The British Project

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SUMMARY

The Leave campaign needs to explain to the British People how the policy-making freedoms that would arise from Brexit could be used practically to improve Britain's economic performance and energy security. This report takes as read that the argument over migration has already been won – and instead develops the economic and energy cases for Brexit.

This report begins by describing the debt spiral that Britain is now in on external trade, where record trade and balance of payments deficits have now turned Britain's historic net positive foreign assets into net liabilities – with disastrous effects on the primary income, trade and current accounts. This debt spiral is shown to be due to a failure to produce and export goods. The report also describes the loaming electricity generation crisis, which will see British power station capacity in 2023 cut to barely half what it was in 2012/2011.

The report makes the economic case for Brexit through the prism of the British Project – a national project of industrial rebuilding which would only possible once free of the EU. The British Project would have two aims: a doubling of the industrial sector of the economy over twenty years and a clean energy program based on nuclear energy and renewables allied to energy storage. In this way the British Project would address directly the two challenges Britain faces on goods production and energy.

The British Project takes its inspiration from Switzerland, where the state has a constitutional obligation to promote innovation (article 64) and has instituted a strategic program of applied innovation, running all the way from the promotion, nurturing and financing of science-based start-ups all the way through to basic scientific research.

The British Project would create an Industrial Bank that would be funded by the Brexit dividend – the £11 billion a year saving on Britain's EU net budget contribution. The bank would fund new industrial start-ups based on technical innovation. An Industrial College would be set-up to allow individuals and companies alike to develop robust business cases during a sabbatical year paid for by the Taxpayer, and to which every British person would have a right, subject to acceptance by the new College. Prototyping centres would be created to take the business cases from the Industrial College and convert them into practical prototypes. Funding for full-scale production would come from the new Industrial Bank.

The energy program addresses Britain loaming blackout crisis that the EU Large Combustion Plant Directive, Industrial Emissions Directive and Renewable Energy Directive have created. The energy program divides into a short-term stream focusing on building ten new nuclear power stations using established technology and a longer term stream to develop new nuclear power stations and energy storage technologies to make de-carbonising the economy a practical reality whilst provide cheap energy to consumer and industry. The existing Climate Change is repealed and the coal-fired stations kept until the new nuclear stations are stream. Longer-term, a single large 4 GW coal fired station is kept for energy storage: Its carbon-dioxide is hydrogenated to methane or methanol using hydrogen made by electrolysis of water using excess nuclear and renewables electricity production.

1 BACKGROUND

In the referendum campaign for the freedom of our country, the critical question to be answered is:

- What would Britain do with her new-found freedom of action – what would Brexit look like?

Inevitably, the remain-in campaign is appealing to the classic "better the devil you know argument". Given that for most British people life is "alright", with no easily discernible economic problem on the horizon, this is a powerful if uninspiring argument.

During Bill Clinton's election campaign for his second term Clinton wrote a very short memo to himself that he pinned prominently to his desk:

"It's the Economy, stupid!"

The purpose of this report is to provide answers to the above question in terms of the impact on Britain's industrial economy. This paper proposes that Britain would launch a "British Project", having recovered full sovereignty over industrial policy, employment law, energy policy, trade etc. The British Project would aim to literally rebuild Britain's industrial base, and in so doing, provide secure, clean energy for the future as well as material prosperity.

The purpose of this report is to highlight to the British people the huge opportunity that is waiting for us over the horizon, if a majority of the British people are willing to take the plunge and vote leave. By describing the opportunity in some detail, this report is seeking to overcome any doubts that might come to the mind of the electorate as to how realistic the opportunity is.

2 THE EU CONTEXT

Britain is not a free and independent country. As a member state of the EU Britain is obliged to comply with the policies and directives set by the EU. A key message of this report is that whilst Britain remains a member of the EU it would be illegal for any British government to undertake unilaterally and independently any program of national industrial renewal and improvement. This is made abundantly clear by the treaties which underpin our membership and which are the legal bedrock of the EU. These treaties are:

- The Treaty of the EU (TEU)
- The Treaty for the Functioning of the EU (TFEU)

The TFEU was originally the Treaty of Rome, i.e. the founding treaty, and the TEU was the Maastricht Treaty. Both treaties have subsequently been amended and revised by the Treaty of Nice, the Treaty of Amsterdam and the Treaty of Lisbon. The TEU and TFEU as amended by the aforesaid subsequent treaties are available as one consolidated document from the EU Commission website.

The EU has very wide and general powers to intervene on every aspect of national life, even on defence policy. In the field of economic, employment, energy and trade the EU rules supreme, as the following articles from the treaties show:

- Article 2(1) of TFEU: “When the Treaties confer on the Union exclusive competence in a specific area, only the Union my legislate and adopt legally binding acts, the Member States being able to do so themselves only if so empowered by the Union or for the implementation of Union Acts.”

- Article 2(2) of TFEU: “When the Treaties confer on the Union a competence shared with the Member States in a specific area, the Union and the Member States may legislate and adopt legally binding acts in that area. The Member States shall exercise their competence to the extent that the Union has not exercised its competence. The Member States shall again exercise their competence to the extent that the Union has decided to cease exercising its competence.”

- Article 2(3) of TFEU: “The Member States shall co-ordinate their economic and employment policies within arrangements as determined by this Treaty, which the Union shall have competence to provide.”

- Article 2(5) of TFEU: “In certain areas and under the conditions laid down in the Treaties , the Union shall have competence to carry out actions to support, coordinate or supplement the actions of the Member States, without thereby superseding their competence in these areas.

Article 2(5) above seems at first reading to be less invasive of national sovereignty than the preceding ones. However, the EU (see below) has exclusive competence in the areas of competition and commercial policy. These areas are so broad that they allow the EU to intervene everywhere – it is impossible to frame any policy on industry or the economy that does not have a significant commercial or competition dimension.

Also the term “shared competency” is at first reading a little misleading. It does not mean that the EU and Member States are sharing out power equally. It just means, as Article 2(2) makes clear, that “the Member States shall exercise their competence to the extent that the Union has not exercised its competence.” Thus in areas of so-called shared competence the EU can intervene and override national sovereignty to any degree it so chooses.

- Article 3(1) of TFEU: “The Union shall have exclusive competence in the following areas:

  (a) customs union;
  (b) the establishment of the competition rules necessary for the functioning of the internal market;
  (c) monetary policy for the Member States whose currency is the Euro;
  (d) the conservation of marine biological resources under the common fisheries policy;
  (e) common commercial policy.

- Article 4(2) of TFEU: “Shared competence between the Union and the Member States applies in the following principal areas:

  (a) internal market;
  (b) social policy, for the aspects defined in this Treaty;
  (c) economic, social and territorial cohesion;
  (d) agriculture and fisheries, excluding the conservation of marine biological resources;
  (e) environment;
  (f) consumer protection;
  (g) transport;
  (h) trans-European networks;
  (i) energy;
  (j) area of freedom, security and justice;
  (k) common safety concerns in public health matters, for the aspects defined in this Treaty.”

- Article 5(1) of TFEU: “The Member States shall coordinate their economic policies within the Union. To this end, the Council shall adopt measures, in particular broad guidelines for these policies.

  Specific provisions shall apply to those Member States whose currency is the euro.”

- Article 5(2) of TFEU: “The Union shall measures to ensure coordination of the employment policies of the Member States, in particular by defining guidelines for these policies.”

- Article 6 of TFEU: “The Union shall have competence to carry out actions to support, coordinate or supplement the actions of the Member States. The areas of such action shall, at a European level, be:

    (a) protection and improvement of human health;
    (b) industry;
    (c) culture;
    (d) tourism;
    (e) education, vocational training, youth and sport;
    (f) civil protection;
    (g) administrative cooperation.

The above articles are but a selection taken from the 400 or so pages of treaties and protocols which together constitute the Treaties of the EU. These articles were selected because of their relevance to economic, industrial, trade and energy. The Commission has used these articles as the legal basis for framing EU directives that provide the regulatory instruments for the EU’s control over the Member States.

3 THE CHALLENGES BRITAIN FACES TODAY

Before describing the British Project is important to set the scene by describing the main challenges to Britain:

- Uncontrolled migration of largely unskilled labourers and their families from impoverished parts of Europe and the Third World, running at around 1000 people a day on a net basis.

- A long-term weakness in the production of goods, leading to unsustainable balance of trade and balance of payments deficits, and arguably social division between formally industrialised parts of Britain, and the wealthier South East.

- An acute lack of electrical generating capacity, which will get worse with further closures of coal-fired power stations and ageing nuclear power stations.

3.1 UNCONTROLLED MIGRATION

This is one of key issues of the referendum campaign, and is arguably the strongest argument so far deployed in the case for leaving the EU. Meeting this key challenge can only be dealt with by leaving the EU and instituting an Australian-style points system for would-be immigrants. As this is established policy of UKIP and is already being argued for by Leave.EU nothing more will be said about this policy in this report, save to commend it.

3.2 PRODUCTION OF GOODS

In 2015 Britain imported £410.7 billion of goods but only exported £285.6 billion, leaving a massive £125.1 billion deficit. This deficit was partially filled by a £90.3 billion surplus on services giving an overall trade deficit of “only” £34.8 billion. In the past trade deficits were offset in the balance of payments by surpluses on net income from our net overseas assets, termed “primary income”. However what were once net overseas assets have now become net liabilities, following decades of trade deficits. So the former net income has become today’s net payment to our overseas creditors. This is shown by the 2015 balance of payments – see below:

Table 1: Britain’s balance of payments for all trade in 2015
(reference ONS Statistical Bulletin 31st March 2016).

	Credits	**Debits**	**Balances**
Goods	£285.5 billion	£410.9 billion	£125.4 billion deficit
Services	£226.0 billion	£137.3 billion	£88.7 billion surplus
Primary Income	£133.5 billion	£167.9 billion	£34.8 billion deficit
Secondary Income*	£19.6 billion	£44.3 billion	£24.8 billion deficit
Total**	£664.3 billion	£771.7 billion	£96.2 billion deficit

*Transfers between governments and international organisations such as the EU institutions and UN.
**The balance of the total is the balance of payments, also termed the current account.

To put the £34.8 billion primary income deficit in perspective, it is **more** than the total value of British goods exports to Germany in 2015. So this means, in effect, that there is **nothing** in our balance of payments to cover the £62 billion of goods that we import from Germany every year.

How are we financing these deficits? Our reserves of foreign exchange and gold are only worth £25 billion – enough to finance our current account deficit in 2015 for 14 weeks. So clearly running down our meagre foreign exchange reserves is not an option. It is the thesis of this report that Britain's current account deficit is being financed by net sales abroad of assets, mostly income bearing:

- Sales of shares – when more than 10% of the shares are purchased the transaction is classified as Foreign Direct Investment (FDI).
- Sales of gilts.
- Real estate.

Britain is in a debt spiral on our foreign trade. To keep going today we sell assets to make-up for not producing enough goods. But today's sale of an asset becomes tomorrow's increased deficit on our primary income account which adds directly to our current account deficit, which in turn prompts more asset sales.

There is only one solution: Produce more and turn our trade deficit into a trade surplus and thereby bring our current account into surplus too.

3.2.1 Are services a solution?

The balance of trade is the sum of our trade in goods and services. So theoretically we could manage our massive goods deficit by growing our large services surplus so that it more than offsets our goods deficit. This is already happening in our non-EU trade – see table 2 below:

Table 2: Britain's balance of payments for non-EU trade in 2015 (ref. ONS Statistical Bulletin 31st March 2016).

	Credits	**Debits**	**Balances**
Goods	£151.2 billion	£187.9 billion	£36.7 billion deficit
Services	£137.0 billion	£69.2 billion	£67.8 billion surplus
Trade = Goods + Services	£288.2 billion	£257.1 billion	£31.1 billion surplus
Primary Income	£83.5 billion	£90.8 billion	£7.3 billion deficit
Secondary Income*	£10.7 billion	£24.3 billion	£14.2 billion deficit
Total**	£382.4 billion	£372.2 billion	£14.1 billion surplus

However service exports need highly qualified people with exceptional expertise. Service exports are largely sales of knowledge sold as reports, software or designs, and crucially, people exporting services have to have the talent and training to produce these reports and designs themselves. This is not an activity for which the vast majority of the population have the training or aptitude for. On the other hand the production of goods involves a very wide range of talents and abilities. In a manufacturing company you need designers and engineers who will design the products and the manufacturing processes. However the operation of the manufacturing process i.e. making the product is done on the shop floor by people who do not need very specialised qualifications, and the shop floor staff will be more numerous than the designers and engineers even for highly automated manufacturing. So an economic model based on making goods automatically employs the general population productively, whereas in the model for exported services, most people do not have a role at all.

Britain's current 56:44 split between goods and services is already very highly weighted towards services than is usual for a first world economy. A comparison with Switzerland is instructive – see table 3 below of Switzerland's balance of payments in 2014:

Table 3: Switzerland's balance of payments for all trade in 2014 (ref. Office Fédéral de la Statistique).

	Credits	**Debits**	**Balances**
Goods	£199.2 billion	£166.4 billion	£32.9 billion surplus
Services	£72.0 billion	£59.9 billion	£12.1 billion surplus
Primary Income	£78.4 billion	£81.0 billion	£2.6 billion deficit
Secondary Income	£23.8 billion	£35.1 billion	£11.3 billion deficit
Total	£373.4 billion	£342.3 billion	£31.1 billion surplus

As can be seen from the above, the Swiss split between goods and services in their exports is 73:27 – much more weighted towards goods than Britain. On a per capita basis Swiss service exports are much higher than for Britain: £9000 per capita versus £3380, however the per capita surpluses are almost the same: £1500 for Switzerland and £1370 for Britain. Switzerland is a multi-lingual country and may well be doing a lot more lower level trade in the service sector – such as conveyancing – with its neighbours than we could ever do. This could explain the higher volume of service trade – but it has not lead to a significantly higher surplus than we are already achieving.

Note that Switzerland's per capita exports of goods are staggering compared with Britain's: £25,000 versus £4,400 – and Switzerland has a positive trade surplus on goods year after year.

Language and culture are determining factors, particularly in the case of services. Britain's strong performance in services is a legacy of history: the British Empire and its huge legacy of the English language, culture, common legal systems, common head of state (Canada, Australia, New Zealand). By the same argument there is little scope to grow our service exports to the EU – countries with different languages, different cultures and (very) different legal systems. It is not surprising that our service trade with the EU, though in surplus, is much lower than our service trade with the rest of the world – see table 4 below.

Table 4: Britain's balance of payments for EU trade in 2015 (ref. ONS Bulletin 31/03/16).

	Credits	**Debits**	**Balances**
Goods	£134.3 billion	£223.0 billion	£88.7 billion deficit
Services	£89.0 billion	£68.1 billion	£20.9 billion surplus
Trade = Goods + Services	£223.3 billion	£291.1 billion	£67.8 billion deficit
Primary Income	£49.6 billion	£77.1 billion	£27.5 billion deficit
Secondary Income	£8.9 billion	£20.1 billion	£11.2 billion deficit
Total	£281.8 billion	£388.2 billion	£106.4 billion deficit

In conclusion it is not realistic to expect service exports to do more than they already do to offset Britain's yawning goods deficit. Our trade balance problem is with our Continental neighbours with their different languages, cultures and legal systems. To remedy our deficit we must produce and export more goods.

3.2.2 The failure of the EU internal market to help British goods exports

Before closing off this section it is worth reviewing briefly the impact the EU internal market has had on British goods exports to the EU.

The "internal market" was introduced on 1st January 1993 across the EU, with harmonisation of standards and "free" movement of goods and people across the EU. Being a member of the "internal market" is held up by supporters of EU membership as being very import for British exports. The facts tell a very different story indeed. In constant US dollars, British goods exports to the EU have only risen from $194 billion in 1992 to $205 billion in 2015. Thus British goods exports have only grown in real terms by 5.7% over the 23 year period since the introduction of the "internal market" or 0.2% per year.

By contract US and Swiss exports to EU less UK over the same period have risen by 46% and 58% respectively in real terms, the corresponding annualised growth rates being 1.7% and 2.0% i.e an order of magnitude higher than the British export growth rate. Indeed US exports to EU less UK have now overtaken British exports. Switzerland has had a free trade agreement with the EU for goods since 1977 whereas trade between the US and EU is subject to tariffs. Nevertheless both the US and Switzerland have massively out-performed the UK in terms of export growth to the EU since the introduction of the "internal market".

The very lacklustre British export performance to the EU could have been due to inherent British weaknesses and not to a failure of the "internal market" to promote British goods. If this had been the case then one would have expected British export performance to other key markets to have been similarly poor. The opposite is true. Since 1992, British goods exports to both the US and Swiss markets have doubled in real terms, to $73 billion and $11 billion respectively. The inescapable conclusion is that British membership of the EU has been singularly unhelpful in promoting exports, in particular since the advent of the "Single Market" in 1993. Therefore the impact of leaving the "internal market" is expected to be neutral to positive for British business.

3.3 ELECTRICAL GENERATING CAPACITY

At the time of writing Britain's power station generating capacity is 56.4 GW, which is only 0.1 GW higher than the peak demand recorded four years ago, and this situation is set to worsen over the next few years significantly. How has this come about? The main cause, apart from neglect by successive governments, is the following three EU directives:

- Large Combustion Plant Directive (LCPD)
- Industrial Emissions Directive (IED)
- Renewable Energy Directive (RED)

The LCPD and IED should be seen together: the IED came into force on January 1st 2016 and replaced the LCPD which came into force in 2001. The LCPD and its successor, the IED, impose strict limits on the emissions of combustion plant with thermal inputs of 50 MW (0.050 GW) or more, so the directives automatically apply to all power stations. The directives are notably concerned with sulphur dioxide, nitrous dioxide and particulates emissions. The IED limit on nitrous oxides from coal-fired plant is 200 mg/Nm^3. It is not clear that any British coal-fired power station has any prospect of getting nitrous oxides this low – typical values are in the range 400 – 1200 mg/Nm^3 for a coal-fired power station.

The result of the LCPD and then IED directives has been widespread closure of coal-fired power stations. To-date 11.6 GW of coal-fired capacity has already been lost due to the LCPD and IED, with a further 4.9 GW of coal-fired capacity to be lost in the next 12 months.

The IED allows EU member states to negotiate "Transitional National Plans" (TNP) under which combustion plant put into the TNP are exempt from full compliance with the IED limits until 2020. The IED also allowed operators to designate a power station as "Limited Lifetime Derogation" (LLD), where the operator is allowed 20,000 operating hours from 1st January 2016 without having to comply with the IED limits. At the end of the 20,000 hours or by 2013 the LLD plant must close.

It appears that all the remaining coal-fired stations are either LLD or TNP – i.e. facing closure in the next 5 – 7 years. Indeed this was underlined on the 18th November 2015 when the Secretary of State Amber Rudd stated the government's intention to close all coal-fired power stations by 2025. Amber Rudd's intervention is arguably irrelevant as the IED will most likely force their closure anyway, mainly because the nitrous oxide limit is too ambitious for the coal-fired power stations to reach.

The RED has set the target of 20% for all of the EU's electricity to be generated by renewables (wind, solar, hydro-electric) by 2020. Every member state has been given a target to achieve by 2020 – Britain's target is 15% of electricity from renewables. Britain currently generates around 11% of electricity from renewables (9% from wind and 2% form hydroelectric). The RED has contributed to Britain's energy crisis because it has forced the prioritisation of wind farms over conventional power stations. Thus over the last eight years the installed capacity of wind has risen from 3.0 GW in 2008 to 13.6 GW in 2015, with additional capacity in the order of 20 GW foreseen. By contrast, at time of writing there is only one new power station project in Britain: this is the gas-fired Carrington power station which is being commissioned now, and will be bring 0.880 GW of capacity to the grid.

The global warming debate is beyond the scope of this report – so renewables are only considered here in terms of their possible contribution to meeting demand for electricity. Unfortunately renewables capacity cannot be taken as a credit in Britain's capacity versus demand equation, because:

- Renewables produce electricity when the wind blows regardless of the demand for electricity. If the wind drops generation of electricity falls very quickly – a 10% reduction in wind speed reduces electricity generation by 33%. (Hydro-electric schemes do not have this weakness, however all of the growth in renewables is in wind which most certainly does.)

- Because wind (the main renewable in Britain) only produces electricity when the wind blows the true time-averaged capacity of the windfarms is barely 20% of the installed capacity – see table 7 below.

- The only practical way of storing renewables electricity currently in operation anywhere in the world is by pumping water back up to the top of hydroelectric schemes. This is of limited use in Britain as we are not a mountainous country. Britain's pumped hydro-electric schemes only account for 0.9% of electrical output.

Energy from renewables must be stored on an adequate scale to be of any use. As this is not the case, the effect of renewables is very disruptive as it leads to sudden bursts of supply coming onto the grid as the wind rises, and sudden withdrawals of power as the wind drops. These sudden changes happen regardless of demand and mean that there is a greater "swing" burden on the power stations than would be imposed by fluctuations in demand alone.

Table 5: Britain's average and peak demand for electrical power, versus capacity. (Data from National Grid Database)

Year	Average demand, GW	Peak demand, GW	Power Station capacity in GW
2012	35.8	56.3	67.9
2013	35.3	55.9	59.6
2014	33.4	51.4	58.6
2015	32.3	52.5	56.4
2016			56.2*
2017			52.3**

*Based on the forecast closure this summer of Rugeley coal-fired power station which has a capacity of 1.000 GW, and the coming on stream of Carrington gas-fired power station with a capacity of 0.880 GW.
**Based on the forecast closures in March 2017 of Eggborough and Fiddlers Ferry coal-fired power stations which have a combined capacity of 3.949 GW.

Table 6: Electricity generation (2015 data) in Britain split-out by generation method. Data from Gridwatch

	Installed Capacity	**Percent utilization**	**Time-averaged generation rate**	**Generated Electricity**
Nuclear	9.111 GW	82.1%	7.484 GW	65.6 TWh
Gas	29.905 GW	32.1%	9.608 GW	84.2 TWh
Coal	17.347 GW	48.9%	8.486 GW	74.3 TWh
Total	***56.363 GW***		***25.578 GW***	***224.1 TWh***
Wind	13.675 GW	21.6%	2.950 GW	25.8 TWh*
Hydro Electric			0.466 GW	4.1 TWh
Pumped Hydro Electric			0.308 GW	2.7 TWh
Total			***3.724 GW***	***32.6 TWh***
Imported Electricity			2.363 GW	20.7 TWh
Other sources			1.285 GW	11.3 TWh
Grand Total			***32.950 GW***	***288.6 TWh***

*23.3 TWh are found to have been produced by metered Wind generation in 2015 – the 25.8 TWh number was calculated such that total generation equalled demand (288.6 TWh). Not all wind turbines are metered hence the total from wind must be calculated as above.

Britain's power station generating capacity is set to fall to even lower than 52 GW because the fleet of nuclear reactors is nearing its end of life – see table 6 below. By 2023 five out of the eight existing nuclear power stations will have closed, causing a further reduction of 5.550 GW. So by the end of 2023, just with current closures, British power station capacity will have fallen to 46.7 GW. This is well below any of the peak demand figures, even for the very mild winters recently experienced.

Table 7: Britain's operational nuclear power stations.

Power Station	**Type**	**Owner**	**Rated capacity**	**Closure date**
Dungeness B	AGR*	EdF (France)	1.009 GW	2028
Hartlepool	AGR	EdF (France)	1.190 GW	2019
Heysham 1	AGR	EdF (France)	1.150 GW	2019
Heysham 2	AGR	EdF (France)	1.250 GW	2023
Hinckley Point B	AGR	EdF (France)	0.960 GW	2023
Hunterston B	AGR	EdF (France)	1.000 GW	2023
Sizewell B	PWR**	EdF (France)	1.188 GW	2035
Torness	AGR	EdF (France)	1.364 GW	2030
		Grand Total capacity	9.111 GW	

*Advanced Gas-cooled Reactor
**Pressurized Water-cooled Reactor

The effect of the IED will be to stop all coal-fired electricity generation. In the worst case this will take British power station generating capacity to only 33.5 GW by 2023 – barely average demand. Under the IED some of the coal-fired stations could remain in operation – but burning wood instead of coal. The 46.7 GW capacity by 2023 is based on current closures. 33.5 GW is the worst case. So by 2023, if we remain in the EU, British power station capacity will be somewhere between 33.5 GW and 46.7 GW, dependent on how much wood burning there is.

It takes around six years to build a nuclear power station from start to finish, and about three years to build a gas-fired power station. At this time there are no British solutions at all to solve our impending energy crisis. Instead there are five possible foreign schemes, four of which are for nuclear and based on unproven designs and the fifth scheme is a new gas-fired power station in Trafford, Manchester. The Trafford Power Station is technically the most certain as it is based on proven technology. However it is on hold due to a lack of funding. Similarly none of the four possible nuclear schemes have received final sanction – they are reviewed in turn below.

3.3.1 Hinckley Point C

This is the government’s preferred choice. It is a Project run by EdF to build a 3.2 GW power station using a new French reactor – the EPR (European Pressurised Reactor) by the French firm Areva. However it is extremely expensive to build, £18 billion, which translates to £5,600 per installed kW of generating capacity. By comparison Sizewell B, Britain’s newest operating nuclear reactor cost £3.1 billion to build at today’s prices (it came on stream in 1995) and delivers 1.188 GW i.e. it cost £2,600 per installed kW – less than half of Hinckley Point C’s forecast capital cost per delivered kW.

The government has had to promise a guaranteed price of £92 per MWh – about three times the price in Continental Europe at current exchange rates. This would put British manufacturing at an immense disadvantage and be very expensive for the British consumer to boot. A disgraceful dimension to the pricing is that when the project was first mooted in 2008 the French reactor builder claimed that Hinckley Point C could produce electricity at £24 per MWh.

In summary Hinckley Point C is a total disaster: It would be more than as twice as expensive to build as a power station 20 years ago and would produce the world’s most expensive electricity. Its EPR reactor is an unproven design which is already the subject of serious safety concerns from the French, British and Finish nuclear regulators. The four EPR sites (Olkiluoto in Finland, Flamanville in France and Taishan 1 & 2 in China) are all subject to serious delays and none have come on stream, even though construction of the Finnish reactor began over 10 years ago.

In the latest twist the chief financial officer of EdF has resigned over concerns that Hinckley Point C would be too high a burden for EdF, which is suffering from collapsing profits on its existing operations. The project has not been given final sanction.

3.3.2 Horizon Nuclear Power

This is a project to build two or three Advanced Boiling Water Reactors at the site of a decommissioned Magnox reactor at Wylfa. The project is by Hitachi of Japan. The reactor is a novel design but operates on the same principle as the Fukushima plant: namely cooling the reactor core directly with boiling water and running the turbines with the steam produced thereby. The design has not been approved in the UK. Funding for the project has not been agreed, nor has the scope – two or three reactors. The project is in its infancy and consequently has not been sanctioned.

3.3.3 Moorside Nuclear Project

This is a project to build three Westinghouse nuclear reactors at the Moorside site in Cumbria. The reactors would produce 3.4 GW i.e. slightly more than Hinckley Point C. The Treasury committed to providing financial security to the project in 2014. The reactors are the API1000 design, which is a PWR (water pressurized reactor) like Sizewell B's and the EPR. The design is novel and majors on improved safety. It has been approved for use in the US and China, with interim acceptance in the UK. Westinghouse used to be British-owned. It was sold by Gordon Brown's government to Toshiba of Japan. Westinghouse was founded in the US and that it is where it is based. Sizewell B's reactor is a Westinghouse house design. The project has not been sanctioned.

3.3.4 Bradwell Nuclear Power Station

The government has been in discussion with the Chinese government for the construction of up to three Chinese nuclear reactors at the Bradwell site. This site was originally the home of a Magnox nuclear power station, which came off stream in 2002. None of the potential Chinese designs have British approval and there are no firm plans, though a "strategic agreement" has been signed between Britain and China.

4 THE BRITISH PROJECT

In a nutshell the British Project is the solution to solve two of the three key challenges to Britain's wellbeing, namely:

- Production of Goods
- Generation of plentiful, cheap and clean electricity

As has already been noted, the other challenge, namely mass migration, has already got a policy response developed: adoption of an Australian-style points system.

Solving all three challenges requires Britain to leave the European Union, because the EU has removed British sovereignty in the areas of industrial policy, energy, trade, environment, anti-trust and employment law.

The British Project is an exciting alternative to the European Project of building a new European Empire. As well meeting the material needs of the British people, the British Project will inspire and raise the national spirit of Britain by bringing a sense of real achievement to the whole country.

This project has already been foreshadowed, by of all people, the Chancellor of the Exchequer, George Osborne, in his remarks that Britain needed to create a "Northern Powerhouse" based on the "March of the Makers". However George Osborne's rhetoric has not been translated into deeds, despite the overriding urgency of so doing.

The British Project will be grounded in technical innovation. The government will pass primary legislation to place a statutory obligation on the British state to promote technical innovation, in the same way as the Swiss Federal law imposes the same obligation on Switzerland (article 61 of the Swiss Constitution and the LERI federal statute – Loi pour l'Encouragement de la Recherche et de l'Innovation). The British Project takes much of its practical inspiration from the Swiss CTI – Commission pour la Technologie et l'Innovation. The CTI and its sister organisation CTI Invest are the main Swiss institutions which help, nurture, develop and fund start-ups in the industrial sector – all the way from the initial idea to full-scale production.

The British Project will be funded by a new Industrial Investment Bank. The new bank will be funded by "Brexit Dividend", i.e. the net contribution that Britain currently pays to the EU budget. This is £11.4 billion a year. The £11 billion a year Brexit dividend will give the bank a lending power of up to ten times this amount - £110 billion per year, assuming 10% of balance sheet is cash. The bank will operate commercially and will be underwritten by the taxpayer. Its purpose will be to provide funding for new manufacturing companies and strategic investments in Britain's energy infrastructure.

4.1 LIBERAL FREE MARKET ECONOMICS

Before describing British Project in detail, it is necessary to review the arguments pertaining to the free market, and by extension the thesis of liberal economics that governments should abstain from any intervention in the commercial part of the economy.

In the Anglo-Saxon world the mainstream viewpoint is the liberal economic thesis that government intervention in the economy does not work. The role of government should be limited to creating the conditions in which industry and trade can flourish. Indeed the Leave campaign's main argument for leaving the EU is that once free of the EU Britain will have more opportunities to strike free trade agreements, and it is hoped, increase exports thereby.

However there is an inconsistency in the argument for striking new free trade deals, however desirable a given free trade agreement might be. Why would free trade agreements with non-EU countries be so much better than the free trade agreement with the EU that is manifestly not working? As already pointed out in section 2.2.2, British exports of goods to the EU have stagnated over the last 20 years, despite a free trade agreement being in place. Over the same period of time British goods exports to the US, with whom we do not have a free trade agreement, have risen by over 90 percent in real terms.

This paper is not against free trade agreements. However the position set out herein is that free trade agreements, whilst helpful at the margins, are not the fundamental point at issue. The real driver for export success is the ability to produce the range and quality of goods that customers in export markets are willing to buy. Britain's success in the US market is down to our strengths in defence equipment, aerospace and luxury cars – all things which the US wants to buy. The EU market is much less interested in the aforesaid goods categories, and consequently our export performance to this key market is poor.

The central thesis of this report is that the key benefit of leaving the EU is to have the policy making freedom to rebuild our industries. Only then, with expanded industries, will we be able to increase our exports and build lasting prosperity. This paper advances an apparent paradox – that it in only by leaving the EU that we can ever hope to increase our exports to the EU.

4.1.1 The free market liberal view

This viewpoint holds that companies must at all times be subject to the full commercial pressure of the marketplace. If companies become shielded from these pressures then their activities become inefficient and ultimately they need permanent state subsidies to stay afloat. Thus state intervention just promotes inefficient allocation of resources and ultimately weakens the economy.

Companies which offer products or services which the market wants, at competitive prices, will succeed. Companies which fail in this endeavour go under. Adherents of the free market view see failing companies going under as necessary destruction of weak enterprises to make space for stronger companies to take their place. It is a sort of Darwinian theory of the survival of the fittest. Implicit in this free market view is that as weak companies are killed off, new companies spring up to take their place. It is this last assumption which needs to be revisited in the context of manufacturing industry.

4.1.2 Critique of the free market liberal view

The peacetime experience of the Soviet Union and British nationalised industries is that companies that were allowed to operate outside of full commercial pressures did indeed become woefully inefficient. Established companies do seem to need the continual pressure of the “market” to maintain focus on commercially relevant activities. Even with the commercial pressures of the market, it is surprising the extent to which companies allow their resources to be thrown away in meetings that have no purpose or corporate bureaucracy that serves no customers. So the ever present pressure of the market is essential for corporate health.

The wartime success of Soviet and British armaments production arguably validates the free market view, in that the wartime imperative of defeating the Axis provided a large and threatening external pressure that gave focus to the armaments industries. Thus fear of Germany became a surrogate for the market pressure that a company would experience in peacetime. Whether it's winning the war or winning new customers all companies need a continual live/die pressure to keep them focused on productive activities. So far so good for the free market view.

As alluded-to above, the free market view does have one critical weakness. When a failing manufacturing company goes under, you do not get home-grown new companies springing up to replace it. What happens is that the failed company’s competitors, most or all of which will be foreign, simply take the market of the failed company. Why is this?

A new manufacturing company takes between 2 - 5 years to become operational, from the first idea to delivering products to paying customers. In addition large capital investment is needed, often running into millions of pounds. Thus creation of a new manufacturing company, unlike a new services company, is not a practical proposition for the vast majority of people. By contrast a new company in the service sector can be created by one person in an afternoon from their house using their home computer. Start-up costs can easily be less than £1000. This vital difference between manufacturing and services explains why start-ups of new companies have overwhelmingly been in the service sector, with manufacturing industry shrinking year by year as a proportional of the total economy.

4.1.3 The free market: Conclusion

This paper is arguing that the doctrine of complete non-government intervention has led to a free market that is distorted, by dint of being very one-sided: the market works efficiently at killing off weak companies but does nothing to grow replacements. The British Project will seek to remedy this weakness and thereby give Britain the best of both worlds: A free market economy where new manufacturing companies do spring into being and grow. How this can be achieved in described in the next sections.

4.2 SWISS LESSONS FOR BRITAIN

Switzerland is often portrayed as a country majoring on its banking sector, with watch-making being the only industrial sector in which Swiss firms are known to have significant positions. The truth is somewhat different. As discussed above Switzerland has significant service exports, including financial services based on a dynamic banking sector. Europe’s largest bank: Union des Banques Suisses (UBS) is Swiss. However Switzerland is a leading industrial nation with its exports far more weighted towards manufactured goods than is the case for Britain.

The World’s largest maker of industrial electric motors is ABB – a Swiss company, that also has dominant positions in the manufacturer of all manner of control and switchgear for electrical installations. The World’s largest maker of industrial instrumentation: flow-meters, temperature probes, pressure probes etc is Endress & Hauser – also a Swiss company, as is Sulzer, the World’s foremost manufacturer of equipment for the oil refining and allied chemical industries: distillation columns, reactors and industrial pumps. Novartis, Roche and Ciba-Geigy are all leading pharmaceutical companies and all Swiss. Although Switzerland has only 8 million inhabitants compared with 65 million in Britain, Novartis, Switzerland’s largest pharmaceutical manufacturer is as big as GSK, Britain’s largest pharmaceutical manufacturer. As well as having major pharmaceutical manufacturers, Switzerland is home to the manufacturers who make the equipment used to make the pharmaceuticals – which is more than can be said for Britain. The World’s largest food processing company is Nestlé – another Swiss company. Switzerland even its own aircraft manufacturer, Pilatus, and Switzerland also has a major train manufacturing capacity. Switzerland is also the World’s foremost refiner of gold, and has 50% of the World market for watches by value.

In Switzerland the net value added of manufacturing industry per inhabitant is £9700. In Britain it is only £2600 – barely a quarter of the Swiss figure. This is the difference between the two countries.

4.2.1 The Swiss commitment to innovation.

Article 64 of the Swiss constitution commits the federal Swiss state to innovation:

“La Confédération encourage la recherche scientifique et l’innovation”

(The Confederation encourages scientific research and innovation.)

The above Article is put onto a statutory footing by the Swiss statute called LERI – Loi pour l’Encouragement de la Recherche et l’Innovation (law for the encouragement of research and innovation.)

The chief organ of the Swiss state that discharges the above duty to encourage research and innovation is the CTI – Commission pour la Technologie et l’Innovation. The CTI has its origins in the decision taken in 1943 by the Swiss government to create the CERS – Commission pour l’Encouragement de la Recherche Scientific (Commission for the encouragement of scientific research). The motivation behind the creation of the CERS was the promotion of Swiss industry, as the Swiss government correctly recognised at the time that industrial growth must be based on technical innovation from scientific research. In 1996 the CERS was renamed the CTI. In 2008 the Swiss LERI law was updated to give decision-making powers to the CTI – before this time the CTI only had the power to advise.

Two years ago the CTI was given further powers so that it could take initiatives on its own without having to refer to the Swiss government.

4.2.2 CTI – Commission pour la Technologie et l'Innovation

At the heart of the Swiss state's continuous effort to promote and nurture the creation of new science and technology-based companies is the CTI – Commission pour la Technologie et l'Innovation. The CTI acts in four areas:

- Promotion and funding of applied Research and Development carried-out in partnership between Swiss universities and Swiss companies;
- Coaching and training for start-ups companies that are science and/or technology-based.
- Transfer of know-how and technology from Swiss universities to Swiss companies.
- Swiss Competence Centres for Energy Research (SCCER).

4.2.2.a Promotion and funding of applied Research and Development.

In Swiss law the CTI exists specifically to promote applied Research and Development (R&D) that is driven by commercial Swiss objectives. Switzerland also devotes state resources to promoting scientific research for knowledge's own sake. However this is the responsibility of another organ of the Swiss state: the Fonds National Suisse (FNS).

In essence the CTI supports applied R&D on a collaborative basis between Swiss universities and Swiss companies. The CTI rarely supports R&D projects that do not have commercial stakeholders right from the beginning. The support given by the CTI takes the form of funding, coaching and training. The CTI employs teams of experts and coaches who are specialists in specific industrial fields.

The Swiss spends around £80 million a year on this aspect of the CTI's activities, around 78% of the CTI's total budget from the Swiss state. The population of Switzerland is 8 million versus 65 million in Britain. So an equivalent level of British expenditure on promotion of applied R&D would be £80 million x 65/8 = £650 million. The CTI funds projects using Swiss taxpayer's money – but on the basis that the other project stakeholders must contribute financially to the projects. On average the CTI funding is around 45% of the total project spend. In 2014 the CTI evaluated 662 proposals for R&D projects, and accepted 362 of them – around 55%.

4.2.2.b Coaching and Training for start-ups in science & technology fields.

The CTI offers free training and coaching to Swiss citizens thinking about starting up a company in the field of science and technology. Since 2004 over 31 thousand Swiss citizens have received this coaching and training. Translating this to Britain's 65 million population this would equate to over 250 thousand people.

Once a company starts trading the coach and training continues, and broadens to include support and advice for exporting. These training programs for start-ups began in 1996, and between this time and 2014 348 companies were successfully started-up by the CTI, and 87% of the start-ups were still trading by the end of 2014. Indeed around 40% of all Swiss start-ups are supported by the CTI, and receive the label "CTI Start-up"

The coverage across industry of the CTI's support for start-ups is very broad. Over the period 2003 to 2014 the CTI has supported start-ups in the following industrial fields:

- IT and Communication Technologies: 31%
- Medical Technologies: 17%
- Biotechnology & Pharmaceuticals: 16%
- General Industry: 12%
- Engineering: 12%
- Micro & nano technologies: 7%
- Energy & green technologies: 6%

The CTI spends around £7 million a year of Swiss taxpayer's money on the above coaching and training.

4.2.2.c Transfer of know-how and technology to Swiss companies.

This aspect of the CTI's activities is termed TST – Transfert du Savoir et de la Technologie i.e. Transfer of Know-How and Technology. The CTI undertakes the TST activity using innovation coaches whose role is to bring the know-how and technology developed in Swiss institutions to Swiss companies. This activity has a particular focus: transferring know-how and technology from Switzerland's eight specialised technology networks to Swiss companies. These networks are termed: Réseaux Thématiques Nationaux (RTN) – National thematic networks. These networks are:

- Carbon Composites Schweiz
- Inartis (life sciences)
- Surfaces Innovantes (Innovative surfaces)
- Swiss Biotech
- Swiss Food Research
- Swissphotonics
- Swiss Wood Innovation Network
- Verein Netzwerk Logistik (Logistics Network)

The CTI spends around £2.5 million of Swiss taxpayer's money every year on TST. Most of this budget is spent on work with the above technology networks.

4.2.2.d Swiss Competence Centres for Energy Research (SCCER)

This is a new development that began in 2013, based on the Swiss government action plan: Coordinated Swiss Energy Research. The CTI, working with its sister organisation the FNS, has been mandated to create eight Swiss Competence Centres for Energy Research (SCCER). The Swiss government has allocated around £50 million to set-up these centres over the period 2013 – 2016, with a further £30 million to fund new R&D projects coming from these centres. The SCCER are:

- FEEB&D - Future Energy Efficient Buildings & Districts
- EIP – Efficiency of Industrial Processes
- FURIES – Future Swiss Electrical Infrastructure
- HaE – Heat & Electricity Storage

- SoE – Supply of Electricity
- CREST – Centre for Research in Energy, Society and Transition
- Mobility – Efficient Technologies and Systems for Mobility
- BIOSWEET – BIOmass for SWiss EnErgy fuTure

4.3 THE BRITISH PROJECT APPLIED TO THE PRODUCTION OF GOODS

4.3.1 Objectives

- To create a stream of new manufacturing companies founded on innovation.
- To rescue and reconfigure failing manufacturing companies into successful enterprises.
- To provide technical resources to grow existing companies

4.3.2 Concept

The concept for creating new manufacturing companies is to facilitate the preparation of very robust business cases for proposed new companies, and then to provide investment funds from the taxpayer-backed Industrial Investment Bank for those companies for which strong business cases have been successfully developed.

This program will be open to all British adults and companies. Anybody with an idea for starting a new manufacturing company will be entitled to apply to join the program. Moreover the program will be open to existing companies as well as private individuals. The concept is that companies wishing transform themselves or undertake large expansions need the same type of help as individuals wishing to start a new company from scratch. The program will also be open to receivers of failed companies to help them build new manufacturing companies on the ashes of the old.

4.3.3 New Institutions

The following new institutions will be created to manage the process of creating new companies from initial idea all the way through to a profitable company:

- A new standalone techno-economic college will be created and paid for by the taxpayer.
- A network of prototype and development centres will be set up across the country, each one specialising on an industrial sector. It will be underwritten by the taxpayer but will charge for its services at commercial rates.
- A project execution service will be created. It will be underwritten by the taxpayer but will charge at commercial rates.

4.3.4 The scale of the British Project: Target growth rates and required investment

4.3.4.a Current economic context of British manufacturing industry

In 1992 the gross added value of British manufacturing industry was £182 billion in constant 2014 £. In 2014, the gross added value of British manufacturing industry was only £171 billion (Data from ONS Blue Book and data series from ONS website). So over the 22 years since the introduction of the EU Single Market British manufacturing has actually declined by 6% in real terms. In the meantime the total economy has seen year on year average real-terms growth of 2.2% over the same period, with total aggregate growth being 62% (GDP basis).

In essence the non-manufacturing part of the economy has been growing at 2.6% per year in real terms, the manufacturing sector has been shrinking and the economy as a whole has grown at 2.2%

4.3.4.b What the British Project needs to achieve: the Target growth rate

The British Project needs to translate into a positive real-terms growth rate for British manufacturing industry such that the current structural deficits on manufactured goods and goods overall are converted over time into surpluses. This report envisages a twenty year timescale for the British Project to take full effect and make the conversion from structural deficit to structural surplus.

This report envisages that the British Project translates into a 5% per year real terms growth rate of British manufacturing industry, as measured by gross added value (GVA). It is assumed that the current 12% uplift between GDP and GVA will continue to apply in the determination of GDP.

The following assumptions are made:

- End 2015 is taken as a datum
- The long-term trend growth rate of 2.58% per year for the non-manufacturing part of the economy is projected twenty years into the future.
- The long-term trend growth rate of 1.23% per year for consumption (by value) of manufactures is projected twenty years into the future.

The above assumptions have been used to make two forecasts twenty years into the future:

- A “do nothing” forecast i.e. the British Project is not implemented and Britain carries on as is, with manufacturing stagnating.
- The British Project forecast, based on the 5% per year growth rate for British manufacturing is achieved.

Table 8: Twenty-year forecasts for British Project and Do Nothing scenarios
(Constant 2014 £ used)

	End 2015	End 2035	
	Current Situation	Do Nothing	British Project
GDP (£ billions)	1865	2974	3296
GVA manufacturing (£ billions)	174	174	462
GDP manufacturing (£ billions)	195	195	517
GDP non-manufacturing (£ billions)	1670	2779	2779
Consumption of manufactures (£ billions)	258	329	329
Manufactures trade balance (£ billions)	84 deficit	155 deficit	188 surplus
Manufactures trade balance in % GDP	4.5% deficit	5.1% deficit	5.7% surplus
Average GDP growth rate (%/year)		2.36%	2.89%
Accumulated GDP over 20 years		£47.0 trillion	£49.6 trillion

Over a twenty year period the 5% per year growth rate in British manufacturing industry adds 0.5% to overall GDP yearly growth rate and turns a current £84 billion trade deficit on manufactured goods into a £188 billion surplus.

4.3.4.c The capital investment needed to make the British Project happen.

From the ONS, the gross value of British manufacturing fixed assets was £510 billion in 2014, and these assets produced £171 billion of gross added value. At the end of 2035, from the above table 8, British manufacturing output will have increased to £462 billion of gross added value, in 2014 prices. This large increase is output will necessitate a proportionate increase in manufacturing industry's fixed assets. On a pro-rata basis to the situation in 2014, the value of fixed assets needed to deliver £462 billion of gross added value is then:

Gross fixed Assets for £462 billion GVA = £510 billion x (£462 billion / £171 billion)
= £1378 billion

The increase in gross fixed assets is then: £1378 billion - £510 billion = £868 billion

The investments made during the next twenty years for the British Project will have to fund the above increase in gross fixed assets. Arguably the above analysis could have been carried-out on a net fixed assets basis, instead of gross assets. This would have resulted in an increase of net fixed assets about one half of the £868 billion increase in gross fixed assets. However this approach would perhaps have not been conservative enough, as the British Project will result in the installation of much brand-new plant and equipment. Gross fixed assets gives a more accurate picture of the investments needed for new plant as gross assets are by definition the replacement cost of existing assets with brand-new plant.

As well as funding the investments needed for new plant, the British Project investment will need to fund the increased level of fixed asset that is inherent with any productive activity. From the ONS, British manufacturing consumed £24.3 billion in 2014 of fixed assets whilst it produced £171 billion of GVA. On a pro-rata basis to the situation in 2014, the consumption of fixed assets needed to deliver £462 billion of gross added value is then:

Fixed assets consumption for £462 billion GVA = £24.3 billion/year x (£462 bn / £171 bn)
= £65.6 billion/year

The increase in fixed assets consumption is then:

£65.6 billion/year - £24.3 billion/year = £41.3 billion/year

Thus the investment funding for the British Project will have to fund:

- £868 billion over 20 years
- Increased consumption of fixed capital every year, rising to an increase of £41.3 billion per year at the end of the 20 years.

To produce a total annual investment figure for the British Project, it is proposed to divide the increase in gross fixed assets (£868 billion) by 20 years and to take the £41.3 billion a year increase in fixed assets consumption as applying to the whole 20 year period, even initially fixed assets consumption will not be much higher than today's level. In this way a conservative requirement for yearly investment levels is obtained, which gives ample room for investments not foreseen by this analysis – development of enabling technologies for example.

Total annual investment for the British Project is then:

Annual Investment = (£868 billion / 20 years) + £41.3 billion / year

Annual Investment = £84.7 billion / year

In conclusion the British Project as it applies to goods will need £85 billion a year investment. The aforesaid investment level covers the British Project applied to the production of goods – i.e. expansion of the manufacturing sector. The £85 billion a year number does not include for the British Project as applied to energy. The necessary investment for the energy element of the British Project is considered separately below.

4.3.5 Creating a new manufacturing company

1. An individual or a company has an idea for a new product or process. Hereinafter the individual is the “originator”.

2. The originator documents his idea in his own time, in the form of a preliminary techno-economic analysis. Guidance for writing this document will be provided by the new techno-economic college and will be publically available.

3. The originator submits his analysis to the techno-economic college, hereinafter the “college”. This submission will not in itself be considered a public disclosure from the point of view of any future patent applications. At this stage the college will be obliged to maintain complete confidentiality.

4. The college will select a number of originators every year for admission into the college. Each admitted originator becomes a student of the college. Every British adult will have a legal right to a sabbatical year in the college, subject to being selected by the college on the strength of their submission. As such every originator will be fully funded, in line with previous earnings but with a floor and a ceiling, say average earnings as the floor and four times average earnings as the ceiling. When the originator is a company, the company will nominate an employee to go to the college. The employee’s salary is paid by the taxpayer during the sabbatical year.

5. The purpose is for each originator to develop his ideas into a complete and rigorous techno-economic analysis, under the auspices of the college, with support, tutoring and mentoring as required. The emphasis will be on the economic and marketing aspects, in that the technical aspects will be largely taken as read at this stage.

   Gate One

6. Based on the analysis in step 5 a decision is taken whether to (a) kill the project or (b) move to the prototyping stage.

7. The techno-economic analysis (step 5) will have defined the key technical tests or trials that need to be undertaken to validate the technical basis of the project. This validation is undertaken, at the taxpayer’s expense, in the appropriate prototyping centre.

   Gate Two

8. Based on the work undertaken in step 7, the project is declared viable or is killed. If the project is viable then the business case for creating a new company to manufacture the new product or operate the new process is then formally constituted

as being the techno-economic analysis from step 5 and the prototyping study in step 7.

9. If the project is found to be viable the following alternatives are possible:

   (a) The originator undertakes to implement the project himself without any further help from taxpayer backed institutions. The originator must then pay for the costs of the prototyping at commercial rates. Subject to the prototyping being paid for, all the IP generated thereby belongs unreservedly to the originator.

   (b) An industrial bank is approached to fund the creation of a new company that will embody the business case developed hitherto.

   Creating the new company following from 9 (b)

10. A new limited company is created, with all the capital provided initially by the industrial bank, hereinafter called the "bank". At this stage 10 percent of the shares are awarded to the originator and the remainder are awarded to the bank, where the originator is a private individual. Where the originator is a company seeking transformational change a higher share of the shares may be awarded, but never more than 49%. The originator can buy additional shares but the bank will always retain a controlling interest (51% or more) at this stage.

11. The new company, hereinafter called the "company", pays for the prototyping undertaken in step 7. All the IP is now vested in the company.

12. The bank, as the majority shareholder, appoints a board to the company. The board then engages the project execution service to project-manage the creation of the company: hiring staff, finding premises, engineering and building the manufacturing plant etc. Once the manufacturing plant is up and running and a sales force is in place the project execution service withdraws and the company pays for its services at commercial rates.

13. The company ramps up production and begins to receive income from sales of its products. At some point the bank then sells its shares to recover its initial investment. The company is now an established manufacturing enterprise trading profitably on its own two feet.

4.3.6 Rescuing failing companies

An existing manufacturing company becomes insolvent or is approaching insolvency. Company insolvency law will be modified so that the insolvent company is obliged to request a rescue.

At this stage the failed company is under court protection from its creditors. The creditors are paid off by the taxpayer, in effect the taxpayer becomes the new creditor of the failed company. Ownership of the company formally transfers from the shareholders to the Industrial Bank. The shareholders get nothing but are released from all obligations. The board is dismissed and the staff are progressively laid off as the failed company's existing activities are wound down.

An individual or company is appointed by the taxpayer as a champion for the failed company, or rather for the new company that will emerge from the wreckage of the old. The champion works with a marketing expert and a technology expert to develop ideas for the innovations that will underpin the reborn company. The outcome of this step is then a preliminary techno-economic analysis of a proposed new business model for the reborn company.

Henceforth the process of creating the reborn company resembles the process for creating a new company from scratch. In effect the champion is analogous to the originator. The main difference is that the timescales will probably be shorter:

- Less time will be needed to prepare the definitive techno-economic analysis, though this will still be done at the college.
- Less prototyping time may be needed and some of the failed company's facilities could be used for this phase of the study.
- Creating the new company may well be easier and take less time as some of the old staff could be rehired and the old premises reused. Nevertheless the project execution service should still be used to project manage the creation and launch of the reborn company.

The business case is the techno-economic analysis plus the prototyping study. When this has been approved by the college then an industrial bank is approached for funding. If the business case is rejected then the techno-economic analysis must be revisited. The industrial bank, having accepted the business case and committed the requisite capital, is then awarded 70 percent of the shares – the taxpayer retains the other 30 percent. Henceforth the process is then the same as steps 12 and 13 in the process for creating a new company from scratch.

4.3.7 Existing Companies

Many companies will fall some way between the extremes of having a transformative idea on the one hand, which is handled as the creation of a new company, or being threatened with imminent insolvency on the other. Many firms will be living with significant deficiencies in:

- Sales and marketing.
- Technology: product, process or both.

The basic idea is that these companies need to be helped by the college and prototyping centres. Thus the college and prototyping centres will have two remits:

(1) Facilitate the transformational developments as already described;
(2) Facilitate development of companies.

The common theme in all of the work done to help start or transform companies is that the originator makes an initial effort himself, without outside assistance. This principle is kept for existing companies. So when the management of a company decides to approach the program for assistance, they will have to submit an initial techno-economic analysis just like individuals wishing to start a company from scratch.

Having successfully submitted a proposal, a company joining the program nominates an employee to attend the college for the purpose of developing the techno-economic analysis into a firm action program. In some cases there will be a need to involve a prototyping centre to validate the technical basis of the analysis. On completion of technical work with a prototyping centre the project has reached the go/no go decision gate – the equivalent of step 8 in the process for creating a new company from scratch.

If both parties agree to "go" any fees due to the prototyping centre must be paid for by the company. At this point the company can decide to fund the project either from their own funds or by taking a loan from the Industrial Bank. The security for the loan will be company shares – new shares may have to be issued for this purpose and held in trust until the loan is repaid.
If the project is a capital investment for new plant then the project execution service will step in to carry it out, in much the same way as for brand new companies. The project may consist of process development services, in which case the actual execution of the project will be by technical resources from a prototyping centre.

4.3.8 Preventing Offshoring

One of the reasons for factory closures is a decision by the company board to relocate the manufacturing activity to a low wage economy. This can happen even when the British factory is a profitable operation. Examples include:

- Kraft's relocation of Cadbury chocolate manufacturing to Turkey.
- Hornby's relocation of airfix and model train manufacturing to India.
- Dyson's relocation of vacuum cleaner manufacturing to Malaysia.

This report advocates that offshoring should be made illegal in the case of takeovers. It cannot be acceptable for an overseas company to acquire a profitable, solvent British company only to close it down and relocate the manufacturing abroad, as in the case of Kraft's takeover of Cadburys. However offshoring can also happen when a British company feels that long-term manufacturing in Britain is not viable. It is not possible to legislate against this. Instead this report is advocating using the college and prototyping centres to help British companies reconfigure their activities so that they can confidently maintain and grow their manufacturing in Britain.

In effect a company thinking of offshoring would be invited to apply to join the program by submitting a preliminary techno-economic analysis, just like any other existing company. The process would follow section 3.3.3.b.4 above. The only difference would be the context.

- The techno-economic analysis underpinning the reconfiguration would be prepared under the auspices of the college.
- The services of the relevant prototyping centre would be available to validate the technical assumptions.

The industrial bank would provide funding. This funding would be as a loan.

4.4 THE BRITISH PROJECT APPLIED TO ENERGY

In section 2.3 the urgency of immediately building new power plant is powerfully made. British power station capacity is barely equal to peak demand today, yet between now and 2023 will fall by between 17% and 40%, depending on the extent to which coal-fired stations are allowed by the EU to stay open by burning wood instead of coal. Without a change of course on energy policy, Britain is facing rolling blackouts and the breakdown of its first world infrastructure.

The British Project divides into three streams as it applies to energy:

- A short-term stream to avert the impending disasters; and
- A long-term stream to build the secure, cheap and clean energy supplies Britain needs.
- A third stream for industrial heat recovery.

4.4.1 Short – term stream: Keeping the lights on.

Here the objective is to keep the lights on over the next 10 – 15 years. No other objective is set as just keeping on the lights will be tough to achieve given the circumstances we find ourselves in. This stream consists of:

- A repeal of both the Climate Change Act and removal from all relevant statutes of the EU Industrial Emissions Directive and EU Renewable Energy Directive. The coal-fired power stations are to be kept in operation until new nuclear stations are up and running;

- A building program for ten new nuclear power stations using 100% established and proven technology.

There are four projects currently on the table to build new nuclear power stations: Hinckley Point C, Horizon Power, Moorside and Bradwell. These should all be cancelled, because:

- None of the four projects are for proven designs;
- The commercial sides of the projects are either extremely onerous (Hinckley Point C) or still undetermined;
- None of the projects have received final sanction;
- The British taxpayer would ultimately have to guarantee the investments – but they would be foreign-owned and operated and built using equipment made abroad.

The Moorside project is the least worst of the four above projects, as it is based on the Westinghouse API reactor – which appears to have promise and is based on proven designs such as the reactor of Sizewell B. A case could be made to let this project go ahead on a technology sharing basis, so that Britain could get an accelerated track to learn state of the art pressurised water reactor technology.

4.4.1.a Repeal of the Climate Change Act

Many British people want to see Britain to show leadership in respecting the environment and showing responsible stewardship towards our shared planet. These are very laudable sentiments – but the overriding concern must be practicality. China has recently been bringing on stream one coal-fired power station a week, and Germany is replacing nuclear with coal. So closing Britain's coal-fired stations will not make a meaningful difference to world CO_2 emissions but it would be a disaster for Britain.

Generation of clean and abundant energy is the objective of the second stream of the British Project as it applies to energy. In the second stream there is only one operational coal-fired station and all of the carbon dioxide from it will be captured and converted to methane (natural gas) or methanol. In the second stream there is no new build of gas-fired stations, and eventually the gas-fired stations will be replaced with new nuclear capacity.

In the short term the priority is to keep the lights – for which the 17 GW of existing coal-fired capacity will be essential. This is why the Climate Change Act as currently constructed must be repealed.

4.4.1.b Building Program of new nuclear power stations

Britain has eight nuclear power stations to two proven designs: seven of the eight stations use the AGR (Advanced Gas-cooled Reactor) and Sizewell B uses a PWR (Pressurised Water-cooled Reactor). The AGR design is 100% British technology. The design is based ultimately on Calder Hall, the first nuclear power station in the World. The AGR design was developed by NNC – the National Nuclear Corporation. NNC is now part of Amec Foster Wheeler, a British Engineering Contractor Company. The AGR design has the advantage of inherent safety – if the gas fans stop the gas will continue to cool the reactor core by natural convection. On the other hand the rest of the world has gone to pressurised water – and Britain's newest operational nuclear power station, Sizewell B, uses a PWR to a Westinghouse design.

So there are two options:

- Build ten new AGR using 100% British technology and leveraging Amec Foster Wheeler's design knowledge inherited from NNC. Toreness, the most recent AGR, which develops a useful 1.36 GW, would be the model.
- Build ten new Sizewell B's. This would mean buying the license for Westinghouse's design. There may be synergy with the Moorside project which is intended to use Westinghouse's latest reactor design.

In either case a new British Reactor Company would need to be set-up – the successor to NNC. This could well be a joint venture with Amec Foster Wheeler. Funding for the program would come from the Industrial Bank. The target cost would be £2000 per delivered kW or £2.6 billion per station delivering 1.3 GW. Building two stations a year would therefore cost £5.2 billion a year, well within the £110 billion a year lending power of the Industrial Bank.

A new British operating company would be set-up to operate the new power stations. The shareholding would be owned 100% by the Industrial Bank and then later sold on the stock market – but with the Taxpayer keeping a golden share to ensure British ownership. The same model would be applied to the British Reactor Company.

4.4.2 Long-term stream: cheap, plentiful and clean British energy.

Whereas the short-term stream is very pragmatic, and resolutely based on proven technology from the 1970's and 1980's, the long-term stream is intended to be based on technological innovation. This long-term stream will have the following strands:

- A new state of the art nuclear reactor design;
- A new "fast breeder" reactor to generate energy from nuclear waste and Britain's huge plutonium stockpile in Sellafield;
- Development of a practical 1 kWh per kg battery based on Lithium – air, as currently being developed in Cambridge University;
- Development of large-scale energy storage using hydrogen and hydrogenation of carbon dioxide to methane and methanol, to decouple harvesting of renewable energy from meeting demand.

4.4.2.a Long-term strategy for clean and plentiful British energy.

The British Project's long-term strategy for energy is zero emissions of carbon dioxide from coal-fired generation of electricity, whilst providing abundant and cheap electricity to industry and consumer alike. No increases to Britain's existing gas-fired capacity. This is to be achieved by the "100 GW" plan:

- 20 GW of installed renewables capacity (up from the current 13.6 GW)
- 30 GW of installed gas-fired capacity (same as today's)
- 50 GW of installed nuclear capacity (up from the current 9.1 GW)

The plan also includes two 4 GW coal-fired stations – but with 100% capture of the carbon dioxide. The carbon dioxide would not be stuffed into the ground but instead hydrogenated to methane (natural gas) or methanol. The hydrogen would come from electrolysis of water, which would be powered by excess nuclear and renewables electricity. Only one of the two coal-fired stations would need to be operational at a time – the other would be the spare. In this way the energy storage issue would be solved: the strategy would be to always produce above demand, with the surplus electricity used to drive the conversion of carbon dioxide into methane and methanol.

In the very long term the gas-fired capacity would be progressively replaced with more nuclear capacity, possibly with additional coal-fired capacity to provide additional energy storage capacity. Ultimately the carbon dioxide needed for the energy storage could be extracted straight from the atmosphere instead of being taken from a coal-fired power station.

The above plan would give Britain real energy security. It is based on an average demand of 40 GW (higher than today's 32 GW), and would be able to cope with spikes in demand of up to 80 GW (today's spikes are around 56 GW). The energy storage through hydrogenation of carbon dioxide (as described above) would provide 50% of all the natural gas used by the gas-fired power stations.

4.4.2.b New Nuclear Reactor Design

The short-term stream is all about winning time. The long-term future for electricity generation in Britain will be based on a state of the art nuclear reactor. The ten new AGR's or Sizewell B's from the 1980's will be built to create a 10 year breathing space for Britain. During the breathing space a new nuclear reactor will be designed. This reactor design will be progressively rolled-out across Britain to replace gas-fired stations and some of the coal-fired stations.

4.4.2.c Fast Breeder Nuclear Reactor

This type of reactor generates power from nuclear waste. The basic ideas were worked out thirty years ago and an experimental reactor built at Dounray. It is proposed to resurrect the fast breeder program – with the aim of developing a commercial reactor. This new reactor will be intended to take as a feedstock the huge stockpile of plutonium in Sellafield.

4.4.2.d New lithium air battery

State of the art Lithium-ion batteries store 0.2 kWh per kg of electrical energy. By comparison gasoline or diesel allied to a modern internal combustion engine has a storage capacity of 5 kW of mechanical work per kg. (Electricity produces mechanical work energy when it is run through an electric motor.) This difference in practical mechanical energy storage between lithium ion and hydrocarbon fuel – a factor of 25 – is the reason why nearly all cars are still powered by the internal combustion engine.

Research currently being carried-out in Cambridge University suggests that a tenfold improvement in battery energy storage is possible using Lithium air. A ten year lead time is given before production of a working battery. This technology would be a key part of the British Project. If even a fivefold improvement were achieved to 1 kWh per kg then motor car transport would revolutionised – there would be applications to civil aviation as well.

With a 1 kWh per kg battery electric and hybrids would quickly replace cars powered by just an internal combustion engine. Cars would charge overnight, ready for use next morning. Carbon dioxide emissions would fall – as would our imports of oil.

4.4.2.e Energy storage.

Energy storage is very important for developing practical clean energy. This is because:

1. The demand for electricity changes from moment to moment, and therefore cannot be predicted with complete accuracy.

2. Renewable energy is dependent on the weather, and the production of renewables is therefore random and completely disconnected from demand. Indeed renewables can even be counter-cyclical with respect to demand: Very cold weather in winter happens when windless high pressure settles over the British Isles; Over the summer there tends

to be an excess of renewables versus demand and the National Grid (Daily Telegraph 8th April 2016) was reported as warning that power station operators would be required to shut down their plant for periods as otherwise there could be excess supply.

3. Nuclear reactors are run at constant output: they do not lend themselves to being modulated.

Unfortunately it is only power stations fired on fossil fuels that lend themselves to be modulated to match demand – but these are the very power stations that produce carbon dioxide. So if all or most of British power generation is to be by nuclear and renewables it follows that energy storage is essential, because production of clean energy cannot be matched to demand.

<u>Batteries.</u>

The most energy-dense rechargeable battery technology in existence is the Lithium Ion battery. This battery is based on the electrochemical reaction of the lithium cell which generates 3V and yields 11.6 kWh of electrical energy per kg of pure lithium. Current batteries develop energy densities of around 0.2 kWh/kg. This is reflected in the lithium content of the batteries, which is comparatively low.

- The 11.6 kWh/kg energy density is the determining parameter for calculating how much pure lithium is needed to store a given amount of electrical energy. This energy density cannot be improved upon because it is a property of lithium itself.

- The 0.2 kWh/kg energy density is the parameter for calculating the weight of a practical battery to store a given amount of energy. There is scope to increase this energy density – research is underway in Cambridge to develop a battery with an energy density of 2.0 kWh/kg.

The total amount of electrical energy consumed in Britain in 2015 was 282 TWh. Using the above energy densities it is possible to calculate the amount of lithium needed and the total weight of all the batteries.

Mass Lithium needed = 282×10^{12} x Wh / (11.6×10^{3} x Wh/kg)
Mass Lithium needed = 24.3×10^{9} kg
Mass Lithium needed = 24.3×10^{6} tons
Mass Lithium needed = 24.3 million tons to store all of Britain's annual electrical energy demand.

The total world reserves of lithium have been estimated at around 13 million tons. So there would not be enough lithium to store Britain's energy, even if we were the only country in the world seeking to store electrical energy on a large scale.

Mass of battery needed = 282×10^{12} x Wh / (0.2×10^{3} x Wh/kg)
Mass of battery needed = 1410×10^{9} kg
Mass of battery needed = 1410×10^{6} tons
Mass of battery needed = 1410 million tons to store all of Britain's annual electrical energy demand.

Even if the above tonnage of battery was parcelled out to every household the result would be around fifty tons of battery for each of Britain's 28 million households. Even if the research in Cambridge succeeds in developing a 2.0 kWh/kg battery it would mean every household needing 5 tons of battery.

Another difficulty with batteries is heat release. People who fly model aeroplanes will be familiar with the hot aircraft battery: as a battery discharges some of the energy is converted to heat. In a small hand-held battery natural cooling will be enough to cool the battery. In batteries weighing many tons it would be necessary to provide cooling water circuits to take away the heat. Very large batteries would need their own cooling towers or have to be sited next to large rivers.

Hydrogenation of carbon dioxide.

Carbon dioxide can be hydrogenated to methane (the main constituent of natural gas) or methanol (the alcohol analogue of methane). A prime conclusion of this report is that hydrogenation of carbon dioxide from a single remaining large coal-fired power station would provide all the required capacity to absorb excess nuclear and renewables electricity production.

The process is production of hydrogen and oxygen by electrolysis of water using excess nuclear and renewables. The hydrogen as a pure gas is very difficult to store because it is so light. However the hydrogen can be used to synthesis methane from carbon dioxide – this is the Sabatier reaction, discovered in 1911. The advantage is that methane is the main constituent of natural gas, and so could be pumped straight into the gas grid and the grid's storage facilities. Where would the carbon dioxide come from? This report proposes to keep one large 4.0 GW coal-fired power station in operation, with a second station on standby. The coal-fired station's primary role would be production of carbon dioxide from coal, with the electricity produced as a by-product. The station would be a net importer of electricity, as its own production of electricity would only provide up to 20% of the electricity needed to produce the hydrogen needed to hydrogenate the carbon dioxide to methane. In effect the " coal-fired power station" is really a coal to methane producer.

At this point it is necessary to consider briefly the usefulness of coal. Coal is essentially carbon – dependent on the grade it is 75% - 95% by weight. Unfortunately the chemical structure of coal is very complex and highly variable. Coal is the result of the degradation of plant matter, and at a chemical level retains much of the detail of its plant origins. Thus coal is composed of complex and interconnected ring structures that ultimately derive from the cellulose and sugar structures of the plants themselves. Chemically, then, coal's very complexity and non-uniformity makes it very difficult to exploit directly in industrial processes. Coal's solid state is also awkward – liquids and gases are much easier to dose and to transport. Methane and methanol are the complete opposite. They are chemically completely uniform and as single carbon molecules they are basic feedstocks to the chemicals industry – they are literally chemical building blocks. As well as being a feedstock, methane is the primary thermal energy "currency" in first world countries, because, being a gas it is very easy and cheap to distribute to multiple users from dwellings to gas-fired power stations.

So burning coal to make carbon dioxide and then methane or methanol is really about converting coal into a much more useful chemical. Given that Britain still has significant reserves of coal but dwindling gas reserves, this process is about giving Britain a measure of energy independence from imported gas, as well as creating a way of storing excess energy from nuclear and renewables.

If the 282 TWh of electrical energy used by Britain were used to produce methane, then 14.2 billion cubic metres (under normal conditions) would be produced. Britain's total storage capacity for natural gas is only 4.0 billion cubic metres (mainly the Rough facility in the North Sea), so methane storage would only store 29% of a year's electrical demand with the current storage facilities. Alternatively, the hydrogenation need not go all the way to methane – methanol could be produced instead. If the same 282 TWh of electrical energy were used to produce methanol then 33.8 million cubic metres of methanol would be produced. Methanol can be stored safely in an atmospheric storage tank. A storage tank with a working volume of 50 thousand cubic metres is common in industry (diameter 60 metres, height 25 metres). 670 such tanks, each holding 50 thousand cubic metres of methanol, would be enough to store all the methanol made from hydrogenation of carbon dioxide, where the electricity so used would equal the total electricity demand for Britain in one year.

Conclusion.

The practical way of storing very large amounts of energy is by using the excess electricity to electrolyse water into hydrogen and oxygen. The hydrogen and oxygen would be collected separately – and the oxygen could either be sold as a valuable chemical in itself or used to enrich the air supply of the coal-fired power station producing the carbon dioxide, and thereby improve its thermal efficiency. The hydrogen would be used to produce methane and/or methanol by reaction with the carbon dioxide from the coal-fired power station. (A single 4.0 GW power station would be enough for this purpose. In practise it is likely that most of the carbon dioxide would go to methane, as Britain is a net-importer of natural gas. However the facility to make methanol must be retained as it is so much easier to store, and methanol is a valuable chemical in its own right

4.4.3 Industrial Heat Recovery

In industry large quantities of heat are emitted to the atmosphere in the form of hot flue gases. The heat content of these flues is considerable. Energy can be recovered potentially in two ways from these flues:

- As heat that is recovered from the flue and then recycled back into the process at a lower temperature. This reduces the consumption of energy for heating the process by a corresponding amount.

- As electricity that is generated by using the waste heat taken from flue to power a low temperature Rankine Cycle generator. (In effect a small scale power-station.) The electricity generated thereby is exported to the grid and allows a corresponding reduction of electricity generated by conventional fossil-fuel power stations.

In 2008 the U.S. Department of Energy published a report in which the total waste heat emitted by US industry was published. The data from table 1 of the report is reproduced in table 9 below, alongside equivalent British data deduced from the US data by pro-rata to the two countries' respective populations.

Table 9: Waste heat in TWh/year

	Waste Heat above 150°C	Electrical energy equivalent of all waste heat above 25°C
U.S. Data.	75.0	172.6
Equivalent U.K. by pro-rata to population.	15.1	34.7

The above table shows the waste heat by recovery approach: In the British case 15 GWh per year can be recovered as heat and recycled into the industrial processes as heat. This assumes the waste heat below 150°C is still emitted to atmosphere via the flues. (In practise it is usually difficult to recycle heat much below 150°C.) Alternatively the flues can be cooled right down to 25°C and 34.7 TWh/year of electrical energy generated thereby. (A much greater quantity of energy could be recovered as heat in this scenario but it would not be possible to recycle it as heat as it would be at too low a temperature.)

In industrial waste heat recovery, every application is specific. In some cases the application will lend itself to straightforward heat recovery as heat, as in retro-fits of steam boiler economisers. In other cases the optimal choice might well be electricity generation. In this report it is assumed that 50% of applications will lend themselves to heat recovery as heat and the other 50% to electricity generation. Thus for the UK:

Potential for waste heat recovery as heat (above 150°C) = 15.1 x 50%/100% = 7.6 TWh/year
Potential for waste heat recovery as electricity = 34.7 x 50%/100% = 17.4 TWh/year

In table 10 below estimates for savings and required investments are given for the scenario where the waste heat is fully recovered. The savings are proportional to the energy savings though the unit costs, for natural gas and wholesale electricity respectively. The investments are deduced from the savings via expected rates of return. In practise these will vary widely with the application, but the rates of return given below are typical of energy recovery projects.

Table 10: Details of savings and investments for full waste heat recovery.

	Heat Recovery as Heat	**Electricity Generation**	**Total**
Waste heat recovery in TWh/year	7.6	17.4 (38.6 heat basis*)	46.2 (heat basis)
Unit cost in pence per kWh	2.2	4.5	
Total cost saving in £ millions/year	166	782	948
CO_2 saving in tons/year	1,094,011	5,593,511**	6,687,522
Rate of return (%)	20	7.0	
Investment in £ millions	900	11,200	12,100

*Thermal input to a power station generating the same output of electricity
**CO_2 saving from a power station generating the same output of electricity

4.4.3.a Program of investment for Waste Heat Recovery

The above analysis finds that the total investment needed to effect full practical recovery of waste heat from British industry is around £12 billion. Spending this sum all in one year would be difficult because each application would be its own project and need time to be worked-up.

It is probably more realistic to envisage undertaking the above investment over a ten year period. This implies an investment loading of £1.2 billion per year for waste heat recovery, spread over ten years. At the end of this period all waste heat that is practically recovered would be recovered.

4.4.3.b Contribution towards meeting Britain's total electrical demand.

In 2015 the average demand for electrical power in Britain was 32.2 GW (National Grid historical data). This translates to a total demand of 282 TWh of electrical energy for 2015. The 17.4 TWh saved by waste heat recovery therefore corresponds to around 6 percent of total British electrical energy demand.

4.4.3.c Contribution towards reducing Britain's output of carbon dioxide to the atmosphere.

Table 12.3 of the ONS Blue Book provides data for Britain's atmospheric emissions of carbon dioxide and other gases. In the 2015 Blue Book total emissions of 543 million tons of carbon dioxide are reported, for 2013. So the 6.7 million tons of carbon dioxide emissions saved by waste heat recovery represent around 1.2 percent of total British emissions.

4.4.4 Investment needed for the British Project applied to energy

British peak demand is currently around 56 GW from data available from the National Grid for the years 2012 – 2015. British power station capacity is barely higher – it is currently 56.3 GW – see appendix A. To allow for a sensible margin between peak demand and installed capacity, this report proposes installed power station generating capacity of 80 GW. This would allow British peak demand and average demand to rise, whilst still providing a significant margin of safety. (British demand is likely to rise given the large expansion of manufacturing industry, even with the energy recovery measures described above.)

Current British power station capacity breaks down into:

- 30.0 GW of relatively modern gas-fired power stations (commissioned 1993 – 2013)
- 17.3 GW of old coal-fired power stations (1970s vintage)
- 9.1 GW of nuclear power stations (1970s and 1980s vintage)

Britain also has 13 GW of installed windfarm capacity – however this capacity is not available on the demand – power is only produced when the wind blows.

The proposed make-up of power station capacity under the British Project is as follows:

- 30.0 GW of gas-fired power stations as now. No new build.
- 50.0 GW of new nuclear, of which the first 13 GW would be to an existing design (either AGR – Torness or PWR – Sizewell B). In twenty years' time all of the existing nuclear power plants will have to have been decommissioned.
- 2 x 4.0 GW of new coal-fired power stations equipped with hydrogenation reactors to make methane and methanol from the stations' carbon dioxide. One station would be in service, the other on standby.

The capacity of the renewables (essentially wind) is expected to have reached 20 GW installed by this time. As explained above, the basic philosophy is to run the nuclear stations at fixed rate with the renewables energy on top. The balancing between production and demand is to be achieved by modulating the gas-fired stations and the production of methane/methanol from the coal-fired station in service.

The above will give the target 80 GW installed capacity (30 GW from gas and 50 GW from nuclear). The coal-fired stations, only one of which is operational at a time, do not contribute to capacity as such, as they are there to soak-up excess nuclear and renewables electricity production by converting coal to methane or methanol. No credit is taken for the 10 GW of renewables as it is 100% weather dependent.

The target capital cost is £2000 per kW of installed capacity. (This is based on the cost of Sizewell B.)

New capacity = 50 GW of nuclear + 8 GW of coal = 58 GW = 58 million kW

Hence capital cost for new capacity = 58 million kW x £2000 per kW = £116 billion.

From section 3.4.4 the required total capital investment for heat recovery = £12 billion.

Hence total capital investment for the British Project applied to energy is:

Total capital investment = £116 billion + £12 billion = £128 billion

As the British Project will run over twenty years the average capital investment will be:

Average capital investment = £128 billion / 20 years = £6.4 billion per year.

4.5 FINANCING FOR THE BRITISH PROJECT

The annual investments needed to finance the two streams of the British Project are:

- Production of Goods stream = £84.7 billion (see section 4.2.4)
- Energy stream = £6.4 billion (see section 4.3.4)

The total is then £91.1 billion a year for both streams. This investment would be required every year for twenty years – a total aggregate investment of £1822 billion. The aforesaid sum is effectively Britain's current GDP in one year. So the British Project will demand a movement of 5% of GDP into industrial and energy infrastructure investment.

How will £1.8 trillion be paid for? What will the return be on the investment? The answer to the second question is provided in table 8:

Accumulated GDP over 20 years with British Project = £49.6 trillion
Accumulated GDP over 20 years without British Project = £47.0 trillion

Thus the British Project is forecast to deliver an extra £2.6 trillion of GDP over the 20 year lifetime of the project. This is in excess of the £1.8 trillion investment – so the project is self-financing over its lifetime.

The financing engine for the British Project will be the industrial bank – it is proposed to use the £11 billion a year Brexit dividend to provide an annual injection of fresh capital to the bank. The bank will offer bonds at attractive rates for other banks and pension funds to buy – the bond returns will be guaranteed to a floor by the taxpayer. With the annual £11 billion fresh capital injection the bank will be in a position to lend out the £90 billion or so needed to finance the British Project.

4.6 PUBLIC PROCUREMENT

Having regained independence from the EU, Britain will no longer advertise British public procurement contracts in the European Commission Journal and will be able, within WTO rules, to give preferential treatment to British manufacturers. These rules allow a "buy British" policy up to contract values of $5 million or about £3 million.

This new freedom of action will dovetail the main elements of the British Project on goods production and energy. The opportunity will exist to nurture new industrial start-ups by awarding public procurement contracts on a preferential basis, to help these firms acquire commercial momentum. For the energy program the new freedom to buy British will help ensure that British equipment manufacturers benefit directly from the program. However the contract values involved in building power stations often exceed £3 million for individual equipment items, and an entire station will cost around £2.6 billion. So it is proposed to negotiate with the WTO an extension of the principle of strategic national interest. This principle is usually used to justify preferential treatment for domestic manufacturers of defence equipment. Switzerland has already set this precedent in the field of energy and water supply.

This paper advocates that the Government creates a purchasing commission on the morrow of the Brexit referendum result to leave. The purpose of the commission would be to channel all government and local government procurement to British manufacturers whenever possible, with due regard to the WTO limit of $5 million on contracts which can be awarded to UK suppliers as a matter of preference. The cabinet office has already organised a centralised purchasing regime for vehicles, and adapting this regime to buy British wherever possible must be a "Monday morning" task. For contract values less than $5 million it must be made the rule that the contract is awarded to a British manufacturer, with contract awards to overseas manufacturers strictly by exception and following a review to show that a suitable British product does not exist within the timeframe of the procurement.

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APPENDIX A: EXISTING POWER STATIONS

Coal-fired Stations

Power Station	Operator	Capacity	LCPD status	Forecast closure
Aberthaw B	Npower RWE	1.555 GW	TNP?	By 2023
Cottam	EDF Energy	2.000 GW	TNP	
Drax	Drax Power	3.960 GW	TNP	
Eggborough	Energetický a Prumyslový Holdings	1.960 GW	LLD	March 2017
Fiddlers Ferry	SSE	1.989 GW	LLD	March 2017
Kilroot	AEB	0.520 GW	TNP	
Ratcliffe on Soar	EON UK	2.000 GW	TNP	
Rugeley B	Engie	1.000 GW	TNP	Summer 2016
Lynemouth	SSE	0.363 GW	Compliant	
West Burton	EDF Energy	2.000 GW	TNP	
	Total Capacity	17.347 GW		

Gas fired power stations

Power Station	Operator/Owner	Capacity	Type	Start-up date
Ballylumford	AES	1.316 GW	CCGT	2003
Barking Reach	Barking Power	1.000 GW	CCGT	1995
Barry	Centrica	0.230 GW	CCGT	1998
Connah’s Quay	E.ON UK	1.420 GW	CCGT	1998
Coolkeeragh	ESB	0.400 GW	CCGT	2005
Corby	ESB	0.401 GW	CCGT	1994
Coryton	Intergen	0.732 GW	CCGT	2002
Cottam Development Centre	E.ON UK	0.400 GW	CCGT	1999
Damhead Creek	Scottish Power	0.792 GW	CCGT	2001
Glanford Brigg	Centrica	0.240 GW	CCGT	1993
Didcot B	Npower/RWE	1.360 GW	CCGT	1997
Enfield	E.ON UK	0.400 GW	CCGT	1999
Grain	E.ON UK	1.275 GW	CCGT	June 2010
Great Yarmouth	Npower/RWE	0.400 GW	CCGT	2002
Immingham	Vitol	1.180 GW	CCGT	2004
Keadby	SSE	0.734 GW	CCGT	1996
Killingholme B	E.ON UK	0.900 GW	CCGT	1993
King’s Lynn	Centrica Energy	0.325 GW Mothballed	CCGT	1997
Langage	Centrica Energy	0.885 GW	CCGT	March 2010

Little Barford	Npower/RWE	0.720 GW	CCGT	1996
Marchwood	SSE	0.840 GW	CCGT	Jan. 2010
Medway	SSE	0.700 GW	CCGT	1995
Pembroke	Npower/RWE	2.000 GW	CCGT	Sept. 2012
Peterborough	Centrica	0.360 GW	CCGT	1993
Peterhead	SSE	1.550 GW	CCGT	2000
Rocksavage	Intergen	0.800 GW	CCGT	1998
Rye House	Scottish Power	0.715 GW	CCGT	1993
Saltend	International Power	1.200 GW	CCGT	2001
Seabank	Cheung Kong / SSE	1.145 GW	CCGT	2000
Shoreham	Scottish Power	0.420 GW	CCGT	2002
South Humber Bank	Centrica	1.285 GW	CCGT	1997
Spalding	Intergen	0.860 GW	CCGT	2004
Staythorpe	Npower/RWE	1.650 GW	CCGT	Nov. 2010
West Burton	EDF Energy	1.270 GW	CCGT	2011
	Total	29.905 GW		

Power Station	**Type**	**Owner**	**Rated capacity**	**Closure date**
Dungeness B	AGR*	EdF (France)	1.009 GW	2028
Hartlepool	AGR	EdF (France)	1.190 GW	2019
Heysham 1	AGR	EdF (France)	1.150 GW	2019
Heysham 2	AGR	EdF (France)	1.250 GW	2023
Hinckley Point B	AGR	EdF (France)	0.960 GW	2023
Hunterston B	AGR	EdF (France)	1.000 GW	2023
Sizewell B	PWR**	EdF (France)	1.188 GW	2035
Torness	AGR	EdF (France)	1.364 GW	2030
		Grand Total capacity	9.111 GW	

APPENDIX B: POWER STATIONS CLOSED BY LCPD AND IMPACT ON CAPACITY

Coal-fired Power Station	Capacity (GW)	Closure Date
Cockenzie	1.152	March 2013
Didcot A	1.940	March 2013
Fawley	0.990	March 2013
Ferrybridge	0.980	March 2014
Grain	1.300	December 2012
Ironbridge	0.970	November 2015
Kingsnorth	1.940	December 2012
Littlebrook	1.245	March 2015
Tilbury	1.037	August 2013
Total	11.554	

Capacity lost in 2013 and December 2012 = 8.359 GW
Capacity lost in 2014 = 0.980 GW
Capacity lost in 2015 = 2.215

From Appendix B, capacity end 2015 for all power stations = 56.363 GW

Hence:
Capacity end 2012 (not including the closures in December) = 56.363 + 11.554 = 67.917 GW
Capacity end 2013 = 67.917 – 8.359 = 59.558 GW
Capacity end 2014 = 59.558 – 0.980 = 58.578 GW
Capacity end 2015 = 58.578 – 2.215 = 56.363 GW