

**Research Article****Thermodynamic Study of CO<sub>2</sub> Conversion Reactions to Fuel****Mahmoud bayanak<sup>1\*</sup>, Amir Hossein Shahbazi Kootenaee<sup>1</sup>  
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**ABSTRACT:**

CO<sub>2</sub> is stable thermodynamically and kinetically, and Methanation is highly exothermic reaction, due to the high concentration of carbon dioxide in the inlet gas. Reactions due to the Gibbs free energy difference between reactants and products progress by the Helmholtz equation - Gibbs is shown.  $G^\circ = \Delta H^\circ - T\Delta S^\circ$ , to convert CO<sub>2</sub> into a useful product, a high energy input, enabling optimal reaction conditions and catalysts needed. Because CO<sub>2</sub> is an inert gas: CO<sub>2</sub> carbon atom is in a heightened state of disruption oxide, a chemical state is thermodynamically have no desire to change. In this case, as a raw material, CO<sub>2</sub> at the lowest energy level remains the biggest problem is to enter CO<sub>2</sub> from industrial processes to convert CO<sub>2</sub>. Gibbs free energy analysis exothermic hydrogenation of CO<sub>2</sub>, batch reactions are found that are not thermodynamically favorable. Because the Gibbs free energy values than the values of  $\Delta H^\circ$  is positive. There are very few negative reactions  $\Delta H^\circ$  and  $G^\circ$ . Negative  $G^\circ$ , refers to products linked c-o. The desirable values of  $\Delta H^\circ$  of hydrogenation reactions are those leading to the water, because the hydrogen must be produced per energy input. Enthalpy and Gibbs free energy values calculated by the software ASPEN, related to the exothermic reaction ( $\Delta H < 0$ ) hydrogenation of CO<sub>2</sub> follows. CO<sub>2</sub> hydrogenation reaction with  $\Delta H > 0$  can be formed. These reactions associated with high levels of positive  $G^\circ$  are not desirable.

**Keywords:** thermodynamics, carbon dioxide, Gibbs free energy, water, exothermic reaction**[I] NTRODUCTION**

Among different greenhouse gases that are released in the atmosphere, CO<sub>2</sub> is released to the atmosphere at the highest volume and tonnage, and is a major contributor to the phenomenon of climate change. Its prevalence, causes great interest for use as a source for the production of valuable products, special fuels, chemicals are. It is also important environmental aspects. This article attempts to use CO<sub>2</sub> to produce fuel, plug-pays and biochemistry. Gas CO<sub>2</sub>, a greenhouse gas emissions topped the list in terms of the amount of similar gases emitted in space. Similar gases, including CO and methane, are CFC<sub>5</sub>.

Increasing greenhouse gas emissions and consequently alters climate consequences such as global warming and the next sequential been breathing problems. China topped the list with the release of 24% of the total emissions are concerned. The United States, after China placed 18%. India's share is 6 percent. CO<sub>2</sub> emission sources into three categories Electric power generation transport and natural resources are classified. The release of CO<sub>2</sub>, the CO<sub>2</sub> emissions from volcanoes is an example of natural resources. Abundance and low price, the benefits of CO<sub>2</sub> as a feedstock in organic synthesis is

promising. CO<sub>2</sub> is an interesting C1 structure, which can replace risky like phosgene is ready for molecules in some industrial processes. Attempts have been made to the CO<sub>2</sub> in commercial applications including food and beverage carbonation processes used. In recent years CO<sub>2</sub> has been able to attract the attention of the chemical industry as a sustainable raw material used in the production of various products. However, it 110MMT (million metric ton) of CO<sub>2</sub> used in the chemical industry that is less than one percent of overall emissions. In general, the conversion of CO<sub>2</sub> associated with the production of CO. Enthalpy of reaction, to produce a product, from CO or CO<sub>2</sub> are comparable, although in most cases, CO is more beneficial than with CO<sub>2</sub>. [9]

### Reaction Mechanisms of CO<sub>2</sub> Methanation

After decades of understanding the mechanism of CO<sub>2</sub> Methanation has created certain challenges. Consequently follow up on several studies; we determined that Methanation of CO<sub>2</sub> occurs in two ways:

- Along with the production of CO<sub>2</sub> as an intermediary
- When CO<sub>2</sub> before Methanation converted to CO
- And direct Methanation of CO<sub>2</sub>, without the formation of CO as intermediary [9]

### Methanation of CO<sub>2</sub> by using CO as an intermediary

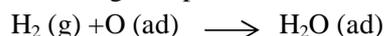
According to the nature and function of catalysts and their reaction conditions, this mechanism is difficult. Methanation particularly CO<sub>2</sub> include the revival of CO<sub>2</sub> to CO:

$\text{CO}_2 + \text{H}_2 \leftrightarrow \text{CO} + \text{H}_2\text{O}$  The conversion of methane and other alkanes will continue CO.  
 $\text{CO} + 3\text{H}_2 \leftrightarrow \text{CH}_4 + \text{H}_2\text{O}$ . Balance reaction  
 CO<sub>2</sub> + H<sub>2</sub> → co + H<sub>2</sub>O, at a temperature (200 - 400 °C) was not satisfactory, that is because of the reaction pathway is not satisfactory. If co pace as fast as it is produced in the reactor output

will not be any carbon monoxide. Another mechanism by Doehlemann first in 1938 and then by Kulkowa and colleagues, and was described by Wagner, CO<sub>2</sub> to co (ad) and o (ad) decomposed.

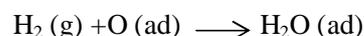


And adsorbed oxygen atoms react with molecular hydrogen in a single step



And water is formed. While co adsorbed methane to be converted Co (ad) CH<sub>4</sub> →

However, assuming that the stage



Methanation speed controller is CO<sub>2</sub>. Methanation CO<sub>2</sub> on Rh/Al<sub>2</sub>O<sub>3</sub> analysis of CO<sub>2</sub> into carbon monoxide and oxygen on the surface of the catalyst, the conversion of infrared reflection and influence come February. The Rh-CO (2048 cm<sup>-1</sup>), Rh<sup>3+</sup>-CO (2123 cm<sup>-1</sup>), and Rh-(CO)<sub>2</sub>. Diffuse reflectance infrared Fourier transform (DRIFT) Forming links Coad's approve. CO<sub>2</sub> is absorbed in the form of Rh-(Co)<sub>2</sub> and co Rh oxide components with reactive hydrogen. Co presence as a key mediator in Methanation of CO<sub>2</sub>, through the study of sst on Ru/TiO<sub>2</sub> is provided. (Steady-state transient study) However, base metal interface, the presence of formats as a result of reaction with the carbonate particles as an intermediary for the co observed. Ni single crystals as crystal models have been proposed for CO<sub>2</sub> Methanation. CO<sub>2</sub> analysis CO<sub>2</sub> to H<sub>2</sub> on Ni proves that the co and then decomposed carbon. Methanation activation energy and the reaction rate for the formation of CO<sub>2</sub> into energy CH<sub>4</sub> (88.7kg.mol<sup>-1</sup>) formed closer to energy (72.8 - 82.4kg.mol<sup>-1</sup>) Co, Co formed is then decomposed into metal c and o the sites before the break H<sub>2</sub> metal particles remaining on the hydrogenation of methane. CO-step analysis set (limited) speed. Despite this early stage Methanation of CO<sub>2</sub> reaction involves two steps, formation of carbon and carbon Methanation. The first mechanism of activation energy for

1.27e ( 120kg mol<sup>-1</sup>) to analyze the CO<sub>2</sub> and 2.97ev ( 290kg mol<sup>-1</sup>) for analysis and co 1.93ev ( 190kg.mol<sup>-1</sup>) to break 2Co is calculated. It has been reported for carbon Methanation mechanism, 0.72ev ( 72kg.mol<sup>-1</sup>) for methyl aldehyde 0.52ev ( 50kg.mol<sup>-1</sup>) for methylene and 0.50ev ( 48kg.mol<sup>-1</sup>) for methane. Alternative mechanism for CO<sub>2</sub> Methanation on various catalysts include Methanation through a formats and carbonate CO<sub>2</sub> is directly CH<sub>4</sub>, are hydrogenation. CO<sub>2</sub> initially Co  $\text{Ce}_{0.95}\text{Ru}_{0.05}\text{O}_2$  decomposed. CO<sub>2</sub> Methanation the catalyst Pd-Mgo/Sio<sub>2</sub> have shown that Mgo base reaction begins. In this case, magnesium carbonate particles were absorbed on the catalyst surface. Pd as the active phase of the catalyst, hydrogenation carbonates and hydrogen molecules breaks down and improves the carbon atoms remains. This result indicates synergy (synergy) between the base and the active phase. CO<sub>2</sub> is an acid molecule, Mgo activated by site basis to magnesium carbonate, while the metal on hydrogen Pd break down. However, the mechanism Methanation of Co methoxy groups were observed. Catalyst Ni/Ceo<sub>2</sub> the highest degree of conversion of CO<sub>2</sub> at the lowest temperature the selectivity of CH<sub>4</sub> (nearly 100%) is shown. Co<sub>2</sub> base to its high ability to absorb proper functioning of the CO<sub>2</sub> molecules, along with his ability to revive the co molecules and then convert CH<sub>4</sub>, is attributed. The revival of the planned experiments has shown that Ru catalysts in terms of temperature on H<sub>2</sub> + Co to produce CO<sub>2</sub> and water react without producing methane. So co gas CO<sub>2</sub> during Methanation not reacts with the catalyst of a middleman. Moreover, when gallium oxide photo catalysts to produce Nano-porous carbon dioxide to methane is used, CO<sub>2</sub> is converted directly to methane without co intermediary role to play. Attention and keen interest in saving and carbon storage (ccs) to reduce CO<sub>2</sub> emissions from large industrial units there. This article focuses on ways to help ccs and a number of reactions have been approved.

As well as future opportunities for the use of CO<sub>2</sub> for chemical units mentioned. The past decade significant change in the role of CO<sub>2</sub> in climate change and it is what is clear is that CO<sub>2</sub> levels and even decrease should be fixed. Although CO<sub>2</sub> is worthless in some ways, but in many industries, including food processing and extraction processes can be used. Highlights of control, storage and usage are CO<sub>2</sub>. One of the methods is the absorption of CO<sub>2</sub> by the depositary. CO<sub>2</sub> absorption by MEA There is a lot of interest, but this method is energy-intensive and damage to the environment. Storage and injection of CO<sub>2</sub> underground is too expensive, and yet the storage of CO<sub>2</sub> equivalent to removing one molecule per molecule of carbon from the carbon cycle. The chemical conversion of CO<sub>2</sub> to useful materials seems to be the best method. The catalyst plays a key role in achieving success in transforming CO<sub>2</sub> to useful materials new reactions. It is also necessary that these catalysts, simple, stable and inexpensive so much CO<sub>2</sub> each year are processed. Generally, two types of CO<sub>2</sub> produced product. [9] Had fully recovered carbon compounds such as hydrocarbons and products with a C = O and an integral part of O-C = O

### Condensation Reaction

These reactions are characterized by the loss of water, and 1 2diols reaction with CO<sub>2</sub> and use of tin catalysts is very important because it leads directly to the cyclic carbonates. But the conversion is only 2 percent. This reaction if the conversion would be more useful. The reaction runs under high temperature and pressure, but the CO<sub>2</sub> can be pumped from the storage tanks, energy prices decreased. Under the terms of slightly milder reaction with CO<sub>2</sub> and o<sub>2</sub> to help styrene oxide, niobium (iii) as a catalyst, as a step leading to cyclic epoxide, the percent conversion of the reaction was 27%. Ktal supercritical CO<sub>2</sub> reacts with the iron or copper catalyst, leading to cyclic carbonates conversion percentage is 87.

CO<sub>2</sub> alcohols and amines in the presence of a catalyst with CO<sub>2</sub> reacts with products such as organic carbonates (x = o), urea, Carbonate and polyurethane (X = O, NH) offered. Photosynthesis is a process where CO<sub>2</sub> and water efficient super useful chemical substances such as sugar and oxygen are converted. An attempt to produce biomimetic photo catalytic continues. Graver's synthesis of methanol from syngas in an article by catalyst cu-Zno / Al<sub>2</sub>O<sub>3</sub> describes. Methanol can, zeolite catalysts and catalyst under hydrocarbon fuels become H-Fe silicate. Benson also elector-catalytic methods for producing liquid fuels to help homogeneous palladium catalysts, iron and molybdenum been examined. CO<sub>2</sub> conversion has been discussed for decades. But many resources and cheap energy are the reactions CO<sub>2</sub>, this process is justified. Application and selection is very important catalyst selectivity of the catalyst and the conversion of the most important factors is reaction. Another challenge is the catalyst which has good low temperature performance. [2]

### Regenerative Reaction

In recent years, much attention to transforming CO<sub>2</sub> to hydrocarbons and especially fuel and oil handling has been paid, in which a reducing agent is hydrogen. Ziang article about the different technologies to convert CO<sub>2</sub> into fuels has to offer. Petrol and Clarified kerosene are the key products, without the need for any change can be used in combustion engines. In the simplest case of carbon dioxide under partially to co Rwas and water using 5% copper and nickel as the catalyst can become smaller amounts. Reaction temperature and pressure is high, and the use of CO<sub>2</sub> to H<sub>2</sub> is equivalent to 1: 4. Efforts are under way to design catalysts that operate under lower temperatures. Co when H is accompanied by useful. (Syngas), according to Fisher-Tropsh reaction larger hydrocarbon-based catalysts can also help iron, cobalt, ruthenium and nickel produced. In this case, high

temperatures and pressures are needed. When the selectivity of the catalyst toward hydrocarbon structure, they are not susceptible to long-chain products and usually larger Shoeshine components are broken into smaller components are then produced. Therefore, efforts are underway to catalysts used to determine sensitive to hydrocarbons with chain lengths and are applied at a lower temperature. Energy issues also continued to challenge. Tests sandia America in New Mexico, has been successfully using a solar oven as a source of energy, the CO<sub>2</sub> Petrol is produced. C-H activation reactions CO<sub>2</sub> insertion reaction is an important Insertion reaction where co as catalytic C-H turns into a sigma bond. For example, CO<sub>2</sub> reacts with methane using vanadyl catalyst to produce some acetic acid. Activation link C-H, aromatic compounds for the production of carbohydrate acids Killick using the catalyst of copper and gold and the articles. The synthesis of poly-carbonates by Zn (ii) and Cr (ii), Co (iii), AL (iii) and Mn (iii) Catalyst also been proposed in the literature. C-C bond formation reactions are extremely important in organic chemistry. [2]

### Fossil Fuels derived from Carbon Dioxide

While water regeneration, only produces hydrogen, a large group of products available that can be produced by the recovery of carbon dioxide. This list includes single-carbon compounds, hydrogen peroxide (C<sub>1</sub>) and two oxygen-carbons (C<sub>2</sub>), such as oxalic acid, formic acid, formaldehyde, methanol and carbon monoxide. In addition to these compounds, methane and carbon saturated and unsaturated hydrocarbons with two to four can also be obtained. Among these potential products, one of which is a higher value for fuel used in transportation, is methanol. Considering the amount of alcohol with high energy, ease of use of the liquid composition with a relatively high boiling point, and the fact that methanol can even be used as an additive to fossil fuels and in the

standard car engines be added. This fuel can be widely used. Methanol has a high octane number and even can be used as a precursor for other oil additives to boost the octane number, such as methyl-tert-butyl ether and ether is used. The amount of energy oxygenated derivatives of these compounds is increased when the percentage of oxygen decreases. Combustion-free energy equations 1 to 3 summarize some solar fuels have been calculated from data gaseous state. It is an important "carbon footprint" of the combustion of a fuel. In the case of combustion of methanol, methanol recovery if carbon dioxide is obtained by water, In addition to methanol, methane is the second most important in the production of solar fuels from recovery of carbon dioxide. The main advantage of methane is that all existing technologies that are currently used for natural gas can be used to methane, apart from what source is obtained, or any other natural gas obtained from the recovery of carbon dioxide photo catalytic be used process. Also, because methane recovered product revival of carbon dioxide, the amount of energy that is at the highest level possible (Eq. 1) and therefore is very active methane due to its high energy density. But the main disadvantage of methane gas in terms of the environment and the risks that may arise in the use of this gas is included. But considering the large gas pipeline networks that are already existing, large-scale methane production could be possible. In view of the problems related to the production of fuels from carbon dioxide, as noted above, the need is there, the selectivity of the product to be controlled, to achieve high levels of target compound. In this respect, it must be said, that now we have a sufficient understanding of the reasons why we do not show some distribution process different products from other processes. But then we have some control methods of distribution that we express the general mood, although there is no clear argument for them. Solar fuel production

its carbon footprint is zero. Carbon footprint is a quantitative index of the effect on climate change is a process characterized by dioxide equivalent into the atmosphere is measured. With the connivance of products derived from photo catalysts and other trace compounds, which may be due to changes in composition occur, if the methanol from carbon dioxide obtained from the use of methanol as a fuel, causing no increase not in atmospheric carbon dioxide. It should be emphasized that the methanol under very active photo catalytic oxidation of the carbon dioxide is converted to formaldehyde, formic acid and carbon monoxide will eventually. point of view, the ideal revival of carbon dioxide with water in accordance with the reverse reaction is 1 to 3. As mentioned earlier, the reversal of equation (2) is of significant importance. But this process in terms of thermodynamic and kinetic point of view is very unfavorable. For this reason, and unlike the photo catalytic water revival, revival photo catalytic carbon dioxide is less desirable. The kinetic point of view, the production of hydrogen from water is much easier than restoring carbon dioxide. Depending on the product, the process of regenerative of carbon dioxide always needs multiple electrons and proton is also likely to be several to form the final product. For example, the methanol from carbon dioxide requires 6 electrons and 6 protons and the reaction mechanism takes place in several stages burst into the system, so in a number of intermediate composition are produced in this reaction. Instead of producing hydrogen from water, not just the less desirable the process of restoration of all products produced carbon dioxide, but faster as well. The simplest mechanism for the formation of hydrogen involves the transfer of an electron from the conduction band of titanium oxide, hydrogen (from water) that causes the production of a hydrogen atom and the hydrogen atom with hydrogen atoms without any activation energy compound. The revival of the carbon dioxide

problem is that on the one hand hydrogen to revive the carbon dioxide is the most suitable water, and the water acts as a whole quencher, but on the other hand, water can compete to grab electrons from the conduction band. For this reason, it has been observed that the revival of photo catalytic hydrogen production and carbon dioxide by water. The hydrogen is generally higher than the value of output of carbon dioxide is produced. Special features for the recovery of carbon dioxide photo catalytic that the process of breaking water (hydrogen production) distinguishes (Table 1).

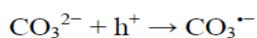
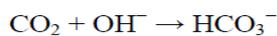
alkaline pH is necessary. But although it's obvious that alkaline pH increases the solubility of carbon dioxide in water, but not necessarily an advantage under these circumstances, because the actual species in these conditions (pH alkaline) carbonates and bicarbonates are present (Eq. 4 and 5). These species are more difficult recovery than carbon dioxide, and hence the advantage of high solubility, which means higher concentrations of the substrate around the optical catalyst, is reduced. In fact, carbonates and bicarbonates, which are negatively charged, are extinguisher good point, and can give electrons to

How to revive the photo catalytic process is carbon dioxide	The revival of photo catalytic carbon dioxide	Rehabilitation photo catalytic water
Gas phase reactions	Sustainable low carbon dioxide in water	Production of hydrogen (H <sub>2</sub> ) from water
Binary catalyst	Different products may be formed	One product
The presence of acid	The mechanism consists of several electron and hydrogen transfer	Simple mechanism
Continuous stream	Product is in contact with the photo catalytic deposition	Exit hydrogen from the liquid phase
Suitable electron regenerative potential	Hydrogen production is very favorable thermodynamically less	The problem of thermodynamically

**Table (1):** some of the difference between water and carbon dioxide photo catalytic revival

The most successful strategy to solve the prevailing problems recovery of photo catalytic water on recovery of carbon dioxide is the use of a co-catalyst, Mobile catalyst. As a general role, platinum is a good center for the production of hydrogen from water. Therefore, it is necessary to prevent the system from entering the metal, or at least of the alloy used, which minimizes the production of hydrogen on the platinum photo catalysts. On the other hand, copper either as single particle, and also in combination with platinum, is to increase the recovery of carbon dioxide to produce hydrogen. An important issue related to the use of water as a reducing agent is the physical state of the photo catalytic under reducing conditions. Most studies in broth and were conducted using water as a solvent. In this case, because of low solubility of carbon dioxide in acid even in neutral pH value (less than micro molar concentrations of carbon dioxide), using

the catalyst, light (photo catalysis). By equations 6 and 7, characterized, in which case the total cycle reaction is oxidation hydroxide to oxygen and carbon dioxide, not a real revival. For this reason, in order to avoid the problem of carbon dioxide solubility in water at neutral and acidic pH, working under the terms of the gas phase by radiation under a humidified atmosphere of carbon dioxide in the presence or absence of inert gases can be helpful. But it causes problems, especially with regard to some products, not escape firmly on the recovery of carbon dioxide absorbed photo catalysts and photo catalytic deposition and can act as a poison. In this respect, experiments conducted under gas phase should not be limited to the analysis of compounds in the gas phase, and it is essential to consider the possibility of oxalic acid, formic acid or methanol and carbon residues are deposited on a solid surface also.



Another problem related to the recovery of carbon dioxide photo catalytic activity improved chemical reaction product which is deposited or absorbed on the surface of solid photo catalysts. Also, it is generally contrary to the resurgence of photo catalytic water, where hydrogen, a gas that is dissolved, the liquid phase was removed and separated from photo catalysts. But the situation is different for the recovery of carbon dioxide, because, as previously stated, the solubility of carbon dioxide in water at acidic pH is relatively low, while the more active products such as methanol produced from its high solubility in water and the environment are condensed liquid phase. In fact, in terms of the methanol concentration is high; the conversion of methanol to carbon dioxide photo catalytic process is one of the best responses in the early stages. In this sense, it is likely that a lot has been done for reactions under conditions of non-continuous (batch) (a condition in which the product of the reaction environment is not), an area with a high concentration of methanol is formed, and at this moment quickly methanol formation of carbon dioxide is equal to the rate of decomposition of methanol into carbon dioxide. To illustrate this problem of instability of the methanol, a simple test can be done. In this case methanol at a concentration higher than the levels achieved in the revival of photocatalytic carbon dioxide is deliberately added to a mixture of water and carbon dioxide. Then the methanol concentration followed by radiation is evaluated to determine whether this decline is due to the decomposition of methanol or not. It is likely that methanol is not sustainable due to the photo catalytic decomposition products such as formic acid derived from the recovery of carbon dioxide, formaldehyde and carbon monoxide exist. All of

these compounds have been reported as photo catalytic decomposition and thus the threshold concentration for their grove reactions in non-continuous (batch) is carried out is expected. Another important point is that in cases where the concentration of carbon dioxide photo catalytic products in revival is low, these products can be derived from carbon dioxide, but are derived from impurities in the photo catalysts. Titanium oxide and other metal oxides, semiconductors, due to their small particle size and their large surface, can absorb organic compounds in the air. These compounds are absorbed because of their contact with the photo catalytic and higher reactivity than carbon dioxide can be a source of optical products, and can cause erroneous conclusions about carbon dioxide photo catalytic activity is reviving. In these cases, where the weight of photo catalytic reactions is high, and low product concentration is recommended that before the photo catalytic reaction, photo catalysts in order to remove substances that may be present on its surface, under the calcinations (calcination) subjected. [15]

## CONCLUSION

### Existing Methods for the Conversion of CO<sub>2</sub> to Chemicals

The product is methanol, which caused the revival of CO<sub>2</sub>. Because they can, by conventional methods also converted to other chemicals and fuel. There are mixed reactions to convert CO<sub>2</sub> into methane, the main reaction, the Sabatier Process reaction in which CO<sub>2</sub> and H<sub>2</sub> is at high temperature and pressure in the presence of nickel catalyst are converted to methane and water.  $\text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O}$  It was discovered by the French scientist Paul Sabatier. The process as a critical step in reducing the cost of discovering life on Mars had been proposed. After the production of hydrogen by water coming from the ground, and CO<sub>2</sub> taken from the Martian atmosphere, oxygen is obtained from the decomposition of water (electrolysis) that can be

used as rocket fuel. The progress of the reaction stoichiometry is just 1: 8 (8 pounds per pound of hydrogen to oxygen for the fuel needs). If only hydrogen and oxygen were sent heavy in the local style came to be, leading to significant weight loss was a cargo that was supposed to be sent to Mars. However, the expensive process of electrolysis techniques used in the Sabatier process to separate hydrogen and oxygen from water is not affordable for testing road cars. In other words electrochemical systems used CO<sub>2</sub> to methane or methanol to revive the cost of consumables (including fuel and high-potential electrodes) compared with the value of products, it does not count. Catalytic hydrogenation of CO<sub>2</sub> to methanol due to the high temperature reaction is not too much attention and satisfaction. Even restoring the electro catalytic CO<sub>2</sub> to formic acid or CO in the presence of a catalyst Pd, Pt and Hg was also affordable. The cost of producing methanol from CO<sub>2</sub> production processes, such as high-temperature catalytic reaction with water vapor and CO<sub>2</sub> vapor-phase restoration of electrochemical / thermochemical CO<sub>2</sub> is also no economic value. The main reason for economically viable recovery of CO<sub>2</sub> to methanol and other chemicals of such reactions is endothermic. According to the thermodynamic process of regenerative of CO<sub>2</sub>, the revival of CO<sub>2</sub> that would be affordable if renewable energy such as solar energy should be used as an energy source. In fact, long, photosynthesis mechanisms to identify the details and then generalized knowledge needed to provide energy for the population studied. Solar energy can be used to convert CO<sub>2</sub>:

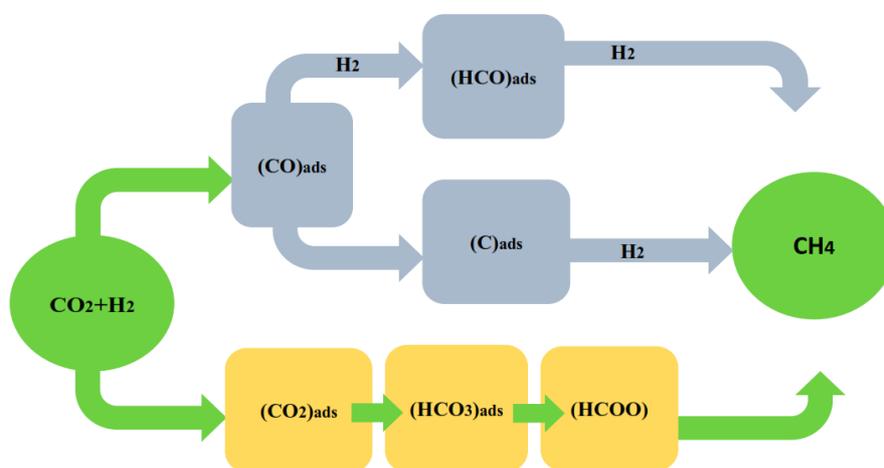
1. Artificial photosynthesis by loading homogeneous and heterogeneous systems
2. Electrochemical restoration using solar electric power plants
3. Hydrogenation of CO<sub>2</sub> with hydrogen generated from the sun (for example, the electrochemical cell)

Although these represent the ability to convert CO<sub>2</sub> to CH<sub>3</sub>OH and HCOOH, HCHO, CH<sub>3</sub>OCH, CO and non, but the limitations such as poor performance, lack of stability and semiconductor catalysts with water, uncertainty electrolytic system, inferior materials Rehabilitation cathode and so suffer. However, photoelectric conversion (PEC) CO<sub>2</sub> to methane, among other methods, seems to be more pleasant. [5]

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**Figure (1):** CO<sub>2</sub> reaction mechanism Methanation