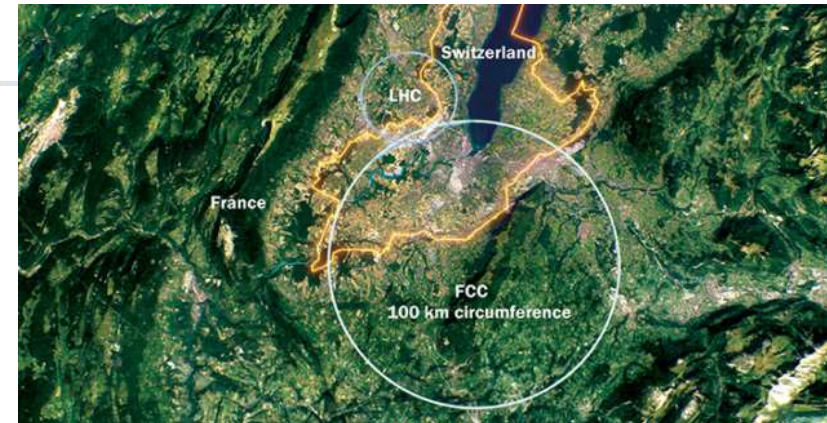
WIFO - Austrian Institute of Economic Research

ESA workshop
Paris, 2023-05-24



Why and what?

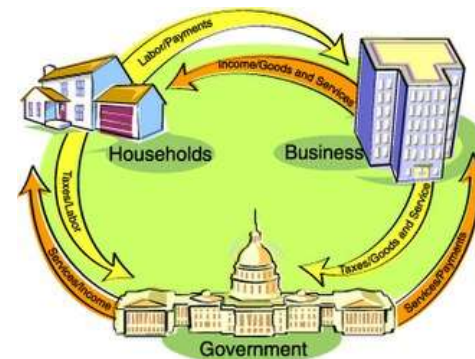
- Huge price tag for Future Circular Collider:
 - 12-20 bn CHF (construction, operation; 2019 estimate)
 - has to be borne by member countries
 - „FCC“ also has to be sold to member countries.....
 - on its scientific merit; but also on economic merit...?
- Multi-dimensional ex-ante examinations of FCC-impact on
 - scientific progress
 - technological development
 - individual (academic) career opportunities
 - **economic linkages – job opportunities**
 - **short term effects** -> jobs needed to build and run the FCC
 - long term effects (effects on know-how and productivity of involved firms) dealt with in a different study



Introduction - the Future Circular Collider FCC

■ Important:

- costs for FCC do not evaporate -> constitute earning opportunities for potential suppliers of goods and services required in the construction and operation of the FCC
- **Someone's got to get the money**
 - „Iron Law of Welfare Economics“

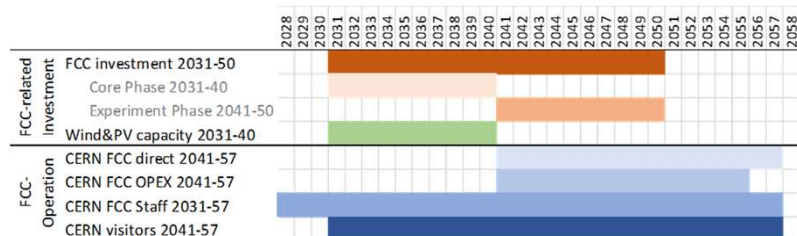


- we will present an estimation as to who this someone might be, and where they might be located.
 - not individual firms, but economic industries in the CERN member states (and beyond).

The project – the Future Circular Collider FCC

■ Chronology and costs of the project

			Investment Volume	annualised Volume
			[mn CHF]	[mn CHF/a]
FCC-related Investment	FCC investment	2031-50	12,097	605
	Core Phase	2031-40	10,709	1,071
	Experiment Phase	2041-50	1,388	139
	Wind&PV capacity	2031-40	644	64
FCC- Operation	FCC OPEX	2041-55	2,950	199
	FCC resident personnel	2028-57	5,400	180
Total		2028-57	21,100	700



estimate economic effects of these spending volumes

in terms of employment (and value added)

taking into account regional and sectoral aspects („where and who“)

ADAGIO – A DynAmic Global Input Output model

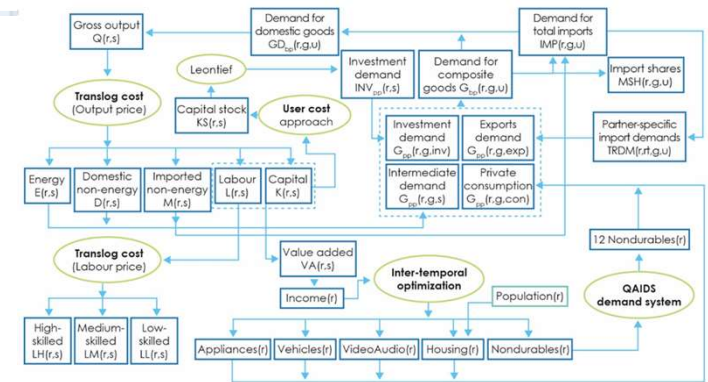
- Widely used impact simulation tool: multi-regional **Input-Output models**
 - divide economy into different sectors/industries in different countries and estimate the flows between them.
- based on **Input-Output tables**: describe „technology“ of each of these industries:
 - vector of **inputs** (commodities = materials, services) is combined with **labour** and **capital** to produce **output**: **Output Q = f(L,K,M,S)**
- various links to „rest of the economy“:
 - this vector of **inputs** represents goods and services purchased from firms from same/other sectors, domestic source or imported from abroad
 - -> **upstream linkages**
 - **Labour** and **capital** owners get their share of Value added (wages, profits)
 - -> feeds into **final demand** (consumption, investment)
 - again, this constitutes demand for domestic/imported commodities.
- multi-regional IO table describes **consistent** flows between all sectors in all regions
 - imports of some country = exports of some other country
 - output of some firm = input of some other firm or final demand

		Region 1			Region r			RoW	Total
		Products	Industries	Final Demand	Products	Industries	Final Demand		
Region 1	Products		U^{11}	Y^{11}		U^{1r}	Y^{1r}	e^1	g^1
	Industries	V^1							x^1
Region r	Products		U^{r1}	Y^{r1}		U^{rr}	Y^{rr}	e^r	g^r
	Industries				V^r				x^r
Rest of World			U^{RoW1}	Y^{RoW1}		U^{RoWr}	Y^{RoWr}		m^*
Value Added			W^1	0		W^r	0		w^*
Total		g^1	x^1	y^1	g^r	x^r	y^r	e^*	

ADAGIO – A DynAmic Global Input Output model

- **ADAGIO** – a multi-regional Input-Output model

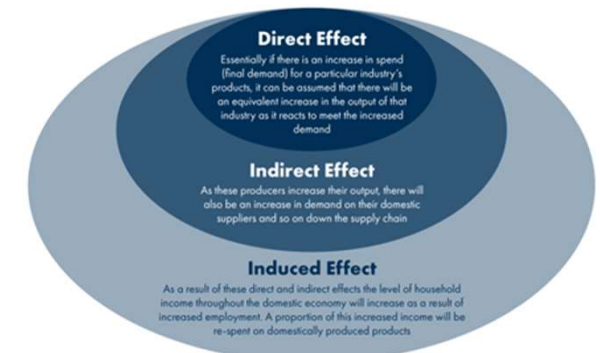
- 43 countries (EU27 & major economies)
- 65 industries/commodities
- fully endogenous sector and trade linkages
- allow to ex-ante simulate effects from „**demand shock**“
 - new demand – e.g. from construction of FCC – translates into production of (and employment in) firms from various sectors and regions



- Simulation setup:

- we include **all production-related** effects into our estimate
- direct effects on suppliers to the FCC
- indirect effects on the suppliers of these suppliers etc.
- depreciation-related investment effects (capital replacement)

Type II output multiplier and direct, indirect and induced output



The project – the Future Circular Collider FCC

- ADAGIO is a tool to answer the central questions of this analysis:
 - how much value added is linked to the construction and operation of the FCC?
 - How much employment opportunities might be generated?

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FCC-related investment

CAPEX - core & upgrade investment phases

renewable capacity

FCC operation

FCC direct effects

OPEX – operational expenditure

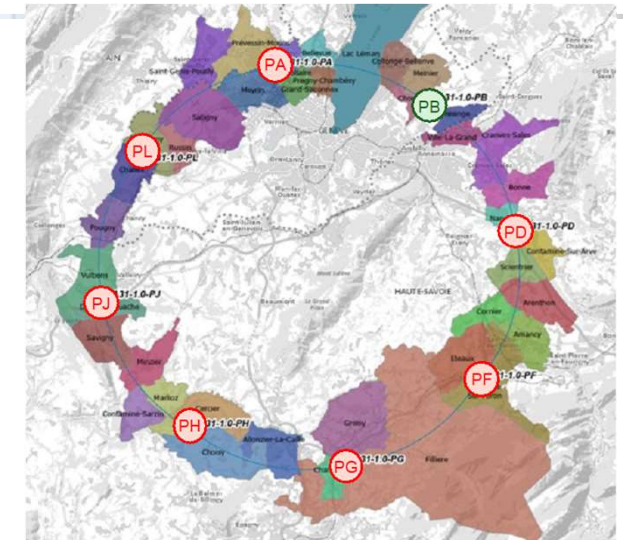
Cost-of-Living of resident personnel and users

Visitors to construction site and FCC

In detail: The investment phase, 2031-40/2041-50

- **Total: ~12 bn CHF**
- technical assets:

FCC section	[mn CHF]
Civil Engineering (Tunnel)	5,250
Accelerator	4,342
Infrastructure	1,805
Experiment	700
Total	12,097



- derive investment demand for commodities
 - translate technical assets into economic classification for ADAGIO
- Sourcing of investment goods: necessary to rely on assumptions
 - ideally proportional to CERN contributions
 - not fully reflected in the past
 - two scenarios – „fair share“ vs. „observed share“
 - commodity structure by country to reflect relative strengths/specialisation

In detail: The investment phase, 2031-50

■ Results – Value added and employment:

■ Investment Volume of 12 bn CHF translates into

- 14.1 bn CHF of world-wide Value added over 20 year construction
- linked to 230 kPY (Person-Years) of employment
 - annual average of almost 12.000 jobs over 20 year construction period

1) 1 Person-Year = amount of labour provided by 1 employee in a 1 year period.
allows to add up employment over the years

■ largest effects in DEU/GBR/FRA/ITA/ESP

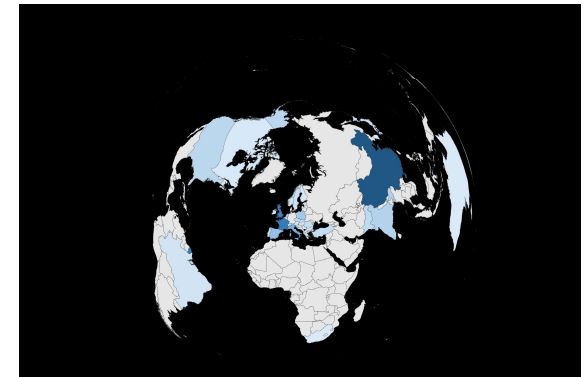
- 57% of VA effects
 - 45% of employment effects
 - to be expected: these 5 are also largest contributors to CERN
- } -> due to superior productivity!

■ But: CHN <1% of contracts, but

- 4.4% of VA effects
 - 10% of employment effects
 - CHN has an important position withing GLOBAL Value Chains!
- } -> lower productivity!

■ largest effects by industry:

- construction, metal products, machinery, electronics





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Visitors to construction site and FCC

In detail: Electricity procurement, 2031-40

- large demand for electricity
 - annually: 1.25-1.95 TWh
- large ecological footprint (and large electricity bill)
- CERN plans to contract out electricity supply to new capacity of renewables (wind, PV)
 - peak demand incl. reserve ~ 500 MW
 - would leave ~20 TWh of off-CERN-peak power over 15 years to be fed into general grid.
 - est. total installation costs (ass. 60 wind : 40 PV): 640 mn CHF
 - location of capacity as yet unspecified („somewhere in Europe“)
- in all, 630 mn CHF of value added and close to 12.000 PY of employment linked to renewables (of which 500 mn CHF and 7.000 PY in Europe)





FCC-related investment

CAPEX - core & upgrade investment phases
renewable capacity

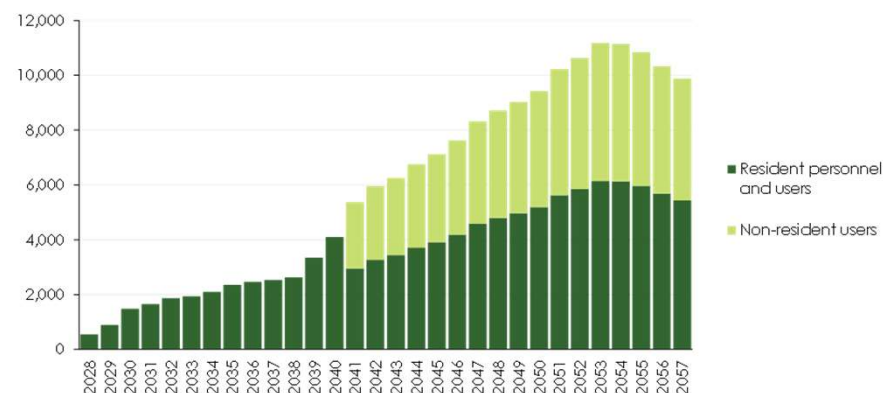
FCC operation

FCC direct effects
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Cost-of-Living of resident personnel and users
Visitors to construction site and FCC

In detail: Direct FCC-related CERN effects, 2041-57

■ Annual Total:

- ~ 200 mn CHF of material inputs (intermediate goods and services)
- plus 450 mn CHF of wages for resident personnel and users



■ various aspects:

- 1 *direct* effects of FCC operation -> VA, employment at CERN
- 2 *direct&indirect* effects of input demand -> VA, employment at suppliers of inputs
- 3 *direct&indirect* effects of consumption by CERN employees
-> VA, employment at suppliers of consumption goods
- 4 tourist expenditures by CERN visitors



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Visitors to construction site and FCC

In detail: Consumption expenditures by CERN employees, 2028-57

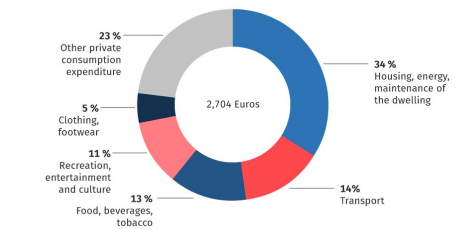
1 direct FCC-related VA and employment at CERN:

- 8.000 jobs on average 2028-2057
- 450 mn CHF of value added
(180 mn CHF of wages + 270 mn CHF depreciation)

2 direct&indirect effects of consumption by resident personnel & users:

- ~ 450 mn CHF wages per year (for resident personnel and users)
- -> 310 mn CHF of consumption expenditure
- -> in all, this consumption expenditure is linked to > 600 mn CHF of Value added supporting >8.000 jobs (of which almost 5.000 in CHE/FRA)
- sectoral effects dominated by „consumption-related“ industries (trade, real estate, personal services)

Private consumption expenditure, 2018
Percentage shares



Source: Sample survey of income and expenditure
© Statistisches Bundesamt (Destatis), 2020



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Visitors to construction site and FCC

In detail: FCC-related OPEX expenditure, 2041-55

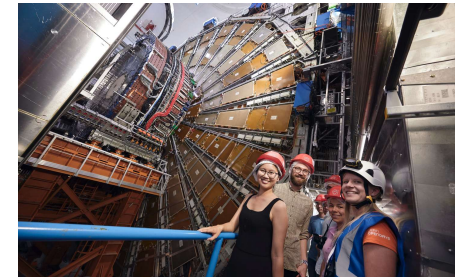
3 direct&indirect effects of input demand - OPEX

-> VA, employment at suppliers of inputs

- ~ 200 mn CHF of OPEX supplies per year
- again assumptions about sourcing of these supplies
- -> in all, linked to 230 mn CHF of Value added supporting 3.400 jobs (of which 2.400 in Europe)

4 Visitors to construction site & FCC

- pre-pandemic: ~150k visitors to CERN per year; will rise to 300k for the FCC
- boost to regional tourism industry: Canton of Geneva records 1.6 mn arrivals and 3.2 mn overnight stays
- especially visitor groups: stay for avg 4 nights, spend around 800 CHF per person (disregard non-group visitors)
- 180 mn CHF of VA per year, 2,700 jobs;
- main benefits to accomodation/restaurants, trade, transportation, cultural sectors
- in France and Switzerland





FCC-related investment

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Summary– the Future Circular Collider FCC

■ Summary of economic effects by project phase:

- construction & operation of FCC directly and indirectly linked to around 50 bn CHF of Value added over its initial 30 year period, offering job opportunities amounting to 800 th Person-years

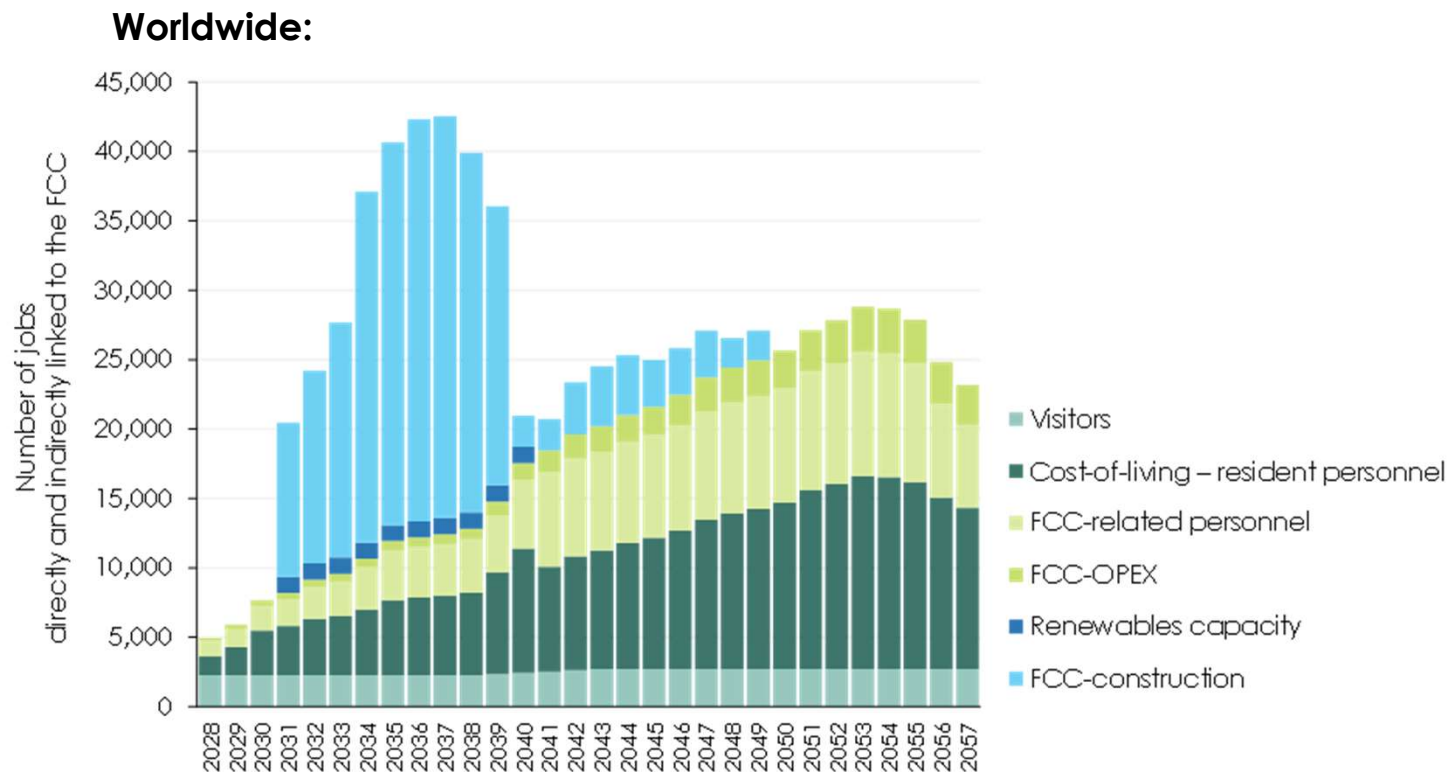
■ annualised effects over 30 years:

- 1.7 bn CHF of Value Added
- linked to 27.000 jobs

			Investment / Consumption Volume	annualised invest/cons volume+	cumulated Value Added effects [mio CHF]					cum. Employment effects [1000 Personyears]				
					Type1			Type2	Sum Total	Type1			Type2	Sum Total
					direct	indirect	total Type1			direct	indirect	total Type1		
FCC-related Investment	FCC investment	2031-50	12,097	605	5,350	6,200	11,550	2,550	14,150	80	100	180	50	230
	Core phase	2031-40	10,709	1,071	4,800	5,500	10,300	2,250	12,550	75	90	160	45	210
	Upgrade phase	2041-50	1,388	139	600	650	1,250	330	1,600	7	11	18	7	25
	Renewables capacity	2031-40	644	64	210	290	500	120	600	3	5	9	3	12
FCC- Operation	FCC direct	2041-57	5,400	180	7,650	-	7,650	-	7,650	170	-	170	-	170
	FCC OPEX	2041-55	2,950	199	1,200	1,500	2,700	800	3,500	13	20	35	15	50
	Cost-of-living – resident	2028-57	9,180	306	4,450	3,150	7,650	11,050	18,700	50	45	95	160	250
	FCC visitors	2028-57	3,900	130	1,400	2,000	3,400	1,800	5,200	20	30	50	25	75
Total		2028-2057	34,200	960	20,300	13,150	33,450	16,350	49,800	340	200	540	250	800

The project – the Future Circular Collider FCC

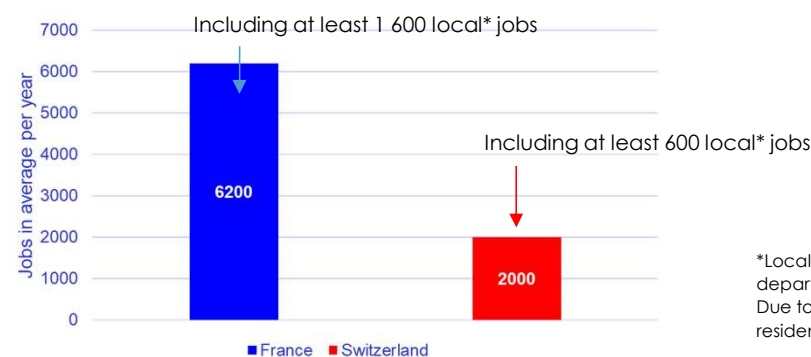
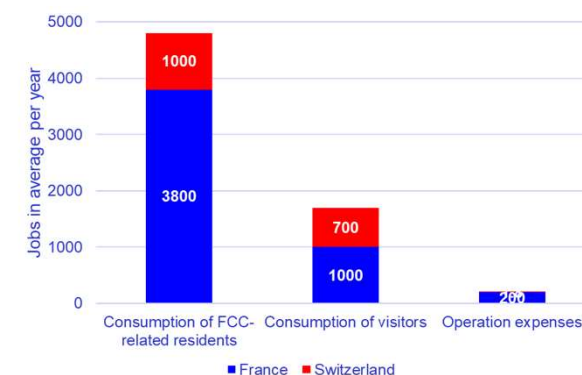
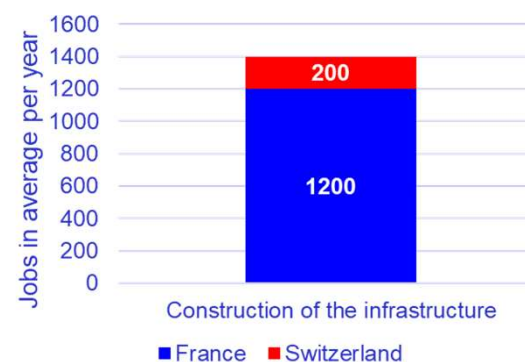
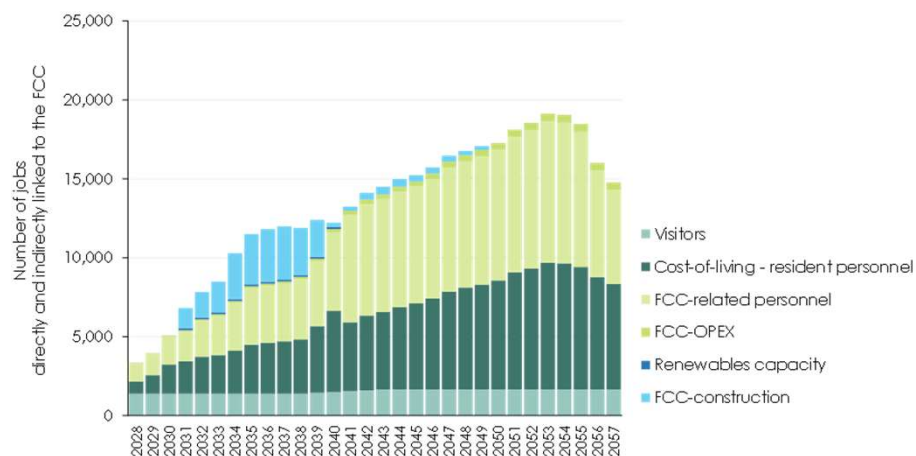
■ Chronology of jobs linked to construction & operation of FCC:



The project – the Future Circular Collider FCC

■ Chronology of jobs linked to construction & operation of FCC:

France & Switzerland:



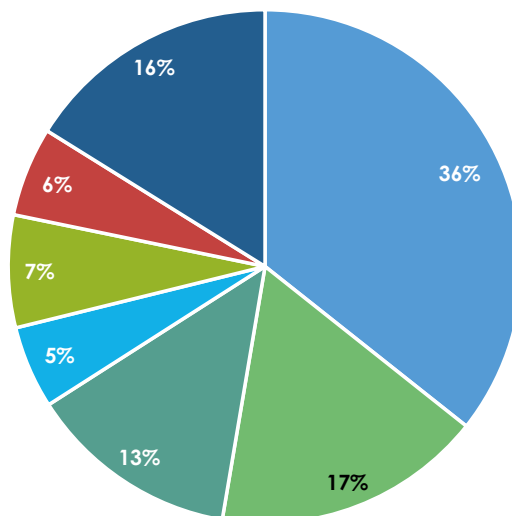
*Local means Ain and Haute-Savoie departments and Canton de Genève. Due to the consumption of FCC-related residents and visitors who spend in the territory.

The project – the Future Circular Collider FCC

■ Economic sectors of employment:

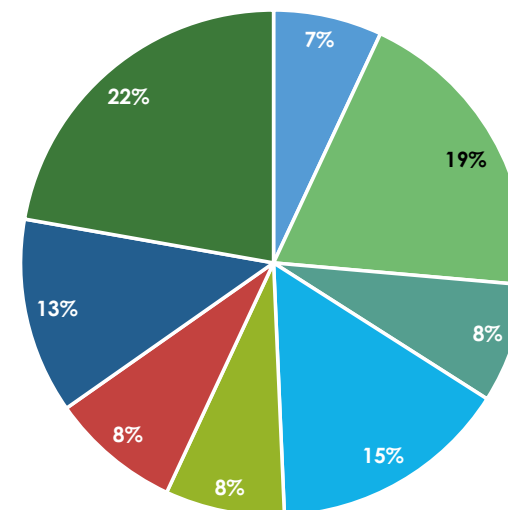
Investment phase

- MANUFACTURING
- CONSTRUCTION
- WHOLESALE AND RETAIL TRADE
- TRANSPORTATION AND STORAGE
- PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES
- ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES
- OTHERS



Operation phase

- AGRICULTURE, FORESTRY AND FISHING
- MANUFACTURING
- CONSTRUCTION
- WHOLESALE AND RETAIL TRADE
- TRANSPORTATION AND STORAGE
- ACCOMMODATION AND FOOD SERVICE ACTIVITIES
- PUBLIC & OTHER SERVICES
- OTHERS



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WIRTSCHAFTSFORSCHUNG

Thanks a million!

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