Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

P.2120-A01-04 – SBQ Production Strategy

07.10.2024 | Rheinfelden | Thomas Narholz, Bernard Villemin, Riccardo Pasinato, Sepp Kohl, Pascal Stenger I Uwe Wilhelm, Roberto Canzutti

SBQ PRODUCTION STRATEGY

SBQ PRODUCTION STRATEGY

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

INTRODUCTION

CMIC is currently producing in the industrial complex of Chardomalou (CHM) the following products :

- 10.000.000 tpy of iron ore concentrate at the mining site
- 3.800.000 tpy of iron oxide pellets
- 1.600.000 tpy of direct reduced iron
- 1.300.000 tpy of steel billets (semi-product)

Exceeding amounts of the different materials which are not used in the subsequent production stages are sold on specific markets. CMIC now intends to carry out a major modernization strategy of the metallurgical plant facilities with the three main objectives:

- Increase Productivity utilizing existing technical assets
- Shift of Production towards SBQ (special bar quality) grades
- Expansion by installation of downstream according to market study and market share

In order to plan properly the expansion of production mix to SBQ quality and to utilize appropriately the available land, without impact for additional future potential development of the complex, NPT suggests to evaluate the overall group strategy.

The group includes two main complex:

- **Chadormalu Mining and Industrial Co (CMIC)**
- **Sarmad Abarkuh**

On the following pages the two entities are described more in detail.

Source:
NPT

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INTRODUCTION

Chadormalu Mining and Industrial Co at a Glance

Chadormalu mining and industrial plant is covering the value chain of crude steel production thoroughly including mining, ore beneficiation, pelletizing, direct reduction and steel making plant. The plant includes two major parts, one part is the mining and ore beneficiation plant which is located in north east of Yazd City and the other part is pelletizing, direct reduction and steel making plant which is located in Ardakan city in north west of the Yazd. The concentrate is being transferred from the mine and beneficiation plant to the pelletizing, DRP and steel Meltshop via rail transportation system.

For the reduction of energy loss in the plant, the steel making plant equipped with hot charging of the DRI via Aumund conveyors to convey the hot sponge iron from direct reduction kilns to electric arc furnace.

The plant near Ardakan city consists of:

1. Wagon dumping system
2. One Pelletizing plant 3.4 MTPA iron ore pellets
3. Direct reduction plant 1.55 MTPA sponge iron
4. Steel making plant 1.2 MTPA as cast product
    a. An Electric arc furnace with 170 tap size
    b. One Ladle furnace
    c. One fume treatment plant
    d. One continuous casting machine
    e. Air separation plant
5. Power plant




Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

INTRODUCTION

Sarmad Abarkuh at a Glance

Introduction:

Sarmad Abarkuh Steel Industries Company, with a capacity of 450 thousand tons, has been operating since 2016 in Abarkuh City, Yazd Province, with majority shares held by Chadormalu Mining and Industrial Company (approximately 52%) and Tajjali Investment and Development Company (approximately 48%).

The company produces A3 type rebars ranging from sizes 8 to 32.

With the utilization of Italian technology from STG, since 2021, the construction of steelmaking, rolling mill, and direct reduction units has commenced with an investment of over 300 million euros.

Investments and Development Plans:

The steelmaking technology for this unit has been sourced from STG company, for the production of 600 thousand tons of rebars in sizes ranging from 6 to 12 meters. As of the end of 2023, this project has achieved over 60% physical progress. The planned time for utilizing this project is the first half of 2025.

Direct Reduction Iron (DRI) Unit Establishment with a Capacity of 1.2 Million Tons:

To facilitate the supply of raw materials for the steelmaking unit, a project for the construction of a Direct Reduction Iron (DRI) unit with an annual capacity of 1 million and 20 thousand tons of sponge iron commenced in June 2022. This project achieved over 40% physical progress by the end of 2023. According to the planned schedule, the project will be completed in November 2025.

Establishment of a Rolling Mill Unit with a Capacity of 450 Thousand Tons:

To create product diversity and considering the existing infrastructure, a rolling mill unit for the production of rebars and simple steel wires in sizes ranging from 5.5 to 16 mm will be established using POMINI Srl. technology.

This project's investment is approximately 20 million euros and is expected to be completed and operational.

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

INTRODUCTION

Sarmad Abarkuh at a Glance

Planning and Securing the Necessary Infrastructure for Development Plans:

1. **Water Supply (Persian Gulf Water Transfer Project to Sarmad Abarkuh Steel Company):**

   To provide the necessary water for industrial projects, a contract has been signed with Farabarsan Company to supply 5 million cubic meters of water annually for 30 years through the water transfer line from the Assaluyeh to Fars and Isfahan provinces. This 860-kilometer water line will provide water to Sarmad Abarkuh Steel Company.

2. **Electricity Supply:**

   The construction of a 40-megawatt solar power plant (10 megawatts in the first phase) will begin in June 2025. Additionally, the company has taken steps to build a 150-megawatt combined cycle power plant to ensure a stable and sustainable electricity supply.

Company Achievements in 2023

- Achieved a nominal capacity of 450 thousand tons and the highest production capacity since the company's establishment, amounting to 475,000 tons.
- Set a new daily production record of 2,138 tons and a new monthly production record of 47,623 tons.
- Achieved 30% progress in the steelmaking project and 25% progress in the direct reduction project.
- Successfully installed all foreign equipment for the rolling mill project within less than 6 months.

Source:
NPT

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INTRODUCTION

In the following slides are outlining the following:

- Slide Page 9: The **actual status / configuration** of the plant of **Chadormalou** as well as its **«sister plant» of Sarmad**, since the 2 plants as strictly connected in therms internal use of semifinished products and product mix for the market.

- Slide Page 10: The **actual investment strategy** of the 2 plants, which includes
  - the investments already on-going in Sarmad Plant (up- and down-stream) making the plant independent from Chadormalou in the near future in regards of billets requirement and with diversification of product mix (rebars in bar and wire rod)
  - The actual strategy of Chadormalou to extend the product mix to high quality steel grades (SBQ) as part of the present study

- Slide Page 11: **Suggestion of NPT** for a proper utilization of CMIC :
  - Downstream Optimization of the actual capacity of the CMIC Meltshop (currently up to 1.2 Mt/y of Billets) for the production of:
    - SBQ Final Products (amount and technological outline to be defined in the present study);
    - Remaining billet production instead of selling “semi-finished products” to do a further diversification into final product mix (rebars, bar in coils, light/medium sections) to be sold to the local and international market

The chapter 05, the document will provide a concept of full utilization of the actual available site plot at Chadormalou, which should be able to properly host

- a **new SBQ rolling mill** and all his required utilities and auxiliary plants
- an **additional rolling mill for long products**, to be defined in a further detailed study (the current indicated rolling mill to be considered as an example for Rebars in coils, bars and light section, but should be properly studied)
- a **new finishing processing line** (which could be located in Chadormalou site or in Maybod available land) for additional added value to the final long product (e.g. cut-and-bend equipment)

Source:
NPT

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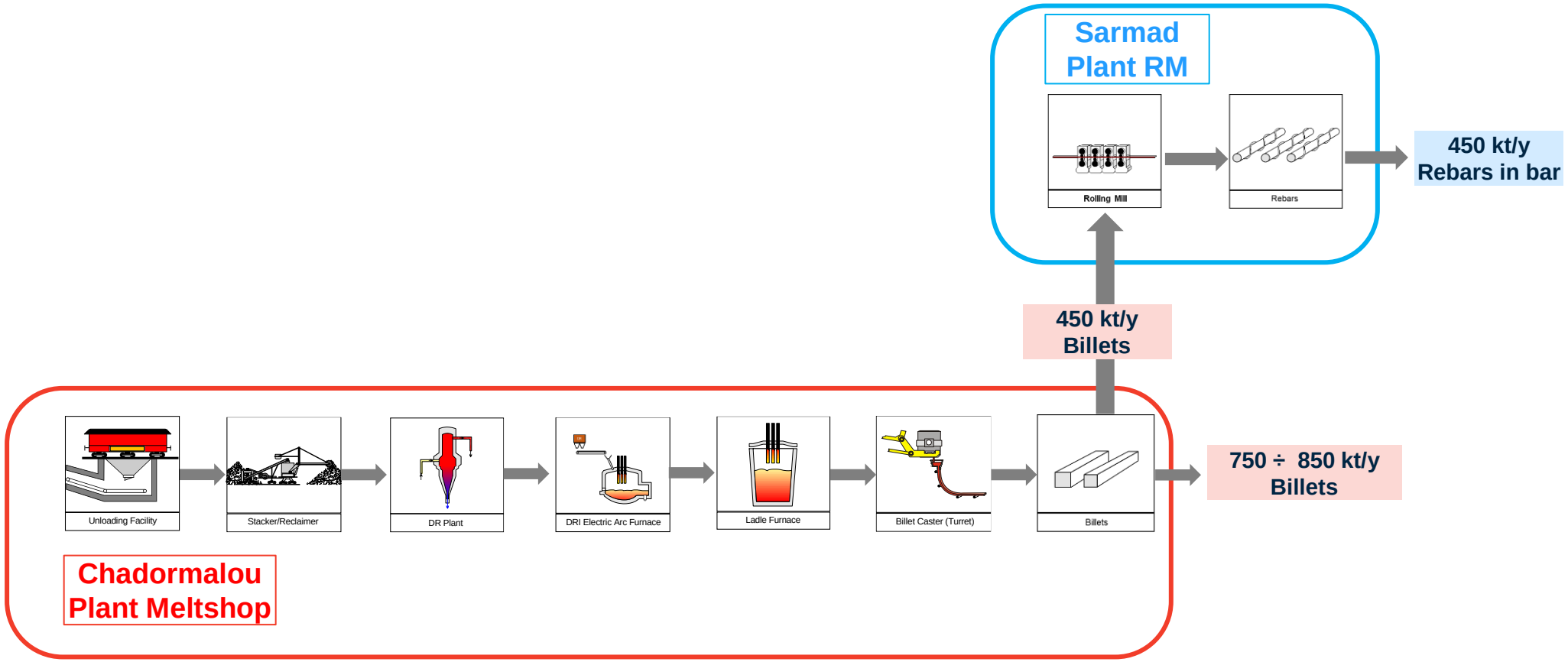
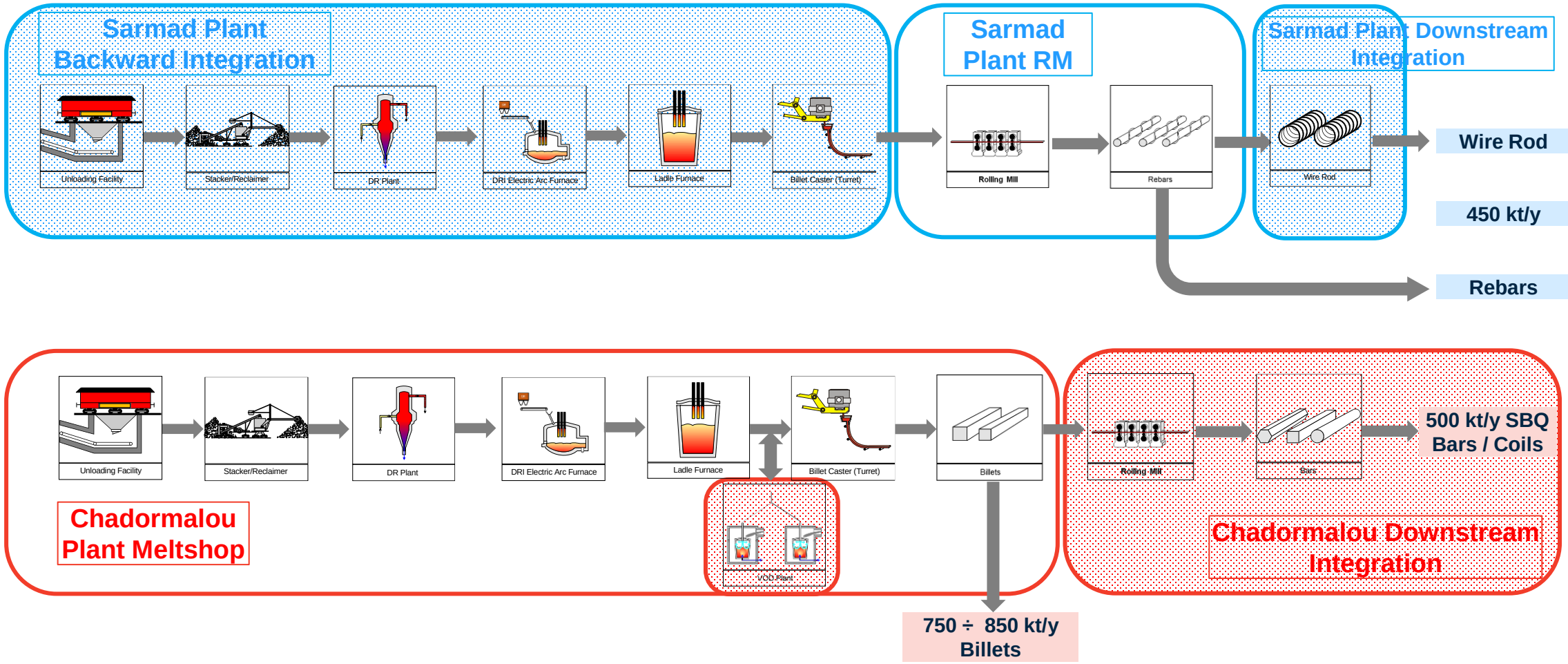
INTRODUCTION – Actual Group Production



Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

INTRODUCTION – Future Production Plan: Actual Planning



Source: NPT

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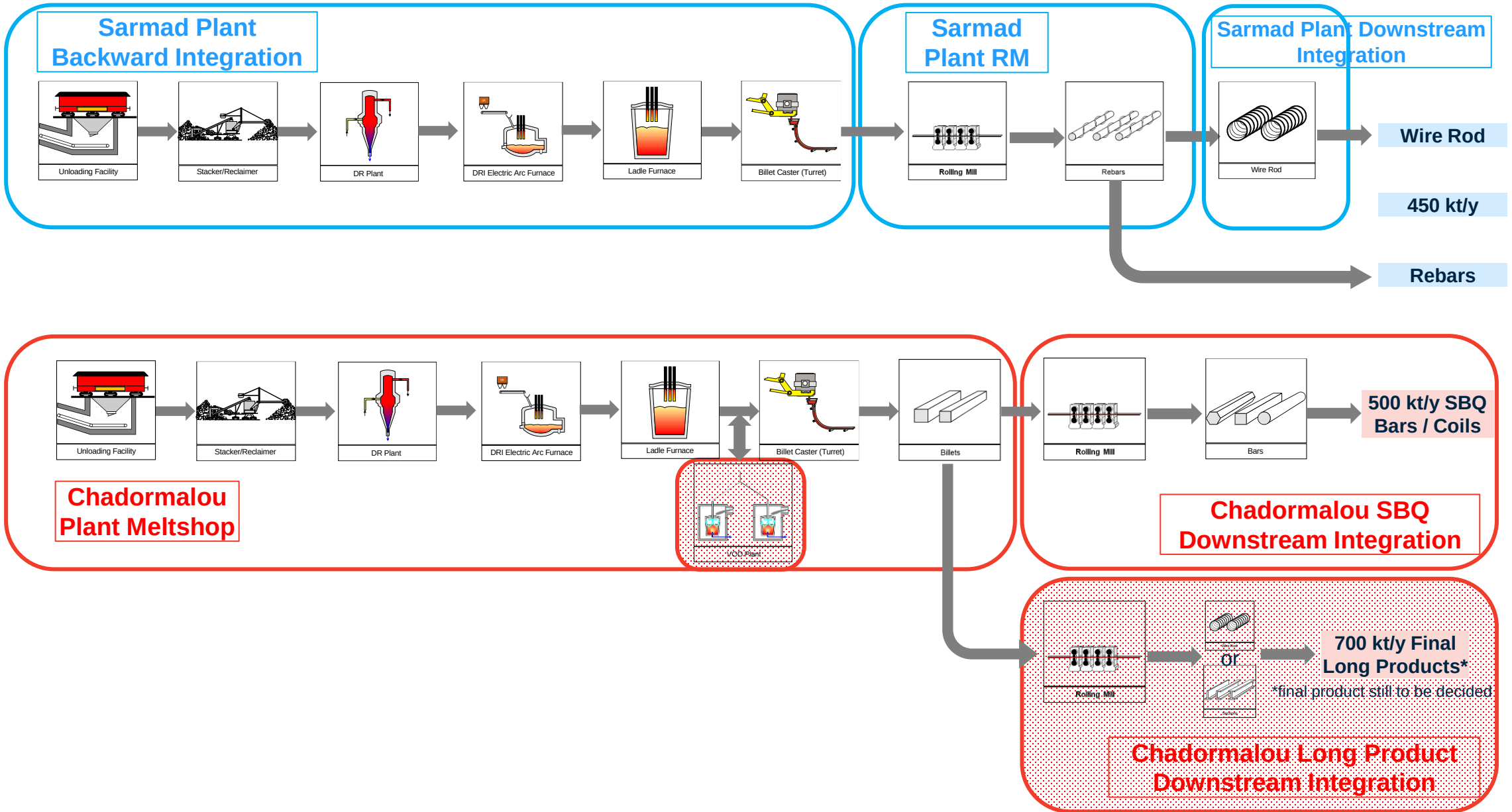
INTRODUCTION – Future Production Plan: Actual Planning

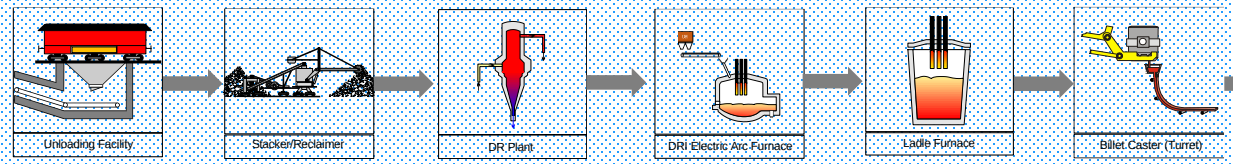


Source: NPT

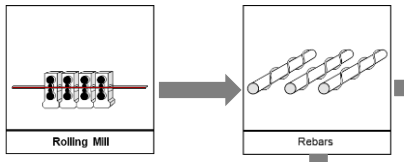
Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

INTRODUCTION – Future Production Plan: Actual Planning

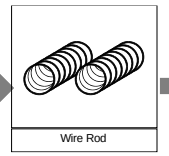
Sarmad Plant Backward Integration



Sarmad Plant RM



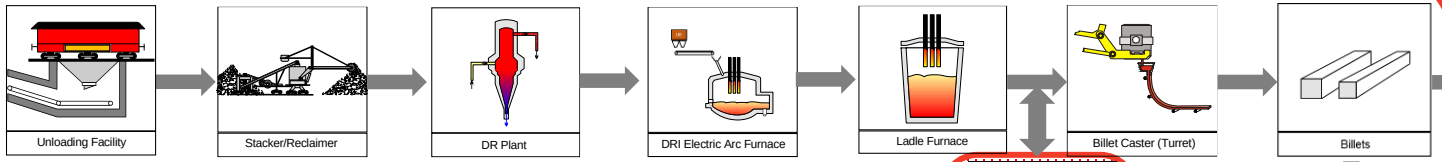
Sarmad Plant Downstream Integration



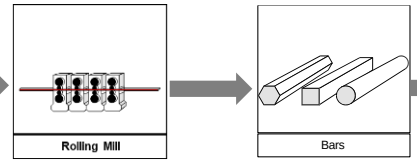
Wire Rod

450 kt/y

Rebars

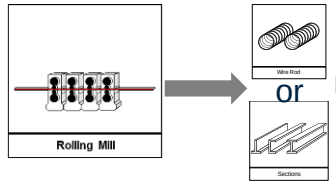


Chadormalou Plant Meltshop



500 kt/y SBQ Bars / Coils

Chadormalou SBQ Downstream Integration



700 kt/y Final Long Products*

*final product still to be decided

Chadormalou Long Product Downstream Integration

Finishing lines for commercial products, i.e. Cut&Bend equipment

? at CMIC or Meybod Plant ?

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

INTRODUCTION

In the chapter 05 a suggested layout has been developed considering the potential additional future expansion of Chadormalu complex, considering the production mix already planned for Sarmad Complex and considering the new SBQ production mix envisaged for Chadormalu.

A new Rolling Mill Line (in addition to the SBQ Mill Lime) could be studied considering:

- The possibility to utilize the remaining billets (not used for SBQ product) as Hot Charge in a Reheating Furnace (low Gas Consumption) or even a semiendless Casting & Rolling, without Gas utilization, but only Induction Heating for temperature uniformity.
- The 2 above solution will depends on the final product :
    - Small/Medium section
    - Wire Rods (probably not required, due to the new WR Mill in Sarmad)
    - Rebars in bar

Eventually the new products could be completed downstream with adding values facilities, such as a Cut & Bend fabshop which could be located inside the boundaries of Chadormalu or eventually in Meybod area, following the recommendations of the local authorities.

In the following slides, the strategy specifically of SBQ production has been analysed, starting from the results of the Market Study.

Source:
NPT

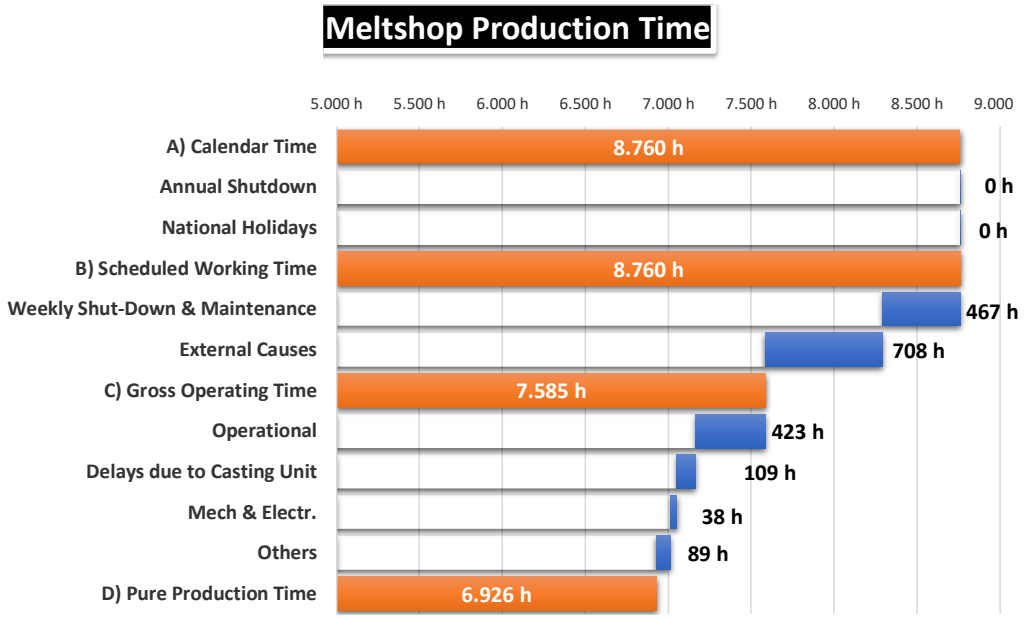
SBQ PRODUCTION STRATEGY

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

OPERATING TIME AND PRODUCTION BALANCE

Meltshop Production Time - Actual 2023

KPI			Weeks	Days	Hours
A) Calendar Time			**52**	**365**	**8.760**
Annual Shutdown	0 d/year	0,0%		0	0
National Holidays	0 d/year	0,0%		0	0
B) Scheduled Working Time			**52**	**365**	**8.760**
Weekly Shut-Down & Maintenance	9,0 h/week	5,3%		-19,5	-467
External Causes	13,6 h/week	8,1%		-29,5	-708
C) Gross Operating Time			**45**	**316**	**7.585**
Operational	-1,34 h/day	-5,58%		-18	-423
Delays due to Casting Unit	-0,34 h/day	-1,44%		-5	-109
Mech & Electr.	-0,12 h/day	-0,50%		-2	-38
Others	-0,28 h/day	-1,17%		-4	-89
D) Pure Production Time			**41**	**289**	**6.926**



Plant Availability	**=D/C**	**91,3%**
Utilization Factor	**=D/B**	**79,1%**

The table above shows the actual recordings of operation time as described in the study chapter 02 - Assessment of the Plant (reference year 2023).

Actually the Maintenance scheduled as “Annual Shut Down” are “hidden” inside the External Causes, which are mainly due to lack of electrical energy.

Due to the fact the at Chadormalu Complex a new dedicated power plant has recently been commissioned, in future the stoppage due to lack of power will be drastically reduced. Additionally the improvement described in the Study chapter 02 will reduce the maintenance time (especially linked to EAF refractory life).

The target Operating Time for the melthsop, shown in the next slide, will consider a Net Operating Time of **approx. 7.200 h**.

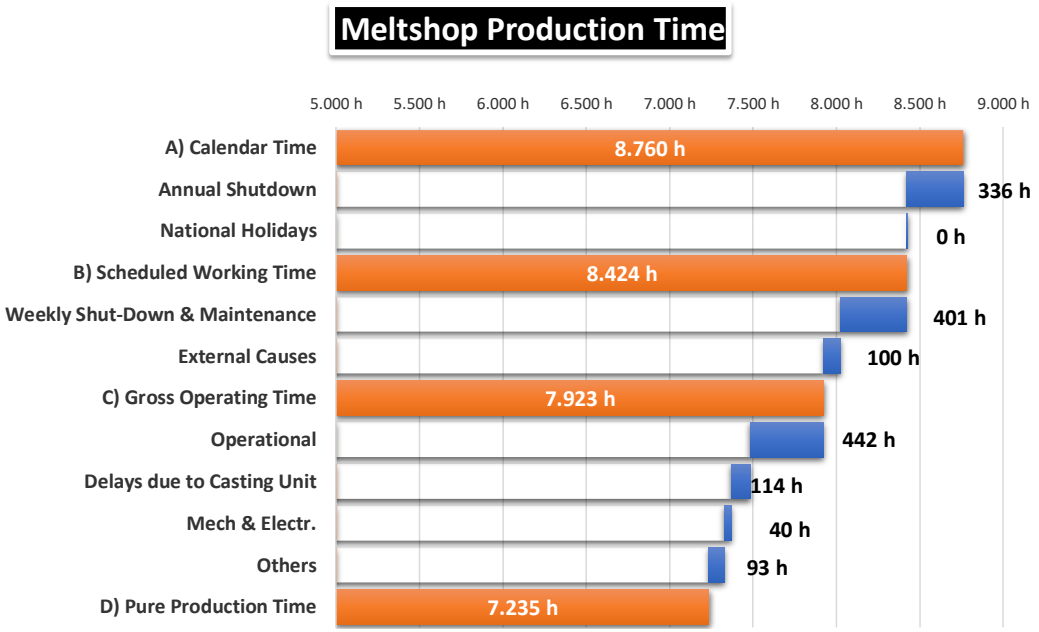
Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

OPERATING TIME AND PRODUCTION BALANCE

Meltshop Production Time - Reference for 2024

KPI			Weeks	Days	Hours
A) Calendar Time			**52**	**365**	**8.760**
Annual Shutdown	14 d/year	3,8%		-14	-336
National Holidays	0 d/year	0,0%		0	0
B) Scheduled Working Time			**50**	**351**	**8.424**
Weekly Shut-Down & Maintenance	8,0 h/week	4,8%		-16,7	-401
External Causes	2,0 h/week	1,2%		-4,2	-100
C) Gross Operating Time			**47**	**330**	**7.923**
Operational	1,34 h/day	5,58%		-18	-442
Delays due to Casting Unit	0,34 h/day	1,44%		-5	-114
Mech & Electr.	0,12 h/day	0,50%		-2	-40
Others	0,28 h/day	1,17%		-4	-93
D) Pure Production Time			**43**	**301**	**7.235**



Plant Availability	**=D/C**	**91,3%**
Utilization Factor	**=D/B**	**85,9%**

Considering all above improvements, a Net Operating Time of approx. 7.200 h for future production schedule would be achievable and will be considered for the implementation of the SBQ production line.

The percentage of delays has not been reduced, while the actual hours will slightly increase, due to additional Gross operating Time available.

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

OPERATING TIME AND PRODUCTION BALANCE

Project Chadormalou

Actual Meltshop

Raw Material	Billets
1.448.000 t/y scrap	1.200.000 t/y billets

Actual Production Balance

Considering the Operating time target and actual main operating data of Meltshop (tapping weight, alloy additions, yields, casting time etc.) it is possible to produce approx. 1.2 Mt of Billets per years.

Raw Material

Total	Purchased Scrap	14.500 t/year	
	Return Scrap	19.592 t/year	
	DRI/HBI	1.413.640 t/year	

DRP

Charge Mix			
	HMS 1&2	1%	14.500 t
	Sheared	0%	0 t
	Shredded	0%	0 t
	Return	1,4%	19.592 t
	HDRI	80%	1.153.050 t
	CDRI	18%	260.590 t
	HBI	0%	0 t

Total Charge Mix
1.447.700 t/y

Meltshop

Production			
	Gross Operating Time	7.922 h	
	CCM Waiting	56 min/seq.	50%
	Unforeseen interruption time	5,1% 3,6 min/heat	
	Net Operating Time	6.890 h	

EAF			
	Heat Size	**181 t**	
	Net TTT	**61,7 min**	
	Pon	54,7 min	
	Yield	83,8%	
	EE	560 kWh/t	
	P_{avg}/P_{max}	90%	
Trafo	Required	161 MVA	
	Actual	160 MVA	
	Productivity	176,1 t/h	
		1.213.207 t/y	
	Production	6.703 Heat/year	
		20,3 Heat/day	

LF + VD			
	LF	1.224.490 t	100,9% Yield
	LF-VD	0 t	103,0% Yield
	Heat Size	183 t	

Total Meltshop Production
1.224.490 t/y

Continuous Casting

Production					
	Gross Operating Time	7.922 h/year		Net Operating Time	7.475 h/year
	Restr. & Ramp Time	447 h/year		Casting Time	6.667 h/year
	Unforeseen interruption time	9,8% due to MS		Utilisation Factor	89,2%
		1,0% due to CCM		Yearly Productivity	180,0 t/h

Design	Strands	6	Radius	10,25	Metalurgical Length	34,8	m

		Product	Billet A	Billet B				
	Share of Production Time		17%	83%	0%	0%	0%	0%
	Billet Size	mm	150	200				
		mm	150	200				
	Linear Weight	t/m	0,172	0,306				
	Yield		98,0%	98,0%	98,0%	98,0%	98,0%	98,0%
	Operative Strands		6,0	5,5				
	Speed Max	m/min	3,5	2,1				
	Speed Actual	**m/min**	**2,9**	**1,8**				
	Metalurgical Length	m	23,4	28,8				
	Casting Time	**min**	**59,7**	**59,7**				
	Casting Time	h/year	1.111	5.556				
	Sequence	heats	10	10				
	Restranding & Ramps	min	40	40				
	Total sequence time	h	10,6	10,6				
	Number of Sequence	#/year	112	559				
	Productivity Max	t/h	216,9	212,1				
	Productivity Actual	**t/h**	**180,0**	**180,0**				
Production	**Actual**	**t/y**	**200.000**	**1.000.000**				

Total CCM Production
1.200.000 t/y

Overall Losses from DRI&Scrap to Billets = 17,11%

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

OPERATING TIME AND PRODUCTION BALANCE

Project Chadormalou

Future Meltshop

Raw Material	Billets
1.436.000 t/y scrap	1.200.000 t/y billets

Future Production Balance, with SBQ

The billets required for SBQ qualities should not result in a loss of production in the CCM due to the design of the machine . The billets size and production mix will be explained in the following slides:

- 61 % billets 150x150 mm
- 39 % billets 250x250 mm

Raw Material

Total	Purchased Scrap	14.400	t/year
	Return Scrap	19.592	t/year
	DRI/HBI	1.401.650	t/year

DRP

Charge Mix				
	HMS 1&2	1%	14.400	t
	Sheared	0%	0	t
	Shredded	0%	0	t
	Return	1,4%	19.592	t
	HDRI	80%	1.143.240	t
	CDRI	18%	258.410	t
	HBI	0%	0	t

Total Charge Mix
1.435.600 t/y

Meltshop

Production			
	Gross Operating Time	7.922	h
	CCM Waiting	47	min/seq.
	Unforeseen interruption time	0,1%	0,1 min/heat
	Net Operating Time	7.162	h

60%

EAF				
		Heat Size	**178**	**t**
		Net TTT	**63,6**	**min**
		Pon	56,6	min
		Yield	83,8%	
		EE	560	kWh/t
		P_{ave}/P_{max}	90%	
	Trafo	Required	153	MVA
		Actual	155	MVA
	Productivity		168,0	t/h
			1.203.048	t/y
	Production		6.759	Heat/year
			20,9	Heat/day

LF + VD			
	LF	714.286 t	100,9% Yield
	LF (VD) SBQ	510.204 t	103,0% Yield
	Heat Size	181 t	

Total Meltshop Production
1.224.490 t/y

Continuous Casting

Production				
	Gross Operating Time	7.922	h/year	Net Operating Time 7.096 h/year
	Restr. & Ramp Time	826	h/year	Casting Time 6.667 h/year
	Unforeseen interruption time	3,1% due to MS		Utilisation Factor 93,9%
		3,0% due to CCM		Yearly Productivity 180,0 t/h

Design	Strands	6	Radius	10,25	Metalurgical Length	34,8	m

	Product		Billet A	Billet B	SBQ 1	SBQ 2	SBQ 3	SBQ 4
	Share of Production Time		8%	50%	25%	16%	0%	0%
Billet Size		mm	150	200	150	250		
		mm	150	200	150	250		
Linear Weight		t/m	0,172	0,306	0,172	0,478		
Yield			98,0%	98,0%	98,0%	98,0%	98,0%	98,0%
Operative Strands			6,0	6,0	6,0	6,0		
Speed	Max	m/min	3,5	2,1	3,5	1,1		
	Actual	**m/min**	**2,9**	**1,6**	**2,9**	**1,0**		
Metalurgical Length		m	23,4	28,8	23,4	23,6		
Casting Time		**min**	**59,2**	**59,2**	**59,2**	**59,2**		
Casting Time		h/year	556	3.333	1.694	1.084		
Sequence		heats	10	10	5	5		
Restranding & Ramps		min	40	40	60	60		
Total sequence time		h	10,5	10,5	5,9	5,9		
Number of Sequence		#/year	56	338	343	220		
Productivity	Max	t/h	216,9	231,3	216,9	189,3		
	Actual	t/h	**180,0**	**180,0**	**180,0**	**180,0**		
Production	**Actual**	**t/y**	**100.000**	**600.000**	**304.873**	**195.127**		

Total CCM Production
1.200.000 t/y

Overall Losses from Processed Scrap to Billets = 16,41%

Source: NPT

SBQ PRODUCTION STRATEGY

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ DEFINITION

SBQ, or **Special Bar Quality**, steel grades are high-quality steel products used extensively in the automotive, machinery, and other manufacturing sectors. These steel grades are characterized by their superior surface quality, concentricity, mechanical properties and precise dimensional attributes.

CHARACTERISTICS

- **SURFACE QUALITY:** SBQ steels have a high standard of surface finish and are free of surface defects that could compromise the performance of the final product, such as seams, scabs, or cracks.
- **DIMENSIONAL ACCURACY:** These steels are produced to maintain tight dimensional tolerances, which is critical for components that require high levels of precision.
- **CONCENTRICITY:** SBQ steels exhibit excellent concentricity, which refers to the uniformity of the steel's cross-section throughout its length. This is important for components that will undergo machining or are expected to perform under high stress.

APPLICATIONS

SBQ steels are primarily used in applications where high stress or critical performance under load is expected. Common applications include:

- **AUTOMOTIVE COMPONENTS:** axles, shafts, gears, and other parts where failure could lead to catastrophic consequences.
- **MACHINERY:** high-strength components in agricultural, construction, and industrial machinery.
- **FASTENERS:** high-strength bolts and screws.

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ DEFINITION

PRODUCTION PROCESS

SBQ steels are often made using electric arc furnace (EAF) or basic oxygen furnace (BOF) processes, followed by secondary refining processes to achieve the desired chemical composition and properties. The steel is then typically cast into billets, blooms, or slabs, and further processed through hot and cold rolling, turning, and grinding to achieve the precise size and surface quality required.

QUALITY ASSURANCE

To ensure that the steel meets SBQ standards, producers conduct a variety of tests, such as ultrasonic testing, magnetic particle inspection, and others to detect internal and surface defects. Additionally, mechanical testing ensures that the steel exhibits the required strength, ductility, and other mechanical properties.

STEEL GRADES

While there isn't a universal grading system for SBQ steel, common designations relate to the chemical composition and mechanical properties, such as 1045, 4140, 8620 in AISI/SAE classification. These numbers represent different alloy compositions and heat treatments that provide distinct properties in strength, hardness, and wear resistance.

The specifics of SBQ steel grades can vary based on the requirements of different industries and applications, but all share the common thread of high quality and capability for critical performance applications.

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ DEFINITION

SBQ (Special Bar Quality) steel grades can be grouped based on several different criteria, each reflecting specific industry needs or manufacturing processes. Here's a look at some typical groupings:

1. BY CHEMICAL COMPOSITION (ANALYSIS)

SBQ steels are often categorized based on their chemical composition. This method focuses on the alloying elements present in the steel, which determine its hardenability, strength, toughness, and other mechanical properties. Common alloying elements include:

- **CARBON STEELS**: Generally contain a higher carbon content for increased hardness.
- **ALLOY STEELS**: Include elements like chromium, molybdenum, nickel, and vanadium, which enhance the steel's mechanical properties and heat treatment response.
- **BORON STEELS**: Contain small amounts of boron, generally added to improve hardenability at lower costs compared to other alloying elements.

2. BY MECHANICAL PROPERTIES

This grouping is based on the mechanical properties that the steel exhibits after heat treatment, such as tensile strength, yield strength, elongation, impact resistance, and hardness. Examples include:

- **HIGH-STRENGTH STEELS**: Designed to withstand high stress and loads.
- **WEAR-RESISTANT STEELS**: Optimized for high wear conditions but might also have high strength.
- **FATIGUE-RESISTANT STEELS**: Engineered to resist failure under cyclic loading conditions.

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ DEFINITION

3. BY MANUFACTURING PROCESS

SBQ steels can also be classified by the methods used to manufacture and finish the steel, which affects the product's final properties:

- **HOT-ROLLED SBQ**: Produced by rolling the steel at high temperatures, typically used for larger diameters.
- **COLD-FINISHED SBQ**: Involves drawing, turning, or grinding hot-rolled steel to provide closer dimensional tolerances and a better surface finish.
- **FORGED SBQ**: Offers superior density and structural integrity by compressing heated steel into specific shapes.

4. BY APPLICATION

Grouping by application is common because it directly relates the steel's properties to its end use, ensuring the material meets the specific demands of the application. Typical applications include:

- **AUTOMOTIVE**: Axles, transmission components, and more, which require high strength and toughness.
- **MACHINERY**: Components subject to high wear and stress.
- **CONSTRUCTION**: High-strength fasteners and reinforcement bars.

5. BY HEAT TREATMENT CAPABILITY

The heat treatment process significantly affects the steel's performance. Grouping by heat treatment capability includes:

- **QUENCHED & TEMPERED STEELS**: Treated to enhance strength and toughness.
- **ANNEALED STEELS**: Heat treated to soften the steel, enhancing its machinability and formability.
- **NORMALIZED STEELS**: Heated and air-cooled to refine the steel's microstructure for uniformity in mechanical properties.

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ DEFINITION

The Group “**BY APPLICATION**” can be further subdivide based on specific end-use requirements or industry sectors. Here's a more detailed breakdown within the "BY APPLICATION" grouping:

1. AUTOMOTIVE INDUSTRY

- **POWERTRAIN COMPONENTS**: Includes crankshafts, camshafts, connecting rods, transmission gears, and differential gears, requiring high strength and fatigue resistance.
- **SUSPENSION COMPONENTS**: Such as torsion bars, stabilizer bars, and coil springs, which need high resilience and impact resistance.
- **STEERING COMPONENTS**: Includes steering racks and pinions, which require precision in manufacturing for smooth operation and durability.

2. MACHINERY AND HEAVY EQUIPMENT

- **HYDRAULIC COMPONENTS**: Such as pistons and cylinders, which need excellent surface finish and strength to withstand high pressures.
- **GEARING & DRIVETRAIN COMPONENTS**: For agricultural and construction machinery, demanding high toughness and wear resistance to cope with variable loads and environmental conditions.
- **SHAFTS AND ROLLERS**: Used in various machines that require precise dimensions and high load-bearing capacity.

3. CONSTRUCTION AND INFRASTRUCTURE

- **BUILDING REINFORCEMENTS**: Includes rebars and tension bars, which require specific strength and ductility to support structural integrity.
- **FASTENERS AND CONNECTORS**: Such as bolts, nuts, and tie rods, needing high tensile strength and shear resistance.
- **CABLE SUPPORT SYSTEMS**: For bridges and large structures, where durability and resistance to environmental stressors are crucial.

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ DEFINITION

4. ENERGY SECTOR

- **OIL & GAS EQUIPMENT**: Includes drilling and pump shafts that must be tough and resistant to corrosion and wear from harsh environments.
- **WIND TURBINES**: Requires high-strength steels for gearbox components and structural supports, which face constant vibration and variable loads.
- **POWER GENERATION COMPONENTS**: Such as turbine shafts and boiler feed pump shafts, requiring high temperature and pressure resistance.

5. AEROSPACE

- **LANDING GEAR COMPONENTS**: Requires steels that can handle high stress and impact loads with excellent fatigue resistance.
- **ACTUATORS AND FITTINGS**: Where precision and strength are paramount to ensure safety and reliability under extreme conditions.

6. CONSUMER GOODS

- **SPORTING EQUIPMENT**: Such as golf club shafts or bicycle frames, which require specific strength-to-weight ratios and aesthetic qualities.
- **TOOLS AND HARDWARE**: Including high-strength hand tools like wrenches and screwdrivers, which need wear resistance and durability.

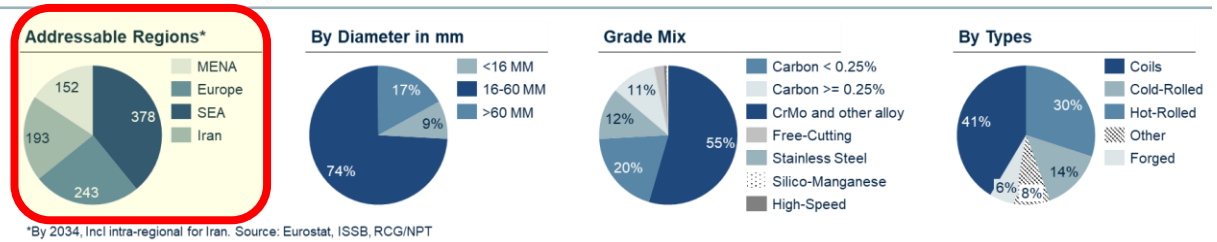
Source: NPT

SBQ PRODUCTION STRATEGY

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SIZING OF THE PLANT

The sizing of the plant, together with the definition of the production mix, must start from the result of the market study: specifically from the accessible market.



*By 2034, Incl intra-regional for Iran. Source: Eurostat, ISSB, RCG/NPT

Accessible Market and Plant Size

	Demand				Serviceable market				Addressable market, kt		
	2022	2027	2030	2034	2022	2027	2030	2034	2027	2030	2034
SBQ	**14.035**	**16.560**	**17.395**	**18.447**	**4.361**	**5.274**	**5.567**	**5.998**	**336**	**587**	**966**
MENA ex Iran	677	895	842	873	513	679	639	663	61	96	152
EU27+UK	9.495	10.837	11.264	11.699	1.971	2.250	2.339	2.429	67	140	243
SEA	3.474	4.343	4.720	5.191	1.487	1.859	2.021	2.222	149	242	378
Iran	389	485	569	684	389	485	569	684	58	108	193

Plant Size	Max Target
500	652

Stainless Steel = 12%

Forged & Other = 14%

Round = 75%

Addressable		
152	16%	MENA ex Iran
243	25%	EU27+UK
378	39%	SEA
193	20%	Iran
966	100%	

Data considered for the definition of the plant size:

- Forecast of Global Market demand for SBQ Products, until year 2034 in the main regions target of the market study
- Accessible Market: 5.2 % of the market demand
- Round shaped Product demand= 75% of the overall demand of SBQ.
- Stainless Steel (mainly flat and party round) is 12% of the addressable market, while forged or other products 14%.
- SBQ Mill Size for CMIC = **500.000 t/y = 76.7%** of the accessible market

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

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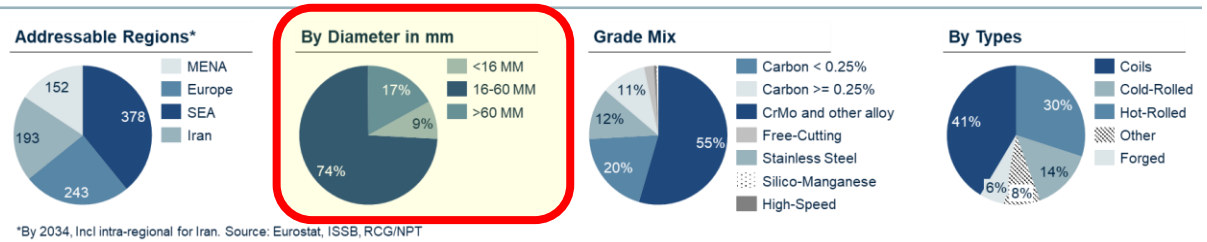
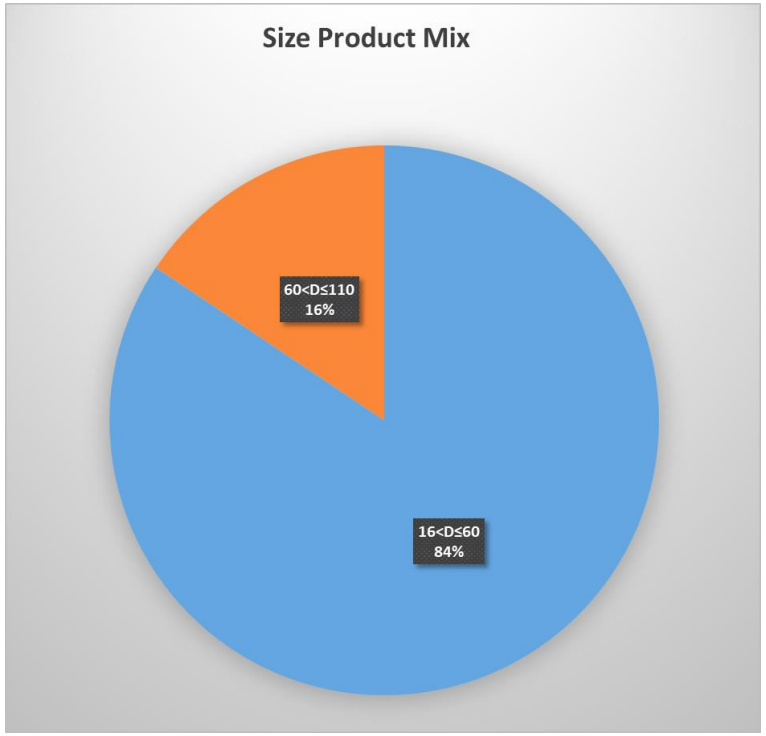


*By 2034, Incl intra-regional for Iran. Source: Eurostat, ISSB, RCG/NPT

Diameter Range

Market				Target			
D≤16	16<D≤60	60<D≤110	D>110	16<D≤60	60<D≤110	16<D≤60	60<D≤110
6,6%	55,5%	10,3%	2,6%	84,4%	15,6%	422	78
	75%			100%		500	

- 75% of the market is supplied as Round Bars
- Diamaters < 16mm require a Wire Rod Mill to be produced: due to the new WR Mill under installation in Sarmad site, these size are excluded from the target production
- Due to the limit of the CCM (max billets 250x250mm) and the reduction required to produce SBQ quality, maximum round 110 mm will be produced.



Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SIZING OF THE PLANT

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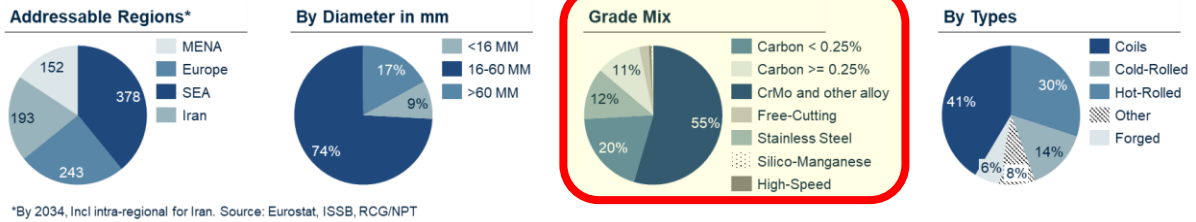
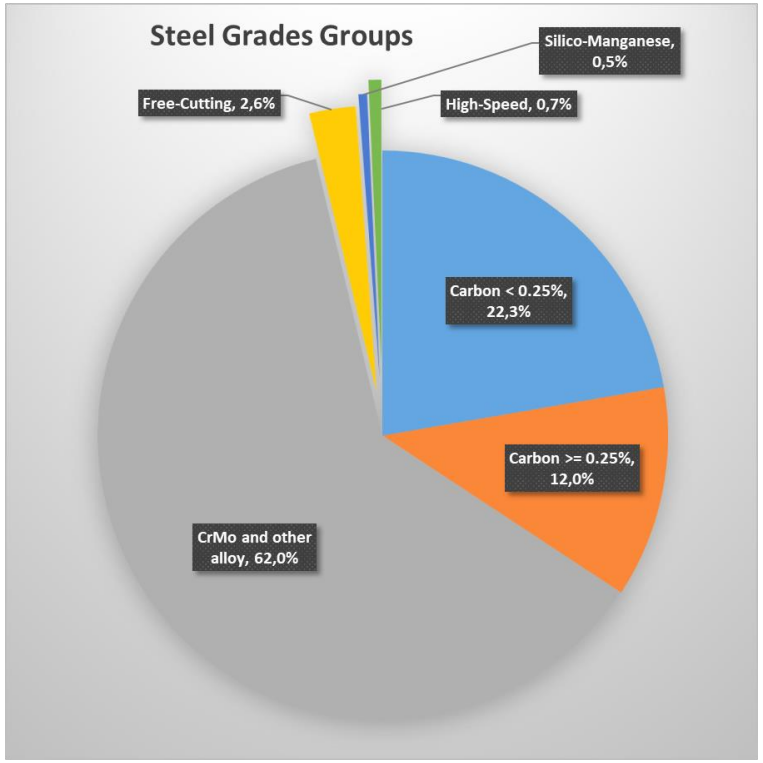


*By 2034, Incl intra-regional for Iran. Source: Eurostat, ISSB, RCG/NPT

Steel Grades Groups

Market							Target					
Carbon < 0.25%	Carbon >= 0.25%	CrMo and other alloy	Free-Cutting	Stainless Steel	Silico-Manganese	High-Speed	Carbon < 0.25%	Carbon >= 0.25%	CrMo and other alloy	Free-Cutting	Silico-Manganese	High-Speed
19,6%	10,5%	54,5%	2,3%	12,0%	0,4%	0,6%	22,3%	12,0%	62,0%	2,6%	0,5%	0,7%
			100,0%							**100%**		



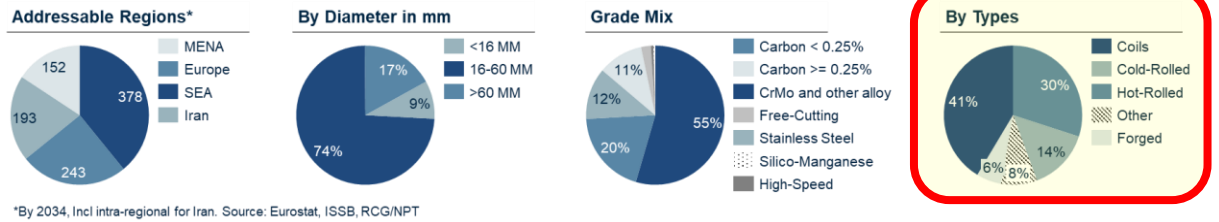
- Stainless Steel is approx. 12% of the accessible market: the recommandation is not to include initially in the production mix, due to the complexity of the process.
- The plant will be anyway designed for future production also of Stainless Steel: the VD is ready for the installation of and Oxygen Lance (VOD): additionally an Heats Shield must be installed inside the roof; a Gas Cooler should be added in the FTP; a dedicated Materal Handling System for additions in VD/VOD to be installed. The space is available in the area of VD installation.
- All the other groups of SBQ steel grades can be included int eh Production Mix for the sizing of the plant.

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SIZING OF THE PLANT

The sizing of the plant, together with the definition of the production mix, must start from the result of the market study: specifically from the accessible market.



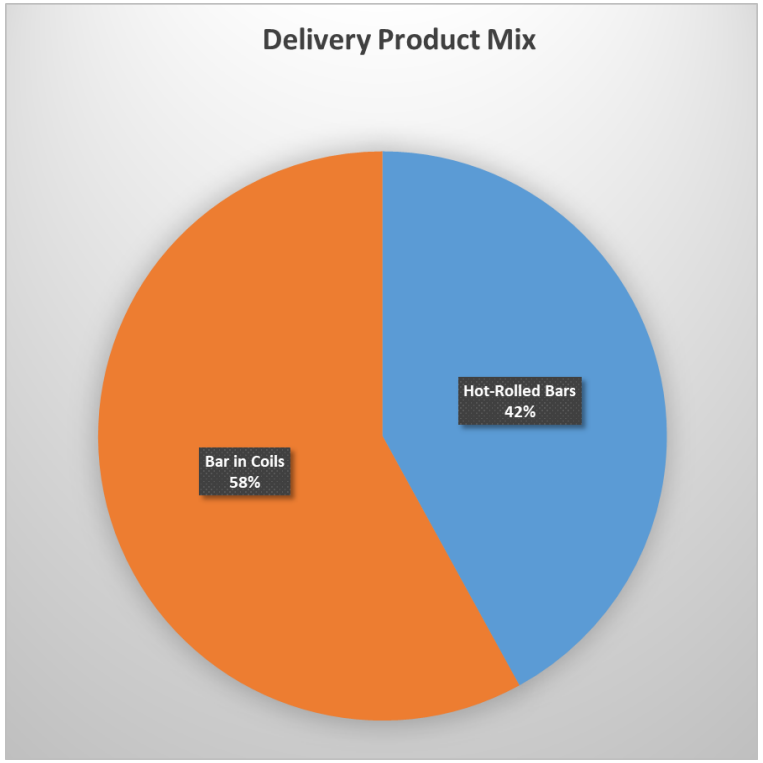
*By 2034, Incl intra-regional for Iran. Source: Eurostat, ISSB, RCG/NPT

Product Delivery: Straight Bar & Coils

Market					Target			
Bars in coils	Cold-Rolled Bars	Hot-Rolled Bars	Other	Forged	Bars in coils	Hot-Rolled Bars	Bars in coils	Hot-Rolled Bars
41,4%	14,4%	30,0%	8,4%	5,8%	58,0%	42,0%	290	210
		100,0%			100%		500	

- Forget and other special products can be excluded from the taget of the plant
- Cold Rolled Bars are usually, for such kind of products, wires: the input material would have then a diameter < 16mm (produced in a Wire Rod Mill): for this reason are excluded from the production mix.

  Eventually, with some modifications to be studied, some products could be manufactured in the new WR Mill of Sarmad.



Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SIZING OF THE PLANT

Overview

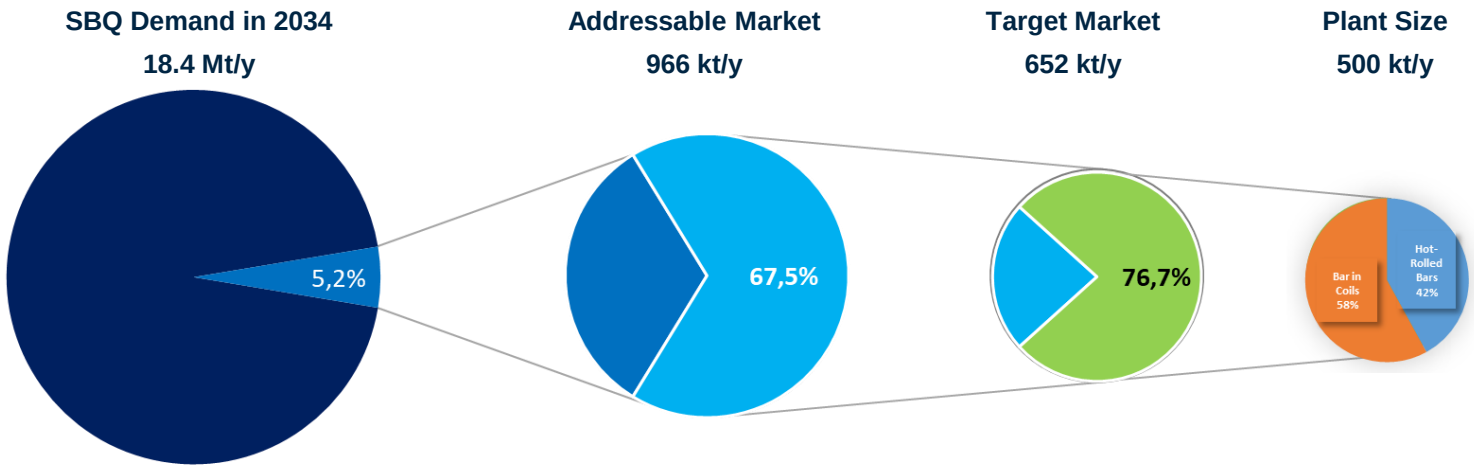
Hot-Rolled Bars	Bar in Coils	16<D≤60	60<D≤110	Carbon < 0.25%	Carbon >= 0.25%	CrMo and other alloy	Free-Cutting	Silico-Mangane se	High-Speed
42%	58%	84%	16%	22,3%	12,0%	62,0%	2,6%	0,5%	0,7%
100%		100%		100%					

The production range of SBQ bar can be defined considering:

- the existing Caster, with a range of billets tahe can be produced between 130x130 and 250x250
- the required reduction ratio in the Rolling Mill to guarantee the SBQ quality
- the market study
- the strategy of CMIC Group to produce Wire Rod in the plant of Sarmad

The rolling mill will be defined then with the following criteria:

- Infeed Billets 150x150 for production of Bars with Diameter from 16 mm to 60 mm
- Infeed Billets 250x250 for production of Bars with Diameter from 36 mm to 110 mm
- Bar in Coils (2 tons or 3 tons) to be produced in a range 16 to 60 mm
- Straight Bars to be produced in a range 20 to 110 mm



Source: NPT

SBQ PRODUCTION STRATEGY

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

The Market Study showed a market accessibility based on the following division of steel grades:

- Carbon < 0.25%
- Carbon >= 0.25%
- CrMo and other alloys
- Free-cutting
- Silico-Manganese
- High-Speed
- Stainless Steel (even if not included in the product mix)

In the next few slides is shown a typical list of Steel Grades included in the list above, with

- Typical Applications
- Typical Mechanical Characteristics such as
  - **Tensile Strength**
    - **Definition**: The maximum amount of stress a material can withstand while being stretched or pulled before breaking. It is a measure of how strong the material is.
    - **Unit**: Typically measured in megapascals (MPa) or pounds per square inch (psi).
    - **Application**: Higher tensile strength indicates a material's ability to handle tension or pulling forces without failure.
  - **Yield Strength**
    - **Definition**: The stress at which a material begins to deform plastically. Once the yield strength is passed, the material will deform permanently and will not return to its original shape.
    - **Unit**: Measured in MPa or psi.
    - **Application**: Yield strength is critical for determining the load a material can handle before it deforms irreversibly, which is important in applications like construction and mechanical engineering.
  - **Elongation**
    - **Definition**: A measure of a material's ductility, it represents the extent to which a material can be stretched or lengthened before breaking, expressed as a percentage of the original length.
    - **Unit**: Percent (%).
    - **Application**: Higher elongation values indicate that the material is more ductile and can be deformed more before failure, which is important in forming and shaping processes.
  - **Hardness**
    - **Definition**: A measure of a material's resistance to localized plastic deformation, such as indentations or scratches. There are various scales for measuring hardness, including Brinell (HB), Rockwell, and Vickers.
    - **Unit**: For Brinell hardness, the unit is HB.
    - **Application**: Hardness is critical in determining how well a material can resist wear, abrasion, and deformation, which is important for components subjected to surface stress, such as gears or bearings.

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Carbon < 0.25%	Typical Application Group	Typical Applications:	Typical Round Size	Typical Product Delivery	Tensile Strength	Yield Strength	Elongation	Hardness
10B21	Automotive, Machinery	Fasteners, Cold-headed parts, Transmission parts	5.5 - 50	WR, Coil, Bar	500 - 700 Mpa	370 - 440 Mpa	15 - 25%	120 - 180 HB
15B25	Automotive, Machinery	Fasteners, Transmission components, Forged parts	20 - 100	Coil, Bar	600 - 800 Mpa	400 - 500 Mpa	15 - 25%	130 - 190 HB
AISI 1006	Machinery, Construction	Wire rods, Mesh wire, Fasteners, Industrial wire products, Cold heading	5.5 - 30	WR, Coil	300 - 450 MPa	200 - 300 MPa	30%	90 - 120 HB
AISI 1008	Automotive, Construction	Wire rods, Mesh wire, Fasteners, Welded wire, Automotive	5.5 - 50	WR, Coil, Bar	350 - 500 MPa	250 - 350 MPa	25%	100 - 130 HB
AISI 1010	Construction	Wire rods, Fasteners, Welded wire, Springs, Forging, Carburized parts, ...	5.5 - 50	WR, Coil, Bar	400 - 550 MPa	300 - 400 MPa	22%	110 - 140 HB
AISI 1015	Machinery, Construction	Wire rods, Fasteners, Welded wire, Springs, Industrial wire products	5.5 - 50	WR, Coil, Bar	450 - 600 MPa	350 - 450 MPa	20%	120 - 160 HB
AISI 1016	Automotive, Machinery	Cold-headed fasteners, Shafts, Machinery components, Machinery parts, Cold-forged parts	10 - 100	Coil, Bar	500 - 650 MPa	400 - 500 MPa	18%	130 - 180 HB
AISI 1018	Machinery, Construction	General purpose bars, Welded tubes, Structural components, Structural steel, Industrial wire products	10 - 100	Coil, Bar	500 - 700 MPa	370 - 440 MPa	15 - 25%	120 - 180 HB
AISI 1020	Machinery, Construction	Cold-formed fasteners, Fasteners, Welded wire, Springs, Industrial wire products	12 - 100	Coil, Bar	550 - 700 MPa	410 - 500 MPa	15 - 25%	130 - 190 HB
AISI 1021	Automotive, Construction, Consumer Goods	Cold-headed fasteners, Automotive parts, Structural components, Hardware, Structural applications	12 - 100	Coil, Bar	550 - 700 MPa	410 - 500 MPa	15 - 25%	130 - 190 HB
AISI 1022	Automotive	Gears, shafts, Automotive parts, Bushings, Pinions, Low-stress parts	12 - 100	Coil, Bar	600 - 750 MPa	450 - 550 MPa	15 - 25%	140 - 200 HB
Grade 1 (SAE J429)	Construction	Bolts, screws, lightly stressed parts	6 - 100	Coil, Bar	400 - 420 MPa	205 - 225 MPa	22 - 25%	120 - 150 HB
Grade 2 (SAE J429)	General Purpose	More stressed parts than Grade 1	6 - 100	Coil, Bar	420 - 520 MPa	240 - 300 MPa	20 - 25%	120 - 150 HB
Grade 3 (SAE J429)	General Purpose	Outdoor fasteners in weathering steel	6 - 100	Coil, Bar	520 - 620 MPa	310 - 380 MPa	20 - 23%	130 - 150 HB
Grade 4 (SAE J429)	General Purpose	Higher strength bolts, screws	6 - 100	Coil, Bar	580 - 780 MPa	400 - 520 MPa	18 - 22%	140 - 170 HB
Grade 5 (SAE J429)	Automotive	Automotive fasteners, engineering applications	6 - 100	Coil, Bar	830 - 1050 MPa	660 - 830 MPa	12 - 15%	180 - 225 HB
Grade 5.1 (SAE J429)	General Purpose	Similar to Grade 5, with weather resistance	6 - 100	Coil, Bar	830 - 1050 MPa	660 - 830 MPa	12 - 15%	180 - 225 HB
Grade 5.2 (SAE J429)	General Purpose	Similar to Grade 5, with higher toughness	6 - 100	Coil, Bar	830 - 1050 MPa	660 - 830 MPa	12 - 15%	180 - 225 HB
Grade 7 (SAE J429)	General Purpose	Similar to Grade 5 but for higher temperatures	6 - 100	Coil, Bar	830 - 1050 MPa	660 - 830 MPa	12 - 15%	180 - 225 HB
S355NL	Construction	Structural applications in cold regions	6 - 200	Bar	470 - 630 MPa	355 MPa min	22 - 24%	-
SAE 5120	Automotive	Gears, shafts	10 - 100	Coil, Bar	850 - 1100 MPa	450 - 700 MPa	15 - 25%	180 - 240 HB
SAE 572 Grade 50	Construction	Structural beams, bridges	6 - 50	Bar	450 - 620 MPa	345 MPa min	18 - 21%	-

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Carbon ≥ 0.25%	Typical Application Group	Typical Applications:	Typical Round Size	Typical Product Delivery	Tensile Strength	Yield Strength	Elongation	Hardness
10B38	Automotive, Machinery, Construction	High-strength fasteners, Springs, Construction parts	5.5 - 50	WR, Coil, Bar	800 - 1000 Mpa	600 - 700 Mpa	10 - 20%	180 - 240 HB
15B30	Automotive, Machinery	Cold-forged parts, Structural automotive components	20 - 100	Coil, Bar	700 - 900 Mpa	500 - 600 Mpa	12 - 20%	160 - 220 HB
15CrNi6	General Purpose	Gear wheels, engine parts	20 - 100	Bar	800 - 1000 MPa	550 - 750 MPa	12 - 18%	200 - 250 HB
28Mn6 (DIN EN ISO 683-17)	Automotive	Heavy-duty shafts, gears, axles	20 - 100	Bar	590 - 840 MPa	340 - 590 MPa	14 - 20%	170 - 212 HB
34Cr4 (DIN EN ISO 683-17)	General Purpose	Crankshafts, gears, steering components	20 - 100	Bar	800 - 1100 MPa	500 - 800 MPa	11 - 16%	207 - 255 HB
AISI 1030	Machinery, Automotive	Chain links, couplings, axles	16 - 100	Coil, Bar	485 - 620 MPa	295 - 440 MPa	18 - 30%	143 - 179 HB
AISI 1035	Machinery, Automotive	Machine parts, bolts, gears	16 - 100	Coil, Bar	510 - 660 MPa	310 - 450 MPa	16 - 28%	150 - 183 HB
AISI 1038	Automotive	Gears, studs, crankshafts	16 - 100	Coil, Bar	550 - 690 MPa	345 - 485 MPa	15 - 25%	160 - 197 HB
AISI 1541	Machinery	Hydraulic components, axles	20 - 100	Coil, Bar	570 - 700 MPa	360 - 480 MPa	13 - 24%	170 - 201 HB
C22E (DIN EN ISO 683-17)	General Purpose	Rods, forgings, welded tubes, slightly stressed components	20 - 100	Bar	430 - 630 MPa	215 - 345 MPa	22 - 30%	126 - 179 HB
C35E (DIN EN ISO 683-17)	General Purpose	Rods, bolts, general engineering purposes	20 - 100	Bar	500 - 700 MPa	300 - 500 MPa	17 - 25%	143 - 187 HB
C45E (DIN EN ISO 683-17)	Automotive	Gears, shafts, axles, disks	20 - 100	Bar	580 - 820 MPa	330 - 560 MPa	14 - 20%	163 - 207 HB
C60E (DIN EN ISO 683-17)	Automotive	Higher strength parts in automotive and machinery	20 - 100	Bar	620 - 860 MPa	340 - 580 MPa	10 - 16%	174 - 229 HB
EN 31	General Purpose	Bearings, rollers, similar to SAE 52100	20 - 150	Coil, Bar	780 - 1080 MPa	500 - 730 MPa	10 - 14%	210 - 260 HB
Grade 8 (SAE J429)	General Purpose	High strength fasteners, critical applications	6 - 100	Coil, Bar	1040 - 1240 MPa	830 - 1040 MPa	10 - 12%	200 - 250 HB
Grade 8.2 (SAE J429)	High Temperature Applications	High temperature, high strength fasteners	6 - 100	Coil, Bar	1040 - 1240 MPa	830 - 1040 MPa	10 - 12%	200 - 250 HB
Grade 9 (SAE J429)	General Purpose	Very high strength applications	6 - 100	Coil, Bar	1170 - 1370 MPa	940 - 1140 MPa	8 - 10%	220 - 260 HB
Grade 9.2 (SAE J429)	General Purpose	Similar to Grade 9, for more severe applications	6 - 100	Coil, Bar	1170 - 1370 MPa	940 - 1140 MPa	8 - 10%	220 - 260 HB
SAE 50100	General Purpose	Bearings, roller applications	20 - 150	Coil, Bar	770 - 1070 MPa	495 - 725 MPa	10 - 15%	207 - 255 HB
SAE 5155	Automotive	Automotive springs, forged components	20 - 150	Bar	635 - 785 MPa	415 - 565 MPa	15 - 20%	179 - 229 HB
SAE 5160	Automotive Suspension	Leaf springs, coil springs	20 - 150	Bar	650 - 800 MPa	430 - 580 MPa	14 - 22%	179 - 229 HB
SAE 5160H	Automotive Suspension	Higher strength leaf springs	20 - 150	Bar	675 - 825 MPa	450 - 600 MPa	13 - 21%	183 - 235 HB
SAE 52100	General Purpose	Bearings, roller applications	20 - 150	Coil, Bar	770 - 1070 MPa	495 - 725 MPa	10 - 15%	207 - 255 HB
SAE 52200	General Purpose	Bearings, roller applications	20 - 150	Coil, Bar	770 - 1070 MPa	495 - 725 MPa	10 - 15%	207 - 255 HB
SAE 6150	General Purpose	Valve springs, gear components	20 - 150	Bar	690 - 840 MPa	460 - 620 MPa	13 - 19%	187 - 241 HB

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

CrMo (Chromium-Molybdenum Steels)	Typical Application Group	Typical Applications:	Typical Round Size	Typical Product Delivery	Tensile Strength	Yield Strength	Elongation	Hardness
17CrNiMo6	Automotive	Gears, high-strength shafts, high-stress applications	20 - 150	Bar	930 - 1230 MPa	590 - 830 MPa	12 - 17%	229 - 341 HB
20NiCrMo3	Automotive	Gear components, automotive applications	20 - 100	Bar	820 - 1050 MPa	550 - 770 MPa	11 - 17%	207 - 255 HB
23MnNiCrMo5-2 (DIN 17115)	General Purpose	Heavy-duty gears, mechanical components	20 - 100	Bar	850 - 1200 MPa	500 - 700 MPa	10 - 15%	217 - 277 HB
30CrNiMo8 (DIN EN ISO 683-17)	Automotive	Heavy-duty shafts, gears, axles	20 - 150	Bar	1050 - 1450 MPa	800 - 1000 MPa	9 - 14%	248 - 325 HB
34CrMo4 (DIN EN ISO 683-17)	Automotive	High-stress components like vehicle axles, gears	20 - 100	Bar	800 - 1200 MPa	500 - 850 MPa	12 - 17%	210 - 270 HB
34CrNiMo6 (DIN EN ISO 683-17)	General Purpose	High-strength gears, shafts, components	20 - 150	Bar	1000 - 1400 MPa	750 - 950 MPa	9 - 14%	248 - 302 HB
36NiCrMo16 (DIN EN ISO 683-17)	General Purpose	Heavy-duty gears, shafts, parts requiring high toughness	20 - 150	Bar	1100 - 1500 MPa	850 - 1050 MPa	8 - 13%	248 - 325 HB
42CrMo4 (DIN EN ISO 683-17)	Automotive	Connecting rods, gear components, axles	20 - 150	Bar	900 - 1300 MPa	650 - 900 MPa	10 - 14%	230 - 290 HB
50CrMo4 (DIN EN ISO 683-17)	General Purpose	Heavy-duty gears, shafts, collets	20 - 150	Bar	900 - 1200 MPa	600 - 800 MPa	11 - 15%	217 - 277 HB
51CrV4	Automotive	Automotive leaf springs, spiral springs, engine valves	20 - 150	Bar	900 - 1200 MPa	540 - 800 MPa	10 - 14%	220 - 340 HB
B16 (Cr Mo V Steel) (ASTM A193)	High Temperature Applications	Very high temperature settings	10 - 150	Bar	860 - 1000 MPa	585 - 725 MPa	18 - 22%	220 - 255 HB
B5 (Cr Mo Steel) (ASTM A193)	High Temperature Applications	Non-corrosive environments at high temperatures	10 - 150	Bar	515 - 690 MPa	275 - 485 MPa	16 - 22%	170 - 210 HB
B7 (Cr Mo Steel) (ASTM A193)	High Temperature Applications	High temperature or high pressure environments	10 - 150	Bar	860 - 1000 MPa	585 - 725 MPa	16 - 22%	190 - 235 HB
B7M (Cr Mo Steel) (ASTM A193)	General Purpose	Similar to B7, with controlled hardness for resistance to hydrogen-assisted cracking	10 - 150	Bar	860 - 1000 MPa	585 - 725 MPa	16 - 22%	190 - 235 HB
L43 (Ni CR Mo Steel) (ASTM A320)	Low Temperature Applications	Low temperature, high strength	10 - 150	Bar	860 - 1000 MPa	585 - 725 MPa	15 - 20%	220 - 260 HB
L7 (Cr Mo Steel) (ASTM A320)	Low Temperature Applications	Low temperature services	10 - 150	Bar	725 - 860 MPa	485 - 655 MPa	16 - 22%	200 - 235 HB
L7M (Cr Mo Steel) (ASTM A320)	General Purpose	As L7 but with controlled hardness	10 - 150	Bar	725 - 860 MPa	485 - 655 MPa	16 - 22%	200 - 235 HB
SAE 4118	Automotive, Construction	Gears, shafts, machinery parts, Bolts and screws, Automotive industry, Automated equipment	15 - 80	Coil, Bar	850 - 1050 MPa	450 - 700 MPa	12 - 15%	180 - 240 HB
SAE 4118H	Automotive	Free-cutting steel,, Bushings, Transmission parts, Pinions, Automated equipment	15 - 80	Coil, Bar	850 - 1050 MPa	450 - 700 MPa	12 - 15%	180 - 240 HB
SAE 4140	Automotive	Axles, conveyor parts, crowbars	20 - 150	Bar	655 - 1035 MPa	415 - 655 MPa	15 - 25%	197 - 302 HB
SAE 4142	Aerospace, Automotive	High strength gears, axles	20 - 150	Bar	680 - 1080 MPa	430 - 675 MPa	12 - 18%	200 - 305 HB
SAE 4340	Aerospace, Automotive	Aircraft landing gear, gear systems	20 - 150	Bar	745 - 1110 MPa	470 - 745 MPa	12 - 18%	217 - 320 HB
SAE 4320	Automotive	Gears, pinions, spline shafts	20 - 150	Coil, Bar	620 - 780 MPa	390 - 550 MPa	17 - 27%	170 - 215 HB
SAE 4320H	General Purpose	High strength gears, shafts, with higher hardness	20 - 150	Coil, Bar	650 - 810 MPa	415 - 575 MPa	16 - 26%	174 - 220 HB
SAE 8620	General Purpose	Gear and engine components requiring case hardening	20 - 150	Coil, Bar	580 - 720 MPa	360 - 510 MPa	18 - 28%	149 - 207 HB
SAE 8620H	Automotive	Gears, shafts	20 - 100	Coil, Bar	850 - 1100 MPa	450 - 700 MPa	12 - 15%	180 - 240 HB
SAE 8720H	Automotive	High performance gears and automotive components	20 - 150	Coil, Bar	600 - 750 MPa	380 - 530 MPa	17 - 25%	152 - 210 HB

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Free-cutting	Typical Application Group	Typical Applications:	Typical Round Size	Typical Product Delivery	Tensile Strength	Yield Strength	Elongation	Hardness
11SMn30 (EN 10087)	Construction	Fasteners, machined parts, precision components	5.5 - 80	WR, Coil, Bar	430 - 600 MPa	240 - 400 MPa	6 - 11%	115 - 155 HB
11SMn37 (EN 10087)	Machinery	Machined parts, high volume production parts	5.5 - 80	WR, Coil, Bar	450 - 620 MPa	250 - 410 MPa	7 - 10%	120 - 160 HB
11SMnPb30 (EN 10087)	Construction	Fasteners, machined parts, where easy machining is required	5.5 - 80	WR, Coil, Bar	400 - 580 MPa	230 - 380 MPa	8 - 12%	110 - 150 HB
11SMnPb37 (EN 10087)	General Purpose	Free-cutting steel applications, threaded bars	5 - 100	Coil, Bar	420 - 600 MPa	240 - 390 MPa	9 - 13%	115 - 155 HB
35S20 (EN 10087)	General Purpose	Non-critical components requiring good tensile strength	5 - 100	Coil, Bar	510 - 710 MPa	280 - 450 MPa	10 - 15%	130 - 180 HB
38SMn28 (EN 10087)	Automotive	Axles, shafts, and other components requiring high machinability	5 - 100	Coil, Bar	530 - 730 MPa	290 - 460 MPa	9 - 14%	135 - 185 HB
44SMn28 (EN 10087)	General Purpose	Components where higher strength is required with good machinability	5 - 100	Coil, Bar	550 - 750 MPa	300 - 480 MPa	8 - 13%	140 - 190 HB
46S20 (EN 10087)	General Purpose	Similar to 38SMn28 but with slightly higher tensile strength	5 - 100	Coil, Bar	570 - 770 MPa	310 - 500 MPa	7 - 12%	145 - 195 HB

Silico-Manganese Steel	Typical Application Group	Typical Applications:	Typical Round Size	Typical Product Delivery	Tensile Strength	Yield Strength	Elongation	Hardness
20MnB5	Automotive, Automotive Suspension, Construction	Hot-stamped parts, Automotive structural components	20 - 150	Coil, Bar	600 - 900 Mpa	450 - 550 Mpa	12 - 20%	140 - 200 HB
21MnSi5 (DIN 17115)	General Purpose	Rods, pins, fasteners	20 - 100	Bar	750 - 1000 MPa	450 - 650 MPa	12 - 17%	207 - 255 HB
22MnB5	Automotive, Construction	Hot-stamped parts, Chassis components, Structural	20 - 150	Coil, Bar	600 - 900 Mpa	450 - 550 Mpa	12 - 20%	140 - 200 HB
27MnSi5 (DIN 17115)	Automotive	Automotive parts, machinery components	20 - 100	Bar	800 - 1050 MPa	450 - 650 MPa	10 - 15%	210 - 270 HB
28MnB5	Automotive, Construction	Hot-stamped parts, Structural automotive components	20 - 150	Coil, Bar	600 - 900 Mpa	450 - 550 Mpa	12 - 20%	140 - 200 HB
30MnB5	Automotive, Construction	Structural parts, Hot-formed automotive components	20 - 150	Coil, Bar	700 - 1000 Mpa	500 - 650 Mpa	12 - 20%	160 - 220 HB
38MnB5	Automotive, Machinery	Structural automotive components, High-stress parts	20 - 150	Coil, Bar	800 - 1000 Mpa	600 - 700 Mpa	10 - 20%	180 - 240 HB

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

High-Speed	Typical Application Group	Typical Applications:	Typical Round Size	Typical Product Delivery	Tensile Strength	Yield Strength	Elongation	Hardness
M2	General Purpose, Cutting Tools	Drill bits, taps, milling cutters	10 - 250 mm	Bar, Coil	900 - 1200 MPa	750 - 1000 MPa	10 - 15%	60 - 67 HRC
M35	General Purpose, Cutting Tools	Drilling, threading tools, reamers	10 - 250 mm	Bar, Coil	950 - 1200 MPa	800 - 1000 MPa	12 - 18%	60 - 67 HRC
M36	High-Strength Applications	High-performance cutting tools	10 - 250 mm	Bar, Coil	1000 - 1250 MPa	850 - 1050 MPa	12 - 18%	60 - 68 HRC
M42	High-Performance, Cutting Tools	Broaches, end mills, high-speed cutting	10 - 250 mm	Bar, Coil	950 - 1300 MPa	800 - 1100 MPa	10 - 15%	60 - 68 HRC
M50	Aerospace, High-Speed Bearings	High-speed spindle bearings, aerospace bearings	10 - 250 mm	Bar, Coil	950 - 1200 MPa	750 - 1000 MPa	10 - 15%	58 - 65 HRC
M52	Extreme High-Strength Applications	Advanced cutting tools, high-stress applications	10 - 250 mm	Bar, Coil	1100 - 1350 MPa	900 - 1150 MPa	10 - 15%	60 - 68 HRC
M7	General Purpose, Cutting Tools	Heavy-duty cutting tools, milling tools	10 - 250 mm	Bar, Coil	900 - 1200 MPa	750 - 1000 MPa	10 - 15%	60 - 67 HRC
T1	General Purpose, High Temperature	Hot-work tools, blades	10 - 250 mm	Bar, Coil	900 - 1150 MPa	750 - 950 MPa	10 - 14%	58 - 66 HRC
T15	High-Wear Resistance, Cutting Tools	High-speed steel cutting tools, high-wear applications	10 - 250 mm	Bar, Coil	950 - 1300 MPa	800 - 1100 MPa	12 - 18%	62 - 68 HRC

Stainless-Steel	Typical Application Group	Typical Applications:	Typical Round Size	Typical Product Delivery	Tensile Strength	Yield Strength	Elongation	Hardness
B6 (410 SS) (ASTM A193)	General Purpose	Moderate corrosion resistant environments	10 - 150	Bar	485 - 655 MPa	275 - 450 MPa	15 - 20%	160 - 210 HB
B6X (410 SS restricted C) (ASTM A193)	General Purpose	Enhanced machinability version of B6	10 - 150	Bar	485 - 655 MPa	275 - 450 MPa	15 - 20%	160 - 210 HB
B8 (304 SS) (ASTM A193)	General Purpose	General corrosion resistant applications	10 - 150	Bar	515 - 690 MPa	205 - 310 MPa	30 - 50%	150 - 210 HB
B8M (316 SS) (ASTM A193)	General Purpose	Severe corrosive environments	10 - 150	Bar	515 - 690 MPa	205 - 310 MPa	30 - 50%	150 - 210 HB
B8C (347 SS) (ASTM A193)	High Temperature Applications	High temperature applications with corrosive environments	10 - 150	Bar	515 - 690 MPa	205 - 310 MPa	30 - 50%	150 - 210 HB
B8T (321 SS) (ASTM A193)	General Purpose	Similar to B8C, stabilized with titanium for weldability	10 - 150	Bar	515 - 690 MPa	205 - 310 MPa	30 - 50%	150 - 210 HB
L70 (450 SS) (ASTM A320)	Low Temperature Applications	Very high strength at low temperatures	10 - 150	Bar	860 - 1000 MPa	585 - 725 MPa	15 - 20%	220 - 260 HB

Stainless Steel, to be excluded from the Production Mix

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

In the table below, the list of steel grades grouped per Application is finally shwon:

Application Group	Description	Steel Grades
Aerospace	Steel grades in this category are crucial for aerospace engineering, offering superior strength-to-weight ratios crucial for aircraft performance and fuel efficiency. They resist extreme environmental conditions such as temperature fluctuations and atmospheric pressure changes, ensuring reliability and safety in aerospace applications.	SAE 4340, SAE 4142
Automotive	These steel grades are selected for their exceptional durability and wear resistance, vital in automotive industry components subjected to significant mechanical stress and environmental exposure. They contribute to the vehicle's overall performance, safety, and longevity.	AISI 1008, AISI 1016, AISI 1021, AISI 1022, SAE 4118, SAE 4118H, EN 10087, SAE 5120, SAE 8620H, AISI 1030, AISI 1035, AISI 1038, SAE 4140, SAE 5155, SAE 5160, SAE 5160H, SAE 4320, SAE 8720H, 20NiCrMo3, 23MnNiCrMo5-2 (DIN 17115), SAE 4140, 51CrV4, 17CrNiMo6, C45E (DIN EN ISO 683-17), C60E (DIN EN ISO 683-17), 28Mn6 (DIN EN ISO 683-17), 34CrMo4 (DIN EN ISO 683-17), 42CrMo4 (DIN EN ISO 683-17), 30CrNiMo8 (DIN EN ISO 683-17), 27MnSi5 (DIN 17115), 15CrNi6, 20NiCrMo3, 23MnNiCrMo5-2, 38SMn28 (EN 10087), SAE 4118, SAE 4140, SAE 5120, Grade 5 (SAE J429), 10B21, 20MnB5, 22MnB5, 15B25, 10B38, 15B30, 28MnB5, 30MnB5, 38MnB5
Automotive Suspension	Chosen for their high fatigue strength, these steels are integral to suspension systems. They withstand repetitive stress and vibrations, maintaining performance and comfort in vehicles across varied terrain.	SAE 5160, SAE 5160H, 20MnB5
Construction	Utilized predominantly in structural components of buildings and infrastructure, these steel grades ensure high strength and durability. They support significant loads and are resistant to environmental degradation, making them indispensable in modern construction.	AISI 1006, AISI 1008, AISI 1010, AISI 1015, AISI 1018, AISI 1020, AISI 1021, SAE 4118, 11SMn30 (EN 10087), 11SMnPb30 (EN 10087), SAE 572 Grade 50, S355NL, Grade 1 (SAE J429), 20MnB5, 22MnB5, 10B38, 28MnB5, 30MnB5
General Purpose	This group includes versatile steel grades used across various industries for non-critical applications. These steels are appreciated for their balance of workability, strength, and cost-efficiency, serving broad manufacturing needs.	SAE 6150, SAE 52100, EN 31, SAE 4320H, SAE 8620, 15CrNi6, C22E (DIN EN ISO 683-17), C35E (DIN EN ISO 683-17), 34Cr4 (DIN EN ISO 683-17), 50CrMo4 (DIN EN ISO 683-17), 34CrNiMo6 (DIN EN ISO 683-17), 36NiCrMo16 (DIN EN ISO 683-17), 23MnNiCrMo5-2 (DIN 17115), 21MnSi5 (DIN 17115), 11SMnPb37 (EN 10087), 35S20 (EN 10087), 44SMn28 (EN 10087), 46S20 (EN 10087), Grade 2 (SAE J429), Grade 3 (SAE J429), Grade 4 (SAE J429), Grade 5.1 (SAE J429), Grade 5.2 (SAE J429), Grade 7 (SAE J429), Grade 8 (SAE J429), Grade 9 (SAE J429), Grade 9.2 (SAE J429), B6 (410 SS) (ASTM A193), B6X (410 SS restricted C) (ASTM A193), B7M (Cr Mo Steel) (ASTM A193), B8 (304 SS) (ASTM A193), B8M (316 SS) (ASTM A193), B8T (321 SS) (ASTM A193), L7M (Cr Mo Steel) (ASTM A320)
Commercial Construction	These steels are foundational in building materials and structural components. They provide the necessary strength for commercial buildings and facilities while supporting innovative architectural designs.	AISI 1020, AISI 1030
Consumer Products	Steel grades in this group are typically used in everyday consumer products which require minimal specialized properties. They provide adequate strength and functionality in cost-effective, mass-produced goods.	AISI 1010, AISI 1018
High Temperature Applications	Essential for applications involving high temperatures such as in boilers, engines, and processing plants. These steels maintain structural integrity and stability under thermal stress, preventing equipment failure.	Grade 8.2 (SAE J429), B5 (Cr Mo Steel) (ASTM A193), B7 (Cr Mo Steel) (ASTM A193), B8C (347 SS) (ASTM A193), B16 (Cr Mo V Steel) (ASTM A193)
Low Temperature Applications	Specially formulated to retain their mechanical properties in sub-zero environments, these steels are ideal for use in cryogenic applications. They resist brittleness and fracturing, crucial in cold climate operations and equipment.	L7 (Cr Mo Steel) (ASTM A320), L43 (Ni CR Mo Steel) (ASTM A320), L70 (450 SS) (ASTM A320)
Machinery	These steel grades are tailored for machinery manufacturing, where high strength, toughness, and abrasion resistance are required. They ensure machinery reliability and longevity under rigorous operational conditions.	AISI 1006, AISI 1015, AISI 1016, AISI 1018, AISI 1020, AISI 1030, AISI 1035, AISI 1541, 11SMn37 (EN 10087), 10B21, 15B25, 10B38, 15B30, 38MnB5, M2, M35, M36, M42, M50, M52, M7, T1, T15
Bearings	Specifically designed for bearing applications, these steels withstand high forces and minimize deformation. They are crucial in reducing friction and wear in moving parts, enhancing the performance and durability of bearings.	SAE 52100, SAE 52200, SAE 50100, EN 31, M2, M35, M42, M50, M52, T15

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

In the following pages, the results of the market study has been applied to define the amount production required for

- each group of steel grade
- each application
- each diameter
- delivery in coils or straight bars

The result is amount of production required for each steel grade considered in the analysis.

The plant, starting from the meltshop, the Caster, downstream to the the Rolling Mill, can produce the complete product mix, even considering important changes in the product mix in case of market changes.

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Here in detail the production distribution per each steel grade.

Classification of Steel Grades by Possible Applications	Aerospace	Automotive	Automotive Suspension	Construction	General Purpose	Commercial Construction	Consumer Products	High Temperature Applications	Low Temperature Applications	Machinery	Bearings	Total Production
	Steel grades used in aircraft and spacecraft components where high strength-to-weight ratio and resistance to extreme conditions are required.	Grades used in car and truck components that require durability and resistance to wear and tear.	Specifically used in vehicle suspension systems where high fatigue strength is necessary.	Used in the construction industry for structural components that require high strength and durability.	Versatile steel grades used in a variety of less demanding applications.	grades used in building materials, structural components, etc.	steel grades used in consumer goods that don't require highly specialized properties	Grades that maintain structural integrity under high temperatures, suitable for boilers, engines, and processing equipment.	Steel grades that retain their properties in extremely cold environments, suitable for cryogenic applications.	Used in the production of various types of machinery where high strength and durability are required.	Specifically used in the manufacture of bearings where high durability and resistance to deformation are critical.	100%
Carbon < 0.25%												
10B21		0,4%								0,4%		0,71%
15B25		0,5%								0,5%		1,04%
AISI 1006				0,2%						0,2%		0,38%
AISI 1008		0,4%		0,4%								0,71%
AISI 1010				0,4%			0,4%					0,71%
AISI 1015				0,4%						0,4%		0,71%
AISI 1016		0,6%								0,6%		1,15%
AISI 1018				0,4%			0,4%			0,4%		1,15%
AISI 1020				0,4%		0,4%				0,4%		1,15%
AISI 1021		0,6%		0,6%								1,15%
AISI 1022		1,2%										1,15%
Grade 1 (SAE J429)				1,2%								1,15%
Grade 2 (SAE J429)					1,2%							1,15%
Grade 3 (SAE J429)					1,2%							1,15%
Grade 4 (SAE J429)					1,2%							1,15%
Grade 5 (SAE J429)		1,2%										1,15%
Grade 5.1 (SAE J429)					1,2%							1,15%
Grade 5.2 (SAE J429)					1,2%							1,15%
Grade 7 (SAE J429)					1,2%							1,15%
S355NL				1,2%								1,18%
SAE 5120		1,2%										1,15%
SAE 572 Grade 50				0,7%								0,71%

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Here in detail the production distribution per each steel grade.

Classification of Steel Grades by Possible Applications	Aerospace	Automotive	Automotive Suspension	Construction	General Purpose	Commercial Construction	Consumer Products	High Temperature Applications	Low Temperature Applications	Machinery	Bearings	Total Production
	Steel grades used in aircraft and spacecraft components where high strength-to-weight ratio and resistance to extreme conditions are required.	Grades used in car and truck components that require durability and resistance to wear and tear.	Specifically used in vehicle suspension systems where high fatigue strength is necessary.	Used in the construction industry for structural components that require high strength and durability.	Versatile steel grades used in a variety of less demanding applications.	grades used in building materials, structural components, etc.	steel grades used in consumer goods that don't require highly specialized properties	Grades that maintain structural integrity under high temperatures, suitable for boilers, engines, and processing equipment.	Steel grades that retain their properties in extremely cold environments, suitable for cryogenic applications.	Used in the production of various types of machinery where high strength and durability are required.	Specifically used in the manufacture of bearings where high durability and resistance to deformation are critical.	100%
Carbon ≥ 0.25%												
10B38		0,1%		0,1%						0,1%		0,34%
15B30		0,2%								0,2%		0,47%
15CrNi6		0,2%			0,2%							0,47%
28Mn6 (DIN EN ISO 683-17)		0,5%										0,47%
34Cr4 (DIN EN ISO 683-17)					0,5%							0,47%
AISI 1030		0,2%				0,2%				0,2%		0,52%
AISI 1035		0,3%								0,3%		0,52%
AISI 1038		0,5%										0,52%
AISI 1541										0,5%		0,47%
C22E (DIN EN ISO 683-17)					0,5%							0,47%
C35E (DIN EN ISO 683-17)					0,5%							0,47%
C45E (DIN EN ISO 683-17)		0,5%										0,47%
C60E (DIN EN ISO 683-17)		0,5%										0,47%
EN 31					0,2%						0,2%	0,48%
Grade 8 (SAE J429)					0,5%							0,52%
Grade 8.2 (SAE J429)								0,5%				0,52%
Grade 9 (SAE J429)					0,5%							0,52%
Grade 9.2 (SAE J429)					0,5%							0,52%
SAE 50100											0,5%	0,48%
SAE 5155		0,5%										0,48%
SAE 5160		0,2%	0,2%									0,48%
SAE 5160H		0,2%	0,2%									0,48%
SAE 52100					0,2%						0,2%	0,48%
SAE 52200											0,5%	0,48%
SAE 6150					0,5%							0,48%

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Here in detail the production distribution per each steel grade.

Classification of Steel Grades by Possible Applications	Aerospace	Automotive	Automotive Suspension	Construction	General Purpose	Commercial Construction	Consumer Products	High Temperature Applications	Low Temperature Applications	Machinery	Bearings	Total Production
	Steel grades used in aircraft and spacecraft components where high strength-to-weight ratio and resistance to extreme conditions are required.	Grades used in car and truck components that require durability and resistance to wear and tear.	Specifically used in vehicle suspension systems where high fatigue strength is necessary.	Used in the construction industry for structural components that require high strength and durability.	Versatile steel grades used in a variety of less demanding applications.	grades used in building materials, structural components, etc.	steel grades used in consumer goods that don't require highly specialized properties	Grades that maintain structural integrity under high temperatures, suitable for boilers, engines, and processing equipment.	Steel grades that retain their properties in extremely cold environments, suitable for cryogenic applications.	Used in the production of various types of machinery where high strength and durability are required.	Specifically used in the manufacture of bearings where high durability and resistance to deformation are critical.	100%
CrMo (Chromium-Molybdenum Steels)												
17CrNiMo6		2,2%										2,23%
20NiCrMo3		2,2%										2,19%
23MnNiCrMo5-2 (DIN 17115)		1,1%			1,1%							2,19%
30CrNiMo8 (DIN EN ISO 683-17)		2,2%										2,23%
34CrMo4 (DIN EN ISO 683-17)		2,2%										2,19%
34CrNiMo6 (DIN EN ISO 683-17)					2,2%							2,23%
36NiCrMo16 (DIN EN ISO 683-17)					2,2%							2,23%
42CrMo4 (DIN EN ISO 683-17)		2,2%										2,23%
50CrMo4 (DIN EN ISO 683-17)					2,2%							2,23%
51CrV4		2,2%										2,23%
B16 (Cr Mo V Steel) (ASTM A193)								2,5%				2,48%
B5 (Cr Mo Steel) (ASTM A193)								2,5%				2,48%
B7 (Cr Mo Steel) (ASTM A193)								2,5%				2,48%
B7M (Cr Mo Steel) (ASTM A193)					2,5%							2,48%
L43 (Ni CR Mo Steel) (ASTM A320)									2,5%			2,48%
L7 (Cr Mo Steel) (ASTM A320)									2,5%			2,48%
L7M (Cr Mo Steel) (ASTM A320)					2,5%							2,48%
SAE 4118		1,2%		1,2%								2,31%
SAE 4118H		2,3%										2,31%
SAE 4140		2,2%										2,23%
SAE 4142	2,2%											2,23%
SAE 4340	2,2%											2,23%
SAE 4320		1,1%			1,1%							2,23%
SAE 4320H					2,2%							2,23%
SAE 8620		1,1%			1,1%							2,23%
SAE 8620H		2,2%										2,19%
SAE 8720H		2,2%										2,23%

Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Here in detail the production distribution per each steel grade.

Classification of Steel Grades by Possible Applications	Aerospace	Automotive	Automotive Suspension	Construction	General Purpose	Commercial Construction	Consumer Products	High Temperature Applications	Low Temperature Applications	Machinery	Bearings	Total Production
	Steel grades used in aircraft and spacecraft components where high strength-to-weight ratio and resistance to extreme conditions are required.	Grades used in car and truck components that require durability and resistance to wear and tear.	Specifically used in vehicle suspension systems where high fatigue strength is necessary.	Used in the construction industry for structural components that require high strength and durability.	Versatile steel grades used in a variety of less demanding applications.	grades used in building materials, structural components, etc.	steel grades used in consumer goods that don't require highly specialized properties	Grades that maintain structural integrity under high temperatures, suitable for boilers, engines, and processing equipment.	Steel grades that retain their properties in extremely cold environments, suitable for cryogenic applications.	Used in the production of various types of machinery where high strength and durability are required.	Specifically used in the manufacture of bearings where high durability and resistance to deformation are critical.	100%
Free-cutting												
11SMn30 (EN 10087)				0,3%								0,31%
11SMn37 (EN 10087)										0,3%		0,31%
11SMnPb30 (EN 10087)				0,3%								0,31%
11SMnPb37 (EN 10087)					0,3%							0,33%
35S20 (EN 10087)					0,3%							0,33%
38SMn28 (EN 10087)		0,3%										0,33%
44SMn28 (EN 10087)					0,3%							0,33%
46S20 (EN 10087)					0,3%							0,33%
Silico-Manganese Steel												
20MnB5		0,0%	0,0%	0,0%								0,07%
21MnSi5 (DIN 17115)					0,1%							0,07%
22MnB5		0,0%		0,0%								0,07%
27MnSi5 (DIN 17115)		0,1%										0,07%
28MnB5		0,0%		0,0%								0,07%
30MnB5		0,0%		0,0%								0,07%
38MnB5		0,0%								0,0%		0,07%
High-Speed												
M2										0,0%	0,0%	0,08%
M35										0,0%	0,0%	0,08%
M36										0,1%		0,08%
M42										0,0%	0,0%	0,08%
M50										0,0%	0,0%	0,08%
M52										0,0%	0,0%	0,08%
M7										0,1%		0,08%
T1										0,0%	0,0%	0,08%
T15										0,0%	0,0%	0,08%

Source:
NPT

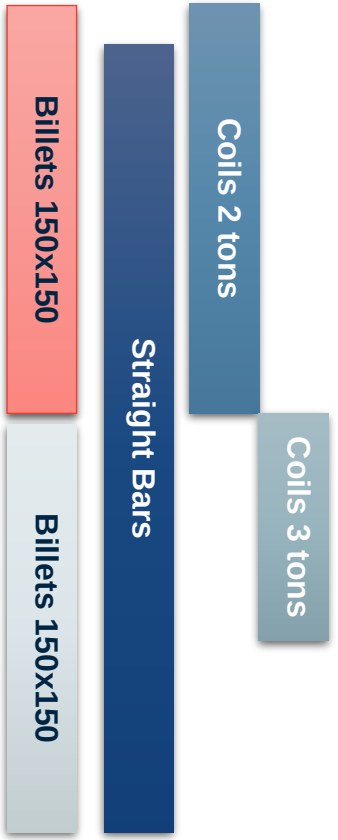
Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Considering a combination of all the above range of production, from steel grades groups, round size range, staigth bars or coils and target of 500kt/y, the following tables of product mix have been elaborated, which will be the base for the Rolling Mill design, modification of Meltshop, overall CAPEX, OPEX and financial model.

The details of the Rolling Mill capacity will be described in the section *2120_07_Technological Concept RHF & SBQ Rolling Mill*

Round Diam.	Cross Section	Billet Weight	Bar Lenght	Out Speed	Rolling Time	Inter Time	Total Time	TEOR PROD	Billet Size	Billets	Hot-Rolled Bars	Bar in Coils		Billets	Hot-Rolled Bars	Bar in Coils		Production		
mm	mm^2	kg	mm	m/s	s	s	s	t/h	mm x mm			2 tons	3 tons			2 tons	3 tons	%	t/y	h/y
16	206,3	2075	1281,1	16	80	5	85	87,9	150x150			2,64%				13.196		2,64%	13.196	150,1
18	261,1	2075	1012,3	14,5	69,7	5	74,7	100	150x150			2,64%				13.196		2,64%	13.196	132,0
20	322,4	2075	819,9	11,8	69,7	5	74,7	100	150x150		1,80%	3,59%			8.990	17.962		5,39%	26.953	269,5
22	390,1	2075	677,6	9,7	69,7	5	74,7	100	150x150		1,80%	3,59%			8.990	17.962		5,39%	26.953	269,5
25	503,7	2075	524,8	7,5	69,7	5	74,7	100	150x150		1,80%	3,59%			8.990	17.962		5,39%	26.953	269,5
28	631,9	2075	418,3	6	69,7	5	74,7	100	150x150		1,80%	3,59%			8.990	17.962		5,39%	26.953	269,5
30	725,4	2075	364,4	5,2	69,7	5	74,7	100	150x150		1,80%	3,59%			8.990	17.962		5,39%	26.953	269,5
32	825,3	2075	320,3	4,6	69,7	5	74,7	100	150x150		1,78%	3,56%			8.899	17.779		5,34%	26.678	266,8
36	1044,5	2075	253,1	3,6	69,7	5	74,7	100	150x150	61,0%	0,89%	1,78%		304.873	4.449	8.890		2,67%	13.339	133,4
38	1163,8	2075	227,1	3,3	69,7	5	74,7	100	150x150		0,89%	1,78%			4.449	8.890		2,67%	13.339	133,4
40	1289,5	2075	205	2,9	69,7	5	74,7	100	150x150		0,89%	1,78%			4.449	8.890		2,67%	13.339	133,4
48	1856,9	2075	142,3	2	69,7	5	74,7	100	150x150		0,89%	1,78%			4.449	8.890		2,67%	13.339	133,4
50	2014,9	2075	131,2	1,9	69,7	5	74,7	100	150x150		0,89%	1,78%			4.449	8.890		2,67%	13.339	133,4
52	2179,3	2075	121,3	1,7	69,7	5	74,7	100	150x150		0,84%	1,68%			4.198	8.388		2,52%	12.587	125,9
54	2350,2	2075	112,5	1,6	69,7	5	74,7	100	150x150		0,84%	1,68%			4.198	8.388		2,52%	12.587	125,9
58	2711,2	2075	97,5	1,4	69,7	5	74,7	100	150x150		0,84%	1,68%			4.198	8.388		2,52%	12.587	125,9
60	2901,4	2075	91,1	1,3	69,7	5	74,7	100	150x150		0,84%	1,68%			4.198	8.388		2,52%	12.587	125,9
36	1044,5	2900	353,7	3,2	111	5	116	90	250x250		0,89%		1,78%		4.449		8.890	2,67%	13.339	148,2
38	1163,8	2900	317,4	2,9	111	5	116	90	250x250		0,89%		1,78%		4.449		8.890	2,67%	13.339	148,2
40	1289,5	2900	286,5	2,6	111	5	116	90	250x250		0,89%		1,78%		4.449		8.890	2,67%	13.339	148,2
48	1856,9	2900	198,9	1,8	111	5	116	90	250x250		0,89%		1,78%		4.449		8.890	2,67%	13.339	148,2
50	2014,9	2900	183,3	1,7	111	5	116	90	250x250		0,89%		1,78%		4.449		8.890	2,67%	13.339	148,2
52	2179,3	2900	169,5	1,5	111	5	116	90	250x250		0,84%		1,68%		4.198		8.388	2,52%	12.587	139,9
54	2350,2	2900	157,2	1,4	111	5	116	90	250x250		0,84%		1,68%		4.198		8.388	2,52%	12.587	139,9
58	2711,2	2900	136,3	1,2	111	5	116	90	250x250		0,84%		1,68%		4.198		8.388	2,52%	12.587	139,9
60	2901,4	2900	127,3	1,1	111	5	116	90	250x250	39,0%	0,84%		1,68%	195.127	4.198		8.388	2,52%	12.587	139,9
62	3098,1	2900	119,2	1,1	111	5	116	90	250x250		1,87%				9.335			1,87%	9.335	103,7
66	3510,7	2900	105,2	0,9	111	5	116	90	250x250		1,87%				9.335			1,87%	9.335	103,7
70	3949,2	2900	93,5	0,8	111	5	116	90	250x250		1,87%				9.335			1,87%	9.335	103,7
75	4533,5	2900	81,5	0,7	111	5	116	90	250x250		1,87%				9.335			1,87%	9.335	103,7
80	5158,1	2900	71,6	0,6	111	5	116	90	250x250		1,87%				9.335			1,87%	9.335	103,7
90	6528,2	2900	56,6	0,5	111	5	116	90	250x250		1,76%				8.805			1,76%	8.805	97,8
95	7273,7	2900	50,8	0,5	111	5	116	90	250x250		1,76%				8.805			1,76%	8.805	97,8
100	8059,5	2900	45,8	0,4	111	5	116	90	250x250		1,76%				8.805			1,76%	8.805	97,8
110	9752	2900	37,9	0,3	111	5	116	90	250x250		1,00%				4.999			1,00%	4.999	55,5
										100%	42,0%	42,4%	15,6%	500.000	210.017	211.983	78.001	100,0%	500.000	5.235
												100%				500.000				



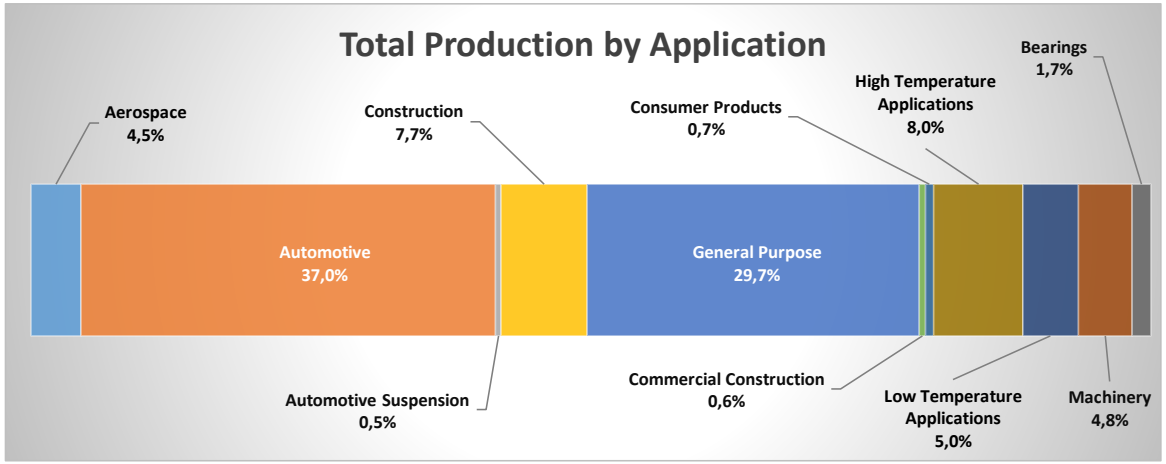
Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

The second table shows the distribution of probuction of production per Application

Aerospace	Automotive	Automotive Suspension	Construction	General Purpose	Commercial Construction	Consumer Products	High Temperature Applications	Low Temperature Applications	Machinery	Bearings	Total
4,5%	37,0%	0,5%	7,7%	29,7%	0,6%	0,7%	8,0%	5,0%	4,8%	1,7%	100,0%
22.318	185.163	2.494	38.321	148.283	2.782	3.703	39.781	24.791	23.891	8.472	500.000



Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

In the production of **SBQ (Special Bar Quality) grades**, the **Vacuum Degassing (VD)** process is commonly required in specific cases where the steel's cleanliness, reduced gas content, and enhanced mechanical properties are crucial. **VD treatment** is used to remove dissolved gases like oxygen, nitrogen, and hydrogen from the liquid steel, which improves the steel's quality and performance in demanding applications.

Here's when VD treatment is typically required for SBQ grades (excluding stainless steel):

1. High-Strength and High-Toughness Applications, such as Aerospace and Automotive Components: For critical structural components in aerospace (like shafts, gears, and fasteners) and automotive (like crankshafts, connecting rods, and transmission components), VD treatment is required to ensure high cleanliness, improved fatigue resistance, and toughness.

2. Bearing Steels (such as **SAE 52100**) often require VD treatment because their performance depends heavily on reduced inclusion levels, increased fatigue life, and resistance to rolling contact fatigue. Any gases or impurities trapped in the steel can lead to premature bearing failure.

3. Critical Automotive Components: for components that undergo high stresses or extreme conditions, VD treatment is used to improve mechanical properties like toughness and fatigue resistance. Examples include components like gears, axles, and suspension parts.

4. Large Forgings: parts used in industries like construction, heavy machinery, and transportation, particularly in large cross-sections, benefit from VD treatment. Vacuum degassing ensures that the steel maintains homogeneity throughout the product, reduces hydrogen-induced cracking, and improves mechanical properties in thick sections.

5. Cleanliness and Fatigue Resistance, such as Spring Steels and steels used in high-performance suspension components also benefit from VD treatment. The reduction in gas content prevents inclusions, improves cleanliness, and extends fatigue life, especially in dynamic and cyclical loading conditions.

6. Tool Steels and Alloy Steels require VD treatment to improve machinability, reduce inclusions, and enhance hardness consistency throughout the product.

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

7. Hydrogen Embrittlement is a significant issue in high-strength steels. VD treatment is particularly effective in removing dissolved hydrogen, making it essential for steels that will be used in environments where hydrogen exposure or stress corrosion cracking is a concern.

8. Seamless Tubes and Pressure Vessels (which are required to withstand high pressure), VD-treated steels ensure low gas content and high cleanliness, preventing hydrogen-induced cracking and other failures.

9. Wear-Resistant Applications, such as Boron Steels: often used in agriculture and automotive, may undergo VD treatment to improve their mechanical properties and reduce impurities, which ensures better performance in hardening processes like quenching and tempering.

Key Benefits of VD Treatment for SBQ Steels:

- **Lower Gas Content**: Reduction of hydrogen, oxygen, and nitrogen to improve steel's fatigue resistance.
- **Improved Cleanliness**: Reduced non-metallic inclusions, critical for high-strength and fatigue-resistant applications.
- **Consistent Mechanical Properties**: Ensures that the steel has uniform hardness, toughness, and wear resistance throughout the product.
- **Hydrogen Reduction**: Mitigates the risk of hydrogen embrittlement, crucial for high-strength and pressure-bearing components.

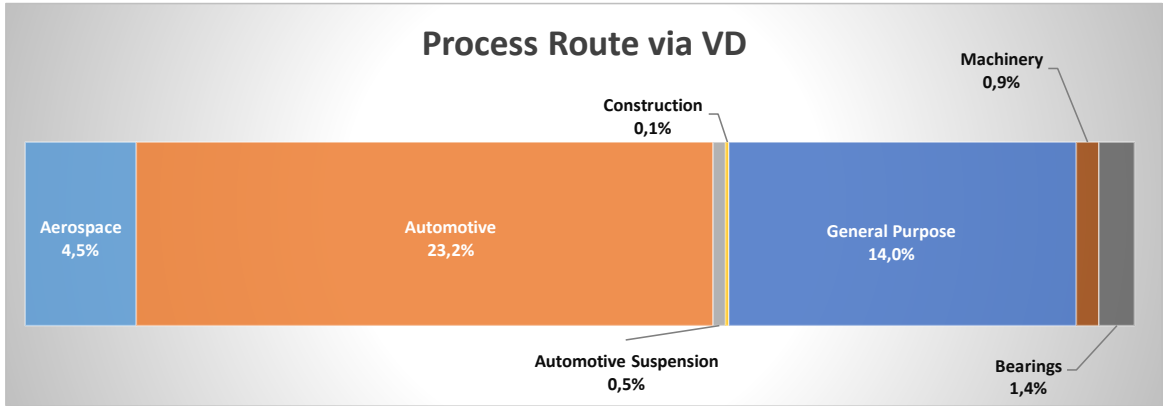
Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

From the analysis of each of the grades considered in the list, approx 45% of the total production will be treated in the new VD station, in order to achieve the required quality:

Aerospace	Automotive	Automotive Suspension	Construction	General Purpose	Commercial Construction	Consumer Products	High Temperature Applications	Low Temperature Applications	Machinery	Bearings	Total
4,5%	23,2%	0,5%	0,1%	14,0%						0,9%	1,4%	44,5%
22.318	115.789	2.494	624	69.807						4.557	7.141	222.730



Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

The use of **Slow Cooling Pits** (also called "controlled cooling pits" or "isothermal pits") for **SBQ billets** is sometimes necessary to manage the cooling rate of the steel before rolling. This process is used to prevent defects and optimize the microstructure of the steel.
Here's when and why it's required:

1. To Prevent Internal Stresses and Cracks

- **When it's required**: Slow cooling is used when there is a risk of **thermal cracking** or **residual stress buildup** in the steel billet due to rapid cooling after casting. It is particularly important for high-carbon steels, alloy steels, and large cross-section billets where rapid cooling could cause uneven contraction.
- **Why**: As billets cool down, different sections of the billet may contract at different rates, leading to internal stresses that can cause cracks. Slow cooling allows the billet to cool more uniformly, reducing the risk of internal stress and cracking.

2. High-Carbon Steels

- **When it's required**: Steels with high carbon content (e.g., **C60**, **C70**, and **SAE 5160**) are prone to **quench cracking** or developing **internal microcracks** during rapid cooling due to their hardenability.
- **Why**: High-carbon steels are more susceptible to the formation of **martensite** (a brittle phase) if cooled too quickly, leading to undesirable hardness or cracking. Slow cooling prevents martensite formation and ensures the steel remains ductile for subsequent rolling and forming processes.

3. Alloy Steels and Hardenable Steels

- **When it's required**: Alloy steels (e.g., **SAE 4140**, **SAE 4340**, **15CrNi6**, **20NiCrMo3**) and other **hardenable grades** need slow cooling to avoid the formation of unwanted phases like **bainite** or **martensite**.
- **Why**: Alloy steels can develop unwanted phases during rapid cooling that could impair their mechanical properties or complicate further processing. Slow cooling gives the steel a **ferrite-pearlite** microstructure, which is softer and more ductile, making the billet easier to roll and form.

4. Avoiding Distortion and Warping

- **When it's required**: Slow cooling is necessary when billets are intended for **high-precision applications** like automotive or aerospace components. Rapid cooling can lead to uneven shrinkage, causing distortion or warping, which would affect the final dimensions of the rolled product.
- **Why**: A slow cooling process helps maintain dimensional stability by ensuring that the billet cools uniformly, which is particularly important for high-tolerance SBQ products.

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

5. Minimizing the Formation of Surface Defects

- **When it's required**: Billets that are to be rolled into **high-surface-quality products**, like **bearing steels** (e.g., **SAE 52100**), or **spring steels** (e.g., **SAE 5160**), are often slow-cooled to prevent surface defects.
- **Why**: Rapid cooling can cause surface cracks or **scale formation** (a layer of iron oxide) that might get rolled into the final product, leading to quality issues. Slow cooling minimizes these defects, ensuring a clean surface for rolling.

6. Improving the Microstructure for Machinability

- **When it's required**: Billets that are intended to be machined after rolling may need slow cooling to develop a softer microstructure that is more **machinable**.
- **Why**: Slow cooling produces a **ferritic-pearlitic** structure, which is softer and easier to machine. This is particularly important for **free-machining steels** (like those containing sulfur or lead, e.g., **11SMn30**, **11SMnPb30**), where machinability is a key property.

7. Boron Steels

- **When it's required**: Boron steels, like **22MnB5**, which are used in hot stamping processes, may require slow cooling if they are to be used in a subsequent hot-forming process.
- **Why**: Boron steels can form hard microstructures if cooled too quickly, making them difficult to form. Slow cooling ensures that the steel remains ductile until it reaches the hot-forming stage, after which it will be quenched to achieve the final hardened state.

8. Large Cross-Section Billets

- **When it's required**: Large billets or heavy sections need slow cooling due to their size and mass, which make them more prone to **temperature gradients** (the core of the billet cools more slowly than the surface).
- **Why**: If the surface cools much faster than the core, it can lead to internal cracking, especially in **high-strength alloy steels** or **high-carbon steels**. Slow cooling equalizes the temperature throughout the billet, preventing these issues.

9. Homogenization of Alloy Steels

- **When it's required**: In the case of high-alloy SBQ steels, slow cooling helps achieve a more **homogeneous microstructure** by allowing the diffusion of alloying elements (like chromium, molybdenum, and nickel) throughout the billet.
- **Why**: Homogenization is important to prevent segregation of alloying elements, which can affect mechanical properties and lead to inconsistencies in the final rolled product.

Source:
NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Summary of When Slow Cooling Pits Are Required:

- **High-carbon steels** prone to quenching cracks or martensite formation.
- **Alloy steels** that require a softer microstructure for further processing.
- **Large cross-section billets** to prevent internal stresses and cracking.
- **Bearings and spring steels** for surface quality and structural consistency.
- **Machinable grades** requiring a ferritic-pearlitic microstructure.
- **Boron steels** used in hot-forming applications to avoid premature hardening.
- **Precision components** where dimensional stability is critical.

Key Benefits of Slow Cooling Pits:

- **Prevents thermal stresses and cracking**: Uniform cooling minimizes internal stresses and surface cracking.
- **Improves machinability**: By producing a softer ferritic-pearlitic structure, it enhances the machinability of the steel.
- **Optimizes microstructure for rolling**: Slow cooling ensures that the billet has the right microstructure (ferrite-pearlite), making it easier to roll into bars or other shapes.
- **Maintains surface quality**: Minimizes surface defects like cracks and scale, improving the final rolled product.

Source:
NPT

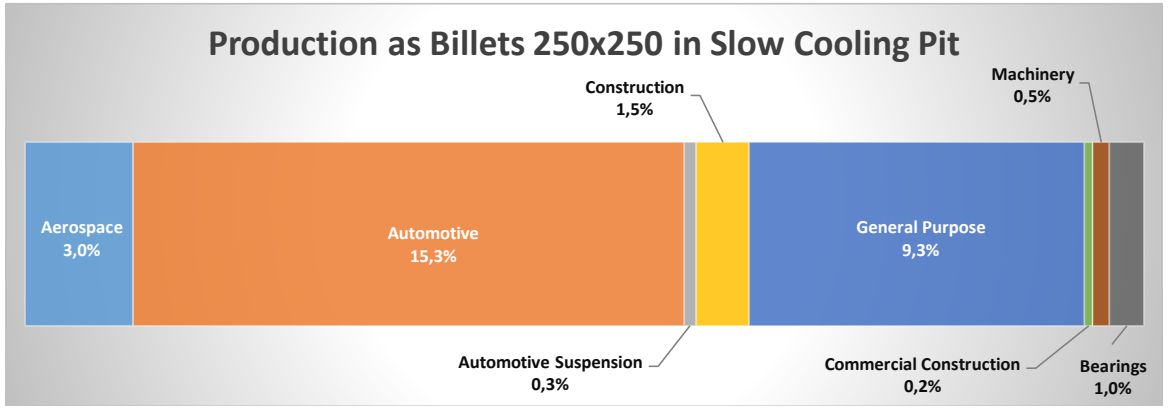
Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

From the analysis of each of the grades considered in the list, approx 30% of the total Billets produced will be deposited in a Slow Cooling Pit immediatelly after Casting, before rolling (only billets 250x250).

The layout is anyway prepared for more than 50% of the production to be processed in slow cooling pits.

Aerospace	Automotive	Automotive Suspension	Construction	General Purpose	Commercial Construction	Consumer Products	High Temperature Applications	Low Temperature Applications	Machinery	Bearings	Total
3,0%	15,3%	0,3%	1,5%	9,3%	0,2%					0,5%	1,0%	30,9%
14.899	76.271	1.597	7.397	46.319	1.184					2.290	4.790	154.746



Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Example of application of SBQ in the Automotive industry.

In the study prepared, approx. 38% of the production will be utilized in the Automotive Sector.

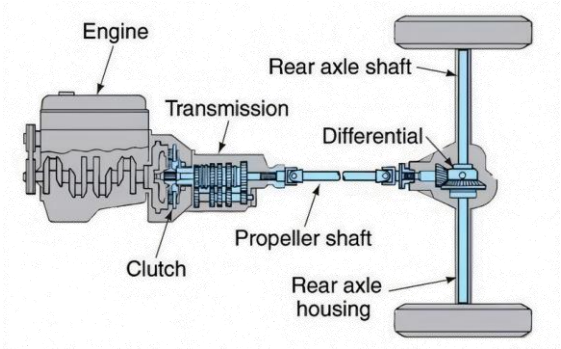
In a standard car, several components are made from **SBQ**, typically produced in round form. These parts often include those subjected to significant mechanical stress and requiring precision manufacturing, such as:

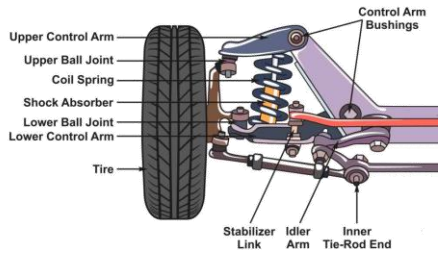
1. Engine Components:
- Crankshafts
- Connecting rods
- Camshafts
- Piston pins
- Gears

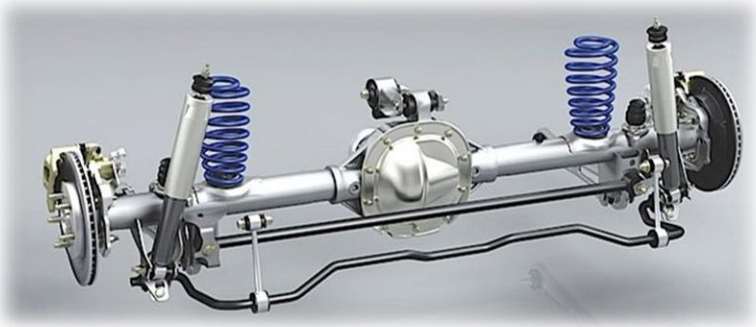
2. Transmission and Drivetrain:
- Axles (drive shafts)
- Transmission shafts
- Differential parts
- Steering knuckles

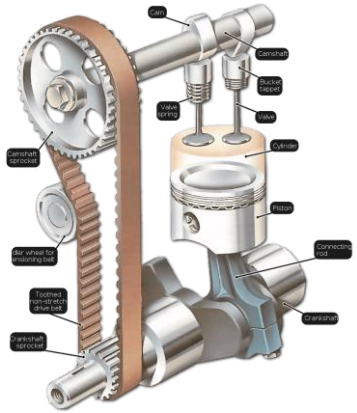
3. Suspension and Chassis Parts:
- Suspension arms
- Stabilizer bars
- Spring components

4. Fasteners and Bolts:
- High-strength bolts and fasteners
- Wheel studs









Source: NPT

Pre-Feasibility Study for major Modernization Works (SBQ Grades) for CPG / CMIC

SBQ PRODUCTION MIX

Example of application of SBQ in the Automotive industry.

The total weight of SBQ steel parts in a typical passenger car can vary depending on the vehicle's size, engine type, and configuration. However, based on industry averages, the weight of SBQ steel components is generally estimated to account for **10÷15% of the total vehicle weight**. This breakdown is based on the fact that the powertrain, chassis, and drivetrain parts (where SBQ steel is heavily used) constitute a significant portion of the car's structural and mechanical mass.

For a typical mid-size car weighing approximately **1,500 kg**, the weight of SBQ steel components would range from approximately **150 ÷ 225 kg.**

For the production evisaged in Chadormalu Complex, approx. 250.000 t/y will be utilized in the construction of cars, which corresponds to approx. **1.2 millions cars per year**.

As a reference, in 2023 worldwide have been produced 88.6 million vehicles: Iran ranks among the top 20 vehicle manufacturers with 1.18 million vehicle produced in 2023.

Rank	Country	Cars Produced (in millions)
1	China	30,16
2	United States	10,61
3	Japan	7,76
4	India	5,46
5	South Korea	3,76
6	Germany	3,67
7	Mexico	3,57
8	Brazil	2,60
9	Thailand	2,15
10	Spain	2,10
11	France	1,75
12	Turkey	1,65
13	Indonesia	1,35
14	Canada	1,33
15	Czech Republic	1,25
16	Iran	1,18
17	Russia	1,15
18	Italy	1,05
19	Slovakia	1,03
20	United Kingdom	1,00

Manufacturer	Key Partnerships	Vehicle Types
Iran Khodro Company (IKCO)	Peugeot, Local Models	Passenger cars, buses, commercial vehicles
Saipa Group	Kia Motors, Local Models	Passenger cars
Pars Khodro	Nissan, Renault	Nissan and Renault models
Bahman Group	Mazda, FAW, Haval	Mazda pickups, Chinese brands
Kerman Motor	JAC Motors, Lifan	Chinese cars
Zamyad	Commercial Vehicles	Commercial vehicles
Modiran Vehicle Manufacturing Company	Chery	Chinese cars (Chery)

Source:
NPT